

**GENETIC VARIATION OF LODGEPOLE PINE (*PINUS CONTORTA* VAR. *LATIFOLIA*
[ENGELM.]) CHEMICAL AND PHYSICAL DEFENSES THAT AFFECT MOUNTAIN
PINE BEETLE *DENDROCTONUS PONDEROSAE* ATTACK AND TREE MORTALITY**

by

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ABSTRACT

The current outbreak of mountain pine beetle (MPB), *Dendroctonus ponderosae* (Coleoptera: Curculionidae), and its fungal complex *Grosmannia clavigera* has affected ~15 million hectares of lodgepole pine *Pinus contorta* var. *latifolia* (Engelm.) in British Columbia. This is of great concern to forestry industry in British Columbia but it has provided a rare opportunity to study genetic variation of lodgepole pine defense mechanisms against MPB. Based on a previous study, we selected 45 open-pollinated families from a population of 180 families, with the number of trees per family ranging from 16-26 (for a total of 887 trees) from two 20-year field tests which had undergone attack from MPB. Chemical and physical defensive responses were quantified in response to simulated attack by the MPB fungal complex on these 45 families. These responses included: physical exudation of resin, host compartmentalization response to fungal inoculation, and levels of constitutive and induced resin terpenoids. Further assessments were made for tree height, DBH (diameter at breast height ~1.4 m), bark texture, tree mortality, and MPB presence, attack density, reproduction, and brood development, as well as the presence of hypersensitivity reactions by the tree to MPB. Data suggest that variation in resin terpenoids pre- and post-induction of simulated MPB attack is significantly different between families. Traits in lodgepole pine that affect MPB colonization and tree mortality also vary among families, and many host tree traits that affect the MPB lifecycle are significantly heritable. In order to examine genetic interrelationships among traits, family mean correlations were calculated for traits with significant heritabilities (as an approximation of the underlying genetic correlation). Constitutive (pre-induction) δ -3-carene was negatively correlated with family mean mortality. The frequency of hypersensitivity reactions was negatively

correlated with MPB gallery production, reproduction, and brood development. δ -3-Carene and hypersensitivity reaction frequency negatively impact MPB induced tree mortality and likely subsequent MPB fitness. These results provide important future directions for studying genetic resistance in lodgepole pine to bark beetles, as well as forest managers trying to manage future MPB outbreaks in lodgepole pine

DEDICATION

I dedicate my thesis to my parents who have always supported me in whatever I do and have always put importance on education. Also to my friend Tamara Charlie who passed away during my thesis. You were a great friend and a blast to raft with.

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Thesis Introduction

Abiotic and biotic stressors exert selective pressures on plants (Safranyik and Carroll 2006) and over evolutionary time lead to the development of specialized adaptations and specific responses to stresses. In this way, the environment in which plants evolve shapes their life cycles, range, growth, reproduction, and defenses. Insects and diseases are particularly potent plant stressors. Insect herbivores exert pressure on plants by feeding on plant parts and using them to reproduce by forming galls and cysts. Some insect species carry mutualistic pathogens on their bodies, which exert pressure on plants in the form of vectored disease.

The model system of mountain pine beetle, *Dendroctonus ponderosae* Hopkins (Coleoptera: Curculionidae: Scolytinae) (MPB), in association with blue-stain fungus, *Ophiostoma clavigerum* (often referred to as *Grossimania clavigera*), attacking lodgepole pine, *Pinus contorta* Douglas ex Louden var. *latifolia* Engelm. ex S. Watson (Pinales: Pinaceae), trees is an example of how selective pressures may result in complex co-evolutionary processes. Selective pressures occur when a plant responds to a particular form of stress in a specific way. Lodgepole pine is differentially affected by population phases of MPB and population levels may result in different rates of MPB attack success. Population phases include endemic, incipient epidemic, epidemic, and post epidemic stages (Carroll, Taylor et al. 2003). During landscape level outbreaks (epidemic) of MPB, almost all trees within suitable habitats across the landscape, regardless of vigor, age, size, will be mass attacked and killed by beetles. However, some trees remain unaffected by MPB (Safranyik, Shore et al. 2004). The reasons these trees remain alive during an outbreak are generally unknown. However, environmental conditions (Ayres and Lombardero 2000; Lombardero,

Ayres et al. 2000) and tree genotype (Yanchuk, Murphy et al. 2007) likely play a role in resistance, and the environmental conditions and genotype interact to produce these phenotypes (Falconer 1981) and this interaction may result in some trees being more resistant to MPB than others.

Specific phenotypic traits that are capable of successfully defending against invading bark beetles and their symbiotic fungi may include those that enable plants to survive herbivory or disease, including being unapparent to herbivores, expressing appropriate defensive responses to kill or inhibit herbivores or disease progression (i.e. antixenosis or antibiosis), or specific anatomical and physiological traits that allow plants to tolerate certain levels and types of damage (Painter 1951). Antixenosis refers to the production of antifeedant chemicals or structures, which cause an insect to find the host unpalatable or difficult to feed upon and which force the insect to continue its search (Painter 1951). Antibiosis occurs when a plant resists an herbivore often by chemical means, negatively impacting the herbivore's survival and reproduction (Painter 1951). Some plants have the ability to tolerate herbivory and continue to survive and reproduce even when a pest is feeding on or colonizing a part of the plant. Plants that survive herbivory and disease persist on the landscape and are able to pass genes related to their phenotype to their progeny. Identification of selective pressures and genetic traits that allow plants to defend against herbivory and disease allows for the analyses of the heritability of those traits and the likelihood of the progeny being able to withstand similar pressures.

In the process of identifying defensive traits, it is important understand where these traits arise within trees. Tree species utilize secondary metabolites in defense against herbivory and disease. Secondary metabolites play an important role in plant-herbivore

interactions. These compounds may act as attractants or repellents to insects, toxins, or growth inhibitors to insects and disease agents. Plant defenses are classified as constitutive when the mechanism of defense is continuously present; or inducible when defense mechanisms are initiated in response to damage (Raffa and Smalley 1995). Trees use both constitutive physical and chemical defenses – some of which can be up-regulated, when induced, for additional defense (Franceschi, Krokene et al. 2005). In addition, induced defense may be direct or in-direct. Direct defenses are toxins meant to specifically harm the insect or pathogen, while an indirect defense may, for instance, result in compartmentalization of tissue to halt blue stain fungus, which in turns makes the phloem unsuitable for MPB.

Lodgepole pine is an early successional, shade-intolerant conifer that ranges from southern Yukon, British Columbia, and the western portion of Alberta south through the Cascade and Rocky Mountain ranges of the United States and into Mexico. Outbreaks of MPB occur in lodgepole pine stands in cyclical patterns, increasing until they reach outbreak numbers and then decreasing as host material becomes exhausted, often resulting in widespread mortality (Safranyik and Carroll 2006). The current outbreak in British Columbia is one of the largest in known history. According to the British Columbia Ministry of Forests and Range, the outbreak started in ~1999 in central British Columbia. To date ~15 million hectares of mature pine forest were affected by MPB by the end of the insect flight period in 2008 (Columbia 2008). However, even during this massive outbreak, scattered mature lodgepole pine individuals have remained alive. The factors underlying the survival of these trees are not well understood. However, given the co-evolutionary history of MPB and many North American pine species (Raffa and Berryman 1983) lodgepole pine defenses

against MPB may be heritably passed through progeny of surviving trees to allow lodgepole pine to persist on the landscape.

MPB is a phloem feeder that spends the majority of its life cycle under the bark of its host tree (Safranyik and Carroll 2006). It is a keystone species that exists, although in small numbers, in lodgepole pine forests and at sub-outbreak population levels. MPBs usually mass attack trees that are already weak due to drought, disease, or fire damage (Raffa and Berryman 1983; Safranyik and Carroll 2006). Populations of MPBs are not usually large enough to overwhelm and kill healthy host trees, so they tend to infest weakened trees. On a landscape-scale, weakened trees occur in patches under normal MPB population levels (Aukema, Carroll et al. 2006). However, when a major disturbance occurs, more stressed trees become susceptible and MPB populations can erupt leading to widespread host mortality (Safranyik, Shore et al. 2004; Aukema, Carroll et al. 2006; Safranyik and Carroll 2006; Wulder, Dymond et al. 2006). At epidemic population levels, MPBs are able to colonize virtually any mature pine that they encounter, no matter its physiological condition. When populations are large, beetle attack densities can surpass the resistance threshold of the host (Raffa and Berryman 1983), to effectively overwhelm the defenses of healthy trees and successfully colonize them (Raffa and Berryman 1983; Safranyik and Carroll 2006). Following its initial increase past a certain threshold, a MPB population may continue to grow for many years until the supply of available mature host pines is exhausted (Raffa and Berryman 1983). During the current outbreak, MPB has been observed successfully colonizing trees that were once thought to be non-preferred, such as young trees, small-diameter trees, trees with high annual growth, or vigorous trees (Aukema, Carroll et al. 2006;

Wulder, Dymond et al. 2006). Such outbreaks can affect millions of hectares of forests, leaving very few large, mature host trees alive.

MPB colonization behavior can be broken into several steps (Amman and Cole 1983; Wallin and Raffa 2002). The process begins when adult beetles emerge from their natal host and begin their dispersal flight in search of a suitable host. The mass attack of a tree by MPB is a dynamic process that involves insect responses to both host chemical cues and pheromone compounds (Borden 1982). Prior to and during colonization, attacking beetles detect volatile secondary metabolites as kairomonal cues to locate suitable hosts (Byers 1995). Upon landing on a host tree, the female will either attempt to colonize the tree, or after testing the tree for levels of secondary metabolites or nutrients, she will leave in search of a more suitable host tree. When a female accepts and enters a host tree, she excavates a nuptial chamber and begins forming an egg gallery. At this time the female begins producing an aggregation pheromone that attracts other female beetles to the tree, as well as males for mating. Due to the co-evolved association between MPB and its host tree species, the female MPB is able to use host chemicals as precursors for pheromone production (Seybold, Quilici et al. 1995; Wallin and Raffa 1999; Raffa 2001). The first females attacking a host tree produce a specific aggregation pheromone compound called *trans*-verbenol (Pitman and Vite 1969). Arriving males join the pioneering females and produce their own pheromone compound, *exo*-brevicomin, which attracts more female and male MPB insects to the tree (Libbey, Oehlschlager et al. 1983). The combination of attractive host chemical cues and MPB aggregation pheromones causes rapid colonization of the host by the beetles and usually leads to the death of the tree (Raffa and Berryman 1983; Aukema, Carroll et al. 2006). When the tree begins to succumb to damage caused by the MPB complex (blue stain

fungus), the colonizing beetles produce verbenone, an anti-aggregation pheromone, to reduce intraspecific competition. Late-arriving MPB detect the anti-aggregation pheromone and begin the attack process in nearby, available hosts instead of competing with established conspecifics (Raffa and Berryman 1983).

Following successful mating, the female deposits individual eggs in niches along the sides of her egg gallery. Larvae emerge from the eggs and begin to feed on phloem tissue, burrowing through the phloem primarily perpendicular to the vertical ovipositional gallery (Safranyik and Carroll 2006). However, at high colonization densities larval galleries may become more sporadic and haphazardly oriented. MPB larvae continue to feed on the phloem of their natal host until winter. They commonly overwinter in their fourth instar stage, although larva has been known to survive winters as other instars as well as other life cycle stages. In winter their processes slow, although they do not freeze due to glycerol buildups in their bodies. In early spring, larvae continue to feed in their overwintering chamber until pupation. Upon maturation to teneral adults, their elytra harden and adults emerge from their natal host to search for a suitable, live host tree (Safranyik and Carroll 2006).

Two symbiotic blue-stain fungi are vectored into lodgepole pine by MPB, *Ophiostoma clavigerum* (Robinson-Jeffrey and Davids.) Harrington (currently called *Grosmannia clavigera*) and *O. montium* (Rumbold) von Arx (Solheim and Krokene 1998; Safranyik and Carroll 2006). MPBs transport the fungi to the tree by carrying it on their bodies or in mycangia, which are specialized external invaginations on their abdomens (Paine, Raffa et al. 1997; Krokene and Solheim 1998; Solheim, Krokene et al. 2001). *O. clavigerum* is the primary aggressive invader of the sapwood. It is more virulent and grows

for a longer time than *O. montium*, possibly because it can tolerate low levels of oxygen (Solheim and Krokene 1998). *O. clavigerum* and *O. montium* serve as a food source for beetles at a critical time in their development (Solheim and Krokene 1998; Safranyik and Carroll 2006). *O. clavigerum* and *O. montium* are pathogenic and present another challenge for the host tree (Krokene and Solheim 1998). Once deposited by MPB, fungal spores quickly germinate and grow throughout both the xylem and phloem of the infected tree (Safranyik and Carroll 2006). The fungi grow throughout the tree's parenchyma cells, collapse trachieds, and block nutrient and water flow (Safranyik and Carroll 2006). The fungi ultimately lead to a tree's inability to produce resin and contribute to the death of the tree.

The primary line of physical- and chemical-based defense that a tree employs is the exudation of oleoresin (Wainhouse, Cross et al. 1990). Oleoresin is a complex blend of water, nutrients, terpenoids (Martin, Tholl et al. 2002), phenolics, and other compounds. If tree resin volume and pressure are high during colonization attempts, MPBs will either exhaust their energy reserves attempting to enter the tree against the resin flow or will be physically halted (Raffa and Berryman 1983; Ruel, Ayres et al. 1998; Wallin and Raffa 1999). A high volume of resin can expel an insect or fungal spores from a wound or bind and contain insects or pathogens (Phillips and Croteau 1999; Franceschi, Krokene et al. 2005). Constitutive oleoresin is stored in resin ducts; however, induced resin can also be produced in other locations, known as traumatic resin ducts, following wounding by an insect or pathogen (Phillips and Croteau 1999; Martin, Tholl et al. 2002).

Terpenoids are composed of two or more ligated, five-carbon isoprene units (Huber and Bohlmann 2006). The primary terpenoids found in conifer oleoresin are monoterpenes,

sesquiterpenes, and diterpenes. Monoterpenes are composed of two isoprene units; sesquiterpenes are composed of three isoprene units; and di-terpenes are composed of four isoprene units. Various side groups are often present – specifically, terpenoids are often oxygenated. Terpenoids constitute a major class of secondary metabolites in conifer oleoresin; they play an important role in the relationship between conifers, insects and pathogens. They may deter insect feeding or affect fungal growth; they may be induced to change in abundance in response to wounding; some are precursors for pheromone components used in insect communication; and some may affect insect and fungal reproductive success. Raffa and Berryman (1987) found induced monoterpenes to be a major factor in tree resistance to mountain pine beetle colonization.

The type and quantity of particular compounds in the oleoresin of particular plants influence which herbivores will be able to feed on them (Zangerl and Berenbaum 2004). These same compounds, or a combination thereof, also affect pathogens that attack plant systems. Herbivores may be deterred or killed because of an inability to overcome these resin toxins or tree physical defenses (Raffa and Berryman 1983). Pathogens may be compartmentalized and contained within the tree, unable to spread. The mode of toxicity of a particular resin secondary metabolite to an invading pest varies. Some terpenoids interfere with insect digestion, while others affect insect development or reproduction, decreasing fecundity or future fitness. Secondary metabolites may also interfere with disease processes; for instance, some terpenoids inhibit germination of spores or growth of fungi (Klepzig, Smalley et al. 1996; Six and Klepzig 2004).

The third line of defense for lodgepole pine is through its induced secondary metabolites, including terpenoids (Franceschi, Krokene et al. 2005). Constitutive terpenoids

may be enough to overwhelm attacking beetles. If the constitutive defenses are not successful, induced terpenoids are produced and may stop the bark beetle and its associated fungi. These tree chemicals can be very toxic to the mountain pine beetle (Raffa and Smalley 1995; Klepzig, Smalley et al. 1996; Reid and Robb 1999).

Quantifying the relationships between concentrations of host compounds at the early phase of host colonization is an important step toward understanding how variability of host responses impacts the success of MPB attacks. This information will improve indices of tree resistance, and relate specific host properties to survival of MPB outbreaks. Studies have shown that the quantity and quality of monoterpenes in either constitutive or induced tissue can be linked to the probability of host mortality to subcortical complexes (Raffa and Berryman 1982; Nebeker, Hodges et al. 1992).

While resin flow and tree chemistry affect MPB progression throughout its lifecycle in the tree, a tree also responds to the fungi by allocating carbon based defenses to the site in an attempt to stop the growth of the fungi (Krokene, Solheim et al. 2000). The tree defense strategy against blue stain fungus is apparent as a dark, resinous lesion in the phloem and xylem (Raffa and Berryman 1983; Wallin and Raffa 2001), which may compartmentalize and stop fungal growth. When this occurs, the tree successfully halts the colonization attempt by the individual beetle or pair of beetles and their associated fungi.

The goal of this research was to quantify tree responses during an outbreak using replicated study plots of 20-year old lodgepole pines, which provided the opportunity to estimate heritabilities and correlations among MPB behaviors and tree response traits during the colonization sequence. Since the trees used in this research were open pollinated progenies (i.e., the mother of each tree and its provenance are known), a genetic model is

present that can allow for the comparison of defense-related phenotypic differences across a broad range of lodgepole pine progenies. An understanding of the heritability of defenses, and correlations among traits, in lodgepole pines will provide guidance to tree breeders as they seek to develop more resistant strains of pines for planting the future forest.

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Chapter 2 Heritability of lodgepole pine defenses

Abstract:

Herbivory exerts pressure on plant populations in both time and space. Selective pressures may have major impacts on plant species and results in plants evolving specialized defensive responses to herbivory. This type of arms race relationship between plants and herbivores is one form of co-evolution. Many co-evolutionary studies have been limited to natural populations; however, less work has been done looking at the genetic components underlying traits for specific defenses observed on individuals in the wild. In studies with genetic structure to them, it is possible to compare genetic variation at the population level by quantifying the level of environmental influences. Empirical studies analyzing genetic components of defense require a known provenance, plants of similar age and vigor, means of measuring or controlling environmental effects, and phenotypic variation among genetic families. These are usually referred to as ‘common garden studies’.

In this study the requirements of the common garden study have been met which allowed for an evaluation of the heritability of lodgepole pine (*Pinus contorta* var. *latifolia*) defenses to mountain pine beetle (MPB) *Dendroctonus ponderosae* Hopkins (Coleoptera: Curculionidae) and its associated fungus *Grosmannia clavigera* (formerly known as *Ophiostoma clavigerum*). It was found that the variation in the physical exudation of resin and compartmentalization of blue stain fungus in tree families are primarily controlled by environmental factors and not highly heritable. However, the productions of tree defensive compounds, specifically of certain terpenoids were low to moderately heritable. These results suggest that lodgepole pine and MPB have co-evolved resulting in some lodgepole pines possessing more optimal levels of specific terpenoids that are toxic to MPB.

Introduction

Plants face many forms of biotic and abiotic stressors throughout their range and lifespan. One form of biotic stress, herbivory, exerts selective pressure on plant populations. Herbivore induced selective pressure has been the basis for many theories in plant-insect interactions (Ehrlich and Raven 1964; Mauricio and Rausher 1997). This is not surprising since herbivores have major impacts on the growth, reproduction, and survivorship of plants and plant populations (Gould 1979; Raffa and Berryman 1987; Simms and Rausher 1987; Mauricio and Rausher 1997). However, there are limitations to the number and function of the traits that arise from selective pressures. Because plants are limited to suitable environments there are complex interactions between growth rate, competitive and reproductive capacity, and defenses against herbivory from herbivores that reside in these same environments.

Plants have developed mechanisms and defensive systems to resist, tolerate, or respond to herbivory. Evolutionary processes have shaped plant responses to these stressors in the form of morphological, anatomical, biochemical and physiological characteristics that can maintain increasing fitness. While plant stress occurs at the individual level, it is important to consider the impacts on population level processes to understand the reasons for biochemical or physiological changes in response to stress and the resulting adaptations. Understanding adaptation of an individual's response to a stressor is vital to the understanding of potential success of a population in a fluctuating environment.

The role and interactions between genes and environment control of defensive responses of plants to herbivore stress varies in time and space. This variation can be

expressed in plants' primary and secondary defenses (Bernardo 1996). To date there have been many studies which have focused on identifying environmental variables that alter plants' primary and secondary defenses (Herms and Mattson 1992; Karban and Baldwin 1997; Lombardero, Ayres et al. 2000). There are relatively few studies that have estimated genetic variation in defensive traits and this number is even lower for tree-insect or disease interactions (Mauricio and Rausher 1997; Alfaro, Lewis et al. 2000; Berzonsky, Ding et al. 2003; Zangerl and Berenbaum 2004). However, there are studies that estimate genetic variance of tree height and diameter growth (Ryan and Yoder 1997), phloem and bark thickness (Haack, Wilkinson et al. 1987), and primary and secondary host defensive responses to herbivory (Alfaro, He et al. 1996; Trapp and Croteau 2001; Roberds, Strom et al. 2003; Yanchuk, Murphy et al. 2007). Furthermore, studies have demonstrated, quantitative variation in primary defenses (Peters 1971; van Noordwijk and de Jong 1986; Wallin and Raffa 1999; Roberds, Strom et al. 2003) and secondary metabolites, which have significant interactions between genes and the environment (King, Yanchuk et al. 1997; Hamilton, Zangerl et al. 2001), but the heritability of specific secondary metabolites have yet to be estimated in the current lodgepole pine, MPB, and fungal pathogen system.

Empirical studies characterizing genetic variation of host tree response(s) to herbivory provide researchers with many challenges. First, the pedigree of individual trees is often unknown. Second, because trees of different ages have different vigor, growth and reproductive potential, and defensive systems, the age distribution of trees in a natural setting may not allow for statistically replicated treatments. Third, it is very difficult to control for heterogeneous environmental effects. Finally, adequate replication across relatively uniform

environments (i.e., common garden tests) is important for estimation of additive genetic variation in a field setting.

Lodgepole pine is an early successional species and typically grows in even aged stands (Harlow, Harrar et al. 1991). Individuals of this species generally only re-establish a new population in a give area after a disturbance event such as a MPB outbreak or a fire (Harlow, Harrar et al. 1991). Lodgepole pine trees have adapted to disturbance and stress with fire-induced cone serotony (Harlow, Harrar et al. 1991). Lodgepole pines have also adapted a series of defensive characteristics against MPB colonization (Harlow, Harrar et al. 1991). Genetic variations in lodgepole pine's physiology and morphology are a result of gene mutation, drift, selection, and historical factors including founding events, and population bottlenecks (Cwynar and MacDonald 1987). These factors, in addition to MPB selective pressure exerted on lodgepole pine, have resulted in high phenotypic variability (Harlow, Harrar et al. 1991). This has resulted in geographical variation of lodgepole pine (Harlow, Harrar et al. 1991; Safranyik and Carroll 2006) with specific traits adapted to specific geographic regions and stressors.

There are numerous studies that describe conifer defense responses and attributes to bark beetles (Klepzig, Smalley et al. 1996; Roberds, Strom et al. 2003; Wallin and Raffa 2004), including MPB (Raffa and Berryman 1982; Raffa and Berryman 1983). Raffa and Berryman (1982) described several defenses against subcortical insects. This study quantified several defensive responses to simulated attack by MPB on lodgepole pine: resin flow, fungal growth and fungal confinement rate, and amount and type of constitutive (prior to attack) and induced (during/post attack) terpenoids. Resin flow and fungal growth are

considered primarily physical defenses. Oleoresin terpenoid content and quantity are considered chemical-based defenses.

The physical presence of resin is the most important constitutive defense the beetle faces during colonization attempts (Wainhouse, Cross et al. 1990). Resin flow has been well-documented as a primary defense that affects many invading tree predators and pathogens (Ruel, Ayres et al. 1998; Lombardero, Ayres et al. 2000; Raffa 2001; Wallin and Raffa 2001; Roberds, Strom et al. 2003; Safranyik and Carroll 2006). Raffa and Berryman (1982; 1983; 1987) and many other authors have demonstrated that resin flow can physically push beetles out of a tree or enshroud them in a sticky mass of resin. Also, if a beetle can not colonize a tree, resin is the key mechanism a tree employs to stop colonization and subsequent production of aggregation pheromones (Raffa 2001; Huber and Bohlmann 2006).

MPB associated fungi including, *G. clavigera*, poses another challenge to lodgepole pine trees (Krokene and Solheim 1998). This fungus, as with many bark beetle-associated fungi, is either brought into the tree by the MPB via the mycangia (Paine, Raffa et al. 1997; Six and Klepzig 2004) or on the surface of the beetle's body (Cardoza, Paskewitz et al. 2006; Safranyik and Carroll 2006). *G. clavigera* can travel throughout parenchyma cells of an infected tree, and in the process collapse tracheids, which block the flow of water and nutrients. Trees respond to the fungi by allocating carbon-based defenses to the infected site in an attempt to compartmentalize fungi (Cook and Hain 1986; Krokene, Solheim et al. 2000; Huber and Bohlmann 2006). The tree defense against the fungus is expressed as a resinous lesion on the phloem and xylem (Raffa and Berryman 1983; Wallin and Raffa 2001), which may compartmentalize and stop fungal growth (Wallin and Raffa 2004). When this occurs, the tree often successfully halts the colonization attempt by the individual beetle. In addition,

many studies have shown that these necrotic reaction lesions contain more secondary metabolites than unattacked tissue within the same tree (Raffa and Berryman 1987; Klepzig, Smalley et al. 1996; Krokene, Solheim et al. 2000).

Additional defensive characteristics of lodgepole pine are the quantity and quality of primary and secondary metabolites, specifically terpenoids, in the tree prior to attack (constitutive) and during or post attack (induced). Lodgepole pine phloem tissue contains terpenes at constitutive concentrations that can deter MPB (Raffa and Berryman 1987). For example, beetles may smell an odour that is undesirable, which causes them to avoid a particular tree or family of trees. However, once a MPB attacks, the phloem tissue at the wound site undergoes changes in host terpenoids that may reach levels toxic to MPB.

Lodgepole pine defenses may successfully defend individual trees from colonization attempts by MPB and its associated fungi. However, MPB are obligate herbivores that have co-evolved with lodgepole pine, and at low population densities MPB usually attack and colonize weakened or dying trees that have less resources than vigorous trees, to allocate to defense responses (Raffa and Berryman 1983; Safranyik and Carroll 2006). MPB has evolved a system to detoxify and/or modify several pine components to use to their advantage. For example, during colonization MPB use host chemicals, such as α -pinene and myrcene, as precursors for pheromone production (Borden 1982; Seybold, Quilici et al. 1995; Raffa 2001; Safranyik and Carroll 2006). These pheromones are used to stimulate and, later, halt aggregation (Raffa and Berryman 1987; Seybold 2006). Miller et al. (2005) described different amounts and rates of these specific terpenes, within trees, necessary for successful aggregation and anti-aggregation by beetles. Through the use of pheromones, small numbers of female beetles successfully colonize an area on a tree and attract

conspecifics females and males to the tree. Aggregation and higher densities of beetles then overwhelm constitutive defenses. Then positive feedback of aggregation overwhelms induced tree defenses, which results in complete colonization of the tree, successful brood production, and eventually host mortality.

As MPB populations increase, the available resources in compromised trees diminish due to overcrowding. If population densities are great enough, MPB can be successful in overcoming even vigorous host tree defenses, which initiates a delayed density dependent positive feedback response (Berryman 1972). Without sufficient abiotic or biotic pressures on the MPB population, this can lead to landscape level outbreaks. Outbreaks of bark beetles have been shown to cause tree mortality which can kill over 90% of the host plant within their range (Amman 1972; Wallin and Raffa 2004). During landscape level outbreaks of MPB most trees in the landscape – regardless of vigor, age, or size – will be successfully attacked by beetles. As resources are being depleted from the landscape, MPB begin to attack less suitable trees (Aukema, Carroll et al. 2006). However, there are 10-20% of trees in a stand that still remain unaffected by the beetles (Safranyik, Shore et al. 2004). The reason(s) these trees escape, resist, or tolerate MPB attack and remain alive during an outbreak are generally unknown. The answer likely lies in the building blocks of a tree's phenotype. Phenotypic characteristics are determined by the environment in which it developed and is growing (Ayres and Lombardero 2000; Lombardero, Ayres et al. 2000); its genetic background or make-up (Yanchuk, Murphy et al. 2007), and its interactions (Falconer 1981; Whitman, Young et al. 2003).

The MPB outbreak in British Columbia lodgepole pine forests and tree breeding progeny trials, established by the BC Ministry of Forests-Tree Genetics Program, provide a

framework to study the complex interactions of the host tree, the insect, and the vectored pathogenic fungus under a genetic lens within a relatively homogenous environment. This study uses families of trees planted in a randomized complete block design, which allows differentiation of genetic and environmental variation that influences phenotypic traits. Understanding host defense mechanisms involved in successful and unsuccessful MPB attacks and colonization may help explain or expand our knowledge of why some trees appear to be resistant or tolerant to MPB attack.

The goal of this study was to contribute to the understanding of the relative strengths of environmental and genetic influences on subcortical-fungal complex of MPB host. The specific objectives were to: 1) Quantify constitutive resin mass flow following mechanical wounding of lodgepole pine trees, 2) Quantify fungal growth and confinement rate following inoculation with *G. clavigera*, 3) Quantify and compare constitutive and induced terpenes in response to simulated attack by MPB and, *G. clavigera*, and 4) Estimate the magnitude of differences among open-pollinated families, and estimate heritabilities for characteristics associated with lodgepole pine defenses against MPB.

Study Area

In 1986, progeny trials of lodgepole pine *Pinus contorta* var. *latifolia* Douglas (Pinales: Pinaceae) were established at three sites in north-central British Columbia, Canada by the B.C. Forest Service, Research Branch. The sites were located near Prince George (Long. W 121° 35' 18" Lat. N 53° 29' 18", UTM Zone 10 East 593630 North 5927586), Wells (Long. W 121° 27' 57" Lat. N 53° 15' 30", UTM Zone 10 East 602371 North 5902142), and Williams Lake (Long. W 121° 21' 42" Lat. N 52° 09' 11", UTM Zone 10 East

612087 North 5779327): plots will be referred to as Indian Point Creek (Indian Point), Bowron Lake (Bowron), and Moffat Creek (Moffat), respectively. Each plot had been set-up in a randomized complete block design. Throughout each replication, trees had been planted at one meter by one meter spacing, in rows of four trees per family, with eight replication blocks per site. Each tree had a unique number associated with its position (Appendix I Figure 1 and 2). Plots had been systematically thinned to one half the stocking density ten years prior to this study. Half-sibling open-pollinated families were common to all three sites, with varying local control wild stand seedlots. The seed sources for families were collected from local and non-local provenances, from the north (Lat. N 53 58) to south (Lat. N 50 42) (Appendix I Map 1).

The Indian Point site was used to acquire preliminary information on the range of resistance parameters (antixenosis, antibiosis, and tolerance) to colonization by MPB (Yanchuk, Murphy et al. 2007). Trees at Indian Point were classified as alive or dead and for the presence or absence of MPB frass or resin exudation. Approximately 13% of the trees at Indian Point were killed by MPB by fall of 2005, and 82% were dead by fall of 2006 (Yanchuk, Murphy et al. 2007). The density of pitch tubes (pitch tubes per m² of bark surface on the lower bole) was also quantified as a representation of entrance holes. Based upon these observations, trees were grouped into discrete classes. Results from Yanchuk et al. (2007) were used to select families for study of potential mechanisms of resistance. Families from the previous Indian Point study that had a high percentage of individuals with high MPB attack density and red crowns were excluded from the study in the other plots because host physiology would be altered by previous defense responses to attack and they would most likely die.

In addition to information from Yanchuk et al. (2007), family selections at Bowron and Moffat were based on abiotic and biotic damage to individual trees. Trees were not used in this study if they had signs or symptoms of MPB; pine bark engraver, *Ips pini* Say (Coleoptera: Scolytidae); western gall rust, *Endocronartium harknessii* Hirats (Uredinales: Cronartiaceae); comandra blister rust, *Cronartium comandrae* Peck (Uredinales: Cronartiaceae); atropellis canker, *Atropellis piniphila* (Weir) Lohman & Cash (Helotiales: Dermateaceae); or stalactiform blister rust, *Cronartium coleosporioides* J.C. Arthur (Uredinales: Cronartiaceae). Families with greater than 50% of individuals showing signs or symptoms of the above agents were not included in the study.

Forty-five families were selected for this study. The number of individuals per family ranged from 16 to 26 for a total of 482 trees at Bowron and 405 trees at Moffat. Trees in the study had diameters at breast height (DBH, ~1.4 m from the base of the tree), between 5.8 and 16.7 cm. The treatments described below were conducted on individual trees prior to the MPB flight period in July 2006 therefore MPB attack levels at the two sites were near 0% at the beginning of the study.

Methods

Objective 1: Quantify constitutive resin mass flow following mechanical wounding of lodgepole pine trees.

Resin was collected from trees to measure a physical defense against MPB prior to MPB attack. Resin was collected in July 2006 from all study trees at Bowron and Moffat using methods similar to those described by Lorio (1993) and Wallin and Raffa (2001).

Collection funnels were made by cutting a 10 cm by 5 cm piece from an aluminum sheet.

The rectangle was cut and bent into the shape of a funnel (Appendix I diagram 1).

Funnels were attached to the outer bark of each tree at 1.4 m from the base of the tree using corkboard pushpins. A 10 mm diameter cork borer was used to remove the outer bark, including phloem, without damaging the sapwood (Appendix I diagram 2).

The core of bark and phloem was removed from north and south aspects of each tree. This tissue was saved for terpene analysis as described in Objective 3 (this chapter). One tapered graduated centrifuge vial was placed below each funnel and attached to the tree with a u-shaped nail. Vials were collected seven days following installation. Any resin that collected on the outside of the funnels was removed placed into the vial upon which it had collected. Vials were labelled with the position number and site of the tree from which they were collected and were capped and returned to the laboratory where they were weighed using an electronic balance (Setra Systems Inc. S1-410S). The average weight of these two samples provided one measurement per tree.

Objective 2: Quantify fungal growth and confinement rate following inoculation with MPB, *G. clavigera*.

G. clavigera, was isolated from adult MPBs collected from Indian Point in August 2005. The samples were cultured using methods described by Raffa and Smalley (1995) and Wallin and Raffa (2001). The cultures were grown in petri plates on potato dextrose agar at 22°C and 85% RH for 14-20 days and provided the source for hyphal tip transfer. After establishing a pure culture, the number of transfers was kept to a minimum to prevent possible contaminations and mutations. To provide more than enough inoculum for field

inoculations, 600 1.5mm agar samples with hyphal tips present were transferred to agar plates.

Agar plates were made using 10 g of Bacto nutrient agar (Becton, Dickson and Company) and 1000 ml of deionized water in a 2 l Erlenmeyer flask. The mixture was agitated until the agar was in solution. The solution was heated using a microwave oven for 1.25 min. The warm agar solution was added to 10 g of Difco malt agar (Becton, Dickson and Company) in a second 2 l Erlenmeyer flask and agitated until it was evenly distributed. The final solution was covered with aluminum foil, loosely taped down around all edges, and placed into a steam sterilizer/autoclave (Getinge/Castle) for 30 min. at 121°C. The solution was cooled to ~100°C and poured into individual quadrants of petri dishes (FisherBrand disposable 100 X 15 mm diameter H, type X catalog number 08-758-2). Each quadrant was filled ~2/3 full to avoid contaminating other quadrants. Using a sterile technique described by Raffa and Smalley (1988), hyphae from previously cultured blue stain fungus was placed into the center of each new quadrant. Each dish was covered and wrapped with Parafilm M (VWR) to prevent contamination and/or desiccation. Dishes were incubated at 22°C for 7-10 days until the presence of hyphal growth could be detected. The process was repeated four times prior to use as field inoculum.

In July 2006, trees were inoculated with blue stain fungus on the east and west side of the main stem at 1.4 m above ground level. A 10 mm diameter cork borer was used to excise bark and phloem. Inoculum containing hyphal tip material was taken from the petri dishes using a 4 mm diameter cork borer. The inoculum was placed onto the exposed xylem tissue. The bark was then resecured to the tree to prevent desiccation and to promote propagation of the fungus. Each tree was sampled for host response at 7 (east side of tree) and 12 (west side

of tree) days following inoculation. Post inoculation times will be referred to as day 7 and day 12 hereafter. At day 7 and day 12, bark was removed from around the inoculation site and the length of necrotic lesion was measured on the xylem (Appendix I photo 1). A 10mm diameter cork borer was used to remove phloem sample from the necrotic lesion and stored as described in Objective 3 (this chapter).

Objective 3: Quantify and compare constitutive and induced terpenes in response to simulated attack by MPB and *G. clavigera*.

Constitutive and induced terpenoids extracted from 887 study trees, collected in phloem samples in July 2006, were quantified. The 10 mm piece of phloem removed during resin collection (constitutive) (Objective 1) and phloem samples excised from necrotic lesions (induced phloem tissue at day 7 and 12) (Objective 2) were placed in labelled envelopes (5.7 x 8.9 cm) and were immediately placed on dry ice until they were transferred the lab for storage in a -80°C freezer. Low temperatures were used to minimize terpene volatilization and preserve the samples. Samples were transported to the British Columbia Ministry of Forests laboratory in Victoria, British Columbia and stored in liquid nitrogen until processed for terpene analysis.

Terpene quantity and composition were analyzed by gas-liquid chromatography. Outer bark tissue was separated from phloem tissue. The phloem was roughly chopped to increase the sample surface area. Samples were weighed (range=0.1 to 0.2 g) before being placed in labelled plastic vials containing 4 ml hexane with 240.5 ppm pentadecane solution. Pentadecane served as the internal standard since it is not present in lodgepole pine phloem and is easily separated from the naturally present terpenes (Hampel, Mosandl et al. 2005).

After 48 hours in solution, each vial was inverted to mix contents then allowed to settle for an additional 24 hours. Extracts (0.5 ml) were removed using an air pipettor and placed into a 2 ml auto-sampler vial for gas chromatography analysis.

The gas chromatograph (Perkin Elmer Clarus 500) was calibrated for all terpene standards and pentadecane. Samples were injected and immediately volatilized at 200 °C. The carrier gas, helium, flowed at a rate of 0.91 ml/min, into a split flow valve, which delivered the sample into the column. Separations were made using a J&W INNOWax 0.2 mm ID, 0.4 µm film column that was 25 m in length. The initial column temperature was 60 °C and increased by 3.0 °C/min to 85 °C, then increased by 8.0 °C/min to 170 °C. The final step increased the temperature by 20.0 °C/min to 250 °C where it was held constant for seven minutes. Each sample was detected using a flame ionization detector (FID) at 250 °C (Appendix I, diagram 3). Peak areas were used to quantify terpenes where the ratio of the area of terpene response was compared with internal standard response. Following extraction, phloem samples were oven-dried and weighed. Total terpenes were corrected based on dry weight per gram of sampled tissue.

Objective 4: Estimates of heritability of characteristics associated with lodgepole pine defenses against MPB.

Individual-tree heritabilities (h^2) of all defensive parameters were estimated as follows: $h^2 = 4 \cdot V_F / V_P$. V_A represents additive genetic variance and V_P is the total phenotypic variation. V_A is the family variance (V_F) multiplied by four and V_P is the sum of environmental (error) variance, variance between family and site interaction, and the family variance. Family variance was multiplied by four to estimate additive genetic variance

because variance among open-pollinated or half-siblings account for only one-quarter of additive genetic variance (Falconer 1981). All variance components used to derive heritability estimates and standard errors were from PROC MIXED procedure in SAS (SAS institute version 8.2, Cary, NC 1999-2001).

Repeated-measure values were calculated from an auto-regressive covariance parameter estimate where environmental variance is the sum variances of tree families, replication within site, and the errors from random effects. Heritability of non-repeated host defense parameters was calculated in the same manner, but without the auto-regressive repeated measure. Standard errors for all heritability values were estimated by adding the statement COVTEST to the PROC MIXED procedure.

Although the study families were not truly randomly sampled, they were chosen to represent a cross section of families in the test which had differential MPB attack rates, therefore it was assumed that the bias should be very minimal for attributes measured.

Statistical analyses

Differences in resin mass flow, lesion length and compartmentalization (length at day 7/length at day 12), and terpene concentrations were determined using ANOVA due to large sample numbers and low quantity of variables (SAS institute version 8.2, Cary, NC 1999-2001). Sources of variation were replication within site, site, family, and interaction of family and site. Assumptions of normality and equal variance were met using residual plots (SAS institute version 8.2, Cary, NC 1999-2001).

Mean lesion length, concentrations of individual terpenes, and total terpene levels were analyzed for all trees and within individual trees, using repeated-measures analysis of

variance (among days after inoculation) with replication within site, site, family, and the interaction of family and site as the effects in the model. Homogeneity of variance and normality were tested using residual plots. Data was transformed as necessary to meet assumptions of tests prior to analyses. Resin volume data were not transformed. Log transformation was used on all terpenes and lesion lengths. δ -2-Carene level data could not be transformed to meet assumptions.

Results

Objective 1: Quantify constitutive resin mass flow following mechanical wounding of lodgepole pine trees.

Constitutive resin collected from study trees seven days after wounding was significantly influenced by site and replication within site ($p \leq 0.05$) (Table 1). Resin was not significantly influenced by either tree family or the interaction between family and site (Table 1). The mean resin weight per family at Bowron ranged from 7.17 to 7.30g and at Moffat from 7.26 to 7.42g (Appendix I Table I). Overall trees at Bowron ($X=7.26$, $SE < 0.01$, $N=477$) produced significantly less resin than did trees at Moffat ($X=7.31$, $SE < 0.01$, $N=403$) (Table 1).

Objective 2: Quantify fungal growth and host confinement rate following inoculation with MPB *G. clavigera*.

Seven and 12 days after inoculation with *G. clavigera*, the fungus elicited reaction lesions in the study trees. Lodgepole pine trees responded to the simulated insect-fungal attack by undergoing histological changes that, in some cases, confined the growth of the

fungus within the lesions. There was significant variation in the lesion lengths between different sample times. All responses were significantly influenced by site, replication within site, family, and the interaction of site and family (Table 2). Similarly, all individual trees were significantly impacted by all sources of variation at different sample times (Table 3). Therefore, reaction lesion length varied with the number of days following inoculation for the sample time of all trees (Table 2) and within individual trees (Table 2). This trend has been reported in other studies (Raffa 1991; Wallin and Raffa 2001). Lesion lengths were significantly influenced at 7 and 12 days post inoculation for replication within site and tree family (Table 1).

Mean lesion lengths were shorter in trees at Bowron 7 days ($X=3.86$, $SE=0.07$, $N=480$) and 12 days ($X=4.30$, $SE=0.08$, $N=477$) post inoculation than in trees at Moffat 7 days ($X=4.10$, $SE=0.09$, $N=403$) and 12 days ($X=5.15$, $SE=0.11$, $N=403$) post inoculation. Mean lesion lengths within each family at Bowron ranged from $X=2.84$ ($SE=0.36$) to $X=5.38$ ($SE=1.04$) cm and $X=3.09$ ($SE=0.25$) to $X=7.12$ ($SE=0.81$) cm, at 7 and 12 days post inoculation, respectively (Appendix I Table I). The mean lesion lengths within each family at Moffat ranged from $X=2.26$ ($SE=0.23$) to $X=6.90$ ($SE=1.09$) cm and $X=3.53$ ($SE=0.18$) to $X=7.68$ ($SE=2.31$) cm at 7 and 12 days post inoculation, respectively (Appendix I Table I).

Lesion formation is a result of the host response to both the fungi and the fungal growth (Berryman 1972; Raffa and Smalley 1995; Klepzig, Smalley et al. 1996; Christiansen, Krokene et al. 1999; Lombardero, Ayres et al. 2006). Because of this interaction the importance of lesion lengths has been a source of confusion Raffa (1991); i.e., whether or not a longer lesion means higher defensive ability, a subject of conflicting

interpretation, remains unclear. Specifically, whether or not a longer lesion means higher defensive ability has been subjected to conflicting interpretation and remains unclear. For example, some authors interpret longer lesions as an indication of increased host defense and others interpret the response as meaning that the tree is more susceptible because of the relatively higher fungal growth. By sampling lesion lengths at two different times, a tree's ability to halt fungal growth may be identified. Using the rationale presented in Wallin and Raffa (2001) an integrated measurement was used to describe fungal confinement rate (the day 7/12 ratio, which is the ratio of lesion length at day 7 to that at day 12). Trees, at day 7, capable of eliciting a rapid and proportionally large response will show longer lesion lengths shortly following the inoculation (Raffa and Berryman 1982; Lieutier and Berryman 1988). However, trees more susceptible may have the longest lesion lengths over time, at day 12, because the lesion will continue to grow as long as the fungi are viable and not stopped by host responses (Cahill and McComb 1992). Therefore fungal confinement rates with ratios $(\text{day } 7/12) \geq 1$ suggest greater host resistance to the fungus. This defensive response may be able to stop the synergistic interaction of fungal growth and MPB gallery formation and thus allow a tree to survive the attack.

Fungal confinement rates were significantly influenced by site, replication within site, and the interaction of site and family, but not family (Table 1). Mean fungal confinement rate was significantly greater at Bowron ($X=0.98$, $SE=0.02$, $N=476$) than at Moffat ($X=0.86$, $SE=0.02$, $N=402$) (Tables 2 and 3). However, the range of fungal confinement rate was less at Bowron ($X=0.67$ to $X=1.20$) than at Moffat ($X=0.52$ to $X=1.38$) (Appendix I Table I).

Objective 3: Quantify and compare constitutive and induced terpenes in response to simulated attack by mountain pine beetle and the associated fungi *G. clavigera*.

Constitutive terpene levels were measured at day 0 and induced terpenes were measured at 7 and 12 days post inoculation with *G. clavigera*. Twenty-six terpenoids were identified from the phloem extracts (Table 2). The proportions of various terpenes in lodgepole pine phloem varied between constitutive and induced tissue (Table 4). Patterns of variation differed based on site, replication within site, family, and family by site interaction (Table 5).

There were significant differences of terpenes between sites for δ -3-carene, terpinolene, borneol, bornyl acetate, camphor, linalool, α -terpinene, γ -terpinene, terpineol, α -thujone, α -cubebene, and α -humulene. Quantities of all terpenoids were significantly influenced ($p \leq 0.05$) by replicate within site with the exception of β -pinene, δ -2-carene, ocimene, and α -thujone (Table 2). Family significantly impacted quantities of all terpenoids except for δ -2-carene and α -thujone. The interaction of family and site caused significant variation in the quantity only of α -cubebene (Tables 5a-c).

Within subject effects ANOVA revealed that all terpenes extracted from trees varied with time of induction and replications within site except for borneol, bornyl acetate, δ -2-carene, and α -thujone (Table 3). The interaction of tree and site significantly impacted the quantities of δ -3-carene, bornyl acetate, camphene, camphor, p-cymene, linalool, pulegone, sabinene, α -terpinene, γ -terpinene, α -thujone, α -caryophyllen, and α -humulene. The amount of terpenes significantly increased or decreased by the tree and family for all chemicals except for borneol, camphor, δ -2-carene, pulegone, terpineol, α -thujone, α -caryophyllen, and α -cubebene. There were significant interactions ($p \leq 0.05$) among tree, family, and site on the

amounts of camphene extracted from the phloem tissue. No other quantities of terpenes showed significant variation for this interaction. Constitutive, 7 and 12 days post inoculation significantly influenced the amount of all terpenes except for δ -2-carene (Table 5); therefore each time will be treated separately.

Constitutive phloem tissue had 12% lower total terpenes (ppm/g) at Bowron than at Moffat (Table 4), however, this difference was not significant (Table 5). Similarly, day 12 induced phloem tissue had 10% lower terpenes (ppm/g) at Bowron than at Moffat. However, day 7 induced tissue was 2% higher at Bowron than at Moffat (Table 4). The total terpenes were primarily comprised of monoterpenes (versus sesquiterpenes) at Bowron (day 0=99.36%, day 7=99.82%, and day 12=99.73%) and at Moffat (day 0=99.47%, day 7=99.87%, and day 12=99.79%) (Table 4). Total amount of monoterpenes increased at Bowron 195.9% from day 0 to 7 and decreased 11.36% from day 7 to 12 post inoculation (Table 6). At Moffat, total amount of monoterpenes increased 156.22% from day 0 to 7 and increased another 0.11% from day 7 to 12 (Table 6).

There were seven terpenoids that made up 94.19 to 95.78% of the total amount of monoterpenes in both constitutive and induced phloem tissue, respectively (Table 6). In order of descending abundance for constitutive tissue they were β -phellandrene, β -pinene, δ -3-carene, α -pinene, limonene, myrcene, and terpinolene (Table 6). In induced tissue, the order of decreasing abundance was β -phellandrene, δ -3-carene, β -pinene, α -pinene, limonene, myrcene, and terpinolene (Table 6).

The monoterpene that comprised the largest percentage from constitutive phloem tissue was β -phellandrene (Table 4). Although the relative proportions of the 26 terpenes were impacted by the simulated MPB attack, β -phellandrene remained the most abundant

terpene extracted from the phloem (Table 4). β -Phellandrene in constitutive phloem tissue made up a higher percentage of the monoterpenes at Bowron than at Moffat (Table 6); however, differences between sites was not significant (Table 2). Similar to the constitutive tissue, β -phellandrene was also the most abundant monoterpene extracted from induced tissue at both times. The proportions of β -phellandrene extracted from day 7 and 12 induced tissue at Bowron were higher than the proportion at Moffat (Table 6).

Site significantly influenced quantities of δ -3-carene, myrcene, and terpinolene. Analysis of variance of the seven most abundant constitutive terpenes indicated replication within site had significant affects on the amount of myrcene and terpinolene present in phloem tissue (Table 5). Family significantly impacted all seven of the most abundant terpenes. However, none of the seven terpenes varied significantly with the interaction of family and site (Table 5).

Quantities of most terpenoids in constitutive phloem tissue were significantly influenced by site, replication within site, family, and the interaction of family and site (Table 5a). Replication within site had significant effects on seven of 26 terpenes (Table 5a). Site significantly influenced 13 of 26 terpenes (Table 5a). Family significantly affected 21 of 26 terpenes (Table 5a).

Seven days post inoculation 2 of 4 sources of variation significantly impacted the amount of the majority of the 7 most abundant terpenes (Table 5). Quantities of δ -3-carene and terpinolene were significantly influenced by the first source of variation, site. The second source of variation, replication within site, significantly influenced amounts of β -phellandrene, δ -3-carene, α -pinene, limonene, myrcene, and terpinolene. Similar to the pattern of variation in constitutive phloem tissue, quantities of all seven terpenes were

significantly influenced by family, but not significantly influenced by the interaction of family and site (Tables 5a-c).

Proportional changes in the makeup of total extractions varied with specific terpenes within 7 days in response to the simulated MPB attack (Table 5b). Site significantly affected 12 of 26 terpenes, and replication within site influenced 20 of 26 terpenes (Table 5b). Family influenced 22 of 26 terpenes at 7 days post inoculation (Table 5b).

Twelve days post inoculation with *G. clavigera*, terpenes extracted from phloem tissue were also influenced many of the main effects in the analyses. (Table 5c). Site didn't significantly impact the amount of any of the seven most abundant terpenoids, however, replication within site significantly changed the quantities of all seven most abundant terpenoids (Table 5c). However, Comparable to the other two sample days (Tables 5a and b), quantities of all of the seven terpenes were significantly different for family but not for the interaction of family and site (Table 5c).

There were significant changes in the abundance of each terpene 12 days post inoculation compared to day 0 and day 7 post inoculation (Tables 5a and b). Site significantly influenced amounts of 15 of the 26 terpenes (Table 5c) and replication within site significantly altered the quantity of 20 of 26 terpenes (Table 5c). Family significantly influenced the quantity of 22 of 26 terpenes (Table 5c). Again, the interaction of family and site did not significantly influence the amounts of any terpenes 12 days post inoculation (Table 5c).

The changes of various terpene proportions in response to MPB simulated attack were complex. Proportionate changes in terpenes occurred between sampling the constitutive resin and sampling on the first after induction (i.e., day 7 samples) (Table 4). Increases in the

abundance of all terpenes except ocimene, terpineol, α -copaene, α -cubebene, and α -humulene occurred between day 0 and day 7 following inoculation at Bowron. At Moffat, there were significant increases, from day 0 to 7 days post inoculation, in the abundance of all terpenes with the exceptions of borneol, bornyl acetate, δ -2-carene, linalool, ocimene, terpineol, α -caryophyllen, α -copaene, α -cubebene, and α -humulene.

Proportional changes in terpenes occurred between the first (day 7) and second (day 12) induction days at both sites (Table 4). At Bowron there were increases in the abundance from day 7 to day 12 of borneol, bornyl acetate, p-cymene, ocimene, terpineol, α -caryophyllen, α -copaene, α -cubebene, and α -humulene. At Moffat, from day 7 to 12, there were increases in the abundance of all terpenes with the exception of β -phellandrene, terpinolene, α -phellandrene, pulegone, sabinene, and α -thujone.

Quantitative changes made in terpene abundance that occurred during induction from day 0 to day 7 varied between Bowron and Moffat, but there were some general trends (Table 6). β -Phellandrene increased in trees at both sites. β -Pinene increased in the phloem tissue collected from trees at both sites. δ -3-Carene, α -pinene, limonene, myrcene, terpinolene all increased at both sites. Total monoterpenes extracted from phloem tissue of study trees increased at Bowron and Moffat (Table 6). Sesquiterpenes were negatively induced from day 0 to 7. Three of four sesquiterpenes decreased in total amount at Bowron and all sesquiterpenes decreased at Moffat (Appendix I Table II). Total sesquiterpenes in phloem tissue decreased at Bowron and Moffat.

Quantitative changes in terpene abundance varied between sites during induction from day 7 to 12 (Table 6). β -Phellandrene decreased in sample trees at Bowron and Moffat. β -Pinene also decreased in the phloem of trees at Bowron, but increased at Moffat. δ -3-

Carene decreased in phloem tissue at Bowron, but increased at Moffat. During this induction, the amount of α -pinene, limonene, and myrcene decreased in study trees at Bowron, but increased at Moffat. Similar to β -phellandrene, terpinolene at both study sites decreased in the phloem tissue at Bowron and Moffat. Total monoterpenes decreased in samples taken at Bowron, but increased at Moffat. All sesquiterpenes increased in proportion at both sites (Appendix I Table II).

During the first induction period (day 0 to 7), most families had inconsistent changes in quantities of terpenoids (Appendix I Table IIIa and b). However, there were similar trends among the seven terpenoids that make-up the majority of the terpene profile. All 45 families had higher amounts of β -phellandrene, β -pinene, δ -3-carene, α -pinene, and terpinolene at day 7 compared to the constitutive profile (Figure 1). Mean percent of limonene increased from day 0 to 7 in 41 of 45 families at Bowron and in 43 of 45 families at Moffat. Myrcene increased in every family with the exceptions of family 25 at Bowron and family 10 at Moffat. Terpineol was the only monoterpene to generally decrease from day 0 to 7, with the exception of families #36 at Bowron and 4, 20, 22, 31, and 42 at Moffat (Appendix I Table IIIa and b). During the same time period 67% of families at Bowron and 89% at Moffat showed decreases in total sesquiterpenes (Appendix I Table IIIa and b).

Unlike the first induction period from day 0 to day 7, the second period from day 7 to 12 had fewer consistent changes among families. Twenty-nine percent of families and 42% of families increased in mean percent of β -phellandrene at Bowron and Moffat, respectively (Figure 2). Thirty-three and 51% of families at Bowron and Moffat, respectively, increased in mean percent of β -pinene and α -pinene. Levels of δ -3-carene increased in 27% of families at Bowron and 40% of families at Moffat. Limonene increased in 51% of families at Bowron

and 56% of families at Moffat. Myrcene increased in 29% and 44% of families at Bowron and Moffat, correspondingly. Mean amounts of terpinolene increased in 38% of families at both sites. Showing a trend contrary to the majority of monoterpenes, terpineol increased in 98% of families at both sites (Appendix I Table IIIa and b). Total sesquiterpenes increased in 80% of families at Bowron and 91% at Moffat from day 7 to 12 (Appendix I Table IIIa and b).

Objective 4: Estimates of the heritability for characteristics associated with lodgepole pine defense against MPB.

Analysis of lodgepole pine host defense traits revealed that most traits responded to simulated MPB attack and that majority of these traits possessed significant additive genetic variation (Table 7). There was a large range of h^2 values estimated for lodgepole primary and secondary defensive responses to simulated MPB (Table 7). Resin mass flow had a non-significant heritability of 0.06 (SE=0.06) (Table 7); however, the estimated heritability of lesion length pooled by geographic region was $h^2=0.11$ (SE=0.04). The confinement rate (i.e., 7/12 day ratio) of blue stain fungus indicated this trait was not heritable (Table 7).

δ -3-Carene levels had a heritability estimated at $h^2=0.48$ (SE=0.12), which was the highest value of all terpenes (Table 7). Limonene, β -pinene, and terpinolene also had heritability estimates above 0.25 (Table 7). Of the 7 most abundant terpenes α -pinene, β -phellandrene, and myrcene all had low heritability values compared to the others (Table 7). Total terpenoids, monoterpenoids, and sesquiterpenoids all had heritabilities estimated to be lower than $h^2=0.25$. The estimated heritability of the ratio of β -pinene to δ -3-carene was $h^2=0.58$ (SE=0.15). The estimated heritability of the ratio of terpinolene to myrcene was

$h^2=0.39$ (SE=0.11). None of the sesquiterpenes had heritability values estimated to be greater than 0.25.

Discussion

This study examined the genetic and environmental variation of tree physical and chemical defenses against an simulated invasion of the subcortical complex, MPB and its blue stain fungus. The defensive mechanisms include resin mass flow, lesion growth and confinement, and changes in terpenoid abundance – and all were expressed in response to simulated MPB attack. Variations in defense parameters sampled at different times suggest a change in the allocation of carbon-based resources due to simulated attack by MPB. Resin mass flow and lesion growth in response to fungal inoculum were primarily affected by site or microenvironment. Constitutive and induced terpenoids were more strongly affected by family, which suggests a stronger genetic than environmental regulation of these responses.

To more fully explain site-to-site variation of primary defense responses, additional variables needed to be collected such as: annual precipitation, annual temperature, snow pack, soil type, and phenotypic characteristics of specific trees, as well as previous disturbance. There may have been abiotic variation between sites during this study that explain differences in resin mass between sites. Other studies support this conclusion citing resin flow being affected by tree height and diameter (Ruel, Ayres et al. 1998). In addition identifying differences among replication within site may also explain variation seen in resin flow, as well as other variables.

Resin collection was low compared to other studies (Klepzig, Robison et al. 2005). Trees in this study were relatively young, small, and well spaced, with limited competition

for resources. Under these conditions trees tend to grow at their maximum potential. For this reason competition should not limit resin flow and for carbon should be primarily allocated towards growth. For example, Lombardero et al. (2000) reported that resin flow was lower in fast-growing trees than in slow-growing trees. This suggests a tradeoff favoring growth rather than defense when nutrients aren't limiting. This is one possible reason for the low resin mass flow recorded in this study. In contrast, a study conducted by Kolb et al. (2006) reported that resin flow of trees in that study did not vary significantly throughout study sites, or by tree size, water retention, or tree carbon. Relative to that study, however, trees in this study were only 20 years old and smaller.

This may help explain the shift in MPB host use to smaller trees, especially during an outbreak period (Wallin and Raffa 2004). During an outbreak, smaller trees, which are usually unsuitable for MPB, are attacked. This is thought to be due to low availability of other hosts (Aukema, Carroll et al. 2006). While resin flow appears to be important in larger diameter and older trees as a defensive trait, in smaller diameter and younger trees it may have less importance.

Many studies, including this one, have followed the resin collection method of wounding trees as presented in Lorio Jr. (1993). The lack of significant differences among the treatments in this study may have an alternate explanation. A single wound on trees may not be enough trauma to produce a substantial amount of resin through the traumatic resin duct system. Christiansen et al. (1999), Faldt et al. (2003), and Klepzig et al. (2005) reported that wounding with fungal inoculation causes traumatic resin ducts to form and thus more resin is produced. The trees in this study received wounds and inoculations on different areas of the surface of the tree. The wounding without inoculation may be limited and localized.

Klepzig et al. (2005) conducted an experiment with higher densities of simulated attack wounding, which successfully induced resin based defenses. However, the overall importance of induced resin is still inconclusive during outbreaks. For example, numerous studies, including Raffa and Berryman (1983) and Huber and Bohlmann (2006), discuss constitutive resin flow as being enough to stop individual MPB attacks, but may not be enough to stop high densities of beetles.

Wounding and inoculating *G. clavigera* into study trees resulted in necrotic lesions to form in phloem and xylem tissue. Lesion growth significantly varied by time since inoculation, site, and tree family. Environmental variation contributed more to the variance of lesion growth than did family. The possible mechanisms causing this site variation may be similar to the mechanisms described for resin mass flow.

The formation of necrotic lesions following simulated bark beetle attack has been shown in many other studies and systems (Cook and Hain 1986; Raffa and Smalley 1988; Klepzig, Smalley et al. 1996). Raffa and Berryman (1983) working in a lodgepole pine MPB system found fewer and less-defined necrotic lesions in study trees and suggested this may be a product of high beetle attack density. In this study, trees were inoculated prior to attack; therefore any links between lesion formation and beetle density are inconclusive. However, possible links may be made between confinement of fungal growth and eventual beetle attack. Mortality data taken from the study trees will provide this link between beetle attack and tree defense (Chapter 3).

Another way to analyze lesion growth, as discussed earlier, is by confinement rate, which in this study was the lesion length at day 7 compared to length at day 12. A longer initial lesion length in response to an inoculation, followed by an equal or lesser length from

a second inoculation, may indicate a response that there is increased allocation of carbon to tree defenses. A tree may allocate resources to stop blue stain fungal growth by compartmentalizing the fungus to existing tissue and stopping its growth. Lesion confinement rate in this study was impacted more by location than by family. This indicates strong environmental regulation of confinement rate. Other studies have suggested that confinement rate is a very important defense in halting a bark beetle associated fungi and the eventual colonization of a tree by bark beetles (Raffa and Berryman 1982; Wallin and Raffa 2001). However, the results do not fully agree with findings in these studies. This may be due to different model systems, or population densities of the bark beetle. During outbreak conditions, environmental effects may overwhelm genetic regulation to properly confine the fungal invader.

Wounding and inoculation with *G. clavigera* significantly affected the abundance and quantity of terpenoids at 7 and 12 days after inoculation. The levels of induction agree with those reported by Klepzig et al. (1996) and Raffa and Smalley (1988). The quantity of total terpenoids was higher in induced tissue than in constitutive tissue. The seven monoterpenes that made up the major fraction of the total terpenoids in the tissue showed similar trends in how they changed overtime, from day 0 to day 7 and day 7 to day 12 (Table 6) (Appendix I Figures 1 & 2).

The overall trend of the seven most abundant terpenoids was for them to increase 7 days following inoculation. This is in contrast to the trends shown for sesquiterpenes. Monoterpene and sesquiterpene abundances were negatively related as induction occurred from day 0 to 7. However, this trend did not remain 12 days following inoculation. At day 12, most monoterpenes at Bowron and Moffat had decreased or remained relatively stable

while sesquiterpenes increased. While it appears in the short-term that a simulated MPB attack induces and increases tree monoterpenes appropriate for defense, sesquiterpenes decreased. This may indicate an immediate increase in defense related to the MPB threat, followed by a return to an original state of defense. MPB mass attack usually occurs within a short period of time following the onset of beetle colonization. This suggests that once the threat has been eliminated the tree may return to normal constitutive defensive levels and its regular functions; however, over time some trees take longer to halt the invasion. Contrary to this hypothesis Klepzig et al. (2005) reported levels of resin based defenses to be induced 105 days after simulated attack. However, both studies support the initial increase and trade-offs for the induction of defenses (Klepzig, Robison et al. 2005).

A possible mechanism for the trade-offs observed during induction may be due to the regulation by gene expression, for instance, upregulation of terpene synthase expression due to herbivory or some particular stress. This may also occur through up- or downregulation of genes that control the induced response and the expression of terpene synthase genes. For example, the mevalonic acid pathway (MVA) may be shut down or have isopentenyl pyrophosphate (IPP) (a building block of terpenoids) shunted off to promote the methylerythritol phosphate pathway (MEP). This may be due to the MVA producing primarily sesquiterpenes, while the MEP produces primarily monoterpenes and diterpenes, especially monoterpenes of interest such as δ -3-carene, myrcene, and α -pinene (Huber, Ralph et al. 2004). All three of these monoterpenes, as well as others, increased with induction. The hypothesis of trade-offs for induction of defenses may be further supported by sesquiterpenes not being associated with lodgepole pine defense to MPB, although toxicity levels of particular sesquiterpenes have not been fully explored at this time.

Another hypothesis is that other cellular-level processes may be occurring, such as genes that regulate traumatic resin or allocation of carbon for fungal confinement being activated, which results in increases of particular defensive terpenoids. Furthermore, other defenses that are regulated by environmental conditions may have gene upregulation as a by-product. The extent of the processes that particular pathways perform is still unclear and broad conclusions can not be made at this time.

The seven most abundant monoterpenes, that increase with induction, have been shown to provide defensive effects against bark beetles or other coniferous herbivores (Lindgren, Nordlander et al. 1996; Rocchini, Lindgren et al. 2000) or to affect pheromone mediated aggregation and anti-aggregation (Pureswaran and Borden 2005). In particular δ -3-carene has been shown to be toxic to many conifer invading insects (Cook and Hain 1988; Rocchini, Lindgren et al. 2000; Faldt, Martin et al. 2003; Carlow, Ayers et al. 2006; Ross, Kohler et al. Unpublished Data). δ -3-Carene occurs in relatively high concentrations in lodgepole pine compared to other terpenes. This is also the case for β -pinene. However, the rank of abundance of these two monoterpenes changes with the onset of induction. δ -3-Carene increases to a higher level than β -pinene. The change in proportion of these two terpenes from a preponderance of the less-toxic terpene β -pinene to the more-toxic δ -3-carene suggests an important relationship. Higher ratios of δ -3-carene to β -pinene may provide a greater level of defense to MPB.

Myrcene and terpinolene have been shown to be important in the synthesis of aggregation and anti-aggregation pheromones produced by MPB (Borden 1982; Raffa and Berryman 1983; Safranyik and Carroll 2006). Raffa and Berryman (1983) reported levels of terpenoids used for aggregation to increase along with toxic terpenoids. This may be an

unintentional by-product of induction that MPB has adapted to and used to its advantage. Myrcene has been shown, in conjunction with α -pinene, to be used by MPB to synthesize aggregation pheromones (Borden 1982; Seybold, Quilici et al. 1995; Raffa 2001). However, it also has been shown to be used within a suite of chemicals used by MPB to produce anti-aggregating pheromones (Pureswaran and Borden 2005). Seybold et al. (2004) reported that in Rocky and Cascade mountain ranges specific populations of MPB experience greater anti-aggregating effects when exposed to terpinolene versus to myrcene. To date this idea has only been tested in British Columbia under laboratory conditions (Borden and Pureswaran 2006). In this study, myrcene and terpinolene were induced at both sites. Terpinolene increased ~200% from the constitutive level and myrcene increased by ~110-150%.

An important factor in estimating levels of genetic variation for some trait of interest is that there must be measureable variation in the trait of interest. The results here support that significant levels of phenotypic and genetic variation exist to estimate h^2 . In order to describe genetic variation of these defensive traits it is important to offer a contextual framework of heritable traits provided by previous studies. Some studies categorize heritability values as high if the estimated value is ≥ 0.45 (King, Yanchuk et al. 1997; Alfaro, Lewis et al. 2000). Quencez and Bastien (2001) characterize moderate levels of heritability as between $h^2=0.30-0.54$. Whereas, Roberds et al. (2003) state moderate levels of heritability are $h^2=0.44$ to 0.59. Hamilton et al. (2001) states that the degree of genetic control or heritability of secondary defenses varies widely among plant species but is generally thought to be 0.3. Zangerl and Berenbaum (2004) discuss heritabilities of primary and secondary metabolites in their study as ranging between -0.048 and 0.728, with an average of approximately 0.3, similar to results shown by Hamilton et al (2001). Within the context of

the other studies discussed, heritabilities will be considered low (0-0.25), moderate (0.25-0.5), or high (>0.5) in this study.

The estimated heritability value (h^2) for resin mass flow was low at $h^2=0.06$ ($se=0.06$). The standard error was large enough, in comparison to the heritability value, that resin mass flow cannot be considered significantly heritable under these conditions. In this study it appears that environmental variables and environmentally-influenced phenotypic variance provides the effects of variation seen for resin mass flow. However, under other environmental conditions, or under other endemic, incipient epidemic, or epidemic conditions, additive genetic variance may appear as significant as in other studies (Roberds, Strom et al. 2003).

A comparable outcome occurred with the heritability estimate ($h^2=0.00$, $se=0.04$) of confinement rate. However, the heritability value for lesion length was low, but significant at $h^2=0.11$ ($se=0.04$). This demonstrates lesion length was affected by family. If lesion growth, not lesion confinement rate, is enough to affect blue stain propagation, then perhaps family is important for this defensive trait. However, if lesion confinement rate is, as predicted in this study, a more important variable for defense, then these results suggest environmental conditions are more important than genetics for this MPB defense. Once again additive genetic variance may be higher or lower under different environmental or MPB population densities. Defensive traits of the trees in this study were known prior to attack, so the ultimate outcome for lodgepole pine defense, within the described sites, is yet to be seen. MPB success may be significantly affected by lesion length within families (Chapter 3).

In contrast to resin mass flow and lesion length, the results indicate the majority of terpenoid variation within study trees can be explained more fully by family instead of any other main effect. It was rare for terpenes to vary significantly by site. This indicates a strong and stable genetic component is present within the suite of secondary metabolites in this system, e.g., only α -cubebene at day 0, bornyl acetate at day 7, and pulegone at day 7 had significant site by family interactions. Further supporting this conclusion, the majority of changes from day 0 to day 7 and day 12 were primarily influenced by family and rarely by site. This could be important when addressing future MPB dispersal and host selection. There are likely many similar habitat types and microclimates across the host range of MPB in lodgepole pine. However, certain regions have experienced frequent MPB pressure, while others have not, especially when comparing northern to southern regions (Carroll, Taylor et al. 2003). This study suggests that particular families of trees produce higher levels of biologically relevant terpenoids.

Heritability estimates for the seven most abundant terpenes show four of the seven to have moderate heritability values (β -pinene, δ -3-carene, limonene, terpinolene), and the other three to have low heritability values (β -phellandrene, α -pinene, myrcene), however, heritability was significant for all of them in that heritability estimates were greater than their standard error estimates. This suggests these chemicals are influenced significantly by their genetic lineage. These results support those reported by Smith (2001), where it was found that monoterpenes were primarily controlled by genes in pine xylem of many pine species. For example, some of the specific terpenes Smith (2001) found to be affected by genetic variation were amongst the majority of the seven most abundant terpenes including: β -phellandrene, α -pinene, β -pinene, δ -3-carene, myrcene and limonene. Many of these

terpenes have been discussed in this study as having important relationships in this lodgepole pine MPB system.

While individual terpenoids have significant heritabilities, it may also be important to look at the ratios of particular terpenes, because some terpene synthases produce more than one terpene product, and it is also likely that terpene synthase genes are sometimes regulated in tandem. The ratio of β -pinene to δ -3-carene was discussed earlier as percent abundance of total terpenoids changed between the two variables. The ratio of these two terpenes measured over sample time had the highest estimated heritability value at 0.58 ($se=0.15$). This may further support the idea that particular terpenoids are being induced at higher levels in some families and this higher level of specific terpenoids or ratios between terpenes should provide some advantage to individual trees.

This is also important when discussing possible anti-aggregation effects. The ratio of terpinolene to myrcene was moderately heritable at $h^2=0.39$ ($se=0.11$). While this value is only considered to be moderate, it is still greater than the majority of other variables tested in this study. This may further support the idea of terpinolene as an important variable for deterring attack by MPB resulting in the beetle avoiding trees with increased levels of terpinolene. Perhaps terpinolene at certain levels masks or acts synergistically with myrcene. These outcomes will be explored further in Chapter 3.

The results, that resin mass flow and lesion length were primarily affected by site, may indicate that for lodgepole pine trees location of planting and a suitable habitat is important for these primary defenses against the natural insect predator MPB (Harlow, Harrar et al. 1991). Also, the first two defenses are primarily based on physical processes within the tree such as the allocation of carbon, which has been shown to be largely affected

by the environment (Herms and Mattson 1992). The other defensive traits, constitutive and induced terpenoids, are based primarily on quantities of secondary chemicals. The results of this study indicate that physically induced defenses are based primarily on the location in which each tree resides, while chemical defense is significantly affected by a tree's lineage or genetics. This may have arisen from a longer history of MPB pressure and attack on lodgepole pine. It may be that terpenoid based defenses, within lodgepole pine, although of tremendous importance have not been subject to strong selection for terpenoids (which may lead to higher levels of genetic variation) as some of the more constitutive or physically based defense mechanisms.

Defenses in this study have been shown to vary significantly, and specifically monoterpene abundances have been shown to have relatively strong genetic component. However, it is important to test hypotheses of defense by linking these traits with negative impacts on the attacking species and/or host mortality. This will be addressed in Chapter 3. Also, while some traits may provide adequate defense during endemic or localized outbreaks of MPB, the current MPB population in British Columbia has decimated a majority of the lodgepole pine across the landscape. Yet, some trees remain and are not killed. The results from this study provide a framework under which desirable traits for MPB defense (i.e.; chemical) can be selected and bred for within tree plantations. The results may also aid in the identification of families with desirable terpenoids, in high or low abundances, or terpenoid-based induced defensive responses, which may provide a means of promoting a greater overall fitness of individual pines. This will be important in the future management plans and strategies for MPB resistance, stand resilience, and tolerance to herbivory,

especially in the context of climate change, population shifts, and landscape-wide epidemic outbreaks.

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Chapter 3 Effects on MPB

Abstract:

The mechanisms that affect herbivore feeding include biotic and abiotic factors. Plants that develop characteristics that deter herbivores may have a greater fitness and pass on effective defensive traits to their offspring. The prevalence of these plant defenses may vary over time and among populations. Understanding herbivore life cycles is critical to elucidating plant defense strategies. Typically herbivore life cycles include host selection, host acceptance, and host utilization.

The lodgepole pine, *Pinus contorta* var. *latifolia*, forests in British Columbia experience episodic outbreaks of mountain pine beetle (MPB), *Dendroctonus ponderosae* Hopkins (Coleoptera: Curculionidae), and its associated fungi *Grosmannia clavigera* (formerly known as *Ophiostoma clavigerum*). The current study has provided a framework to observe heritable tree characteristics and how they interfere with the life-cycle of MPB. Many tree variables associated with host selection and acceptance such as DBH, tree height, bark texture and MPB landing were not significantly associated with selecting a host and initiating an entry point. However, the frequency of hypersensitivity reactions was negatively correlated with host utilization, including MPB gallery production, reproduction, and brood development. Overall MPB success is determined by tree mortality. It was found that constitutive δ -3-carene and hypersensitivity reactions, occurring in response to MPB attack, negatively impacts MPB host utilization and lowers tree mortality.

Introduction

Feeding patterns of herbivores are influenced by a range of biotic and abiotic factors, central among which is the dynamic interaction between the physiology of the animal and the chemical composition of the plants it contacts and eats (Hughes 1993; Simpson and Raubenheimer 1993a, b; Illius and Jessop 1995; Kause et al. 1999a, b). For example, any plant that evolves a chemical that is repellent or harmful to insects will be favored. But the frequency of these phenotypic traits will put pressure on the insect population, and any insect that happens to have the ability to overcome this defense will be favored. This, in turn, puts pressure back onto the plant population, and any plant that evolves a stronger chemical defense will be favored. This then puts new pressure on the insect population. This sort of evolutionary 'arms race' is likely common for many plant/herbivore systems (Thompson 2005).

For insect herbivores, laboratory studies have made substantial progress identifying the key processes involved in host selection and utilization (Frazier and Chyb 1995; Simpson 1995). Every step in the behavioral sequence of events leading to, and including, plant ingestion is potentially influenced by the physical and chemical composition of plant tissues (Mitchell 1981, Stadler 1992; Bernays and Chapman 1994; Frazier and Chyb 1995). The relative roles of plant primary and secondary metabolites in determining patterns of food selection among herbivores, however, generate continuing debate (Fraenkel 1959; Bernays and Chapman 1994; Berenbaum 1995; Hagele and Rowell-Rahier 1999). It is becoming increasingly clear that studies of herbivores and the chemicals affecting their behavior must be done at a spatial and temporal scale that is relevant to the herbivore in question.

Host-plant quality is a key determinant of the fecundity of herbivorous insects, and it also affects insect reproductive strategies (Awmack & Leather, 2002). A good host plant (especially for insects that feed as adults) should be suitable for larval development, allow high fecundity for foraging adults, and permit oviposition by females (Xue and Yang, 2007). Although the immature stages of some phytophagous insects have little opportunity to change their developmental location, the highly mobile adults will select more suitable host plants for feeding upon eclosion (Xue and Yang, 2007).

In addition to the documented steps of host selection and utilization behaviors such as landing, acceptance, colonization, and reproduction, there is a well-known hierarchy in host resistance mechanisms against insects that corresponds with these behaviors.

Constitutive defenses are active in a plant prior to consumption attempts by an herbivore. Constitutive defenses have evolved due to different abiotic or biotic stressors plants face over evolutionary time. They include a broad range of physical defenses including, but not limited to; morphological shape, the toughness of the chewing surface, and chemical defenses including levels of primary and secondary metabolites, as well as other water-based defenses where chemicals are solubilized. These defenses may change herbivore preference taste and smell or make the plant tissue inedible due to toxins (Safranyik and Carroll 2006).

Induced defenses are comprised by direct defenses, such as secondary metabolites that negatively affect herbivore growth and survival, as well as indirect defenses, such as herbivore-induced plant volatiles and herbivore-induced responses that enhance the foraging success of natural enemies of herbivores, such as parasitoids or predators (Kessler and Baldwin, 2002; Heil et al., 2004; Kappers et al., 2005; D'Alessandro and Turlings, 2006;

Mumm and Hilker, 2006). The induction of defenses is often impacted by abiotic and biotic factors, and an individual plant species can therefore express a range of different phenotypes where the quantitative and qualitative responses vary. For instance, previous attack may influence the induction of subsequent defenses in specific ways and thereby affect herbivore and plant fitness (Kessler and Baldwin, 2004; Voelckel and Baldwin, 2004b). Identifying phenotypic traits involved in hierarchical interactions and their ecological function should be investigated through in-depth studies.

An useful model system to identify these phenotypic defensive traits is mountain pine beetle (MPB), *Dendroctonus ponderosae* (Coleoptera: Curculionidae) and its associated fungi *Grosmannia clavigera*. The model system has both hierarchical insect host selection and utilization behaviors and host resistance mechanisms. A companion study has identified three broad defensive categories that lodgepole pines employ against this invading herbivore. They are physical exudation of resin, compartmentalization of associated fungi, and production of primary and secondary metabolites in the oleoresin. These defenses were quantified in the companion study where lesion growth and compartmentalization and tree-induced response chemistry have been estimated to be significantly heritable. This complex interaction between three species (tree, herbivore, fungi) has resulted in lodgepole pine evolving defenses against one of its most important stressors, MPB.

Once host selection by MPB has occurred, following MPB landing on the bark of lodgepole pine, adult beetles encounter primary and secondary defenses, physical exudation of resin, compartmentalization of associated fungi, and constitutive and induced tree chemistry incrementally throughout each stage of their reproductive lifecycle. These tree defenses can slow beetle success, kill beetles, inhibit aggregation pheromone production, halt

the progression of blue stain fungus and kill or slow developmental stages of MPB offspring. In addition to all of these factors, MPB is preyed upon throughout the whole process by other bark beetles and borers, parasitoids, and birds including woodpeckers (Safranyik and Carroll 2006).

The defenses quantified in the companion study, additional lodgepole pine tree phenotypic traits have been shown to impact host selection, host acceptance, and host morality for MPB. Some of these traits have been shown to be heritable while the heritability of others is not known. Identifying and examining tree characteristics that are heritable and their interactions with each step of host selection and utilization may further reveal defensive and non-defensive qualities of lodgepole pine, which will increase the current understanding of specific traits that affect MPB during endemic or epidemic population phases.

Raffa and Berryman (1983) state that beetle colonization behavior is linked to tree physiology. To understand which lodgepole pine characteristics play a key role in MPB colonization and reproduction, it is important to look at each step of a MPB's host selection behavior that corresponds with its lifecycle within individual trees and stands of lodgepole pine. MPB face challenges throughout emergence and dispersal, host selection and colonization, and mating and oviposition. Many of these stages of their life cycle, including emergence, are affected by temperature, which is driven by seasonal factors. Dispersal is driven by wind, light, individual beetle lipid content, and response to host volatiles and pheromones (Amman and Cole 1983; Wallin and Raffa 2004; Bentz and Six 2006).

During emergence and host selection, vision is a key trait for MPB in locating host trees. This may be due to their affinity for large, dark silhouettes (Shepherd 1966) that

appear as vertically oriented cylinders (Cole and Amman 1969; Billings, Gara et al. 1976). However, Hynum and Berryman (1980) add that the greater number of beetles landing on larger trees is simple a function of random landing and the larger surface area of such trees. Many believe host selection is a combination of the two processes (Borden 1982; Pureswaran and Borden 2003) along with beetles making a primary assessment of host suitability by sampling of the bark and phloem tissues (Raffa and Berryman 1982).

Tree diameter and height have been linked as factors affecting beetle success. Cole and Amman (1969) stated that MPB preferentially attack large trees because characteristics of the stem that are related to tree size make a tree's potential MPB fitness higher. Diameter and height are the primary factors used to describe larger trees. In addition to diameter and height, which tend to increase with age, bark texture tends to increase in roughness and features, with younger and smaller trees having smoother bark than older and larger trees. MPB have been shown to prefer older and larger trees due to their need for bark scales, crevices, and fissures for attack initiation (Shepherd 1965).

MPB also prefer larger trees due to the positive relationship between tree diameter and phloem thickness (Amman 1969; Shrimpton and Thomson 1985). These two are related; further up the bole, diameter and phloem thickness decrease. Berryman (1976) and Amman and Cole (1983) found brood production of MPB to be directly related to phloem thickness, thus beetles tend to attempt colonization closer to the ground. However, Raffa and Berryman (1983) state that thicker phloem is also associated with higher resistance to MPB. It is important to confirm that trees are actually being landed upon to make reasonable conclusions about the factors that influence initial host selection to determine whether host landing and perhaps selection is occurring or if landing is random.

Once a host is selected by a female MPB, she accepts and attempts to enter the tree. The tree responds to initial colonizing attempts by the herbivore by exuding resin. At this point she can be pushed out, blocked, or entrapped by resin. Measurements of resin exudation may be used to describe attack severity. Resin exudation results in pitch tubes at beetle entrance sites. Counting pitch tubes provides a relatively accurate estimation of attack density for individual trees (Raffa and Berryman 1983). At a certain attack density trees tend to be overwhelmed by MPB and the beetle has passed into the next stage of its lifecycle. However, Raffa and Berryman (1983) indicate there are different attack densities that are important each step in host utilization. For example, colonization is optimal at ~ 40 attacks/m², where as maximum egg hatch, larval development, and pupal survival is closer to ~ 70 beetles/m². Survivorship of MPB drops off at densities great than that. However, up to that point, defenses are continually decreased to a more suitable level for MPB success (Raffa and Berryman 1983).

If MPB survive the challenges of host selection and acceptance, they progress to host utilization. The female constructs a nuptial chamber, emits pheromones, and attracts conspecifics. At this time she also begins constructing an ovipositional gallery that is parallel to the main stem. Once again a suite of factors are at play that determine the success of the invading insect. If the MPB's construct an ovipositional gallery without being significantly disrupted by tree defenses, they deposit eggs. By this stage in MPB progression, bark can be removed from the bole of the tree to observe parental galleries. Various measurements of galleries and egg niches are indicative of individual beetle's success (Raffa and Berryman 1983).

After copulation, the female places eggs into niches along the ovipositional/parental gallery walls. Eggs eclose and larvae begin feeding and constructing galleries that are perpendicular to the parental gallery (Amman and Cole 1983). Larvae have four instars as they continue to grow and consume tree phloem and fungus. At this stage, tree characteristics may still affect MPB development and overwintering. Counting of larval galleries and pupal chambers may provide an additional estimate of success of MPB lifecycle. Finally, MPB generally over winter as larvae, pupate in the spring, and disperse to find new hosts in mid summer. If MPB successfully complete a lifecycle then their host most likely died.

Once a tree is attacked and colonized, there are a few ways to determine mortality in a tree (Amman and Cole 1983; Safranyik and Carroll 2006). First and the most obvious is the color of the crown. Trees attacked and killed by mountain pine beetle have crowns that change from green to yellow green, yellow green to red green, and eventually red. Another way to determine death is if a tree has been girdled. This can be determined by observing bark sloughing and also by a visual examination underneath the bark of the tree.

MPB are obligate herbivores that need their host to die in order for themselves to colonize the tree and reproduce successfully (Safranyik and Carroll 2006). However, with lodgepole pine and MPB coevolving, there are many tree characteristics that can affect MPB success. While there are numerous studies on the hierarchy of resistance mechanisms, little has been reported on genetic variation of defense characteristics (Strom et al. 2002) during naturally occurring colonization, and how each step correlates with bark beetle behavior. This study will examine various tree characteristics and their positive and/or negative effects on fecundity of MPB. If traits that negatively affect MPB can be identified and are heritable,

future breeding approaches with lodgepole pine may be able to consider some of these resistance traits.

The goal of this study was to quantify and link lodgepole pine characteristics that may affect the multiple steps in host selection, acceptance, and utilization by MPB. Open pollinated family trials were assessed to: 1) determine the levels of genetic variation present in diameter, tree height, and bark texture; 2) describe and quantify the multiple steps for MPB unsuccessful and successful attack of among families; 3) estimate heritabilities of the traits listed above; and 4) determine if the steps of MPB host selection, acceptance, and utilization in lodgepole pine are correlated to heritable defense traits described earlier.

Study Area

For the sake of continuity and completeness for Chapter 3, the study is again described below. This study took place in progeny trials of lodgepole pine that were established at two sites in central British Columbia, Canada during 1986. Plots will be referred to as Bowron Lake (Bowron) and Moffat Creek (Moffat). Trees were planted in a randomized complete block design. Trees were planted in one by one meter spacing, and in rows of four trees per family. Families were half-siblings due to open-pollination, where only the female tree was known, and pollen contributions were assuming to be random and unrelated. ‘Control’ seedlots, which are commercial wild stand collections, were also present in the study in order to represent the common genetic background of the native population or provenance. . The studied families were from local and non-local provenances, ranging from the Lat. N 53 58 to Lat. N 50 42 (Appendix I Map 1, Chapter 2). As indicated earlier, 45 of the original 180 families were used, and family selection criterion was as described in

Chapter 2. The number of trees per family ranged from sixteen to twenty-six with the total number of study trees at Bowron and Moffat being 482 and 405, respectively. Data was collected on individual trees during the period of June 2006 to October 2007. Correlation comparisons for this chapter are based on variables that may have significance in the lifecycle of MPB, had significant family variation, and therefore had a greater than zero heritability. Making correlations between variables with significant heritability values ($h^2 \geq se$) allows us to detect further interactions between tree genetics and the life cycle of MPB.

Methods:

Objective 1: Quantify DBH, height, and bark texture of lodgepole pines

The DBH of each tree was measured 1.4m from the base of the tree on the highest side of the tree. DBH of study trees was measured to the nearest 0.1 cm in June 2007. Heights were measured by the BC Ministry of Forests and Range when the trees were 10 years old (Yanchuk, Murphy et al. 2007).

The texture of each trees outer bark was recorded in June of 2007. Textures were categorized at 1.4 m above ground level on a scale of bark roughness and fissures from 1-5 (Appendix II photos 1-5). Trees with predominately smooth bark were given a score of 1 (Smooth). Trees with smooth bark but with some light fissuring were categorized as 2 (Smooth-Medium). Trees received a score of 3 if they had moderate fissuring (Medium). Trees with extensive fissuring and more than 50% of the sections of bark beginning to lift off the bole of the tree around the edges of each section, were given a score of 4 (Medium-Rough). Trees with extensive deep fissuring and many sections of bark rising off the tree, around the edges and curling back upon themselves were scored as 5 (Rough).

Objective 2: Quantify the multiple host selection, acceptance and utilization success of MPB attack of lodgepole pine

Host selection landing – To determine if all lodgepole pine trees in the study area were landed upon by MPB, sticky traps were secured to the surface of every study tree ($N=887$). Sticky traps were attached to individual trees before the MPB flight seasons of 2006 and 2007. Sticky traps were constructed using 21.59 x 27.94 cm transparent plastic film (Staples Business Depot) that were covered with ~2-5 mm of Stick Em, (Pherotech International Inc. Delta, British Columbia), leaving a 3 cm border for handling purposes. Sticky traps were stapled approximately 2 m from the base of each study tree. We assumed beetles would land on this surface because of previous observations of beetle landing behavior and results from other studies (Wood 1982). This placement left the area around 1.4 m above ground level free for the work described in Chapter 2. The sticky traps were left in place throughout the flight season. Post flight they were collected from the trees and visually examined for the presence or absence of MPB. In addition, the bole of each tree was examined for the presence of MPB. Each sticky trap and tree was given a score of 1 for MPB present or 0 if there were no signs of MPB.

Host acceptance – We calculated the density of pitch tubes on the north and south aspects of study trees to determine if MPB had attempted to colonize a tree and the density of those MPB attempts. Pitch tubes are defined as the physical exudation of resin combined with boring wood dust and particles created by MPB during the attempt. The density of pitch tubes on each study tree was measured at Bowron after the MPB flight of 2006, but prior to

MPB flight in 2007. Following beetle flight in 2006, density of pitch tubes was quantified and categorized at Bowron but not at Moffat due to the lack of attack at the second site. After freezing temperatures had occurred, in early October of 2007, density of pitch tubes was quantified and categorized at Bowron and Moffat. Freezing temperatures likely ended beetle flight and additional colonization attempts by MPB.

Attack density for each study tree was quantified using a 150 cm² frame made from flexible plastic. Frames were placed on the south and north aspects at 1.4 m from the base of each tree. This was done in a standardized location to provide an accurate estimate of attack density. Pitch tubes from 2007 were differentiated from 2006 pitch tubes by color and pliability. For example, older pitch tubes were hard, tan in color, and would crumble under pressure; whereas new pitch tubes were pink in color, sticky to the touch, and pliable. Only recent-year pitch tubes were counted within the frame, since 2006 densities were previously calculated. A classification was given for the overall attack density of MPB on each study tree. Overall attack classification was done to provide another estimate of attack density and to avoid the misrepresentation of trees that had escaped notice during pitch tube counts. Trees without pitch tubes were scored as 0. Trees with one to five pitch tubes were classified as 1 and trees with more than five pitch tubes were ranked as 2.

Host utilization – To determine the internal tree dynamics of the MPB attacks, 303 trees were intensively sampled. Depending on the availability and accessibility of pitch tubes, one to three pitch tubes were identified on each tree for intensive sampling. Outer bark was removed from around the pitch tube to expose the sapwood. Each area varied in width and length, but was large enough to reveal the full parental gallery and larval galleries. Within

the exposed area the first variable identified was the presence or absence of a hypersensitive resinous lesion. Formation of a hypersensitive resinous lesion is one response the tree has to MPB attack that typically stops the attack. They are dark brown and occur around the nuptial chamber and parental gallery.

If the tree response did not kill the entering beetle, the beetle excavated an ovipositional gallery. Ovipositional galleries were ranked with a 1 if there was a hypersensitive response or a 0 if there was no visible hypersensitive response. The length of the ovipositional gallery was measured. Sampled gallery length(s) excavated within each tree were averaged providing one value per tree.

Larvae survivorship and brood development, indicated by larval galleries perpendicular to the parental gallery, received a score of 1 if they were present or 0 if the parental gallery lacked evidence of egg eclosion and larval feeding. The numbers of visible larval galleries were counted. Counts were averaged for each tree, providing one value for analysis.

Successful MPB attacks resulted in mortality of the lodgepole pine tree. The stage of tree mortality was described at the end of MPB flight season in 2006 and 2007. Trees with green, live crowns, with or without insect damage, were classified as 0. Trees with red, red-green or fading crowns received a 1 to indicate the likelihood of mortality. To confirm tree death the outer bark of each tree was inspected for entrance and/or exit holes of MPB, *Ips* spp., and other wood boring insects, although tree mortality caused by agents other than MPB was minimal and these trees were removed from the study population. Galleries exposed for ovipositional gallery length were used to identify patterns of bark beetle genera and/or species that colonized the tree (Furniss and Carolin 1977; Wood 1982). It was

assumed that the insect with the greatest number of galleries was the mortality agent. If MPB galleries were not present, but *Ips* spp. galleries were present, then *Ips* spp. were assumed to be the cause of death.

Objective 3: Estimate the heritability of lodgepole pine phenotypic characteristics related to MPB host selection, acceptance and utilization in lodgepole pine

Heritabilities (h^2) were estimated for data that included MPB host selection, reproduction, and brood development. Calculations were made for MPB presence or absence on the sticky traps and tree bole, pitch tube density and classification, hypersensitive response, mean parental gallery length, and mean number of larval galleries. Tree classification for pitch tubes and pitch tube density were adjusted to binary data to provide a 'yes' or 'no' response for attack and to decrease the number of variables. Trees with pitch tubes were scored as 1 and trees without pitch tubes were indicated scored as 0 (i.e., a pooled pitch tube classification). Hypersensitive responses, parental gallery lengths, brood development, and number of larval galleries were each averaged and pooled within each sample year and sample numbers (trials) within individual trees. Pooling both individual parental gallery lengths and the number of larval galleries increased sample sizes for each variable by lowering the quantity of individual galleries compared and creating a mean variable instead. This also decreased the overall number of variables. Pooling variables provided more accurate estimates of MPB development and resulting host mortality over the two-year study. Variables were pooled for trees that had been attacked by the end of the 2007 MPB flight season. The hypersensitive responses to MPB attack rating for 2006 and 2007 were summed and if a value was >1 it was converted to 1. This indicated whether or

not the tree produced a hypersensitive response to MPB attack when attacked. Brood development rating was summed across years and values >1 were also converted to 1. This indicated whether or not the tree was able to defend against this step in MPB progression. The mean parental gallery length was calculated using the average length of parental galleries in 2006 and 2007. Similarly, the number of larval galleries was averaged and pooled for both years.

Heritabilities (h^2) for tree height, DBH, bark texture, and tree mortality as well as MPB host selection, reproduction, and brood development variables were estimated as follows: $h^2 = 4*V_F/V_P$, V_A represents additive genetic variance and V_P being total phenotypic variation, $V_A = \text{family variance } (V_F) \text{ multiplied by four}$ and $V_P = \text{the sum of environmental variance and the variance from the interaction of family and site}$. Family variance was multiplied by four before estimating additive genetic variance because variance among families in half-sibling trials account for only one-fourth of additive genetic variance (Falconer 1981). All heritability values were calculated using PROC MIXED (SAS institute version 8.2, Cary, NC 1999-2001). Standard errors for all heritability values were estimated using the COVTEST statement within PROC MIXED. This gives appropriate estimates for heritability standard errors (Becker 1975) (Appendix II Diagram 1).

Although the study families were not truly random effects, they were chosen to represent a cross section of families that had differential MPB attack rates, therefore it is assumed that the bias is minimal for attributes in this study.

Objective 4: Determine if the steps of MPB host selection, acceptance, and utilization in lodgepole pine are correlated to lodgepole pine defensive responses

A correlation matrix was constructed using both whole sample population (phenotypic) and family (genetic) mean correlations. Although family mean correlations are not true genetic correlations, and tend to be lower than genetic correlations, they can be considered suitable substitutes when sample sizes are not extremely large (Roff 1995); they will still provide useful insights into the magnitude of the important relationships between traits with significant genetic variation.

Tree defense traits used in the matrix were calculated from a companion study (Chapter 2). Constitutive tissue was collected at sample time 0 indicating pre-simulated attack condition. Trees were inoculated with fungi on both the east and west side. Seven days after the inoculations a lesion resulting from the inoculation was exposed and phloem tissue was collected from the lesion area representing induced defense at sample times 1 and 2 (i.e., sample days 7 and 12 post inoculation). Lesions were measured at both sample times and compared. Defensive traits were included if they had a positive estimated heritability with a standard error that was not greater than or equal to the estimate. Defensive traits were further parameterized to include terpenes that had high proportions, greater than ~2% of total terpenes, and were identified as having toxic effects on MPB or other coniferophagous herbivores (Cook and Hain 1988; Lindgren, Nordlander et al. 1996; Rocchini, Lindgren et al. 2000; Faldt, Martin et al. 2003; Carlow, Ayers et al. 2006) or known to be pheromone precursors (Borden 1982; Seybold, Quilici et al. 1995; Raffa 2001; Pureswaran and Borden 2005). These included lesion lengths at sample times 1 and 2 post inoculation, β -phellandrene, δ -3-carene, limonene, α -pinene, β -pinene, myrcene, terpineol, terpinolene, and total monoterpenes. All sample times of terpenes and terpene ratios were included in the correlation matrix. Variables from this study were included if there was significant genetic

variation ($h^2 > 0$, $se \leq h^2$). These variables included tree height, diameter, bark texture, MPB presence or absence on sticky traps, pooled pitch tube rating, pooled hypersensitive responses to MPB attack, pooled brood development, and pooled parental gallery length.

Statistical analyses

Variation was calculated for the phenotypic measurements of tree height, diameter, and bark texture and for density and classification (un-adjusted to binary) of pitch tubes. Variances were calculated for the site, replicate within site, tree family, and interaction of family and site. Variances were calculated using PROC GLM (SAS Institute version 8.2, Cary, NC). Assumptions of normality and equal variance were met using residual plots.

Chi-squared analyses were used to compare the binary variables MPB presence or absence on sticky traps, tree mortality, pooled pitch tube classification (adjusted to binary), hypersensitive responses to MPB attack, and MPB brood development. Chi-squared analyses were conducted on these variables for all data combined, at individual sites, and within individual tree families. Chi-squared and Fisher's exact test statistics were calculated using PROC FREQ with a CHISQ test (SAS Institute version 8.2, Cary, NC). After test statistics and probabilities were produced, Chi-squared and Fisher's exact test statistics were compared. Probabilities of Chi-squared values were removed due to their similarity to values produce using Fisher's exact test. Furthermore, Fisher's exact test is a more robust and conservative test for the low sample sizes. Correlations were calculated using PROC CORR (SAS institute version 8.2, Cary, NC 1999-2001).

Results

Objective 1: Quantify DBH, height, and bark texture of lodgepole pines

Diameters of study trees varied significantly by site, replication within site, family, and the interaction of family and site (Table 1). The mean DBH of families ranged from 9.38 to 12.13 cm (SE=0.47, 0.30) (Table 2). The mean DBH of families at Moffat ranged from $X=8.29$ to 12.23 (SE=0.68, 0.70) had a wider range than families at Bowron [$(X=9.89$ to 12.51) (SE=0.51, 0.56)] (Table 3).

The height of study trees varied significantly by the main effects of site, replicate within site, family, and the interaction of family and site (Table 1). The mean tree height of families ranged from 300.65 to 407.81 cm (SE=11.98, 16.63) (Table 2). There was more variability with mean tree height of families at Moffat ($X=241.29$ -380.83 (SE=24.13, 17.15)) than at Bowron ($X=312.86$ to 432.00) (SE=19.82, 21.44)) (Table 3).

The bark texture of the study trees varied significantly by the main effects site, replicate within site, and family (Table 1). It did not vary significantly with the interaction of family and site (Table 1). The mean texture of the bark of families ranged from 1.75 to 3.17 (SE=0.22, 0.17) (Table 2). Similar to diameter and tree height, the mean bark texture classification of families was more variable at Moffat ($X=1.60$ to 3.45 SE=0.40, 0.16) than at Bowron ($X=1.63$ to 3.14 (SE=0.26, 0.26)) (Table 3).

Objective 2: Quantify the multiple host selection, acceptance and utilization success of MPB attack of lodgepole pine

Sticky traps captured MPB on 264 trees in both 2006 and 2007. Thirteen of forty-five families had significant differences (Fisher's Exact $P > \chi^2 = \leq 0.05$) in the presence/absence of beetles on trees between the years 2006 and 2007 (Table 4). Seventeen families had more,

eighteen families had fewer, and ten families had the same percentage of trees with MPB present on sticky traps in 2006 compared to 2007 (Table 5). The percentage of trees within families with MPB present on sticky traps ranged from 5% to 56% after the flight period of 2006 (Table 5).

In 2006 the percent of families with MPB present on sticky traps ranged from 0% to 88% at Bowron and 0% to 33% at Moffat (Table 6). Twenty-five families at Moffat did not have MPB on their sticky traps in 2006, while only one family (#45) at Bowron had no beetles caught on its sticky traps (Table 6). After the MPB flight period in 2007, 6% to 64% of trees per family had MPB present on sticky traps (Table 5). The percent of MPB on sticky traps in 2007 within families ranged from 9% to 87% of trees at Bowron (Table 6). At Moffat, the percent of trees within families, with MPB present on sticky traps, ranged from 0% to 38% in 2007 (Table 6). Fourteen of forty-five families at Moffat did not have beetles land on their sticky traps in 2007, while all forty-five families at Bowron were landed upon by MPB.

Chi-squared test indicated that significantly more trees in 2006 than 2007 had sticky traps containing MPB ($\chi^2 = 259.17$, Fisher's Exact $P > \chi^2 = <0.001$) (Table 7). Similarly, at Bowron there was a significantly higher presence of beetles on trees in 2006 than 2007 ($\chi^2 = 183.74$, Fisher's Exact $P > \chi^2 = <0.001$). However, at Moffat there was no significant difference between years ($\chi^2 = 0.05$, Fisher's Exact $P > \chi^2 = 1.00$) (Table 8).

Of the overall 887 trees in this study, 39% (349) showed signs of MPB colonization and had pitch tubes. The number of pitch tubes per 150 cm² (pt/150 cm²) on north and south aspects in 2007 varied significantly by site and replicate within site (Table 1). Pooled data for pitch tube presence within families ranged from 0% to 25% of trees (Table 5). In 2006

pitch tube density and classification varied by replicate within site, but not by family (Table 1). Pitch tube data was not gathered at Moffat in 2006 and therefore cannot be discussed (Table 1). Pitch tube classification in 2007 varied significantly by site, replicate within site, and by tree family (Table 1). All pitch tube variables in 2007 (i.e. pitch tube counts north, south, and classification) did not vary significantly with the interaction of site and family (Table 1).

In 2006, the mean density of pitch tubes for families at Bowron ranged from 0-0.89 pitch tubes/150 cm² (SE=0, 0.48) on the north side of the trees and 0 to 1.29 pitch tubes/150 cm² (SE=0, 0.84) on the south sides of study trees (Table 3). That same year, mean pitch tube classification for families at Bowron ranged from 0.14 to 1.43 (SE=0.14, 0.30) (Table 3).

The mean pitch tube density on the north side of trees in 2007 ranged from 0 to 0.89 pitch tubes/150 cm² (SE=0, 0.48) (Table 2). However, the south side of trees had a greater range from 0 to 1.29 pitch tubes/150 cm² (SE=0, 0.84) (Table 2). The density of pitch tubes on study trees at Moffat was more variable than those at Bowron. The mean ranged from 0 to 0.57 pitch tubes/150 cm² (SE=0, 0.43) and 0-0.43 pitch tubes/150 cm² (SE=0, 0.43) on the north and south sides of study trees, respectively (Table 3).

Mean pitch tube classification in 2007 ranged from 0 to 1.43 (SE=0, 0.30) for all families (Table 2). The range for all families at Moffat in 2007 was 0 to 0.57 pitch tubes/150 cm² (SE=0, 0.57) on the north side and 0 to 0.43 pitch tubes/150 cm² (SE=0, 0.43) on the south sides of the study trees (Table 3). The classification of pitch tubes for families at Moffat ranged from 0 to 1.00 (SE=0, 0.33) (Table 3). The range for all families at Bowron in 2007 was 0 to 0.22 pitch tubes/150 cm² (SE=0, 0.22) on the north side and 0 to 0.20 pitch

tubes/150 cm² (SE=0, 0.20) on the south sides of the study trees (Table 3). That same year the classification of families at Bowron ranged from 0 (SE=0) to 0.30 (SE=0.21) (Table 3).

Many trees attacked by MPB exhibited hypersensitive reactions in response to host utilization. The overall number of trees exhibiting this response was 211 of the 349 attacked by MPB. The percent of all study trees within families, that displayed a hypersensitive response to MPB attack ranged from 17% to 100% (Table 5). Seven families had hypersensitive reactions occurring in every tree that was attacked by MPB (Table 5).

While hypersensitive reactions halted the progression of many female beetles, in 306 of the 349 trees attacked, MPB females started construction of ovipositional galleries. All forty-five families had parental gallery formation in at least one of their trees (Table 9). The average length of parental galleries ranged from 0.94 to 13.41 cm (SE=0.28, 2.71) (Table 9). Of the 306 trees that had parental galleries initiated, 49 produced larval galleries. The proportion of trees with MPB offspring developing ranged from 0 to 50% within tree families (Table 5). In twenty-five families there were no signs of MPB larval galleries and therefore no reproduction (Table 5). The mean count of larval galleries per family ranged from 4 to 27.67 galleries (Table 9).

By the end of the flight period in 2007, 113 study trees were killed by MPB. In 2006, at Bowron, 76 trees were found to have been killed by MPB. The percent of study trees at Bowron, within families, that were killed by MPB in 2006 ranged from 0% to 57% (Table 5). No study trees at Moffat were killed in 2006. In 2007 trees killed per family at both sites ranged from 0% to 39% (Table 5). After the flight of 2007 the percent of trees killed per family ranged from 0% to 67% and from 0% to 27% at Bowron and Moffat, respectively

(Table 6). Chi-squared analysis revealed, as expected, that there were significant differences in tree mortality in 2006 and 2007 ($\chi^2 = 341.79$, Fisher's Exact $P > \chi^2 = <0.001$).

Objective 3: Estimate the heritability of lodgepole pine phenotypic characteristics related to MPB host selection, acceptance and utilization in lodgepole pine

Analysis of lodgepole phenotypic characteristics revealed that all traits had significant additive genetic variation (Table 10). The estimate of h^2 for tree height was 0.45 (SE=0.14) and for DBH 0.30 (SE=0.10). The texture of the outer bark had the highest estimated heritability value of 0.64 (SE=0.17).

Heritability estimates were different for each step of MPB host selection, acceptance and utilization. The estimated heritability of beetle presence on sticky traps was significantly heritable although pitch tube densities were not significant (Table 10). The pitch tube classification in 2006 had an estimated heritability of 0.04 (SE=0.09), which is not surprising due to relatively low attack incidence. However, the pitch tube classification during 2007 had a significant estimated $h^2=0.08$ (SE=0.05) (Table 10). Hypersensitive reactions in response to MPB utilization and colonization had an estimated heritability value of 0.16 (SE=0.15). The estimated heritability of the pooled average length of parental galleries was 0.18 (SE=0.16). Brood development had an estimated heritability value of 0.19 (SE=0.15). The estimated heritability of the number of larval galleries suggested significance at a value of 1.29 (SE=0.97), however estimates over 1.0 are out of the range of possible estimated additive genetic variance and suggest the sample sizes may have been too small for such a variable. Estimated heritabilities of MPB-caused mortality in 2006 was 0.37 (SE=0.15) and 0.20 (SE=0.08) during 2007.

Objective 4: Determine if the steps of MPB host selection, acceptance, and utilization in lodgepole pine are correlated to lodgepole pine defensive responses

As MPB approach a tree it is thought that they select a host based upon DBH and tree height among others traits. MPB presence on sticky traps indicated host tree selection. Family mean DBH was not significantly correlated with host selection in 2006 ($r=0.09$, $P>r=0.54$) or 2007 ($r=0.24$, $P>r=0.11$). However, DBH for the population (phenotypic) showed significant correlations with landing in both 2006 ($r=0.08$, $P>r=0.02$) and 2007 ($r=0.12$, $P>r<0.01$). Family means for height is not significantly correlated with landing in 2006 ($r=-0.01$, $P>r=0.96$) or 2007 ($r=0.16$, $P>r=0.29$), but population is significantly correlated in both 2006 ($r=0.24$, $P>r<0.001$) and 2007 ($r=0.27$, $P>r<0.001$).

Whether a MPB had selected and accepted a host was determined by the presence of pitch tube(s) (i.e. density converted to 1 present or 0 absent) due to the tree attempting to stop beetle entry. Family mean pitch tube presence or host acceptance was not significantly correlated with host selection in 2006 ($r=-0.13$, $P>r=0.38$) or 2007 ($r=-0.02$, $P>r=0.90$) (Table 11a). Population host selection in 2006 ($r=-0.05$, $P>r=0.11$) was not significantly correlated with host acceptance; however, they were significantly correlated in 2007 ($r=0.17$, $P>r<0.001$) (Table 11b). Bark texture based on family means ($r=-0.22$, $P>r=0.15$) and population ($r=-0.02$, $P>r=0.52$) was not significantly correlated with host acceptance (i.e., pitch tube presence) (Table 11a/b).

Host utilization was determined by the ability of attacking female MPBs to construct a parental gallery through the phloem tissue. The presence of pitch tube(s) showed a significant correlation with parental gallery length for the population ($r=0.23$, $P>r<0.001$)

(Table 11b), but not between families ($r=0.01$, $P>r=0.94$) (Table 11a). Hypersensitivity was strongly negatively correlated with the parental gallery length for both family ($r=-0.71$, $P>r<0.001$) and population ($r=-0.73$, $P>r<0.001$) correlations (Tables 11a/b). Family mean parental gallery length was significantly correlated at sample day 12 with δ -3-carene ($r=0.30$, $P>r=0.05$), myrcene ($r=0.34$, $P>r=0.02$), β -phellandrene ($r=0.41$, $P>r=0.01$), terpinolene ($r=0.32$, $P>r=0.03$), and total terpenoids/monoterpenes ($r=0.45$, $P>r<0.01$) (Table 11a). However, limonene ($r=0.14$, $P>r=0.37$), α -pinene ($r=0.07$, $P>r=0.65$), β -pinene ($r=0.09$, $P>r=0.57$), and terpineol ($r=0.28$, $P>r=0.37$) did not show significant trends at sample day 12 (Table 11a). No other sample times displayed significant correlations with parental gallery length (Table 11a). Parental gallery length for the population exhibits significant correlations at sample day 12 for limonene ($r=0.12$, $P>r=0.05$), myrcene ($r=0.12$, $P>r=0.05$), β -phellandrene ($r=0.14$, $P>r=0.01$), and total terpenoids/monoterpenes ($r=0.12$, $P>r=0.04$) (Table 11b). In contrast δ -3-carene ($r=0.09$, $P>r=0.15$), α ($r=0.06$, $P>r=0.31$) and β -pinene ($r=0.03$, $P>r=0.56$), terpineol ($r=0.07$, $P>r=0.27$), and terpinolene ($r=0.10$, $P>r=0.11$) were not significantly correlated with parental gallery length (Table 11b).

Host utilization and suitability for MPB is also determined in study trees by the production of offspring or through beetle fecundity. Family brood development (i.e., offspring production) and parental gallery length were positively correlated ($r=0.62$, $P>r<0.001$) (Table 11a). Population brood development and parental gallery length also displayed a positive slope ($r=0.54$, $P>r<0.001$) (Table 11b). Family ($r=-0.44$, $P>r<0.01$) (Table 11a) and population ($r=-0.50$, $P>r<0.01$) (Table 11b) hypersensitivity correlated significantly with brood development. Of the seven major lodgepole pine terpenoids, only β -phellandrene at day 12 exhibited a significant trend with family brood development ($r=0.31$,

$P>r=0.04$) (Table 11a). All terpenoids for the population were not significantly correlated with family brood production at all sample times (Table 11b).

Host survival was a useful parameter to describe MPB success within lodgepole pine. Family lodgepole pine mortality in 2006 correlated significantly and showed an increasing trend in mortality when compared with DBH ($r=0.39$, $P>r=0.01$), landing in 2006 ($r=0.31$, $P>r=0.04$), parental gallery length ($r=0.69$, $P>r<0.001$), brood development ($r=0.63$, $P>r<0.001$), and total terpenoids/monoterpenes at sample day 12 ($r=0.38$, $P>r=0.01$) (Table 11a). Family hypersensitivity correlated with host mortality in 2006, showing a significant decreasing trend ($r=-0.50$, $P>r<0.01$) (Table 11a). Family mortality in 2006 was not significantly correlated to tree height ($r=0.16$, $P>r=0.30$), bark texture ($r=0.26$, $P>r=0.09$), or pitch tube presence (Table 11a). Mortality in 2006 for the population displayed significant increases with increasing DBH ($r=0.17$, $P>r<0.001$), tree height ($r=0.19$, $P>r<0.001$), bark texture ($r=0.15$, $P>r<0.01$), landing in 2006 ($r=0.36$, $P>r<0.001$), parental gallery length ($r=0.67$, $P>r<0.001$), brood development ($r=0.65$, $P>r<0.001$), myrcene at sample day 7 ($r=0.10$, $P>r=0.03$), β -phellandrene at sample days 7 ($r=0.10$, $P>r=0.03$) and 12 ($r=0.13$, $P>r=0.01$), α -pinene at sample day 12 ($r=0.10$, $P>r=0.03$), and total terpenoids/monoterpenes at sample days 7 ($r=0.10$, $P>r=0.03$) and 12 ($r=0.12$, $P>r=0.01$) (Table 11b). Negative trends were seen with pitch tube presence ($r=-0.10$, $P>r=0.02$), hypersensitivity ($r=-0.75$, $P>r<0.001$), and δ -3-carene at sample day 0 ($r=-0.09$, $P>r=0.05$) (Table 11b).

Mortality in 2007, and over the course of the study, for families was significantly correlated with DBH ($r=0.31$, $P>r=0.04$) landing in 2006 ($r=0.40$, $P>r=0.01$) and 2007 ($r=0.63$, $P>r<0.001$), mortality in 2006 ($r=0.86$, $P>r<0.001$), parental gallery length ($r=0.58$, $P>r<0.001$), and brood development ($r=0.52$, $P>r<0.01$). Significant decreasing

trends in host mortality by 2007 were shown when compared with hypersensitivity ($r=-0.44$, $P>r<0.01$) and δ -3-Carene at day 0 ($r=-0.35$, $P>r=0.02$) (constitutive) (Table 11a). Family mortality in 2007 was not significantly correlated with tree height ($r=0.21$, $P>r=0.17$), bark texture ($r=0.25$, $P>r=0.10$), or the presence of pitch tubes ($r=-0.03$, $P>r=0.85$) (Table 11a). The mortality of the population in 2007, exhibited significant increases due to increases in DBH ($r=0.12$, $P>r<0.01$), tree height ($r=0.23$, $P>r<0.001$), landing in 2006 ($r=0.47$, $P>r<0.001$) and 2007 ($r=0.47$, $P>r<0.001$), parental gallery length ($r=0.49$, $P>r<0.001$), brood development ($r=0.54$, $P>r<0.001$), limonene at sample day 12 ($r=0.07$, $P>r=0.04$), β -phellandrene at sample days 7 ($r=0.08$, $P>r=0.03$) and 12 ($r=0.08$, $P>r=0.01$), and total terpenoids/monoterpenes at sample day and 12 ($r=0.07$, $P>r=0.04$) (Table 11b). Negative trends were seen with pitch tube presence ($r=-0.11$, $P>r<0.01$), hypersensitivity ($r=-0.52$, $P>r<0.001$), and δ -3-carene at sample days 0 ($r=-0.11$, $P>r<0.01$) and 7 ($r=-0.07$, $P>r=0.05$) (Table 11b). Bark texture was not significantly correlated with mortality in 2007 ($r=0.02$, $P>r=0.58$) (Table 11b).

Discussion

Lodgepole pine attacked by MPB-fungal complex displays various defense characteristics throughout the multiple host selection, acceptance and utilization processes undertaken by the colonizing insects. Many tree characteristics are passed from parents to their progeny, i.e. many processes are heritable. However, the degree of variation differs with each variable. This study examined lodgepole pine defense characteristics for their heritability and correlations with the life cycle of MPB as well as tree defenses from a companion study as they related to overall MPB success or host death.

Diameter and tree height was taken for all study trees. DBH and tree height varied by the main effects site (environment), family (genetics) and by the interaction (family x site). This was also shown in a study conducted by Yanchuk et al. (2000). Diameter is well known to be a relatively low heritability trait and as such is affected by environmental conditions such as available water, sunlight, temperature, etc., to a large degree.

Bark texture varied by site and family, but not by the interaction between site and family, with trees at the Moffat site having rougher bark than those at Bowron. This suggests that both environmental factors and genetics affect phenotypic characteristics.

For the discrete variable, MPB landing on lodgepole pine sticky traps was significantly different for less than one-third of families from 2006 to 2007. Lack of variance indicates that host differentiation is not done prior to landing on the tree, which indicates that pioneering MPB may leave a possible host in search of a more desirable one. This suggests environment and microhabitat may also play a role in host selection. Furthermore, the variation in inter-year landing rates supports the idea beetles not making a pre-landing decision. However, the data strongly supports MPB making a choice between families.

Overall there were significantly more trees with MPB on the sticky traps in 2006 than 2007. However, differences were significant only at Bowron, which was the primary site in this study. At Bowron only one tree family was not landed upon in 2006 and all tree families were landed upon in 2007. The proportion of trees with MPB present per family at Bowron was 9% to 87% in 2007 while Moffat had a range of 0% to 38%. Bowron's range spans nearly the majority of possible landings per family. Lower landing rates at Moffat were potentially affected by scramble competition for better quality sources or simply by random landing.

Host acceptance was determined by the presence of MPB attempting to colonize the tree. Thirty-nine percent of trees in this study had pitch tubes by the second and final study year (2007). The south side of trees had significantly more pitch tubes than the north in 2006 and 2007. This suggests that microclimate is important during host acceptance. Allow the direction the beetles are flying from may play a role as well. For example, it may be more important to have a sun-exposed (warmer temperature) environment during particular times in the MPB life cycle. Host acceptance variables over the course of the study, showed significant variation for the main effects site, replicate within site, family and by the interaction of family and site. Following host acceptance, trees respond to MPB-fungus by allocating carbon-based defenses to the site of entry. This is usually expressed by the formation of hypersensitive reaction tissue in the phloem. As initial entry into the tree occurred, formation of hypersensitive reaction tissue was generally present if the tree was capable of expressing this resistance. Trees responded to MPB acceptance in the form of hypersensitive reactions in 211 of 349 trees attacked. There was a wide range of trees within families exhibiting hypersensitive reactions (17% to 100%). This indicates the range of variation and suggests, as earlier reported, a statistically significant, albeit low, h^2 for this trait. Seven families had hypersensitive reactions in every attacked tree.

Hypersensitive reactions in response to host acceptance may have an impact on the variation in host utilization that can be observed in parental gallery length. Similar to results discussed in Yanchuk et al., (2007) hypersensitive reactions halted female pioneering beetles. Evidence of hypersensitive reactions at entry sites revealed hypersensitive reactions to slow or stop the beetle and to decrease parental gallery length. This may have led to only 49 trees containing larval galleries. However, other factors such as phloem thickness, other tree

traits, or even colder-than-normal temperatures during specific months may have played a part.

Brood development occurring in such low numbers of total trees attacked could be a product of many variables. However, there was family variation in the percent of trees per family having larval galleries (0% to 50%) and the number of larval galleries variation in host utilization per family. It appears that although many trees were attacked by MPB, very few MPB were able to successfully use the tree. The data indicate that hypersensitive reactions affect every step in the life cycle of MPB after host selection. The final step used to describe MPB success is by a resulting dead host tree.

Although beetles were not generally successful in fully using their host trees, many trees succumbed to the higher attack rates; however, there was variation by family in tree mortality over both years. The range of trees killed per family by the end of the study was smaller at Moffat than at Bowron. During this study, significantly more trees were killed by the end of the study in 2007 than by the end of the beetles' flight period in 2006. This seems to follow a logical path that other studies have reported with infestation patches starting in a forest one year and then a subsequent larger outbreak the next (Yanchuk, Murphy et al. 2007).

Many tree variables that potentially affect the life cycle of MPB showed variability among families, and by the magnitude of the heritabilities estimated here it is clear that significant levels of additive genetic variation are present for many of these characteristics in lodgepole pine. As discussed in the companion study (Chapter 2) correlations will be limited to traits with low (0-0.25), moderate (0.25-0.5), or high (>0.5) heritabilities. For the steps involved in host selection, moderate heritability values (h^2) were observed for DBH and tree

height. Bark texture was estimated to have a high h^2 . Bark texture may play an important role in host selection and acceptance, providing niches for initial entry; however, the two key variables for host selection (MPB landing on sticky traps) and host acceptance (pitch tube presence) did not have significant h^2 except for host acceptance in 2007, which was low. This does not support the hypothesis that families are differentially attacked based on landing rates. With a reasonable beetle pressure in the study, and a relatively large sample size of sample trees (and degrees of freedom for the test), the results suggest that MPB landing and pitch tube presence might not be related. Other variables that affect MPB choice must be occurring after landing, as earlier discussed with respect to host tree volatiles, presence of other beetles (Wallin and Raffa 2005), pheromone production and gustation as reported by (Safranyik and Carroll 2006).

As MPB attempt to colonize a host tree the formation of hypersensitive reactions seems to immediately halt them from constructing parental galleries. Hypersensitive reactions had a significant, but low, heritability value. As such, environmental influences, i.e., the condition of the tree and other micro-site affects, largely affect this trait, although it still appears to be an important variable.

Variables associated with host utilization also had significant but low h^2 . Although presence of larval galleries had significant family effects in the ANOVA, the heritability exceeded 1.0 and therefore cannot be considered a reliable estimate. This may be due to a small sample population (n), where degrees of freedom for an accurate calculation are limited.

Finally, the success of MPB in killing their host was examined. Mortality heritabilities were significant for both years, with 2006 showing moderate heritability and

2007 showing low heritability. The results indicate that while many variables affect the life cycle of MPB some are not highly heritable. The joint effects of many variables likely contributed to make mortality a heritable trait (Yanchuk, Murphy et al. 2007). To examine which variables may interact to affect tree host family throughout the MPB life cycle family, mean correlations (approximate genetic correlations) were calculated. In addition whole population correlations (phenotypic) were calculated for comparisons between genetic effects and environmental effects.

In the process of host selection it is thought that diameter and tree height have a key role (Safranyik and Carroll 2006). Diameter and tree height are linked to tree age, vigor, bark roughness and other variables associated with MPB attack and colonization (Shepherd 1966; Amman 1969). Family DBH and tree height were not significantly correlated with host selection in 2006 or 2007. However, there were small population trends indicating minor increases in host selection based upon DBH and tree height. This indicates that while there are genetic controls over the diameter and tree height, other variables may be more important for host selection. These could include, but are not limited to, host tree volatiles, beetle population levels, beetle vigor, scramble competition and random landing. However, the minor trends seen in the population do support other studies. Host selection not being correlated with tree characteristics among families may help explain the non-significant correlations seen between sticky traps and pitch tube presence. However, host selection in 2007 did show significant trends in host acceptance. This may be due to MPB spread through the study site or the occurrence of high beetle populations. A variety of other variables, such as other avoidance mechanisms or the environment, may also cause significant effects. Bark texture was not significantly correlated with host acceptance. This

suggests that despite variation in bark texture the minimum roughness was still enough to provide crevices and niches for colonization attempts. As colonization attempts occurred, another possible defense related to the MPB-fungal complex also presented itself, i.e., the presence of dark resinous lesions, surrounding an entrance site, on the phloem and xylem.

This hypersensitive response halts beetle utilization and this is supported by the presence of the hypersensitive reaction tissue being significantly negatively correlated among tree families for MPB parental gallery length. This trend held constant for population correlation as well. This indicates that both family and environmentally controlled hypersensitive responses result in decreasing trends in host utilization.

Host utilization and parental gallery length were significantly affected by some induced terpenoids quantified in the companion study. Traits used for correlation analyses, referenced earlier in Chapter 2, showed that at sample day 12, family δ -3-carene, myrcene, β -phellandrene, terpinolene, and total terpenoids/monoterpenes were positively correlated with host use. Studies have shown that myrcene and terpinolene are involved in aggregation pheromone production. However, δ -3-carene is known to be a toxic compound to MPB and other bark beetles. Perhaps these chemicals are made through the same pathway and therefore increases in certain toxic chemicals may also increase specific pheromone precursors that allow MPB to overcome tree defenses (Raffa and Berryman 1983). Or MPB maybe detoxification products have secondarily been used as pheromone components.

Beetles may have initially entered the study trees and encountered levels of constitutive δ -3-carene that were not toxic enough to halt beetles completely. However, induced terpenoids have effects on many correlation variables and this is further supported by possible levels of terpenoids in hypersensitive reaction tissue.

Overall host utilization and beetle success is determined in this study by host mortality. Host utilization in the form of brood development was significantly correlated with parental gallery length. Other studies have indicated that longer parental galleries are correlated with more larval galleries and higher brood production (Amman 1972; Safranyik and Carroll 2006). This trend was seen for family ($r=0.62$, $P < 0.001$) and population ($r=0.54$, $P < 0.001$) correlations. Decreasing trends in successful host use (brood development) were observed with the presence of hypersensitive reactions for family and population correlations. At this point in the insect life cycle, hypersensitive reactions appear to have effects on MPB success and subsequent tree resistance and survival.

Many factors were significantly correlated with increases in mortality. Family tree mortality in 2006 increased with increasing DBH, host selection in 2006, and host utilization. These increases in mortality support MPB progressing through their life cycle. In the 2006 results, if a MPB selected a tree from a particular family, landed upon it, created a parental gallery, and progressed to producing brood, then trees from that family were more likely to die. However, hypersensitive responses affected this process in the opposite manner. Tree families exhibiting hypersensitive reaction tissue were significantly correlated with decreasing trends in host tree mortality. Similar decreasing trends in host mortality were observed with population correlations of hypersensitive reactions. Other significant correlations were observed to affect whole population's mortality; tree height, bark texture, and specific terpenoids and times, increased population mortality in 2006.

Over the course of the study, the same increasing trends were seen for families in 2007 as in 2006. Significant decreasing correlations were once again observed for hypersensitive reactions. However, by the end of the study, constitutive δ -3-carene also

significantly negatively impacted host mortality. For tree families in this study, families experiencing higher levels of constitutive δ -3-carene or the occurrence of hypersensitive reactions were less likely to be killed.

While it is assumed that other variables, such as environmental characteristics, beetle pressure or attack density (Raffa and Berryman 1983) affect tree mortality, there are also heritable traits that have negative effects on MPB and its associated fungi. The high beetle population levels present during this study may have ‘masked’ subtleties seen between the MPB-fungus complex and its interactions with lodgepole pine. It may be relevant to conduct a study with beetle population levels either rising or at an endemic state. MPB may use lodgepole pine defenses to increase their chance of survival; however lodgepole pine has maintained traits that allow it to successfully defend itself against MPB. Some of those traits are passed down through their offspring creating a next generation that are resistant, resilient or tolerant, or a combination of the three, assuming they do form the next generation of lodgepole pine. The results in this chapter further support results in Chapter 2 that indicate co-evolution within this complex system.

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Tables

Table 2: Repeated measures analysis of variance for between subject effects of lesion length (*cm*) and for terpenoids (*ppm/g*) 0, 7, and 12 days post inoculation with *G. clavigera* onto the phloem tissue of 45 half-sibling lodgepole pine families (FAM) at Bowron and Moffat (SITE). There are eight replications within each site (REP(SITE)). The E following the source of variation indicates the degrees of freedom for the error term.

Source of variation	SITE		REP(SITE)		FAM		FAM*SITE	
<i>df</i>	1		14		44		44	
Variable	<i>F</i>	<i>Pr > F</i>	<i>F</i>	<i>Pr > F</i>	<i>F</i>	<i>Pr > F</i>	<i>F</i>	<i>Pr > F</i>
Lesion ^{EE}	20.93	<0.001	14.14	<0.001	2.75	<0.001	1.65	0.01
β-Phellandrene	0.01	0.91	4.5	<0.001	3.09	<0.001	0.85	0.74
β-Pinene	0.89	0.35	1.31	0.20	3.26	<0.001	1.32	0.08
δ-3-Carene	18.95	<0.001	3.34	<0.001	5.05	<0.001	0.71	0.92
α-Pinene	0	0.95	3.81	<0.001	3.02	<0.001	1.15	0.24
Limonene	0.25	0.62	2.26	0.01	4.64	<0.001	1.29	0.10
Myrcene	2.54	0.11	4.39	<0.001	2.77	<0.001	1.05	0.38
Terpinolene	7.52	0.01	3.58	<0.001	2.99	<0.001	0.93	0.61
α-Phellandrene ^E	1.75	0.19	4.45	<0.001	2.44	<0.001	0.83	0.78
Borneol	93.26	<0.001	2.06	0.01	3.74	<0.001	1.04	0.41
Bornyl Acetate	69.04	<0.001	2.31	<0.01	3.27	<0.001	1.31	0.09
Camphene	0.37	0.54	3.2	<0.001	2.25	<0.001	0.76	0.87
Camphor	35.79	<0.001	3.14	<0.001	1.46	0.03	1.01	0.45

df for error 740, 684^E, and 774^{EE}

Table 2: continued

Source of variation	SITE		REP(SITE)		FAM		FAM*SITE	
<i>df</i>	1		14		44		44	
Variable	<i>F</i>	<i>Pr</i> > <i>F</i>	<i>F</i>	<i>Pr</i> > <i>F</i>	<i>F</i>	<i>Pr</i> > <i>F</i>	<i>F</i>	<i>Pr</i> > <i>F</i>
δ-2-Carene	0.05	0.82	0.65	0.83	0.94	0.58	0.79	0.84
p-Cymene	0.11	0.74	2.14	0.01	2.53	<0.001	0.92	0.61
Linalool	43.61	<0.001	1.92	0.02	2.75	<0.001	0.67	0.95
Ocimene	1.07	0.30	0.88	0.58	4.04	<0.001	1.07	0.36
Pulegone	0.03	0.87	2.67	<0.01	1.57	0.01	1.21	0.17
Sabinene	3.12	0.08	3.33	<0.001	2.23	<0.001	0.95	0.57
α-Terpinene	54.98	<0.001	2.17	0.01	2.54	<0.001	0.95	0.57
γ-Terpinene	105.53	<0.001	2.41	<0.01	2.93	<0.001	0.94	0.58
Terpineol	15.43	<0.001	1.79	0.04	2.19	<0.001	0.96	0.54
α-Thujone	37.45	<0.001	1.22	0.25	1.03	0.42	1.03	0.43
α-Caryophyllen	2.66	0.10	1.48	0.11	2.21	<0.001	1.11	0.29
α-Copaene	1.43	0.23	1.86	0.03	2.42	<0.001	1.2	0.18
α-Cubebene	17.44	<0.001	1.6	0.07	2.11	<0.001	1.47	0.03
α-Humulene	46.88	<0.001	3.58	<0.001	2	<0.001	1.2	0.18
Total Terpenoids	0.21	0.65	6.07	<0.001	2.22	<0.001	1.12	0.28
Total Monoterpenes	0.23	0.63	6.08	<0.001	2.21	<0.001	1.12	0.28
Total Sesquiterpenes	33.98	<0.001	2.38	<0.01	2.98	<0.001	1.14	0.25

Table 3: Repeated measures analysis of variance for within subject effects (TREE) of lesion length (*cm*) and for terpenoids 0, 7, and 12 days post inoculation with *G. clavigera* onto the phloem tissue of 45 half-sibling lodgepole pine families (FAM) at Bowron and Moffat (SITE). There are eight replications within each site (REP(SITE)). The E following the source of variation indicates the degrees of freedom for the error term.

Source of variation	TREE		TREE*SITE		TREE*REP(SITE)		TREE*FAM		TREE*FAM*SITE	
<i>df</i>	2		2		28		88		88	
Variable	<i>F</i>	<i>Pr</i> > <i>F</i>	<i>F</i>	<i>Pr</i> > <i>F</i>	<i>F</i>	<i>Pr</i> > <i>F</i>	<i>F</i>	<i>Pr</i> > <i>F</i>	<i>F</i>	<i>Pr</i> > <i>F</i>
Lesion ^{EE}	150.52	<0.001	45.41	<0.001	8.02	<0.001	1.48	0.03	1.48	0.02
β-Phellandrene	628.34	<0.001	0.41	0.66	2.62	<0.001	1.64	<0.001	1.06	0.33
β-Pinene	642.97	<0.001	0.85	0.43	2.77	<0.001	1.37	0.01	1.08	0.29
δ-3-Carene	1027.64	<0.001	5.56	<0.01	3.4	<0.001	1.43	0.01	1.12	0.22
α-Pinene	607.46	<0.001	0.07	0.93	2.95	<0.001	1.57	<0.001	1.03	0.41
Limonene	325.88	<0.001	0.13	0.88	2.09	<0.001	1.41	0.01	1.11	0.24
Myrcene	454.11	<0.001	1.86	0.16	2.64	<0.001	1.59	<0.001	1.15	0.16
Terpinolene	610.07	<0.001	0.95	0.39	2.42	<0.001	1.55	<0.01	1.06	0.34
α-Phellandrene ^E	523.93	<0.001	0.08	0.93	2.99	<0.001	1.5	<0.01	1.15	0.16
Borneol	17.6	<0.001	0.84	0.43	1.35	0.11	1.24	0.07	1.1	0.24
Bornyl Acetate	326	<0.001	24.03	<0.001	1.08	0.36	1.61	<0.001	1.09	0.26
Camphene	482.21	<0.001	7.02	<0.001	2.17	<0.001	1.58	<0.001	1.28	0.05
Camphor	392.01	<0.001	29.44	<0.001	1.48	0.05	0.96	0.60	0.93	0.67

df for error 1480 and 1368^E

df 1, 14, 1, 44, 44, and 774^{EE}

Table 3: continued

Source of variation	TREE		TREE*SITE		TREE*REP(SITE)		TREE*FAM		TREE*FAM*SITE	
	F	Pr > F	F	Pr > F	F	Pr > F	F	Pr > F	F	Pr > F
df	2		2		28		88		88	
Variable	F	Pr > F	F	Pr > F	F	Pr > F	F	Pr > F	F	Pr > F
δ -2-Carene	0.42	0.66	2.59	0.08	1.29	0.14	0.84	0.85	1.14	0.18
p-Cymene	376.38	<0.001	19.75	<0.001	1.93	<0.01	1.29	0.04	0.96	0.60
Linalool	105.92	<0.001	33.28	<0.001	1.67	0.02	1.34	0.02	1.19	0.12
Ocimene	39.3	<0.001	0.73	0.48	2.88	<0.001	1.49	<0.01	1.15	0.16
Pulegone	398.41	<0.001	23.73	<0.001	2.62	<0.001	1.06	0.35	0.95	0.62
Sabinene	763.16	<0.001	11.89	<0.001	2.56	<0.001	1.51	<0.01	1.05	0.35
α -Terpinene	383.19	<0.001	30.98	<0.001	1.91	<0.01	1.36	0.02	1.12	0.21
γ -Terpinene	420	<0.001	66.82	<0.001	1.69	0.01	1.3	0.04	1.24	0.07
Terpineol	127.98	<0.001	0.54	0.58	1.75	0.01	0.93	0.66	1.18	0.13
α -Thujone	151.37	<0.001	8.92	<0.001	1.01	0.45	0.84	0.85	1	0.47
α -Caryophyllen	127.07	<0.001	8.94	<0.001	1.95	<0.01	1.17	0.14	1.02	0.43
α -Copaene	28.17	<0.001	1.59	0.21	2.27	<0.001	1.67	<0.001	0.94	0.65
α -Cubebene	6.34	<0.01	1.78	0.17	1.54	0.04	1.24	0.07	1.09	0.27
α -Humulene	47.25	<0.001	4.45	0.01	2.31	<0.001	1.44	0.01	1.22	0.09
Total Terpenoids	759.71	<0.001	0.35	0.71	2.96	<0.001	1.57	<0.001	1.12	0.22
Total Monoterpenes	759.54	<0.001	0.36	0.70	2.95	<0.001	1.57	<0.001	1.12	0.21
Total Sesquiterpenes	52.55	<0.001	4.22	0.01	2.51	<0.001	1.57	<0.001	1.12	0.22

Table 4: Mean (ppm/g) and standard error (se) of terpenes extracted from ploem tissue 0, 7, and 12 days following challenge inoculation with *G. clavigera* onto the phloem tissue of half-sibling families at Bowron and Moffat. There were varying numbers of trees sampled with each sample time and at each site. (*n*=day 0, day 7, day 12)

Terpenoid	Day following inoculation											
	Bowron						Moffat					
	0		7		12		0		7		12	
	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>
β-Phellandrene	11556.52	325.73	32733.77	1095.01	28913.73	858.93	12849.81	560.30	31656.19	1012.41	30852.56	1256.94
β-Pinene	1751.88	82.09	5451.06	289.87	5055.24	269.60	2000.91	140.59	5558.32	272.51	5882.14	369.94
δ-3-Carene	1304.51	69.26	6620.86	303.18	5548.08	274.57	1827.87	101.10	7104.90	307.81	7269.47	425.39
α-Pinene	952.92	38.18	2960.91	175.98	2616.30	152.12	1166.73	78.69	2984.70	215.38	3280.01	276.66
Limonene	831.26	51.27	1403.27	60.56	1345.58	57.77	768.47	47.81	1360.68	74.64	1405.11	77.25
Myrcene	492.81	14.23	1214.03	37.71	1101.53	31.14	588.21	23.72	1239.16	39.84	1242.44	49.51
Terpinolene	343.67	15.21	1131.34	72.20	978.23	62.35	384.09	16.91	1126.22	41.32	1041.23	51.63
α-Phellandrene	198.14	6.37	601.54	20.47	530.58	17.86	238.36	10.11	618.47	21.43	596.09	26.44
Borneol	19.73	1.86	21.69	2.37	26.38	2.66	48.08	6.96	37.27	4.15	47.85	5.59
Bornyl Acetate	138.29	22.64	170.69	11.50	215.25	18.27	138.30	24.25	115.83	12.34	151.21	19.26
Camphene	110.90	8.31	259.17	8.47	240.16	8.22	138.49	12.41	242.32	9.42	254.92	11.42
Camphor	11.71	1.45	44.32	1.72	35.90	1.66	12.28	1.26	24.21	1.25	25.59	1.42
δ-2-Carene	4.47	0.22	4.62	0.56	4.05	0.04	4.24	0.22	4.16	0.07	4.18	0.07
p-Cymene	31.41	1.92	72.36	2.72	102.67	3.07	40.71	2.79	52.94	2.02	75.34	2.70

bowron (*n*=466,474,475) *moffat* (*n*=403,392,300)

Table 4: continued

Terpenoid	Day following inoculation											
	Bowron						Moffat					
	0		7		12		0		7		12	
	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>
Linalool	69.96	2.97	111.31	3.96	102.78	3.45	69.99	3.34	62.72	2.78	80.62	3.01
Ocimene	79.21	6.81	46.13	4.40	73.70	5.05	80.59	6.67	47.50	4.24	69.06	5.27
Pulegone	34.53	5.54	95.34	5.32	85.84	3.59	63.30	8.05	68.21	2.86	67.03	3.82
Sabinene	213.02	13.83	995.30	87.24	829.58	68.23	242.74	10.46	780.40	28.10	741.92	35.32
α -Terpinene	37.18	15.56	56.94	2.98	35.49	4.13	15.46	0.97	56.28	3.61	58.43	3.86
γ -Terpinene	17.93	1.26	84.72	3.57	38.84	2.90	28.68	1.73	75.53	3.43	85.76	4.28
Terpineol	91.26	4.64	41.33	2.57	94.77	3.82	80.87	3.82	48.17	2.60	93.79	3.81
α -Thujone	5.27	0.41	19.59	1.35	13.56	0.85	4.58	0.21	11.64	0.82	8.81	0.49
α -Caryophyllen	30.61	1.80	40.75	2.12	61.85	3.22	30.47	1.67	29.32	1.67	42.16	1.76
α -Copaene	19.56	1.30	14.09	0.98	19.91	1.22	21.89	1.60	13.92	1.02	22.64	1.47
α -Cubebene	8.89	0.80	7.01	0.41	7.72	0.59	11.77	0.87	7.48	0.47	9.06	0.69
α -Humulene	58.30	3.05	35.59	2.58	38.73	2.20	47.05	3.02	19.61	1.41	38.75	2.78
Total Terpenoids	18413.92	478.70	54237.73	1665.41	48116.45	1352.38	20903.94	834.37	53346.14	1580.10	53446.14	2116.34
Total Monoterpenes	18296.56	476.79	54140.28	1663.81	47988.23	1351.75	20792.75	831.94	53275.82	1579.64	53333.54	2116.15
Total Sesquiterpenes	117.36	4.44	97.44	4.35	128.21	4.99	111.18	5.24	70.32	3.24	112.60	4.47

Table 5: Analysis of variance for terpenoids (*ppm/g*) in the phloem tissue 0, 7, and 12 days post inoculation with *G. clavigera* onto the phloem tissue of 45 half sibling lodgepole pine families (FAM) at Bowron and Moffat (SITE). There are eight replications within each site (REP(SITE)). The E following the source of variation indicates the degrees of freedom for the error term.

Source of variation <i>df</i>	Day following inoculation							
	0							
	SITE		REP(SITE)		FAM		FAM*SITE	
	1		14		44		44	
Terpenoid	<i>F</i>	<i>Pr</i> > <i>F</i>	<i>F</i>	<i>Pr</i> > <i>F</i>	<i>F</i>	<i>Pr</i> > <i>F</i>	<i>F</i>	<i>Pr</i> > <i>F</i>
β-Phellandrene	0.21	0.65	1.63	0.07	2.64	<0.001	0.98	0.51
β-Pinene	0.70	0.40	0.59	0.87	2.51	<0.001	1.38	0.06
δ-3-Carene	25.31	<0.001	1.20	0.27	3.47	<0.001	0.86	0.73
α-Pinene	0.04	0.84	1.52	0.10	2.41	<0.001	1.11	0.29
Limonene	0.01	0.92	1.39	0.15	3.27	<0.001	1.19	0.19
Myrcene	3.96	0.05	1.83	0.03	2.18	<0.001	1.10	0.30
Terpinolene	5.11	0.02	1.70	0.05	2.49	<0.001	0.90	0.65
α-Phellandrene ^E	1.45	0.23	1.51	0.10	2.12	<0.001	1.15	0.24
Borneol	44.46	<0.001	1.79	0.04	2.88	<0.001	0.99	0.50
Bornyl Acetate	0.70	0.40	1.27	0.22	2.80	<0.001	1.11	0.30
Camphene	5.04	0.03	1.92	0.02	2.00	<0.001	1.06	0.37
Camphor	4.47	0.03	1.38	0.16	1.25	0.13	1.10	0.30
δ-2-Carene	1.94	0.16	1.30	0.20	1.08	0.33	1.24	0.14

df for error 740 or 684^E

Table 5a: continued

Source of variation	Day following inoculation							
	0							
	SITE		REP(SITE)		FAM		FAM*SITE	
	1		14		44		44	
<i>df</i>								
Terpenoid	<i>F</i>	<i>Pr > F</i>	<i>F</i>	<i>Pr > F</i>	<i>F</i>	<i>Pr > F</i>	<i>F</i>	<i>Pr > F</i>
p-Cymene	15.59	<0.001	1.51	0.10	1.98	<0.001	1.03	0.42
Linalool	0.01	0.91	1.55	0.09	2.26	<0.001	0.80	0.82
Ocimene	0.56	0.46	0.86	0.60	2.97	<0.001	1.21	0.17
Pulegone	18.71	<0.001	0.97	0.48	1.06	0.38	0.69	0.94
Sabinene	14.06	<0.001	1.35	0.17	2.01	<0.001	0.90	0.66
α -Terpinene	8.91	<0.01	0.93	0.53	1.31	0.09	1.17	0.22
γ -Terpinene	35.55	<0.001	0.71	0.76	1.59	0.01	1.19	0.19
Terpineol	3.45	0.06	1.76	0.04	1.57	0.01	1.07	0.36
α -Thujone	1.99	0.16	0.36	0.99	0.96	0.55	1.25	0.14
α -Caryophyllen	3.73	0.05	2.32	<0.01	1.72	<0.01	1.17	0.21
α -Copaene	0.61	0.43	1.79	0.04	2.51	<0.001	1.20	0.18
α -Cubebene	11.52	<0.001	0.89	0.56	1.76	<0.01	1.52	0.02
α -Humulene	19.79	<0.001	0.83	0.64	1.98	<0.001	1.30	0.10
Total Terpenoids	0.62	0.43	1.59	0.08	2.17	<0.001	1.25	0.13
Total Monoterpenes	0.66	0.42	1.59	0.08	2.16	<0.001	1.25	0.13
Total Sesquiterpenes	7.16	0.01	1.24	0.24	2.34	<0.001	1.16	0.23

Table 5b: continued

Source of variation	Day following inoculation							
	7							
	SITE		REP(SITE)		FAM		FAM*SITE	
	1		14		44		44	
<i>df</i>								
Terpenoid	<i>F</i>	<i>Pr > F</i>	<i>F</i>	<i>Pr > F</i>	<i>F</i>	<i>Pr > F</i>	<i>F</i>	<i>Pr > F</i>
β-Phellandrene	0.13	0.72	2.47	<0.01	2.78	<0.001	1.10	0.30
β-Pinene	2.10	0.15	1.54	0.09	3.07	<0.001	1.30	0.10
δ-3-Carene	6.51	0.01	2.79	<0.001	3.42	<0.001	0.90	0.66
α-Pinene	0.02	0.88	3.58	<0.001	2.49	<0.001	1.24	0.14
Limonene	0.68	0.41	2.11	0.01	3.53	<0.001	1.33	0.08
Myrcene	0.40	0.53	2.56	<0.01	2.38	<0.001	1.24	0.14
Terpinolene	6.49	0.01	2.12	0.01	2.34	<0.001	1.23	0.15
α-Phellandrene ^E	0.48	0.49	1.98	0.02	2.41	<0.001	1.06	0.38
Borneol	66.59	<0.001	0.96	0.49	2.36	<0.001	1.05	0.38
Bornyl Acetate	137.01	<0.001	3.28	<0.001	1.93	<0.001	1.53	0.02
Camphene	2.54	0.11	2.28	0.00	1.45	0.03	0.96	0.55
Camphor	76.51	<0.001	0.95	0.50	1.47	0.03	0.87	0.70
δ-2-Carene	0.74	0.39	0.66	0.81	0.57	0.99	0.67	0.95
p-Cymene	5.85	0.02	1.20	0.27	1.63	0.01	0.86	0.73
Linalool	154.33	<0.001	2.27	0.01	1.79	<0.01	1.20	0.18

Table 5b: continued

Source of variation	Day following inoculation							
	7							
	SITE		REP(SITE)		FAM		FAM*SITE	
	1		14		44		44	
<i>df</i>								
Terpenoid	<i>F</i>	<i>Pr > F</i>	<i>F</i>	<i>Pr > F</i>	<i>F</i>	<i>Pr > F</i>	<i>F</i>	<i>Pr > F</i>
Ocimene	2.73	0.10	3.94	<0.001	3.49	<0.001	1.18	0.20
Pulegone	11.21	<0.001	1.98	0.02	1.45	0.03	1.90	<0.001
Sabinene	0.15	0.70	2.95	<0.001	2.19	<0.001	1.22	0.16
α -Terpinene	2.44	0.12	1.99	0.02	2.80	<0.001	0.91	0.65
γ -Terpinene	0.06	0.81	2.36	<0.01	2.68	<0.001	1.16	0.23
Terpineol	12.54	<0.001	1.84	0.03	1.16	0.23	1.16	0.23
α -Thujone	27.67	<0.001	1.54	0.09	0.93	0.60	1.28	0.11
α -Caryophyllen	6.06	0.01	1.60	0.07	1.48	0.02	0.91	0.63
α -Copaene	0.00	0.97	2.95	<0.001	2.08	<0.001	1.27	0.11
α -Cubebene	2.10	0.15	2.46	<0.01	1.30	0.10	1.10	0.31
α -Humulene	41.33	<0.001	2.53	<0.01	1.39	0.05	0.91	0.65
Total Terpenoids	0.14	0.71	3.09	<0.001	2.04	<0.001	1.22	0.16
Total Monoterpenes	0.15	0.70	3.08	<0.001	2.04	<0.001	1.22	0.16
Total Sesquiterpenes	44.95	<0.001	3.84	<0.001	1.78	<0.01	0.94	0.58

Table 5c: continued

Source of variation	Day following inoculation							
	12							
	SITE		REP(SITE)		FAM		FAM*SITE	
	1		14		44		44	
<i>df</i>								
Terpenoid	<i>F</i>	<i>Pr > F</i>	<i>F</i>	<i>Pr > F</i>	<i>F</i>	<i>Pr > F</i>	<i>F</i>	<i>Pr > F</i>
β-Phellandrene	0.32	0.57	6.23	<0.001	1.60	0.01	0.82	0.79
β-Pinene	0.01	0.92	3.25	<0.001	2.47	<0.001	1.05	0.38
δ-3-Carene	4.88	0.03	6.64	<0.001	3.77	<0.001	0.89	0.67
α-Pinene	0.04	0.84	5.45	<0.001	2.11	<0.001	0.95	0.57
Limonene	0.12	0.72	3.73	<0.001	3.03	<0.001	1.16	0.23
Myrcene	0.01	0.94	7.06	<0.001	1.59	0.01	1.02	0.44
Terpinolene	1.39	0.24	5.98	<0.001	1.93	<0.001	0.94	0.58
α-Phellandrene ^E	0.66	0.42	6.23	<0.001	1.48	0.03	0.87	0.72
Borneol	37.04	<0.001	2.30	<0.01	2.31	<0.001	1.17	0.21
Bornyl Acetate	109.10	<0.001	1.63	0.07	1.93	<0.001	1.21	0.17
Camphene	1.40	0.24	5.98	<0.001	1.84	<.01	1.09	0.33
Camphor	12.20	<0.001	3.48	<0.001	0.76	0.87	0.93	0.60
δ-2-Carene	2.82	0.09	1.18	0.29	0.95	0.57	1.07	0.36
p-Cymene	12.98	<0.001	3.68	<0.001	1.47	0.03	0.87	0.71
Linalool	25.27	<0.001	1.95	0.02	1.91	<0.001	0.94	0.59

Table 5c: continued

Source of variation	Day following inoculation							
	12							
	SITE		REP(SITE)		FAM		FAM*SITE	
	1		14		44		44	
	<i>F</i>	<i>Pr</i> > <i>F</i>	<i>F</i>	<i>Pr</i> > <i>F</i>	<i>F</i>	<i>Pr</i> > <i>F</i>	<i>F</i>	<i>Pr</i> > <i>F</i>
Terpenoid								
Ocimene	0.05	0.82	0.60	0.86	3.09	<0.001	0.91	0.64
Pulegone	9.80	<0.01	6.08	<0.001	1.46	0.03	1.01	0.45
Sabinene	1.08	0.30	6.26	<0.001	1.16	0.23	1.06	0.37
α -Terpinene	98.14	<0.001	2.78	<0.001	1.51	0.02	1.08	0.33
γ -Terpinene	193.27	<0.001	2.92	<0.001	1.90	<0.001	0.99	0.49
Terpineol	6.28	0.01	1.69	0.05	1.65	0.01	1.05	0.39
α -Thujone	10.65	<0.01	0.63	0.84	0.86	0.72	0.65	0.96
α -Caryophyllen	10.28	<0.01	1.11	0.35	1.55	0.01	1.03	0.41
α -Copaene	3.38	0.07	1.64	0.06	1.73	<0.01	0.85	0.74
α -Cubebene	6.30	0.01	1.75	0.04	1.49	0.02	0.96	0.55
α -Humulene	3.91	0.05	5.31	<0.001	1.50	0.02	1.37	0.06
Total Terpenoids	0.08	0.78	8.08	<0.001	1.30	0.09	0.89	0.67
Total Monoterpenes	0.08	0.78	8.05	<0.001	1.30	0.10	0.89	0.68
Total Sesquiterpenes	7.95	<0.01	2.98	<0.001	2.40	<0.001	1.27	0.12

Table 6: Percent change ($\% \Delta = (\text{day/previous day} * 100) - 100$) and percent of total monoterpenes (% of total) in phloem tissue 0, 7, and 12 days following challenge inoculation with *G. clavigera* onto the phloem tissue of half-sibling families at Bowron and Moffat.

Terpenoid	Day following inoculation											
	Bowron						Moffat					
	0		7		12		0		7		12	
	% Δ	% of total	% Δ	% of total	% Δ	% of total	% Δ	% of total	% Δ	% of total	% Δ	% of total
β -Phellandrene	0.00	63.16	183.25	60.46	-11.67	60.25	0.00	61.80	146.36	59.42	-2.54	57.85
β -Pinene	0.00	9.57	211.15	10.07	-7.26	10.53	0.00	9.62	177.79	10.43	5.83	11.03
δ -3-Carene	0.00	7.13	407.54	12.23	-16.20	11.56	0.00	8.79	288.70	13.34	2.32	13.63
α -Pinene	0.00	5.21	210.72	5.47	-11.64	5.45	0.00	5.61	155.82	5.60	9.89	6.15
Limonene	0.00	4.54	68.81	2.59	-4.11	2.80	0.00	3.70	77.06	2.55	3.27	2.63
Myrcene	0.00	2.69	146.35	2.24	-9.27	2.30	0.00	2.83	110.67	2.33	0.26	2.33
Terpinolene	0.00	1.88	229.19	2.09	-13.53	2.04	0.00	1.85	193.22	2.11	-7.55	1.95
α -Phellandrene	0.00	1.08	203.60	1.11	-11.80	1.11	0.00	1.15	159.47	1.16	-3.62	1.12
Borneol	0.00	0.11	9.94	0.04	21.64	0.05	0.00	0.23	-22.48	0.07	28.39	0.09
Bornyl Acetate	0.00	0.76	23.42	0.32	26.11	0.45	0.00	0.67	-16.25	0.22	30.55	0.28
Camphene	0.00	0.61	133.71	0.48	-7.34	0.50	0.00	0.67	74.98	0.45	5.20	0.48
Camphor	0.00	0.06	278.40	0.08	-19.00	0.07	0.00	0.06	97.12	0.05	5.69	0.05
δ -2-Carene	0.00	0.02	3.40	0.01	-12.23	0.01	0.00	0.02	-1.88	0.01	0.47	0.01
p-Cymene	0.00	0.17	130.34	0.13	41.90	0.21	0.00	0.20	30.05	0.10	42.31	0.14
Linalool	0.00	0.38	59.11	0.21	-7.66	0.21	0.00	0.34	-10.39	0.12	28.53	0.15

Table 6: continued

Terpenoid	Day following inoculation											
	Bowron						Moffat					
	0		7		12		0		7		12	
	% Δ	% of total	% Δ	% of total	% Δ	% of total	% Δ	% of total	% Δ	% of total	% Δ	% of total
Ocimene	0.00	0.43	-41.77	0.09	59.78	0.15	0.00	0.39	-41.05	0.09	45.37	0.13
Pulegone	0.00	0.19	176.11	0.18	-9.97	0.18	0.00	0.30	7.74	0.13	-1.73	0.13
Sabinene	0.00	1.16	367.24	1.84	-16.65	1.73	0.00	1.17	221.50	1.46	-4.93	1.39
α -Terpinene	0.00	0.20	53.16	0.11	-37.67	0.07	0.00	0.07	264.06	0.11	3.82	0.11
γ -Terpinene	0.00	0.10	372.59	0.16	-54.16	0.08	0.00	0.14	163.35	0.14	13.55	0.16
Terpineol	0.00	0.50	-54.71	0.08	129.29	0.20	0.00	0.39	-40.43	0.09	94.69	0.18
α -Thujone	0.00	0.03	271.63	0.04	-30.79	0.03	0.00	0.02	154.39	0.02	-24.33	0.02
Total Monoterpenes	0.00	100.00	195.90	100.00	-11.36	100.00	0.00	100.00	156.22	100.00	0.11	100.00

Table 7:		Estimates of heritability (h^2) of resin mass (g), lesion length (cm), host confinement rate (7/12), and individual, total, β -pinene/ δ -3-carene, terpinolene/myrcene terpenoids (ppm/g) in half sibling lodgepole pine families at Bowron and Moffat. Estimates were based on covariance parameter estimates from tree families, replications within sites, and the errors Falconer (1981 Equation 10.1, pg 148)				
Variable	h^2	se		Variable	h^2	se
Resin	0.06	0.06		Linalool	0.21	0.06
Lesion	0.11	0.04		Ocimene	0.42	0.11
7/12 days	0.00	0.04		Pulegone	0.05	0.03
β -Phellandrene	0.20	0.06		Sabinene	0.14	0.05
β -Pinene	0.37	0.11		α -Terpinene	0.16	0.05
δ -3-Carene	0.48	0.12		γ -Terpinene	0.19	0.06
α -Pinene	0.22	0.07		Terpineol	0.12	0.04
Limonene	0.44	0.11		α -Thujone	0.00	0.00
Myrcene	0.16	0.05		α -Caryophyllen	0.14	0.05
Terpinolene	0.29	0.08		α -Copaene	0.17	0.06
α -Phellandrene	0.19	0.06		α -Cubebene	0.08	0.03
Borneol	0.28	0.08		α -Humulene	0.07	0.03
Bornyl Acetate	0.22	0.07		Total Terpenoids	0.12	0.04
Camphene	0.13	0.04		Total Monoterpenes	0.12	0.04
Camphor	0.03	0.02		Total Sesquiterpenes	0.19	0.06
δ -2-Carene	0.00	0.01		β -Pinene/ δ -3-Carene	0.58	0.15
p-Cymene	0.13	0.04		Terpinolene/Myrcene	0.39	0.11

CHAPTER 3 Tables

Table 1: Analysis of variance for DBH=Diameter at Breast Height 1.4m (cm), tree height=height in cm at ten years, bark texture classification 1 (smooth) to 5 (rough), PT North 06=Pitch tube count on north side of tree in 2006, PT North 07=Pitch tube count on north side of tree in 2007, PT South 06=Pitch tube count on south side of tree in 2006, PT South 07=Pitch tube count on south side of tree in 2007, PT class 06=Pitch tube classification per tree in 2006, 0 (no pitch tubes), 1 (1-5 pitch tubes), 2 (>5 pitch tubes), PT class 07=Pitch tube classification per tree in 2007, 0 (no pitch tubes), 1 (1-5 pitch tubes), 2 (>5 pitch tubes) for 45 half-sibling lodgepole pine families at Bowron and Moffat. There are eight replications within each site. The E following the source of variation indicates the degrees of freedom for the error term.

Source of variation	SITE		REP(SITE)		FAM		FAM*SITE	
<i>df</i>	1		14		44		44	
Variable	<i>F</i>	<i>Pr > F</i>	<i>F</i>	<i>Pr > F</i>	<i>F</i>	<i>Pr > F</i>	<i>F</i>	<i>Pr > F</i>
DBH	24.88	<0.001	2.13	<0.01	2.57	<0.001	1.56	0.01
Tree Height	294.63	<0.001	4.21	<0.001	3.74	<0.001	2.32	<0.001
Bark Texture	35.71	<0.001	3.41	<0.001	5.06	<0.001	1.31	0.09
PT North 07	13.35	<0.001	6.32	<0.001	0.99	0.49	1.24	0.14
PT South 07	16.23	<0.001	5.57	<0.001	0.89	0.67	0.99	0.49
PT Class 07	40.46	<0.001	7.89	<0.001	1.65	<0.01	1.40	0.05
PT North 06 ^E	.	.	4.89	<0.001	0.87	0.71	.	.
PT South 06 ^E	.	.	6.06	<0.001	1.10	0.32	.	.
PT Class 06 ^E	.	.	4.24	<0.001	1.27	0.12	.	.

E df site 0, rep(site) 7, fam 44, and fam*site 0

Table 2: Average ($\bar{x}$) and standard error (se) for non-binary variables. DBH=Diameter at Breast Height 1.4m (cm), Tree height=height in cm at ten years, Bark texture=categorey of roughness 1 (smooth) to 5 (rough), PT North 06=Pitch tube count on north side of tree in 2006, PT North 07=Pitch tube count on north side of tree in 2007, PT South 06=Pitch tube count on south side of tree in 2006, PT South 07=Pitch tube count on south side of tree in 2007, PT class 06=Pitch tube classification per tree in 2006, 0 (no pitch tubes), 1 (1-5 pitch tubes), 2 (>5 pitch tubes), PT class 07=Pitch tube classification per tree in 2007, 0 (no pitch tubes), 1 (1-5 pitch tubes), 2 (>5 pitch tubes). Families are listed from north to south latitude, 1-45. Tot=total sample size for each family. 06=sample size for variables ending in 06 (2006), which is only data from Bowron.

Family			Variable																	
	N		DBH		Tree Height		Bark Texture		PT North 07		PT South 07		PT Class 07		PT North 06		PT South 06		PT Class 06	
	Tot	06	$\bar{x}$	se	$\bar{x}$	se	$\bar{x}$	se	$\bar{x}$	se	$\bar{x}$	se	$\bar{x}$	se	$\bar{x}$	se	$\bar{x}$	se	$\bar{x}$	se
1	19	12	9.38	0.47	316.58	14.23	2.74	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.22	0.58	0.34	0.50	0.23
2	17	10	11.89	0.38	360.94	16.85	2.29	0.17	0.18	0.13	0.00	0.00	0.47	0.19	0.30	0.30	0.40	0.27	0.90	0.28
3	16	8	11.31	0.33	347.50	13.58	2.44	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.50	0.38	0.25	0.16	0.50	0.27
4	26	12	10.82	0.37	350.69	10.06	2.50	0.14	0.08	0.05	0.08	0.05	0.38	0.12	0.08	0.08	0.08	0.08	0.58	0.23
5	25	12	10.80	0.35	371.08	14.04	2.52	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.18	0.17	0.17	0.50	0.23
6	22	12	11.03	0.41	373.86	13.63	1.91	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.26	0.33	0.26	0.92	0.26
7	22	14	10.35	0.31	356.41	13.06	2.41	0.13	0.09	0.06	0.05	0.05	0.36	0.15	0.00	0.00	0.00	0.00	0.43	0.14
8	25	15	11.47	0.32	363.36	9.22	2.52	0.13	0.04	0.04	0.08	0.08	0.16	0.09	0.67	0.21	0.47	0.22	1.20	0.22
9	20	7	10.42	0.36	300.65	11.98	2.20	0.19	0.05	0.05	0.15	0.11	0.20	0.14	0.14	0.14	0.00	0.00	0.14	0.14
10	17	12	11.21	0.35	357.47	12.31	1.88	0.17	0.00	0.00	0.00	0.00	0.12	0.08	0.17	0.17	0.17	0.17	0.17	0.17
11	19	9	10.24	0.38	331.32	14.47	2.21	0.12	0.21	0.21	0.21	0.21	0.16	0.12	0.67	0.37	0.44	0.44	0.56	0.29
12	23	14	10.75	0.44	312.87	15.48	2.52	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.21	0.21	0.00	0.00	0.50	0.20
13	16	9	10.03	0.49	343.44	17.61	2.06	0.21	0.25	0.25	0.19	0.19	0.25	0.14	0.00	0.00	0.00	0.00	0.44	0.18
14	21	14	11.52	0.45	369.29	15.29	2.52	0.16	0.05	0.05	0.00	0.00	0.14	0.10	0.00	0.00	0.00	0.00	0.21	0.11

Table 2: continued

			Variable																	
Family	N		DBH		Tree Height		Bark Texture		PT North 07		PT South 07		PT Class 07		PT North 06		PT South 06		PT Class 06	
	Tot	06	x	se	x	se	x	se	x	se	x	se	x	se	x	se	x	se	x	se
15	20	8	12.13	0.30	377.95	9.33	1.75	0.22	0.38	0.18	0.25	0.25	0.50	0.27	0.00	0.00	0.05	0.05	0.30	0.16
16	17	9	10.12	0.36	376.24	13.46	2.24	0.14	0.00	0.00	0.00	0.00	0.33	0.17	0.06	0.06	0.06	0.06	0.41	0.17
17	16	10	11.25	0.41	379.06	13.21	2.88	0.13	0.10	0.10	0.00	0.00	0.70	0.30	0.00	0.00	0.00	0.00	0.13	0.09
18	16	7	10.83	0.50	316.88	16.20	2.56	0.22	0.29	0.29	0.00	0.00	0.71	0.29	0.19	0.14	0.00	0.00	0.19	0.14
19	28	16	10.88	0.42	345.07	13.08	2.29	0.13	0.69	0.39	0.63	0.39	0.63	0.20	0.07	0.07	0.04	0.04	0.21	0.09
20	16	8	10.58	0.43	352.81	13.91	1.75	0.17	0.13	0.13	0.00	0.00	0.63	0.26	0.00	0.00	0.00	0.00	0.06	0.06
21	23	13	11.15	0.43	356.22	15.32	2.35	0.15	0.00	0.00	0.00	0.00	0.46	0.14	0.22	0.15	0.17	0.12	0.17	0.12
22	17	7	10.51	0.44	371.24	9.97	2.71	0.19	0.00	0.00	0.00	0.00	0.43	0.20	0.06	0.06	0.06	0.06	0.12	0.08
23	16	9	11.12	0.58	329.00	23.27	2.44	0.16	0.89	0.48	0.33	0.17	0.89	0.31	0.25	0.25	0.19	0.19	0.13	0.13
24	25	10	12.06	0.35	361.68	12.97	2.40	0.14	0.50	0.40	0.20	0.13	0.80	0.25	0.20	0.16	0.24	0.17	0.16	0.11
25	24	12	11.25	0.24	365.83	10.23	2.38	0.15	0.08	0.08	0.08	0.08	0.50	0.19	0.08	0.08	0.04	0.04	0.21	0.10
26	17	10	11.21	0.43	361.35	15.22	2.00	0.15	0.40	0.22	0.30	0.21	0.80	0.25	0.00	0.00	0.00	0.00	0.06	0.06
27	20	12	12.02	0.33	383.25	12.96	2.50	0.17	0.58	0.43	0.42	0.23	1.00	0.26	0.00	0.00	0.00	0.00	0.15	0.08
28	28	15	10.96	0.32	353.46	11.95	1.79	0.12	0.40	0.16	0.40	0.21	1.00	0.24	0.07	0.07	0.11	0.11	0.29	0.10
29	17	10	10.53	0.42	328.06	11.08	1.94	0.20	0.10	0.10	0.20	0.20	0.30	0.21	0.00	0.00	0.06	0.06	0.18	0.10
30	22	15	10.98	0.35	342.64	16.54	2.23	0.17	0.13	0.09	0.00	0.00	0.47	0.17	0.05	0.05	0.05	0.05	0.09	0.06
31	16	8	10.54	0.30	341.75	12.26	2.75	0.17	0.25	0.16	0.25	0.25	0.50	0.27	0.00	0.00	0.00	0.00	0.00	0.00

Table 2: continued

			Variable																	
Family	N		DBH		Tree Height		Bark Texture		PT North 07		PT South 07		PT Class 07		PT North 06		PT South 06		PT Class 06	
	Tot	06	x	se	x	se	x	se	x	se	x	se	x	se	x	se	x	se	x	se
32	18	9	10.17	0.40	339.72	10.84	2.33	0.21	0.22	0.22	0.11	0.11	0.56	0.29	0.06	0.06	0.00	0.00	0.06	0.06
33	16	11	10.35	0.57	337.50	15.59	2.19	0.16	0.36	0.28	0.00	0.00	0.73	0.27	0.13	0.13	0.13	0.13	0.19	0.14
34	17	9	9.63	0.35	319.71	9.22	2.18	0.20	0.22	0.15	0.00	0.00	0.78	0.22	0.12	0.12	0.00	0.00	0.12	0.12
35	18	9	9.39	0.36	320.33	13.96	2.28	0.18	0.78	0.46	0.33	0.33	0.78	0.32	0.00	0.00	0.00	0.00	0.06	0.06
36	23	10	10.77	0.28	354.30	9.79	2.65	0.10	0.60	0.40	0.70	0.52	1.00	0.21	0.00	0.00	0.00	0.00	0.00	0.00
37	17	11	10.29	0.44	352.65	12.96	2.47	0.17	0.27	0.14	0.09	0.09	0.64	0.24	0.06	0.06	0.00	0.00	0.06	0.06
38	18	11	10.44	0.36	357.78	9.21	2.61	0.14	0.00	0.00	0.00	0.00	0.27	0.14	0.06	0.06	0.00	0.00	0.33	0.16
39	26	15	10.76	0.29	362.35	12.52	3.00	0.12	0.53	0.38	0.40	0.24	0.80	0.20	0.00	0.00	0.04	0.04	0.08	0.05
40	18	7	10.81	0.47	382.39	13.75	3.17	0.17	0.43	0.43	1.29	0.84	1.43	0.30	0.00	0.00	0.00	0.00	0.11	0.08
41	24	13	11.05	0.34	349.00	11.08	3.00	0.15	0.62	0.42	0.54	0.40	0.62	0.21	0.25	0.18	0.08	0.08	0.17	0.12
42	17	8	10.99	0.49	361.71	21.32	3.12	0.12	0.00	0.00	0.00	0.00	0.63	0.26	0.00	0.00	0.00	0.00	0.12	0.08
43	15	10	10.49	0.39	399.06	18.57	2.67	0.16	0.50	0.27	0.60	0.34	0.90	0.31	0.19	0.14	0.00	0.00	0.13	0.09
44	15	10	10.51	0.45	407.81	16.63	2.80	0.20	0.50	0.34	0.60	0.60	0.40	0.22	0.00	0.00	0.00	0.00	0.07	0.07
45	16	9	10.28	0.53	365.31	14.62	2.19	0.23	0.00	0.00	0.00	0.00	0.33	0.17	0.06	0.06	0.06	0.06	0.19	0.14

Table 3: Average ($\bar{x}$) and standard error (se) for non-binary variables separated by site a) Bowron, b) Moffat. For each table DBH=Diameter at Breast Height 1.4m, Tree height=height in cm at ten years, Bark texture=category of roughness 1 (smooth) to 5 (rough), PT North 06=Pitch tube count on north side of tree in 2006, PT North 07=Pitch tube count on north side of tree in 2007, PT South 06=Pitch tube count on south side of tree in 2006, PT South 07=Pitch tube count on south side of tree in 2007, PT class 06=Pitch tube classification per tree in 2006, 0 (no pitch tubes), 1 (1-5 pitch tubes), 2 (>5 pitch tubes), PT class 07=Pitch tube classification per tree in 2007, 0 (no pitch tubes), 1 (1-5 pitch tubes), 2 (>5 pitch tubes). Families are listed from north to south latitude, 1-45. Tot=total sample size for each family. Pitch tube data was not gathered at Moffat in 2006 due to a lack of MPB attack.

Table 3a: Bowron		Variable																	
Family	N <i>Tot</i>	DBH		Tree Height		Bark Texture		PT North 07		PT South 07		PT Class 07		PT North 06		PT South 06		PT Class 06	
		$\bar{x}$	se	$\bar{x}$	se	$\bar{x}$	se	$\bar{x}$	se	$\bar{x}$	se	$\bar{x}$	se	$\bar{x}$	se	$\bar{x}$	se	$\bar{x}$	se
1	12	10.02	0.57	330.83	15.36	2.50	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.22	0.58	0.34	0.50	0.23
2	10	12.51	0.56	404.00	14.51	2.20	0.25	0.00	0.00	0.00	0.00	0.30	0.21	0.30	0.30	0.40	0.27	0.90	0.28
3	8	11.14	0.54	371.25	15.52	2.25	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.38	0.25	0.16	0.50	0.27
4	12	10.00	0.51	363.33	15.53	2.33	0.22	0.08	0.08	0.00	0.00	0.17	0.11	0.08	0.08	0.08	0.08	0.58	0.23
5	12	11.58	0.43	428.33	12.25	2.58	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.18	0.17	0.17	0.50	0.23
6	12	11.13	0.51	406.67	14.74	1.67	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.26	0.33	0.26	0.92	0.26
7	14	10.64	0.41	384.64	10.41	2.29	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.43	0.14
8	15	11.38	0.46	379.00	11.59	2.33	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.67	0.21	0.47	0.22	1.20	0.22
9	7	10.37	0.60	350.71	14.24	2.14	0.34	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.14	0.00	0.00	0.14	0.14
10	12	11.60	0.40	369.58	16.01	2.00	0.17	0.00	0.00	0.00	0.00	0.08	0.08	0.17	0.17	0.17	0.17	0.17	0.17
11	9	10.24	0.52	356.67	18.20	2.11	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.67	0.37	0.44	0.44	0.56	0.29

Table 3a: continued

		Variable																	
Family	<i>N</i>	DBH		Tree Height		Bark Texture		PT North 07		PT South 07		PT Class 07		PT North 06		PT South 06		PT Class 06	
	<i>Tot</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>
12	14	11.69	0.54	356.79	13.54	2.36	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.21	0.21	0.00	0.00	0.50	0.20
13	9	10.34	0.70	375.00	22.33	2.00	0.29	0.00	0.00	0.00	0.00	0.11	0.11	0.00	0.00	0.00	0.00	0.44	0.18
14	14	11.82	0.60	395.00	17.96	2.64	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.21	0.11
15	8	12.13	0.63	407.50	12.68	1.63	0.26	0.00	0.00	0.00	0.00	0.00	0.00	0.38	0.18	0.25	0.25	0.50	0.27
16	9	10.17	0.51	398.33	11.61	2.11	0.20	0.00	0.00	0.00	0.00	0.11	0.11	0.00	0.00	0.00	0.00	0.33	0.17
17	10	10.66	0.43	378.00	19.17	2.70	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.10	0.00	0.00	0.70	0.30
18	7	10.01	0.25	312.86	19.82	2.29	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.29	0.29	0.00	0.00	0.71	0.29
19	16	11.84	0.59	390.94	10.07	2.19	0.10	0.13	0.13	0.00	0.00	0.13	0.09	0.69	0.39	0.63	0.39	0.63	0.20
20	8	11.33	0.53	375.00	18.73	1.75	0.25	0.00	0.00	0.00	0.00	0.13	0.13	0.13	0.13	0.00	0.00	0.63	0.26
21	13	11.51	0.31	390.77	13.56	2.38	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.46	0.14
22	7	11.03	0.61	385.00	13.93	2.43	0.37	0.00	0.00	0.00	0.00	0.14	0.14	0.00	0.00	0.00	0.00	0.43	0.20
23	9	11.88	0.45	397.22	11.67	2.56	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.89	0.48	0.33	0.17	0.89	0.31
24	10	12.22	0.50	405.00	17.27	2.60	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.40	0.20	0.13	0.80	0.25
25	12	11.43	0.41	392.50	11.27	2.25	0.22	0.00	0.00	0.00	0.00	0.08	0.08	0.08	0.08	0.08	0.08	0.50	0.19
26	10	11.29	0.61	381.00	17.75	1.80	0.20	0.00	0.00	0.00	0.00	0.10	0.10	0.40	0.22	0.30	0.21	0.80	0.25
27	12	12.28	0.49	405.83	16.16	2.42	0.23	0.00	0.00	0.00	0.00	0.08	0.08	0.58	0.43	0.42	0.23	1.00	0.26
28	15	11.56	0.48	384.33	13.47	1.80	0.17	0.13	0.13	0.20	0.20	0.27	0.15	0.40	0.16	0.40	0.21	1.00	0.24

Table 3a: continued

		Variable																	
Family	<i>N</i>	DBH		Tree Height		Bark Texture		PT North 07		PT South 07		PT Class 07		PT North 06		PT South 06		PT Class 06	
	<i>Tot</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>
29	10	10.27	0.55	355.50	12.14	1.80	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.10	0.20	0.20	0.30	0.21
30	15	11.15	0.49	382.00	14.25	1.93	0.18	0.07	0.07	0.07	0.07	0.13	0.09	0.13	0.09	0.00	0.00	0.47	0.17
31	8	10.89	0.44	380.63	9.04	2.50	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.16	0.25	0.25	0.50	0.27
32	9	10.19	0.51	350.00	17.74	1.67	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.22	0.22	0.11	0.11	0.56	0.29
33	11	10.15	0.51	341.36	16.07	2.27	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.36	0.28	0.00	0.00	0.73	0.27
34	9	9.89	0.51	325.56	12.95	1.78	0.28	0.22	0.22	0.00	0.00	0.22	0.22	0.22	0.15	0.00	0.00	0.78	0.22
35	9	9.91	0.59	358.33	14.91	2.11	0.26	0.00	0.00	0.00	0.00	0.11	0.11	0.78	0.46	0.33	0.33	0.78	0.32
36	10	10.59	0.36	354.50	15.06	2.60	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.60	0.40	0.70	0.52	1.00	0.21
37	11	10.70	0.53	376.82	13.81	2.18	0.23	0.09	0.09	0.00	0.00	0.09	0.09	0.27	0.14	0.09	0.09	0.64	0.24
38	11	10.40	0.46	372.27	10.63	2.36	0.20	0.09	0.09	0.00	0.00	0.18	0.12	0.00	0.00	0.00	0.00	0.27	0.14
39	15	10.71	0.35	386.00	15.88	2.67	0.13	0.00	0.00	0.00	0.00	0.07	0.07	0.53	0.38	0.40	0.24	0.80	0.20
40	7	12.16	0.61	431.43	18.35	3.14	0.26	0.00	0.00	0.00	0.00	0.14	0.14	0.43	0.43	1.29	0.84	1.43	0.30
41	13	11.39	0.42	380.00	10.95	2.85	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.62	0.42	0.54	0.40	0.62	0.21
42	8	11.76	0.42	416.25	32.36	3.00	0.19	0.00	0.00	0.00	0.00	0.13	0.13	0.00	0.00	0.00	0.00	0.63	0.26
43	10	10.99	0.44	432.00	21.44	2.78	0.15	0.20	0.20	0.00	0.00	0.10	0.10	0.50	0.27	0.60	0.34	0.90	0.31
44	10	10.77	0.45	426.36	13.67	2.60	0.16	0.00	0.00	0.00	0.00	0.10	0.10	0.50	0.34	0.60	0.60	0.40	0.22
45	9	10.41	0.79	393.33	16.89	2.11	0.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.17

Table 3b: Moffat

		Variable																	
Family	<i>N</i>	DBH		Tree Height		Bark Texture		PT North 07		PT South 07		PT Class 07		PT North 06		PT South 06		PT Class 06	
	<i>Tot</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>
1	7	8.29	0.68	292.14	27.38	3.14	0.14	0.00	0.00	0.00	0.00	0.00	0.00	.	.	.	.	.	.
2	7	11.00	0.17	299.43	17.79	2.43	0.20	0.43	0.30	0.00	0.00	0.71	0.36	.	.	.	.	.	.
3	8	11.48	0.39	323.75	19.70	2.63	0.18	0.25	0.25	0.25	0.25	0.25	0.25	.	.	.	.	.	.
4	14	11.53	0.46	339.86	12.93	2.64	0.17	0.07	0.07	0.14	0.10	0.57	0.20	.	.	.	.	.	.
5	13	10.08	0.47	318.23	12.08	2.46	0.18	0.00	0.00	0.00	0.00	0.00	0.00	.	.	.	.	.	.
6	10	10.91	0.69	334.50	17.86	2.20	0.33	0.00	0.00	0.00	0.00	0.00	0.00	.	.	.	.	.	.
7	8	9.85	0.45	307.00	22.53	2.63	0.18	0.25	0.16	0.13	0.13	1.00	0.33	.	.	.	.	.	.
8	10	11.60	0.44	339.90	12.29	2.80	0.13	0.10	0.10	0.20	0.20	0.40	0.22	.	.	.	.	.	.
9	13	10.45	0.46	273.69	11.03	2.23	0.23	0.08	0.08	0.23	0.17	0.31	0.21	.	.	.	.	.	.
10	5	10.26	0.56	328.40	8.40	1.60	0.40	0.00	0.00	0.00	0.00	0.20	0.20	.	.	.	.	.	.
11	10	10.24	0.57	308.50	20.22	2.30	0.15	0.40	0.40	0.40	0.40	0.30	0.21	.	.	.	.	.	.
12	9	9.29	0.40	244.56	16.22	2.78	0.22	0.00	0.00	0.00	0.00	0.00	0.00	.	.	.	.	.	.
13	7	9.63	0.70	302.86	20.73	2.14	0.34	0.57	0.57	0.43	0.43	0.43	0.30	.	.	.	.	.	.
14	7	10.93	0.60	317.86	16.72	2.29	0.29	0.14	0.14	0.00	0.00	0.43	0.30	.	.	.	.	.	.
15	12	12.13	0.30	358.25	9.70	1.83	0.32	0.00	0.00	0.08	0.08	0.50	0.26	.	.	.	.	.	.
16	8	10.06	0.55	351.38	23.25	2.38	0.18	0.13	0.13	0.13	0.13	0.75	0.31	.	.	.	.	.	.
17	6	12.23	0.70	380.83	17.15	3.17	0.17	0.00	0.00	0.00	0.00	0.33	0.21	.	.	.	.	.	.

Table 3b: continued

		Variable																	
Family	N	DBH		Tree Height		Bark Texture		PT North 07		PT South 07		PT Class 07		PT North 06		PT South 06		PT Class 06	
	Tot	x	se	x	se	x	se	x	se	x	se	x	se	x	se	x	se	x	se
18	9	11.47	0.83	320.00	25.36	2.78	0.36	0.33	0.24	0.00	0.00	0.33	0.24	.	.	.	.	.	.
19	12	9.58	0.35	283.92	14.13	2.42	0.29	0.00	0.00	0.08	0.08	0.33	0.19	.	.	.	.	.	.
20	8	9.83	0.60	330.63	18.38	1.75	0.25	0.00	0.00	0.00	0.00	0.00	0.00	.	.	.	.	.	.
21	10	10.69	0.91	311.30	24.57	2.30	0.26	0.50	0.34	0.40	0.27	0.40	0.27	.	.	.	.	.	.
22	10	10.15	0.61	361.60	13.60	2.90	0.18	0.10	0.10	0.10	0.10	0.10	0.10	.	.	.	.	.	.
23	7	10.14	1.12	241.29	24.13	2.29	0.29	0.57	0.57	0.43	0.43	0.29	0.29	.	.	.	.	.	.
24	15	11.95	0.49	332.80	14.27	2.27	0.21	0.33	0.27	0.40	0.27	0.27	0.18	.	.	.	.	.	.
25	12	11.06	0.27	339.17	13.48	2.50	0.19	0.17	0.17	0.08	0.08	0.33	0.19	.	.	.	.	.	.
26	7	11.10	0.62	333.29	24.55	2.29	0.18	0.00	0.00	0.00	0.00	0.00	0.00	.	.	.	.	.	.
27	8	11.61	0.39	349.38	15.85	2.63	0.26	0.00	0.00	0.00	0.00	0.25	0.16	.	.	.	.	.	.
28	13	10.27	0.35	317.85	15.82	1.77	0.17	0.00	0.00	0.00	0.00	0.31	0.13	.	.	.	.	.	.
29	7	10.90	0.68	293.75	11.48	2.14	0.26	0.00	0.00	0.14	0.14	0.43	0.20	.	.	.	.	.	.
30	7	10.60	0.32	258.29	16.01	2.86	0.26	0.00	0.00	0.00	0.00	0.00	0.00	.	.	.	.	.	.
31	8	10.19	0.40	302.88	11.41	3.00	0.27	0.00	0.00	0.00	0.00	0.00	0.00	.	.	.	.	.	.
32	9	10.14	0.65	329.44	12.57	3.00	0.24	0.11	0.11	0.00	0.00	0.11	0.11	.	.	.	.	.	.
33	5	10.80	1.54	329.00	38.35	2.00	0.32	0.40	0.40	0.40	0.40	0.60	0.40	.	.	.	.	.	.
34	8	9.34	0.50	313.13	13.63	2.63	0.18	0.00	0.00	0.00	0.00	0.00	0.00	.	.	.	.	.	.

Table 3b: continued

		Variable																	
Family	<i>N</i>	DBH		Tree Height		Bark Texture		PT North 07		PT South 07		PT Class 07		PT North 06		PT South 06		PT Class 06	
	<i>Tot</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>
35	9	8.88	0.36	282.33	15.67	2.44	0.24	0.00	0.00	0.00	0.00	0.00	0.00	.	.	.	.	.	.
36	13	10.90	0.41	354.15	13.41	2.69	0.13	0.00	0.00	0.00	0.00	0.00	0.00	.	.	.	.	.	.
37	6	9.55	0.77	308.33	14.76	3.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.	.	.	.	.	.
38	7	10.50	0.60	335.00	13.45	3.00	0.00	0.00	0.00	0.00	0.00	0.57	0.37	.	.	.	.	.	.
39	11	10.83	0.52	330.09	16.28	3.45	0.16	0.00	0.00	0.09	0.09	0.09	0.09	.	.	.	.	.	.
40	11	9.95	0.54	351.18	12.14	3.18	0.23	0.00	0.00	0.00	0.00	0.09	0.09	.	.	.	.	.	.
41	11	10.65	0.56	312.36	14.10	3.18	0.30	0.55	0.39	0.18	0.18	0.36	0.24	.	.	.	.	.	.
42	9	10.31	0.80	313.22	16.68	3.22	0.15	0.00	0.00	0.00	0.00	0.11	0.11	.	.	.	.	.	.
43	6	9.73	0.62	344.17	20.39	2.50	0.34	0.17	0.17	0.00	0.00	0.17	0.17	.	.	.	.	.	.
44	5	9.98	1.04	367.00	41.04	3.20	0.49	0.00	0.00	0.00	0.00	0.00	0.00	.	.	.	.	.	.
45	7	10.10	0.71	329.29	18.63	2.29	0.36	0.14	0.14	0.14	0.14	0.43	0.30	.	.	.	.	.	.

Table 4: Percentage (%) of trees, with beetle landing, colonization, and tree effect characteristics, for each family. Families are ranked by latitude from north (1) to south (45). MPB Pres. 06=Presence 1 absence 0 in 2006, MPB Pres. 07=Presence 1 absence 0 in 2007, Pitch Tube=Pooled pitch tube classification of 1 yes 0 no for years 2006-07, Hypersensitive response=Pooled hypersensitive resinous lesions from under pitch tubes for 2006-07, 1 yes 0 no, Brood Development=Pooled larval gallery progression from 2006-07, 1 yes larval galleries 0 no larval galleries. Morality 06=Tree death (red crown) 1 yes 0 no in 06 (2006), Morality 07=Tree death (red crown) 1 yes 0 no in 07 (2007). Tot=total sample size for each family. 06=sample size for variables ending in 06 (2006), which is only data from Bowron. Att=sample size for trees that had been attacked with pooled hypersensitive resinous lesions and pooled gallery progression.

Family	N			MPB Present on Stick Traps		Pooled MPB Attack/Colonization Variables			MPB Caused Mortality	
	Tot	06	Att	MPB Pres. 06	MPB Pres. 07	Pitch Tube	Hypersensitive Response	Brood Development	Mortality 06	Mortality 07
1	19	12	4	42	37	0	25	25	17	16
2	17	10	10	29	29	18	60	40	40	24
3	16	8	4	6	19	6	50	0	13	6
4	26	12	13	31	31	8	69	23	17	19
5	25	12	4	24	16	8	75	25	17	12
6	22	12	7	50	41	5	86	0	8	5
7	22	14	11	32	41	0	64	0	0	5
8	25	15	14	56	64	16	43	0	33	28
9	20	7	3	15	15	5	33	0	14	5
10	17	12	3	12	18	0	33	33	17	12
11	19	9	5	5	21	11	40	20	22	11
12	23	14	5	39	35	13	100	0	29	22
13	16	9	7	25	31	0	100	0	0	0
14	21	14	5	24	29	10	60	0	14	10
15	20	8	6	30	35	10	33	17	25	10

Table 4: continued

Family	N			MPB Present on Stick Traps		Pooled MPB Attack/Colonization Variables			MPB Caused Mortality	
	Tot	06	Att	MPB Pres. 06	MPB Pres. 07	Pitch Tube	Hypersensitive Response	Brood Development	Mortality 06	Mortality 07
16	17	9	8	29	29	0	75	13	11	6
17	16	10	6	25	25	6	83	0	10	6
18	16	7	6	31	38	0	83	0	0	0
19	28	16	11	22	21	4	91	18	25	18
20	16	8	4	50	38	6	75	25	13	13
21	23	13	8	35	30	4	63	25	8	9
22	17	7	4	29	18	0	100	0	0	0
23	16	9	6	44	50	19	17	50	56	38
24	25	10	8	32	24	8	63	13	10	16
25	24	12	9	38	25	4	89	0	8	13
26	17	10	6	35	35	0	100	0	0	0
27	20	12	9	40	55	25	67	11	50	35
28	28	15	14	32	25	4	79	14	13	11
29	17	10	6	18	18	0	67	0	0	0
30	22	15	7	27	27	0	86	0	7	9
31	16	8	3	38	19	13	33	0	25	13
32	18	9	4	50	11	0	75	0	0	6
33	16	11	7	44	50	0	71	0	0	25

Table 4: continued

Family	N			MPB Present on Stick Traps		Pooled MPB Attack/Colonization Variables			MPB Caused Mortality	
	Tot	06	Att	MPB Pres. 06	MPB Pres. 07	Pitch Tube	Hypersensitive Response	Brood Development	Mortality 06	Mortality 07
34	17	9	6	24	24	0	100	0	0	6
35	18	9	5	28	17	0	100	0	0	0
36	23	10	8	13	48	4	75	13	20	13
37	17	11	5	29	24	0	80	20	9	6
38	18	11	7	22	11	0	71	0	0	0
39	26	15	10	46	42	19	60	30	47	27
40	18	7	7	39	39	11	57	29	57	39
41	24	13	8	25	29	0	63	13	8	4
42	17	8	5	12	6	0	100	0	0	0
43	16	10	7	25	44	13	43	0	30	25
44	15	10	4	13	25	0	50	0	0	13
45	16	9	5	6	19	0	80	0	0	13

Table 5: Percentage (%) of trees with binary variable characteristic for each family. Families are ranked by latitude from north (1) to south (45). MPB Pres. 06=Presence 1 absence 0 in 2006, MPB Pres. 07=Presence 1 absence 0 in 2007, Mortality 06=Tree death (red crown) 1 yes 0 no in 06 (2006), Mortality 07=Tree death (red crown) 1 yes 0 no in 07 (2007), N=total sample size for each family. Mortality data for MPB caused mortality wasn't collected at Moffat in 2006 due to no MPB mortality.

Bowron						Moffat				
Family	N	MPB Pres. 06	MPB Pres. 07	Mortality 06	Mortality 07	N	MPB Pres. 06	MPB Pres. 07	Mortality 06	Mortality 07
1	12	67	58	17	25	7	0	0	.	0
2	10	50	40	40	40	7	0	14	.	0
3	8	13	25	13	13	8	0	13	.	0
4	12	33	50	17	25	14	29	14	.	14
5	12	50	25	17	25	13	0	8	.	0
6	12	83	67	8	8	10	10	10	.	0
7	14	50	43	0	7	8	0	38	.	0
8	15	87	87	33	47	10	10	30	.	0
9	7	14	14	14	14	13	15	15	.	0
10	12	17	17	17	17	5	0	20	.	0
11	9	11	33	22	22	10	0	10	.	0
12	14	43	50	29	36	9	33	11	.	0
13	9	44	44	0	0	7	0	14	.	0
14	14	36	29	14	14	7	0	29	.	0
15	8	75	50	25	25	12	0	25	.	0
16	9	44	33	11	11	8	13	25	.	0

Table 5: continued

Family	Bowron					Moffat				
	N	MPB Pres. 06	MPB Pres. 07	Mortality 06	Mortality 07	N	MPB Pres. 06	MPB Pres. 07	Mortality 06	Mortality 07
17	10	40	30	10	10	6	0	17	.	0
18	7	57	43	0	0	9	11	33	.	0
19	16	38	38	25	31	11	0	0	.	0
20	8	88	63	13	25	8	13	13	.	0
21	13	54	38	8	8	10	10	20	.	10
22	7	57	43	0	0	10	10	0	.	0
23	9	78	78	56	67	7	0	14	.	0
24	10	40	50	10	20	15	27	7	.	13
25	12	42	33	8	17	12	33	17	.	8
26	10	60	60	0	0	7	0	0	.	0
27	12	67	75	50	50	8	0	25	.	13
28	15	47	47	13	20	13	15	0	.	0
29	10	20	20	0	0	7	14	14	.	0
30	15	40	40	7	13	7	0	0	.	0
31	8	75	38	25	25	8	0	0	.	0
32	9	67	22	0	11	9	33	0	.	0
33	11	64	64	0	36	5	0	20	.	0
34	9	44	44	0	11	8	0	0	.	0

Table 5: continued

Family	Bowron					Moffat				
	N	MPB Pres. 06	MPB Pres. 07	Mortality 06	Mortality 07	N	MPB Pres. 06	MPB Pres. 07	Mortality 06	Mortality 07
35	9	56	33	0	0	9	0	0	.	0
36	10	30	70	20	20	13	0	31	.	8
37	11	45	36	9	9	6	0	0	.	0
38	11	27	9	0	0	7	14	14	.	0
39	15	73	73	47	47	11	9	0	.	0
40	7	86	86	57	57	11	9	9	.	27
41	13	46	46	8	8	11	0	9	.	0
42	8	13	13	0	0	9	11	0	.	0
43	10	40	50	30	40	6	0	33	.	0
44	10	18	36	0	20	5	0	0	.	0
45	9	0	11	0	11	7	14	29	.	14

Table 6:

Phenotypic frequency tests (chi squared, Fisher's exact) for significant differences between variables. MPB Pres. 06=Mountain pine beetle presence 1 absence 0 on sticky trap in 2006, MPB Pres. 07=Mountain pine beetle presence 1 absence 0 on sticky trap in 2007, Pitch Tube=Pooled pitch tube classification for 2006-07 pitch tubes present=1 absent=0, Hypersensitive Response=Pooled hypersensitive reactions under pitch tubes for 2006-07 yes=1 no=0, Brood Development=Progression of beetles under the bark for 2006-07 larval galleries yes=1 no=0, Mortality 06=Crown color red=1 (death) green=0 (life) in 2006, Mortality 07=Crown color red=1 (death) green=0 (life) in 2007. Degrees of freedom (df) 1 for all variables.

Variable	Fisher's Exact			Variable	Fisher's Exact		
	<i>N</i>	χ^2	$P>\chi^2$		<i>N</i>	χ^2	$P>\chi^2$
MPB Pres. 06*MPB Pres. 07	885	259.17	<0.001	MPB Pres. 07*Mortality 06	481	104.76	<0.001
Pitch Tube*MPB Pres. 06	884	104.00	<0.001	MPB Pres. 07*Mortality 07	885	198.01	<0.001
Pitch Tube*MPB Pres. 07	885	279.64	<0.001	Pitch Tube*Mortality 06	481	22.18	<0.001
Hypersensitive Response*MPB Pres. 06	303	2.33	0.14	Pitch Tube*Mortality 07	885	48.67	<0.001
Hypersensitive Response*MPB Pres. 07	303	18.04	<0.001	Hypersensitive Response*Mortality 06	230	127.82	<0.001
Brood Development*MPB Pres. 06	303	11.05	<0.001	Hypersensitive Response*Mortality 07	302	82.61	<0.001
Brood Development*MPB Pres. 07	303	19.64	<0.001	Brood Development*Mortality 06	230	98.63	<0.001
Brood Development*Hypersensitive Response	304	75.60	<0.001	Brood Development*Mortality 07	302	87.10	<0.001
MPB Pres. 06*Mortality 06	481	60.62	<0.001	Mortality 06*Mortality 07	481	341.79	<0.001
MPB Pres. 06*Mortality 07	884	191.47	<0.001				

Table 7:

Site frequency tests (chi squared, Fisher's exact) for significant differences between variables. MPB Pres. 06=Mountain pine beetle presence 1 absence 0 on sticky trap in 2006, MPB Pres. 07=Mountain pine beetle presence 1 absence 0 on transparency in 2007, Mortality 06=Crown color red=1 (death) green=0 (life) in 2006, Mortality 07=Crown color red=1 (death) green=0 (life) in 2007, Pitch Tube=Pooled pitch tube classification for 2006-07 pitch tubes present=1 absent=0, Hypersensitive Response=Pooled hypersensitive resinous lesions under pitch tubes for 2006-07 yes=1 no=0, Brood Development=Progression of beetles under the bark for 2006-07 larval galleries yes=1 no=0. Bowron (a), Moffat (b). Degrees of freedom (df) 1 for all variables.

Variable	N	χ^2	Fisher's Exact $P>\chi^2$	Variable	N	χ^2	Fisher's Exact $P>\chi^2$
MPB Pres. 06*MPB Pres. 07	482	183.74	<0.001	Hypersensitive Response*MPB Pres. 06	231	15.97	<0.001
MPB Pres. 06*Mortality 06	481	60.62	<0.001	Hypersensitive Response*MPB Pres. 07	231	10.63	<0.001
MPB Pres. 06*Mortality 07	481	83.62	<0.001	Hypersensitive Response*Mortality 06	230	127.82	<0.001
MPB Pres. 07*Mortality 06	481	104.76	<0.001	Hypersensitive Response*Mortality 07	230	116.93	<0.001
MPB Pres. 07*Mortality 07	481	138.31	<0.001	Brood Development*MPB Pres. 06	231	10.54	<0.001
Mortality 06*Mortality 07	481	341.79	<0.001	Brood Development*MPB Pres. 07	231	13.84	<0.001
Pitch Tube*MPB Pres. 06	481	39.76	<0.001	Brood Development*Mortality 06	230	98.63	<0.001
Pitch Tube*MPB Pres. 07	481	126.27	<0.001	Brood Development*Mortality 07	230	77.43	<0.001
Pitch Tube*Mortality 06	481	22.18	<0.001	Brood Development*Hypersensitive Response	231	83.96	<0.001
Pitch Tube*Mortality 07	481	25.17	<0.001				

Table 7b:

Variable	<i>N</i>	χ^2	Fisher's Exact $P > \chi^2$	Variable	<i>N</i>	χ^2	Fisher's Exact $P > \chi^2$
MPB Pres. 06*MPB Pres. 07	403	0.05	1.00	Hypersensitive Response*MPB Pres. 06	72	2.21	0.21
MPB Pres. 06*Mortality 06		<i>NV</i>		Hypersensitive Response*MPB Pres. 07	72	16.06	<0.001
MPB Pres. 06*Mortality 07	403	52.43	<0.001	Hypersensitive Response*Mortality 06		<i>NV</i>	
MPB Pres. 07*Mortality 06		<i>NV</i>		Hypersensitive Response*Mortality 07	72	1.27	0.44
MPB Pres. 07*Mortality 07	404	0.21	1.00	Brood Development*MPB Pres. 06	72	0.85	1.00
Mortality 06*Mortality 07		<i>NV</i>		Brood Development*MPB Pres. 07	72	4.48	0.05
Pitch Tube*MPB Pres. 06	403	7.04	0.02	Brood Development*Mortality 06		<i>NV</i>	
Pitch Tube*MPB Pres. 07	404	102.87	<0.001	Brood Development*Mortality 07	72	0.06	1.00
Pitch Tube*Mortality 06		<i>NV</i>		Brood Development*Hypersensitive Response	73	5.13	0.04
Pitch Tube*Mortality 07	404	0.76	0.70				

Table 8: Family frequency tests (chi squared, Fisher's exact) for significant differences between variables. Families are listed 1-45. MPB Pres. 06=Mountain pine beetle presence 1 absence 0 on sticky trap in 2006, MPB Pres. 07=Mountain pine beetle presence 1 absence 0 on sticky trap in 2007, Mortality 06=Crown color red=1 (death) green=0 (life) in 2006, Mortality 07=Crown color red=1 (death) green=0 (life) in 2007, Pitch Tube=Pooled pitch tube classification for 2006-07 pitch tubes present=1 absent=0, Hypersens.=Pooled hypersensitive resinous lesions under pitch tubes for 2006-07 yes=1 no=0, Brood Develop.=Progression of beetles under the bark for 2006-07 larval galleries yes=1 no=0. Degrees of freedom (df) 1 for all variables.

Variable MPB Pres. 06*MPB Pres. 07				MPB Pres. 06*Mortality 06			MPB Pres. 06*Mortality 07			MPB Pres. 07*Mortality 06		
Family	<i>N</i>	χ^2	Fisher's Exact $P > \chi^2$	<i>N</i>	χ^2	Fisher's Exact $P > \chi^2$	<i>N</i>	χ^2	Fisher's Exact $P > \chi^2$	<i>N</i>	χ^2	Fisher's Exact $P > \chi^2$
1	19	8.65	<0.01	12	1.20	0.52	19	4.90	0.06	12	1.71	0.47
2	17	8.73	<0.01	10	6.67	0.05	17	12.55	<0.01	10	10.00	<0.01
3	16	4.62	0.19	8	0.16	1.00	16	0.07	1.00	8	3.43	0.25
4	26	2.01	0.20	12	4.80	0.09	26	13.93	<0.01	12	2.40	0.45
5	25	6.79	0.03	12	2.40	0.45	25	10.80	<0.01	12	7.20	0.05
6	22	9.21	<0.01	12	0.22	1.00	22	1.05	1.00	12	0.55	1.00
7	22	3.96	0.07	<i>NV</i>			22	2.24	0.32	<i>NV</i>		
8	25	6.51	0.02	15	1.15	0.52	25	7.64	<0.01	15	1.15	0.52
9	20	0.93	0.40	7	0.19	1.00	20	0.19	1.00	7	7.00	0.14
10	17	10.58	0.02	12	12.00	0.02	17	17.00	<0.01	12	12.00	0.02
11	19	3.96	0.21	9	3.94	0.22	19	8.97	0.11	9	5.14	0.08
12	23	6.63	0.02	14	7.47	0.02	23	9.94	<0.01	14	5.60	0.07
13	16	4.75	0.06	<i>NV</i>			<i>NV</i>			<i>NV</i>		

Table 8: continued

Variable		MPB Pres. 06*MPB Pres. 07			MPB Pres. 06*Mortality 06			MPB Pres. 06*Mortality 07			MPB Pres. 07*Mortality 06				
Family	N	Fisher's		Fisher's Exact $P>\chi^2$	Fisher's		Fisher's Exact $P>\chi^2$	Fisher's		Fisher's Exact $P>\chi^2$	Fisher's		Fisher's Exact $P>\chi^2$		
		χ^2			χ^2			χ^2			χ^2				
14	21	3.18	0.11		14	4.20	0.11		21	7.07	0.05		14	5.83	0.07
15	20	3.78	0.12		8	0.89	1.00		20	5.19	0.08		8	2.67	0.43
16	17	3.19	0.12		9	1.41	0.44		17	2.55	0.29		9	2.25	0.33
17	16	7.11	0.03		10	1.67	0.40		16	3.20	0.25		10	2.59	0.30
18	16	5.60	0.04												
19	27	16.67	<0.001		16	3.20	0.12		27	11.85	<0.01		16	8.89	<0.01
20	16	4.27	0.12		8	0.16	1.00		16	2.29	0.47		8	0.69	1.00
21	23	11.51	<0.01		13	0.93	1.00		23	4.11	0.11		13	1.73	0.38
22	17	8.74	0.01												
23	16	12.44	<0.01		9	3.21	0.17		16	12.34	<0.01		9	3.21	0.17
24	25	1.18	0.34		10	0.74	1.00		25	0.71	0.57		10	1.11	1.00
25	24	2.90	0.15		12	1.53	0.42		24	5.71	0.04		12	2.18	0.33
26	17	9.37	<0.01												
27	20	10.91	<0.01		12	6.00	0.06		20	9.38	<0.01		12	4.00	0.18
28	28	12.28	<0.01		15	2.64	0.20		28	7.09	0.03		15	2.64	0.20
29	17	6.02	0.06												

Table 8: continued

Variable	MPB Pres. 06*MPB Pres. 07				MPB Pres. 06*Mortality 06				MPB Pres. 06*Mortality 07				MPB Pres. 07*Mortality 06			
	Family	N	χ^2	Fisher's Exact $P>\chi^2$	N	χ^2	Fisher's Exact $P>\chi^2$	N	χ^2	Fisher's Exact $P>\chi^2$	N	χ^2	Fisher's Exact $P>\chi^2$	N	χ^2	Fisher's Exact $P>\chi^2$
30		22	6.45	0.03	15	1.61	0.40	22	5.87	0.06	15	1.61	0.40			
31		16	6.15	0.04	8	0.89	1.00	16	3.81	0.13	8	4.44	0.11			
32		18	2.25	0.47				18	1.06	1.00						
33		16	2.29	0.31				16	6.86	0.02						
34		17	2.04	0.22				17	3.45	0.24						
35		18	9.36	0.01												
36		23	3.76	0.09	10	0.48	1.00	23	1.25	0.36	10	1.07	1.00			
37		17	5.24	0.05	11	1.32	0.45	17	2.55	0.29	11	1.93	0.36			
38		18	1.00	0.41												
39		26	15.37	<0.001	15	1.03	0.57	26	6.03	0.03	15	4.77	0.08			
40		18	10.57	<0.01	7	1.56	0.43	18	5.10	0.05	7	1.56	0.43			
41		24	5.45	0.04	13	1.26	0.46	24	3.13	0.25	13	1.26	0.46			
42		17	7.97	0.12												
43		16	2.12	0.26	10	1.27	0.50	16	1.78	0.24	10	0.48	1.00			
44		16	6.86	0.05				15	15.00	0.01						
45		16	0.25	1.00				16	7.47	0.13						

Table 8: continued

Variable		MPB Pres. 07*Mortality 07			Mortality 06*Mortality 07			Pitch Tube*MPB Pres. 06			Pitch Tube*MPB Pres. 07		
Family	N	χ^2	Fisher's Exact $P > \chi^2$		N	χ^2	Fisher's Exact $P > \chi^2$	N	χ^2	Fisher's Exact $P > \chi^2$	N	χ^2	Fisher's Exact $P > \chi^2$
1	19	6.11	0.04		12	7.20	0.05	19	6.97	0.02	19	8.69	<0.01
2	17	12.55	<0.01		10	10.00	<0.01	17	1.31	0.34	17	1.31	0.34
3	16	4.62	0.19		8	8.00	0.13	16	3.20	0.25	16	11.08	<0.01
4	26	2.48	0.28		12	7.20	0.05	26	0.72	0.67	26	6.50	0.03
5	25	17.90	<0.01		12	7.20	0.05	25	6.79	0.03	25	12.33	<0.01
6	22	1.51	0.41		12	12.00	0.08	22	10.27	0.00	22	14.83	<0.001
7	22	1.51	0.41			NV		22	0.21	1.00	22	4.70	0.08
8	25	5.47	0.03		15	8.57	<0.01	25	6.58	0.02	25	17.90	<0.001
9	20	5.96	0.15		7	7.00	0.14	20	0.93	0.40	20	7.39	0.05
10	17	10.58	0.02		12	12.00	0.02	17	1.63	0.33	17	6.02	0.06
11	19	8.38	0.04		9	9.00	0.03	19	2.96	0.26	19	6.19	0.04
12	23	11.98	<0.01		14	10.08	<0.01	23	1.17	0.34	23	5.76	0.03
13		NV				NV		16	6.86	0.02	16	9.35	<0.01
14	21	5.53	0.07		14	14.00	0.01	21	0.05	1.00	21	8.51	0.01
15	20	4.13	0.11		8	8.00	0.04	20	1.63	0.30	20	15.92	<0.001
16	17	2.55	0.29		9	9.00	0.11	17	0.14	1.00	17	3.09	0.13

Table 8: continued

Variable		MPB Pres. 07*Mortality 07			Mortality 06*Mortality 07			Pitch Tube*MPB Pres. 06			Pitch Tube*MPB Pres. 07					
Family	N	χ ²	Fisher's		N	χ ²	Fisher's		N	χ ²	Fisher's		N	χ ²	Fisher's	
			Exact	P>χ ²			Exact	P>χ ²			Exact	P>χ ²			Exact	P>χ ²
17	16	3.20	0.25		10	10.00	0.10		16	0.36	0.60		16	3.20	0.12	
18			NV			NV			16	5.60	0.04		16	0.64	0.61	
19	28	22.32	<0.001		16	11.73	<0.01		27	2.15	0.19		28	2.40	0.17	
20	16	3.81	0.13		8	3.43	0.25		16	1.33	0.57		16	3.20	0.12	
21	23	5.01	0.08		13	13.00	0.08		23	4.15	0.07		23	11.51	<0.01	
22			NV			NV			17	1.07	0.54		17	3.77	0.12	
23	16	9.60	<0.01		9	5.63	0.05		16	6.11	0.04		16	9.60	<0.01	
24	25	1.76	0.23		10	4.44	0.20		25	1.75	0.36		25	16.78	<0.001	
25	24	3.17	0.14		12	5.45	0.17		24	0.11	1.00		24	0.06	1.00	
26			NV			NV			17	4.00	0.11		17	9.37	<0.01	
27	20	4.10	0.07		12	12.00	<0.01		20	4.85	0.06		20	7.59	0.01	
28	28	10.08	0.01		15	9.23	0.03		28	8.02	0.01		28	9.33	<0.01	
29			NV			NV			17	2.44	0.19		17	8.74	0.01	
30	22	0.57	0.48		15	6.96	0.13		22	4.62	0.05		22	4.62	0.05	
31	16	9.90	0.03		8	8.00	0.04		16	6.15	0.04		16	16.00	<0.01	
32	18	8.47	0.11			NV			18	1.29	0.58		18	7.88	0.04	

Table 8: continued

Variable		MPB Pres. 07*Mortality 07			Mortality 06*Mortality 07			Pitch Tube*MPB Pres. 06			Pitch Tube*MPB Pres. 07					
Family	N	χ^2	Fisher's		N	χ^2	Fisher's		N	χ^2	Fisher's		N	χ^2	Fisher's	
			Exact	$P>\chi^2$			Exact	$P>\chi^2$			Exact	$P>\chi^2$			Exact	$P>\chi^2$
33	16	5.33	0.08			NV			16	0.91	0.61		16	2.29	0.31	
34	17	0.33	1.00			NV			17	3.61	0.10		17	3.61	0.10	
35		NV				NV			18	9.41	<0.01		18	9.36	0.01	
36	23	0.49	0.59		10	10.00	0.02		23	1.55	0.27		23	3.63	0.09	
37	17	3.45	0.24		11	11.00	0.09		17	3.19	0.12		17	12.55	<0.01	
38		NV				NV			18	0.27	1.00		18	3.54	0.14	
39	26	13.06	<0.01		15	15.00	<0.001		26	7.49	0.01		26	5.11	0.04	
40	18	1.61	0.33		7	7.00	0.03		18	10.57	<0.01		18	10.57	<0.01	
41	24	2.53	0.29		13	13.00	0.08		24	1.00	0.36		24	12.20	<0.01	
42		NV				NV			17	0.46	0.51		17	2.55	0.29	
43	16	2.12	0.26		10	6.43	0.03		16	2.12	0.26		16	8.91	<0.01	
44	15	6.35	0.06			NV			15	1.30	0.37		15	3.07	0.15	
45	16	1.47	0.35			NV			16	0.48	1.00		16	0.01	1.00	

Table 8: continued

Variable	Pitch Tube*Mortality 06			Pitch Tube*Mortality 07			Hypersens.*MPB Pres. 06			Hypersens.*MPB Pres. 07		
Family	<i>N</i>	χ^2	Fisher's Exact $P>\chi^2$	<i>N</i>	χ^2	Fisher's Exact $P>\chi^2$	<i>N</i>	χ^2	Fisher's Exact $P>\chi^2$	<i>N</i>	χ^2	Fisher's Exact $P>\chi^2$
1	12	0.30	1.00	19	4.46	0.10						
2	10	0.08	1.00	17	0.57	0.60	10	3.40	0.19	10	10.00	<0.01
3	8	1.90	0.38	16	3.20	0.25	4	1.33	1.00	4	1.33	1.00
4	12	1.71	0.47	26	0.25	1.00	13	0.33	1.00	13	4.95	0.07
5	12	4.80	0.09	25	17.90	<0.01	4	0.44	1.00	4	0.44	1.00
6	12	0.78	1.00	22	2.24	0.32						
7				22	1.05	1.00	11	2.36	0.24	11	0.35	1.00
8	15	2.73	0.23	25	7.64	<0.01	14	0.88	0.54			
9	7	0.19	1.00	20	0.19	1.00	3	0.75	1.00	3	3.00	0.33
10	12	1.92	0.32	17	1.63	0.33	3	0.75	1.00	3	3.00	0.33
11	9	0.32	1.00	19	0.65	0.47	5	0.83	1.00	5	0.14	1.00
12	14	0.28	1.00	23	1.25	0.29						
13												
14	14	0.64	1.00	21	0.69	1.00	5	0.83	1.00	5	0.83	1.00
15	8	0.18	1.00	20	0.42	0.52	6	3.00	0.40			
16	9	1.41	0.44	17	1.20	0.47	8	0.89	0.46	8	0.00	1.00

Table 8: continued

Variable	Pitch Tube*Mortality 06			Pitch Tube*Mortality 07			Hypersens.*MPB Pres. 06			Hypersens.*MPB Pres. 07		
Family	N	χ^2	Fisher's Exact $P > \chi^2$	N	χ^2	Fisher's Exact $P > \chi^2$	N	χ^2	Fisher's Exact $P > \chi^2$	N	χ^2	Fisher's Exact $P > \chi^2$
17	10	0.74	1.00	16	0.64	1.00	6	0.60	1.00	6	1.20	1.00
18		NV			NV		6	2.40	0.33	6	1.20	1.00
19	16	0.00	1.00	28	1.10	0.35	11	1.93	0.36	11	1.93	0.36
20	8	1.14	1.00	16	0.76	0.45	4	0.44	1.00	4	0.44	1.00
21	13	1.26	0.46	23	4.11	0.11	8	0.04	1.00	8	1.60	0.46
22		NV			NV			NV			NV	
23	9	2.72	0.21	16	3.48	0.12	6	0.24	1.00		NV	
24	10	0.74	1.00	25	0.71	0.57	8	0.53	1.00	8	0.18	1.00
25	12	1.09	1.00	24	0.03	1.00	9	0.56	1.00	9	3.94	0.22
26		NV			NV			NV			NV	
27	12	0.34	1.00	20	0.64	0.64	9	2.25	0.46	9	0.56	1.00
28	15	1.15	0.52	28	3.36	0.22	14	0.14	1.00	14	0.42	1.00
29		NV			NV		5	0.83	1.00	5	1.88	0.40
30	15	1.22	0.47	22	0.34	1.00	7	0.88	1.00	7	0.88	1.00
31	8	4.44	0.11	16	9.90	0.03		NV			NV	
32		NV		18	3.71	0.22	4	0.44	1.00	4	1.33	1.00

Table 8: continued

Variable	Pitch Tube*Mortality 06			Pitch Tube*Mortality 07			Hypersens.*MPB Pres. 06			Hypersens.*MPB Pres. 07		
	<i>N</i>	χ^2	Fisher's Exact $P > \chi^2$	<i>N</i>	χ^2	Fisher's Exact $P > \chi^2$	<i>N</i>	χ^2	Fisher's Exact $P > \chi^2$	<i>N</i>	χ^2	Fisher's Exact $P > \chi^2$
Family												
33		<i>NV</i>		16	2.12	0.26	7	3.73	0.14	7	7.00	0.05
34		<i>NV</i>		17	0.58	1.00		<i>NV</i>			<i>NV</i>	
35		<i>NV</i>			<i>NV</i>			<i>NV</i>			<i>NV</i>	
36	10	0.63	1.00	23	1.55	0.27	8	0.89	0.46	8	0.89	1.00
37	11	1.32	0.45	17	2.55	0.29	5	0.83	1.00	5	0.31	1.00
38		<i>NV</i>			<i>NV</i>		7	0.63	1.00	7	1.12	1.00
39	15	0.04	1.00	26	1.41	0.37	10	0.10	1.00	10	2.86	0.20
40	7	1.56	0.43	18	1.61	0.33	7	0.88	1.00	7	0.88	1.00
41	13	1.26	0.46	24	2.09	0.33	8	0.04	1.00	8	0.18	1.00
42		<i>NV</i>			<i>NV</i>			<i>NV</i>			<i>NV</i>	
43	10	2.86	0.20	16	6.86	0.02	7	3.94	0.14	7	0.88	1.00
44		<i>NV</i>		15	1.30	0.37	4	1.33	1.00	4	0.00	1.00
45		<i>NV</i>		16	1.04	1.00		<i>NV</i>		5	5.00	0.20

Table 8: continued

Variable	Hypersens. *Mortality 06			Hypersens. *Mortality 07			Brood Develop. *MPB Pres. 06			Brood Develop. *MPB Pres. 07		
	<i>N</i>	χ^2	Fisher's Exact $P > \chi^2$	<i>N</i>	χ^2	Fisher's Exact $P > \chi^2$	<i>N</i>	χ^2	Fisher's Exact $P > \chi^2$	<i>N</i>	χ^2	Fisher's Exact $P > \chi^2$
Family												
1	4	0.44	1.00	4	1.33	1.00						
2	7	7.00	0.03	10	6.43	0.03	10	3.40	0.19	10	10.00	<0.01
3	3	0.75	1.00	4	1.33	1.00						
4	7	7.00	0.05	13	5.32	0.08	13	0.04	1.00	13	3.34	0.19
5	4	1.33	1.00	4	0.44	1.00	4	0.44	1.00	4	0.44	1.00
6	7	7.00	0.14	7	7.00	0.14						
7				11	0.63	1.00						
8	11	5.24	0.06	14	4.67	0.10						
9												
10	2	2.00	1.00	3	0.75	1.00	3	3.00	0.33	3	0.75	1.00
11	3	3.00	0.33	5	0.83	1.00	5	5.00	0.20	5	0.83	1.00
12												
13												
14												
15	3	3.00	0.33	6	0.60	1.00	6	1.20	1.00			
16	4	4.00	0.25	8	3.43	0.25	8	3.43	0.25	8	1.14	1.00

Table 8: continued

Variable	Hypersens. *Mortality 06			Hypersens. *Mortality 07			Brood Develop. *MPB Pres. 06			Brood Develop. *MPB Pres. 07		
Family	<i>N</i>	χ^2	Fisher's Exact $P > \chi^2$	<i>N</i>	χ^2	Fisher's Exact $P > \chi^2$	<i>N</i>	χ^2	Fisher's Exact $P > \chi^2$	<i>N</i>	χ^2	Fisher's Exact $P > \chi^2$
17		NV			NV			NV			NV	
18		NV			NV			NV			NV	
19	8	3.43	0.25	11	2.93	0.27	11	4.28	0.11	11	4.28	0.11
20	4	4.00	0.25	4	4.00	0.25	4	0.44	1.00	4	0.44	1.00
21	6	6.00	0.17	8	4.44	0.11	8	0.18	1.00	8	0.89	1.00
22		NV			NV			NV			NV	
23	5	5.00	0.20	6	2.40	0.33	6	1.20	1.00			
24	6	6.00	0.17	8	0.18	1.00	8	1.14	1.00	8	0.38	1.00
25		NV		9	0.14	1.00		NV			NV	
26		NV			NV			NV			NV	
27	7	3.94	0.14	9	5.63	0.05	9	0.56	1.00	9	0.14	1.00
28	10	0.48	1.00	14	4.64	0.09	14	1.75	0.47	14	2.33	0.46
29		NV			NV			NV			NV	
30	7	7.00	0.14	7	7.00	0.14		NV			NV	
31	3	3.00	0.33	3	3.00	0.33		NV			NV	
32		NV		4	4.00	0.25		NV			NV	

Table 8: continued

Variable	Hypersens. *Mortality 06			Hypersens. *Mortality 07			Brood Develop. *MPB Pres. 06			Brood Develop. *MPB Pres. 07		
	<i>N</i>	χ^2	Fisher's Exact $P > \chi^2$	<i>N</i>	χ^2	Fisher's Exact $P > \chi^2$	<i>N</i>	χ^2	Fisher's Exact $P > \chi^2$	<i>N</i>	χ^2	Fisher's Exact $P > \chi^2$
Family												
33		NV		7	2.10	0.43		NV			NV	
34		NV			NV			NV			NV	
35		NV			NV			NV			NV	
36	8	8.00	0.04	8	8.00	0.04	8	0.38	1.00	8	0.38	1.00
37	5	5.00	0.20	5	5.00	0.20	5	0.83	1.00	5	0.31	1.00
38		NV			NV			NV			NV	
39	9	9.00	<0.01	10	10.00	<0.01	10	0.48	1.00	10	1.84	0.48
40	6	3.00	0.40	7	3.94	0.14	7	0.47	1.00	7	0.47	1.00
41	6	6.00	0.17	8	1.90	0.38	8	1.90	0.38	8	0.38	1.00
42		NV			NV			NV			NV	
43	6	3.00	0.40	7	1.22	0.49		NV			NV	
44		NV		3	3.00	0.33		NV			NV	
45		NV			NV			NV			NV	

Table 8: continued

Variable	Brood Develop.*Mortality 06				Brood Develop.*Mortality 07				Brood Develop.*Hypersens.			
	<i>N</i>	χ^2	Fisher's Exact $P > \chi^2$		<i>N</i>	χ^2	Fisher's Exact $P > \chi^2$		<i>N</i>	χ^2	Fisher's Exact $P > \chi^2$	
Family												
1	4	4.00	0.25		4	1.33	1.00		4	0.44	1.00	
2	7	7.00	0.03		10	6.43	0.03		10	10.00	<0.01	
3		NV				NV				NV		
4	7	2.92	0.29		13	0.97	0.42		13	8.78	0.01	
5	4	1.33	1.00		4	0.44	1.00		4	4.00	0.25	
6		NV				NV				NV		
7		NV				NV				NV		
8		NV				NV				NV		
9		NV				NV				NV		
10	2	2.00	1.00		3	3.00	0.33		3	0.75	1.00	
11	3	3.00	0.33		5	5.00	0.20		5	0.83	1.00	
12		NV				NV				NV		
13		NV				NV				NV		
14		NV				NV				NV		
15	3	3.00	0.33		6	6.00	0.17		6	0.60	1.00	
16	4	4.00	0.25		8	8.00	0.13		8	3.43	0.25	

Table 8: continued

Variable	Brood Develop.*Mortality 06			Brood Develop.*Mortality 07			Brood Develop.*Hypersens.		
	<i>N</i>	χ^2	Fisher's Exact $P > \chi^2$	<i>N</i>	χ^2	Fisher's Exact $P > \chi^2$	<i>N</i>	χ^2	Fisher's Exact $P > \chi^2$
Family									
17		NV			NV			NV	
18		NV			NV			NV	
19	8	8.00	0.04	11	6.52	0.05	11	4.95	0.18
20	4	4.00	0.25	4	4.00	0.25	4	4.00	0.25
21	6	6.00	0.17	8	0.89	0.46	8	4.44	0.11
22		NV			NV			NV	
23	5	1.88	0.40	6	3.00	0.40	6	1.20	1.00
24	6	6.00	0.17	8	3.43	0.25	8	1.90	0.38
25		NV			NV			NV	
26		NV			NV			NV	
27	7	0.88	1.00	9	1.41	0.44	9	2.25	0.33
28	10	1.41	0.38	14	8.56	0.03	14	8.56	0.03
29		NV			NV			NV	
30		NV			NV			NV	
31		NV			NV			NV	
32		NV			NV			NV	

Table 8: continued

Variable	Brood Develop.*Mortality 06			Brood Develop.*Mortality 07			Brood Develop.*Hypersens.		
	<i>N</i>	χ^2	Fisher's Exact $P > \chi^2$	<i>N</i>	χ^2	Fisher's Exact $P > \chi^2$	<i>N</i>	χ^2	Fisher's Exact $P > \chi^2$
Family									
33		NV			NV			NV	
34		NV			NV			NV	
35		NV			NV			NV	
36	8	3.43	0.25	8	3.43	0.25	8	3.43	0.25
37	5	5.00	0.20	5	5.00	0.20	5	5.00	0.20
38		NV			NV			NV	
39	9	5.63	0.05	10	6.43	0.03	10	6.43	0.03
40	6	1.50	0.47	7	2.10	0.43	7	3.73	0.14
41	6	6.00	0.17	8	8.00	0.13	8	1.90	0.38
42		NV			NV			NV	
43		NV			NV			NV	
44		NV			NV			NV	
45		NV			NV			NV	

Table 9: Averages ($\bar{x}$) and standard errors (se) for Par. Gall. Length=average length of parental galleries in *cm* for families and Larval Gall. Cnt.=average larval gallery counts. Tot=the total sample size for families. Lar=samples size for families with larval galleries.

			Variable			
Family	<i>N</i>		Par. Gall. Length		Larval Gall. Cnt.	
	<i>Tot</i>	<i>Lar</i>	$\bar{x}$	se	$\bar{x}$	se
1	4	1	9.82	2.32	6.00	.
2	11	5	8.72	2.35	7.00	2.54
3	4	0	5.50	3.34	.	.
4	11	3	5.05	1.77	7.56	1.28
5	3	1	5.11	4.12	11.67	.
6	7	1	4.93	2.30	13.00	.
7	11	0	3.03	1.04	.	.
8	13	0	4.93	1.08	.	.
9	4	1	12.18	3.96	19.33	.
10	3	1	6.93	3.43	8.67	.
11	5	1	8.31	3.86	27.67	.
12	7	4	7.45	2.08	7.75	2.36
13	7	0	0.94	0.28	.	.
14	7	2	6.01	2.84	6.33	1.33
15	7	2	8.12	2.80	8.50	5.17
16	9	1	4.01	1.85	15.00	.
17	5	1	6.02	4.28	27.67	.
18	6	0	1.96	0.81	.	.
19	13	4	5.58	1.97	15.17	2.23
20	5	2	6.77	3.99	14.50	4.50
21	7	2	8.45	4.29	18.25	8.25
22	4	0	0.97	0.28	.	.
23	7	4	13.41	2.71	18.92	3.04
24	8	1	5.41	2.71	16.00	.
25	9	0	2.19	0.71	.	.

Table 9: continued

			Variable			
Family	<i>N</i>		Par. Gall. Length		Larval Gall. Cnt.	
	<i>Tot</i>	<i>Lar</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>
26	5	0	2.66	1.36	.	.
27	8	2	8.49	3.28	18.58	0.08
28	14	2	4.80	1.62	8.17	3.50
29	5	0	1.98	0.77	.	.
30	7	0	1.88	0.88	.	.
31	3	0	6.71	3.11	.	.
32	3	0	1.72	0.87	.	.
33	7	0	5.54	1.69	.	.
34	6	0	2.62	1.15	.	.
35	5	0	2.30	0.74	.	.
36	8	1	3.38	1.71	14.00	.
37	5	1	4.00	2.86	4.50	.
38	7	0	3.77	0.94	.	.
39	11	4	7.72	2.20	10.17	2.84
40	7	2	6.67	2.24	8.33	6.33
41	8	1	4.68	2.47	4.00	.
42	5	1	1.45	0.81	4.00	.
43	6	0	5.43	1.91	.	.
44	4	0	2.53	1.34	.	.
45	5	0	3.67	2.26	.	.

Table 10: Estimates of heritability (h^2) of dbh (cm), tree height (cm), bark texture, MPB presence, mortality, pitch tube (PT) count north and south, PT classification, hypersensitivity, brood development, pooled parental gallery length, pooled larval gallery count, in half sibling lodgepole pine families at Bowron and Moffat. Estimates were based on covariance parameter estimates from tree families, replications within site, and the error. Falconer (1981 Equation 10.1, pg 148)

Variable	h^2	<i>se</i>	<i>N</i>	Variable	h^2	<i>se</i>	<i>N</i>
DBH	0.30	0.10	884	PT Class 06	0.04	0.09	479
Tree Height	0.45	0.14	887	PT Class 07	0.08	0.05	885
Bark Texture	0.64	0.17	884	Hypersensitivity	0.16	0.15	306
MPB Pres. 06	0.18	0.08	885	Brood Development	0.19	0.15	306
MPB Pres. 07	0.11	0.06	886	Par. Gall. Length	0.18	0.16	306
PT North 06	0.00	0.00	481	Larval Gall. Cnt.	1.29	0.97	51
PT North 07	0.00	0.00	885	Mortality 06	0.37	0.15	481
PT South 06	0.02	0.08	481	Mortality 07	0.20	0.08	885
PT South 07	0.00	0.00	885				

Table 11: DBH = diameter at breast height (~1.4m), Tree Height = the height of trees at age 10, Bark Texture = bark classification from 1 (smooth) to 5 (rough), PT Class 07 = the overall pitch tube classification for study trees, Hypersensitive reaction = hypersensitive responses occurring from MPB attack, Brood Development = evidence of larval gallery progression, Par. Gall. Length = length of parental gallery in cm, Mortality 06 and 07 = whether or not trees died due to MPB attack in 2006 and 2007, Lesion day 7 and 12 = the length of lesions in cm induced in Chapter 1, Terpenes day 0, 7, 12 = the rest of the variables are terpenes, terpene totals, or terpene ratios at day 0 (constitutive), day 7 (induced), and day 12 (induced). The first value is the correlation coefficient (r) and the second value is the probability ($p > r$).

Table 11

Correlations between variables that have significant heritability value estimates (Table 10) (Companion study). Correlation coefficient (r) and probability ($P>r$). (a) Family mean correlations (b) Whole sample population correlations

Variable X	Variable Y	Rel. (Pos/Neg)	r	$P>r$
Tree Height	DBH	Positive	0.43	<0.01
MPB Pres. 07	DBH	Positive	0.24	0.11
Mortality 06	DBH	Positive	0.39	0.01
Mortality 07	DBH	Positive	0.31	0.04
PT Class 07	DBH	Positive	0.20	0.19
Hypersensitivity	DBH	Negative	-0.18	0.24
Brood Development	DBH	Positive	0.21	0.17
Par. Gall. Length	DBH	Positive	0.26	0.09
Lesion day 7	DBH	Positive	0.23	0.14
Lesion day 12	DBH	Positive	0.22	0.14
δ -3-Carene day 12	DBH	Positive	0.23	0.12
Myrcene day 12	DBH	Positive	0.27	0.07
β -Phellandrene day 12	DBH	Positive	0.22	0.15
α -Pinene day 0	DBH	Positive	0.26	0.09
α -Pinene day 7	DBH	Positive	0.26	0.08
α -Pinene day 12	DBH	Positive	0.35	0.02
Terpineol day 0	DBH	Positive	0.20	0.18
Terpineol day 7	DBH	Positive	0.16	0.30
Terpineol day 12	DBH	Positive	0.15	0.33
Terpinolene day 12	DBH	Positive	0.22	0.14
Total Terpenoids day 12	DBH	Positive	0.31	0.04
Total Monoterpenes day 12	DBH	Positive	0.31	0.04
Terpinolene/Myrcene day 0	DBH	Positive	0.05	0.73
Terpinolene/Myrcene day 7	DBH	Negative	-0.04	0.81
Terpinolene/Myrcene day 12	DBH	Positive	0.06	0.68
Bark Texture	Tree Height	Positive	0.21	0.17

Table 11a:

Variable X	Variable Y	Rel. (Pos/Neg)	<i>r</i>	<i>P>r</i>
MPB Pres. 06	Tree Height	Negative	-0.01	0.96
MPB Pres. 07	Tree Height	Positive	0.16	0.29
Mortality 06	Tree Height	Positive	0.16	0.30
Mortality 07	Tree Height	Positive	0.21	0.17
PT Class 07	Tree Height	Positive	0.10	0.50
Hypersensitivity	Tree Height	Negative	-0.02	0.88
Brood Development	Tree Height	Positive	0.02	0.90
Par. Gall. Length	Tree Height	Negative	-0.16	0.28
Lesion day 7	Tree Height	Negative	-0.24	0.11
Lesion day 12	Tree Height	Positive	0.03	0.86
δ -3-Carene day 0	Tree Height	Negative	-0.26	0.08
δ -3-Carene day 7	Tree Height	Negative	-0.25	0.10
δ -3-Carene day 12	Tree Height	Negative	-0.21	0.17
Limonene day 0	Tree Height	Positive	0.09	0.56
Limonene day 7	Tree Height	Positive	0.09	0.55
Limonene day 12	Tree Height	Negative	-0.02	0.91
Myrcene day 0	Tree Height	Negative	-0.33	0.03
Myrcene day 7	Tree Height	Positive	0.03	0.83
Myrcene day 12	Tree Height	Negative	-0.20	0.20
β -Phellandrene day 0	Tree Height	Negative	-0.36	0.01
β -Phellandrene day 7	Tree Height	Positive	0.11	0.48
β -Phellandrene day 12	Tree Height	Negative	-0.12	0.41
α -Pinene day 0	Tree Height	Positive	0.08	0.62
α -Pinene day 7	Tree Height	Positive	0.27	0.07
α -Pinene day 12	Tree Height	Positive	0.19	0.22
β -Pinene day 0	Tree Height	Positive	0.11	0.48
β -Pinene day 7	Tree Height	Positive	0.51	<0.001
β -Pinene day 12	Tree Height	Positive	0.29	0.06

Table 11a:

Variable X	Variable Y	Rel. (Pos/Neg)	<i>r</i>	<i>P>r</i>
Terpineol day 0	Tree Height	Negative	-0.07	0.63
Terpineol day 7	Tree Height	Negative	-0.12	0.42
Terpineol day 12	Tree Height	Negative	-0.30	0.05
Terpinolene day 0	Tree Height	Negative	-0.05	0.75
Terpinolene day 7	Tree Height	Negative	-0.26	0.08
Terpinolene day 12	Tree Height	Negative	-0.16	0.31
Total Terpenoids day 0	Tree Height	Negative	-0.26	0.08
Total Terpenoids day 7	Tree Height	Positive	0.17	0.26
Total Terpenoids day 12	Tree Height	Negative	-0.06	0.70
Total Monoterpenes day 0	Tree Height	Negative	-0.26	0.08
Total Monoterpenes day 7	Tree Height	Positive	0.17	0.26
Total Monoterpenes day 12	Tree Height	Negative	-0.06	0.71
Total Sesquiterpenes day 0	Tree Height	Negative	-0.27	0.07
Total Sesquiterpenes day 7	Tree Height	Negative	-0.14	0.35
Total Sesquiterpenes day 12	Tree Height	Negative	-0.36	0.02
β -Pinene/ δ -3-Carene day 0	Tree Height	Positive	0.08	0.59
β -Pinene/ δ -3-Carene day 7	Tree Height	Positive	0.03	0.84
β -Pinene/ δ -3-Carene day 12	Tree Height	Positive	0.39	0.01
Terpinolene/Myrcene day 0	Tree Height	Positive	0.18	0.25
Terpinolene/Myrcene day 7	Tree Height	Negative	-0.22	0.14
Terpinolene/Myrcene day 12	Tree Height	Positive	0.01	0.95
MPB Pres. 06	Bark Texture	Negative	-0.02	0.89
MPB Pres. 07	Bark Texture	Positive	0.03	0.85
Mortality 06	Bark Texture	Positive	0.26	0.09
Mortality 07	Bark Texture	Positive	0.25	0.10
PT Class 07	Bark Texture	Negative	-0.22	0.15
Hypersensitivity	Bark Texture	Negative	-0.07	0.65
Brood Development	Bark Texture	Positive	0.00	0.98

Table 11a:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
Par. Gall. Length	Bark Texture	Negative	-0.01	0.95
Lesion day 7	Bark Texture	Negative	-0.21	0.16
Lesion day 12	Bark Texture	Negative	-0.03	0.85
δ -3-Carene day 0	Bark Texture	Negative	-0.14	0.34
δ -3-Carene day 7	Bark Texture	Negative	-0.06	0.71
δ -3-Carene day 12	Bark Texture	Positive	0.11	0.46
Limonene day 0	Bark Texture	Negative	-0.27	0.07
Limonene day 7	Bark Texture	Negative	-0.20	0.18
Limonene day 12	Bark Texture	Negative	-0.21	0.17
Myrcene day 0	Bark Texture	Negative	-0.21	0.17
Myrcene day 7	Bark Texture	Negative	-0.03	0.83
Myrcene day 12	Bark Texture	Positive	0.05	0.72
β -Phellandrene day 0	Bark Texture	Negative	-0.20	0.18
β -Phellandrene day 7	Bark Texture	Negative	-0.02	0.89
β -Phellandrene day 12	Bark Texture	Positive	0.00	0.98
α -Pinene day 0	Bark Texture	Negative	-0.11	0.46
α -Pinene day 7	Bark Texture	Negative	-0.09	0.55
α -Pinene day 12	Bark Texture	Positive	0.00	0.99
β -Pinene day 0	Bark Texture	Negative	-0.07	0.65
β -Pinene day 7	Bark Texture	Positive	0.18	0.25
β -Pinene day 12	Bark Texture	Positive	0.25	0.09
Terpineol day 0	Bark Texture	Negative	-0.24	0.12
Terpineol day 7	Bark Texture	Negative	-0.01	0.97
Terpineol day 12	Bark Texture	Negative	-0.20	0.20
Terpinolene day 0	Bark Texture	Negative	-0.13	0.41
Terpinolene day 7	Bark Texture	Positive	0.02	0.87
Terpinolene day 12	Bark Texture	Positive	0.12	0.45
Total Terpenoids day 0	Bark Texture	Negative	-0.23	0.12

Table 11a:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
Total Terpenoids day 7	Bark Texture	Negative	-0.01	0.92
Total Terpenoids day 12	Bark Texture	Positive	0.09	0.57
Total Monoterpenes day 0	Bark Texture	Negative	-0.23	0.13
Total Monoterpenes day 7	Bark Texture	Negative	-0.02	0.92
Total Monoterpenes day 12	Bark Texture	Positive	0.09	0.57
Total Sesquiterpenes day 0	Bark Texture	Negative	-0.30	0.05
Total Sesquiterpenes day 7	Bark Texture	Positive	0.07	0.63
Total Sesquiterpenes day 12	Bark Texture	Negative	-0.11	0.48
β -Pinene/ δ -3-Carene day 0	Bark Texture	Negative	-0.16	0.29
β -Pinene/ δ -3-Carene day 7	Bark Texture	Negative	-0.02	0.89
β -Pinene/ δ -3-Carene day 12	Bark Texture	Positive	0.05	0.72
Terpinolene/Myrcene day 0	Bark Texture	Positive	0.19	0.22
Terpinolene/Myrcene day 7	Bark Texture	Positive	0.05	0.72
Terpinolene/Myrcene day 12	Bark Texture	Positive	0.08	0.59
MPB Pres. 07	MPB Pres. 06	Positive	0.57	<0.001
Mortality 06	MPB Pres. 06	Positive	0.31	0.04
Mortality 07	MPB Pres. 06	Positive	0.40	0.01
PT Class 07	MPB Pres. 06	Negative	-0.13	0.38
Hypersensitivity	MPB Pres. 06	Negative	-0.01	0.96
Brood Development	MPB Pres. 06	Positive	0.15	0.31
Par. Gall. Length	MPB Pres. 06	Positive	0.17	0.26
Lesion day 7	MPB Pres. 06	Positive	0.04	0.77
Lesion day 12	MPB Pres. 06	Negative	-0.11	0.49
δ -3-Carene day 0	MPB Pres. 06	Negative	-0.23	0.13
δ -3-Carene day 7	MPB Pres. 06	Negative	-0.41	0.01
δ -3-Carene day 12	MPB Pres. 06	Negative	-0.06	0.70
Limonene day 0	MPB Pres. 06	Positive	0.09	0.58
Limonene day 7	MPB Pres. 06	Negative	-0.08	0.61

Table 11a:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
Limonene day 12	MPB Pres. 06	Positive	0.18	0.24
Myrcene day 0	MPB Pres. 06	Negative	-0.06	0.69
Myrcene day 7	MPB Pres. 06	Negative	-0.37	0.01
Myrcene day 12	MPB Pres. 06	Positive	0.19	0.21
β -Phellandrene day 0	MPB Pres. 06	Negative	-0.16	0.30
β -Phellandrene day 7	MPB Pres. 06	Negative	-0.32	0.03
β -Phellandrene day 12	MPB Pres. 06	Positive	0.17	0.27
α -Pinene day 0	MPB Pres. 06	Positive	0.09	0.57
α -Pinene day 7	MPB Pres. 06	Negative	-0.01	0.95
α -Pinene day 12	MPB Pres. 06	Positive	0.30	0.05
β -Pinene day 0	MPB Pres. 06	Negative	-0.07	0.67
β -Pinene day 7	MPB Pres. 06	Negative	-0.24	0.12
β -Pinene day 12	MPB Pres. 06	Positive	0.22	0.15
Terpineol day 0	MPB Pres. 06	Negative	-0.01	0.97
Terpineol day 7	MPB Pres. 06	Negative	-0.12	0.44
Terpineol day 12	MPB Pres. 06	Positive	0.11	0.48
Terpinolene day 0	MPB Pres. 06	Positive	0.11	0.48
Terpinolene day 7	MPB Pres. 06	Negative	-0.19	0.20
Terpinolene day 12	MPB Pres. 06	Positive	0.07	0.64
Total Terpenoids day 0	MPB Pres. 06	Negative	-0.12	0.43
Total Terpenoids day 7	MPB Pres. 06	Negative	-0.42	<0.01
Total Terpenoids day 12	MPB Pres. 06	Positive	0.24	0.11
Total Monoterpenes day 0	MPB Pres. 06	Negative	-0.12	0.43
Total Monoterpenes day 7	MPB Pres. 06	Negative	-0.42	<0.01
Total Monoterpenes day 12	MPB Pres. 06	Positive	0.24	0.11
Total Sesquiterpenes day 0	MPB Pres. 06	Negative	-0.16	0.30
Total Sesquiterpenes day 7	MPB Pres. 06	Negative	-0.14	0.34
Total Sesquiterpenes day 12	MPB Pres. 06	Positive	0.16	0.28

Table 11a:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
β -Pinene/ δ -3-Carene day 0	MPB Pres. 06	Negative	-0.22	0.14
β -Pinene/ δ -3-Carene day 7	MPB Pres. 06	Positive	0.06	0.67
β -Pinene/ δ -3-Carene day 12	MPB Pres. 06	Negative	-0.04	0.80
Terpinolene/Myrcene day 0	MPB Pres. 06	Negative	-0.02	0.88
Terpinolene/Myrcene day 7	MPB Pres. 06	Positive	0.08	0.61
Terpinolene/Myrcene day 12	MPB Pres. 06	Positive	0.03	0.82
Mortality 06	MPB Pres. 07	Positive	0.51	<0.01
Mortality 07	MPB Pres. 07	Positive	0.63	<0.001
PT Class 07	MPB Pres. 07	Negative	-0.02	0.90
Hypersensitivity	MPB Pres. 07	Negative	-0.23	0.12
Brood Development	MPB Pres. 07	Positive	0.20	0.20
Par. Gall. Length	MPB Pres. 07	Positive	0.30	0.05
Lesion day 7	MPB Pres. 07	Positive	0.29	0.05
Lesion day 12	MPB Pres. 07	Positive	0.17	0.26
δ -3-Carene day 0	MPB Pres. 07	Negative	-0.23	0.13
δ -3-Carene day 7	MPB Pres. 07	Negative	-0.26	0.08
δ -3-Carene day 12	MPB Pres. 07	Negative	-0.13	0.41
Limonene day 0	MPB Pres. 07	Positive	0.09	0.54
Limonene day 7	MPB Pres. 07	Positive	0.08	0.62
Limonene day 12	MPB Pres. 07	Positive	0.23	0.12
Myrcene day 0	MPB Pres. 07	Negative	-0.17	0.27
Myrcene day 7	MPB Pres. 07	Negative	-0.11	0.47
Myrcene day 12	MPB Pres. 07	Positive	0.02	0.90
β -Phellandrene day 0	MPB Pres. 07	Negative	-0.34	0.02
β -Phellandrene day 7	MPB Pres. 07	Negative	-0.10	0.50
β -Phellandrene day 12	MPB Pres. 07	Positive	0.03	0.85
α -Pinene day 0	MPB Pres. 07	Negative	-0.12	0.45
α -Pinene day 7	MPB Pres. 07	Positive	0.00	0.98

Table 11a:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
α -Pinene day 12	MPB Pres. 07	Positive	0.11	0.48
β -Pinene day 0	MPB Pres. 07	Negative	-0.28	0.06
β -Pinene day 7	MPB Pres. 07	Negative	-0.05	0.73
β -Pinene day 12	MPB Pres. 07	Positive	0.08	0.62
Terpineol day 0	MPB Pres. 07	Negative	-0.08	0.61
Terpineol day 7	MPB Pres. 07	Positive	0.02	0.87
Terpineol day 12	MPB Pres. 07	Negative	-0.13	0.39
Terpinolene day 0	MPB Pres. 07	Positive	0.00	0.98
Terpinolene day 7	MPB Pres. 07	Negative	-0.02	0.91
Terpinolene day 12	MPB Pres. 07	Positive	0.11	0.46
Total Terpenoids day 0	MPB Pres. 07	Negative	-0.32	0.03
Total Terpenoids day 7	MPB Pres. 07	Negative	-0.14	0.35
Total Terpenoids day 12	MPB Pres. 07	Positive	0.05	0.73
Total Monoterpenes day 0	MPB Pres. 07	Negative	-0.32	0.03
Total Monoterpenes day 7	MPB Pres. 07	Negative	-0.14	0.35
Total Monoterpenes day 12	MPB Pres. 07	Positive	0.05	0.73
Total Sesquiterpenes day 0	MPB Pres. 07	Negative	-0.10	0.53
Total Sesquiterpenes day 7	MPB Pres. 07	Positive	0.09	0.54
Total Sesquiterpenes day 12	MPB Pres. 07	Negative	-0.07	0.65
β -Pinene/ δ -3-Carene day 0	MPB Pres. 07	Negative	-0.14	0.37
β -Pinene/ δ -3-Carene day 7	MPB Pres. 07	Positive	0.01	0.94
β -Pinene/ δ -3-Carene day 12	MPB Pres. 07	Positive	0.01	0.93
Terpinolene/Myrcene day 0	MPB Pres. 07	Negative	-0.06	0.71
Terpinolene/Myrcene day 7	MPB Pres. 07	Positive	0.04	0.80
Terpinolene/Myrcene day 12	MPB Pres. 07	Positive	0.18	0.24
Mortality 07	Mortality 06	Positive	0.86	<0.001
PT Class 07	Mortality 06	Negative	-0.02	0.90
Hypersensitivity	Mortality 06	Negative	-0.50	<0.01

Table 11a:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
Brood Development	Mortality 06	Positive	0.63	<0.001
Par. Gall. Length	Mortality 06	Positive	0.69	<0.001
Lesion day 7	Mortality 06	Positive	0.12	0.43
Lesion day 12	Mortality 06	Positive	0.02	0.90
δ -3-Carene day 0	Mortality 06	Negative	-0.24	0.12
δ -3-Carene day 7	Mortality 06	Negative	-0.11	0.48
δ -3-Carene day 12	Mortality 06	Positive	0.14	0.34
Limonene day 0	Mortality 06	Negative	-0.12	0.44
Limonene day 7	Mortality 06	Negative	-0.13	0.40
Limonene day 12	Mortality 06	Positive	0.08	0.62
Myrcene day 0	Mortality 06	Negative	-0.12	0.42
Myrcene day 7	Mortality 06	Negative	-0.12	0.42
Myrcene day 12	Mortality 06	Positive	0.25	0.10
β -Phellandrene day 0	Mortality 06	Negative	-0.15	0.32
β -Phellandrene day 7	Mortality 06	Negative	-0.07	0.63
β -Phellandrene day 12	Mortality 06	Positive	0.28	0.06
α -Pinene day 0	Mortality 06	Positive	0.07	0.66
α -Pinene day 7	Mortality 06	Positive	0.05	0.74
α -Pinene day 12	Mortality 06	Positive	0.25	0.09
β -Pinene day 0	Mortality 06	Negative	-0.15	0.31
β -Pinene day 7	Mortality 06	Negative	-0.02	0.91
β -Pinene day 12	Mortality 06	Positive	0.21	0.16
Terpineol day 0	Mortality 06	Positive	0.06	0.68
Terpineol day 7	Mortality 06	Positive	0.14	0.37
Terpineol day 12	Mortality 06	Positive	0.05	0.73
Terpinolene day 0	Mortality 06	Negative	-0.06	0.68
Terpinolene day 7	Mortality 06	Positive	0.02	0.87
Terpinolene day 12	Mortality 06	Positive	0.27	0.08

Table 11a:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
Total Terpenoids day 0	Mortality 06	Negative	-0.16	0.30
Total Terpenoids day 7	Mortality 06	Negative	-0.08	0.61
Total Terpenoids day 12	Mortality 06	Positive	0.38	0.01
Total Monoterpenes day 0	Mortality 06	Negative	-0.16	0.29
Total Monoterpenes day 7	Mortality 06	Negative	-0.08	0.61
Total Monoterpenes day 12	Mortality 06	Positive	0.38	0.01
Total Sesquiterpenes day 0	Mortality 06	Positive	0.04	0.78
Total Sesquiterpenes day 7	Mortality 06	Positive	0.09	0.54
Total Sesquiterpenes day 12	Mortality 06	Positive	0.07	0.63
β -Pinene/ δ -3-Carene day 0	Mortality 06	Positive	0.07	0.66
β -Pinene/ δ -3-Carene day 7	Mortality 06	Negative	-0.07	0.66
β -Pinene/ δ -3-Carene day 12	Mortality 06	Positive	0.12	0.41
Terpinolene/Myrcene day 0	Mortality 06	Negative	-0.09	0.54
Terpinolene/Myrcene day 7	Mortality 06	Positive	0.06	0.68
Terpinolene/Myrcene day 12	Mortality 06	Positive	0.16	0.30
PT Class 07	Mortality 07	Negative	-0.03	0.85
Hypersensitivity	Mortality 07	Negative	-0.44	<0.01
Brood Development	Mortality 07	Positive	0.52	<0.01
Par. Gall. Length	Mortality 07	Positive	0.58	<0.001
Lesion day 7	Mortality 07	Positive	0.08	0.60
Lesion day 12	Mortality 07	Positive	0.02	0.88
δ -3-Carene day 0	Mortality 07	Negative	-0.35	0.02
δ -3-Carene day 7	Mortality 07	Negative	-0.23	0.13
δ -3-Carene day 12	Mortality 07	Negative	-0.10	0.52
Limonene day 0	Mortality 07	Negative	-0.11	0.46
Limonene day 7	Mortality 07	Negative	-0.05	0.74
Limonene day 12	Mortality 07	Positive	0.06	0.69
Myrcene day 0	Mortality 07	Negative	-0.21	0.17

Table 11a:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
Myrcene day 7	Mortality 07	Negative	-0.05	0.75
Myrcene day 12	Mortality 07	Positive	0.09	0.58
β -Phellandrene day 0	Mortality 07	Negative	-0.23	0.13
β -Phellandrene day 7	Mortality 07	Positive	0.05	0.73
β -Phellandrene day 12	Mortality 07	Positive	0.19	0.21
α -Pinene day 0	Mortality 07	Positive	0.06	0.69
α -Pinene day 7	Mortality 07	Positive	0.12	0.45
α -Pinene day 12	Mortality 07	Positive	0.27	0.08
β -Pinene day 0	Mortality 07	Negative	-0.16	0.30
β -Pinene day 7	Mortality 07	Positive	0.03	0.82
β -Pinene day 12	Mortality 07	Positive	0.18	0.23
Terpineol day 0	Mortality 07	Positive	0.01	0.95
Terpineol day 7	Mortality 07	Positive	0.08	0.62
Terpineol day 12	Mortality 07	Negative	-0.08	0.59
Terpinolene day 0	Mortality 07	Negative	-0.03	0.84
Terpinolene day 7	Mortality 07	Positive	0.01	0.93
Terpinolene day 12	Mortality 07	Positive	0.14	0.37
Total Terpenoids day 0	Mortality 07	Negative	-0.23	0.13
Total Terpenoids day 7	Mortality 07	Positive	0.02	0.88
Total Terpenoids day 12	Mortality 07	Positive	0.23	0.13
Total Monoterpenes day 0	Mortality 07	Negative	-0.23	0.13
Total Monoterpenes day 7	Mortality 07	Positive	0.02	0.88
Total Monoterpenes day 12	Mortality 07	Positive	0.23	0.13
Total Sesquiterpenes day 0	Mortality 07	Negative	-0.06	0.69
Total Sesquiterpenes day 7	Mortality 07	Positive	0.15	0.32
Total Sesquiterpenes day 12	Mortality 07	Positive	0.11	0.47
β -Pinene/ δ -3-Carene day 0	Mortality 07	Positive	0.07	0.64
β -Pinene/ δ -3-Carene day 7	Mortality 07	Negative	-0.04	0.78

Table 11a:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
β -Pinene/ δ -3-Carene day 12	Mortality 07	Positive	0.22	0.14
Terpinolene/Myrcene day 0	Mortality 07	Negative	-0.09	0.56
Terpinolene/Myrcene day 7	Mortality 07	Positive	0.05	0.76
Terpinolene/Myrcene day 12	Mortality 07	Positive	0.16	0.31
Hypersensitivity	PT Class 07	Negative	-0.04	0.79
Brood Development	PT Class 07	Positive	0.12	0.44
Par. Gall. Length	PT Class 07	Positive	0.01	0.94
Lesion day 7	PT Class 07	Negative	-0.02	0.91
Lesion day 12	PT Class 07	Positive	0.08	0.60
δ -3-Carene day 0	PT Class 07	Positive	0.04	0.78
δ -3-Carene day 7	PT Class 07	Positive	0.20	0.19
δ -3-Carene day 12	PT Class 07	Negative	-0.03	0.85
Limonene day 0	PT Class 07	Positive	0.13	0.39
Limonene day 7	PT Class 07	Positive	0.22	0.14
Limonene day 12	PT Class 07	Positive	0.10	0.53
Myrcene day 0	PT Class 07	Positive	0.03	0.87
Myrcene day 7	PT Class 07	Positive	0.26	0.09
Myrcene day 12	PT Class 07	Negative	-0.04	0.80
β -Phellandrene day 0	PT Class 07	Negative	-0.03	0.85
β -Phellandrene day 7	PT Class 07	Positive	0.12	0.41
β -Phellandrene day 12	PT Class 07	Positive	0.00	1.00
α -Pinene day 0	PT Class 07	Positive	0.19	0.21
α -Pinene day 7	PT Class 07	Positive	0.41	<0.01
α -Pinene day 12	PT Class 07	Positive	0.24	0.12
β -Pinene day 0	PT Class 07	Positive	0.01	0.96
β -Pinene day 7	PT Class 07	Positive	0.07	0.63
β -Pinene day 12	PT Class 07	Negative	-0.24	0.11
Terpineol day 0	PT Class 07	Positive	0.31	0.04

Table 11a:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
Terpineol day 7	PT Class 07	Positive	0.11	0.47
Terpineol day 12	PT Class 07	Negative	-0.08	0.60
Terpinolene day 0	PT Class 07	Positive	0.01	0.94
Terpinolene day 7	PT Class 07	Positive	0.03	0.83
Terpinolene day 12	PT Class 07	Negative	-0.16	0.29
Total Terpenoids day 0	PT Class 07	Positive	0.03	0.83
Total Terpenoids day 7	PT Class 07	Positive	0.24	0.11
Total Terpenoids day 12	PT Class 07	Negative	-0.03	0.82
Total Monoterpenes day 0	PT Class 07	Positive	0.03	0.84
Total Monoterpenes day 7	PT Class 07	Positive	0.24	0.11
Total Monoterpenes day 12	PT Class 07	Negative	-0.03	0.83
Total Sesquiterpenes day 0	PT Class 07	Positive	0.16	0.28
Total Sesquiterpenes day 7	PT Class 07	Positive	0.04	0.82
Total Sesquiterpenes day 12	PT Class 07	Negative	-0.27	0.07
β -Pinene/ δ -3-Carene day 0	PT Class 07	Negative	-0.09	0.58
β -Pinene/ δ -3-Carene day 7	PT Class 07	Positive	0.03	0.87
β -Pinene/ δ -3-Carene day 12	PT Class 07	Negative	-0.08	0.62
Terpinolene/Myrcene day 0	PT Class 07	Negative	-0.01	0.97
Terpinolene/Myrcene day 7	PT Class 07	Negative	-0.17	0.26
Terpinolene/Myrcene day 12	PT Class 07	Negative	-0.14	0.36
Brood Development	Hypersensitivity	Negative	-0.44	<0.01
Par. Gall. Length	Hypersensitivity	Negative	-0.71	<0.001
Lesion day 7	Hypersensitivity	Negative	-0.01	0.95
Lesion day 12	Hypersensitivity	Negative	-0.08	0.59
δ -3-Carene day 0	Hypersensitivity	Positive	0.13	0.38
δ -3-Carene day 7	Hypersensitivity	Negative	-0.05	0.73
δ -3-Carene day 12	Hypersensitivity	Negative	-0.12	0.42
Limonene day 0	Hypersensitivity	Positive	0.05	0.75

Table 11a:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
Limonene day 7	Hypersensitivity	Negative	-0.11	0.46
Limonene day 12	Hypersensitivity	Negative	-0.12	0.42
Myrcene day 0	Hypersensitivity	Positive	0.03	0.85
Myrcene day 7	Hypersensitivity	Negative	-0.18	0.24
Myrcene day 12	Hypersensitivity	Negative	-0.28	0.07
β -Phellandrene day 0	Hypersensitivity	Negative	-0.08	0.62
β -Phellandrene day 7	Hypersensitivity	Negative	-0.25	0.09
β -Phellandrene day 12	Hypersensitivity	Negative	-0.36	0.02
α -Pinene day 0	Hypersensitivity	Positive	0.07	0.66
α -Pinene day 7	Hypersensitivity	Positive	0.07	0.63
α -Pinene day 12	Hypersensitivity	Positive	0.00	0.98
β -Pinene day 0	Hypersensitivity	Positive	0.01	0.95
β -Pinene day 7	Hypersensitivity	Negative	-0.03	0.83
β -Pinene day 12	Hypersensitivity	Negative	-0.17	0.27
Terpineol day 0	Hypersensitivity	Negative	-0.14	0.37
Terpineol day 7	Hypersensitivity	Negative	-0.28	0.06
Terpineol day 12	Hypersensitivity	Negative	-0.28	0.06
Terpinolene day 0	Hypersensitivity	Positive	0.12	0.42
Terpinolene day 7	Hypersensitivity	Positive	0.04	0.78
Terpinolene day 12	Hypersensitivity	Negative	-0.02	0.88
Total Terpenoids day 0	Hypersensitivity	Negative	-0.01	0.92
Total Terpenoids day 7	Hypersensitivity	Negative	-0.22	0.15
Total Terpenoids day 12	Hypersensitivity	Negative	-0.35	0.02
Total Monoterpenes day 0	Hypersensitivity	Negative	-0.01	0.93
Total Monoterpenes day 7	Hypersensitivity	Negative	-0.22	0.15
Total Monoterpenes day 12	Hypersensitivity	Negative	-0.35	0.02
Total Sesquiterpenes day 0	Hypersensitivity	Negative	-0.12	0.45
Total Sesquiterpenes day 7	Hypersensitivity	Negative	-0.21	0.16

Table 11a:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
Total Sesquiterpenes day 12	Hypersensitivity	Negative	-0.27	0.08
β -Pinene/ δ -3-Carene day 0	Hypersensitivity	Negative	-0.26	0.08
β -Pinene/ δ -3-Carene day 7	Hypersensitivity	Negative	-0.04	0.79
β -Pinene/ δ -3-Carene day 12	Hypersensitivity	Negative	-0.18	0.23
Terpinolene/Myrcene day 0	Hypersensitivity	Positive	0.18	0.23
Terpinolene/Myrcene day 7	Hypersensitivity	Positive	0.17	0.26
Terpinolene/Myrcene day 12	Hypersensitivity	Positive	0.13	0.38
Par. Gall. Length	Brood Development	Positive	0.62	<0.001
Lesion day 7	Brood Development	Positive	0.11	0.46
Lesion day 12	Brood Development	Positive	0.09	0.56
δ -3-Carene day 0	Brood Development	Negative	-0.16	0.30
δ -3-Carene day 7	Brood Development	Positive	0.04	0.78
δ -3-Carene day 12	Brood Development	Positive	0.08	0.60
Limonene day 0	Brood Development	Negative	-0.05	0.72
Limonene day 7	Brood Development	Positive	0.01	0.96
Limonene day 12	Brood Development	Positive	0.11	0.49
Myrcene day 0	Brood Development	Positive	0.01	0.92
Myrcene day 7	Brood Development	Positive	0.08	0.59
Myrcene day 12	Brood Development	Positive	0.21	0.16
β -Phellandrene day 0	Brood Development	Positive	0.03	0.83
β -Phellandrene day 7	Brood Development	Positive	0.13	0.39
β -Phellandrene day 12	Brood Development	Positive	0.31	0.04
α -Pinene day 0	Brood Development	Positive	0.02	0.91
α -Pinene day 7	Brood Development	Positive	0.05	0.76
α -Pinene day 12	Brood Development	Positive	0.08	0.58
β -Pinene day 0	Brood Development	Positive	0.04	0.80
β -Pinene day 7	Brood Development	Negative	-0.06	0.67
β -Pinene day 12	Brood Development	Negative	-0.01	0.93

Table 11a:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
Terpineol day 0	Brood Development	Positive	0.12	0.45
Terpineol day 7	Brood Development	Positive	0.08	0.60
Terpineol day 12	Brood Development	Positive	0.03	0.85
Terpinolene day 0	Brood Development	Negative	-0.24	0.11
Terpinolene day 7	Brood Development	Negative	-0.17	0.28
Terpinolene day 12	Brood Development	Negative	-0.05	0.74
Total Terpenoids day 0	Brood Development	Positive	0.00	0.99
Total Terpenoids day 7	Brood Development	Positive	0.10	0.52
Total Terpenoids day 12	Brood Development	Positive	0.27	0.07
Total Monoterpenes day 0	Brood Development	Positive	0.00	0.99
Total Monoterpenes day 7	Brood Development	Positive	0.10	0.52
Total Monoterpenes day 12	Brood Development	Positive	0.27	0.07
Total Sesquiterpenes day 0	Brood Development	Positive	0.04	0.78
Total Sesquiterpenes day 7	Brood Development	Positive	0.11	0.47
Total Sesquiterpenes day 12	Brood Development	Negative	-0.02	0.89
β -Pinene/ δ -3-Carene day 0	Brood Development	Positive	0.26	0.08
β -Pinene/ δ -3-Carene day 7	Brood Development	Positive	0.17	0.26
β -Pinene/ δ -3-Carene day 12	Brood Development	Positive	0.06	0.70
Terpinolene/Myrcene day 0	Brood Development	Negative	-0.23	0.13
Terpinolene/Myrcene day 7	Brood Development	Negative	-0.28	0.06
Terpinolene/Myrcene day 12	Brood Development	Negative	-0.15	0.32
Lesion day 7	Par. Gall. Length	Positive	0.19	0.22
Lesion day 12	Par. Gall. Length	Positive	0.02	0.88
δ -3-Carene day 0	Par. Gall. Length	Negative	-0.02	0.89
δ -3-Carene day 7	Par. Gall. Length	Positive	0.17	0.27
δ -3-Carene day 12	Par. Gall. Length	Positive	0.30	0.05
Limonene day 0	Par. Gall. Length	Negative	-0.10	0.50
Limonene day 7	Par. Gall. Length	Positive	0.01	0.94

Table 11a:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
Limönene day 12	Par. Gall. Length	Positive	0.14	0.37
Myrcene day 0	Par. Gall. Length	Negative	-0.04	0.78
Myrcene day 7	Par. Gall. Length	Positive	0.08	0.61
Myrcene day 12	Par. Gall. Length	Positive	0.34	0.02
β -Phellandrene day 0	Par. Gall. Length	Positive	0.07	0.63
β -Phellandrene day 7	Par. Gall. Length	Positive	0.10	0.53
β -Phellandrene day 12	Par. Gall. Length	Positive	0.41	0.01
α -Pinene day 0	Par. Gall. Length	Negative	-0.02	0.91
α -Pinene day 7	Par. Gall. Length	Negative	-0.11	0.47
α -Pinene day 12	Par. Gall. Length	Positive	0.07	0.65
β -Pinene day 0	Par. Gall. Length	Negative	-0.08	0.61
β -Pinene day 7	Par. Gall. Length	Negative	-0.16	0.30
β -Pinene day 12	Par. Gall. Length	Positive	0.09	0.57
Terpineol day 0	Par. Gall. Length	Positive	0.13	0.41
Terpineol day 7	Par. Gall. Length	Positive	0.26	0.09
Terpineol day 12	Par. Gall. Length	Positive	0.28	0.07
Terpinolene day 0	Par. Gall. Length	Negative	-0.07	0.64
Terpinolene day 7	Par. Gall. Length	Positive	0.19	0.21
Terpinolene day 12	Par. Gall. Length	Positive	0.32	0.03
Total Terpenoids day 0	Par. Gall. Length	Positive	0.03	0.85
Total Terpenoids day 7	Par. Gall. Length	Positive	0.08	0.59
Total Terpenoids day 12	Par. Gall. Length	Positive	0.45	<0.01
Total Monoterpenes day 0	Par. Gall. Length	Positive	0.03	0.85
Total Monoterpenes day 7	Par. Gall. Length	Positive	0.08	0.59
Total Monoterpenes day 12	Par. Gall. Length	Positive	0.45	<0.01
Total Sesquiterpenes day 0	Par. Gall. Length	Positive	0.09	0.58
Total Sesquiterpenes day 7	Par. Gall. Length	Positive	0.26	0.09
Total Sesquiterpenes day 12	Par. Gall. Length	Positive	0.25	0.10

Table 11a:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
β -Pinene/ δ -3-Carene day 0	Par. Gall. Length	Positive	0.10	0.50
β -Pinene/ δ -3-Carene day 7	Par. Gall. Length	Positive	0.17	0.27
β -Pinene/ δ -3-Carene day 12	Par. Gall. Length	Positive	0.01	0.95
Terpinolene/Myrcene day 0	Par. Gall. Length	Negative	-0.03	0.83
Terpinolene/Myrcene day 7	Par. Gall. Length	Positive	0.05	0.72
Terpinolene/Myrcene day 12	Par. Gall. Length	Positive	0.09	0.56
Lesion day 12	Lesion day 7	Positive	0.62	<0.001
δ -3-Carene day 0	Lesion day 7	Positive	0.01	0.94
δ -3-Carene day 7	Lesion day 7	Positive	0.10	0.51
δ -3-Carene day 12	Lesion day 7	Positive	0.15	0.33
Limonene day 0	Lesion day 7	Negative	-0.09	0.54
Limonene day 7	Lesion day 7	Negative	-0.05	0.73
Limonene day 12	Lesion day 7	Positive	0.05	0.75
Myrcene day 0	Lesion day 7	Positive	0.10	0.50
Myrcene day 7	Lesion day 7	Positive	0.13	0.39
Myrcene day 12	Lesion day 7	Positive	0.15	0.32
β -Phellandrene day 0	Lesion day 7	Positive	0.16	0.30
β -Phellandrene day 7	Lesion day 7	Positive	0.12	0.43
β -Phellandrene day 12	Lesion day 7	Positive	0.23	0.13
α -Pinene day 0	Lesion day 7	Negative	-0.23	0.13
α -Pinene day 7	Lesion day 7	Negative	-0.23	0.12
α -Pinene day 12	Lesion day 7	Negative	-0.19	0.21
β -Pinene day 0	Lesion day 7	Negative	-0.26	0.09
β -Pinene day 7	Lesion day 7	Negative	-0.38	0.01
β -Pinene day 12	Lesion day 7	Negative	-0.24	0.12
Terpineol day 0	Lesion day 7	Positive	0.10	0.51
Terpineol day 7	Lesion day 7	Positive	0.30	0.05
Terpineol day 12	Lesion day 7	Positive	0.17	0.26

Table 11a:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
Terpinolene day 0	Lesion day 7	Negative	-0.05	0.77
Terpinolene day 7	Lesion day 7	Positive	0.03	0.85
Terpinolene day 12	Lesion day 7	Positive	0.16	0.29
Total Terpenoids day 0	Lesion day 7	Positive	0.03	0.83
Total Terpenoids day 7	Lesion day 7	Positive	0.00	0.99
Total Terpenoids day 12	Lesion day 7	Positive	0.13	0.41
Total Monoterpenes day 0	Lesion day 7	Positive	0.03	0.83
Total Monoterpenes day 7	Lesion day 7	Positive	0.00	0.99
Total Monoterpenes day 12	Lesion day 7	Positive	0.13	0.41
Total Sesquiterpenes day 0	Lesion day 7	Positive	0.16	0.29
Total Sesquiterpenes day 7	Lesion day 7	Positive	0.12	0.45
Total Sesquiterpenes day 12	Lesion day 7	Negative	-0.01	0.93
β -Pinene/ δ -3-Carene day 0	Lesion day 7	Negative	-0.33	0.03
β -Pinene/ δ -3-Carene day 7	Lesion day 7	Positive	0.05	0.72
β -Pinene/ δ -3-Carene day 12	Lesion day 7	Negative	-0.40	0.01
Terpinolene/Myrcene day 0	Lesion day 7	Negative	-0.25	0.09
Terpinolene/Myrcene day 7	Lesion day 7	Negative	-0.04	0.80
Terpinolene/Myrcene day 12	Lesion day 7	Positive	0.03	0.83
δ -3-Carene day 0	Lesion day 12	Positive	0.06	0.71
δ -3-Carene day 7	Lesion day 12	Positive	0.15	0.34
δ -3-Carene day 12	Lesion day 12	Positive	0.04	0.79
Limonene day 0	Lesion day 12	Negative	-0.22	0.14
Limonene day 7	Lesion day 12	Negative	-0.07	0.63
Limonene day 12	Lesion day 12	Negative	-0.21	0.16
Myrcene day 0	Lesion day 12	Positive	0.23	0.12
Myrcene day 7	Lesion day 12	Positive	0.47	<0.01
Myrcene day 12	Lesion day 12	Positive	0.11	0.46
β -Phellandrene day 0	Lesion day 12	Positive	0.28	0.06

Table 11a:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
β -Phellandrene day 7	Lesion day 12	Positive	0.50	<0.01
β -Phellandrene day 12	Lesion day 12	Positive	0.22	0.15
α -Pinene day 0	Lesion day 12	Negative	-0.14	0.37
α -Pinene day 7	Lesion day 12	Negative	-0.06	0.70
α -Pinene day 12	Lesion day 12	Negative	-0.21	0.17
β -Pinene day 0	Lesion day 12	Negative	-0.09	0.56
β -Pinene day 7	Lesion day 12	Negative	-0.06	0.71
β -Pinene day 12	Lesion day 12	Negative	-0.21	0.17
Terpineol day 0	Lesion day 12	Positive	0.17	0.26
Terpineol day 7	Lesion day 12	Positive	0.23	0.12
Terpineol day 12	Lesion day 12	Positive	0.08	0.60
Terpinolene day 0	Lesion day 12	Positive	0.10	0.50
Terpinolene day 7	Lesion day 12	Positive	0.12	0.44
Terpinolene day 12	Lesion day 12	Positive	0.07	0.66
Total Terpenoids day 0	Lesion day 12	Positive	0.17	0.27
Total Terpenoids day 7	Lesion day 12	Positive	0.41	<0.01
Total Terpenoids day 12	Lesion day 12	Positive	0.07	0.65
Total Monoterpenes day 0	Lesion day 12	Positive	0.17	0.27
Total Monoterpenes day 7	Lesion day 12	Positive	0.41	<0.01
Total Monoterpenes day 12	Lesion day 12	Positive	0.07	0.65
Total Sesquiterpenes day 0	Lesion day 12	Positive	0.21	0.16
Total Sesquiterpenes day 7	Lesion day 12	Positive	0.07	0.63
Total Sesquiterpenes day 12	Lesion day 12	Negative	-0.03	0.86
β -Pinene/ δ -3-Carene day 0	Lesion day 12	Negative	-0.28	0.06
β -Pinene/ δ -3-Carene day 7	Lesion day 12	Positive	0.02	0.92
β -Pinene/ δ -3-Carene day 12	Lesion day 12	Negative	-0.16	0.29
Terpinolene/Myrcene day 0	Lesion day 12	Negative	-0.15	0.34
Terpinolene/Myrcene day 7	Lesion day 12	Negative	-0.06	0.68

Table 11a:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
Terpinolene/Myrcene day 12	Lesion day 12	Positive	0.00	0.98
δ -3-Carene day 7	δ -3-Carene day 0	Positive	0.74	<0.001
δ -3-Carene day 12	δ -3-Carene day 0	Positive	0.66	<0.001
Limonene day 0	δ -3-Carene day 0	Positive	0.23	0.13
Limonene day 7	δ -3-Carene day 0	Positive	0.13	0.39
Limonene day 12	δ -3-Carene day 0	Positive	0.17	0.27
Myrcene day 0	δ -3-Carene day 0	Positive	0.44	<0.01
Myrcene day 7	δ -3-Carene day 0	Positive	0.21	0.17
Myrcene day 12	δ -3-Carene day 0	Positive	0.31	0.04
β -Phellandrene day 0	δ -3-Carene day 0	Positive	0.46	<0.01
β -Phellandrene day 7	δ -3-Carene day 0	Positive	0.04	0.80
β -Phellandrene day 12	δ -3-Carene day 0	Positive	0.14	0.37
α -Pinene day 0	δ -3-Carene day 0	Positive	0.17	0.27
α -Pinene day 7	δ -3-Carene day 0	Negative	-0.17	0.25
α -Pinene day 12	δ -3-Carene day 0	Negative	-0.15	0.34
β -Pinene day 0	δ -3-Carene day 0	Positive	0.10	0.50
β -Pinene day 7	δ -3-Carene day 0	Negative	-0.15	0.33
β -Pinene day 12	δ -3-Carene day 0	Negative	-0.19	0.21
Terpineol day 0	δ -3-Carene day 0	Positive	0.18	0.24
Terpineol day 7	δ -3-Carene day 0	Negative	-0.04	0.79
Terpineol day 12	δ -3-Carene day 0	Positive	0.26	0.09
Terpinolene day 0	δ -3-Carene day 0	Positive	0.43	<0.01
Terpinolene day 7	δ -3-Carene day 0	Positive	0.43	<0.01
Terpinolene day 12	δ -3-Carene day 0	Positive	0.40	0.01
Total Terpenoids day 0	δ -3-Carene day 0	Positive	0.56	<0.001
Total Terpenoids day 7	δ -3-Carene day 0	Positive	0.17	0.26
Total Terpenoids day 12	δ -3-Carene day 0	Positive	0.24	0.11
Total Monoterpenes day 0	δ -3-Carene day 0	Positive	0.56	<0.001

Table 11a:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
Total Monoterpenes day 7	δ -3-Carene day 0	Positive	0.17	0.26
Total Monoterpenes day 12	δ -3-Carene day 0	Positive	0.24	0.11
Total Sesquiterpenes day 0	δ -3-Carene day 0	Positive	0.45	<0.01
Total Sesquiterpenes day 7	δ -3-Carene day 0	Negative	-0.06	0.72
Total Sesquiterpenes day 12	δ -3-Carene day 0	Positive	0.12	0.43
β -Pinene/ δ -3-Carene day 0	δ -3-Carene day 0	Negative	-0.12	0.42
β -Pinene/ δ -3-Carene day 7	δ -3-Carene day 0	Negative	-0.10	0.50
β -Pinene/ δ -3-Carene day 12	δ -3-Carene day 0	Negative	-0.50	<0.001
Terpinolene/Myrcene day 0	δ -3-Carene day 0	Positive	0.16	0.30
Terpinolene/Myrcene day 7	δ -3-Carene day 0	Positive	0.24	0.12
Terpinolene/Myrcene day 12	δ -3-Carene day 0	Positive	0.15	0.33
δ -3-Carene day 12	δ -3-Carene day 7	Positive	0.71	<0.001
Limonene day 0	δ -3-Carene day 7	Negative	-0.10	0.52
Limonene day 7	δ -3-Carene day 7	Positive	0.08	0.61
Limonene day 12	δ -3-Carene day 7	Positive	0.01	0.92
Myrcene day 0	δ -3-Carene day 7	Positive	0.24	0.12
Myrcene day 7	δ -3-Carene day 7	Positive	0.54	<0.001
Myrcene day 12	δ -3-Carene day 7	Positive	0.40	0.01
β -Phellandrene day 0	δ -3-Carene day 7	Positive	0.29	0.05
β -Phellandrene day 7	δ -3-Carene day 7	Positive	0.36	0.02
β -Phellandrene day 12	δ -3-Carene day 7	Positive	0.27	0.08
α -Pinene day 0	δ -3-Carene day 7	Negative	-0.08	0.60
α -Pinene day 7	δ -3-Carene day 7	Negative	-0.23	0.13
α -Pinene day 12	δ -3-Carene day 7	Negative	-0.23	0.13
β -Pinene day 0	δ -3-Carene day 7	Negative	-0.03	0.84
β -Pinene day 7	δ -3-Carene day 7	Negative	-0.07	0.62
β -Pinene day 12	δ -3-Carene day 7	Negative	-0.17	0.27
Terpineol day 0	δ -3-Carene day 7	Positive	0.15	0.32

Table 11a:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
Terpineol day 7	δ -3-Carene day 7	Positive	0.18	0.24
Terpineol day 12	δ -3-Carene day 7	Positive	0.18	0.24
Terpinolene day 0	δ -3-Carene day 7	Positive	0.12	0.42
Terpinolene day 7	δ -3-Carene day 7	Positive	0.57	<0.001
Terpinolene day 12	δ -3-Carene day 7	Positive	0.36	0.02
Total Terpenoids day 0	δ -3-Carene day 7	Positive	0.29	0.05
Total Terpenoids day 7	δ -3-Carene day 7	Positive	0.50	<0.01
Total Terpenoids day 12	δ -3-Carene day 7	Positive	0.32	0.03
Total Monoterpenes day 0	δ -3-Carene day 7	Positive	0.29	0.05
Total Monoterpenes day 7	δ -3-Carene day 7	Positive	0.50	<0.01
Total Monoterpenes day 12	δ -3-Carene day 7	Positive	0.32	0.03
Total Sesquiterpenes day 0	δ -3-Carene day 7	Positive	0.32	0.03
Total Sesquiterpenes day 7	δ -3-Carene day 7	Positive	0.16	0.31
Total Sesquiterpenes day 12	δ -3-Carene day 7	Positive	0.05	0.75
β -Pinene/ δ -3-Carene day 0	δ -3-Carene day 7	Negative	-0.06	0.71
β -Pinene/ δ -3-Carene day 7	δ -3-Carene day 7	Negative	-0.10	0.51
β -Pinene/ δ -3-Carene day 12	δ -3-Carene day 7	Negative	-0.46	<0.01
Terpinolene/Myrcene day 0	δ -3-Carene day 7	Positive	0.15	0.33
Terpinolene/Myrcene day 7	δ -3-Carene day 7	Positive	0.12	0.45
Terpinolene/Myrcene day 12	δ -3-Carene day 7	Positive	0.03	0.82
Limonene day 0	δ -3-Carene day 12	Negative	-0.14	0.35
Limonene day 7	δ -3-Carene day 12	Negative	-0.19	0.20
Limonene day 12	δ -3-Carene day 12	Positive	0.01	0.97
Myrcene day 0	δ -3-Carene day 12	Positive	0.15	0.32
Myrcene day 7	δ -3-Carene day 12	Positive	0.08	0.60
Myrcene day 12	δ -3-Carene day 12	Positive	0.67	<0.001
β -Phellandrene day 0	δ -3-Carene day 12	Positive	0.23	0.13
β -Phellandrene day 7	δ -3-Carene day 12	Negative	-0.06	0.72

Table 11a:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
β -Phellandrene day 12	δ -3-Carene day 12	Positive	0.50	<0.01
α -Pinene day 0	δ -3-Carene day 12	Negative	-0.04	0.80
α -Pinene day 7	δ -3-Carene day 12	Negative	-0.32	0.03
α -Pinene day 12	δ -3-Carene day 12	Negative	-0.03	0.84
β -Pinene day 0	δ -3-Carene day 12	Negative	-0.16	0.28
β -Pinene day 7	δ -3-Carene day 12	Negative	-0.30	0.05
β -Pinene day 12	δ -3-Carene day 12	Positive	0.00	0.98
Terpineol day 0	δ -3-Carene day 12	Negative	-0.07	0.65
Terpineol day 7	δ -3-Carene day 12	Positive	0.01	0.95
Terpineol day 12	δ -3-Carene day 12	Positive	0.21	0.17
Terpinolene day 0	δ -3-Carene day 12	Positive	0.18	0.24
Terpinolene day 7	δ -3-Carene day 12	Positive	0.31	0.04
Terpinolene day 12	δ -3-Carene day 12	Positive	0.60	<0.001
Total Terpenoids day 0	δ -3-Carene day 12	Positive	0.21	0.16
Total Terpenoids day 7	δ -3-Carene day 12	Positive	0.01	0.97
Total Terpenoids day 12	δ -3-Carene day 12	Positive	0.67	<0.001
Total Monoterpenes day 0	δ -3-Carene day 12	Positive	0.21	0.16
Total Monoterpenes day 7	δ -3-Carene day 12	Positive	0.01	0.97
Total Monoterpenes day 12	δ -3-Carene day 12	Positive	0.67	<0.001
Total Sesquiterpenes day 0	δ -3-Carene day 12	Positive	0.23	0.12
Total Sesquiterpenes day 7	δ -3-Carene day 12	Negative	-0.01	0.95
Total Sesquiterpenes day 12	δ -3-Carene day 12	Positive	0.02	0.90
β -Pinene/ δ -3-Carene day 0	δ -3-Carene day 12	Negative	-0.27	0.07
β -Pinene/ δ -3-Carene day 7	δ -3-Carene day 12	Negative	-0.15	0.31
β -Pinene/ δ -3-Carene day 12	δ -3-Carene day 12	Negative	-0.63	<0.001
Terpinolene/Myrcene day 0	δ -3-Carene day 12	Positive	0.29	0.05
Terpinolene/Myrcene day 7	δ -3-Carene day 12	Positive	0.19	0.22
Terpinolene/Myrcene day 12	δ -3-Carene day 12	Positive	0.08	0.60

Table 11a:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
Limonene day 7	Limonene day 0	Positive	0.83	<0.001
Limonene day 12	Limonene day 0	Positive	0.85	<0.001
Myrcene day 0	Limonene day 0	Positive	0.24	0.11
Myrcene day 7	Limonene day 0	Negative	-0.10	0.51
Myrcene day 12	Limonene day 0	Negative	-0.16	0.29
β -Phellandrene day 0	Limonene day 0	Positive	0.10	0.51
β -Phellandrene day 7	Limonene day 0	Negative	-0.21	0.17
β -Phellandrene day 12	Limonene day 0	Negative	-0.27	0.07
α -Pinene day 0	Limonene day 0	Positive	0.17	0.25
α -Pinene day 7	Limonene day 0	Negative	-0.01	0.95
α -Pinene day 12	Limonene day 0	Negative	-0.01	0.94
β -Pinene day 0	Limonene day 0	Positive	0.09	0.55
β -Pinene day 7	Limonene day 0	Negative	-0.10	0.52
β -Pinene day 12	Limonene day 0	Negative	-0.14	0.35
Terpineol day 0	Limonene day 0	Positive	0.34	0.02
Terpineol day 7	Limonene day 0	Negative	-0.03	0.83
Terpineol day 12	Limonene day 0	Positive	0.06	0.67
Terpinolene day 0	Limonene day 0	Positive	0.24	0.11
Terpinolene day 7	Limonene day 0	Negative	-0.06	0.67
Terpinolene day 12	Limonene day 0	Negative	-0.18	0.25
Total Terpenoids day 0	Limonene day 0	Positive	0.27	0.08
Total Terpenoids day 7	Limonene day 0	Negative	-0.16	0.29
Total Terpenoids day 12	Limonene day 0	Negative	-0.23	0.13
Total Monoterpenes day 0	Limonene day 0	Positive	0.27	0.08
Total Monoterpenes day 7	Limonene day 0	Negative	-0.16	0.28
Total Monoterpenes day 12	Limonene day 0	Negative	-0.23	0.13
Total Sesquiterpenes day 0	Limonene day 0	Positive	0.18	0.24
Total Sesquiterpenes day 7	Limonene day 0	Positive	0.12	0.42

Table 11a:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
Total Sesquiterpenes day 12	Limonene day 0	Positive	0.01	0.97
β -Pinene/ δ -3-Carene day 0	Limonene day 0	Positive	0.10	0.50
β -Pinene/ δ -3-Carene day 7	Limonene day 0	Negative	-0.05	0.74
β -Pinene/ δ -3-Carene day 12	Limonene day 0	Negative	-0.07	0.65
Terpinolene/Myrcene day 0	Limonene day 0	Negative	-0.13	0.40
Terpinolene/Myrcene day 7	Limonene day 0	Negative	-0.04	0.79
Terpinolene/Myrcene day 12	Limonene day 0	Positive	0.00	0.98
Limonene day 12	Limonene day 7	Positive	0.86	<0.001
Myrcene day 0	Limonene day 7	Positive	0.11	0.48
Myrcene day 7	Limonene day 7	Positive	0.26	0.08
Myrcene day 12	Limonene day 7	Negative	-0.14	0.35
β -Phellandrene day 0	Limonene day 7	Positive	0.03	0.85
β -Phellandrene day 7	Limonene day 7	Positive	0.18	0.24
β -Phellandrene day 12	Limonene day 7	Negative	-0.16	0.28
α -Pinene day 0	Limonene day 7	Negative	-0.12	0.45
α -Pinene day 7	Limonene day 7	Negative	-0.11	0.47
α -Pinene day 12	Limonene day 7	Negative	-0.23	0.12
β -Pinene day 0	Limonene day 7	Negative	-0.06	0.69
β -Pinene day 7	Limonene day 7	Negative	-0.07	0.63
β -Pinene day 12	Limonene day 7	Negative	-0.25	0.09
Terpineol day 0	Limonene day 7	Positive	0.26	0.08
Terpineol day 7	Limonene day 7	Positive	0.04	0.79
Terpineol day 12	Limonene day 7	Negative	-0.07	0.65
Terpinolene day 0	Limonene day 7	Positive	0.06	0.70
Terpinolene day 7	Limonene day 7	Positive	0.12	0.42
Terpinolene day 12	Limonene day 7	Negative	-0.25	0.10
Total Terpenoids day 0	Limonene day 7	Positive	0.10	0.50
Total Terpenoids day 7	Limonene day 7	Positive	0.20	0.19

Table 11a:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
Total Terpenoids day 12	Limonene day 7	Negative	-0.24	0.12
Total Monoterpenes day 0	Limonene day 7	Positive	0.10	0.50
Total Monoterpenes day 7	Limonene day 7	Positive	0.20	0.19
Total Monoterpenes day 12	Limonene day 7	Negative	-0.24	0.12
Total Sesquiterpenes day 0	Limonene day 7	Positive	0.09	0.57
Total Sesquiterpenes day 7	Limonene day 7	Positive	0.28	0.07
Total Sesquiterpenes day 12	Limonene day 7	Negative	-0.01	0.97
β -Pinene/ δ -3-Carene day 0	Limonene day 7	Positive	0.11	0.49
β -Pinene/ δ -3-Carene day 7	Limonene day 7	Negative	-0.03	0.86
β -Pinene/ δ -3-Carene day 12	Limonene day 7	Negative	-0.04	0.79
Terpinolene/Myrcene day 0	Limonene day 7	Negative	-0.15	0.34
Terpinolene/Myrcene day 7	Limonene day 7	Negative	-0.08	0.62
Terpinolene/Myrcene day 12	Limonene day 7	Negative	-0.08	0.60
Myrcene day 0	Limonene day 12	Positive	0.08	0.60
Myrcene day 7	Limonene day 12	Negative	-0.01	0.92
Myrcene day 12	Limonene day 12	Positive	0.08	0.61
β -Phellandrene day 0	Limonene day 12	Negative	-0.03	0.84
β -Phellandrene day 7	Limonene day 12	Negative	-0.11	0.46
β -Phellandrene day 12	Limonene day 12	Positive	0.02	0.91
α -Pinene day 0	Limonene day 12	Negative	-0.10	0.50
α -Pinene day 7	Limonene day 12	Negative	-0.20	0.18
α -Pinene day 12	Limonene day 12	Negative	-0.11	0.47
β -Pinene day 0	Limonene day 12	Negative	-0.14	0.36
β -Pinene day 7	Limonene day 12	Negative	-0.24	0.11
β -Pinene day 12	Limonene day 12	Negative	-0.13	0.40
Terpineol day 0	Limonene day 12	Positive	0.19	0.22
Terpineol day 7	Limonene day 12	Negative	-0.05	0.77
Terpineol day 12	Limonene day 12	Positive	0.02	0.92

Table 11a:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
Terpinolene day 0	Limonene day 12	Positive	0.03	0.84
Terpinolene day 7	Limonene day 12	Negative	-0.01	0.94
Terpinolene day 12	Limonene day 12	Negative	-0.14	0.34
Total Terpenoids day 0	Limonene day 12	Positive	0.06	0.71
Total Terpenoids day 7	Limonene day 12	Negative	-0.12	0.45
Total Terpenoids day 12	Limonene day 12	Positive	0.02	0.90
Total Monoterpenes day 0	Limonene day 12	Positive	0.06	0.72
Total Monoterpenes day 7	Limonene day 12	Negative	-0.12	0.45
Total Monoterpenes day 12	Limonene day 12	Positive	0.02	0.90
Total Sesquiterpenes day 0	Limonene day 12	Positive	0.07	0.64
Total Sesquiterpenes day 7	Limonene day 12	Positive	0.18	0.24
Total Sesquiterpenes day 12	Limonene day 12	Negative	-0.03	0.86
β -Pinene/ δ -3-Carene day 0	Limonene day 12	Positive	0.03	0.83
β -Pinene/ δ -3-Carene day 7	Limonene day 12	Negative	-0.08	0.62
β -Pinene/ δ -3-Carene day 12	Limonene day 12	Negative	-0.20	0.18
Terpinolene/Myrcene day 0	Limonene day 12	Negative	-0.09	0.54
Terpinolene/Myrcene day 7	Limonene day 12	Negative	-0.09	0.57
Terpinolene/Myrcene day 12	Limonene day 12	Negative	-0.14	0.37
Myrcene day 7	Myrcene day 0	Positive	0.41	0.01
Myrcene day 12	Myrcene day 0	Positive	0.46	<0.01
β -Phellandrene day 0	Myrcene day 0	Positive	0.81	<0.001
β -Phellandrene day 7	Myrcene day 0	Positive	0.25	0.10
β -Phellandrene day 12	Myrcene day 0	Positive	0.27	0.07
α -Pinene day 0	Myrcene day 0	Positive	0.46	<0.01
α -Pinene day 7	Myrcene day 0	Positive	0.11	0.47
α -Pinene day 12	Myrcene day 0	Positive	0.06	0.69
β -Pinene day 0	Myrcene day 0	Positive	0.33	0.03
β -Pinene day 7	Myrcene day 0	Negative	-0.06	0.72

Table 11a:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
β -Pinene day 12	Myrcene day 0	Negative	-0.17	0.26
Terpineol day 0	Myrcene day 0	Positive	0.62	<0.001
Terpineol day 7	Myrcene day 0	Positive	0.28	0.06
Terpineol day 12	Myrcene day 0	Positive	0.47	<0.01
Terpinolene day 0	Myrcene day 0	Positive	0.50	<0.001
Terpinolene day 7	Myrcene day 0	Positive	0.20	0.18
Terpinolene day 12	Myrcene day 0	Positive	0.17	0.26
Total Terpenoids day 0	Myrcene day 0	Positive	0.84	<0.001
Total Terpenoids day 7	Myrcene day 0	Positive	0.28	0.07
Total Terpenoids day 12	Myrcene day 0	Positive	0.24	0.12
Total Monoterpenes day 0	Myrcene day 0	Positive	0.84	<0.001
Total Monoterpenes day 7	Myrcene day 0	Positive	0.28	0.07
Total Monoterpenes day 12	Myrcene day 0	Positive	0.24	0.12
Total Sesquiterpenes day 0	Myrcene day 0	Positive	0.73	<0.001
Total Sesquiterpenes day 7	Myrcene day 0	Positive	0.22	0.15
Total Sesquiterpenes day 12	Myrcene day 0	Positive	0.40	0.01
β -Pinene/ δ -3-Carene day 0	Myrcene day 0	Positive	0.14	0.35
β -Pinene/ δ -3-Carene day 7	Myrcene day 0	Negative	-0.06	0.68
β -Pinene/ δ -3-Carene day 12	Myrcene day 0	Negative	-0.12	0.45
Terpinolene/Myrcene day 0	Myrcene day 0	Negative	-0.19	0.22
Terpinolene/Myrcene day 7	Myrcene day 0	Positive	0.01	0.96
Terpinolene/Myrcene day 12	Myrcene day 0	Negative	-0.01	0.93
Myrcene day 12	Myrcene day 7	Positive	0.35	0.02
β -Phellandrene day 0	Myrcene day 7	Positive	0.41	0.01
β -Phellandrene day 7	Myrcene day 7	Positive	0.92	<0.001
β -Phellandrene day 12	Myrcene day 7	Positive	0.39	0.01
α -Pinene day 0	Myrcene day 7	Negative	-0.12	0.45
α -Pinene day 7	Myrcene day 7	Negative	-0.03	0.85

Table 11a:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
α -Pinene day 12	Myrcene day 7	Negative	-0.27	0.07
β -Pinene day 0	Myrcene day 7	Positive	0.08	0.62
β -Pinene day 7	Myrcene day 7	Positive	0.23	0.13
β -Pinene day 12	Myrcene day 7	Negative	-0.17	0.26
Terpineol day 0	Myrcene day 7	Positive	0.27	0.07
Terpineol day 7	Myrcene day 7	Positive	0.27	0.07
Terpineol day 12	Myrcene day 7	Positive	0.08	0.58
Terpinolene day 0	Myrcene day 7	Positive	0.02	0.91
Terpinolene day 7	Myrcene day 7	Positive	0.39	0.01
Terpinolene day 12	Myrcene day 7	Negative	-0.05	0.74
Total Terpenoids day 0	Myrcene day 7	Positive	0.32	0.03
Total Terpenoids day 7	Myrcene day 7	Positive	0.95	<0.001
Total Terpenoids day 12	Myrcene day 7	Positive	0.21	0.16
Total Monoterpenes day 0	Myrcene day 7	Positive	0.32	0.03
Total Monoterpenes day 7	Myrcene day 7	Positive	0.95	<0.001
Total Monoterpenes day 12	Myrcene day 7	Positive	0.21	0.17
Total Sesquiterpenes day 0	Myrcene day 7	Positive	0.31	0.04
Total Sesquiterpenes day 7	Myrcene day 7	Positive	0.32	0.03
Total Sesquiterpenes day 12	Myrcene day 7	Positive	0.06	0.70
β -Pinene/ δ -3-Carene day 0	Myrcene day 7	Positive	0.02	0.91
β -Pinene/ δ -3-Carene day 7	Myrcene day 7	Positive	0.00	0.99
β -Pinene/ δ -3-Carene day 12	Myrcene day 7	Negative	-0.05	0.73
Terpinolene/Myrcene day 0	Myrcene day 7	Negative	-0.13	0.39
Terpinolene/Myrcene day 7	Myrcene day 7	Negative	-0.21	0.16
Terpinolene/Myrcene day 12	Myrcene day 7	Negative	-0.23	0.13
β -Phellandrene day 0	Myrcene day 12	Positive	0.39	0.01
β -Phellandrene day 7	Myrcene day 12	Positive	0.24	0.12
β -Phellandrene day 12	Myrcene day 12	Positive	0.88	<0.001

Table 11a:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
α -Pinene day 0	Myrcene day 12	Positive	0.03	0.84
α -Pinene day 7	Myrcene day 12	Negative	-0.18	0.24
α -Pinene day 12	Myrcene day 12	Positive	0.11	0.47
β -Pinene day 0	Myrcene day 12	Negative	-0.07	0.63
β -Pinene day 7	Myrcene day 12	Negative	-0.19	0.21
β -Pinene day 12	Myrcene day 12	Positive	0.12	0.43
Terpineol day 0	Myrcene day 12	Positive	0.10	0.52
Terpineol day 7	Myrcene day 12	Positive	0.04	0.77
Terpineol day 12	Myrcene day 12	Positive	0.31	0.04
Terpinolene day 0	Myrcene day 12	Positive	0.21	0.17
Terpinolene day 7	Myrcene day 12	Positive	0.14	0.36
Terpinolene day 12	Myrcene day 12	Positive	0.41	0.01
Total Terpenoids day 0	Myrcene day 12	Positive	0.32	0.03
Total Terpenoids day 7	Myrcene day 12	Positive	0.21	0.16
Total Terpenoids day 12	Myrcene day 12	Positive	0.92	<0.001
Total Monoterpenes day 0	Myrcene day 12	Positive	0.32	0.03
Total Monoterpenes day 7	Myrcene day 12	Positive	0.21	0.16
Total Monoterpenes day 12	Myrcene day 12	Positive	0.92	<0.001
Total Sesquiterpenes day 0	Myrcene day 12	Positive	0.39	0.01
Total Sesquiterpenes day 7	Myrcene day 12	Positive	0.07	0.63
Total Sesquiterpenes day 12	Myrcene day 12	Positive	0.23	0.12
β -Pinene/ δ -3-Carene day 0	Myrcene day 12	Negative	-0.15	0.33
β -Pinene/ δ -3-Carene day 7	Myrcene day 12	Negative	-0.14	0.37
β -Pinene/ δ -3-Carene day 12	Myrcene day 12	Negative	-0.38	0.01
Terpinolene/Myrcene day 0	Myrcene day 12	Positive	0.14	0.35
Terpinolene/Myrcene day 7	Myrcene day 12	Negative	-0.06	0.72
Terpinolene/Myrcene day 12	Myrcene day 12	Negative	-0.19	0.22
β -Phellandrene day 7	β -Phellandrene day 0	Positive	0.38	0.01

Table 11a:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
β -Phellandrene day 12	β -Phellandrene day 0	Positive	0.41	<0.01
α -Pinene day 0	β -Phellandrene day 0	Positive	0.29	0.06
α -Pinene day 7	β -Phellandrene day 0	Negative	-0.10	0.50
α -Pinene day 12	β -Phellandrene day 0	Negative	-0.16	0.30
β -Pinene day 0	β -Phellandrene day 0	Positive	0.46	<0.01
β -Pinene day 7	β -Phellandrene day 0	Negative	-0.02	0.92
β -Pinene day 12	β -Phellandrene day 0	Negative	-0.12	0.44
Terpineol day 0	β -Phellandrene day 0	Positive	0.52	<0.001
Terpineol day 7	β -Phellandrene day 0	Positive	0.19	0.21
Terpineol day 12	β -Phellandrene day 0	Positive	0.43	<0.01
Terpinolene day 0	β -Phellandrene day 0	Positive	0.42	<0.01
Terpinolene day 7	β -Phellandrene day 0	Positive	0.21	0.16
Terpinolene day 12	β -Phellandrene day 0	Positive	0.18	0.24
Total Terpenoids day 0	β -Phellandrene day 0	Positive	0.94	<0.001
Total Terpenoids day 7	β -Phellandrene day 0	Positive	0.37	0.01
Total Terpenoids day 12	β -Phellandrene day 0	Positive	0.32	0.03
Total Monoterpenes day 0	β -Phellandrene day 0	Positive	0.94	<0.001
Total Monoterpenes day 7	β -Phellandrene day 0	Positive	0.36	0.01
Total Monoterpenes day 12	β -Phellandrene day 0	Positive	0.32	0.03
Total Sesquiterpenes day 0	β -Phellandrene day 0	Positive	0.66	<0.001
Total Sesquiterpenes day 7	β -Phellandrene day 0	Positive	0.18	0.23
Total Sesquiterpenes day 12	β -Phellandrene day 0	Positive	0.36	0.02
β -Pinene/ δ -3-Carene day 0	β -Phellandrene day 0	Negative	-0.04	0.78
β -Pinene/ δ -3-Carene day 7	β -Phellandrene day 0	Positive	0.02	0.90
β -Pinene/ δ -3-Carene day 12	β -Phellandrene day 0	Negative	-0.18	0.25
Terpinolene/Myrcene day 0	β -Phellandrene day 0	Negative	-0.15	0.31
Terpinolene/Myrcene day 7	β -Phellandrene day 0	Negative	-0.01	0.95
Terpinolene/Myrcene day 12	β -Phellandrene day 0	Negative	-0.05	0.73

Table 11a:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
β -Phellandrene day 12	β -Phellandrene day 7	Positive	0.42	<0.01
α -Pinene day 0	β -Phellandrene day 7	Negative	-0.23	0.12
α -Pinene day 7	β -Phellandrene day 7	Negative	-0.10	0.50
α -Pinene day 12	β -Phellandrene day 7	Negative	-0.37	0.01
β -Pinene day 0	β -Phellandrene day 7	Positive	0.08	0.62
β -Pinene day 7	β -Phellandrene day 7	Positive	0.25	0.10
β -Pinene day 12	β -Phellandrene day 7	Negative	-0.16	0.30
Terpineol day 0	β -Phellandrene day 7	Positive	0.17	0.27
Terpineol day 7	β -Phellandrene day 7	Positive	0.17	0.26
Terpineol day 12	β -Phellandrene day 7	Positive	0.01	0.93
Terpinolene day 0	β -Phellandrene day 7	Negative	-0.07	0.67
Terpinolene day 7	β -Phellandrene day 7	Positive	0.26	0.08
Terpinolene day 12	β -Phellandrene day 7	Negative	-0.13	0.39
Total Terpenoids day 0	β -Phellandrene day 7	Positive	0.24	0.11
Total Terpenoids day 7	β -Phellandrene day 7	Positive	0.94	<0.001
Total Terpenoids day 12	β -Phellandrene day 7	Positive	0.17	0.26
Total Monoterpenes day 0	β -Phellandrene day 7	Positive	0.24	0.11
Total Monoterpenes day 7	β -Phellandrene day 7	Positive	0.94	<0.001
Total Monoterpenes day 12	β -Phellandrene day 7	Positive	0.17	0.26
Total Sesquiterpenes day 0	β -Phellandrene day 7	Positive	0.19	0.22
Total Sesquiterpenes day 7	β -Phellandrene day 7	Positive	0.27	0.08
Total Sesquiterpenes day 12	β -Phellandrene day 7	Positive	0.07	0.65
β -Pinene/ δ -3-Carene day 0	β -Phellandrene day 7	Positive	0.03	0.86
β -Pinene/ δ -3-Carene day 7	β -Phellandrene day 7	Negative	-0.01	0.93
β -Pinene/ δ -3-Carene day 12	β -Phellandrene day 7	Positive	0.08	0.62
Terpinolene/Myrcene day 0	β -Phellandrene day 7	Negative	-0.18	0.23
Terpinolene/Myrcene day 7	β -Phellandrene day 7	Negative	-0.27	0.07
Terpinolene/Myrcene day 12	β -Phellandrene day 7	Negative	-0.25	0.10

Table 11a:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
α -Pinene day 0	β -Phellandrene day 12	Negative	-0.12	0.44
α -Pinene day 7	β -Phellandrene day 12	Negative	-0.22	0.15
α -Pinene day 12	β -Phellandrene day 12	Negative	-0.01	0.97
β -Pinene day 0	β -Phellandrene day 12	Negative	-0.04	0.77
β -Pinene day 7	β -Phellandrene day 12	Negative	-0.15	0.34
β -Pinene day 12	β -Phellandrene day 12	Positive	0.10	0.51
Terpineol day 0	β -Phellandrene day 12	Positive	0.03	0.85
Terpineol day 7	β -Phellandrene day 12	Negative	-0.03	0.83
Terpineol day 12	β -Phellandrene day 12	Positive	0.18	0.23
Terpinolene day 0	β -Phellandrene day 12	Positive	0.04	0.77
Terpinolene day 7	β -Phellandrene day 12	Positive	0.01	0.97
Terpinolene day 12	β -Phellandrene day 12	Positive	0.22	0.14
Total Terpenoids day 0	β -Phellandrene day 12	Positive	0.26	0.08
Total Terpenoids day 7	β -Phellandrene day 12	Positive	0.32	0.03
Total Terpenoids day 12	β -Phellandrene day 12	Positive	0.91	<0.001
Total Monoterpenes day 0	β -Phellandrene day 12	Positive	0.26	0.08
Total Monoterpenes day 7	β -Phellandrene day 12	Positive	0.32	0.03
Total Monoterpenes day 12	β -Phellandrene day 12	Positive	0.91	<0.001
Total Sesquiterpenes day 0	β -Phellandrene day 12	Positive	0.28	0.07
Total Sesquiterpenes day 7	β -Phellandrene day 12	Positive	0.04	0.79
Total Sesquiterpenes day 12	β -Phellandrene day 12	Positive	0.12	0.43
β -Pinene/ δ -3-Carene day 0	β -Phellandrene day 12	Negative	-0.24	0.12
β -Pinene/ δ -3-Carene day 7	β -Phellandrene day 12	Negative	-0.11	0.47
β -Pinene/ δ -3-Carene day 12	β -Phellandrene day 12	Negative	-0.32	0.03
Terpinolene/Myrcene day 0	β -Phellandrene day 12	Positive	0.04	0.80
Terpinolene/Myrcene day 7	β -Phellandrene day 12	Negative	-0.23	0.13
Terpinolene/Myrcene day 12	β -Phellandrene day 12	Negative	-0.32	0.03
α -Pinene day 7	α -Pinene day 0	Positive	0.75	<0.001

Table 11a:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
α -Pinene day 12	α -Pinene day 0	Positive	0.79	<0.001
β -Pinene day 0	α -Pinene day 0	Positive	0.43	<0.01
β -Pinene day 7	α -Pinene day 0	Positive	0.10	0.51
β -Pinene day 12	α -Pinene day 0	Positive	0.06	0.71
Terpineol day 0	α -Pinene day 0	Positive	0.52	<0.001
Terpineol day 7	α -Pinene day 0	Positive	0.17	0.27
Terpineol day 12	α -Pinene day 0	Positive	0.34	0.02
Terpinolene day 0	α -Pinene day 0	Positive	0.51	<0.001
Terpinolene day 7	α -Pinene day 0	Negative	-0.07	0.67
Terpinolene day 12	α -Pinene day 0	Positive	0.08	0.61
Total Terpenoids day 0	α -Pinene day 0	Positive	0.52	<0.001
Total Terpenoids day 7	α -Pinene day 0	Negative	-0.07	0.64
Total Terpenoids day 12	α -Pinene day 0	Positive	0.07	0.63
Total Monoterpenes day 0	α -Pinene day 0	Positive	0.52	<0.001
Total Monoterpenes day 7	α -Pinene day 0	Negative	-0.07	0.64
Total Monoterpenes day 12	α -Pinene day 0	Positive	0.07	0.64
Total Sesquiterpenes day 0	α -Pinene day 0	Positive	0.45	<0.01
Total Sesquiterpenes day 7	α -Pinene day 0	Negative	-0.01	0.93
Total Sesquiterpenes day 12	α -Pinene day 0	Positive	0.28	0.06
β -Pinene/ δ -3-Carene day 0	α -Pinene day 0	Positive	0.10	0.50
β -Pinene/ δ -3-Carene day 7	α -Pinene day 0	Positive	0.07	0.66
β -Pinene/ δ -3-Carene day 12	α -Pinene day 0	Positive	0.06	0.69
Terpinolene/Myrcene day 0	α -Pinene day 0	Positive	0.01	0.95
Terpinolene/Myrcene day 7	α -Pinene day 0	Positive	0.05	0.76
Terpinolene/Myrcene day 12	α -Pinene day 0	Positive	0.09	0.55
α -Pinene day 12	α -Pinene day 7	Positive	0.81	<0.001
β -Pinene day 0	α -Pinene day 7	Positive	0.13	0.39
β -Pinene day 7	α -Pinene day 7	Positive	0.20	0.18

Table 11a:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
β -Pinene day 12	α -Pinene day 7	Negative	-0.05	0.74
Terpineol day 0	α -Pinene day 7	Positive	0.33	0.03
Terpineol day 7	α -Pinene day 7	Positive	0.10	0.53
Terpineol day 12	α -Pinene day 7	Positive	0.05	0.73
Terpinolene day 0	α -Pinene day 7	Positive	0.14	0.37
Terpinolene day 7	α -Pinene day 7	Negative	-0.23	0.12
Terpinolene day 12	α -Pinene day 7	Negative	-0.22	0.14
Total Terpenoids day 0	α -Pinene day 7	Positive	0.06	0.69
Total Terpenoids day 7	α -Pinene day 7	Positive	0.05	0.75
Total Terpenoids day 12	α -Pinene day 7	Negative	-0.13	0.39
Total Monoterpenes day 0	α -Pinene day 7	Positive	0.06	0.69
Total Monoterpenes day 7	α -Pinene day 7	Positive	0.05	0.75
Total Monoterpenes day 12	α -Pinene day 7	Negative	-0.13	0.39
Total Sesquiterpenes day 0	α -Pinene day 7	Positive	0.18	0.24
Total Sesquiterpenes day 7	α -Pinene day 7	Negative	-0.08	0.59
Total Sesquiterpenes day 12	α -Pinene day 7	Negative	-0.02	0.88
β -Pinene/ δ -3-Carene day 0	α -Pinene day 7	Positive	0.17	0.25
β -Pinene/ δ -3-Carene day 7	α -Pinene day 7	Negative	-0.03	0.84
β -Pinene/ δ -3-Carene day 12	α -Pinene day 7	Positive	0.24	0.11
Terpinolene/Myrcene day 0	α -Pinene day 7	Positive	0.04	0.81
Terpinolene/Myrcene day 7	α -Pinene day 7	Negative	-0.16	0.29
Terpinolene/Myrcene day 12	α -Pinene day 7	Negative	-0.10	0.52
β -Pinene day 0	α -Pinene day 12	Positive	0.06	0.71
β -Pinene day 7	α -Pinene day 12	Positive	0.00	1.00
β -Pinene day 12	α -Pinene day 12	Positive	0.16	0.28
Terpineol day 0	α -Pinene day 12	Positive	0.25	0.10
Terpineol day 7	α -Pinene day 12	Positive	0.03	0.83
Terpineol day 12	α -Pinene day 12	Positive	0.13	0.39

Table 11a:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
Terpinolene day 0	α -Pinene day 12	Positive	0.24	0.11
Terpinolene day 7	α -Pinene day 12	Negative	-0.25	0.10
Terpinolene day 12	α -Pinene day 12	Positive	0.03	0.85
Total Terpenoids day 0	α -Pinene day 12	Positive	0.02	0.87
Total Terpenoids day 7	α -Pinene day 12	Negative	-0.24	0.11
Total Terpenoids day 12	α -Pinene day 12	Positive	0.22	0.15
Total Monoterpenes day 0	α -Pinene day 12	Positive	0.02	0.88
Total Monoterpenes day 7	α -Pinene day 12	Negative	-0.24	0.11
Total Monoterpenes day 12	α -Pinene day 12	Positive	0.22	0.15
Total Sesquiterpenes day 0	α -Pinene day 12	Positive	0.15	0.33
Total Sesquiterpenes day 7	α -Pinene day 12	Negative	-0.14	0.34
Total Sesquiterpenes day 12	α -Pinene day 12	Positive	0.10	0.53
β -Pinene/ δ -3-Carene day 0	α -Pinene day 12	Negative	-0.02	0.91
β -Pinene/ δ -3-Carene day 7	α -Pinene day 12	Negative	-0.03	0.84
β -Pinene/ δ -3-Carene day 12	α -Pinene day 12	Positive	0.04	0.81
Terpinolene/Myrcene day 0	α -Pinene day 12	Positive	0.11	0.48
Terpinolene/Myrcene day 7	α -Pinene day 12	Negative	-0.02	0.88
Terpinolene/Myrcene day 12	α -Pinene day 12	Negative	-0.01	0.97
β -Pinene day 7	β -Pinene day 0	Positive	0.65	<0.001
β -Pinene day 12	β -Pinene day 0	Positive	0.55	<0.001
Terpineol day 0	β -Pinene day 0	Positive	0.35	0.02
Terpineol day 7	β -Pinene day 0	Positive	0.07	0.63
Terpineol day 12	β -Pinene day 0	Positive	0.33	0.03
Terpinolene day 0	β -Pinene day 0	Positive	0.28	0.06
Terpinolene day 7	β -Pinene day 0	Negative	-0.11	0.47
Terpinolene day 12	β -Pinene day 0	Negative	-0.06	0.69
Total Terpenoids day 0	β -Pinene day 0	Positive	0.60	<0.001
Total Terpenoids day 7	β -Pinene day 0	Positive	0.20	0.19

Table 11a:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
Total Terpenoids day 12	β -Pinene day 0	Positive	0.05	0.74
Total Monoterpenes day 0	β -Pinene day 0	Positive	0.60	<0.001
Total Monoterpenes day 7	β -Pinene day 0	Positive	0.20	0.19
Total Monoterpenes day 12	β -Pinene day 0	Positive	0.05	0.75
Total Sesquiterpenes day 0	β -Pinene day 0	Positive	0.19	0.22
Total Sesquiterpenes day 7	β -Pinene day 0	Positive	0.02	0.90
Total Sesquiterpenes day 12	β -Pinene day 0	Positive	0.13	0.40
β -Pinene/ δ -3-Carene day 0	β -Pinene day 0	Positive	0.14	0.34
β -Pinene/ δ -3-Carene day 7	β -Pinene day 0	Positive	0.48	<0.01
β -Pinene/ δ -3-Carene day 12	β -Pinene day 0	Positive	0.38	0.01
Terpinolene/Myrcene day 0	β -Pinene day 0	Negative	-0.08	0.60
Terpinolene/Myrcene day 7	β -Pinene day 0	Negative	-0.17	0.26
Terpinolene/Myrcene day 12	β -Pinene day 0	Negative	-0.01	0.95
β -Pinene day 12	β -Pinene day 7	Positive	0.68	<0.001
Terpineol day 0	β -Pinene day 7	Positive	0.03	0.87
Terpineol day 7	β -Pinene day 7	Negative	-0.06	0.70
Terpineol day 12	β -Pinene day 7	Negative	-0.07	0.64
Terpinolene day 0	β -Pinene day 7	Negative	-0.03	0.86
Terpinolene day 7	β -Pinene day 7	Negative	-0.14	0.37
Terpinolene day 12	β -Pinene day 7	Negative	-0.21	0.17
Total Terpenoids day 0	β -Pinene day 7	Positive	0.07	0.63
Total Terpenoids day 7	β -Pinene day 7	Positive	0.41	<0.01
Total Terpenoids day 12	β -Pinene day 7	Negative	-0.06	0.69
Total Monoterpenes day 0	β -Pinene day 7	Positive	0.08	0.62
Total Monoterpenes day 7	β -Pinene day 7	Positive	0.41	<0.01
Total Monoterpenes day 12	β -Pinene day 7	Negative	-0.06	0.70
Total Sesquiterpenes day 0	β -Pinene day 7	Negative	-0.13	0.39
Total Sesquiterpenes day 7	β -Pinene day 7	Negative	-0.09	0.54

Table 11a:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
Total Sesquiterpenes day 12	β -Pinene day 7	Negative	-0.22	0.14
β -Pinene/ δ -3-Carene day 0	β -Pinene day 7	Positive	0.18	0.24
β -Pinene/ δ -3-Carene day 7	β -Pinene day 7	Positive	0.21	0.16
β -Pinene/ δ -3-Carene day 12	β -Pinene day 7	Positive	0.60	<0.001
Terpinolene/Myrcene day 0	β -Pinene day 7	Positive	0.12	0.44
Terpinolene/Myrcene day 7	β -Pinene day 7	Negative	-0.27	0.08
Terpinolene/Myrcene day 12	β -Pinene day 7	Negative	-0.09	0.56
Terpineol day 0	β -Pinene day 12	Negative	-0.12	0.43
Terpineol day 7	β -Pinene day 12	Negative	-0.10	0.53
Terpineol day 12	β -Pinene day 12	Positive	0.16	0.29
Terpinolene day 0	β -Pinene day 12	Positive	0.01	0.96
Terpinolene day 7	β -Pinene day 12	Negative	-0.23	0.13
Terpinolene day 12	β -Pinene day 12	Positive	0.05	0.75
Total Terpenoids day 0	β -Pinene day 12	Negative	-0.03	0.82
Total Terpenoids day 7	β -Pinene day 12	Negative	-0.06	0.70
Total Terpenoids day 12	β -Pinene day 12	Positive	0.34	0.02
Total Monoterpenes day 0	β -Pinene day 12	Negative	-0.03	0.83
Total Monoterpenes day 7	β -Pinene day 12	Negative	-0.06	0.71
Total Monoterpenes day 12	β -Pinene day 12	Positive	0.34	0.02
Total Sesquiterpenes day 0	β -Pinene day 12	Negative	-0.19	0.21
Total Sesquiterpenes day 7	β -Pinene day 12	Negative	-0.17	0.27
Total Sesquiterpenes day 12	β -Pinene day 12	Negative	-0.01	0.93
β -Pinene/ δ -3-Carene day 0	β -Pinene day 12	Positive	0.00	0.99
β -Pinene/ δ -3-Carene day 7	β -Pinene day 12	Positive	0.23	0.12
β -Pinene/ δ -3-Carene day 12	β -Pinene day 12	Positive	0.41	0.01
Terpinolene/Myrcene day 0	β -Pinene day 12	Positive	0.17	0.27
Terpinolene/Myrcene day 7	β -Pinene day 12	Negative	-0.11	0.45
Terpinolene/Myrcene day 12	β -Pinene day 12	Negative	-0.03	0.85

Table 11a:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
Terpineol day 7	Terpineol day 0	Positive	0.55	<0.001
Terpineol day 12	Terpineol day 0	Positive	0.61	<0.001
Terpinolene day 0	Terpineol day 0	Positive	0.37	0.01
Terpinolene day 7	Terpineol day 0	Positive	0.11	0.49
Terpinolene day 12	Terpineol day 0	Positive	0.02	0.92
Total Terpenoids day 0	Terpineol day 0	Positive	0.62	<0.001
Total Terpenoids day 7	Terpineol day 0	Positive	0.25	0.10
Total Terpenoids day 12	Terpineol day 0	Positive	0.04	0.79
Total Monoterpenes day 0	Terpineol day 0	Positive	0.62	<0.001
Total Monoterpenes day 7	Terpineol day 0	Positive	0.25	0.10
Total Monoterpenes day 12	Terpineol day 0	Positive	0.04	0.80
Total Sesquiterpenes day 0	Terpineol day 0	Positive	0.63	<0.001
Total Sesquiterpenes day 7	Terpineol day 0	Positive	0.43	<0.01
Total Sesquiterpenes day 12	Terpineol day 0	Positive	0.41	0.01
β -Pinene/ δ -3-Carene day 0	Terpineol day 0	Positive	0.23	0.13
β -Pinene/ δ -3-Carene day 7	Terpineol day 0	Negative	-0.11	0.48
β -Pinene/ δ -3-Carene day 12	Terpineol day 0	Positive	0.11	0.47
Terpinolene/Myrcene day 0	Terpineol day 0	Negative	-0.17	0.28
Terpinolene/Myrcene day 7	Terpineol day 0	Negative	-0.08	0.61
Terpinolene/Myrcene day 12	Terpineol day 0	Positive	0.05	0.76
Terpineol day 12	Terpineol day 7	Positive	0.60	<0.001
Terpinolene day 0	Terpineol day 7	Positive	0.10	0.51
Terpinolene day 7	Terpineol day 7	Positive	0.12	0.44
Terpinolene day 12	Terpineol day 7	Positive	0.10	0.53
Total Terpenoids day 0	Terpineol day 7	Positive	0.19	0.21
Total Terpenoids day 7	Terpineol day 7	Positive	0.20	0.20
Total Terpenoids day 12	Terpineol day 7	Negative	-0.02	0.87
Total Monoterpenes day 0	Terpineol day 7	Positive	0.19	0.21

Table 11a:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
Total Monoterpenes day 7	Terpineol day 7	Positive	0.20	0.20
Total Monoterpenes day 12	Terpineol day 7	Negative	-0.03	0.87
Total Sesquiterpenes day 0	Terpineol day 7	Positive	0.23	0.13
Total Sesquiterpenes day 7	Terpineol day 7	Positive	0.58	<0.001
Total Sesquiterpenes day 12	Terpineol day 7	Positive	0.32	0.03
β -Pinene/ δ -3-Carene day 0	Terpineol day 7	Positive	0.23	0.12
β -Pinene/ δ -3-Carene day 7	Terpineol day 7	Positive	0.04	0.79
β -Pinene/ δ -3-Carene day 12	Terpineol day 7	Positive	0.07	0.67
Terpinolene/Myrcene day 0	Terpineol day 7	Negative	-0.23	0.13
Terpinolene/Myrcene day 7	Terpineol day 7	Negative	-0.10	0.50
Terpinolene/Myrcene day 12	Terpineol day 7	Positive	0.09	0.56
Terpinolene day 0	Terpineol day 12	Positive	0.27	0.07
Terpinolene day 7	Terpineol day 12	Positive	0.02	0.87
Terpinolene day 12	Terpineol day 12	Positive	0.22	0.14
Total Terpenoids day 0	Terpineol day 12	Positive	0.48	<0.01
Total Terpenoids day 7	Terpineol day 12	Positive	0.04	0.78
Total Terpenoids day 12	Terpineol day 12	Positive	0.28	0.06
Total Monoterpenes day 0	Terpineol day 12	Positive	0.48	<0.01
Total Monoterpenes day 7	Terpineol day 12	Positive	0.04	0.78
Total Monoterpenes day 12	Terpineol day 12	Positive	0.28	0.06
Total Sesquiterpenes day 0	Terpineol day 12	Positive	0.45	<0.01
Total Sesquiterpenes day 7	Terpineol day 12	Positive	0.34	0.02
Total Sesquiterpenes day 12	Terpineol day 12	Positive	0.65	<0.001
β -Pinene/ δ -3-Carene day 0	Terpineol day 12	Positive	0.21	0.16
β -Pinene/ δ -3-Carene day 7	Terpineol day 12	Positive	0.10	0.52
β -Pinene/ δ -3-Carene day 12	Terpineol day 12	Positive	0.09	0.54
Terpinolene/Myrcene day 0	Terpineol day 12	Negative	-0.07	0.64
Terpinolene/Myrcene day 7	Terpineol day 12	Negative	-0.04	0.80

Table 11a:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
Terpinolene/Myrcene day 12	Terpineol day 12	Positive	0.05	0.76
Terpinolene day 7	Terpinolene day 0	Positive	0.39	0.01
Terpinolene day 12	Terpinolene day 0	Positive	0.60	<0.001
Total Terpenoids day 0	Terpinolene day 0	Positive	0.57	<0.001
Total Terpenoids day 7	Terpinolene day 0	Positive	0.02	0.88
Total Terpenoids day 12	Terpinolene day 0	Positive	0.18	0.24
Total Monoterpenes day 0	Terpinolene day 0	Positive	0.57	<0.001
Total Monoterpenes day 7	Terpinolene day 0	Positive	0.02	0.89
Total Monoterpenes day 12	Terpinolene day 0	Positive	0.18	0.24
Total Sesquiterpenes day 0	Terpinolene day 0	Positive	0.52	<0.001
Total Sesquiterpenes day 7	Terpinolene day 0	Positive	0.04	0.79
Total Sesquiterpenes day 12	Terpinolene day 0	Positive	0.45	<0.01
β -Pinene/ δ -3-Carene day 0	Terpinolene day 0	Negative	-0.10	0.52
β -Pinene/ δ -3-Carene day 7	Terpinolene day 0	Positive	0.06	0.70
β -Pinene/ δ -3-Carene day 12	Terpinolene day 0	Negative	-0.04	0.80
Terpinolene/Myrcene day 0	Terpinolene day 0	Positive	0.17	0.27
Terpinolene/Myrcene day 7	Terpinolene day 0	Positive	0.52	<0.001
Terpinolene/Myrcene day 12	Terpinolene day 0	Positive	0.58	<0.001
Terpinolene day 12	Terpinolene day 7	Positive	0.63	<0.001
Total Terpenoids day 0	Terpinolene day 7	Positive	0.21	0.18
Total Terpenoids day 7	Terpinolene day 7	Positive	0.35	0.02
Total Terpenoids day 12	Terpinolene day 7	Positive	0.04	0.81
Total Monoterpenes day 0	Terpinolene day 7	Positive	0.20	0.18
Total Monoterpenes day 7	Terpinolene day 7	Positive	0.35	0.02
Total Monoterpenes day 12	Terpinolene day 7	Positive	0.04	0.81
Total Sesquiterpenes day 0	Terpinolene day 7	Positive	0.34	0.02
Total Sesquiterpenes day 7	Terpinolene day 7	Positive	0.33	0.03
Total Sesquiterpenes day 12	Terpinolene day 7	Positive	0.32	0.03

Table 11a:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
β -Pinene/ δ -3-Carene day 0	Terpinolene day 7	Negative	-0.04	0.80
β -Pinene/ δ -3-Carene day 7	Terpinolene day 7	Positive	0.03	0.86
β -Pinene/ δ -3-Carene day 12	Terpinolene day 7	Negative	-0.16	0.28
Terpinolene/Myrcene day 0	Terpinolene day 7	Positive	0.12	0.44
Terpinolene/Myrcene day 7	Terpinolene day 7	Positive	0.76	<0.001
Terpinolene/Myrcene day 12	Terpinolene day 7	Positive	0.58	<0.001
Total Terpenoids day 0	Terpinolene day 12	Positive	0.20	0.18
Total Terpenoids day 7	Terpinolene day 12	Negative	-0.07	0.64
Total Terpenoids day 12	Terpinolene day 12	Positive	0.41	<0.01
Total Monoterpenes day 0	Terpinolene day 12	Positive	0.20	0.18
Total Monoterpenes day 7	Terpinolene day 12	Negative	-0.07	0.64
Total Monoterpenes day 12	Terpinolene day 12	Positive	0.41	0.01
Total Sesquiterpenes day 0	Terpinolene day 12	Positive	0.32	0.03
Total Sesquiterpenes day 7	Terpinolene day 12	Positive	0.20	0.18
Total Sesquiterpenes day 12	Terpinolene day 12	Positive	0.39	0.01
β -Pinene/ δ -3-Carene day 0	Terpinolene day 12	Negative	-0.14	0.37
β -Pinene/ δ -3-Carene day 7	Terpinolene day 12	Positive	0.08	0.61
β -Pinene/ δ -3-Carene day 12	Terpinolene day 12	Negative	-0.19	0.20
Terpinolene/Myrcene day 0	Terpinolene day 12	Positive	0.29	0.05
Terpinolene/Myrcene day 7	Terpinolene day 12	Positive	0.73	<0.001
Terpinolene/Myrcene day 12	Terpinolene day 12	Positive	0.77	<0.001
Total Terpenoids day 7	Total Terpenoids day 0	Positive	0.30	0.05
Total Terpenoids day 12	Total Terpenoids day 0	Positive	0.27	0.07
Total Monoterpenes day 0	Total Terpenoids day 0	Positive	1.00	<0.001
Total Monoterpenes day 7	Total Terpenoids day 0	Positive	0.30	0.05
Total Monoterpenes day 12	Total Terpenoids day 0	Positive	0.27	0.08
Total Sesquiterpenes day 0	Total Terpenoids day 0	Positive	0.70	<0.001
Total Sesquiterpenes day 7	Total Terpenoids day 0	Positive	0.16	0.30

Table 11a:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
Total Sesquiterpenes day 12	Total Terpenoids day 0	Positive	0.38	0.01
β -Pinene/ δ -3-Carene day 0	Total Terpenoids day 0	Positive	0.01	0.95
β -Pinene/ δ -3-Carene day 7	Total Terpenoids day 0	Positive	0.08	0.60
β -Pinene/ δ -3-Carene day 12	Total Terpenoids day 0	Negative	-0.13	0.40
Terpinolene/Myrcene day 0	Total Terpenoids day 0	Negative	-0.11	0.45
Terpinolene/Myrcene day 7	Total Terpenoids day 0	Positive	0.03	0.85
Terpinolene/Myrcene day 12	Total Terpenoids day 0	Positive	0.03	0.84
Total Terpenoids day 12	Total Terpenoids day 7	Positive	0.16	0.29
Total Monoterpenes day 0	Total Terpenoids day 7	Positive	0.30	0.05
Total Monoterpenes day 7	Total Terpenoids day 7	Positive	1.00	<0.001
Total Monoterpenes day 12	Total Terpenoids day 7	Positive	0.16	0.29
Total Sesquiterpenes day 0	Total Terpenoids day 7	Positive	0.25	0.09
Total Sesquiterpenes day 7	Total Terpenoids day 7	Positive	0.26	0.08
Total Sesquiterpenes day 12	Total Terpenoids day 7	Positive	0.04	0.78
β -Pinene/ δ -3-Carene day 0	Total Terpenoids day 7	Positive	0.08	0.59
β -Pinene/ δ -3-Carene day 7	Total Terpenoids day 7	Positive	0.01	0.97
β -Pinene/ δ -3-Carene day 12	Total Terpenoids day 7	Positive	0.11	0.46
Terpinolene/Myrcene day 0	Total Terpenoids day 7	Negative	-0.08	0.59
Terpinolene/Myrcene day 7	Total Terpenoids day 7	Negative	-0.22	0.15
Terpinolene/Myrcene day 12	Total Terpenoids day 7	Negative	-0.18	0.22
Total Monoterpenes day 0	Total Terpenoids day 12	Positive	0.27	0.08
Total Monoterpenes day 7	Total Terpenoids day 12	Positive	0.16	0.29
Total Monoterpenes day 12	Total Terpenoids day 12	Positive	1.00	<0.001
Total Sesquiterpenes day 0	Total Terpenoids day 12	Positive	0.28	0.06
Total Sesquiterpenes day 7	Total Terpenoids day 12	Positive	0.00	0.98
Total Sesquiterpenes day 12	Total Terpenoids day 12	Positive	0.16	0.30
β -Pinene/ δ -3-Carene day 0	Total Terpenoids day 12	Negative	-0.25	0.10
β -Pinene/ δ -3-Carene day 7	Total Terpenoids day 12	Negative	-0.07	0.65

Table 11a:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
β -Pinene/ δ -3-Carene day 12	Total Terpenoids day 12	Negative	-0.32	0.03
Terpinolene/Myrcene day 0	Total Terpenoids day 12	Positive	0.18	0.23
Terpinolene/Myrcene day 7	Total Terpenoids day 12	Negative	-0.10	0.53
Terpinolene/Myrcene day 12	Total Terpenoids day 12	Negative	-0.17	0.27
Total Monoterpenes day 7	Total Monoterpenes day 0	Positive	0.30	0.05
Total Monoterpenes day 12	Total Monoterpenes day 0	Positive	0.27	0.08
Total Sesquiterpenes day 0	Total Monoterpenes day 0	Positive	0.70	<0.001
Total Sesquiterpenes day 7	Total Monoterpenes day 0	Positive	0.16	0.30
Total Sesquiterpenes day 12	Total Monoterpenes day 0	Positive	0.37	0.01
β -Pinene/ δ -3-Carene day 0	Total Monoterpenes day 0	Positive	0.01	0.96
β -Pinene/ δ -3-Carene day 7	Total Monoterpenes day 0	Positive	0.08	0.59
β -Pinene/ δ -3-Carene day 12	Total Monoterpenes day 0	Negative	-0.13	0.40
Terpinolene/Myrcene day 0	Total Monoterpenes day 0	Negative	-0.11	0.45
Terpinolene/Myrcene day 7	Total Monoterpenes day 0	Positive	0.03	0.86
Terpinolene/Myrcene day 12	Total Monoterpenes day 0	Positive	0.03	0.85
Total Monoterpenes day 12	Total Monoterpenes day 7	Positive	0.16	0.29
Total Sesquiterpenes day 0	Total Monoterpenes day 7	Positive	0.25	0.09
Total Sesquiterpenes day 7	Total Monoterpenes day 7	Positive	0.26	0.08
Total Sesquiterpenes day 12	Total Monoterpenes day 7	Positive	0.04	0.79
β -Pinene/ δ -3-Carene day 0	Total Monoterpenes day 7	Positive	0.08	0.59
β -Pinene/ δ -3-Carene day 7	Total Monoterpenes day 7	Positive	0.01	0.97
β -Pinene/ δ -3-Carene day 12	Total Monoterpenes day 7	Positive	0.11	0.46
Terpinolene/Myrcene day 0	Total Monoterpenes day 7	Negative	-0.08	0.59
Terpinolene/Myrcene day 7	Total Monoterpenes day 7	Negative	-0.22	0.15
Terpinolene/Myrcene day 12	Total Monoterpenes day 7	Negative	-0.19	0.22
Total Sesquiterpenes day 0	Total Monoterpenes day 12	Positive	0.28	0.06
Total Sesquiterpenes day 7	Total Monoterpenes day 12	Negative	-0.01	0.97
Total Sesquiterpenes day 12	Total Monoterpenes day 12	Positive	0.15	0.32

Table 11a:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
β -Pinene/ δ -3-Carene day 0	Total Monoterpenes day 12	Negative	-0.25	0.10
β -Pinene/ δ -3-Carene day 7	Total Monoterpenes day 12	Negative	-0.07	0.65
β -Pinene/ δ -3-Carene day 12	Total Monoterpenes day 12	Negative	-0.32	0.03
Terpinolene/Myrcene day 0	Total Monoterpenes day 12	Positive	0.18	0.23
Terpinolene/Myrcene day 7	Total Monoterpenes day 12	Negative	-0.10	0.52
Terpinolene/Myrcene day 12	Total Monoterpenes day 12	Negative	-0.17	0.26
Total Sesquiterpenes day 7	Total Sesquiterpenes day 0	Positive	0.33	0.03
Total Sesquiterpenes day 12	Total Sesquiterpenes day 0	Positive	0.47	<0.01
β -Pinene/ δ -3-Carene day 0	Total Sesquiterpenes day 0	Positive	0.10	0.51
β -Pinene/ δ -3-Carene day 7	Total Sesquiterpenes day 0	Negative	-0.17	0.27
β -Pinene/ δ -3-Carene day 12	Total Sesquiterpenes day 0	Negative	-0.16	0.31
Terpinolene/Myrcene day 0	Total Sesquiterpenes day 0	Negative	-0.06	0.68
Terpinolene/Myrcene day 7	Total Sesquiterpenes day 0	Positive	0.18	0.24
Terpinolene/Myrcene day 12	Total Sesquiterpenes day 0	Positive	0.13	0.39
Total Sesquiterpenes day 12	Total Sesquiterpenes day 7	Positive	0.41	0.01
β -Pinene/ δ -3-Carene day 0	Total Sesquiterpenes day 7	Positive	0.28	0.07
β -Pinene/ δ -3-Carene day 7	Total Sesquiterpenes day 7	Negative	-0.03	0.86
β -Pinene/ δ -3-Carene day 12	Total Sesquiterpenes day 7	Positive	0.09	0.57
Terpinolene/Myrcene day 0	Total Sesquiterpenes day 7	Negative	-0.02	0.91
Terpinolene/Myrcene day 7	Total Sesquiterpenes day 7	Positive	0.05	0.75
Terpinolene/Myrcene day 12	Total Sesquiterpenes day 7	Positive	0.19	0.22
β -Pinene/ δ -3-Carene day 0	Total Sesquiterpenes day 12	Positive	0.29	0.05
β -Pinene/ δ -3-Carene day 7	Total Sesquiterpenes day 12	Positive	0.02	0.89
β -Pinene/ δ -3-Carene day 12	Total Sesquiterpenes day 12	Positive	0.17	0.27
Terpinolene/Myrcene day 0	Total Sesquiterpenes day 12	Negative	-0.04	0.80
Terpinolene/Myrcene day 7	Total Sesquiterpenes day 12	Positive	0.39	0.01
Terpinolene/Myrcene day 12	Total Sesquiterpenes day 12	Positive	0.36	0.02
β -Pinene/ δ -3-Carene day 7	β -Pinene/ δ -3-Carene day 0	Positive	0.01	0.92

Table 11a:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
β -Pinene/ δ -3-Carene day 12	β -Pinene/ δ -3-Carene day 0	Positive	0.63	<0.001
Terpinolene/Myrcene day 0	β -Pinene/ δ -3-Carene day 0	Negative	-0.08	0.62
Terpinolene/Myrcene day 7	β -Pinene/ δ -3-Carene day 0	Negative	-0.06	0.69
Terpinolene/Myrcene day 12	β -Pinene/ δ -3-Carene day 0	Positive	0.02	0.87
β -Pinene/ δ -3-Carene day 12	β -Pinene/ δ -3-Carene day 7	Positive	0.24	0.11
Terpinolene/Myrcene day 0	β -Pinene/ δ -3-Carene day 7	Positive	0.00	0.99
Terpinolene/Myrcene day 7	β -Pinene/ δ -3-Carene day 7	Positive	0.07	0.67
Terpinolene/Myrcene day 12	β -Pinene/ δ -3-Carene day 7	Positive	0.20	0.19
Terpinolene/Myrcene day 0	β -Pinene/ δ -3-Carene day 12	Positive	0.07	0.64
Terpinolene/Myrcene day 7	β -Pinene/ δ -3-Carene day 12	Negative	-0.05	0.76
Terpinolene/Myrcene day 12	β -Pinene/ δ -3-Carene day 12	Positive	0.16	0.31
Terpinolene/Myrcene day 7	Terpinolene/Myrcene day 0	Positive	0.22	0.14
Terpinolene/Myrcene day 12	Terpinolene/Myrcene day 0	Positive	0.18	0.24
Terpinolene/Myrcene day 12	Terpinolene/Myrcene day 7	Positive	0.83	<0.001

Table 11b:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
Tree Height	DBH	Positive	0.61	<0.001
Bark Texture	DBH	Positive	0.21	<0.001
MPB Pres. 06	DBH	Positive	0.08	0.02
MPB Pres. 07	DBH	Positive	0.12	<0.01
Mortality 06	DBH	Positive	0.17	<0.001
Mortality 07	DBH	Positive	0.12	<0.01
PT Class 07	DBH	Positive	0.11	<0.01
Hypersensitivity	DBH	Negative	-0.18	<0.01
Brood Development	DBH	Positive	0.24	<0.001
Par. Gall. Length	DBH	Positive	0.21	<0.001
Lesion day 7	DBH	Positive	0.10	<0.01

Table 11b:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
Lesion day 12	DBH	Positive	0.03	0.41
δ -3-Carene day 0	DBH	Negative	-0.09	0.01
δ -3-Carene day 7	DBH	Positive	0.02	0.63
δ -3-Carene day 12	DBH	Positive	0.07	0.03
Limonene day 0	DBH	Positive	0.00	0.94
Limonene day 7	DBH	Positive	0.10	<0.01
Limonene day 12	DBH	Positive	0.11	<0.01
Myrcene day 0	DBH	Negative	-0.02	0.60
Myrcene day 7	DBH	Positive	0.13	<0.001
Myrcene day 12	DBH	Positive	0.16	<0.001
β -Phellandrene day 0	DBH	Positive	0.00	0.92
β -Phellandrene day 7	DBH	Positive	0.10	<0.01
β -Phellandrene day 12	DBH	Positive	0.14	<0.001
α -Pinene day 0	DBH	Positive	0.02	0.66
α -Pinene day 7	DBH	Positive	0.12	<0.001
α -Pinene day 12	DBH	Positive	0.15	<0.001
β -Pinene day 0	DBH	Negative	-0.02	0.50
β -Pinene day 7	DBH	Positive	0.02	0.48
β -Pinene day 12	DBH	Positive	0.09	0.01
Terpineol day 0	DBH	Positive	0.03	0.36
Terpineol day 7	DBH	Positive	0.08	0.02
Terpineol day 12	DBH	Positive	0.04	0.21
Terpinolene day 0	DBH	Negative	-0.02	0.54
Terpinolene day 7	DBH	Positive	0.08	0.01
Terpinolene day 12	DBH	Positive	0.14	<0.001
Total Terpenoids day 0	DBH	Positive	0.00	0.93
Total Terpenoids day 7	DBH	Positive	0.12	<0.001
Total Terpenoids day 12	DBH	Positive	0.17	<0.001

Table 11b:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
Total Monoterpenes day 0	DBH	Positive	0.00	0.95
Total Monoterpenes day 7	DBH	Positive	0.12	<0.001
Total Monoterpenes day 12	DBH	Positive	0.17	<0.001
Total Sesquiterpenes day 0	DBH	Positive	0.09	0.01
Total Sesquiterpenes day 7	DBH	Positive	0.07	0.04
Total Sesquiterpenes day 12	DBH	Positive	0.08	0.01
β -Pinene/ δ -3-Carene day 0	DBH	Positive	0.05	0.14
β -Pinene/ δ -3-Carene day 7	DBH	Positive	0.01	0.86
β -Pinene/ δ -3-Carene day 12	DBH	Positive	0.01	0.70
Terpinolene/Myrcene day 0	DBH	Negative	-0.01	0.82
Terpinolene/Myrcene day 7	DBH	Negative	-0.02	0.56
Terpinolene/Myrcene day 12	DBH	Positive	0.03	0.37
Bark Texture	Tree Height	Positive	0.13	<0.001
MPB Pres. 06	Tree Height	Positive	0.24	<0.001
MPB Pres. 07	Tree Height	Positive	0.27	<0.001
Mortality 06	Tree Height	Positive	0.19	<0.001
Mortality 07	Tree Height	Positive	0.23	<0.001
PT Class 07	Tree Height	Positive	0.04	0.22
Hypersensitivity	Tree Height	Negative	-0.05	0.38
Brood Development	Tree Height	Positive	0.20	<0.001
Par. Gall. Length	Tree Height	Positive	0.14	0.01
Lesion day 7	Tree Height	Negative	-0.04	0.30
Lesion day 12	Tree Height	Negative	-0.08	0.02
δ -3-Carene day 0	Tree Height	Negative	-0.17	<0.001
δ -3-Carene day 7	Tree Height	Negative	-0.03	0.42
δ -3-Carene day 12	Tree Height	Negative	-0.03	0.42
Limonene day 0	Tree Height	Positive	0.00	0.89
Limonene day 7	Tree Height	Positive	0.10	<0.01

Table 11b:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
Limonene day 12	Tree Height	Positive	0.07	0.05
Myrcene day 0	Tree Height	Negative	-0.08	0.02
Myrcene day 7	Tree Height	Positive	0.07	0.03
Myrcene day 12	Tree Height	Positive	0.05	0.12
β -Phellandrene day 0	Tree Height	Negative	-0.07	0.03
β -Phellandrene day 7	Tree Height	Positive	0.08	0.02
β -Phellandrene day 12	Tree Height	Positive	0.07	0.04
α -Pinene day 0	Tree Height	Negative	-0.04	0.25
α -Pinene day 7	Tree Height	Positive	0.11	<0.01
α -Pinene day 12	Tree Height	Positive	0.08	0.02
β -Pinene day 0	Tree Height	Positive	-0.04	0.23
β -Pinene day 7	Tree Height	Positive	0.03	0.38
β -Pinene day 12	Tree Height	Positive	0.05	0.11
Terpineol day 0	Tree Height	Negative	-0.03	0.40
Terpineol day 7	Tree Height	Negative	-0.09	0.01
Terpineol day 12	Tree Height	Negative	-0.06	0.10
Terpinolene day 0	Tree Height	Negative	-0.06	0.09
Terpinolene day 7	Tree Height	Positive	0.00	0.98
Terpinolene day 12	Tree Height	Positive	0.02	0.59
Total Terpenoids day 0	Tree Height	Negative	-0.07	0.05
Total Terpenoids day 7	Tree Height	Positive	0.09	0.01
Total Terpenoids day 12	Tree Height	Positive	0.08	0.02
Total Monoterpenes day 0	Tree Height	Negative	-0.07	0.05
Total Monoterpenes day 7	Tree Height	Positive	0.09	0.01
Total Monoterpenes day 12	Tree Height	Positive	0.08	0.02
Total Sesquiterpenes day 0	Tree Height	Positive	0.04	0.25
Total Sesquiterpenes day 7	Tree Height	Positive	0.04	0.25
Total Sesquiterpenes day 12	Tree Height	Positive	0.01	0.86

Table 11b:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
β -Pinene/ δ -3-Carene day 0	Tree Height	Positive	0.10	<0.01
β -Pinene/ δ -3-Carene day 7	Tree Height	Positive	0.04	0.20
β -Pinene/ δ -3-Carene day 12	Tree Height	Positive	0.07	0.05
Terpinolene/Myrcene day 0	Tree Height	Positive	0.01	0.83
Terpinolene/Myrcene day 7	Tree Height	Negative	-0.08	0.02
Terpinolene/Myrcene day 12	Tree Height	Negative	-0.03	0.36
MPB Pres. 06	Bark Texture	Negative	-0.08	0.01
MPB Pres. 07	Bark Texture	Negative	-0.08	0.01
Mortality 06	Bark Texture	Positive	0.15	<0.01
Mortality 07	Bark Texture	Positive	0.02	0.58
PT Class 07	Bark Texture	Negative	-0.02	0.52
Hypersensitivity	Bark Texture	Negative	-0.11	0.07
Brood Development	Bark Texture	Positive	0.13	0.02
Par. Gall. Length	Bark Texture	Positive	0.06	0.34
Lesion day 7	Bark Texture	Positive	0.03	0.34
Lesion day 12	Bark Texture	Positive	0.10	<0.01
δ -3-Carene day 0	Bark Texture	Negative	-0.03	0.43
δ -3-Carene day 7	Bark Texture	Positive	0.06	0.08
δ -3-Carene day 12	Bark Texture	Positive	0.05	0.15
Limonene day 0	Bark Texture	Negative	-0.05	0.13
Limonene day 7	Bark Texture	Positive	0.01	0.71
Limonene day 12	Bark Texture	Positive	0.00	0.89
Myrcene day 0	Bark Texture	Negative	-0.06	0.08
Myrcene day 7	Bark Texture	Positive	0.08	0.02
Myrcene day 12	Bark Texture	Positive	0.02	0.48
β -Phellandrene day 0	Bark Texture	Negative	-0.09	0.01
β -Phellandrene day 7	Bark Texture	Positive	0.08	0.03
β -Phellandrene day 12	Bark Texture	Positive	0.00	0.89

Table 11b:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
α -Pinene day 0	Bark Texture	Negative	-0.05	0.15
α -Pinene day 7	Bark Texture	Positive	0.05	0.12
α -Pinene day 12	Bark Texture	Positive	0.02	0.65
β -Pinene day 0	Bark Texture	Negative	-0.01	0.79
β -Pinene day 7	Bark Texture	Positive	0.08	0.02
β -Pinene day 12	Bark Texture	Positive	0.05	0.13
Terpineol day 0	Bark Texture	Positive	0.00	0.98
Terpineol day 7	Bark Texture	Positive	0.08	0.02
Terpineol day 12	Bark Texture	Negative	-0.05	0.16
Terpinolene day 0	Bark Texture	Negative	-0.03	0.32
Terpinolene day 7	Bark Texture	Positive	0.06	0.10
Terpinolene day 12	Bark Texture	Positive	0.03	0.41
Total Terpenoids day 0	Bark Texture	Negative	-0.07	0.03
Total Terpenoids day 7	Bark Texture	Positive	0.09	0.01
Total Terpenoids day 12	Bark Texture	Positive	0.03	0.38
Total Monoterpenes day 0	Bark Texture	Negative	-0.07	0.03
Total Monoterpenes day 7	Bark Texture	Positive	0.09	0.01
Total Monoterpenes day 12	Bark Texture	Positive	0.03	0.38
Total Sesquiterpenes day 0	Bark Texture	Negative	-0.05	0.13
Total Sesquiterpenes day 7	Bark Texture	Negative	-0.07	0.04
Total Sesquiterpenes day 12	Bark Texture	Positive	0.03	0.45
β -Pinene/ δ -3-Carene day 0	Bark Texture	Positive	0.01	0.70
β -Pinene/ δ -3-Carene day 7	Bark Texture	Positive	0.02	0.62
β -Pinene/ δ -3-Carene day 12	Bark Texture	Positive	0.00	0.90
Terpinolene/Myrcene day 0	Bark Texture	Positive	0.02	0.57
Terpinolene/Myrcene day 7	Bark Texture	Negative	-0.01	0.70
Terpinolene/Myrcene day 12	Bark Texture	Positive	0.01	0.67
MPB Pres. 07	MPB Pres. 06	Positive	0.54	<0.001

Table 11b:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
Mortality 06	MPB Pres. 06	Positive	0.36	<0.001
Mortality 07	MPB Pres. 06	Positive	0.47	<0.001
PT Class 07	MPB Pres. 06	Negative	-0.05	0.11
Hypersensitivity	MPB Pres. 06	Negative	-0.09	0.13
Brood Development	MPB Pres. 06	Positive	0.19	<0.01
Par. Gall. Length	MPB Pres. 06	Positive	0.15	0.01
Lesion day 7	MPB Pres. 06	Positive	0.02	0.49
Lesion day 12	MPB Pres. 06	Negative	-0.04	0.22
δ -3-Carene day 0	MPB Pres. 06	Negative	-0.11	<0.01
δ -3-Carene day 7	MPB Pres. 06	Negative	-0.09	0.01
δ -3-Carene day 12	MPB Pres. 06	Negative	-0.06	0.09
Limonene day 0	MPB Pres. 06	Positive	0.06	0.08
Limonene day 7	MPB Pres. 06	Positive	0.06	0.09
Limonene day 12	MPB Pres. 06	Positive	0.07	0.03
Myrcene day 0	MPB Pres. 06	Negative	-0.01	0.80
Myrcene day 7	MPB Pres. 06	Positive	0.00	0.90
Myrcene day 12	MPB Pres. 06	Positive	0.02	0.51
β -Phellandrene day 0	MPB Pres. 06	Positive	0.04	0.27
β -Phellandrene day 7	MPB Pres. 06	Positive	0.03	0.33
β -Phellandrene day 12	MPB Pres. 06	Positive	0.06	0.06
α -Pinene day 0	MPB Pres. 06	Negative	-0.01	0.77
α -Pinene day 7	MPB Pres. 06	Positive	0.01	0.81
α -Pinene day 12	MPB Pres. 06	Positive	0.03	0.36
β -Pinene day 0	MPB Pres. 06	Negative	-0.02	0.58
β -Pinene day 7	MPB Pres. 06	Negative	-0.01	0.69
β -Pinene day 12	MPB Pres. 06	Positive	0.03	0.36
Terpineol day 0	MPB Pres. 06	Positive	0.02	0.61
Terpineol day 7	MPB Pres. 06	Negative	-0.07	0.03

Table 11b:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
Terpineol day 12	MPB Pres. 06	Negative	-0.05	0.18
Terpinolene day 0	MPB Pres. 06	Negative	-0.04	0.25
Terpinolene day 7	MPB Pres. 06	Negative	-0.09	0.01
Terpinolene day 12	MPB Pres. 06	Negative	-0.04	0.22
Total Terpenoids day 0	MPB Pres. 06	Positive	0.01	0.72
Total Terpenoids day 7	MPB Pres. 06	Positive	0.00	0.89
Total Terpenoids day 12	MPB Pres. 06	Positive	0.04	0.28
Total Monoterpenes day 0	MPB Pres. 06	Positive	0.01	0.71
Total Monoterpenes day 7	MPB Pres. 06	Positive	0.00	0.89
Total Monoterpenes day 12	MPB Pres. 06	Positive	0.04	0.28
Total Sesquiterpenes day 0	MPB Pres. 06	Positive	0.03	0.33
Total Sesquiterpenes day 7	MPB Pres. 06	Positive	0.10	<0.01
Total Sesquiterpenes day 12	MPB Pres. 06	Positive	0.05	0.12
β -Pinene/ δ -3-Carene day 0	MPB Pres. 06	Positive	0.07	0.04
β -Pinene/ δ -3-Carene day 7	MPB Pres. 06	Positive	0.06	0.10
β -Pinene/ δ -3-Carene day 12	MPB Pres. 06	Positive	0.07	0.04
Terpinolene/Myrcene day 0	MPB Pres. 06	Negative	-0.04	0.21
Terpinolene/Myrcene day 7	MPB Pres. 06	Negative	-0.12	<0.01
Terpinolene/Myrcene day 12	MPB Pres. 06	Negative	-0.09	0.01
Mortality 06	MPB Pres. 07	Positive	0.47	<0.001
Mortality 07	MPB Pres. 07	Positive	0.47	<0.001
PT Class 07	MPB Pres. 07	Positive	0.17	<0.001
Hypersensitivity	MPB Pres. 07	Negative	-0.24	<0.001
Brood Development	MPB Pres. 07	Positive	0.25	<0.001
Par. Gall. Length	MPB Pres. 07	Positive	0.24	<0.001
Lesion day 7	MPB Pres. 07	Positive	0.09	0.01
Lesion day 12	MPB Pres. 07	Negative	-0.06	0.10
δ -3-Carene day 0	MPB Pres. 07	Negative	-0.10	<0.01

Table 11b:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
δ -3-Carene day 7	MPB Pres. 07	Negative	-0.01	0.88
δ -3-Carene day 12	MPB Pres. 07	Positive	0.02	0.59
Limonene day 0	MPB Pres. 07	Positive	0.06	0.08
Limonene day 7	MPB Pres. 07	Positive	0.08	0.01
Limonene day 12	MPB Pres. 07	Positive	0.08	0.01
Myrcene day 0	MPB Pres. 07	Positive	0.03	0.42
Myrcene day 7	MPB Pres. 07	Positive	0.08	0.02
Myrcene day 12	MPB Pres. 07	Positive	0.08	0.02
β -Phellandrene day 0	MPB Pres. 07	Positive	0.05	0.15
β -Phellandrene day 7	MPB Pres. 07	Positive	0.09	0.01
β -Phellandrene day 12	MPB Pres. 07	Positive	0.09	0.01
α -Pinene day 0	MPB Pres. 07	Positive	0.02	0.52
α -Pinene day 7	MPB Pres. 07	Positive	0.07	0.04
α -Pinene day 12	MPB Pres. 07	Positive	0.07	0.04
β -Pinene day 0	MPB Pres. 07	Negative	-0.02	0.65
β -Pinene day 7	MPB Pres. 07	Positive	0.02	0.53
β -Pinene day 12	MPB Pres. 07	Positive	0.06	0.09
Terpineol day 0	MPB Pres. 07	Negative	-0.01	0.83
Terpineol day 7	MPB Pres. 07	Negative	-0.04	0.27
Terpineol day 12	MPB Pres. 07	Negative	-0.04	0.28
Terpinolene day 0	MPB Pres. 07	Positive	0.01	0.67
Terpinolene day 7	MPB Pres. 07	Positive	0.03	0.36
Terpinolene day 12	MPB Pres. 07	Positive	0.04	0.20
Total Terpenoids day 0	MPB Pres. 07	Positive	0.03	0.33
Total Terpenoids day 7	MPB Pres. 07	Positive	0.09	0.01
Total Terpenoids day 12	MPB Pres. 07	Positive	0.09	0.01
Total Monoterpenes day 0	MPB Pres. 07	Positive	0.03	0.33
Total Monoterpenes day 7	MPB Pres. 07	Positive	0.09	0.01

Table 11b:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
Total Monoterpenes day 12	MPB Pres. 07	Positive	0.09	0.01
Total Sesquiterpenes day 0	MPB Pres. 07	Positive	0.09	0.01
Total Sesquiterpenes day 7	MPB Pres. 07	Positive	0.11	<0.01
Total Sesquiterpenes day 12	MPB Pres. 07	Positive	0.02	0.55
β -Pinene/ δ -3-Carene day 0	MPB Pres. 07	Positive	0.06	0.07
β -Pinene/ δ -3-Carene day 7	MPB Pres. 07	Positive	0.02	0.55
β -Pinene/ δ -3-Carene day 12	MPB Pres. 07	Positive	0.03	0.32
Terpinolene/Myrcene day 0	MPB Pres. 07	Negative	-0.01	0.75
Terpinolene/Myrcene day 7	MPB Pres. 07	Negative	-0.04	0.21
Terpinolene/Myrcene day 12	MPB Pres. 07	Negative	-0.02	0.49
Mortality 07	Mortality 06	Positive	0.84	<0.001
PT Class 07	Mortality 06	Negative	-0.10	0.02
Hypersensitivity	Mortality 06	Negative	-0.75	<0.001
Brood Development	Mortality 06	Positive	0.65	<0.001
Par. Gall. Length	Mortality 06	Positive	0.67	<0.001
Lesion day 7	Mortality 06	Positive	0.08	0.06
Lesion day 12	Mortality 06	Positive	0.04	0.33
δ -3-Carene day 0	Mortality 06	Negative	-0.09	0.05
δ -3-Carene day 7	Mortality 06	Positive	0.02	0.73
δ -3-Carene day 12	Mortality 06	Positive	0.07	0.13
Limonene day 0	Mortality 06	Negative	-0.01	0.91
Limonene day 7	Mortality 06	Positive	0.07	0.12
Limonene day 12	Mortality 06	Positive	0.09	0.05
Myrcene day 0	Mortality 06	Positive	0.03	0.54
Myrcene day 7	Mortality 06	Positive	0.10	0.03
Myrcene day 12	Mortality 06	Positive	0.11	0.01
β -Phellandrene day 0	Mortality 06	Positive	0.04	0.38
β -Phellandrene day 7	Mortality 06	Positive	0.10	0.03

Table 11b:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
β -Phellandrene day 12	Mortality 06	Positive	0.13	0.01
α -Pinene day 0	Mortality 06	Positive	0.02	0.67
α -Pinene day 7	Mortality 06	Positive	0.06	0.20
α -Pinene day 12	Mortality 06	Positive	0.10	0.03
β -Pinene day 0	Mortality 06	Negative	-0.01	0.85
β -Pinene day 7	Mortality 06	Positive	0.03	0.54
β -Pinene day 12	Mortality 06	Positive	0.05	0.29
Terpineol day 0	Mortality 06	Positive	0.03	0.51
Terpineol day 7	Mortality 06	Positive	0.00	0.98
Terpineol day 12	Mortality 06	Positive	0.01	0.83
Terpinolene day 0	Mortality 06	Negative	-0.04	0.38
Terpinolene day 7	Mortality 06	Positive	0.06	0.17
Terpinolene day 12	Mortality 06	Positive	0.06	0.16
Total Terpenoids day 0	Mortality 06	Positive	0.02	0.72
Total Terpenoids day 7	Mortality 06	Positive	0.10	0.03
Total Terpenoids day 12	Mortality 06	Positive	0.12	0.01
Total Monoterpenes day 0	Mortality 06	Positive	0.02	0.71
Total Monoterpenes day 7	Mortality 06	Positive	0.10	0.03
Total Monoterpenes day 12	Mortality 06	Positive	0.12	0.01
Total Sesquiterpenes day 0	Mortality 06	Positive	0.02	0.63
Total Sesquiterpenes day 7	Mortality 06	Positive	0.07	0.14
Total Sesquiterpenes day 12	Mortality 06	Positive	0.04	0.41
β -Pinene/ δ -3-Carene day 0	Mortality 06	Positive	0.06	0.20
β -Pinene/ δ -3-Carene day 7	Mortality 06	Positive	0.01	0.83
β -Pinene/ δ -3-Carene day 12	Mortality 06	Negative	-0.01	0.76
Terpinolene/Myrcene day 0	Mortality 06	Negative	-0.08	0.09
Terpinolene/Myrcene day 7	Mortality 06	Negative	-0.02	0.71
Terpinolene/Myrcene day 12	Mortality 06	Negative	-0.02	0.73

Table 11b:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
PT Class 07	Mortality 07	Negative	-0.11	<0.01
Hypersensitivity	Mortality 07	Negative	-0.52	<0.001
Brood Development	Mortality 07	Positive	0.54	<0.001
Par. Gall. Length	Mortality 07	Positive	0.49	<0.001
Lesion day 7	Mortality 07	Positive	0.07	0.04
Lesion day 12	Mortality 07	Negative	-0.02	0.49
δ -3-Carene day 0	Mortality 07	Negative	-0.11	<0.01
δ -3-Carene day 7	Mortality 07	Negative	-0.07	0.05
δ -3-Carene day 12	Mortality 07	Positive	0.00	0.96
Limonene day 0	Mortality 07	Positive	0.02	0.66
Limonene day 7	Mortality 07	Positive	0.05	0.11
Limonene day 12	Mortality 07	Positive	0.07	0.04
Myrcene day 0	Mortality 07	Positive	0.01	0.77
Myrcene day 7	Mortality 07	Positive	0.05	0.13
Myrcene day 12	Mortality 07	Positive	0.06	0.09
β -Phellandrene day 0	Mortality 07	Positive	0.04	0.26
β -Phellandrene day 7	Mortality 07	Positive	0.08	0.03
β -Phellandrene day 12	Mortality 07	Positive	0.08	0.01
α -Pinene day 0	Mortality 07	Positive	0.02	0.57
α -Pinene day 7	Mortality 07	Positive	0.04	0.22
α -Pinene day 12	Mortality 07	Positive	0.05	0.11
β -Pinene day 0	Mortality 07	Negative	-0.02	0.60
β -Pinene day 7	Mortality 07	Positive	0.00	0.95
β -Pinene day 12	Mortality 07	Positive	0.01	0.80
Terpineol day 0	Mortality 07	Positive	0.02	0.65
Terpineol day 7	Mortality 07	Negative	-0.03	0.40
Terpineol day 12	Mortality 07	Negative	-0.03	0.42
Terpinolene day 0	Mortality 07	Negative	-0.01	0.67

Table 11b:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
Terpinolene day 7	Mortality 07	Positive	0.01	0.68
Terpinolene day 12	Mortality 07	Positive	0.02	0.47
Total Terpenoids day 0	Mortality 07	Positive	0.02	0.56
Total Terpenoids day 7	Mortality 07	Positive	0.07	0.06
Total Terpenoids day 12	Mortality 07	Positive	0.07	0.04
Total Monoterpenes day 0	Mortality 07	Positive	0.02	0.56
Total Monoterpenes day 7	Mortality 07	Positive	0.07	0.06
Total Monoterpenes day 12	Mortality 07	Positive	0.07	0.04
Total Sesquiterpenes day 0	Mortality 07	Positive	0.04	0.20
Total Sesquiterpenes day 7	Mortality 07	Positive	0.12	<0.01
Total Sesquiterpenes day 12	Mortality 07	Positive	0.08	0.02
β -Pinene/ δ -3-Carene day 0	Mortality 07	Positive	0.07	0.04
β -Pinene/ δ -3-Carene day 7	Mortality 07	Positive	0.05	0.13
β -Pinene/ δ -3-Carene day 12	Mortality 07	Positive	0.01	0.87
Terpinolene/Myrcene day 0	Mortality 07	Negative	-0.03	0.38
Terpinolene/Myrcene day 7	Mortality 07	Negative	-0.04	0.28
Terpinolene/Myrcene day 12	Mortality 07	Negative	-0.03	0.42
Hypersensitivity	PT Class 07	Negative	-0.19	<0.001
Brood Development	PT Class 07	Negative	-0.11	0.07
Par. Gall. Length	PT Class 07	Positive	0.23	<0.001
Lesion day 7	PT Class 07	Positive	0.02	0.60
Lesion day 12	PT Class 07	Positive	0.06	0.07
δ -3-Carene day 0	PT Class 07	Positive	0.02	0.48
δ -3-Carene day 7	PT Class 07	Positive	0.03	0.37
δ -3-Carene day 12	PT Class 07	Positive	0.08	0.02
Limonene day 0	PT Class 07	Positive	0.08	0.01
Limonene day 7	PT Class 07	Positive	0.12	<0.01
Limonene day 12	PT Class 07	Positive	0.09	0.01

Table 11b:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
Myrcene day 0	PT Class 07	Positive	0.03	0.36
Myrcene day 7	PT Class 07	Positive	0.10	<0.01
Myrcene day 12	PT Class 07	Positive	0.09	0.01
β -Phellandrene day 0	PT Class 07	Positive	0.05	0.16
β -Phellandrene day 7	PT Class 07	Positive	0.08	0.02
β -Phellandrene day 12	PT Class 07	Positive	0.09	0.01
α -Pinene day 0	PT Class 07	Positive	0.06	0.06
α -Pinene day 7	PT Class 07	Positive	0.10	<0.01
α -Pinene day 12	PT Class 07	Positive	0.09	0.01
β -Pinene day 0	PT Class 07	Positive	0.04	0.19
β -Pinene day 7	PT Class 07	Positive	0.07	0.05
β -Pinene day 12	PT Class 07	Positive	0.07	0.03
Terpineol day 0	PT Class 07	Positive	0.04	0.27
Terpineol day 7	PT Class 07	Positive	0.06	0.08
Terpineol day 12	PT Class 07	Positive	0.04	0.20
Terpinolene day 0	PT Class 07	Positive	0.05	0.13
Terpinolene day 7	PT Class 07	Positive	0.07	0.04
Terpinolene day 12	PT Class 07	Positive	0.08	0.02
Total Terpenoids day 0	PT Class 07	Positive	0.05	0.11
Total Terpenoids day 7	PT Class 07	Positive	0.09	0.01
Total Terpenoids day 12	PT Class 07	Positive	0.10	<0.01
Total Monoterpenes day 0	PT Class 07	Positive	0.05	0.11
Total Monoterpenes day 7	PT Class 07	Positive	0.09	0.01
Total Monoterpenes day 12	PT Class 07	Positive	0.10	<0.01
Total Sesquiterpenes day 0	PT Class 07	Positive	0.01	0.74
Total Sesquiterpenes day 7	PT Class 07	Negative	-0.01	0.76
Total Sesquiterpenes day 12	PT Class 07	Negative	-0.05	0.15
β -Pinene/ δ -3-Carene day 0	PT Class 07	Positive	0.02	0.65

Table 11b:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
β -Pinene/ δ -3-Carene day 7	PT Class 07	Positive	0.03	0.39
β -Pinene/ δ -3-Carene day 12	PT Class 07	Positive	0.00	0.97
Terpinolene/Myrcene day 0	PT Class 07	Positive	0.04	0.30
Terpinolene/Myrcene day 7	PT Class 07	Negative	-0.02	0.61
Terpinolene/Myrcene day 12	PT Class 07	Positive	0.02	0.63
Brood Development	Hypersensitivity	Negative	-0.50	<0.001
Par. Gall. Length	Hypersensitivity	Negative	-0.73	<0.001
Lesion day 7	Hypersensitivity	Negative	-0.18	<0.01
Lesion day 12	Hypersensitivity	Negative	-0.19	<0.001
δ -3-Carene day 0	Hypersensitivity	Positive	0.01	0.90
δ -3-Carene day 7	Hypersensitivity	Negative	-0.01	0.81
δ -3-Carene day 12	Hypersensitivity	Negative	-0.16	<0.01
Limonene day 0	Hypersensitivity	Positive	0.01	0.91
Limonene day 7	Hypersensitivity	Negative	-0.07	0.26
Limonene day 12	Hypersensitivity	Negative	-0.11	0.05
Myrcene day 0	Hypersensitivity	Positive	0.00	1.00
Myrcene day 7	Hypersensitivity	Negative	-0.08	0.16
Myrcene day 12	Hypersensitivity	Negative	-0.16	0.01
β -Phellandrene day 0	Hypersensitivity	Negative	-0.03	0.56
β -Phellandrene day 7	Hypersensitivity	Negative	-0.09	0.14
β -Phellandrene day 12	Hypersensitivity	Negative	-0.18	<0.01
α -Pinene day 0	Hypersensitivity	Positive	0.00	0.98
α -Pinene day 7	Hypersensitivity	Negative	-0.03	0.64
α -Pinene day 12	Hypersensitivity	Negative	-0.09	0.11
β -Pinene day 0	Hypersensitivity	Positive	0.03	0.57
β -Pinene day 7	Hypersensitivity	Positive	0.02	0.78
β -Pinene day 12	Hypersensitivity	Negative	-0.06	0.28
Terpineol day 0	Hypersensitivity	Negative	-0.01	0.88

Table 11b:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
Terpineol day 7	Hypersensitivity	Negative	-0.05	0.37
Terpineol day 12	Hypersensitivity	Negative	-0.04	0.49
Terpinolene day 0	Hypersensitivity	Positive	0.04	0.52
Terpinolene day 7	Hypersensitivity	Negative	-0.04	0.52
Terpinolene day 12	Hypersensitivity	Negative	-0.12	0.03
Total Terpenoids day 0	Hypersensitivity	Negative	-0.01	0.90
Total Terpenoids day 7	Hypersensitivity	Negative	-0.07	0.21
Total Terpenoids day 12	Hypersensitivity	Negative	-0.17	<0.01
Total Monoterpenes day 0	Hypersensitivity	Negative	-0.01	0.90
Total Monoterpenes day 7	Hypersensitivity	Negative	-0.07	0.21
Total Monoterpenes day 12	Hypersensitivity	Negative	-0.17	<0.01
Total Sesquiterpenes day 0	Hypersensitivity	Negative	-0.04	0.45
Total Sesquiterpenes day 7	Hypersensitivity	Negative	-0.09	0.13
Total Sesquiterpenes day 12	Hypersensitivity	Negative	-0.03	0.58
β -Pinene/ δ -3-Carene day 0	Hypersensitivity	Positive	0.03	0.70
β -Pinene/ δ -3-Carene day 7	Hypersensitivity	Negative	-0.07	0.36
β -Pinene/ δ -3-Carene day 12	Hypersensitivity	Positive	0.06	0.41
Terpinolene/Myrcene day 0	Hypersensitivity	Positive	0.02	0.78
Terpinolene/Myrcene day 7	Hypersensitivity	Positive	0.00	0.97
Terpinolene/Myrcene day 12	Hypersensitivity	Positive	0.11	0.09
Par. Gall. Length	Brood Development	Positive	0.54	<0.001
Lesion day 7	Brood Development	Positive	0.08	0.15
Lesion day 12	Brood Development	Positive	0.00	1.00
δ -3-Carene day 0	Brood Development	Negative	-0.02	0.75
δ -3-Carene day 7	Brood Development	Positive	0.03	0.57
δ -3-Carene day 12	Brood Development	Positive	0.10	0.09
Limonene day 0	Brood Development	Positive	0.02	0.79
Limonene day 7	Brood Development	Negative	-0.02	0.78

Table 11b:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
Limonene day 12	Brood Development	Positive	0.06	0.31
Myrcene day 0	Brood Development	Positive	0.06	0.31
Myrcene day 7	Brood Development	Positive	0.00	0.94
Myrcene day 12	Brood Development	Positive	0.07	0.20
β -Phellandrene day 0	Brood Development	Positive	0.06	0.32
β -Phellandrene day 7	Brood Development	Positive	0.00	0.95
β -Phellandrene day 12	Brood Development	Positive	0.09	0.13
α -Pinene day 0	Brood Development	Positive	0.05	0.41
α -Pinene day 7	Brood Development	Negative	-0.02	0.76
α -Pinene day 12	Brood Development	Positive	0.07	0.26
β -Pinene day 0	Brood Development	Negative	-0.04	0.55
β -Pinene day 7	Brood Development	Negative	-0.06	0.29
β -Pinene day 12	Brood Development	Positive	0.01	0.81
Terpineol day 0	Brood Development	Positive	0.03	0.63
Terpineol day 7	Brood Development	Negative	-0.04	0.55
Terpineol day 12	Brood Development	Negative	-0.01	0.90
Terpinolene day 0	Brood Development	Negative	-0.07	0.26
Terpinolene day 7	Brood Development	Positive	0.01	0.82
Terpinolene day 12	Brood Development	Positive	0.04	0.46
Total Terpenoids day 0	Brood Development	Positive	0.05	0.42
Total Terpenoids day 7	Brood Development	Positive	0.00	0.98
Total Terpenoids day 12	Brood Development	Positive	0.09	0.14
Total Monoterpenes day 0	Brood Development	Positive	0.05	0.43
Total Monoterpenes day 7	Brood Development	Positive	0.00	0.98
Total Monoterpenes day 12	Brood Development	Positive	0.09	0.14
Total Sesquiterpenes day 0	Brood Development	Positive	0.06	0.27
Total Sesquiterpenes day 7	Brood Development	Positive	0.05	0.42
Total Sesquiterpenes day 12	Brood Development	Positive	0.05	0.38

Table 11b:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
β -Pinene/ δ -3-Carene day 0	Brood Development	Positive	0.01	0.84
β -Pinene/ δ -3-Carene day 7	Brood Development	Negative	-0.02	0.81
β -Pinene/ δ -3-Carene day 12	Brood Development	Negative	-0.06	0.36
Terpinolene/Myrcene day 0	Brood Development	Negative	-0.08	0.28
Terpinolene/Myrcene day 7	Brood Development	Positive	0.04	0.51
Terpinolene/Myrcene day 12	Brood Development	Negative	-0.01	0.87
Lesion day 7	Par. Gall. Length	Positive	0.08	0.16
Lesion day 12	Par. Gall. Length	Positive	0.10	0.09
δ -3-Carene day 0	Par. Gall. Length	Negative	-0.12	0.04
δ -3-Carene day 7	Par. Gall. Length	Positive	0.03	0.66
δ -3-Carene day 12	Par. Gall. Length	Positive	0.09	0.15
Limonene day 0	Par. Gall. Length	Negative	-0.03	0.59
Limonene day 7	Par. Gall. Length	Positive	0.07	0.22
Limonene day 12	Par. Gall. Length	Positive	0.12	0.05
Myrcene day 0	Par. Gall. Length	Negative	-0.06	0.35
Myrcene day 7	Par. Gall. Length	Positive	0.07	0.25
Myrcene day 12	Par. Gall. Length	Positive	0.12	0.05
β -Phellandrene day 0	Par. Gall. Length	Negative	-0.01	0.89
β -Phellandrene day 7	Par. Gall. Length	Positive	0.09	0.12
β -Phellandrene day 12	Par. Gall. Length	Positive	0.14	0.01
α -Pinene day 0	Par. Gall. Length	Negative	-0.04	0.55
α -Pinene day 7	Par. Gall. Length	Positive	0.02	0.68
α -Pinene day 12	Par. Gall. Length	Positive	0.06	0.31
β -Pinene day 0	Par. Gall. Length	Negative	-0.05	0.40
β -Pinene day 7	Par. Gall. Length	Negative	-0.01	0.91
β -Pinene day 12	Par. Gall. Length	Positive	0.03	0.56
Terpineol day 0	Par. Gall. Length	Positive	0.00	0.96
Terpineol day 7	Par. Gall. Length	Positive	0.01	0.84

Table 11b:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
Terpineol day 12	Par. Gall. Length	Positive	0.07	0.27
Terpinolene day 0	Par. Gall. Length	Negative	-0.14	0.02
Terpinolene day 7	Par. Gall. Length	Positive	0.02	0.71
Terpinolene day 12	Par. Gall. Length	Positive	0.10	0.11
Total Terpenoids day 0	Par. Gall. Length	Negative	-0.05	0.39
Total Terpenoids day 7	Par. Gall. Length	Positive	0.07	0.24
Total Terpenoids day 12	Par. Gall. Length	Positive	0.12	0.04
Total Monoterpenes day 0	Par. Gall. Length	Negative	-0.05	0.39
Total Monoterpenes day 7	Par. Gall. Length	Positive	0.07	0.24
Total Monoterpenes day 12	Par. Gall. Length	Positive	0.12	0.04
Total Sesquiterpenes day 0	Par. Gall. Length	Negative	-0.01	0.91
Total Sesquiterpenes day 7	Par. Gall. Length	Positive	0.14	0.02
Total Sesquiterpenes day 12	Par. Gall. Length	Positive	0.03	0.59
β -Pinene/ δ -3-Carene day 0	Par. Gall. Length	Positive	0.08	0.27
β -Pinene/ δ -3-Carene day 7	Par. Gall. Length	Positive	0.08	0.29
β -Pinene/ δ -3-Carene day 12	Par. Gall. Length	Positive	0.07	0.36
Terpinolene/Myrcene day 0	Par. Gall. Length	Negative	-0.07	0.35
Terpinolene/Myrcene day 7	Par. Gall. Length	Positive	0.00	0.98
Terpinolene/Myrcene day 12	Par. Gall. Length	Negative	-0.03	0.67
Lesion day 12	Lesion day 7	Positive	0.36	<0.001
δ -3-Carene day 0	Lesion day 7	Positive	0.02	0.59
δ -3-Carene day 7	Lesion day 7	Positive	0.03	0.39
δ -3-Carene day 12	Lesion day 7	Positive	0.04	0.19
Limonene day 0	Lesion day 7	Positive	0.02	0.51
Limonene day 7	Lesion day 7	Positive	0.10	<0.01
Limonene day 12	Lesion day 7	Positive	0.09	0.01
Myrcene day 0	Lesion day 7	Positive	0.04	0.30
Myrcene day 7	Lesion day 7	Positive	0.13	<0.001

Table 11b:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
Myrcene day 12	Lesion day 7	Positive	0.11	<0.01
β -Phellandrene day 0	Lesion day 7	Positive	0.04	0.21
β -Phellandrene day 7	Lesion day 7	Positive	0.13	<0.001
β -Phellandrene day 12	Lesion day 7	Positive	0.12	<0.01
α -Pinene day 0	Lesion day 7	Negative	-0.02	0.63
α -Pinene day 7	Lesion day 7	Positive	0.04	0.28
α -Pinene day 12	Lesion day 7	Positive	0.04	0.27
β -Pinene day 0	Lesion day 7	Negative	-0.04	0.20
β -Pinene day 7	Lesion day 7	Positive	0.00	0.97
β -Pinene day 12	Lesion day 7	Positive	0.01	0.82
Terpineol day 0	Lesion day 7	Positive	0.07	0.05
Terpineol day 7	Lesion day 7	Positive	0.14	<0.001
Terpineol day 12	Lesion day 7	Positive	0.06	0.07
Terpinolene day 0	Lesion day 7	Positive	0.02	0.58
Terpinolene day 7	Lesion day 7	Positive	0.04	0.26
Terpinolene day 12	Lesion day 7	Positive	0.05	0.12
Total Terpenoids day 0	Lesion day 7	Positive	0.02	0.48
Total Terpenoids day 7	Lesion day 7	Positive	0.10	<0.01
Total Terpenoids day 12	Lesion day 7	Positive	0.10	<0.01
Total Monoterpenes day 0	Lesion day 7	Positive	0.02	0.47
Total Monoterpenes day 7	Lesion day 7	Positive	0.10	<0.01
Total Monoterpenes day 12	Lesion day 7	Positive	0.10	<0.01
Total Sesquiterpenes day 0	Lesion day 7	Positive	0.04	0.26
Total Sesquiterpenes day 7	Lesion day 7	Positive	0.10	<0.01
Total Sesquiterpenes day 12	Lesion day 7	Positive	0.08	0.02
β -Pinene/ δ -3-Carene day 0	Lesion day 7	Negative	-0.05	0.17
β -Pinene/ δ -3-Carene day 7	Lesion day 7	Negative	-0.02	0.54
β -Pinene/ δ -3-Carene day 12	Lesion day 7	Negative	-0.03	0.41

Table 11b:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
Terpinolene/Myrcene day 0	Lesion day 7	Negative	-0.01	0.69
Terpinolene/Myrcene day 7	Lesion day 7	Negative	-0.09	0.01
Terpinolene/Myrcene day 12	Lesion day 7	Negative	-0.04	0.21
δ -3-Carene day 0	Lesion day 12	Positive	0.00	0.89
δ -3-Carene day 7	Lesion day 12	Positive	0.01	0.72
δ -3-Carene day 12	Lesion day 12	Positive	0.00	0.99
Limonene day 0	Lesion day 12	Negative	-0.06	0.06
Limonene day 7	Lesion day 12	Positive	0.00	0.91
Limonene day 12	Lesion day 12	Negative	-0.01	0.78
Myrcene day 0	Lesion day 12	Negative	-0.01	0.86
Myrcene day 7	Lesion day 12	Positive	0.08	0.02
Myrcene day 12	Lesion day 12	Positive	0.04	0.27
β -Phellandrene day 0	Lesion day 12	Negative	-0.02	0.60
β -Phellandrene day 7	Lesion day 12	Positive	0.08	0.02
β -Phellandrene day 12	Lesion day 12	Positive	0.04	0.20
α -Pinene day 0	Lesion day 12	Negative	-0.06	0.08
α -Pinene day 7	Lesion day 12	Positive	0.03	0.32
α -Pinene day 12	Lesion day 12	Positive	0.00	0.95
β -Pinene day 0	Lesion day 12	Negative	-0.03	0.36
β -Pinene day 7	Lesion day 12	Positive	0.06	0.10
β -Pinene day 12	Lesion day 12	Positive	0.02	0.47
Terpineol day 0	Lesion day 12	Positive	0.05	0.12
Terpineol day 7	Lesion day 12	Positive	0.07	0.05
Terpineol day 12	Lesion day 12	Positive	0.06	0.10
Terpinolene day 0	Lesion day 12	Positive	0.00	0.89
Terpinolene day 7	Lesion day 12	Positive	0.02	0.64
Terpinolene day 12	Lesion day 12	Positive	0.02	0.60
Total Terpenoids day 0	Lesion day 12	Negative	-0.04	0.26

Table 11b:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
Total Terpenoids day 7	Lesion day 12	Positive	0.07	0.04
Total Terpenoids day 12	Lesion day 12	Positive	0.03	0.39
Total Monoterpenes day 0	Lesion day 12	Negative	-0.04	0.26
Total Monoterpenes day 7	Lesion day 12	Positive	0.07	0.04
Total Monoterpenes day 12	Lesion day 12	Positive	0.03	0.39
Total Sesquiterpenes day 0	Lesion day 12	Positive	0.00	0.93
Total Sesquiterpenes day 7	Lesion day 12	Negative	-0.03	0.34
Total Sesquiterpenes day 12	Lesion day 12	Positive	0.01	0.86
β -Pinene/ δ -3-Carene day 0	Lesion day 12	Negative	-0.02	0.55
β -Pinene/ δ -3-Carene day 7	Lesion day 12	Positive	0.03	0.32
β -Pinene/ δ -3-Carene day 12	Lesion day 12	Positive	0.02	0.56
Terpinolene/Myrcene day 0	Lesion day 12	Positive	0.00	1.00
Terpinolene/Myrcene day 7	Lesion day 12	Negative	-0.06	0.06
Terpinolene/Myrcene day 12	Lesion day 12	Negative	-0.02	0.64
δ -3-Carene day 7	δ -3-Carene day 0	Positive	0.45	<0.001
δ -3-Carene day 12	δ -3-Carene day 0	Positive	0.47	<0.001
Limonene day 0	δ -3-Carene day 0	Positive	0.30	<0.001
Limonene day 7	δ -3-Carene day 0	Negative	-0.07	0.03
Limonene day 12	δ -3-Carene day 0	Positive	0.00	0.92
Myrcene day 0	δ -3-Carene day 0	Positive	0.50	<0.001
Myrcene day 7	δ -3-Carene day 0	Positive	0.08	0.03
Myrcene day 12	δ -3-Carene day 0	Positive	0.13	<0.001
β -Phellandrene day 0	δ -3-Carene day 0	Positive	0.51	<0.001
β -Phellandrene day 7	δ -3-Carene day 0	Negative	-0.01	0.88
β -Phellandrene day 12	δ -3-Carene day 0	Positive	0.08	0.03
α -Pinene day 0	δ -3-Carene day 0	Positive	0.40	<0.001
α -Pinene day 7	δ -3-Carene day 0	Negative	-0.10	<0.01
α -Pinene day 12	δ -3-Carene day 0	Negative	-0.03	0.39

Table 11b:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
β -Pinene day 0	δ -3-Carene day 0	Positive	0.14	<0.001
β -Pinene day 7	δ -3-Carene day 0	Negative	-0.18	<0.001
β -Pinene day 12	δ -3-Carene day 0	Negative	-0.12	<0.01
Terpineol day 0	δ -3-Carene day 0	Positive	0.24	<0.001
Terpineol day 7	δ -3-Carene day 0	Positive	0.03	0.37
Terpineol day 12	δ -3-Carene day 0	Positive	0.02	0.65
Terpinolene day 0	δ -3-Carene day 0	Positive	0.56	<0.001
Terpinolene day 7	δ -3-Carene day 0	Positive	0.36	<0.001
Terpinolene day 12	δ -3-Carene day 0	Positive	0.31	<0.001
Total Terpenoids day 0	δ -3-Carene day 0	Positive	0.57	<0.001
Total Terpenoids day 7	δ -3-Carene day 0	Positive	0.04	0.22
Total Terpenoids day 12	δ -3-Carene day 0	Positive	0.10	<0.01
Total Monoterpenes day 0	δ -3-Carene day 0	Positive	0.57	<0.001
Total Monoterpenes day 7	δ -3-Carene day 0	Positive	0.04	0.22
Total Monoterpenes day 12	δ -3-Carene day 0	Positive	0.10	<0.01
Total Sesquiterpenes day 0	δ -3-Carene day 0	Positive	0.30	<0.001
Total Sesquiterpenes day 7	δ -3-Carene day 0	Negative	-0.01	0.77
Total Sesquiterpenes day 12	δ -3-Carene day 0	Positive	0.07	0.05
β -Pinene/ δ -3-Carene day 0	δ -3-Carene day 0	Negative	-0.65	<0.001
β -Pinene/ δ -3-Carene day 7	δ -3-Carene day 0	Negative	-0.46	<0.001
β -Pinene/ δ -3-Carene day 12	δ -3-Carene day 0	Negative	-0.46	<0.001
Terpinolene/Myrcene day 0	δ -3-Carene day 0	Positive	0.20	<0.001
Terpinolene/Myrcene day 7	δ -3-Carene day 0	Positive	0.40	<0.001
Terpinolene/Myrcene day 12	δ -3-Carene day 0	Positive	0.31	<0.001
δ -3-Carene day 12	δ -3-Carene day 7	Positive	0.41	<0.001
Limonene day 0	δ -3-Carene day 7	Negative	-0.02	0.58
Limonene day 7	δ -3-Carene day 7	Positive	0.33	<0.001
Limonene day 12	δ -3-Carene day 7	Negative	-0.03	0.37

Table 11b:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
Myrcene day 0	δ -3-Carene day 7	Positive	0.08	0.02
Myrcene day 7	δ -3-Carene day 7	Positive	0.64	<0.001
Myrcene day 12	δ -3-Carene day 7	Positive	0.12	<0.01
β -Phellandrene day 0	δ -3-Carene day 7	Positive	0.09	0.01
β -Phellandrene day 7	δ -3-Carene day 7	Positive	0.56	<0.001
β -Phellandrene day 12	δ -3-Carene day 7	Positive	0.08	0.02
α -Pinene day 0	δ -3-Carene day 7	Positive	0.00	0.91
α -Pinene day 7	δ -3-Carene day 7	Positive	0.36	<0.001
α -Pinene day 12	δ -3-Carene day 7	Negative	-0.03	0.36
β -Pinene day 0	δ -3-Carene day 7	Negative	-0.12	<0.001
β -Pinene day 7	δ -3-Carene day 7	Positive	0.12	<0.001
β -Pinene day 12	δ -3-Carene day 7	Negative	-0.14	<0.001
Terpineol day 0	δ -3-Carene day 7	Positive	0.04	0.19
Terpineol day 7	δ -3-Carene day 7	Positive	0.00	0.96
Terpineol day 12	δ -3-Carene day 7	Negative	-0.03	0.33
Terpinolene day 0	δ -3-Carene day 7	Positive	0.14	<0.001
Terpinolene day 7	δ -3-Carene day 7	Positive	0.77	<0.001
Terpinolene day 12	δ -3-Carene day 7	Positive	0.25	<0.001
Total Terpenoids day 0	δ -3-Carene day 7	Positive	0.08	0.02
Total Terpenoids day 7	δ -3-Carene day 7	Positive	0.64	<0.001
Total Terpenoids day 12	δ -3-Carene day 7	Positive	0.09	0.01
Total Monoterpenes day 0	δ -3-Carene day 7	Positive	0.08	0.02
Total Monoterpenes day 7	δ -3-Carene day 7	Positive	0.64	<0.001
Total Monoterpenes day 12	δ -3-Carene day 7	Positive	0.09	0.01
Total Sesquiterpenes day 0	δ -3-Carene day 7	Positive	0.04	0.23
Total Sesquiterpenes day 7	δ -3-Carene day 7	Positive	0.08	0.02
Total Sesquiterpenes day 12	δ -3-Carene day 7	Positive	0.01	0.82
β -Pinene/ δ -3-Carene day 0	δ -3-Carene day 7	Negative	-0.43	<0.001

Table 11b:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
β -Pinene/ δ -3-Carene day 7	δ -3-Carene day 7	Negative	-0.64	<0.001
β -Pinene/ δ -3-Carene day 12	δ -3-Carene day 7	Negative	-0.44	<0.001
Terpinolene/Myrcene day 0	δ -3-Carene day 7	Positive	0.11	<0.01
Terpinolene/Myrcene day 7	δ -3-Carene day 7	Positive	0.36	<0.001
Terpinolene/Myrcene day 12	δ -3-Carene day 7	Positive	0.23	<0.001
Limonene day 0	δ -3-Carene day 12	Negative	-0.04	0.25
Limonene day 7	δ -3-Carene day 12	Negative	-0.03	0.45
Limonene day 12	δ -3-Carene day 12	Positive	0.39	<0.001
Myrcene day 0	δ -3-Carene day 12	Positive	0.04	0.21
Myrcene day 7	δ -3-Carene day 12	Positive	0.12	<0.001
Myrcene day 12	δ -3-Carene day 12	Positive	0.71	<0.001
β -Phellandrene day 0	δ -3-Carene day 12	Positive	0.07	0.04
β -Phellandrene day 7	δ -3-Carene day 12	Positive	0.04	0.19
β -Phellandrene day 12	δ -3-Carene day 12	Positive	0.63	<0.001
α -Pinene day 0	δ -3-Carene day 12	Negative	-0.03	0.31
α -Pinene day 7	δ -3-Carene day 12	Negative	-0.06	0.09
α -Pinene day 12	δ -3-Carene day 12	Positive	0.46	<0.001
β -Pinene day 0	δ -3-Carene day 12	Negative	-0.16	<0.001
β -Pinene day 7	δ -3-Carene day 12	Negative	-0.13	<0.001
β -Pinene day 12	δ -3-Carene day 12	Positive	0.23	<0.001
Terpineol day 0	δ -3-Carene day 12	Negative	-0.02	0.49
Terpineol day 7	δ -3-Carene day 12	Positive	0.04	0.27
Terpineol day 12	δ -3-Carene day 12	Positive	0.00	0.88
Terpinolene day 0	δ -3-Carene day 12	Positive	0.16	<0.001
Terpinolene day 7	δ -3-Carene day 12	Positive	0.32	<0.001
Terpinolene day 12	δ -3-Carene day 12	Positive	0.80	<0.001
Total Terpenoids day 0	δ -3-Carene day 12	Positive	0.06	0.07
Total Terpenoids day 7	δ -3-Carene day 12	Positive	0.08	0.02

Table 11b:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
Total Terpenoids day 12	δ -3-Carene day 12	Positive	0.71	<0.001
Total Monoterpenes day 0	δ -3-Carene day 12	Positive	0.06	0.07
Total Monoterpenes day 7	δ -3-Carene day 12	Positive	0.08	0.02
Total Monoterpenes day 12	δ -3-Carene day 12	Positive	0.71	<0.001
Total Sesquiterpenes day 0	δ -3-Carene day 12	Positive	0.02	0.58
Total Sesquiterpenes day 7	δ -3-Carene day 12	Negative	-0.01	0.77
Total Sesquiterpenes day 12	δ -3-Carene day 12	Positive	0.08	0.02
β -Pinene/ δ -3-Carene day 0	δ -3-Carene day 12	Negative	-0.48	<0.001
β -Pinene/ δ -3-Carene day 7	δ -3-Carene day 12	Negative	-0.41	<0.001
β -Pinene/ δ -3-Carene day 12	δ -3-Carene day 12	Negative	-0.60	<0.001
Terpinolene/Myrcene day 0	δ -3-Carene day 12	Positive	0.16	<0.001
Terpinolene/Myrcene day 7	δ -3-Carene day 12	Positive	0.31	<0.001
Terpinolene/Myrcene day 12	δ -3-Carene day 12	Positive	0.38	<0.001
Limonene day 7	Limonene day 0	Positive	0.42	<0.001
Limonene day 12	Limonene day 0	Positive	0.44	<0.001
Myrcene day 0	Limonene day 0	Positive	0.65	<0.001
Myrcene day 7	Limonene day 0	Positive	0.08	0.03
Myrcene day 12	Limonene day 0	Positive	0.06	0.09
β -Phellandrene day 0	Limonene day 0	Positive	0.58	<0.001
β -Phellandrene day 7	Limonene day 0	Positive	0.06	0.06
β -Phellandrene day 12	Limonene day 0	Positive	0.05	0.15
α -Pinene day 0	Limonene day 0	Positive	0.59	<0.001
α -Pinene day 7	Limonene day 0	Positive	0.05	0.11
α -Pinene day 12	Limonene day 0	Positive	0.03	0.36
β -Pinene day 0	Limonene day 0	Positive	0.42	<0.001
β -Pinene day 7	Limonene day 0	Positive	0.04	0.28
β -Pinene day 12	Limonene day 0	Positive	0.03	0.39
Terpineol day 0	Limonene day 0	Positive	0.36	<0.001

Table 11b:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
Terpineol day 7	Limonene day 0	Positive	0.06	0.08
Terpineol day 12	Limonene day 0	Positive	0.09	0.01
Terpinolene day 0	Limonene day 0	Positive	0.48	<0.001
Terpinolene day 7	Limonene day 0	Positive	0.00	0.97
Terpinolene day 12	Limonene day 0	Positive	0.00	0.98
Total Terpenoids day 0	Limonene day 0	Positive	0.66	<0.001
Total Terpenoids day 7	Limonene day 0	Positive	0.07	0.04
Total Terpenoids day 12	Limonene day 0	Positive	0.05	0.11
Total Monoterpenes day 0	Limonene day 0	Positive	0.66	<0.001
Total Monoterpenes day 7	Limonene day 0	Positive	0.07	0.04
Total Monoterpenes day 12	Limonene day 0	Positive	0.05	0.11
Total Sesquiterpenes day 0	Limonene day 0	Positive	0.40	<0.001
Total Sesquiterpenes day 7	Limonene day 0	Positive	0.09	0.01
Total Sesquiterpenes day 12	Limonene day 0	Positive	0.10	<0.01
β -Pinene/ δ -3-Carene day 0	Limonene day 0	Positive	0.09	0.01
β -Pinene/ δ -3-Carene day 7	Limonene day 0	Positive	0.04	0.22
β -Pinene/ δ -3-Carene day 12	Limonene day 0	Positive	0.06	0.11
Terpinolene/Myrcene day 0	Limonene day 0	Negative	-0.07	0.04
Terpinolene/Myrcene day 7	Limonene day 0	Negative	-0.08	0.02
Terpinolene/Myrcene day 12	Limonene day 0	Negative	-0.07	0.05
Limonene day 12	Limonene day 7	Positive	0.47	<0.001
Myrcene day 0	Limonene day 7	Positive	0.06	0.09
Myrcene day 7	Limonene day 7	Positive	0.71	<0.001
Myrcene day 12	Limonene day 7	Positive	0.12	<0.001
β -Phellandrene day 0	Limonene day 7	Positive	0.07	0.03
β -Phellandrene day 7	Limonene day 7	Positive	0.68	<0.001
β -Phellandrene day 12	Limonene day 7	Positive	0.13	<0.001
α -Pinene day 0	Limonene day 7	Positive	0.03	0.42

Table 11b:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
α -Pinene day 7	Limonene day 7	Positive	0.52	<0.001
α -Pinene day 12	Limonene day 7	Positive	0.05	0.17
β -Pinene day 0	Limonene day 7	Positive	0.06	0.10
β -Pinene day 7	Limonene day 7	Positive	0.38	<0.001
β -Pinene day 12	Limonene day 7	Positive	0.02	0.52
Terpineol day 0	Limonene day 7	Positive	0.05	0.12
Terpineol day 7	Limonene day 7	Positive	0.15	<0.001
Terpineol day 12	Limonene day 7	Positive	0.01	0.84
Terpinolene day 0	Limonene day 7	Negative	-0.02	0.49
Terpinolene day 7	Limonene day 7	Positive	0.37	<0.001
Terpinolene day 12	Limonene day 7	Positive	0.00	0.98
Total Terpenoids day 0	Limonene day 7	Positive	0.08	0.02
Total Terpenoids day 7	Limonene day 7	Positive	0.70	<0.001
Total Terpenoids day 12	Limonene day 7	Positive	0.11	<0.01
Total Monoterpenes day 0	Limonene day 7	Positive	0.08	0.02
Total Monoterpenes day 7	Limonene day 7	Positive	0.70	<0.001
Total Monoterpenes day 12	Limonene day 7	Positive	0.11	<0.01
Total Sesquiterpenes day 0	Limonene day 7	Positive	0.02	0.59
Total Sesquiterpenes day 7	Limonene day 7	Positive	0.26	<0.001
Total Sesquiterpenes day 12	Limonene day 7	Positive	0.00	0.96
β -Pinene/ δ -3-Carene day 0	Limonene day 7	Positive	0.10	<0.01
β -Pinene/ δ -3-Carene day 7	Limonene day 7	Positive	0.05	0.14
β -Pinene/ δ -3-Carene day 12	Limonene day 7	Positive	0.04	0.26
Terpinolene/Myrcene day 0	Limonene day 7	Negative	-0.10	0.01
Terpinolene/Myrcene day 7	Limonene day 7	Negative	-0.26	<0.001
Terpinolene/Myrcene day 12	Limonene day 7	Negative	-0.13	<0.001
Myrcene day 0	Limonene day 12	Positive	0.08	0.02
Myrcene day 7	Limonene day 12	Positive	0.13	<0.001

Table 11b:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
Myrcene day 12	Limonene day 12	Positive	0.69	<0.001
β -Phellandrene day 0	Limonene day 12	Positive	0.10	<0.01
β -Phellandrene day 7	Limonene day 12	Positive	0.12	<0.001
β -Phellandrene day 12	Limonene day 12	Positive	0.66	<0.001
α -Pinene day 0	Limonene day 12	Positive	0.04	0.22
α -Pinene day 7	Limonene day 12	Positive	0.04	0.24
α -Pinene day 12	Limonene day 12	Positive	0.53	<0.001
β -Pinene day 0	Limonene day 12	Positive	0.04	0.28
β -Pinene day 7	Limonene day 12	Positive	0.03	0.38
β -Pinene day 12	Limonene day 12	Positive	0.40	<0.001
Terpineol day 0	Limonene day 12	Positive	0.06	0.08
Terpineol day 7	Limonene day 12	Positive	0.06	0.07
Terpineol day 12	Limonene day 12	Positive	0.13	<0.001
Terpinolene day 0	Limonene day 12	Positive	0.04	0.21
Terpinolene day 7	Limonene day 12	Positive	0.00	0.92
Terpinolene day 12	Limonene day 12	Positive	0.43	<0.001
Total Terpenoids day 0	Limonene day 12	Positive	0.12	<0.01
Total Terpenoids day 7	Limonene day 12	Positive	0.10	<0.01
Total Terpenoids day 12	Limonene day 12	Positive	0.69	<0.001
Total Monoterpenes day 0	Limonene day 12	Positive	0.12	<0.01
Total Monoterpenes day 7	Limonene day 12	Positive	0.10	<0.01
Total Monoterpenes day 12	Limonene day 12	Positive	0.69	<0.001
Total Sesquiterpenes day 0	Limonene day 12	Positive	0.04	0.29
Total Sesquiterpenes day 7	Limonene day 12	Positive	0.09	0.01
Total Sesquiterpenes day 12	Limonene day 12	Positive	0.19	<0.001
β -Pinene/ δ -3-Carene day 0	Limonene day 12	Positive	0.03	0.45
β -Pinene/ δ -3-Carene day 7	Limonene day 12	Positive	0.05	0.18
β -Pinene/ δ -3-Carene day 12	Limonene day 12	Positive	0.02	0.50

Table 11b:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
Terpinolene/Myrcene day 0	Limonene day 12	Negative	-0.03	0.39
Terpinolene/Myrcene day 7	Limonene day 12	Negative	-0.13	<0.001
Terpinolene/Myrcene day 12	Limonene day 12	Negative	-0.14	<0.001
Myrcene day 7	Myrcene day 0	Positive	0.13	<0.001
Myrcene day 12	Myrcene day 0	Positive	0.14	<0.001
β -Phellandrene day 0	Myrcene day 0	Positive	0.80	<0.001
β -Phellandrene day 7	Myrcene day 0	Positive	0.09	0.01
β -Phellandrene day 12	Myrcene day 0	Positive	0.09	0.01
α -Pinene day 0	Myrcene day 0	Positive	0.77	<0.001
α -Pinene day 7	Myrcene day 0	Positive	0.08	0.02
α -Pinene day 12	Myrcene day 0	Positive	0.08	0.02
β -Pinene day 0	Myrcene day 0	Positive	0.49	<0.001
β -Pinene day 7	Myrcene day 0	Positive	0.03	0.44
β -Pinene day 12	Myrcene day 0	Positive	0.04	0.21
Terpineol day 0	Myrcene day 0	Positive	0.40	<0.001
Terpineol day 7	Myrcene day 0	Positive	0.10	<0.01
Terpineol day 12	Myrcene day 0	Positive	0.12	<0.01
Terpinolene day 0	Myrcene day 0	Positive	0.68	<0.001
Terpinolene day 7	Myrcene day 0	Positive	0.10	<0.01
Terpinolene day 12	Myrcene day 0	Positive	0.09	0.01
Total Terpenoids day 0	Myrcene day 0	Positive	0.86	<0.001
Total Terpenoids day 7	Myrcene day 0	Positive	0.10	<0.01
Total Terpenoids day 12	Myrcene day 0	Positive	0.10	0.01
Total Monoterpenes day 0	Myrcene day 0	Positive	0.86	<0.001
Total Monoterpenes day 7	Myrcene day 0	Positive	0.10	<0.01
Total Monoterpenes day 12	Myrcene day 0	Positive	0.10	0.01
Total Sesquiterpenes day 0	Myrcene day 0	Positive	0.49	<0.001
Total Sesquiterpenes day 7	Myrcene day 0	Positive	0.09	0.01

Table 11b:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
Total Sesquiterpenes day 12	Myrcene day 0	Positive	0.14	<0.001
β -Pinene/ δ -3-Carene day 0	Myrcene day 0	Negative	-0.01	0.75
β -Pinene/ δ -3-Carene day 7	Myrcene day 0	Negative	-0.04	0.29
β -Pinene/ δ -3-Carene day 12	Myrcene day 0	Positive	0.00	0.97
Terpinolene/Myrcene day 0	Myrcene day 0	Negative	-0.19	<0.001
Terpinolene/Myrcene day 7	Myrcene day 0	Positive	0.00	0.93
Terpinolene/Myrcene day 12	Myrcene day 0	Negative	-0.02	0.60
Myrcene day 12	Myrcene day 7	Positive	0.22	<0.001
β -Phellandrene day 0	Myrcene day 7	Positive	0.16	<0.001
β -Phellandrene day 7	Myrcene day 7	Positive	0.94	<0.001
β -Phellandrene day 12	Myrcene day 7	Positive	0.22	<0.001
α -Pinene day 0	Myrcene day 7	Positive	0.07	0.05
α -Pinene day 7	Myrcene day 7	Positive	0.73	<0.001
α -Pinene day 12	Myrcene day 7	Positive	0.10	<0.01
β -Pinene day 0	Myrcene day 7	Positive	0.04	0.22
β -Pinene day 7	Myrcene day 7	Positive	0.47	<0.001
β -Pinene day 12	Myrcene day 7	Positive	0.04	0.25
Terpineol day 0	Myrcene day 7	Positive	0.07	0.04
Terpineol day 7	Myrcene day 7	Positive	0.17	<0.001
Terpineol day 12	Myrcene day 7	Positive	0.01	0.86
Terpinolene day 0	Myrcene day 7	Positive	0.04	0.23
Terpinolene day 7	Myrcene day 7	Positive	0.69	<0.001
Terpinolene day 12	Myrcene day 7	Positive	0.12	<0.001
Total Terpenoids day 0	Myrcene day 7	Positive	0.12	<0.001
Total Terpenoids day 7	Myrcene day 7	Positive	0.97	<0.001
Total Terpenoids day 12	Myrcene day 7	Positive	0.19	<0.001
Total Monoterpenes day 0	Myrcene day 7	Positive	0.12	<0.001
Total Monoterpenes day 7	Myrcene day 7	Positive	0.97	<0.001

Table 11b:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
Total Monoterpenes day 12	Myrcene day 7	Positive	0.19	<0.001
Total Sesquiterpenes day 0	Myrcene day 7	Positive	0.05	0.12
Total Sesquiterpenes day 7	Myrcene day 7	Positive	0.29	<0.001
Total Sesquiterpenes day 12	Myrcene day 7	Positive	0.04	0.24
β -Pinene/ δ -3-Carene day 0	Myrcene day 7	Negative	-0.02	0.47
β -Pinene/ δ -3-Carene day 7	Myrcene day 7	Negative	-0.11	<0.01
β -Pinene/ δ -3-Carene day 12	Myrcene day 7	Negative	-0.07	0.06
Terpinolene/Myrcene day 0	Myrcene day 7	Negative	-0.08	0.01
Terpinolene/Myrcene day 7	Myrcene day 7	Negative	-0.14	<0.001
Terpinolene/Myrcene day 12	Myrcene day 7	Negative	-0.07	0.06
β -Phellandrene day 0	Myrcene day 12	Positive	0.17	<0.001
β -Phellandrene day 7	Myrcene day 12	Positive	0.19	<0.001
β -Phellandrene day 12	Myrcene day 12	Positive	0.92	<0.001
α -Pinene day 0	Myrcene day 12	Positive	0.07	0.03
α -Pinene day 7	Myrcene day 12	Positive	0.10	<0.01
α -Pinene day 12	Myrcene day 12	Positive	0.76	<0.001
β -Pinene day 0	Myrcene day 12	Positive	0.00	0.96
β -Pinene day 7	Myrcene day 12	Positive	0.04	0.28
β -Pinene day 12	Myrcene day 12	Positive	0.52	<0.001
Terpineol day 0	Myrcene day 12	Positive	0.04	0.21
Terpineol day 7	Myrcene day 12	Positive	0.11	<0.01
Terpineol day 12	Myrcene day 12	Positive	0.15	<0.001
Terpinolene day 0	Myrcene day 12	Positive	0.11	<0.01
Terpinolene day 7	Myrcene day 12	Positive	0.15	<0.001
Terpinolene day 12	Myrcene day 12	Positive	0.73	<0.001
Total Terpenoids day 0	Myrcene day 12	Positive	0.14	<0.001
Total Terpenoids day 7	Myrcene day 12	Positive	0.18	<0.001
Total Terpenoids day 12	Myrcene day 12	Positive	0.97	<0.001

Table 11b:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
Total Monoterpenes day 0	Myrcene day 12	Positive	0.14	<0.001
Total Monoterpenes day 7	Myrcene day 12	Positive	0.18	<0.001
Total Monoterpenes day 12	Myrcene day 12	Positive	0.97	<0.001
Total Sesquiterpenes day 0	Myrcene day 12	Positive	0.07	0.03
Total Sesquiterpenes day 7	Myrcene day 12	Positive	0.08	0.02
Total Sesquiterpenes day 12	Myrcene day 12	Positive	0.25	<0.001
β -Pinene/ δ -3-Carene day 0	Myrcene day 12	Negative	-0.10	<0.01
β -Pinene/ δ -3-Carene day 7	Myrcene day 12	Negative	-0.06	0.09
β -Pinene/ δ -3-Carene day 12	Myrcene day 12	Negative	-0.13	<0.001
Terpinolene/Myrcene day 0	Myrcene day 12	Negative	-0.01	0.82
Terpinolene/Myrcene day 7	Myrcene day 12	Negative	-0.03	0.31
Terpinolene/Myrcene day 12	Myrcene day 12	Negative	-0.03	0.35
β -Phellandrene day 7	β -Phellandrene day 0	Positive	0.22	<0.001
β -Phellandrene day 12	β -Phellandrene day 0	Positive	0.23	<0.001
α -Pinene day 0	β -Phellandrene day 0	Positive	0.68	<0.001
α -Pinene day 7	β -Phellandrene day 0	Positive	0.00	0.96
α -Pinene day 12	β -Phellandrene day 0	Positive	0.03	0.44
β -Pinene day 0	β -Phellandrene day 0	Positive	0.48	<0.001
β -Pinene day 7	β -Phellandrene day 0	Positive	0.01	0.78
β -Pinene day 12	β -Phellandrene day 0	Positive	0.02	0.47
Terpineol day 0	β -Phellandrene day 0	Positive	0.41	<0.001
Terpineol day 7	β -Phellandrene day 0	Positive	0.07	0.04
Terpineol day 12	β -Phellandrene day 0	Positive	0.11	<0.01
Terpinolene day 0	β -Phellandrene day 0	Positive	0.60	<0.001
Terpinolene day 7	β -Phellandrene day 0	Positive	0.09	0.01
Terpinolene day 12	β -Phellandrene day 0	Positive	0.09	0.01
Total Terpenoids day 0	β -Phellandrene day 0	Positive	0.93	<0.001
Total Terpenoids day 7	β -Phellandrene day 0	Positive	0.15	<0.001

Table 11b:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
Total Terpenoids day 12	β -Phellandrene day 0	Positive	0.15	<0.001
Total Monoterpenes day 0	β -Phellandrene day 0	Positive	0.93	<0.001
Total Monoterpenes day 7	β -Phellandrene day 0	Positive	0.15	<0.001
Total Monoterpenes day 12	β -Phellandrene day 0	Positive	0.15	<0.001
Total Sesquiterpenes day 0	β -Phellandrene day 0	Positive	0.50	<0.001
Total Sesquiterpenes day 7	β -Phellandrene day 0	Positive	0.10	<0.01
Total Sesquiterpenes day 12	β -Phellandrene day 0	Positive	0.16	<0.001
β -Pinene/ δ -3-Carene day 0	β -Phellandrene day 0	Negative	-0.02	0.63
β -Pinene/ δ -3-Carene day 7	β -Phellandrene day 0	Negative	-0.06	0.10
β -Pinene/ δ -3-Carene day 12	β -Phellandrene day 0	Negative	-0.03	0.32
Terpinolene/Myrcene day 0	β -Phellandrene day 0	Negative	-0.08	0.02
Terpinolene/Myrcene day 7	β -Phellandrene day 0	Negative	-0.05	0.17
Terpinolene/Myrcene day 12	β -Phellandrene day 0	Negative	-0.06	0.09
β -Phellandrene day 12	β -Phellandrene day 7	Positive	0.27	<0.001
α -Pinene day 0	β -Phellandrene day 7	Positive	0.02	0.63
α -Pinene day 7	β -Phellandrene day 7	Positive	0.64	<0.001
α -Pinene day 12	β -Phellandrene day 7	Positive	0.04	0.21
β -Pinene day 0	β -Phellandrene day 7	Positive	0.02	0.66
β -Pinene day 7	β -Phellandrene day 7	Positive	0.43	<0.001
β -Pinene day 12	β -Phellandrene day 7	Positive	0.01	0.70
Terpineol day 0	β -Phellandrene day 7	Positive	0.06	0.06
Terpineol day 7	β -Phellandrene day 7	Positive	0.11	<0.01
Terpineol day 12	β -Phellandrene day 7	Negative	-0.01	0.73
Terpinolene day 0	β -Phellandrene day 7	Positive	0.00	0.92
Terpinolene day 7	β -Phellandrene day 7	Positive	0.57	<0.001
Terpinolene day 12	β -Phellandrene day 7	Positive	0.03	0.31
Total Terpenoids day 0	β -Phellandrene day 7	Positive	0.11	<0.01
Total Terpenoids day 7	β -Phellandrene day 7	Positive	0.95	<0.001

Table 11b:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
Total Terpenoids day 12	β -Phellandrene day 7	Positive	0.18	<0.001
Total Monoterpenes day 0	β -Phellandrene day 7	Positive	0.11	<0.01
Total Monoterpenes day 7	β -Phellandrene day 7	Positive	0.95	<0.001
Total Monoterpenes day 12	β -Phellandrene day 7	Positive	0.17	<0.001
Total Sesquiterpenes day 0	β -Phellandrene day 7	Positive	0.03	0.36
Total Sesquiterpenes day 7	β -Phellandrene day 7	Positive	0.24	<0.001
Total Sesquiterpenes day 12	β -Phellandrene day 7	Positive	0.03	0.39
β -Pinene/ δ -3-Carene day 0	β -Phellandrene day 7	Positive	0.02	0.65
β -Pinene/ δ -3-Carene day 7	β -Phellandrene day 7	Negative	-0.07	0.03
β -Pinene/ δ -3-Carene day 12	β -Phellandrene day 7	Negative	-0.02	0.48
Terpinolene/Myrcene day 0	β -Phellandrene day 7	Negative	-0.11	<0.01
Terpinolene/Myrcene day 7	β -Phellandrene day 7	Negative	-0.23	<0.001
Terpinolene/Myrcene day 12	β -Phellandrene day 7	Negative	-0.16	<0.001
α -Pinene day 0	β -Phellandrene day 12	Positive	0.01	0.88
α -Pinene day 7	β -Phellandrene day 12	Positive	0.05	0.18
α -Pinene day 12	β -Phellandrene day 12	Positive	0.67	<0.001
β -Pinene day 0	β -Phellandrene day 12	Negative	-0.04	0.29
β -Pinene day 7	β -Phellandrene day 12	Positive	0.02	0.58
β -Pinene day 12	β -Phellandrene day 12	Positive	0.48	<0.001
Terpineol day 0	β -Phellandrene day 12	Positive	0.01	0.68
Terpineol day 7	β -Phellandrene day 12	Positive	0.05	0.14
Terpineol day 12	β -Phellandrene day 12	Positive	0.11	<0.01
Terpinolene day 0	β -Phellandrene day 12	Positive	0.05	0.13
Terpinolene day 7	β -Phellandrene day 12	Positive	0.08	0.01
Terpinolene day 12	β -Phellandrene day 12	Positive	0.62	<0.001
Total Terpenoids day 0	β -Phellandrene day 12	Positive	0.13	<0.001
Total Terpenoids day 7	β -Phellandrene day 12	Positive	0.19	<0.001
Total Terpenoids day 12	β -Phellandrene day 12	Positive	0.94	<0.001

Table 11b:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
Total Monoterpenes day 0	β -Phellandrene day 12	Positive	0.13	<0.001
Total Monoterpenes day 7	β -Phellandrene day 12	Positive	0.19	<0.001
Total Monoterpenes day 12	β -Phellandrene day 12	Positive	0.94	<0.001
Total Sesquiterpenes day 0	β -Phellandrene day 12	Positive	0.05	0.17
Total Sesquiterpenes day 7	β -Phellandrene day 12	Positive	0.05	0.16
Total Sesquiterpenes day 12	β -Phellandrene day 12	Positive	0.19	<0.001
β -Pinene/ δ -3-Carene day 0	β -Phellandrene day 12	Negative	-0.09	0.01
β -Pinene/ δ -3-Carene day 7	β -Phellandrene day 12	Negative	-0.04	0.20
β -Pinene/ δ -3-Carene day 12	β -Phellandrene day 12	Negative	-0.10	<0.01
Terpinolene/Myrcene day 0	β -Phellandrene day 12	Negative	-0.02	0.47
Terpinolene/Myrcene day 7	β -Phellandrene day 12	Negative	-0.12	<0.01
Terpinolene/Myrcene day 12	β -Phellandrene day 12	Negative	-0.12	<0.01
α -Pinene day 7	α -Pinene day 0	Positive	0.31	<0.001
α -Pinene day 12	α -Pinene day 0	Positive	0.30	<0.001
β -Pinene day 0	α -Pinene day 0	Positive	0.67	<0.001
β -Pinene day 7	α -Pinene day 0	Positive	0.17	<0.001
β -Pinene day 12	α -Pinene day 0	Positive	0.18	<0.001
Terpineol day 0	α -Pinene day 0	Positive	0.43	<0.001
Terpineol day 7	α -Pinene day 0	Positive	0.13	<0.001
Terpineol day 12	α -Pinene day 0	Positive	0.13	<0.001
Terpinolene day 0	α -Pinene day 0	Positive	0.59	<0.001
Terpinolene day 7	α -Pinene day 0	Positive	0.05	0.15
Terpinolene day 12	α -Pinene day 0	Positive	0.03	0.31
Total Terpenoids day 0	α -Pinene day 0	Positive	0.83	<0.001
Total Terpenoids day 7	α -Pinene day 0	Positive	0.10	<0.01
Total Terpenoids day 12	α -Pinene day 0	Positive	0.09	0.01
Total Monoterpenes day 0	α -Pinene day 0	Positive	0.83	<0.001
Total Monoterpenes day 7	α -Pinene day 0	Positive	0.10	<0.01

Table 11b:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
Total Monoterpenes day 12	α -Pinene day 0	Positive	0.09	0.01
Total Sesquiterpenes day 0	α -Pinene day 0	Positive	0.51	<0.001
Total Sesquiterpenes day 7	α -Pinene day 0	Positive	0.08	0.03
Total Sesquiterpenes day 12	α -Pinene day 0	Positive	0.11	<0.01
β -Pinene/ δ -3-Carene day 0	α -Pinene day 0	Positive	0.21	<0.001
β -Pinene/ δ -3-Carene day 7	α -Pinene day 0	Positive	0.13	<0.001
β -Pinene/ δ -3-Carene day 12	α -Pinene day 0	Positive	0.17	<0.001
Terpinolene/Myrcene day 0	α -Pinene day 0	Negative	-0.06	0.06
Terpinolene/Myrcene day 7	α -Pinene day 0	Positive	0.00	0.89
Terpinolene/Myrcene day 12	α -Pinene day 0	Negative	-0.03	0.36
α -Pinene day 12	α -Pinene day 7	Positive	0.39	<0.001
β -Pinene day 0	α -Pinene day 7	Positive	0.24	<0.001
β -Pinene day 7	α -Pinene day 7	Positive	0.64	<0.001
β -Pinene day 12	α -Pinene day 7	Positive	0.21	<0.001
Terpineol day 0	α -Pinene day 7	Positive	0.10	0.01
Terpineol day 7	α -Pinene day 7	Positive	0.18	<0.001
Terpineol day 12	α -Pinene day 7	Positive	0.06	0.10
Terpinolene day 0	α -Pinene day 7	Positive	0.04	0.29
Terpinolene day 7	α -Pinene day 7	Positive	0.44	<0.001
Terpinolene day 12	α -Pinene day 7	Positive	0.01	0.74
Total Terpenoids day 0	α -Pinene day 7	Positive	0.10	<0.01
Total Terpenoids day 7	α -Pinene day 7	Positive	0.79	<0.001
Total Terpenoids day 12	α -Pinene day 7	Positive	0.14	<0.001
Total Monoterpenes day 0	α -Pinene day 7	Positive	0.11	<0.01
Total Monoterpenes day 7	α -Pinene day 7	Positive	0.79	<0.001
Total Monoterpenes day 12	α -Pinene day 7	Positive	0.14	<0.001
Total Sesquiterpenes day 0	α -Pinene day 7	Positive	0.03	0.34
Total Sesquiterpenes day 7	α -Pinene day 7	Positive	0.16	<0.001

Table 11b:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
Total Sesquiterpenes day 12	α -Pinene day 7	Positive	0.01	0.80
β -Pinene/ δ -3-Carene day 0	α -Pinene day 7	Positive	0.26	<0.001
β -Pinene/ δ -3-Carene day 7	α -Pinene day 7	Positive	0.23	<0.001
β -Pinene/ δ -3-Carene day 12	α -Pinene day 7	Positive	0.22	<0.001
Terpinolene/Myrcene day 0	α -Pinene day 7	Negative	-0.04	0.22
Terpinolene/Myrcene day 7	α -Pinene day 7	Negative	-0.18	<0.001
Terpinolene/Myrcene day 12	α -Pinene day 7	Negative	-0.10	<0.01
β -Pinene day 0	α -Pinene day 12	Positive	0.21	<0.001
β -Pinene day 7	α -Pinene day 12	Positive	0.21	<0.001
β -Pinene day 12	α -Pinene day 12	Positive	0.68	<0.001
Terpineol day 0	α -Pinene day 12	Positive	0.09	0.01
Terpineol day 7	α -Pinene day 12	Positive	0.14	<0.001
Terpineol day 12	α -Pinene day 12	Positive	0.16	<0.001
Terpinolene day 0	α -Pinene day 12	Positive	0.09	0.01
Terpinolene day 7	α -Pinene day 12	Positive	0.04	0.22
Terpinolene day 12	α -Pinene day 12	Positive	0.51	<0.001
Total Terpenoids day 0	α -Pinene day 12	Positive	0.13	<0.001
Total Terpenoids day 7	α -Pinene day 12	Positive	0.13	<0.001
Total Terpenoids day 12	α -Pinene day 12	Positive	0.83	<0.001
Total Monoterpenes day 0	α -Pinene day 12	Positive	0.13	<0.001
Total Monoterpenes day 7	α -Pinene day 12	Positive	0.13	<0.001
Total Monoterpenes day 12	α -Pinene day 12	Positive	0.83	<0.001
Total Sesquiterpenes day 0	α -Pinene day 12	Positive	0.05	0.11
Total Sesquiterpenes day 7	α -Pinene day 12	Positive	0.03	0.42
Total Sesquiterpenes day 12	α -Pinene day 12	Positive	0.18	<0.001
β -Pinene/ δ -3-Carene day 0	α -Pinene day 12	Positive	0.18	<0.001
β -Pinene/ δ -3-Carene day 7	α -Pinene day 12	Positive	0.19	<.0001
β -Pinene/ δ -3-Carene day 12	α -Pinene day 12	Positive	0.20	<0.001

Table 11b:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
Terpinolene/Myrcene day 0	α -Pinene day 12	Positive	0.03	0.37
Terpinolene/Myrcene day 7	α -Pinene day 12	Negative	-0.05	0.12
Terpinolene/Myrcene day 12	α -Pinene day 12	Negative	-0.09	0.01
β -Pinene day 7	β -Pinene day 0	Positive	0.56	<0.001
β -Pinene day 12	β -Pinene day 0	Positive	0.53	<0.001
Terpineol day 0	β -Pinene day 0	Positive	0.35	<0.001
Terpineol day 7	β -Pinene day 0	Positive	0.16	<0.001
Terpineol day 12	β -Pinene day 0	Positive	0.17	<0.001
Terpinolene day 0	β -Pinene day 0	Positive	0.35	<0.001
Terpinolene day 7	β -Pinene day 0	Negative	-0.04	0.27
Terpinolene day 12	β -Pinene day 0	Negative	-0.06	0.08
Total Terpenoids day 0	β -Pinene day 0	Positive	0.62	<0.001
Total Terpenoids day 7	β -Pinene day 0	Positive	0.09	0.01
Total Terpenoids day 12	β -Pinene day 0	Positive	0.05	0.13
Total Monoterpenes day 0	β -Pinene day 0	Positive	0.62	<0.001
Total Monoterpenes day 7	β -Pinene day 0	Positive	0.09	0.01
Total Monoterpenes day 12	β -Pinene day 0	Positive	0.05	0.13
Total Sesquiterpenes day 0	β -Pinene day 0	Positive	0.29	<0.001
Total Sesquiterpenes day 7	β -Pinene day 0	Positive	0.09	0.01
Total Sesquiterpenes day 12	β -Pinene day 0	Positive	0.05	0.17
β -Pinene/ δ -3-Carene day 0	β -Pinene day 0	Positive	0.66	<0.001
β -Pinene/ δ -3-Carene day 7	β -Pinene day 0	Positive	0.52	<.0001
β -Pinene/ δ -3-Carene day 12	β -Pinene day 0	Positive	0.56	<0.001
Terpinolene/Myrcene day 0	β -Pinene day 0	Negative	-0.07	0.05
Terpinolene/Myrcene day 7	β -Pinene day 0	Negative	-0.10	<0.01
Terpinolene/Myrcene day 12	β -Pinene day 0	Negative	-0.09	0.01
β -Pinene day 12	β -Pinene day 7	Positive	0.58	<0.001
Terpineol day 0	β -Pinene day 7	Positive	0.06	0.09

Table 11b:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
Terpineol day 7	β -Pinene day 7	Positive	0.19	<0.001
Terpineol day 12	β -Pinene day 7	Positive	0.12	<0.001
Terpinolene day 0	β -Pinene day 7	Negative	-0.02	0.52
Terpinolene day 7	β -Pinene day 7	Positive	0.20	<0.001
Terpinolene day 12	β -Pinene day 7	Negative	-0.06	0.10
Total Terpenoids day 0	β -Pinene day 7	Positive	0.07	0.04
Total Terpenoids day 7	β -Pinene day 7	Positive	0.55	<0.001
Total Terpenoids day 12	β -Pinene day 7	Positive	0.09	0.01
Total Monoterpenes day 0	β -Pinene day 7	Positive	0.07	0.04
Total Monoterpenes day 7	β -Pinene day 7	Positive	0.55	<0.001
Total Monoterpenes day 12	β -Pinene day 7	Positive	0.09	0.01
Total Sesquiterpenes day 0	β -Pinene day 7	Negative	-0.07	0.05
Total Sesquiterpenes day 7	β -Pinene day 7	Positive	0.11	<0.01
Total Sesquiterpenes day 12	β -Pinene day 7	Negative	-0.01	0.83
β -Pinene/ δ -3-Carene day 0	β -Pinene day 7	Positive	0.56	<0.001
β -Pinene/ δ -3-Carene day 7	β -Pinene day 7	Positive	0.68	<0.001
β -Pinene/ δ -3-Carene day 12	β -Pinene day 7	Positive	0.57	<0.001
Terpinolene/Myrcene day 0	β -Pinene day 7	Negative	-0.06	0.09
Terpinolene/Myrcene day 7	β -Pinene day 7	Negative	-0.23	<0.001
Terpinolene/Myrcene day 12	β -Pinene day 7	Negative	-0.12	<0.001
Terpineol day 0	β -Pinene day 12	Positive	0.07	0.04
Terpineol day 7	β -Pinene day 12	Positive	0.17	<0.001
Terpineol day 12	β -Pinene day 12	Positive	0.19	<0.001
Terpinolene day 0	β -Pinene day 12	Positive	0.02	0.51
Terpinolene day 7	β -Pinene day 12	Negative	-0.06	0.10
Terpinolene day 12	β -Pinene day 12	Positive	0.30	<0.001
Total Terpenoids day 0	β -Pinene day 12	Positive	0.10	0.01
Total Terpenoids day 7	β -Pinene day 12	Positive	0.08	0.02

Table 11b:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
Total Terpenoids day 12	β -Pinene day 12	Positive	0.61	<0.001
Total Monoterpenes day 0	β -Pinene day 12	Positive	0.10	<0.01
Total Monoterpenes day 7	β -Pinene day 12	Positive	0.08	0.02
Total Monoterpenes day 12	β -Pinene day 12	Positive	0.61	<0.001
Total Sesquiterpenes day 0	β -Pinene day 12	Negative	-0.03	0.44
Total Sesquiterpenes day 7	β -Pinene day 12	Positive	0.03	0.33
Total Sesquiterpenes day 12	β -Pinene day 12	Positive	0.11	<0.01
β -Pinene/ δ -3-Carene day 0	β -Pinene day 12	Positive	0.49	<0.001
β -Pinene/ δ -3-Carene day 7	β -Pinene day 12	Positive	0.55	<0.001
β -Pinene/ δ -3-Carene day 12	β -Pinene day 12	Positive	0.65	<0.001
Terpinolene/Myrcene day 0	β -Pinene day 12	Negative	-0.02	0.62
Terpinolene/Myrcene day 7	β -Pinene day 12	Negative	-0.12	<0.01
Terpinolene/Myrcene day 12	β -Pinene day 12	Negative	-0.14	<0.001
Terpineol day 7	Terpineol day 0	Positive	0.14	<0.001
Terpineol day 12	Terpineol day 0	Positive	0.17	<0.001
Terpinolene day 0	Terpineol day 0	Positive	0.35	<0.001
Terpinolene day 7	Terpineol day 0	Positive	0.07	0.03
Terpinolene day 12	Terpineol day 0	Positive	0.04	0.25
Total Terpenoids day 0	Terpineol day 0	Positive	0.49	<0.001
Total Terpenoids day 7	Terpineol day 0	Positive	0.08	0.02
Total Terpenoids day 12	Terpineol day 0	Positive	0.04	0.21
Total Monoterpenes day 0	Terpineol day 0	Positive	0.49	<0.001
Total Monoterpenes day 7	Terpineol day 0	Positive	0.08	0.02
Total Monoterpenes day 12	Terpineol day 0	Positive	0.04	0.21
Total Sesquiterpenes day 0	Terpineol day 0	Positive	0.42	<0.001
Total Sesquiterpenes day 7	Terpineol day 0	Positive	0.15	<0.001
Total Sesquiterpenes day 12	Terpineol day 0	Positive	0.13	<0.001
β -Pinene/ δ -3-Carene day 0	Terpineol day 0	Positive	0.08	0.01

Table 11b:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
β -Pinene/ δ -3-Carene day 7	Terpineol day 0	Positive	0.01	0.74
β -Pinene/ δ -3-Carene day 12	Terpineol day 0	Positive	0.08	0.03
Terpinolene/Myrcene day 0	Terpineol day 0	Positive	0.02	0.48
Terpinolene/Myrcene day 7	Terpineol day 0	Positive	0.03	0.47
Terpinolene/Myrcene day 12	Terpineol day 0	Positive	0.01	0.79
Terpineol day 12	Terpineol day 7	Positive	0.23	<0.001
Terpinolene day 0	Terpineol day 7	Positive	0.11	<0.01
Terpinolene day 7	Terpineol day 7	Positive	0.08	0.02
Terpinolene day 12	Terpineol day 7	Positive	0.12	<0.01
Total Terpenoids day 0	Terpineol day 7	Positive	0.11	<0.01
Total Terpenoids day 7	Terpineol day 7	Positive	0.15	<0.001
Total Terpenoids day 12	Terpineol day 7	Positive	0.11	<0.01
Total Monoterpenes day 0	Terpineol day 7	Positive	0.11	<0.01
Total Monoterpenes day 7	Terpineol day 7	Positive	0.15	<0.001
Total Monoterpenes day 12	Terpineol day 7	Positive	0.11	<0.01
Total Sesquiterpenes day 0	Terpineol day 7	Positive	0.09	0.01
Total Sesquiterpenes day 7	Terpineol day 7	Positive	0.39	<0.001
Total Sesquiterpenes day 12	Terpineol day 7	Positive	0.14	<0.001
β -Pinene/ δ -3-Carene day 0	Terpineol day 7	Positive	0.10	0.01
β -Pinene/ δ -3-Carene day 7	Terpineol day 7	Positive	0.15	<0.001
β -Pinene/ δ -3-Carene day 12	Terpineol day 7	Positive	0.11	<0.01
Terpinolene/Myrcene day 0	Terpineol day 7	Positive	0.03	0.36
Terpinolene/Myrcene day 7	Terpineol day 7	Negative	-0.07	0.03
Terpinolene/Myrcene day 12	Terpineol day 7	Positive	0.05	0.13
Terpinolene day 0	Terpineol day 12	Positive	0.10	<0.01
Terpinolene day 7	Terpineol day 12	Positive	0.02	0.49
Terpinolene day 12	Terpineol day 12	Positive	0.12	<0.001
Total Terpenoids day 0	Terpineol day 12	Positive	0.13	<0.001

Table 11b:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
Total Terpenoids day 7	Terpineol day 12	Positive	0.01	0.76
Total Terpenoids day 12	Terpineol day 12	Positive	0.13	<0.001
Total Monoterpenes day 0	Terpineol day 12	Positive	0.13	<0.001
Total Monoterpenes day 7	Terpineol day 12	Positive	0.01	0.76
Total Monoterpenes day 12	Terpineol day 12	Positive	0.12	<0.001
Total Sesquiterpenes day 0	Terpineol day 12	Positive	0.14	<0.001
Total Sesquiterpenes day 7	Terpineol day 12	Positive	0.16	<0.001
Total Sesquiterpenes day 12	Terpineol day 12	Positive	0.42	<0.001
β -Pinene/ δ -3-Carene day 0	Terpineol day 12	Positive	0.12	<0.01
β -Pinene/ δ -3-Carene day 7	Terpineol day 12	Positive	0.12	<0.001
β -Pinene/ δ -3-Carene day 12	Terpineol day 12	Positive	0.16	<0.001
Terpinolene/Myrcene day 0	Terpineol day 12	Positive	0.01	0.86
Terpinolene/Myrcene day 7	Terpineol day 12	Positive	0.03	0.46
Terpinolene/Myrcene day 12	Terpineol day 12	Positive	0.02	0.60
Terpinolene day 7	Terpinolene day 0	Positive	0.29	<0.001
Terpinolene day 12	Terpinolene day 0	Positive	0.34	<0.001
Total Terpenoids day 0	Terpinolene day 0	Positive	0.69	<0.001
Total Terpenoids day 7	Terpinolene day 0	Positive	0.05	0.16
Total Terpenoids day 12	Terpinolene day 0	Positive	0.11	<0.01
Total Monoterpenes day 0	Terpinolene day 0	Positive	0.69	<0.001
Total Monoterpenes day 7	Terpinolene day 0	Positive	0.05	0.16
Total Monoterpenes day 12	Terpinolene day 0	Positive	0.11	<0.01
Total Sesquiterpenes day 0	Terpinolene day 0	Positive	0.42	<0.001
Total Sesquiterpenes day 7	Terpinolene day 0	Positive	0.09	0.01
Total Sesquiterpenes day 12	Terpinolene day 0	Positive	0.14	<0.001
β -Pinene/ δ -3-Carene day 0	Terpinolene day 0	Negative	-0.16	<0.001
β -Pinene/ δ -3-Carene day 7	Terpinolene day 0	Negative	-0.12	<0.001
β -Pinene/ δ -3-Carene day 12	Terpinolene day 0	Negative	-0.11	<0.01

Table 11b:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
Terpinolene/Myrcene day 0	Terpinolene day 0	Positive	0.59	<0.001
Terpinolene/Myrcene day 7	Terpinolene day 0	Positive	0.35	<0.001
Terpinolene/Myrcene day 12	Terpinolene day 0	Positive	0.39	<0.001
Terpinolene day 12	Terpinolene day 7	Positive	0.39	<0.001
Total Terpenoids day 0	Terpinolene day 7	Positive	0.11	<0.01
Total Terpenoids day 7	Terpinolene day 7	Positive	0.69	<0.001
Total Terpenoids day 12	Terpinolene day 7	Positive	0.13	<0.001
Total Monoterpenes day 0	Terpinolene day 7	Positive	0.11	<0.01
Total Monoterpenes day 7	Terpinolene day 7	Positive	0.69	<0.001
Total Monoterpenes day 12	Terpinolene day 7	Positive	0.13	<0.001
Total Sesquiterpenes day 0	Terpinolene day 7	Positive	0.08	0.02
Total Sesquiterpenes day 7	Terpinolene day 7	Positive	0.21	<0.001
Total Sesquiterpenes day 12	Terpinolene day 7	Positive	0.10	<0.01
β -Pinene/ δ -3-Carene day 0	Terpinolene day 7	Negative	-0.30	<0.001
β -Pinene/ δ -3-Carene day 7	Terpinolene day 7	Negative	-0.41	<0.001
β -Pinene/ δ -3-Carene day 12	Terpinolene day 7	Negative	-0.30	<0.001
Terpinolene/Myrcene day 0	Terpinolene day 7	Positive	0.28	<0.001
Terpinolene/Myrcene day 7	Terpinolene day 7	Positive	0.62	<0.001
Terpinolene/Myrcene day 12	Terpinolene day 7	Positive	0.41	<0.001
Total Terpenoids day 0	Terpinolene day 12	Positive	0.11	<0.01
Total Terpenoids day 7	Terpinolene day 12	Positive	0.09	0.01
Total Terpenoids day 12	Terpinolene day 12	Positive	0.73	<0.001
Total Monoterpenes day 0	Terpinolene day 12	Positive	0.11	<0.01
Total Monoterpenes day 7	Terpinolene day 12	Positive	0.09	0.01
Total Monoterpenes day 12	Terpinolene day 12	Positive	0.73	<0.001
Total Sesquiterpenes day 0	Terpinolene day 12	Positive	0.11	<0.01
Total Sesquiterpenes day 7	Terpinolene day 12	Positive	0.11	<0.01
Total Sesquiterpenes day 12	Terpinolene day 12	Positive	0.25	<0.001

Table 11b:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
β -Pinene/ δ -3-Carene day 0	Terpinolene day 12	Negative	-0.29	<0.001
β -Pinene/ δ -3-Carene day 7	Terpinolene day 12	Negative	-0.22	<0.001
β -Pinene/ δ -3-Carene day 12	Terpinolene day 12	Negative	-0.38	<0.001
Terpinolene/Myrcene day 0	Terpinolene day 12	Positive	0.35	<0.001
Terpinolene/Myrcene day 7	Terpinolene day 12	Positive	0.40	<0.001
Terpinolene/Myrcene day 12	Terpinolene day 12	Positive	0.66	<0.001
Total Terpenoids day 7	Total Terpenoids day 0	Positive	0.12	<0.001
Total Terpenoids day 12	Total Terpenoids day 0	Positive	0.14	<0.001
Total Monoterpenes day 0	Total Terpenoids day 0	Positive	1.00	<0.001
Total Monoterpenes day 7	Total Terpenoids day 0	Positive	0.12	<0.001
Total Monoterpenes day 12	Total Terpenoids day 0	Positive	0.14	<0.001
Total Sesquiterpenes day 0	Total Terpenoids day 0	Positive	0.56	<0.001
Total Sesquiterpenes day 7	Total Terpenoids day 0	Positive	0.11	<0.01
Total Sesquiterpenes day 12	Total Terpenoids day 0	Positive	0.17	<0.001
β -Pinene/ δ -3-Carene day 0	Total Terpenoids day 0	Positive	0.04	0.20
β -Pinene/ δ -3-Carene day 7	Total Terpenoids day 0	Positive	0.00	0.93
β -Pinene/ δ -3-Carene day 12	Total Terpenoids day 0	Positive	0.03	0.37
Terpinolene/Myrcene day 0	Total Terpenoids day 0	Negative	-0.02	0.50
Terpinolene/Myrcene day 7	Total Terpenoids day 0	Positive	0.02	0.56
Terpinolene/Myrcene day 12	Total Terpenoids day 0	Positive	0.00	0.97
Total Terpenoids day 12	Total Terpenoids day 7	Positive	0.18	<0.001
Total Monoterpenes day 0	Total Terpenoids day 7	Positive	0.07	0.03
Total Monoterpenes day 7	Total Terpenoids day 7	Positive	1.00	<0.001
Total Monoterpenes day 12	Total Terpenoids day 7	Positive	0.18	<0.001
Total Sesquiterpenes day 0	Total Terpenoids day 7	Positive	0.04	0.26
Total Sesquiterpenes day 7	Total Terpenoids day 7	Positive	0.25	<0.001
Total Sesquiterpenes day 12	Total Terpenoids day 7	Positive	0.04	0.29
β -Pinene/ δ -3-Carene day 0	Total Terpenoids day 7	Positive	0.04	0.27

Table 11b:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
β -Pinene/ δ -3-Carene day 7	Total Terpenoids day 7	Negative	-0.05	0.16
β -Pinene/ δ -3-Carene day 12	Total Terpenoids day 7	Positive	0.00	0.95
Terpinolene/Myrcene day 0	Total Terpenoids day 7	Negative	-0.05	0.16
Terpinolene/Myrcene day 7	Total Terpenoids day 7	Negative	-0.10	<0.01
Terpinolene/Myrcene day 12	Total Terpenoids day 7	Negative	-0.06	0.08
Total Monoterpenes day 0	Total Terpenoids day 12	Positive	0.14	<0.001
Total Monoterpenes day 7	Total Terpenoids day 12	Positive	0.18	<0.001
Total Monoterpenes day 12	Total Terpenoids day 12	Positive	1.00	<0.001
Total Sesquiterpenes day 0	Total Terpenoids day 12	Positive	0.06	0.10
Total Sesquiterpenes day 7	Total Terpenoids day 12	Positive	0.06	0.06
Total Sesquiterpenes day 12	Total Terpenoids day 12	Positive	0.22	<0.001
β -Pinene/ δ -3-Carene day 0	Total Terpenoids day 12	Negative	-0.04	0.26
β -Pinene/ δ -3-Carene day 7	Total Terpenoids day 12	Positive	0.01	0.81
β -Pinene/ δ -3-Carene day 12	Total Terpenoids day 12	Negative	-0.06	0.07
Terpinolene/Myrcene day 0	Total Terpenoids day 12	Positive	0.04	0.28
Terpinolene/Myrcene day 7	Total Terpenoids day 12	Negative	-0.03	0.39
Terpinolene/Myrcene day 12	Total Terpenoids day 12	Positive	0.00	0.97
Total Monoterpenes day 7	Total Monoterpenes day 0	Positive	0.12	<0.001
Total Monoterpenes day 12	Total Monoterpenes day 0	Positive	0.14	<0.001
Total Sesquiterpenes day 0	Total Monoterpenes day 0	Positive	0.56	<0.001
Total Sesquiterpenes day 7	Total Monoterpenes day 0	Positive	0.11	<0.01
Total Sesquiterpenes day 12	Total Monoterpenes day 0	Positive	0.16	<0.001
β -Pinene/ δ -3-Carene day 0	Total Monoterpenes day 0	Positive	0.04	0.20
β -Pinene/ δ -3-Carene day 7	Total Monoterpenes day 0	Positive	0.00	0.95
β -Pinene/ δ -3-Carene day 12	Total Monoterpenes day 0	Positive	0.03	0.36
Terpinolene/Myrcene day 0	Total Monoterpenes day 0	Negative	-0.02	0.50
Terpinolene/Myrcene day 7	Total Monoterpenes day 0	Positive	0.02	0.57
Terpinolene/Myrcene day 12	Total Monoterpenes day 0	Positive	0.00	0.99

Table 11b:

Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
Total Monoterpenes day 12	Total Monoterpenes day 7	Positive	0.18	<0.001
Total Sesquiterpenes day 0	Total Monoterpenes day 7	Positive	0.04	0.26
Total Sesquiterpenes day 7	Total Monoterpenes day 7	Positive	0.25	<0.001
Total Sesquiterpenes day 12	Total Monoterpenes day 7	Positive	0.04	0.29
β -Pinene/ δ -3-Carene day 0	Total Monoterpenes day 7	Positive	0.04	0.27
β -Pinene/ δ -3-Carene day 7	Total Monoterpenes day 7	Negative	-0.05	0.16
β -Pinene/ δ -3-Carene day 12	Total Monoterpenes day 7	Positive	0.00	0.95
Terpinolene/Myrcene day 0	Total Monoterpenes day 7	Negative	-0.05	0.16
Terpinolene/Myrcene day 7	Total Monoterpenes day 7	Negative	-0.10	<0.01
Terpinolene/Myrcene day 12	Total Monoterpenes day 7	Negative	-0.06	0.08
Total Sesquiterpenes day 0	Total Monoterpenes day 12	Positive	0.06	0.10
Total Sesquiterpenes day 7	Total Monoterpenes day 12	Positive	0.06	0.07
Total Sesquiterpenes day 12	Total Monoterpenes day 12	Positive	0.21	<0.001
β -Pinene/ δ -3-Carene day 0	Total Monoterpenes day 12	Negative	-0.04	0.25
β -Pinene/ δ -3-Carene day 7	Total Monoterpenes day 12	Positive	0.01	0.82
β -Pinene/ δ -3-Carene day 12	Total Monoterpenes day 12	Negative	-0.06	0.07
Terpinolene/Myrcene day 0	Total Monoterpenes day 12	Positive	0.04	0.28
Terpinolene/Myrcene day 7	Total Monoterpenes day 12	Negative	-0.03	0.39
Terpinolene/Myrcene day 12	Total Monoterpenes day 12	Positive	0.00	0.95
Total Sesquiterpenes day 7	Total Sesquiterpenes day 0	Positive	0.19	<0.001
Total Sesquiterpenes day 12	Total Sesquiterpenes day 0	Positive	0.23	<0.001
β -Pinene/ δ -3-Carene day 0	Total Sesquiterpenes day 0	Positive	0.00	0.93
β -Pinene/ δ -3-Carene day 7	Total Sesquiterpenes day 0	Negative	-0.08	0.02
β -Pinene/ δ -3-Carene day 12	Total Sesquiterpenes day 0	Negative	-0.04	0.28
Terpinolene/Myrcene day 0	Total Sesquiterpenes day 0	Positive	0.02	0.50
Terpinolene/Myrcene day 7	Total Sesquiterpenes day 0	Positive	0.05	0.12
Terpinolene/Myrcene day 12	Total Sesquiterpenes day 0	Positive	0.07	0.04
Total Sesquiterpenes day 12	Total Sesquiterpenes day 7	Positive	0.22	<0.001

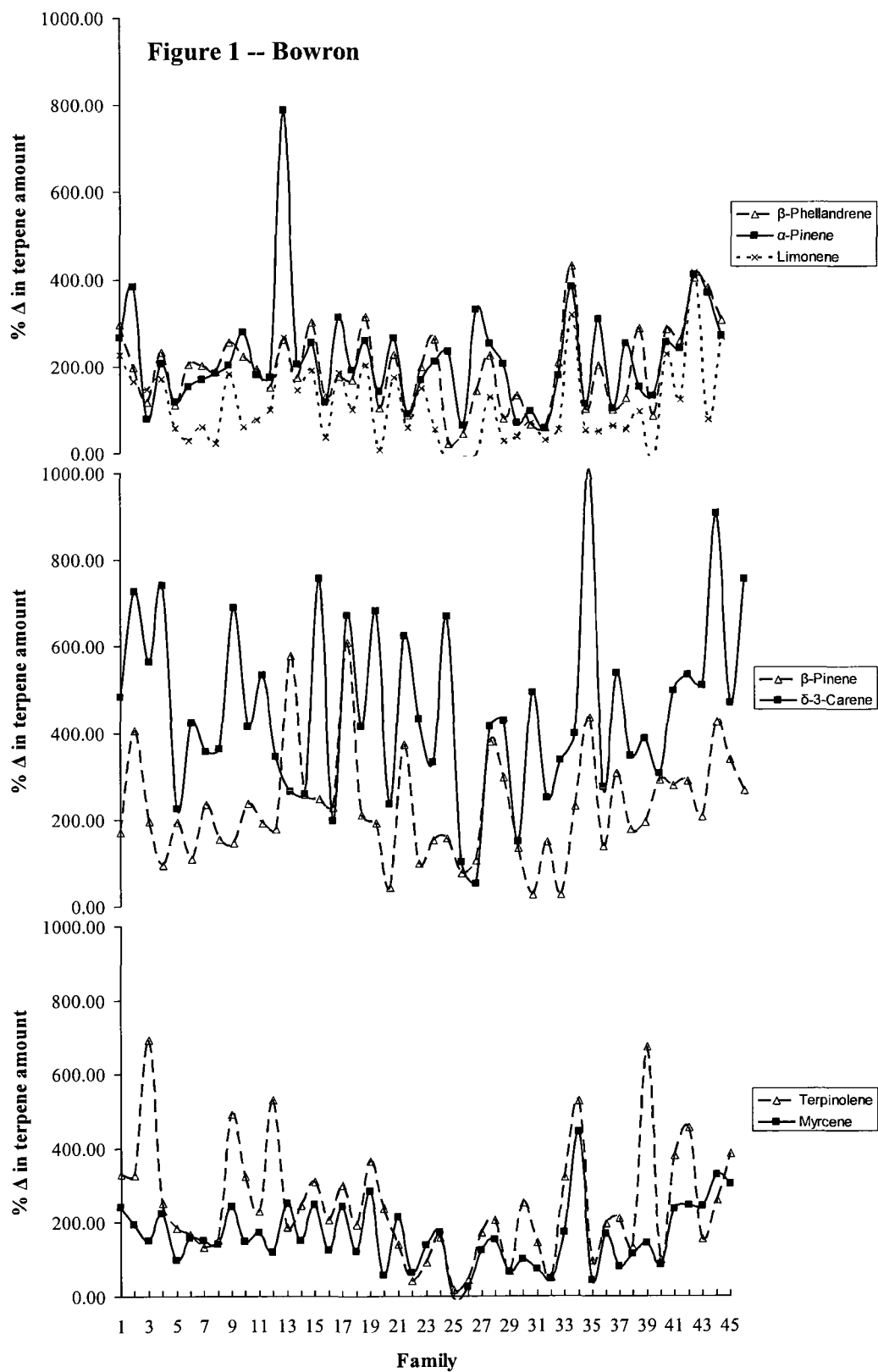
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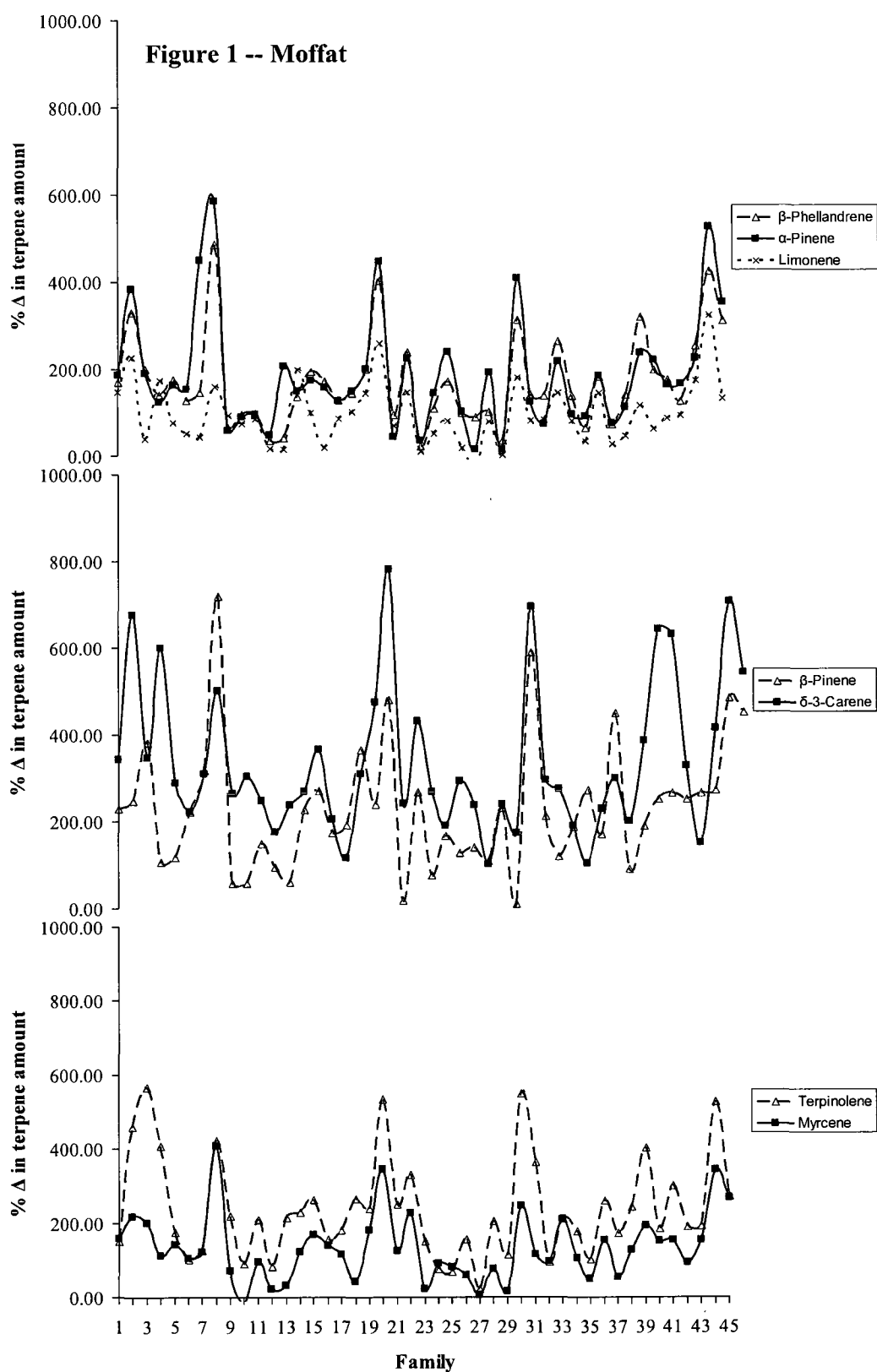
Variable X	Variable Y	Rel. (Pos/Neg)	r^2	$P>r$
β -Pinene/ δ -3-Carene day 0	Total Sesquiterpenes day 7	Positive	0.07	0.03
β -Pinene/ δ -3-Carene day 7	Total Sesquiterpenes day 7	Positive	0.03	0.40
β -Pinene/ δ -3-Carene day 12	Total Sesquiterpenes day 7	Positive	0.03	0.31
Terpinolene/Myrcene day 0	Total Sesquiterpenes day 7	Positive	0.02	0.55
Terpinolene/Myrcene day 7	Total Sesquiterpenes day 7	Negative	-0.03	0.44
Terpinolene/Myrcene day 12	Total Sesquiterpenes day 7	Positive	0.07	0.04
β -Pinene/ δ -3-Carene day 0	Total Sesquiterpenes day 12	Negative	-0.02	0.66
β -Pinene/ δ -3-Carene day 7	Total Sesquiterpenes day 12	Positive	-0.01	0.74
β -Pinene/ δ -3-Carene day 12	Total Sesquiterpenes day 12	Positive	0.03	0.40
Terpinolene/Myrcene day 0	Total Sesquiterpenes day 12	Positive	0.03	0.32
Terpinolene/Myrcene day 7	Total Sesquiterpenes day 12	Positive	0.09	0.01
Terpinolene/Myrcene day 12	Total Sesquiterpenes day 12	Positive	0.09	0.01
β -Pinene/ δ -3-Carene day 7	β -Pinene/ δ -3-Carene day 0	Positive	0.75	<0.001
β -Pinene/ δ -3-Carene day 12	β -Pinene/ δ -3-Carene day 0	Positive	0.78	<0.001
Terpinolene/Myrcene day 0	β -Pinene/ δ -3-Carene day 0	Negative	-0.20	<0.001
Terpinolene/Myrcene day 7	β -Pinene/ δ -3-Carene day 0	Negative	-0.38	<0.001
Terpinolene/Myrcene day 12	β -Pinene/ δ -3-Carene day 0	Negative	-0.31	<0.001
β -Pinene/ δ -3-Carene day 12	β -Pinene/ δ -3-Carene day 7	Positive	0.76	<0.001
Terpinolene/Myrcene day 0	β -Pinene/ δ -3-Carene day 7	Negative	-0.12	<0.001
Terpinolene/Myrcene day 7	β -Pinene/ δ -3-Carene day 7	Negative	-0.44	<0.001
Terpinolene/Myrcene day 12	β -Pinene/ δ -3-Carene day 7	Negative	-0.26	<0.001
Terpinolene/Myrcene day 0	β -Pinene/ δ -3-Carene day 12	Negative	-0.14	<0.001
Terpinolene/Myrcene day 7	β -Pinene/ δ -3-Carene day 12	Negative	-0.34	<0.001
Terpinolene/Myrcene day 12	β -Pinene/ δ -3-Carene day 12	Negative	-0.41	<0.001
Terpinolene/Myrcene day 7	Terpinolene/Myrcene day 0	Positive	0.47	<0.001
Terpinolene/Myrcene day 12	Terpinolene/Myrcene day 0	Positive	0.53	<0.001
Terpinolene/Myrcene day 12	Terpinolene/Myrcene day 7	Positive	0.63	<0.001

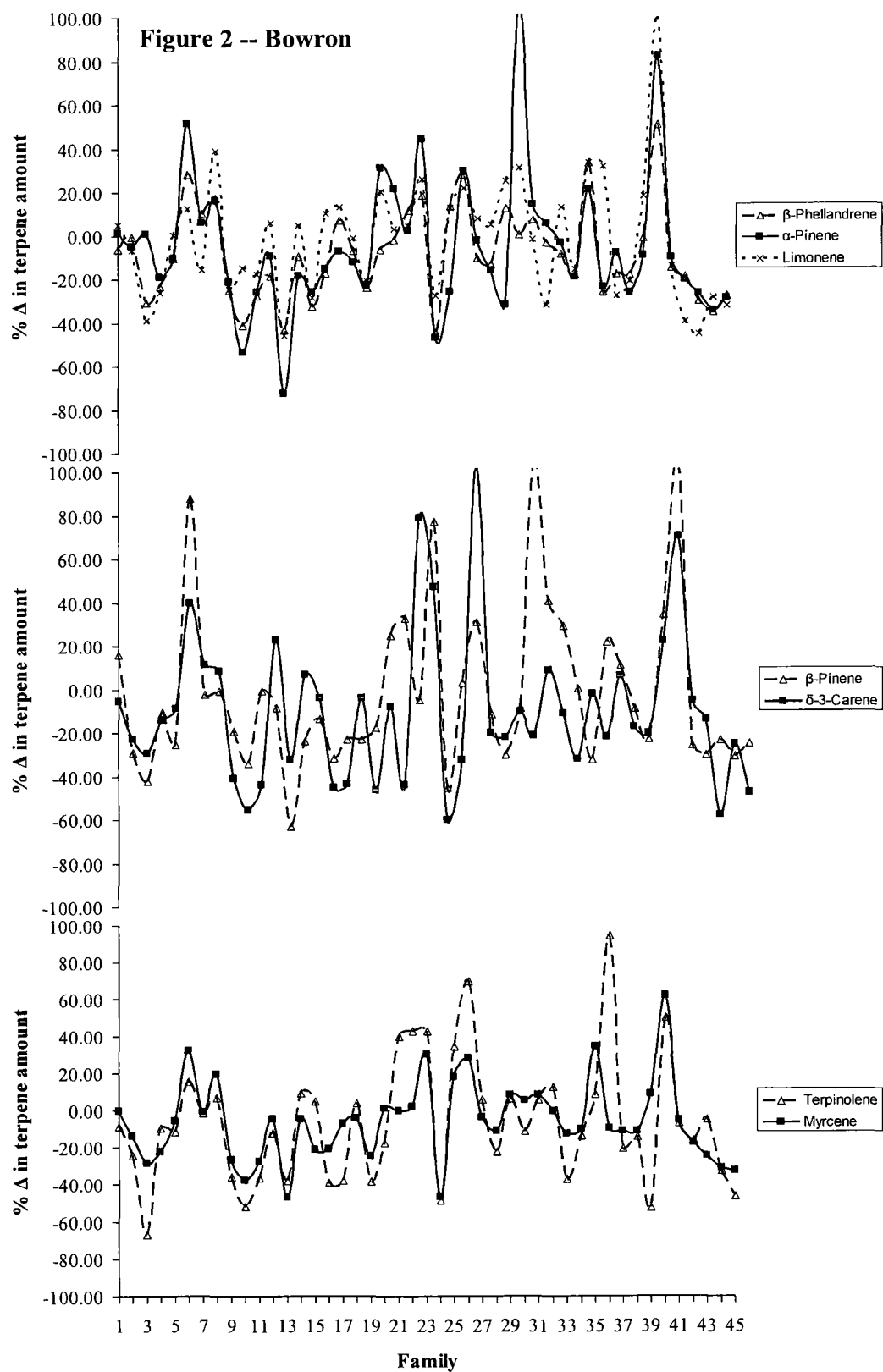
CHAPTER 2 FIGURES

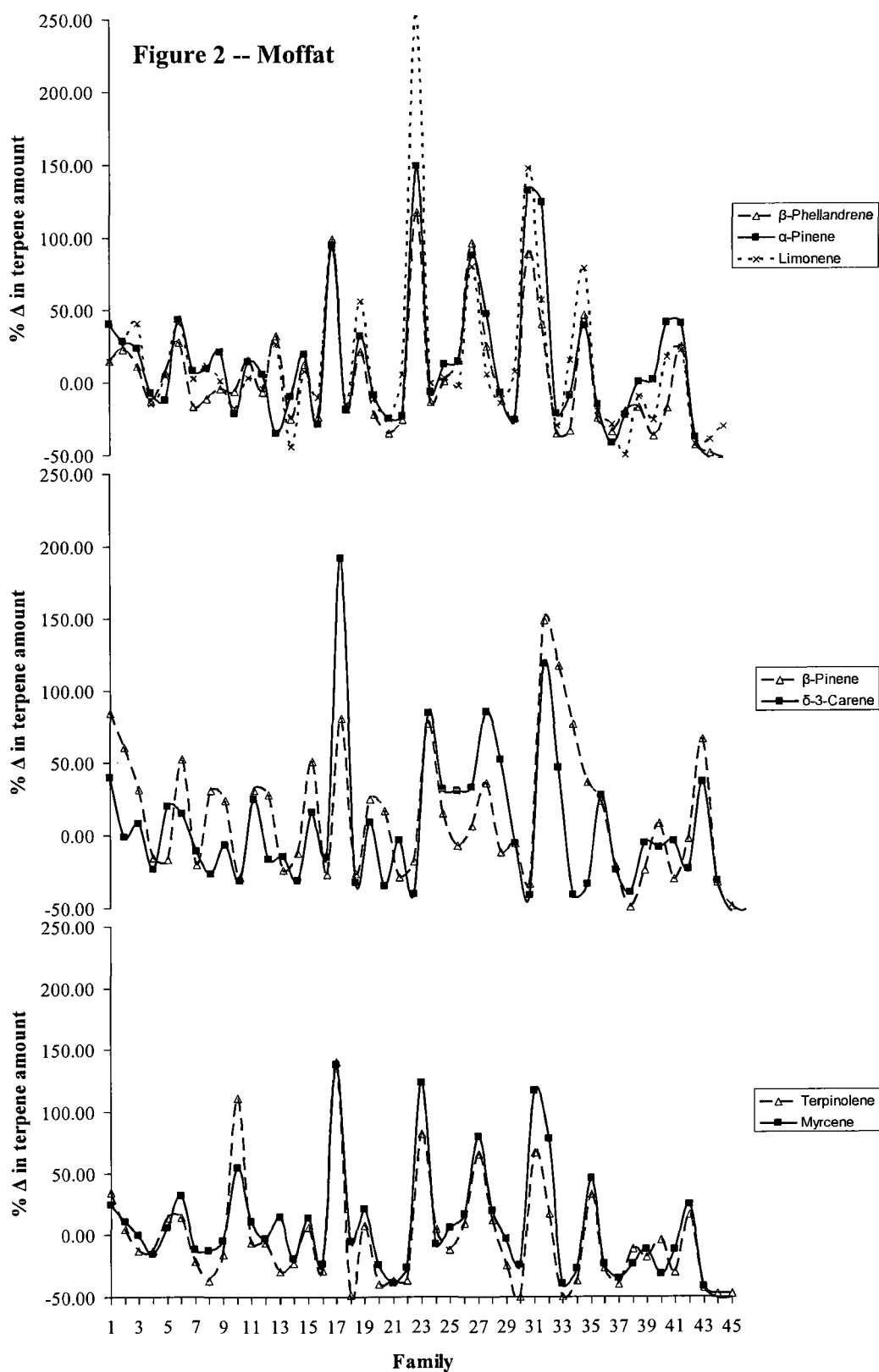
Figure 1 - Percent change of the seven most abundant terpenes within families is given for Bowron and Moffat from day 0 to day 7. Families are listed from north (1) to south (45) based on provenance origin.

Figure 2 - Percent change of the seven most abundant terpenes within families is given for Bowron and Moffat from day 7 to day 12. Families are listed from north (1) to south (45) based on provenance origin.



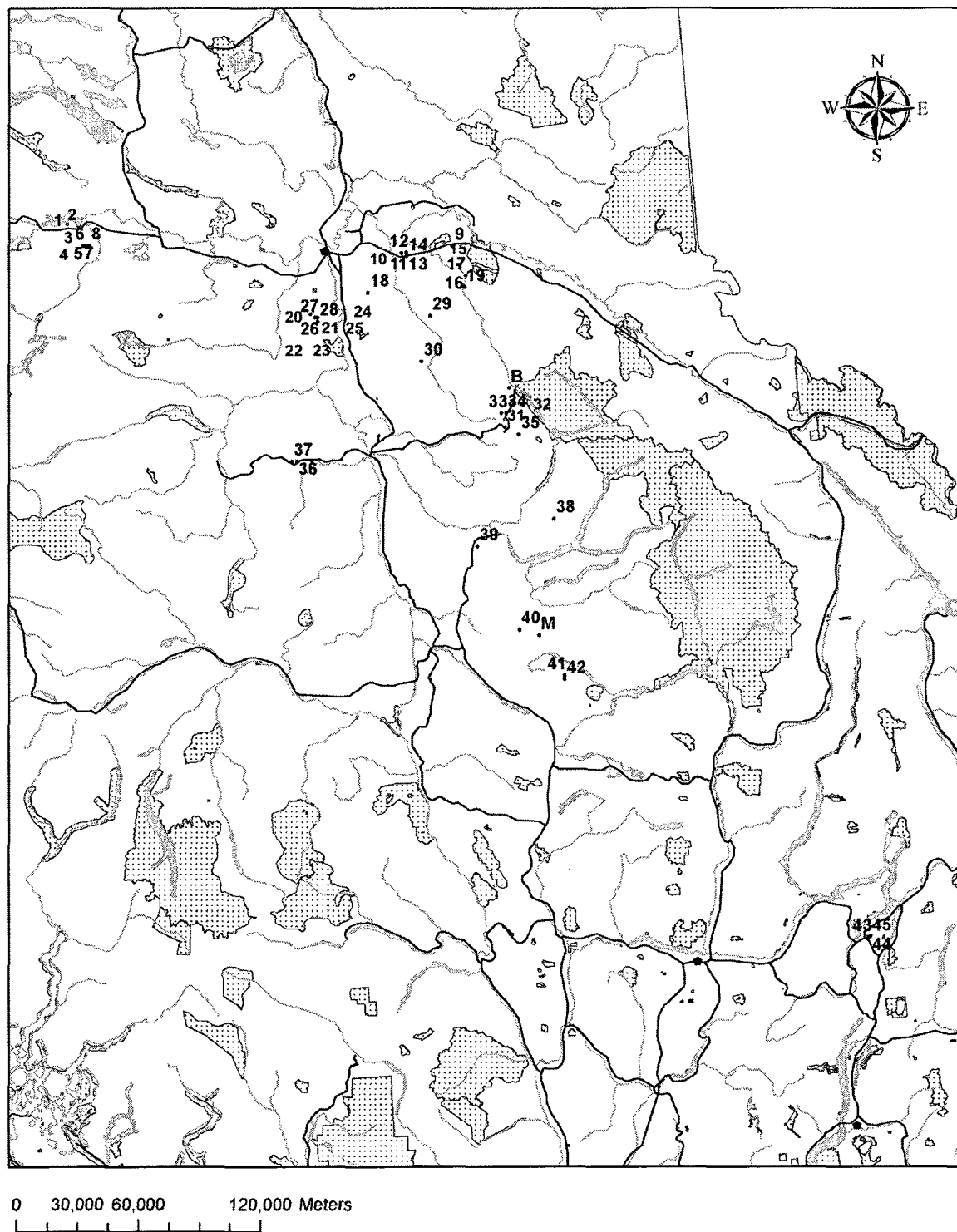






APPENDIX

Map 1 – Locations of where genetic material originated for each family from north to south latitudes. Sites B=Bowron, M=Moffat.



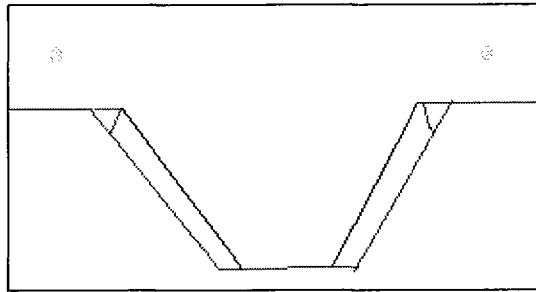


Diagram 1 - Funnel assembly used to collect resin from lodgepole pine. Circles=punched holes, Lines=cuts and bends.

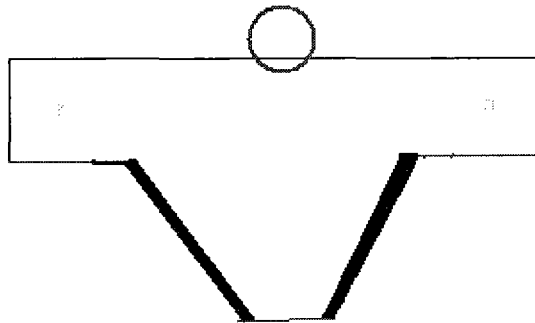


Diagram 2 - The cork borer positioning is represented by the open circle.

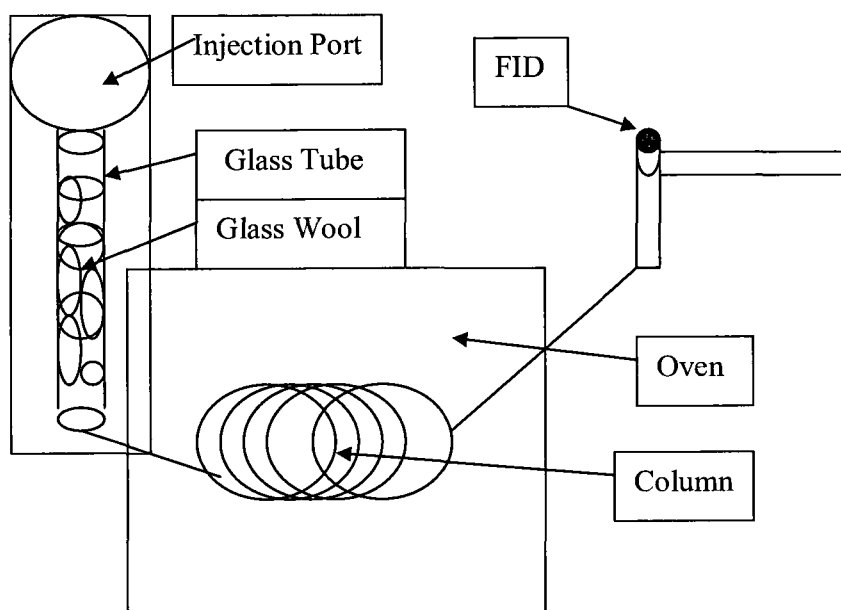


Diagram 3 - Gas chromatograph with FID.



Photo 1 - Inoculation and lesion.

Table I: Mean and standard error of resin (g), lesion length (cm) at 7 and 12 days, and host confinement rate (7/12) post inoculation with *G. clavigera* onto the phloem tissue of half-sibling families at Bowron and Moffat. Families are listed from north (1) to south (45) based on the provenance origin.

Family	Bowron										Moffat											
	N	Lesion								N	Lesion											
		Resin		7 days				12 days			7/12 days		Resin		7 days				12 days		7/12 days	
		x	se	x	se	x	se	x	se		x	se	x	se	x	se	x	se	x	se		
1	11 ^E or 12	7.24 ^E	0.01 ^E	4.53	0.63	4.03	0.25	1.20	0.19	7	7.33	0.02	2.26	0.23	4.71	0.45	0.52	0.11				
2	10	7.25	0.01	4.33	0.85	5.38	0.90	0.82	0.07	7	7.29	0.02	4.67	0.91	5.49	0.45	0.87	0.15				
3	8	7.25	0.02	3.94	0.58	4.15	0.73	1.06	0.19	8	7.28	0.02	3.18	0.41	4.70	0.67	0.73	0.08				
4	12	7.26	0.01	3.90	0.50	5.25	1.00	0.90	0.17	14	7.36	0.04	4.78	0.37	5.12	0.45	1.02	0.11				
5	12	7.17	0.09	3.25	0.37	4.21	0.68	0.82	0.05	13	7.29	0.01	3.75	0.36	4.25	0.27	0.90	0.08				
6	12	7.30	0.02	3.89	0.48	4.27	0.38	0.94	0.11	10	7.29	0.02	4.70	0.65	4.47	0.61	1.08	0.12				
7	14	7.25	0.01	3.40	0.24	4.19	0.50	0.96	0.13	8	7.32	0.04	3.09	0.38	3.53	0.18	0.90	0.12				
8	14 or 15 ^E	7.25	0.01	3.67	0.25	4.16 ^E	0.25 ^E	0.93	0.07	10	7.30	0.02	3.61	0.41	5.28	0.74	0.73	0.06				
9	7	7.27	0.01	4.67	0.57	4.14	0.46	1.18	0.15	13	7.28	0.01	4.43	0.64	5.67	0.72	0.80	0.10				
10	12	7.25	0.01	2.98	0.34	3.38	0.26	0.93	0.13	5	7.29	0.03	3.44	0.38	4.50	0.56	0.77	0.03				
11	9	7.27	0.02	4.69	0.41	4.56	0.43	1.07	0.09	10	7.30	0.01	4.31	0.77	5.01	0.58	0.84	0.08				
12	13 or 14 ^E	7.26 ^E	0.01 ^E	3.61 ^E	0.40 ^E	3.61	0.20	1.01	0.11	9	7.29	0.01	4.20	0.65	4.22	0.32	1.05	0.20				
13	9	7.26	0.02	4.57	1.02	4.39	0.59	1.06	0.15	7	7.27	0.01	4.10	0.39	5.69	0.57	0.76	0.10				
14	14	7.25	0.01	4.01	0.53	4.14	0.41	0.99	0.09	7	7.30	0.02	5.13	0.42	6.53	0.69	0.81	0.08				
15	8	7.26	0.02	3.45	0.31	4.78	0.55	0.78	0.11	12	7.29	0.01	4.78	0.51	5.48	0.54	0.94	0.13				

Table I: continued

Family	Bowron										Moffat									
	Lesion										Lesion									
	Resin					7 days					7 days					12 days				
	N	x	se	x	se	N	x	se	x	se	N	x	se	x	se	N	x	se	x	se
16	9	7.26	0.02	3.98	0.52	4.10	0.35	1.05	0.20		8	7.31	0.01	3.13	0.14	4.03	0.37	0.82	0.07	
17	10	7.27	0.02	3.30	0.44	3.56	0.45	1.08	0.24		6	7.27	0.02	3.55	0.83	4.92	0.51	0.74	0.17	
18	7	7.23	0.01	4.34	0.32	4.20	0.62	1.14	0.15		9	7.32	0.02	4.77	0.75	6.78	1.08	0.83	0.19	
19	14 or 16 ^E	7.26 ^E	0.01 ^E	4.21 ^E	0.39 ^E	4.01	0.39	1.20	0.12		11 or 12 ^E	7.28 ^E	0.01 ^E	4.28 ^E	0.54 ^E	5.11	0.61	0.90	0.11	
20	8	7.22	0.01	3.73	0.72	4.74	0.75	0.96	0.24		8	7.27	0.01	4.66	0.77	5.79	0.69	0.84	0.11	
21	13	7.25	0.01	4.05	0.51	4.63	0.54	0.93	0.10		10	7.29	0.02	4.34	0.79	4.97	0.50	0.88	0.13	
22	7	7.24	0.01	4.04	0.76	4.64	1.30	1.04	0.15		10	7.35	0.04	4.55	0.76	5.67	0.68	0.84	0.11	
23	9	7.30	0.03	5.38	1.04	4.93	0.77	1.12	0.15		7	7.39	0.08	3.59	0.42	4.70	0.39	0.75	0.04	
24	10	7.26	0.02	4.03	0.45	5.82	0.91	0.78	0.10		15	7.27	0.01	5.30	0.56	7.51	1.06	0.82	0.10	
25	12	7.26	0.02	3.40	0.37	3.78	0.27	0.94	0.11		12	7.31	0.04	3.24	0.32	4.05	0.44	0.83	0.06	
26	10	7.25	0.01	4.21	0.45	4.95	0.84	0.99	0.12		7	7.30	0.02	5.03	1.24	3.89	0.13	1.35	0.38	
27	12	7.25	0.01	3.88	0.50	4.23	0.43	0.91	0.06		8	7.30	0.03	3.79	0.86	4.73	0.91	0.87	0.16	
28	15	7.26	0.02	4.25	0.31	4.51	0.44	1.06	0.13		13	7.37	0.07	3.39	0.52	4.41	0.25	0.74	0.07	
29	10	7.24	0.01	3.92	0.59	5.40	0.84	0.79	0.11		7	7.30	0.02	3.74	0.76	4.99	0.74	0.86	0.26	
30	14 or 15 ^E	7.27 ^E	0.01 ^E	3.68 ^E	0.40 ^E	3.63	0.40	1.15	0.19		7	7.30	0.02	6.90	1.09	5.44	0.58	1.30	0.18	
31	8	7.25	0.01	3.18	0.43	3.73	0.43	0.85	0.07		8	7.28	0.01	5.04	0.86	4.31	0.54	1.38	0.38	

Table I: continued

Bowron															Moffat														
Family	N	Resin					Lesion					N	Resin					Lesion											
		x	se	x	se	x	se	x	se	x	se		x	se	x	se													
																	7/12 days												
32	9	7.25	0.01	3.63	0.50	3.43	0.22	1.03	0.08	9	7.34	0.03	3.03	0.46	4.49	0.62	0.71	0.08											
33	11	7.30	0.01	4.22	0.49	4.24	0.30	1.05	0.16	5	7.29	0.02	4.72	0.66	5.22	0.94	0.96	0.15											
34	9	7.27	0.02	2.84	0.36	4.34	0.42	0.67	0.05	8	7.29	0.01	4.71	0.88	6.20	1.13	0.85	0.13											
35	9	7.24	0.01	3.82	0.46	3.28	0.32	1.19	0.11	9	7.27	0.01	3.76	0.70	4.79	0.78	0.81	0.10											
36	10	7.26	0.01	5.33	1.00	5.77	0.98	1.08	0.20	13	7.30	0.02	5.08	0.68	5.99	0.47	0.87	0.11											
37	10 ^E or 11	7.29 ^E	0.01 ^E	3.38	0.25	3.75	0.22	0.94	0.09	6	7.31	0.03	3.58	0.36	7.68	2.31	0.69	0.20											
38	11	7.29	0.02	2.90	0.26	3.09	0.25	1.03	0.14	7	7.31	0.04	3.43	0.42	5.14	0.94	0.72	0.07											
39	13 ^E or 15	7.25 ^E	0.01 ^E	3.79	0.30	3.92	0.40	1.09	0.13	11	7.30	0.02	3.65	0.36	5.53	0.90	0.80	0.12											
40	7	7.35	0.08	3.19	0.32	3.43	0.23	0.93	0.07	11	7.30	0.02	3.81	0.49	4.37	0.42	0.90	0.10											
41	13	7.28	0.02	3.80	0.33	4.45	0.42	0.91	0.09	10 ^E or 11	7.33 ^E	0.02 ^E	3.44	0.26	5.07	0.56	0.73	0.07											
42	8	7.26	0.02	3.48	0.42	3.59	0.30	0.99	0.10	9	7.33	0.02	3.70	0.23	5.82	1.19	0.80	0.11											
43	10	7.30	0.03	4.47	0.52	7.12	0.81	0.69	0.08	6	7.42	0.15	2.98	0.36	4.57	0.42	0.67	0.08											
44	10 ^E or 11	7.27 ^E	0.02 ^E	3.67	0.39	4.23	0.32	0.88	0.07	5	7.26	0.02	3.08	0.31	5.86	1.05	0.56	0.05											
45	9	7.24	0.01	3.28	0.46	3.83	0.37	0.88	0.13	6 or 7 ^E	7.31 ^E	0.02 ^E	3.70	0.44	4.19 ^E	0.40 ^E	0.84	0.07											

Table II: Percent change ($\% \Delta = (\text{day/previous day} * 100) - 100$) and percent of total sesquiterpenes (% of total) in phloem tissue 0, 7, and 12 days following challenge inoculation with *G. clavigera* onto the phloem tissue of half-sibling families at Bowron and Moffat.

Day following inoculation												
Terpenoid	Bowron						Moffat					
	0		7		12		0		7		12	
	% Δ	% of total	% Δ	% of total	% Δ	% of total	% Δ	% of total	% Δ	% of total	% Δ	% of total
α-Caryophyllen	0.00	26.08	33.14	41.82	51.77	48.24	0.00	27.41	-3.79	41.69	43.81	37.44
α-Copaene	0.00	16.66	-27.95	14.46	41.31	15.53	0.00	19.69	-36.40	19.80	62.61	20.10
α-Cubebene	0.00	7.58	-21.17	7.19	10.09	6.02	0.00	10.59	-36.48	10.63	21.20	8.05
α-Humulene	0.00	49.68	-38.96	36.52	8.84	30.21	0.00	42.32	-58.33	27.88	97.62	34.41
Total Sesquiterpenes	0.00	100.00	-16.97	100.00	31.58	100.00	0.00	100.00	-36.75	100.00	60.13	100.00

bowron (n=466,474,475) moffat (=403,392,300)

Table III: Mean (*ppm/g*) and standard error (*se*) of terpenes extracted from phloem tissue 0, 7, and 12 days following challenge inoculation with *G. clavigera* onto the phloem tissue of half-sibling families at Bowron (*a*) and Moffat (*b*). Families are listed from north (1) to south (45) based on the provenance of origin.

Variable			β -Phellandrene		β -Pinene		δ -3-Carene		α -Pinene		Limonene	
Family #	Trial Day	<i>N</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>
1	0	11	7924.70	1580.61	1284.59	554.90	894.95	402.89	520.54	95.21	260.93	49.69
	7	12	31350.79	6095.31	3490.17	748.29	5202.25	1625.29	1902.27	289.85	853.49	134.44
	12	12	29343.57	4438.73	4039.66	1044.71	4908.01	1039.01	1918.47	237.47	893.63	126.47
2	0	10	8439.82	1214.05	1232.44	399.11	673.86	164.81	1782.20	617.50	294.98	33.95
	7	10	25073.11	4775.89	6228.36	2395.76	5569.66	1452.41	8608.15	3700.81	779.77	129.22
	12	10	24924.36	3799.68	4427.32	1036.63	4287.96	905.98	8147.54	3837.40	725.19	103.66
3	0	8	13782.42	3440.30	2186.66	544.92	1022.42	311.76	1329.28	376.74	464.51	84.20
	7	8	30038.09	6723.54	6450.96	2153.88	6794.32	1956.75	2354.98	446.71	1140.79	271.00
	12	8	20827.24	3908.43	3733.49	694.83	4802.92	1316.97	2367.43	946.01	698.51	99.80
4	0	12	13229.73	2714.44	2366.27	663.80	991.46	256.54	1273.17	260.88	509.95	109.03
	7	12	44062.32	13118.05	4622.79	1321.94	8331.15	3115.57	3904.04	1136.34	1380.69	454.71
	12	12	33842.98	6401.33	4138.78	899.09	7141.88	3469.71	3148.60	876.56	1021.42	184.85
5	0	11	13991.81	2298.65	1288.76	293.60	1891.85	610.01	810.14	114.38	589.49	125.88
	7	12	29413.10	4030.60	3785.79	886.18	6150.24	1684.37	1762.64	254.34	924.56	104.97
	12	12	26300.56	2899.63	2822.41	531.26	5614.92	1449.15	1577.94	178.69	925.07	122.95

Table IIIa: continued

Variable			β -Phellandrene		β -Pinene		δ -3-Carene		α -Pinene		Limonene	
Family #	Trial Day	<i>N</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>
6	0	11	8920.31	1395.22	1703.01	767.60	843.02	204.86	708.71	141.36	1152.76	568.96
	7	12	27071.22	5445.86	3548.44	796.64	4400.18	1183.06	1783.45	343.46	1485.36	450.39
	12	11	34668.20	8267.23	6675.99	1512.67	6159.11	1603.28	2697.15	507.51	1671.99	462.51
7	0	14	7542.03	1114.63	823.83	140.11	1163.36	311.57	603.73	80.99	1613.72	235.71
	7	14	22767.89	2564.93	2759.47	640.60	5306.37	1207.82	1624.92	205.61	2570.91	282.87
	12	14	25177.65	5389.80	2697.65	619.11	5904.48	1675.28	1721.57	332.64	2177.74	273.06
8	0	13	9828.93	1421.85	2687.15	811.06	694.98	111.50	791.14	165.76	1045.21	269.23
	7	14	28189.27	4446.59	6825.65	1869.11	3206.83	616.87	2242.21	391.30	1291.84	154.82
	12	15	33137.16	6103.49	6775.91	2016.58	3482.61	863.82	2604.65	498.06	1792.67	259.90
9	0	7	12376.91	1716.73	1366.73	256.57	1797.19	408.79	824.64	100.51	531.88	67.21
	7	7	43870.10	7619.26	3370.92	536.74	14192.47	2014.45	2481.46	341.68	1493.55	327.29
	12	7	32960.90	8051.56	2724.75	376.40	8387.53	1909.96	1958.40	373.13	1127.06	252.85
10	0	12	12982.17	1965.65	2593.86	456.43	1938.19	692.72	1348.72	346.27	1555.43	561.62
	7	12	41733.39	8127.85	8732.65	2053.66	9958.13	2636.95	5086.23	1611.08	2479.13	542.99
	12	12	24564.69	3372.66	5775.93	1384.71	4443.20	993.29	2379.73	343.28	2115.80	595.08
11	0	9	14079.28	1407.47	833.24	276.74	1694.20	657.09	883.80	109.92	2361.27	628.06
	7	9	41394.79	6162.54	2424.17	624.26	10724.24	3831.46	2463.55	373.48	4138.30	994.51
	12	9	30036.80	3892.42	2405.14	758.68	6024.77	1214.53	1830.64	243.46	3419.68	528.57

Table IIIa: continued

Variable Family #	Trial Day	N	β-Phellandrene			β-Pinene			δ-3-Carene			α-Pinene			Limonene		
			x	se		x	se		x	se		x	se		x	se	
12	0	14	11343.54	1758.82		1263.28	336.23		843.12	405.42		797.26	100.36		511.62	124.36	
	7	14	28316.48	3972.11		3498.45	862.90		3747.86	761.60		2180.75	284.71		1013.86	193.74	
	12	13	23167.94	5142.44		3201.99	707.77		4608.17	1772.31		1978.81	376.22		1073.50	383.69	
13	0	9	9962.85	2139.72		1312.31	432.61		1008.62	416.15		748.08	133.46		295.18	54.95	
	7	9	36002.13	13849.68		8888.91	4158.95		3671.39	1159.87		6630.71	4748.83		1075.83	411.16	
	12	9	20429.62	4595.22		3307.44	1124.15		2486.08	1163.97		1818.53	345.72		586.22	108.64	
14	0	12	14342.38	2055.87		1866.96	390.69		2928.08	905.37		981.66	154.80		521.03	76.45	
	7	14	39227.00	6049.42		6685.14	1691.63		10435.57	2472.80		2981.34	549.34		1272.64	202.47	
	12	14	35508.21	4262.40		5092.40	800.57		11141.62	3178.67		2437.21	296.82		1330.91	341.48	
15	0	8	10088.06	1814.68		1960.24	640.07		1035.94	233.65		905.35	192.67		358.17	46.63	
	7	8	40431.56	17651.87		6818.84	2221.63		8852.15	2536.01		3205.00	786.11		1037.07	367.95	
	12	8	27383.09	7913.31		5907.70	1863.75		8499.00	3763.06		2385.19	481.99		742.89	187.50	
16	0	9	13284.18	2951.54		2059.82	463.61		3339.56	1002.77		1186.60	229.57		2034.31	481.11	
	7	9	30330.15	4058.77		6740.24	2357.62		9838.51	2162.46		2543.81	493.58		2727.00	750.18	
	12	9	25082.18	5833.58		4627.58	1387.23		5383.77	961.96		2165.44	462.20		3018.34	867.03	
17	0	10	11845.41	2939.44		1214.93	351.35		1466.48	356.05		708.57	182.77		395.89	92.99	
	7	10	32547.17	7814.70		8605.91	3938.24		11314.38	3679.91		2903.66	790.96		1124.41	194.99	
	12	10	34911.23	10151.67		6638.35	1849.85		6398.25	1475.37		2698.50	717.03		1276.80	326.77	

Table IIIa: continued

Variable			β -Phellandrene		β -Pinene		δ -3-Carene		α -Pinene		Limonene	
Family #	Trial Day	<i>N</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>
18	0	7	18139.39	4136.45	1321.98	627.24	1873.35	405.63	1064.66	207.73	710.38	120.94
	7	7	48506.70	8300.31	4105.15	1354.83	9639.18	2840.59	3084.79	486.21	1409.61	175.87
	12	7	45201.30	9555.68	3162.57	663.31	9257.65	2914.56	2709.75	554.00	1397.20	343.41
19	0	15	10367.43	1336.79	1920.94	515.02	1274.13	415.36	731.71	97.81	399.21	64.95
	7	16	42729.28	7730.69	5591.10	989.10	9959.59	2607.69	2609.95	379.63	1204.56	189.03
	12	16	32583.03	5264.37	4611.36	961.83	5344.15	1263.49	2013.19	305.42	951.49	133.91
20	0	8	15824.12	2595.10	2402.38	659.17	1783.61	431.27	1543.95	443.85	1276.96	383.63
	7	8	32131.50	6968.89	3447.84	1086.11	5984.83	1445.52	3705.27	1805.24	1358.57	346.53
	12	8	30142.82	4901.05	4303.29	1299.33	5494.71	2298.05	4852.30	3096.93	1634.23	588.34
21	0	13	9026.89	1345.08	1580.97	299.73	691.90	171.63	662.19	111.36	318.00	36.72
	7	13	29502.57	5150.64	7469.64	1292.09	5010.19	1460.43	2406.49	331.12	869.38	116.40
	12	12	28898.50	7094.56	9919.98	3413.40	2820.00	669.66	2929.07	872.41	894.84	209.73
22	0	7	14184.67	2826.72	2726.48	885.13	529.34	145.61	1096.70	236.91	548.68	106.78
	7	7	26484.58	4243.76	5431.68	1780.18	2809.10	554.13	2069.12	418.94	862.20	162.53
	12	7	29575.05	6673.30	5169.30	1838.23	5030.12	1936.28	2112.07	522.41	901.20	197.61
23	0	9	12592.18	1657.32	438.79	90.37	1187.53	328.09	624.65	58.70	358.14	57.19
	7	8	37424.30	10509.25	1109.76	245.80	5113.10	1155.80	1669.07	380.74	891.34	223.21
	12	9	44449.24	11382.14	1969.12	520.84	7525.59	1404.97	2411.20	599.68	1125.42	244.21

Table IIIa: continued

Variable			β -Phellandrene		β -Pinene		δ -3-Carene		α -Pinene		Limonene	
Family #	Trial Day	<i>N</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>
24	0	10	13886.31	1513.56	2581.32	728.23	816.74	151.31	1167.74	133.51	1513.35	371.03
	7	10	50139.37	7697.67	6636.72	2669.85	6276.22	1382.50	3609.72	663.48	2336.71	734.57
	12	10	27930.24	3767.06	3652.54	900.38	2503.69	442.42	1913.02	238.78	1698.07	479.84
25	0	12	11515.63	4184.50	1807.86	488.85	1328.55	768.20	2209.51	589.93	1278.26	586.48
	7	12	13924.75	2939.32	3194.67	390.66	2658.82	786.22	7348.86	2235.79	913.93	234.07
	12	12	15871.27	3613.50	3297.36	668.69	1797.32	451.31	5443.75	1732.06	1032.81	321.27
26	0	10	11169.44	2390.92	1760.41	356.37	1849.02	510.47	820.41	178.91	2779.67	817.85
	7	10	16053.22	3605.08	3606.08	958.49	2796.08	746.72	1319.11	282.50	2485.15	743.06
	12	10	20605.68	4100.21	4724.94	907.61	5674.86	1363.60	1715.63	288.31	3029.65	789.09
27	0	12	10651.73	2801.93	1424.00	368.61	1363.10	369.55	1374.99	517.95	1024.15	591.44
	7	10	25814.08	4472.26	6828.26	1614.52	7013.87	1615.54	5906.08	2282.89	986.62	186.45
	12	11	23227.56	4516.23	6046.74	1828.27	5606.66	1012.11	5771.73	2468.12	1067.42	186.07
28	0	14	11564.79	1140.10	1030.45	293.67	915.40	244.50	648.71	79.49	497.54	70.47
	7	14	37442.42	7162.67	4079.98	1442.64	4807.52	1001.62	2281.63	470.52	1133.86	184.06
	12	15	32557.36	4494.66	2862.61	615.05	3748.63	778.11	1920.54	204.59	1190.89	270.14
29	0	10	16761.01	2661.46	1836.82	674.24	2000.79	608.98	1078.33	203.64	737.67	236.16
	7	10	29793.45	7651.31	4302.42	1447.48	4961.53	1270.01	3271.11	1346.16	932.57	189.15
	12	10	33612.27	5674.33	3941.05	1243.85	4463.49	687.29	2243.20	382.44	1168.92	240.98

Table IIIa: continued

Variable			β -Phellandrene		β -Pinene		δ -3-Carene		α -Pinene		Limonene	
Family #	Trial Day	<i>N</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>
30	0	15	11279.01	895.57	1665.27	583.06	1145.18	232.56	997.36	224.55	853.03	230.35
	7	15	26143.52	3703.72	2120.58	415.90	6772.31	2501.79	1684.55	249.00	1167.72	235.10
	12	14	26280.62	3158.04	4357.00	1704.41	5346.47	973.32	3488.19	1801.67	1535.41	475.95
31	0	8	14528.76	3279.71	2367.63	658.76	1239.70	342.21	972.64	218.88	466.70	84.86
	7	8	23881.33	6106.38	5868.82	1036.98	4324.38	569.27	1890.71	352.40	782.47	133.61
	12	8	25681.37	6132.26	8279.23	3806.87	4704.25	1308.36	2165.64	683.92	771.75	181.02
32	0	9	16222.78	1880.67	2225.24	864.83	1299.26	282.39	1096.92	167.62	1476.89	407.07
	7	9	25408.95	4010.51	2839.78	893.03	5648.95	805.33	1712.75	226.82	1898.28	787.58
	12	9	24601.71	3927.27	3679.45	1280.16	5021.17	1440.46	1805.20	261.23	1302.25	225.05
33	0	11	9021.12	1339.29	680.69	250.89	1464.35	360.80	642.47	123.83	833.21	243.47
	7	11	27786.22	3469.37	2248.16	503.42	7266.00	1429.77	1773.22	239.74	1277.47	253.86
	12	11	25553.34	5482.94	2258.24	963.08	4930.09	902.05	1717.19	380.12	1448.43	382.22
34	0	9	7021.74	929.07	942.37	358.43	917.04	131.45	505.83	97.70	265.26	50.21
	7	9	37221.90	4058.22	5027.42	2226.48	10164.38	1326.75	2433.83	422.81	1104.19	105.14
	12	8	30760.08	9368.63	3421.57	1702.62	9968.69	5629.33	1974.53	686.03	937.44	275.83
35	0	9	10661.71	1623.65	4109.23	890.86	1501.38	575.72	1152.15	180.51	479.55	93.57
	7	9	21374.31	2468.41	9778.76	2434.22	5625.34	1648.36	2442.52	425.43	723.65	62.21
	12	9	28676.99	5629.05	11944.95	3836.97	4397.34	961.70	2967.84	801.80	971.30	191.59

Table IIIa: continued

Variable Family #	Trial Day	N	β-Phellandrene			β-Pinene			δ-3-Carene			α-Pinene			Limonene		
			x	se		x	se		x	se		x	se		x	se	
36	0	10	9343.37	929.10		1745.62	626.14		1412.58	305.41		698.27	112.73		548.63	231.52	
	7	10	28268.92	5794.06		7096.33	1525.57		9002.28	2378.05		2836.44	605.63		818.47	135.09	
	12	10	21111.51	3124.74		7888.69	2171.41		9578.97	2393.52		2170.20	486.11		1084.37	491.02	
37	0	11	19773.91	2743.99		3236.90	467.03		2175.00	771.19		1407.23	221.06		907.56	337.82	
	7	11	39395.99	7226.78		8936.16	1383.92		9686.65	1573.31		2830.38	430.95		1461.29	454.05	
	12	11	32646.52	4749.80		8197.24	1817.88		8027.44	1259.72		2614.20	434.79		1064.02	141.54	
38	0	10	10633.28	2260.63		2697.48	565.43		1021.78	296.84		869.45	166.89		927.71	343.70	
	7	11	23989.86	4334.43		7915.87	1940.72		4958.69	1315.17		3055.31	791.12		1418.81	386.90	
	12	11	19767.28	5452.82		6143.38	1448.41		3973.38	1782.87		2263.20	519.50		1126.75	238.64	
39	0	14	7697.79	1165.59		788.64	229.52		1308.08	328.59		940.69	319.21		1152.88	321.13	
	7	15	29638.86	4279.83		3075.18	662.57		5299.77	988.46		2345.39	342.63		2240.04	442.31	
	12	15	29499.05	2707.97		4140.90	1094.83		6479.93	1154.03		2141.98	175.55		2657.63	476.77	
40	0	7	12354.19	2148.96		1928.92	389.69		466.96	209.84		865.23	113.53		848.84	256.85	
	7	6	22869.22	8359.92		7284.64	3180.67		2786.01	1640.99		1992.48	782.36		669.11	207.80	
	12	7	34610.50	6911.04		14915.83	5458.48		4752.43	1853.40		3641.77	987.79		1341.80	340.74	
41	0	12	10277.87	2427.80		817.17	199.78		1579.12	422.04		633.74	121.27		326.98	63.05	
	7	12	39411.19	6196.77		3168.51	900.51		9994.47	2116.18		2235.33	283.48		1065.54	126.69	
	12	13	33726.73	5905.69		2359.52	567.88		9475.22	2751.08		2019.07	326.66		920.73	137.64	

Table IIIa: continued

Variable			β -Phellandrene		β -Pinene		δ -3-Carene		α -Pinene		Limonene	
Family #	Trial Day	<i>N</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>
42	0	8	10248.42	2619.17	878.26	477.02	1770.86	486.81	616.35	155.06	630.06	337.45
	7	8	36507.95	7062.53	2688.79	950.78	10772.01	2319.04	2088.79	368.35	1390.62	380.32
	12	8	29760.28	7932.47	1882.22	856.50	9265.15	3115.29	1673.11	482.57	846.09	209.26
43	0	9	9192.90	2052.65	2116.90	530.74	345.74	90.89	732.60	128.67	358.41	61.39
	7	10	46120.65	9691.58	11077.37	4626.84	3473.95	1289.31	3714.01	917.54	1839.62	421.51
	12	10	32610.82	9164.67	8543.45	3911.67	1480.59	489.10	2738.73	837.60	1017.05	217.37
44	0	9	9147.53	1180.31	2052.19	606.45	522.12	186.40	702.88	130.02	714.52	205.71
	7	10	43862.97	7481.82	8982.52	2116.75	2965.46	699.57	3273.02	490.04	1254.07	190.59
	12	10	28685.06	3588.06	6247.20	1606.75	2227.24	507.12	2163.86	336.36	903.06	102.18
45	0	8	11758.04	1467.76	3311.82	959.55	827.33	171.58	1084.04	158.44	388.60	40.12
	7	9	47476.57	19571.90	12080.99	5574.89	7064.05	3910.96	3992.91	1775.28	1418.97	616.98
	12	9	34555.89	5750.80	9097.05	3126.49	3738.26	1022.38	2869.81	657.43	971.01	170.08
Variable			Myrcene		Terpinolene		α -Phellandrene		Borneol		Bornyl Acetate	
Family #	Trial Day	<i>N</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>
1	0	11	301.55	58.36	169.46	46.46	136.47	31.18	9.38	3.28	29.72	16.59
	7	12	1021.16	195.21	727.39	178.06	566.78	113.94	27.46	9.93	112.12	11.43
	12	12	1017.66	143.89	664.99	118.67	516.67	93.42	23.54	9.83	150.93	18.11

Table IIIa: continued

Variable Family #	Trial Day	N	Myrcene		Terpinolene		α -Phellandrene		Borneol		Bornyl Acetate	
			x	se	x	se	x	se	x	se	x	se
2	0	10	360.04	63.84	180.97	29.27	190.64	46.49	54.47	30.58	532.55	341.34
	7	10	1056.10	198.06	770.84	154.71	469.51	90.45	43.64	26.67	399.55	165.51
	12	10	906.00	149.74	585.59	111.11	427.09	81.57	69.70	40.74	343.40	114.26
3	0	8	453.58	103.88	264.88	54.80	233.72	66.92	16.37	4.96	145.47	43.83
	7	8	1130.95	209.19	2101.23	1217.74	556.49	128.42	10.20	5.72	140.70	22.26
	12	8	808.29	122.76	688.65	222.59	367.36	81.34	10.73	3.40	197.85	25.94
4	0	12	477.69	91.74	351.45	81.71	206.39	51.87	29.27	15.72	266.89	156.35
	7	12	1544.27	479.38	1233.95	450.74	792.01	234.03	25.23	9.17	327.03	108.59
	12	12	1202.58	270.60	1111.83	440.39	612.02	124.14	29.55	11.40	390.94	152.38
5	0	11	526.02	76.86	296.33	65.98	245.19	41.78	19.20	7.65	51.04	16.87
	7	12	1029.64	157.87	841.20	188.51	534.26	76.42	14.35	3.02	90.76	9.60
	12	12	971.69	116.66	741.38	168.97	457.28	60.96	17.81	5.21	154.96	31.15
6	0	11	368.59	63.42	403.89	91.84	142.55	27.01	12.69	5.28	76.24	36.93
	7	12	947.61	172.38	1077.25	360.89	487.84	102.67	9.75	2.30	114.87	18.94
	12	11	1250.72	259.94	1245.14	276.83	642.63	160.02	24.19	6.45	137.68	41.79
7	0	14	405.22	70.60	415.74	106.27	135.16	22.80	11.05	5.55	40.96	10.63
	7	14	1012.64	108.47	971.37	170.65	423.56	45.26	9.67	2.62	105.35	11.59
	12	14	1001.61	177.83	957.15	242.05	454.67	114.49	12.77	4.19	122.38	18.93

Table IIIa: continued

Variable			Myrcene		Terpinolene		α -Phellandrene		Borneol		Bornyl Acetate	
Family #	Trial Day	<i>N</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>
8	0	13	409.53	72.05	219.34	68.86	149.35	30.38	6.63	1.65	87.10	30.34
	7	14	985.59	145.18	552.64	82.35	514.64	82.92	8.28	2.02	129.34	23.48
	12	15	1175.94	187.98	591.14	117.60	615.92	128.68	8.47	1.77	189.88	28.73
9	0	7	518.74	44.98	304.52	39.09	228.83	42.35	26.37	10.94	96.68	30.84
	7	7	1773.79	269.37	1803.83	270.65	828.63	144.83	17.10	2.57	186.12	54.93
	12	7	1297.12	285.50	1157.73	279.19	622.63	157.30	19.87	9.21	220.15	36.73
10	0	12	650.52	104.89	309.00	81.01	215.99	43.09	21.04	5.93	302.80	204.84
	7	12	1605.12	240.55	1309.75	326.86	773.42	153.06	36.35	19.63	258.76	85.26
	12	12	994.34	98.34	628.83	115.16	442.80	68.34	19.01	6.08	508.68	297.79
11	0	9	588.93	56.48	423.02	128.63	262.04	27.10	20.61	10.99	165.38	52.22
	7	9	1602.79	306.30	1397.03	428.49	768.40	122.62	27.35	12.61	200.97	27.67
	12	9	1158.22	97.29	890.54	129.22	573.64	83.29	8.95	3.51	220.25	43.17
12	0	14	466.15	83.63	482.83	151.45	189.49	33.45	13.28	4.57	133.64	37.83
	7	14	1015.05	117.27	3044.44	1413.99	517.80	71.69	12.10	4.51	164.40	25.70
	12	13	966.16	215.89	2678.49	1301.55	423.06	111.47	13.65	3.72	145.14	23.08
13	0	9	366.37	73.47	240.41	64.32	183.99	40.23	4.00	0.00	150.70	58.62
	7	9	1276.28	498.49	686.65	204.88	671.13	263.53	26.62	8.35	268.58	100.73
	12	9	676.73	147.22	426.82	163.48	360.96	83.35	12.30	4.77	130.21	22.30

Table IIIa: continued

Variable			Myrcene		Terpinolene		α -Phellandrene		Borneol		Bornyl Acetate	
Family #	Trial Day	N	x	se	x	se	x	se	x	se	x	se
14	0	12	594.26	121.62	384.13	98.45	258.73	34.21	17.36	5.23	56.78	15.11
	7	14	1490.64	229.14	1326.65	281.81	743.80	116.63	14.50	4.34	103.13	20.23
	12	14	1420.41	213.71	1450.19	387.73	696.61	89.99	27.04	6.59	125.26	22.13
15	0	8	402.61	52.16	284.60	56.86	154.49	41.72	21.27	11.76	36.46	22.57
	7	8	1396.93	456.03	1164.10	273.13	729.81	305.18	49.71	19.91	113.66	21.14
	12	8	1098.92	303.81	1220.58	429.68	544.13	166.64	33.12	10.85	100.45	29.50
16	0	9	556.75	116.03	465.05	80.08	189.95	60.75	20.46	7.32	104.62	32.74
	7	9	1244.33	152.79	1427.64	201.05	555.25	69.49	5.37	1.13	147.16	18.27
	12	9	987.54	196.59	870.61	128.13	434.47	114.62	10.53	2.96	190.76	16.25
17	0	10	399.70	100.25	360.01	81.71	201.89	55.49	9.16	5.16	34.69	17.28
	7	10	1368.83	321.00	1438.02	413.81	602.83	146.48	11.95	4.68	158.89	23.59
	12	10	1271.48	306.87	894.53	196.38	647.05	217.05	31.05	11.56	151.89	22.93
18	0	7	929.99	184.31	442.70	61.43	315.16	76.94	20.74	7.68	46.06	15.33
	7	7	2055.05	242.30	1299.32	258.97	885.43	149.38	25.48	10.35	96.08	16.80
	12	7	1965.11	465.72	1351.67	355.26	893.97	196.14	43.08	14.44	133.50	22.79
19	0	15	386.88	50.90	271.45	43.98	170.32	30.75	8.76	2.65	40.12	14.76
	7	16	1482.92	254.38	1262.07	291.00	780.89	138.86	16.55	4.81	127.32	19.26
	12	16	1117.70	166.60	779.87	148.77	611.24	117.30	14.86	6.10	148.75	19.56

Table IIIa: continued

Variable			Myrcene		Terpinolene		α -Phellandrene		Borneol		Bornyl Acetate	
Family #	Trial Day	<i>N</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>
20	0	8	751.48	130.79	263.21	60.00	274.14	50.57	30.95	22.48	340.71	259.92
	7	8	1163.69	188.51	886.73	163.20	597.32	127.86	27.93	16.83	199.37	116.19
	12	8	1175.62	250.53	730.90	295.10	571.86	107.12	6.95	2.05	134.81	35.46
21	0	13	327.61	47.71	408.07	174.03	161.14	25.84	27.65	15.69	82.91	61.33
	7	13	1029.21	156.21	985.72	272.36	546.99	91.61	23.34	7.04	147.28	36.50
	12	12	1025.39	247.95	1379.34	880.85	510.70	128.49	18.87	8.56	321.65	150.63
22	0	7	631.17	154.73	433.15	102.00	217.95	58.79	16.40	10.23	110.90	45.55
	7	7	1032.21	251.47	612.12	139.28	467.32	73.58	11.43	4.45	179.62	63.62
	12	7	1050.62	220.32	874.38	259.49	543.70	137.62	37.54	21.44	169.88	22.28
23	0	9	472.68	65.69	371.33	99.78	201.34	40.50	11.98	5.42	29.78	12.48
	7	8	1122.93	269.53	710.24	135.17	659.52	181.82	13.10	5.38	99.99	16.31
	12	9	1460.25	318.45	1013.48	174.45	870.77	252.58	24.72	9.85	106.55	15.09
24	0	10	641.23	85.38	371.08	68.60	253.37	28.16	13.38	4.57	94.72	22.89
	7	10	1742.53	238.25	968.47	150.11	915.47	142.45	18.10	7.42	122.18	27.73
	12	10	934.42	122.64	497.18	66.30	509.25	72.94	24.69	7.96	150.05	41.69
25	0	12	648.72	165.58	436.85	103.79	221.37	95.76	70.39	35.43	855.86	459.77
	7	12	601.78	78.77	511.76	87.05	253.40	50.96	37.52	22.84	354.32	148.41
	12	12	709.67	107.88	687.81	191.68	270.94	74.28	85.12	46.73	596.72	227.98

Table IIIa: continued

Variable			Myrcene		Terpinolene		α -Phellandrene		Borneol		Bornyl Acetate	
Family #	Trial Day	<i>N</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>
26	0	10	568.41	117.79	305.66	54.64	184.00	46.43	9.41	5.41	39.29	14.31
	7	10	709.34	147.58	439.13	92.72	293.05	62.15	13.08	5.73	116.23	22.72
	12	10	907.62	158.30	745.50	166.03	341.40	82.09	24.32	12.84	141.10	35.35
27	0	12	497.61	122.35	392.64	60.51	189.98	49.60	59.20	30.68	665.46	504.96
	7	10	1109.95	131.29	1063.29	186.02	467.96	80.58	114.63	41.68	581.82	299.15
	12	11	1064.72	163.60	1127.22	182.00	424.50	86.87	146.72	65.56	924.23	489.27
28	0	14	498.65	100.52	224.16	56.60	189.72	25.66	5.07	1.07	55.81	22.09
	7	14	1255.07	214.70	684.93	131.75	685.44	132.65	11.60	4.37	108.51	22.01
	12	15	1114.97	138.75	532.93	83.06	602.92	94.17	11.88	2.84	163.30	28.24
29	0	10	621.22	104.03	469.67	91.87	295.92	49.54	10.41	3.80	16.40	6.77
	7	10	1032.06	232.72	788.41	174.80	555.33	143.24	20.98	14.14	161.38	79.09
	12	10	1115.77	159.62	839.13	70.22	630.11	119.64	29.63	10.29	99.31	20.09
30	0	15	485.27	38.67	243.34	46.21	202.44	13.68	14.48	7.18	90.38	39.27
	7	15	971.56	175.05	854.64	250.67	474.50	69.28	8.99	2.69	117.86	15.76
	12	14	1023.68	129.80	757.63	110.52	482.75	67.37	34.35	21.90	215.85	70.57
31	0	8	511.83	110.32	259.81	39.59	250.06	54.33	21.66	8.96	67.96	32.77
	7	8	886.24	156.28	637.22	64.62	441.64	106.65	20.68	8.92	164.48	33.21
	12	8	960.18	222.97	674.07	175.67	468.37	117.30	17.12	6.01	126.68	11.51

Table IIIa: continued

Variable			Myrcene		Terpinolene		α -Phellandrene		Borneol		Bornyl Acetate	
Family #	Trial Day	N	x	se	x	se	x	se	x	se	x	se
32	0	9	644.86	81.51	727.29	254.02	277.53	31.17	39.40	11.04	126.33	30.10
	7	9	949.16	127.48	1094.28	202.98	462.78	71.43	20.99	10.29	117.33	15.77
	12	9	946.25	125.20	1232.27	414.40	433.75	89.11	48.13	20.78	167.98	34.09
33	0	11	409.92	71.69	442.61	101.08	140.33	24.62	17.73	6.85	85.04	29.50
	7	11	1109.69	170.47	1869.34	633.67	518.33	65.74	18.05	5.35	123.68	20.61
	12	11	970.85	175.10	1176.32	349.29	455.80	109.09	14.46	4.43	161.57	23.51
34	0	9	241.87	43.09	231.84	46.07	108.09	25.06	4.23	0.23	25.03	11.35
	7	9	1314.82	128.26	1455.00	166.18	673.65	72.26	10.67	4.74	168.20	16.25
	12	8	1180.53	451.64	1259.81	638.87	551.29	176.44	14.85	5.40	158.78	54.01
35	0	9	685.42	92.21	488.94	43.20	182.33	33.68	14.34	6.80	38.27	11.03
	7	9	966.42	85.37	963.79	184.97	403.06	45.49	11.44	4.49	79.67	14.59
	12	9	1297.24	260.10	1050.26	315.20	519.38	118.18	23.98	7.64	173.24	41.19
36	0	10	429.52	34.83	378.72	171.58	170.76	12.35	4.00	0.00	47.78	16.64
	7	10	1143.11	201.32	1123.79	265.73	519.41	106.77	18.10	7.77	130.90	24.47
	12	10	1032.52	196.01	2186.97	1044.27	390.40	64.16	9.66	3.08	133.93	31.33
37	0	11	806.60	101.43	374.60	84.47	324.84	51.72	25.72	9.52	63.20	21.20
	7	11	1445.14	235.59	1163.52	198.44	696.09	127.61	8.48	2.98	131.45	31.94
	12	11	1284.56	173.76	923.54	117.64	585.48	100.52	11.58	4.13	172.92	31.66

Table IIIa: continued

Variable	Myrcene		Terpinolene		α -Phellandrene		Borneol		Bornyl Acetate	
Family #	Trial Day	<i>N</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>
38	0	10	421.61	95.75	352.64	84.09	175.55	43.70	13.56	4.41
	7	11	904.78	146.13	825.75	177.74	437.88	82.18	16.52	6.69
	12	11	802.08	206.29	708.08	273.20	360.99	118.26	39.40	21.27
39	0	14	491.66	62.89	206.60	42.16	126.25	21.85	24.14	10.24
	7	15	1193.97	119.77	1599.70	938.54	539.23	74.49	21.95	13.55
	12	15	1296.33	122.27	760.02	128.40	523.77	54.02	30.34	10.36
40	0	7	428.93	56.72	255.39	67.60	224.47	42.15	25.99	11.49
	7	6	787.52	270.63	510.31	178.04	413.49	150.19	16.94	6.16
	12	7	1277.39	237.18	768.96	191.17	678.25	149.17	10.80	2.96
41	0	12	448.92	98.31	278.78	60.48	160.40	47.31	21.24	8.72
	7	12	1499.79	224.25	1338.73	254.49	731.45	112.33	22.81	5.72
	12	13	1417.46	266.69	1250.13	336.32	641.22	131.72	32.87	11.71
42	0	8	391.04	80.55	251.18	44.81	189.55	47.04	4.00	0.00
	7	8	1342.97	222.43	1395.80	252.62	664.31	129.99	6.12	0.85
	12	8	1106.56	304.19	1174.26	372.48	563.90	179.75	9.20	3.14
43	0	9	454.87	96.48	776.64	284.17	160.51	34.40	9.09	3.70
	7	10	1561.34	288.86	1976.16	1127.82	865.12	180.80	16.60	9.68
	12	10	1173.56	260.26	1878.35	868.78	588.12	190.83	7.81	1.42

Table IIIa: continued

Variable			Myrcene		Terpinolene		α -Phellandrene		Borneol		Bornyl Acetate	
Family #	Trial Day	<i>N</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>
44	0	9	323.44	50.36	126.10	23.81	162.66	20.14	11.79	4.23	34.89	13.15
	7	10	1384.03	226.73	451.45	75.09	810.68	141.08	7.99	3.99	94.91	16.65
	12	10	952.18	109.89	304.32	71.93	505.55	78.64	13.68	5.67	187.11	28.98
45	0	8	435.83	60.91	223.56	50.26	227.57	20.25	43.45	18.99	52.09	19.26
	7	9	1758.81	814.26	1082.23	555.22	926.21	420.72	92.38	84.55	148.99	25.40
	12	9	1189.53	218.61	584.46	133.14	630.51	111.66	20.56	8.71	160.90	29.64

Variable			Camphene		Camphor		δ -2-Carene		p-Cymene		Linalool	
Family #	Trial Day	<i>N</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>
1	0	11	49.50	16.73	6.50	2.50	4.00	0.00	33.41	10.21	58.68	25.31
	7	12	224.58	36.74	42.90	6.79	4.00	0.00	73.79	12.37	92.98	14.30
	12	12	225.07	29.54	56.70	16.17	4.00	0.00	140.41	26.22	93.34	17.45
2	0	10	272.75	116.61	15.66	7.40	4.00	0.00	56.41	37.23	67.35	15.43
	7	10	340.75	94.78	45.35	7.20	4.00	0.00	55.68	10.12	112.56	21.70
	12	10	318.83	100.53	27.87	6.22	4.00	0.00	74.96	15.41	74.58	14.13
3	0	8	102.92	23.52	27.33	19.26	4.00	0.00	25.50	11.17	48.45	13.21
	7	8	221.56	43.96	35.83	11.35	4.00	0.00	82.35	11.30	68.37	14.33
	12	8	174.09	18.50	43.22	13.14	4.00	0.00	74.20	18.58	69.66	15.56

Table IIIa: continued

Variable Family #	Trial Day	N	Camphene		Camphor		δ -2-Carene		p-Cymene		Linalool	
			x	se	x	se	x	se	x	se	x	se
4	0	12	153.35	52.69	24.14	18.88	14.95	7.60	53.33	16.90	65.22	23.55
	7	12	367.25	105.15	69.49	26.09	4.00	0.00	119.08	63.94	168.26	65.72
	12	12	306.88	57.26	29.78	9.15	4.00	0.00	140.67	33.20	94.82	14.89
5	0	11	107.87	13.82	19.00	6.49	4.00	0.00	34.79	9.99	98.03	21.75
	7	12	207.81	26.44	50.04	11.14	4.00	0.00	77.35	11.40	110.10	16.09
	12	12	189.50	20.85	29.07	7.30	4.00	0.00	133.29	14.89	142.76	24.13
6	0	11	71.38	12.78	5.89	1.34	4.00	0.00	51.31	13.73	62.34	18.57
	7	12	186.64	33.60	29.70	7.22	4.00	0.00	48.88	11.28	99.99	13.71
	12	11	242.12	52.33	38.80	8.74	4.00	0.00	89.29	10.04	82.19	12.74
7	0	14	74.18	13.90	8.11	4.11	4.00	0.00	54.72	15.64	64.54	15.61
	7	14	183.64	16.66	42.37	7.98	4.00	0.00	71.39	11.50	150.54	18.71
	12	14	179.75	35.17	41.14	11.81	4.83	0.83	93.32	16.56	120.29	18.21
8	0	13	62.21	12.58	44.10	38.41	4.00	0.00	20.68	5.38	65.65	18.52
	7	14	219.99	31.38	36.66	5.83	4.00	0.00	60.01	8.77	115.95	28.54
	12	15	247.21	41.83	29.75	5.20	4.00	0.00	90.51	16.04	118.47	22.90
9	0	7	93.86	7.70	7.88	3.88	4.00	0.00	44.09	11.92	92.01	6.37
	7	7	310.63	42.73	58.53	11.57	4.00	0.00	112.77	10.99	168.34	50.84
	12	7	240.09	52.93	51.58	18.67	4.00	0.00	137.46	32.51	168.72	34.65

Table IIIa: continued

Variable Family #	Trial Day	N	Camphene		Camphor		δ -2-Carene		p-Cymene		Linalool	
			x	se	x	se	x	se	x	se	x	se
10	0	12	157.97	63.01	8.43	4.43	4.00	0.00	32.29	11.89	84.23	19.16
	7	12	354.58	55.11	63.56	11.73	4.00	0.00	92.19	7.42	125.36	15.60
	12	12	255.08	57.39	29.71	7.92	4.00	0.00	99.00	13.19	112.70	12.79
11	0	9	86.94	24.66	9.64	5.64	4.00	0.00	23.46	11.32	103.00	24.06
	7	9	300.81	45.71	46.81	11.33	4.00	0.00	76.53	23.15	95.78	21.96
	12	9	216.88	28.46	31.31	5.62	4.00	0.00	107.44	16.25	128.95	18.16
12	0	14	85.38	15.21	12.93	5.56	4.00	0.00	38.50	10.36	74.70	21.37
	7	14	209.07	23.90	39.00	7.84	4.00	0.00	77.44	11.63	103.42	14.73
	12	13	186.79	34.52	23.69	4.24	4.00	0.00	118.96	19.09	111.25	16.34
13	0	9	86.67	11.76	4.00	0.00	4.00	0.00	4.00	0.00	29.24	13.06
	7	9	341.44	154.89	54.22	23.43	4.00	0.00	78.97	38.37	92.29	29.37
	12	9	208.49	58.56	31.08	8.08	4.00	0.00	48.76	14.99	47.62	8.35
14	0	12	109.20	18.66	10.86	4.98	4.00	0.00	40.61	12.86	74.24	24.89
	7	14	294.59	42.66	43.44	9.72	5.22	1.22	86.93	11.55	110.80	17.29
	12	14	243.49	29.08	36.72	9.84	4.00	0.00	112.33	15.22	123.91	24.60
15	0	8	104.49	39.01	4.00	0.00	4.00	0.00	11.72	7.72	84.20	15.35
	7	8	310.22	95.01	51.44	10.07	4.00	0.00	72.95	22.97	95.59	22.69
	12	8	248.04	61.35	27.40	8.27	4.00	0.00	52.31	14.99	113.84	27.53

Table IIIa: continued

Variable Family #	Trial Day	N	Camphene		Camphor		δ -2-Carene		p-Cymene		Linalool	
			x	se	x	se	x	se	x	se	x	se
16	0	9	112.48	24.36	21.15	17.15	4.00	0.00	80.84	24.02	49.01	10.26
	7	9	232.52	29.94	54.70	11.97	4.00	0.00	89.82	7.30	123.78	24.19
	12	9	212.18	44.10	32.00	11.16	4.00	0.00	116.51	29.40	100.29	17.02
17	0	10	83.49	21.46	13.64	4.92	4.00	0.00	13.70	5.19	93.65	29.08
	7	10	244.08	58.64	51.62	9.97	4.00	0.00	84.64	12.91	140.86	17.00
	12	10	265.67	66.45	63.42	17.14	4.00	0.00	146.81	25.62	127.81	29.63
18	0	7	128.30	29.20	5.44	1.44	4.00	0.00	41.15	17.37	97.57	25.72
	7	7	335.12	57.91	36.15	6.99	4.00	0.00	91.83	11.68	139.28	39.97
	12	7	324.92	63.04	42.15	18.40	5.94	1.94	111.16	27.17	178.18	27.17
19	0	15	74.49	13.34	8.51	3.07	4.00	0.00	16.53	4.87	31.10	9.14
	7	16	296.34	45.00	41.26	8.62	20.56	16.56	63.46	12.34	105.52	19.31
	12	16	231.57	33.09	38.36	9.18	4.00	0.00	95.49	14.67	74.71	12.97
20	0	8	220.24	101.56	11.06	7.06	4.00	0.00	27.10	7.64	86.90	24.48
	7	8	284.47	66.07	54.95	11.58	4.00	0.00	47.68	15.18	111.11	14.87
	12	8	249.14	67.05	26.90	8.06	4.00	0.00	71.48	15.77	72.08	12.17
21	0	13	76.52	17.45	5.83	1.83	4.00	0.00	14.63	5.81	49.56	9.28
	7	13	234.82	32.06	43.94	9.17	4.00	0.00	58.19	10.53	83.50	14.01
	12	12	269.76	80.97	20.58	8.05	4.00	0.00	57.82	16.43	114.85	59.11

Table IIIa: continued

Variable Family #	Trial Day	N	Camphene		Camphor		δ -2-Carene		p-Cymene		Linalool	
			x	se	x	se	x	se	x	se	x	se
22	0	7	106.86	23.78	7.14	3.14	4.00	0.00	20.89	10.94	90.47	21.86
	7	7	198.25	30.99	31.66	8.36	4.00	0.00	61.44	13.57	127.88	27.08
	12	7	217.97	45.38	30.90	15.64	4.00	0.00	101.38	25.78	127.50	29.29
23	0	9	70.80	19.56	4.00	0.00	4.00	0.00	15.34	7.50	65.54	13.87
	7	8	234.67	60.27	54.42	8.88	4.00	0.00	60.26	12.31	117.26	22.38
	12	9	307.52	69.68	60.27	15.46	4.00	0.00	133.11	15.80	107.14	15.57
24	0	10	131.87	11.54	11.41	3.67	4.00	0.00	50.86	12.36	101.25	30.78
	7	10	345.89	52.18	28.47	6.50	4.00	0.00	85.93	11.06	113.07	25.26
	12	10	198.66	26.71	19.54	6.15	4.00	0.00	106.38	31.53	78.44	9.37
25	0	12	385.64	165.15	13.39	8.87	4.00	0.00	28.16	10.34	86.17	17.44
	7	12	220.90	45.38	21.00	5.06	4.00	0.00	36.98	7.82	95.74	16.87
	12	12	306.86	59.79	22.21	5.42	4.00	0.00	80.92	16.64	119.77	18.99
26	0	10	60.73	21.67	13.29	9.29	4.00	0.00	18.71	8.60	103.41	27.17
	7	10	139.89	31.10	18.47	5.72	4.00	0.00	62.75	16.71	136.00	30.34
	12	10	172.70	30.45	48.46	16.26	4.00	0.00	112.45	29.19	106.21	27.40
27	0	12	307.07	183.16	7.57	2.89	4.00	0.00	16.40	6.27	82.34	19.33
	7	10	388.30	95.10	46.99	5.06	4.00	0.00	66.58	11.38	143.08	22.31
	12	11	498.71	173.02	59.94	18.40	4.00	0.00	106.22	21.65	135.34	25.18

Table IIIa: continued

Variable Family #	Trial Day	N	Camphene		Camphor		δ -2-Carene		p-Cymene		Linalool	
			x	se	x	se	x	se	x	se	x	se
28	0	14	67.20	13.26	13.78	9.17	4.00	0.00	14.01	3.69	39.63	11.24
	7	14	265.26	51.61	56.07	9.09	4.00	0.00	76.14	13.33	85.39	20.86
	12	15	227.56	28.01	43.82	8.26	4.00	0.00	108.20	11.56	70.57	8.53
29	0	10	126.60	24.02	5.16	1.16	4.00	0.00	26.47	10.17	38.91	9.28
	7	10	274.94	69.72	33.72	9.22	4.00	0.00	66.57	14.23	74.45	17.41
	12	10	234.14	35.56	28.23	6.14	4.00	0.00	81.13	14.70	66.64	4.40
30	0	15	106.12	26.94	16.83	7.03	5.16	1.16	41.61	11.20	68.57	13.22
	7	15	191.96	22.85	49.34	7.78	4.00	0.00	53.22	11.39	75.08	11.23
	12	14	234.18	53.87	39.52	8.79	4.00	0.00	106.48	14.59	87.36	17.21
31	0	8	102.85	25.94	10.22	4.20	4.00	0.00	38.69	9.14	70.29	29.10
	7	8	227.87	37.48	49.46	19.27	4.00	0.00	94.13	44.15	128.11	27.66
	12	8	194.21	45.22	19.90	6.25	4.00	0.00	104.05	10.85	97.19	16.75
32	0	9	110.43	21.03	14.55	7.00	4.00	0.00	33.16	11.89	103.48	33.30
	7	9	182.38	22.49	21.24	5.75	4.00	0.00	45.29	8.38	79.90	15.28
	12	9	189.66	25.16	44.61	8.54	4.00	0.00	116.60	21.20	93.36	22.95
33	0	11	67.05	17.71	9.85	3.29	4.00	0.00	51.84	19.55	39.74	13.26
	7	11	198.69	22.71	35.86	7.50	4.00	0.00	62.21	10.99	100.62	17.10
	12	11	181.21	32.56	23.07	6.47	4.00	0.00	89.98	15.22	81.31	18.92

Table IIIa: continued

Variable Family #	Trial Day	N	Camphene		Camphor		δ -2-Carene		p-Cymene		Linalool	
			x	se	x	se	x	se	x	se	x	se
34	0	9	54.70	19.13	9.97	5.97	4.00	0.00	23.04	15.29	25.82	11.44
	7	9	267.34	28.37	59.17	7.90	4.00	0.00	76.95	11.71	151.97	48.99
	12	8	239.99	79.82	49.18	31.28	4.00	0.00	153.06	53.54	140.65	48.26
35	0	9	89.43	24.65	4.00	0.00	5.49	1.49	43.34	16.46	96.17	26.10
	7	9	187.56	16.83	20.59	4.94	4.80	0.80	46.58	6.45	90.24	8.30
	12	9	237.26	48.53	33.44	8.98	4.00	0.00	110.72	26.31	129.55	46.00
36	0	10	58.34	20.13	7.33	3.33	4.00	0.00	28.68	14.53	79.78	13.84
	7	10	219.95	36.42	33.10	7.64	4.00	0.00	71.85	12.19	109.94	18.81
	12	10	159.32	26.65	24.01	8.14	4.00	0.00	60.45	16.97	103.68	16.93
37	0	11	145.93	27.50	7.41	1.86	4.00	0.00	55.45	13.92	111.95	21.51
	7	11	271.23	46.52	40.80	11.66	4.00	0.00	74.59	18.08	104.70	15.57
	12	11	237.77	34.49	29.14	7.07	4.00	0.00	103.97	12.88	92.37	16.50
38	0	10	76.01	17.05	7.79	2.53	4.00	0.00	20.44	7.79	60.85	14.30
	7	11	216.13	35.15	29.02	7.49	4.00	0.00	58.19	10.09	85.23	12.20
	12	11	223.32	67.05	33.35	11.25	4.00	0.00	69.00	15.26	76.96	14.47
39	0	14	127.39	59.20	20.28	5.68	5.52	1.52	21.25	5.90	62.09	16.19
	7	15	256.22	28.94	44.69	7.44	4.00	0.00	78.79	9.25	100.11	13.02
	12	15	255.84	25.23	47.14	9.62	4.00	0.00	99.65	13.04	111.87	17.62

Table IIIa: continued

Variable Family #	Trial Day	N	Camphene		Camphor		δ -2-Carene		p-Cymene		Linalool	
			x	se	x	se	x	se	x	se	x	se
40	0	7	69.98	20.10	8.65	4.14	4.00	0.00	17.30	7.21	90.90	23.81
	7	6	183.21	58.41	23.42	8.44	4.00	0.00	33.50	13.45	85.10	28.25
	12	7	287.11	62.56	21.82	7.34	4.00	0.00	94.43	18.99	92.24	12.86
41	0	12	73.00	18.63	7.56	3.56	4.64	0.64	28.22	7.97	93.00	27.50
	7	12	272.88	30.83	54.98	9.19	4.00	0.00	95.69	10.08	97.05	12.77
	12	13	247.92	34.84	33.97	9.09	4.00	0.00	119.15	12.64	89.79	18.79
42	0	8	80.77	17.92	4.00	0.00	4.58	0.58	15.95	5.64	48.33	11.02
	7	8	261.77	43.90	51.05	14.14	4.45	0.45	91.10	21.87	126.42	20.05
	12	8	197.05	52.23	42.26	15.03	4.00	0.00	99.30	19.19	76.96	14.15
43	0	9	51.56	16.58	5.37	1.21	6.19	2.19	16.58	8.02	52.29	15.97
	7	10	323.65	78.32	90.38	26.95	4.00	0.00	79.44	23.25	203.34	87.93
	12	10	241.23	59.93	56.78	13.05	4.00	0.00	153.51	18.16	82.03	17.08
44	0	9	62.45	16.62	8.61	4.61	4.18	0.18	22.37	11.97	40.98	13.24
	7	10	325.96	52.86	47.43	11.06	4.00	0.00	77.72	12.07	90.59	12.12
	12	10	218.81	26.43	13.06	4.37	4.00	0.00	87.60	19.78	96.94	20.63
45	0	8	100.33	16.58	15.95	8.23	4.00	0.00	37.20	15.46	61.05	16.92
	7	9	375.42	161.49	56.61	20.93	4.00	0.00	86.17	29.02	120.51	28.48
	12	9	261.23	46.30	38.51	18.44	4.00	0.00	106.18	28.15	134.87	36.00

Table IIIa: continued

Variable	Ocimene			Sabinene			Pulegone			α -Terpinene			γ -Terpinene		
Family #	Trial Day	N	x	se	x	se	x	se	x	se	x	se	x	se	
1	0	11	80.36	30.61	121.98	32.66	10.53	3.56	7.48	2.66	7.55	2.51			
	7	12	81.03	30.55	719.35	167.40	75.99	15.21	28.60	9.64	63.12	17.59			
	12	12	116.24	32.25	633.17	102.68	100.16	27.31	11.58	5.23	24.32	8.59			
2	0	10	85.85	36.26	143.54	28.00	23.09	10.30	33.30	16.64	7.55	2.90			
	7	10	64.65	29.75	642.35	128.17	50.14	8.64	57.36	15.92	67.16	14.54			
	12	10	43.97	19.29	556.53	88.61	71.14	13.00	29.63	11.00	29.89	11.24			
3	0	8	37.56	22.53	150.98	42.78	15.66	7.57	4.27	0.17	13.62	4.81			
	7	8	29.21	14.09	2166.24	1487.78	134.55	49.39	71.60	20.83	106.03	27.99			
	12	8	31.61	14.72	451.18	98.19	115.26	41.65	11.39	4.84	22.02	9.47			
4	0	12	46.65	17.94	151.54	26.58	27.05	11.43	578.09	560.40	21.42	12.00			
	7	12	16.81	5.34	968.00	272.92	132.37	42.66	55.31	23.48	112.77	42.97			
	12	12	36.24	9.09	792.24	224.06	100.60	27.30	135.82	122.36	36.18	18.51			
5	0	11	81.57	37.80	162.51	33.15	62.81	26.76	4.00	0.00	13.40	5.52			
	7	12	26.15	15.93	652.92	111.40	65.70	18.38	37.00	7.22	72.10	18.78			
	12	12	60.98	19.70	554.73	86.65	152.16	65.46	13.61	4.91	37.32	12.78			
6	0	11	58.80	30.77	152.09	30.06	18.91	7.91	12.65	4.85	9.96	5.96			
	7	12	25.50	12.57	989.73	435.49	45.92	10.56	51.47	14.18	61.26	14.49			
	12	11	71.38	20.80	1161.52	426.54	62.98	13.59	53.36	17.66	53.24	13.72			

Table IIIa: continued

Variable Family #	Trial Day	N	Ocimene		Sabinene		Pulegone		α -Terpinene		γ -Terpinene	
			x	se	x	se	x	se	x	se	x	se
7	0	14	60.34	22.44	126.84	24.66	39.77	10.79	6.19	1.70	16.24	5.27
	7	14	61.37	20.96	536.52	64.36	70.65	14.62	49.21	13.23	66.85	13.59
	12	14	54.43	21.83	579.00	116.57	100.26	17.61	37.13	12.77	42.43	22.30
8	0	13	138.06	36.55	113.57	26.93	10.05	3.33	13.52	5.37	13.15	3.54
	7	14	73.94	30.58	595.48	96.88	64.47	19.29	52.28	21.04	34.12	8.49
	12	15	160.19	28.78	666.60	134.14	71.14	16.75	71.90	30.09	15.05	5.76
9	0	7	103.25	40.38	167.99	13.04	20.35	10.08	6.82	2.82	18.16	8.39
	7	7	101.99	39.49	1128.86	172.21	83.63	13.47	71.61	9.32	161.93	21.15
	12	7	178.74	78.37	718.99	169.80	86.17	16.39	13.23	4.11	68.71	15.35
10	0	12	200.66	108.76	208.24	40.09	15.55	6.63	11.82	4.99	15.21	6.72
	7	12	91.83	40.19	1001.88	167.99	108.81	27.38	142.15	51.43	126.97	26.88
	12	12	93.20	30.45	537.20	66.66	75.17	10.23	38.82	17.23	21.66	7.76
11	0	9	40.84	26.92	218.05	38.64	35.37	13.16	4.00	0.00	15.32	8.88
	7	9	17.78	13.78	1017.83	227.00	250.89	118.47	57.92	19.91	114.33	35.23
	12	9	29.75	14.36	663.50	79.08	135.94	18.11	16.96	4.55	39.29	10.09
12	0	14	108.66	34.44	591.37	235.79	38.73	9.03	10.79	3.15	27.73	9.37
	7	14	48.77	10.08	3827.12	1912.58	68.79	10.62	64.78	17.95	110.54	26.81
	12	13	112.84	33.60	3152.31	1583.09	75.53	13.91	61.59	23.64	78.67	37.06

Table IIIa: continued

Variable Family #	Trial Day	N	Ocimene		Sabinene		Pulegone		α -Terpinene		γ -Terpinene	
			x	se	x	se	x	se	x	se	x	se
13	0	9	41.45	16.85	140.28	25.50	29.16	23.74	7.82	2.75	19.18	8.49
	7	9	15.43	7.86	778.74	310.95	128.35	39.78	30.62	11.30	45.96	16.37
	12	9	36.38	16.39	400.47	103.34	44.96	11.43	13.10	6.07	16.16	8.51
14	0	12	10.37	6.37	216.89	37.85	21.10	9.71	24.95	11.21	33.38	8.89
	7	14	9.71	4.30	985.67	165.91	94.26	20.26	106.28	25.49	123.71	25.04
	12	14	13.97	5.10	845.96	135.86	88.73	17.58	89.88	32.29	98.93	31.72
15	0	8	10.82	6.82	191.29	20.87	32.53	17.39	6.42	2.42	12.71	5.90
	7	8	4.99	0.99	953.61	305.81	124.26	42.05	54.85	19.49	90.69	25.29
	12	8	35.23	16.39	742.70	229.68	70.29	17.55	36.70	13.50	73.23	34.70
16	0	9	9.95	5.95	200.73	46.04	25.57	10.92	107.80	90.17	35.44	15.21
	7	9	16.25	9.16	782.50	120.41	160.32	36.17	91.21	17.15	110.54	21.82
	12	9	12.47	6.05	515.89	104.47	96.46	22.78	44.20	17.57	27.26	12.78
17	0	10	25.79	10.79	150.82	41.92	11.52	5.55	13.89	6.91	20.32	8.42
	7	10	47.00	14.03	900.33	258.50	73.13	17.95	67.63	22.82	120.01	38.47
	12	10	44.48	19.83	761.93	199.36	71.19	34.87	19.87	8.12	35.47	11.38
18	0	7	82.07	35.01	250.30	30.16	141.35	128.06	12.59	5.82	31.35	10.51
	7	7	50.50	46.50	1090.82	159.16	82.41	21.17	70.14	13.76	121.75	19.51
	12	7	39.72	26.63	997.32	205.36	79.88	19.30	56.99	19.70	77.50	32.13

Table IIIa: continued

Variable Family #	Trial Day	N	Ocimene		Sabinene		Pulegone		α -Terpinene		γ -Terpinene	
			x	se	x	se	x	se	x	se	x	se
19	0	15	67.86	14.25	141.82	24.60	17.73	7.10	4.51	0.51	14.01	6.13
	7	16	33.41	12.34	994.92	190.56	105.65	22.81	47.26	13.32	102.76	26.68
	12	16	72.32	16.04	663.32	119.68	106.66	19.61	16.00	6.43	30.81	13.20
20	0	8	450.69	126.70	234.76	43.66	49.35	22.64	4.33	0.33	22.85	7.08
	7	8	122.48	41.66	736.07	139.22	111.75	38.71	24.02	7.50	78.02	14.10
	12	8	235.72	88.70	661.91	201.88	53.77	24.48	18.65	9.99	44.12	22.73
21	0	13	24.22	10.32	246.52	106.10	144.63	136.66	11.37	6.11	22.05	13.89
	7	13	6.32	1.88	950.00	267.77	75.48	10.83	47.85	10.39	65.81	17.40
	12	12	12.35	3.64	1708.51	1099.90	37.46	8.74	28.11	16.49	33.02	26.07
22	0	7	95.26	36.43	208.56	38.51	24.17	9.51	9.97	5.09	11.53	4.95
	7	7	39.98	20.54	513.25	70.61	118.97	28.60	68.25	20.01	43.52	13.45
	12	7	55.51	35.31	619.27	155.86	121.50	27.67	21.22	6.61	25.75	13.42
23	0	9	14.19	7.07	145.00	35.71	23.91	14.02	4.92	0.92	14.05	6.66
	7	8	5.76	1.76	697.81	170.93	66.07	8.82	35.80	6.82	67.64	15.66
	12	9	11.37	4.91	965.93	233.16	117.37	22.32	56.73	40.60	42.65	14.56
24	0	10	270.38	134.71	219.09	17.77	35.03	11.16	156.09	146.60	10.11	4.10
	7	10	154.15	107.15	1072.80	176.82	84.09	16.63	110.37	31.57	79.55	12.20
	12	10	79.76	29.66	513.31	72.07	68.24	12.05	32.17	10.90	18.30	5.47

Table IIIa: continued

Variable	Ocimene			Sabinene			Pulegone			α -Terpinene			γ -Terpinene		
	Family #	Trial Day	N	x	se	x	se	x	se	x	se	x	se	x	se
25	0	12	12	122.28	35.73	272.37	118.06	28.36	9.40	11.24	5.12	21.18	9.00		
	7	12	12	28.36	14.52	375.29	64.89	85.75	24.48	18.67	5.16	26.32	6.73		
	12	12	12	134.63	39.77	502.99	188.02	85.69	22.74	5.89	1.89	8.74	3.31		
26	0	10	10	69.94	36.18	197.13	42.90	26.53	12.62	101.25	93.60	8.99	3.39		
	7	10	10	39.04	15.78	366.35	75.95	89.94	23.59	15.60	5.41	35.07	10.11		
	12	10	10	34.56	13.77	535.90	106.70	136.84	40.38	15.58	4.69	35.27	12.80		
27	0	12	12	22.01	9.63	222.57	46.45	49.49	19.18	10.20	2.92	16.08	8.19		
	7	10	10	12.43	7.45	659.80	100.00	112.71	24.17	58.52	13.53	93.09	16.57		
	12	11	11	29.47	13.52	731.78	165.04	165.97	32.44	50.72	27.67	49.14	13.64		
28	0	14	14	49.69	13.33	160.89	49.78	107.59	96.13	11.69	4.92	18.24	7.09		
	7	14	14	13.42	5.31	797.30	151.02	70.49	18.95	64.80	18.43	72.56	13.65		
	12	15	15	58.66	15.02	622.62	89.28	60.37	15.76	15.52	4.43	12.58	4.67		
29	0	10	10	63.92	19.39	235.13	30.57	36.51	22.80	11.69	3.63	35.75	12.32		
	7	10	10	12.57	5.73	660.81	163.09	85.04	17.05	66.71	20.35	67.28	15.86		
	12	10	10	88.05	24.79	641.38	112.46	56.63	17.86	28.31	14.50	21.15	7.93		
30	0	15	15	92.25	39.98	168.79	17.77	25.68	8.05	6.67	2.21	13.38	4.92		
	7	15	15	82.77	51.80	623.10	138.50	98.21	20.20	33.24	10.23	75.60	23.07		
	12	14	14	59.83	25.04	559.99	69.08	87.65	14.09	26.03	16.09	27.27	9.75		

Table IIIa: continued

Variable Family #	Trial Day	N	Ocimene		Sabinene		Pulegone		α -Terpinene		γ -Terpinene	
			x	se	x	se	x	se	x	se	x	se
31	0	8	96.56	47.68	238.57	59.59	17.30	5.90	7.08	2.43	18.48	7.10
	7	8	48.49	33.81	574.31	102.05	118.42	70.26	14.50	5.42	48.59	11.23
	12	8	107.51	50.07	533.12	136.95	68.39	28.14	5.71	1.71	20.93	7.06
32	0	9	66.77	33.15	511.04	301.04	28.18	12.63	9.62	5.62	32.80	13.33
	7	9	19.34	9.50	764.27	156.92	85.84	26.97	50.20	12.02	80.25	11.21
	12	9	36.38	16.13	1004.27	445.36	93.12	27.59	27.25	10.11	58.32	27.85
33	0	11	42.75	19.99	268.78	138.78	22.27	15.45	156.19	147.19	19.92	8.78
	7	11	77.35	35.73	1734.86	791.55	47.73	6.11	66.49	18.37	113.40	27.03
	12	11	67.13	18.30	925.50	385.06	67.20	12.89	45.18	28.91	40.76	13.42
34	0	9	19.15	11.60	146.15	22.03	11.26	4.81	8.96	3.86	4.00	0.00
	7	9	24.28	11.24	876.08	84.61	67.23	18.52	56.33	13.57	119.65	17.35
	12	8	36.73	12.66	800.12	348.01	56.56	18.94	30.18	16.74	62.25	34.21
35	0	9	45.49	13.01	184.44	35.82	38.03	15.90	9.30	5.17	21.74	10.72
	7	9	21.36	6.42	549.52	77.65	224.25	137.01	44.55	10.49	72.70	15.94
	12	9	69.34	25.09	608.84	125.66	87.82	18.62	25.04	11.06	20.81	9.36
36	0	10	87.61	21.20	356.84	207.11	17.78	7.61	5.96	1.96	24.26	13.56
	7	10	65.35	21.47	730.63	145.71	53.19	11.26	46.51	17.02	102.95	25.27
	12	10	99.65	38.09	1927.72	1322.95	54.30	13.31	57.93	21.13	116.58	39.62

Table IIIa: continued

Variable Family #	Trial Day	N	Ocimene		Sabinene		Pulegone		α -Terpinene		γ -Terpinene	
			x	se	x	se	x	se	x	se	x	se
37	0	11	44.28	11.55	304.55	51.06	18.28	9.42	100.34	94.89	19.42	9.05
	7	11	17.36	6.19	883.35	143.74	37.66	7.11	67.42	18.15	106.69	19.59
	12	11	15.01	4.79	741.47	97.25	82.84	18.73	26.20	7.98	22.67	4.70
38	0	10	70.91	55.26	147.69	35.10	11.87	7.30	8.39	3.18	18.04	5.86
	7	11	22.61	10.00	561.70	106.13	62.98	12.18	81.86	28.55	60.65	15.51
	12	11	76.25	27.97	453.51	140.83	60.34	13.49	37.02	13.35	26.81	17.41
39	0	14	134.78	48.03	104.55	16.27	42.36	27.76	6.58	1.84	13.87	5.38
	7	15	133.67	35.82	1916.26	1259.52	105.52	14.83	50.21	11.06	80.17	18.55
	12	15	232.29	69.76	639.77	62.85	81.25	15.44	15.93	4.91	33.44	12.51
40	0	7	40.58	29.76	189.20	49.07	19.66	9.57	7.81	2.83	4.00	0.00
	7	6	47.11	43.11	502.89	202.51	83.18	6.92	17.56	11.05	28.06	17.85
	12	7	61.99	52.65	789.02	172.67	63.95	10.61	16.52	6.09	21.75	8.55
41	0	12	50.57	37.15	181.26	35.75	8.06	2.25	5.98	1.35	18.99	8.37
	7	12	25.59	10.00	1027.82	143.56	71.51	9.54	63.57	13.35	119.33	19.75
	12	13	48.67	16.05	913.67	170.23	104.99	14.01	30.76	16.06	55.07	24.20
42	0	8	26.77	12.05	188.29	42.68	23.59	17.99	5.82	1.64	13.55	6.33
	7	8	18.01	7.19	948.55	146.01	130.21	46.87	47.54	13.39	114.80	24.10
	12	8	36.56	21.43	750.72	210.73	62.43	13.19	38.95	18.88	63.55	28.80

Table IIIa: continued

Variable			Ocimene		Sabinene		Pulegone		α -Terpinene		γ -Terpinene	
Family #	Trial Day	<i>N</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>
43	0	9	166.53	51.26	551.60	273.89	16.80	9.90	27.23	11.91	33.74	20.03
	7	10	42.95	29.99	2453.91	1359.03	173.38	58.40	92.00	37.01	111.78	41.04
	12	10	148.00	50.90	2066.36	959.37	73.24	16.68	98.46	54.07	60.25	32.79
44	0	9	51.07	20.37	147.90	24.70	38.37	19.15	4.00	0.00	8.51	4.51
	7	10	41.59	19.37	899.49	161.12	85.33	19.38	39.28	6.58	49.65	9.73
	12	10	33.34	12.41	552.90	70.63	128.94	41.07	5.30	1.30	7.38	3.38
45	0	8	70.90	32.41	194.77	28.20	73.09	60.76	12.90	5.77	14.26	6.73
	7	9	108.69	53.00	1075.75	497.82	148.80	82.17	47.11	15.94	97.69	55.32
	12	9	132.96	37.64	730.98	137.61	60.68	18.20	17.14	7.30	17.41	7.95

Variable			Terpineol		α -Caryophyllen		α -Copaene		α -Cubebene		α -Humulene	
Family #	Trial Day	<i>N</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>
1	0	11	56.53	25.88	18.62	9.84	12.65	7.13	4.66	0.66	51.33	12.27
	7	12	50.24	18.18	54.39	11.44	18.64	4.79	6.22	2.22	61.37	21.75
	12	12	106.14	22.38	68.96	10.30	28.80	7.19	7.22	3.22	80.32	37.00
2	0	10	134.20	33.99	25.37	12.14	14.77	5.74	8.48	2.99	123.20	25.26
	7	10	42.10	17.46	27.25	6.37	7.19	2.24	15.73	7.34	36.75	13.35
	12	10	75.46	13.53	42.02	7.11	7.15	2.45	8.58	2.54	22.37	8.98

Table IIIa: continued

Variable Family #	Trial Day	N	Terpineol		α -Caryophyllen		α -Copaene		α -Cubebene		α -Humulene	
			x	se	x	se	x	se	x	se	x	se
3	0	8	55.58	14.75	51.67	16.44	7.85	3.38	4.00	0.00	38.24	9.74
	7	8	23.99	11.24	57.76	17.86	8.62	4.62	6.98	1.64	16.38	5.34
	12	8	64.65	16.88	57.65	13.67	4.00	0.00	4.00	0.00	26.98	10.14
4	0	12	176.91	80.11	30.78	9.88	42.87	12.83	23.56	19.56	66.58	24.05
	7	12	30.20	9.36	69.58	39.76	7.93	2.73	4.40	0.40	91.86	65.28
	12	12	110.06	29.33	72.60	19.83	26.97	9.75	6.84	2.84	33.25	8.45
5	0	11	94.64	25.08	26.05	9.61	35.18	14.56	9.65	2.95	68.51	17.49
	7	12	21.31	8.30	27.68	6.11	12.23	3.54	5.72	1.72	27.48	8.25
	12	12	118.17	27.06	49.96	11.94	24.52	8.02	9.35	3.51	59.83	21.41
6	0	11	78.20	20.36	48.79	24.61	13.46	4.82	8.26	2.72	64.23	15.08
	7	12	30.61	14.52	21.77	6.61	16.80	5.51	9.15	2.83	29.78	7.35
	12	11	104.08	16.51	67.70	17.41	20.21	5.65	6.19	2.05	33.82	12.59
7	0	14	87.44	31.00	26.59	8.58	20.46	7.92	7.06	2.81	37.42	10.54
	7	14	59.21	14.48	53.08	10.25	25.08	6.85	9.52	2.60	42.21	9.66
	12	14	58.72	13.11	32.43	8.72	11.60	3.19	4.91	0.67	25.24	10.29
8	0	13	113.62	36.74	18.66	5.47	20.45	4.94	7.77	2.10	26.31	6.52
	7	14	40.30	13.16	29.48	6.01	16.42	5.92	4.46	0.46	46.03	14.52
	12	15	136.46	17.56	63.88	9.56	28.86	5.75	4.60	0.60	41.43	7.12

Table IIIa: continued

Variable		Terpineol			α -Caryophyllen			α -Copaene			α -Cubebene			α -Humulene		
Family #	Trial Day	N	x	se	x	se	x	se	x	se	x	se	x	se	x	se
9	0	7	139.24	42.47	29.58	10.06	42.75	17.08	7.36	3.36	49.22	8.47				
	7	7	108.64	39.47	54.37	16.93	46.45	20.66	9.14	3.49	71.31	23.05				
	12	7	286.28	67.47	94.24	13.59	71.17	30.86	11.25	4.70	46.75	25.61				
10	0	12	105.99	33.90	48.40	15.47	16.46	9.43	7.96	2.76	53.30	15.74				
	7	12	84.66	33.66	74.57	11.78	22.66	8.81	7.03	1.68	35.64	9.70				
	12	12	114.54	24.49	79.65	12.90	17.34	7.21	4.00	0.00	49.10	13.60				
11	0	9	145.15	31.03	55.75	22.63	46.38	22.19	10.79	4.01	83.89	33.78				
	7	9	70.58	24.55	48.68	10.93	32.71	16.64	10.67	6.05	49.95	13.38				
	12	9	112.61	19.70	68.01	9.96	31.80	9.76	10.48	4.28	63.35	15.94				
12	0	14	87.66	22.71	44.77	12.04	14.74	5.39	26.77	10.49	39.37	10.17				
	7	14	32.99	8.13	76.50	29.18	15.66	4.73	8.10	2.13	40.45	13.03				
	12	13	80.95	14.32	130.31	45.81	16.73	5.09	19.57	8.39	71.90	17.84				
13	0	9	47.51	27.80	28.51	8.51	4.00	0.00	4.00	0.00	75.19	15.59				
	7	9	27.60	17.05	17.31	9.23	4.94	0.94	4.00	0.00	13.73	3.84				
	12	9	59.17	15.23	25.26	7.12	10.45	4.44	4.00	0.00	13.08	6.09				
14	0	12	110.71	23.78	49.07	13.90	25.42	9.78	8.41	2.83	63.10	12.25				
	7	14	39.14	9.76	49.16	10.30	11.97	3.42	9.79	2.85	25.92	6.61				
	12	14	117.62	30.02	66.64	9.92	26.51	9.14	4.54	0.54	27.63	11.17				

Table IIIa: continued

Variable Family #	Trial Day	N	Terpineol			α -Caryophyllen			α -Copaene			α -Cubebene			α -Humulene		
			x	se		x	se		x	se		x	se		x	se	
15	0	8	90.10	26.92		5.85	1.85		21.13	6.10		4.00	0.00		111.77	33.74	
	7	8	50.90	26.78		32.91	8.96		17.31	7.62		7.34	2.68		26.42	10.42	
	12	8	145.81	44.82		39.51	9.86		34.30	16.38		5.05	1.05		16.31	7.16	
16	0	9	138.11	24.18		37.07	8.70		28.54	13.01		8.21	4.21		104.62	22.75	
	7	9	20.86	4.01		51.94	9.09		4.90	0.90		5.75	1.61		11.68	5.08	
	12	9	113.08	15.98		78.57	12.16		12.00	4.31		4.68	0.68		17.64	8.01	
17	0	10	50.47	22.09		18.90	6.07		15.89	5.86		7.53	3.53		81.34	45.60	
	7	10	21.96	5.33		51.75	9.67		12.74	6.95		6.68	1.94		44.56	10.87	
	12	10	76.51	29.57		29.19	7.07		20.16	11.07		5.79	1.79		27.73	10.69	
18	0	7	102.57	36.65		39.97	7.85		16.29	8.25		16.18	6.20		103.54	29.28	
	7	7	53.44	25.59		56.11	8.18		17.13	13.13		13.41	6.81		22.33	8.64	
	12	7	92.06	18.92		71.33	9.10		21.45	5.76		4.00	0.00		50.44	14.09	
19	0	15	51.86	14.49		14.11	4.58		6.61	1.81		4.97	0.97		19.67	7.22	
	7	16	30.45	9.27		25.89	5.40		6.07	2.07		4.00	0.00		43.54	11.21	
	12	16	76.94	19.20		45.12	9.80		13.23	4.12		5.58	0.79		27.51	8.10	
20	0	8	127.29	29.30		43.03	16.28		20.04	6.73		6.35	2.35		52.44	22.68	
	7	8	18.78	9.66		37.23	9.07		14.09	4.76		4.00	0.00		18.89	6.62	
	12	8	62.99	22.63		58.01	15.25		19.85	6.15		10.95	5.22		19.57	6.29	

Table IIIa: continued

Variable Family #	Trial Day	N	Terpineol		α -Caryophyllen		α -Copaene		α -Cubebene		α -Humulene	
			x	se	x	se	x	se	x	se	x	se
21	0	13	74.33	22.24	30.60	18.85	9.94	4.12	5.45	1.04	36.33	9.14
	7	13	55.46	14.86	56.82	16.96	8.42	2.92	4.29	0.29	20.37	5.82
	12	12	71.38	18.69	60.05	27.50	11.09	4.34	13.14	6.96	46.44	24.33
22	0	7	152.86	45.88	23.41	10.10	29.04	13.08	4.00	0.00	43.39	14.10
	7	7	98.27	39.50	28.75	9.24	32.39	12.08	14.16	4.94	53.04	15.29
	12	7	143.70	32.34	60.78	22.13	20.88	11.60	8.45	3.53	21.68	7.26
23	0	9	69.06	32.10	7.94	3.56	12.34	8.34	7.88	3.88	51.06	11.55
	7	8	17.23	7.07	40.47	9.44	4.50	0.50	7.20	3.20	25.38	12.40
	12	9	66.41	23.92	50.44	4.52	19.29	7.76	4.25	0.25	24.30	9.42
24	0	10	140.06	32.71	53.03	11.39	39.04	11.07	8.48	3.57	92.06	25.15
	7	10	74.70	26.60	43.57	8.32	20.50	8.15	13.13	4.92	33.16	8.39
	12	10	121.05	21.64	62.92	6.43	23.41	7.45	5.22	1.22	62.79	17.79
25	0	12	141.31	27.89	43.41	10.13	33.76	8.66	17.46	5.21	39.91	10.86
	7	12	41.58	11.70	29.55	8.60	13.93	6.25	4.16	0.16	26.91	7.93
	12	12	126.94	38.05	77.73	27.15	37.53	11.71	14.49	6.43	60.66	14.30
26	0	10	87.30	42.32	25.27	10.71	22.54	11.98	4.83	0.83	34.86	12.77
	7	10	41.91	13.21	24.32	6.14	22.05	8.91	4.77	0.77	74.60	41.97
	12	10	121.60	36.94	48.17	10.10	12.12	5.41	4.00	0.00	37.45	19.44

Table IIIa: continued

Variable Family #	Trial Day	N	Terpineol			α -Caryophyllen			α -Copaene			α -Cubebene			α -Humulene		
			x	se		x	se		x	se		x	se		x	se	
27	0	12	77.16	20.81		39.04	12.93		21.35	7.21		8.98	3.79		60.99	11.75	
	7	10	73.71	14.42		43.15	9.03		18.89	5.61		6.12	2.12		40.23	6.76	
	12	11	105.90	21.05		92.21	31.78		32.79	5.59		5.06	0.59		32.12	11.32	
28	0	14	65.66	16.43		27.23	9.64		17.53	7.63		6.51	1.72		57.22	22.82	
	7	14	18.96	6.74		27.58	7.10		6.13	1.68		5.70	1.10		10.54	3.53	
	12	15	53.79	14.79		48.33	6.81		9.98	3.79		7.25	2.03		40.10	9.11	
29	0	10	69.55	31.18		48.65	17.76		15.42	8.50		6.23	1.58		60.80	18.70	
	7	10	38.14	18.09		44.09	13.26		11.66	7.66		10.07	4.38		19.11	7.28	
	12	10	132.75	25.26		68.14	13.01		28.37	10.92		10.03	3.87		40.68	9.76	
30	0	15	111.64	23.41		15.96	4.00		25.13	8.41		9.94	3.36		98.74	30.32	
	7	15	29.69	14.49		34.72	6.59		15.21	7.04		8.60	4.38		34.97	9.41	
	12	14	53.93	13.08		59.63	9.32		15.33	7.05		8.89	3.19		23.06	7.08	
31	0	8	63.88	25.69		27.18	8.00		13.38	4.67		5.22	1.22		47.46	16.07	
	7	8	56.12	37.59		42.26	28.26		5.67	1.67		4.00	0.00		17.89	5.37	
	12	8	137.82	35.12		60.83	14.39		27.06	9.30		10.20	6.20		47.22	15.91	
32	0	9	101.97	16.79		45.57	7.47		21.07	9.59		10.23	4.13		51.90	21.36	
	7	9	30.82	11.15		28.03	7.37		8.84	3.02		5.14	1.14		36.63	8.91	
	12	9	92.10	32.58		100.42	44.64		23.48	13.30		14.84	9.58		61.27	16.30	

Table IIIa: continued

Variable Family #	Trial Day	N	Terpineol		α -Caryophyllen		α -Copaene		α -Cubebene		α -Humulene	
			x	se	x	se	x	se	x	se	x	se
33	0	11	80.90	24.15	10.63	3.78	20.04	7.39	4.97	0.97	69.50	33.37
	7	11	42.37	18.67	36.15	7.49	24.15	12.67	10.44	3.94	27.37	8.68
	12	11	76.62	15.71	66.80	12.06	13.95	5.04	12.20	6.56	42.33	9.18
34	0	9	55.00	31.80	12.81	4.36	6.12	2.12	9.90	3.70	72.72	36.00
	7	9	25.09	17.24	20.84	7.43	10.16	6.16	6.84	2.84	34.54	19.44
	12	8	79.91	16.91	34.98	9.06	15.69	8.31	5.40	1.40	52.49	37.90
35	0	9	90.39	34.21	24.84	11.69	24.84	8.15	9.19	3.51	92.76	22.67
	7	9	35.55	10.53	25.93	7.43	16.13	5.59	4.60	0.60	34.14	13.81
	12	9	120.84	25.86	49.83	14.05	34.13	9.97	8.72	3.96	25.24	9.51
36	0	10	41.55	17.42	44.44	15.65	9.41	2.90	7.48	3.48	40.99	19.91
	7	10	44.49	14.61	32.18	10.56	9.09	2.65	5.44	0.88	38.95	14.82
	12	10	97.00	23.67	107.59	42.27	12.65	6.47	14.10	9.52	21.70	6.83
37	0	11	109.92	20.20	26.22	10.13	28.26	5.37	6.54	1.77	59.43	18.03
	7	11	14.73	3.64	18.46	3.83	8.11	1.75	4.00	0.00	17.80	4.39
	12	11	55.65	14.25	37.31	11.16	6.85	2.14	4.66	0.66	38.72	12.09
38	0	10	97.36	36.69	17.50	4.79	13.50	6.39	5.57	1.57	25.39	6.87
	7	11	26.07	7.76	24.88	5.58	10.94	3.15	4.92	0.92	26.74	8.64
	12	11	102.55	24.99	60.07	9.66	22.09	9.24	5.66	1.32	24.82	7.86

Table IIIa: continued

Variable Family #	Trial Day	N	Terpineol		α -Caryophyllen		α -Copaene		α -Cubebene		α -Humulene	
			x	se	x	se	x	se	x	se	x	se
39	0	14	84.64	18.92	32.24	8.95	11.10	3.82	5.45	1.45	35.98	7.96
	7	15	47.06	10.11	50.33	8.33	20.02	5.21	4.00	0.00	54.10	14.54
	12	15	71.61	19.56	57.79	8.10	20.57	6.57	5.74	1.74	43.91	9.23
40	0	7	86.25	29.74	21.52	10.25	26.18	16.40	23.35	19.35	53.73	13.09
	7	6	54.45	21.01	33.62	10.14	4.00	0.00	5.81	1.81	30.53	10.43
	12	7	89.95	27.27	34.98	7.76	4.00	0.00	4.00	0.00	52.21	19.88
41	0	12	54.27	17.68	32.74	11.55	24.60	10.35	4.00	0.00	27.54	9.00
	7	12	47.09	12.98	34.35	7.08	16.09	6.07	4.53	0.53	43.01	24.10
	12	13	74.23	23.36	51.17	8.67	16.63	6.00	5.71	1.71	19.61	6.38
42	0	8	25.88	14.27	16.57	5.84	7.52	3.36	4.00	0.00	74.18	18.41
	7	8	7.24	1.82	23.71	9.06	7.14	3.14	4.61	0.61	30.04	9.05
	12	8	56.77	20.81	46.97	7.91	8.36	2.86	5.25	1.25	22.13	5.96
43	0	9	117.21	35.06	60.12	24.06	11.24	5.53	20.40	8.19	15.26	5.65
	7	10	43.27	23.54	50.99	16.68	16.46	7.21	6.47	2.19	23.21	9.98
	12	10	81.06	24.86	123.84	85.97	19.62	5.80	16.19	10.36	58.04	15.18
44	0	9	44.24	21.20	20.41	7.46	8.80	3.67	11.14	7.14	60.56	24.99
	7	10	20.41	8.36	42.43	7.95	4.00	0.00	14.27	4.95	17.71	6.97
	12	10	44.44	15.39	23.76	8.61	8.96	3.80	5.53	1.53	43.78	9.70

Table IIIa: continued

Variable			Terpineol		α -Caryophyllen		α -Copaene		α -Cubebene		α -Humulene	
Family #	Trial Day	<i>N</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>
45	0	8	88.43	52.56	7.66	2.74	4.33	0.33	4.00	0.00	77.38	17.53
	7	9	59.49	35.58	65.25	38.48	4.00	0.00	6.27	1.57	52.92	25.32
	12	9	79.08	23.64	48.08	10.31	17.93	6.01	6.40	1.65	34.97	12.18
Variable			α -Thujone		Total Terpenoids		Total Monoterpenes		Total Sesquiterpenes			
Family #	Trial Day	<i>N</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>		
1	0	11	4.00	0.00	12060.06	2321.25	11972.80	2309.95	87.26	19.70		
	7	12	8.64	2.37	46859.72	8484.85	46719.10	8488.03	140.62	29.05		
	12	12	15.27	7.62	45188.83	5982.36	45003.53	5987.22	185.30	44.09		
2	0	10	4.00	0.00	14761.48	2054.18	14589.67	2052.97	171.82	29.63		
	7	10	30.84	11.17	50598.52	10779.39	50511.60	10776.37	86.92	15.05		
	12	10	8.74	3.45	46239.87	8532.78	46159.75	8531.88	80.12	12.51		
3	0	8	4.00	0.00	20490.94	3993.40	20389.17	3977.07	101.77	23.76		
	7	8	26.48	8.25	53778.64	9433.78	53688.91	9428.75	89.73	22.04		
	12	8	16.24	8.10	35672.63	5245.49	35580.01	5261.53	92.63	23.16		
4	0	12	4.00	0.00	21182.71	3964.69	21018.93	3934.41	163.78	53.52		
	7	12	23.45	14.86	68464.24	20029.10	68290.48	19927.79	173.76	104.16		
	12	12	10.07	3.49	54577.59	11913.19	54437.92	11903.21	139.66	35.86		

Table IIIa: continued

Variable			α -Thujone		Total Terpenoids		Total Monoterpenes		Total Sesquiterpenes	
Family #	Trial Day	<i>N</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>
5	0	11	7.37	2.60	20539.20	3030.56	20399.80	3022.30	139.40	27.50
	7	12	20.94	12.67	45965.08	6891.03	45891.96	6885.17	73.11	9.72
	12	12	11.53	5.41	41174.82	4797.23	41031.15	4804.11	143.67	29.79
6	0	11	4.00	0.00	14996.01	2462.21	14861.28	2445.43	134.73	33.25
	7	12	15.05	3.97	42592.23	7754.01	42514.72	7749.99	77.51	15.08
	12	11	5.96	1.33	57269.65	11617.09	57141.73	11626.50	127.93	28.94
7	0	14	4.00	0.00	13392.69	1897.67	13301.18	1882.18	91.52	22.18
	7	14	16.62	5.74	38994.40	3879.67	38864.50	3873.32	129.89	16.33
	12	14	13.58	3.87	41626.74	7764.56	41552.57	7759.75	74.18	14.69
8	0	13	4.00	0.00	16595.15	2582.35	16521.98	2569.35	73.18	14.11
	7	14	26.08	12.16	45365.94	6900.33	45269.55	6896.32	96.39	22.78
	12	15	10.17	3.16	52134.58	8920.71	51995.81	8919.45	138.78	17.22
9	0	7	4.00	0.00	18903.08	1936.12	18774.17	1921.49	128.91	28.78
	7	7	14.01	5.78	72524.17	10494.72	72342.91	10496.85	181.27	57.76
	12	7	4.80	0.80	52658.31	11492.08	52434.91	11493.75	223.40	50.09
10	0	12	4.00	0.00	22892.24	3088.44	22766.11	3062.62	126.13	33.85
	7	12	12.37	4.17	74321.20	10928.94	74181.30	10926.52	139.90	21.60
	12	12	18.80	7.22	43422.98	4926.69	43272.89	4928.76	150.09	18.67

Table IIIa: continued

Variable			α -Thujone		Total Terpenoids		Total Monoterpenes		Total Sesquiterpenes	
Family #	Trial Day	<i>N</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>
11	0	9	16.15	12.15	22210.50	2123.64	22013.70	2084.85	196.80	58.77
	7	9	13.26	6.13	67350.13	11485.87	67208.12	11471.48	142.01	33.55
	12	9	21.76	9.47	48250.68	4548.57	48077.04	4541.70	173.64	18.09
12	0	14	4.00	0.00	17254.33	2564.69	17128.68	2548.02	125.65	24.75
	7	14	16.05	3.93	48253.86	5920.02	48113.15	5908.90	140.70	35.17
	12	13	21.15	8.27	42523.16	9272.39	42284.66	9242.77	238.51	57.89
13	0	9	4.00	0.00	14801.54	2938.69	14689.83	2935.43	111.70	17.39
	7	9	43.46	32.96	60879.28	24858.27	60839.30	24858.04	39.98	10.84
	12	9	7.33	3.33	31205.24	7093.76	31152.45	7094.48	52.79	9.46
14	0	12	4.00	0.00	22757.70	3217.99	22611.69	3202.17	146.00	27.51
	7	14	16.51	5.93	66293.50	10472.71	66196.66	10464.55	96.84	11.03
	12	14	12.00	5.45	61142.72	7573.62	61017.40	7563.03	125.32	25.03
15	0	8	4.00	0.00	15946.20	2657.50	15803.45	2629.90	142.75	38.38
	7	8	28.90	7.72	65725.19	21501.22	65641.22	21502.15	83.98	22.26
	12	8	6.66	2.66	49566.46	12931.42	49471.29	12928.89	95.17	26.45
16	0	9	6.90	2.90	24211.74	4740.80	24033.30	4718.92	178.45	33.27
	7	9	21.75	9.69	57342.00	8307.48	57267.73	8306.26	74.27	5.13
	12	9	12.13	5.35	44170.58	8767.56	44057.68	8759.30	112.89	14.80

Table IIIa: continued

Variable			α -Thujone		Total Terpenoids		Total Monoterpenes		Total Sesquiterpenes	
Family #	Trial Day	<i>N</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>
17	0	10	4.63	0.63	17246.29	3946.29	17122.63	3946.88	123.66	49.43
	7	10	16.40	5.47	61963.42	14952.58	61847.70	14957.91	115.72	21.99
	12	10	23.79	6.91	56642.93	13784.73	56560.06	13789.80	82.87	24.07
18	0	7	4.00	0.00	25941.08	4826.96	25765.10	4811.66	175.98	23.02
	7	7	27.17	7.63	73318.39	9475.94	73209.41	9454.96	108.98	27.42
	12	7	27.70	13.45	68296.55	13309.29	68149.33	13308.22	147.22	21.43
19	0	15	5.01	1.01	16053.71	1972.18	16008.35	1967.38	45.36	9.42
	7	16	10.59	2.83	67695.92	11444.02	67616.42	11441.12	79.49	11.74
	12	16	20.50	6.47	49697.75	7634.46	49606.31	7625.31	91.45	17.15
20	0	8	7.15	3.15	25859.10	3970.39	25737.24	3942.28	121.86	39.30
	7	8	25.70	7.44	51196.28	8407.93	51122.07	8409.92	74.21	17.73
	12	8	10.32	4.14	50666.95	10944.33	50558.56	10951.40	108.38	25.41
21	0	13	4.00	0.00	14047.32	1948.70	13965.00	1932.28	82.32	21.81
	7	13	26.88	6.55	49732.96	7339.46	49643.07	7334.39	89.90	16.53
	12	12	9.39	2.94	51216.26	12939.56	51085.54	12915.50	130.72	39.84
22	0	7	6.72	2.72	21333.72	4464.54	21233.89	4449.89	99.84	30.29
	7	7	17.94	8.53	41411.11	7569.86	41282.78	7540.84	128.33	35.07
	12	7	6.49	2.49	47050.81	10590.96	46939.02	10570.77	111.79	40.34

Table IIIa: continued

Variable			α -Thujone		Total Terpenoids		Total Monoterpenes		Total Sesquiterpenes	
Family #	Trial Day	<i>N</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>
23	0	9	16.57	12.57	16815.01	2148.11	16735.78	2142.02	79.23	14.19
	7	8	21.07	4.53	50272.88	12964.36	50195.34	12947.59	77.54	22.56
	12	9	14.13	4.58	62941.25	14151.58	62842.98	14150.50	98.27	11.03
24	0	10	4.00	0.00	22666.00	2350.35	22473.39	2352.00	192.61	33.93
	7	10	4.00	0.00	75032.86	10796.59	74922.51	10803.23	110.36	20.78
	12	10	8.71	3.47	41216.05	5179.39	41061.72	5171.59	154.34	19.27
25	0	12	4.00	0.00	21625.64	5750.92	21491.11	5753.10	134.53	22.58
	7	12	15.72	5.07	30844.68	4854.45	30770.12	4860.88	74.56	18.71
	12	12	10.68	3.14	31392.49	5118.57	31202.08	5110.60	190.41	52.41
26	0	10	4.00	0.00	20268.53	4032.57	20181.03	4021.58	87.50	19.07
	7	10	14.25	7.71	28919.49	5900.87	28793.75	5868.78	125.74	50.09
	12	10	17.82	7.60	39353.81	6866.50	39252.07	6851.25	101.74	22.60
27	0	12	4.00	0.00	18592.12	4515.03	18461.76	4507.49	130.36	17.68
	7	10	28.81	8.24	51682.97	7010.84	51574.58	7013.98	108.39	17.03
	12	11	21.57	7.92	47528.44	8114.23	47366.25	8127.87	162.18	32.94
28	0	14	6.48	2.48	16297.66	1487.05	16189.18	1484.29	108.49	24.37
	7	14	24.36	13.47	54089.64	9833.05	54039.69	9832.38	49.95	7.94
	12	15	17.95	5.80	46107.33	5429.01	46001.67	5424.80	105.66	12.24

Table IIIa: continued

Variable			α -Thujone		Total Terpenoids		Total Monoterpenes		Total Sesquiterpenes	
Family #	Trial Day	<i>N</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>
29	0	10	4.00	0.00	24617.05	4055.25	24485.95	4045.21	131.11	25.69
	7	10	15.17	6.35	47303.58	10178.93	47218.65	10168.14	84.94	16.47
	12	10	10.62	2.82	49683.12	7529.14	49535.91	7512.94	147.21	22.16
30	0	15	4.00	0.00	17786.24	1411.18	17636.47	1400.75	149.77	36.50
	7	15	21.13	4.98	41747.08	6799.33	41653.58	6794.30	93.50	17.24
	12	14	20.76	6.84	44935.84	5967.47	44828.94	5961.24	106.90	19.09
31	0	8	4.00	0.00	21451.93	4755.29	21358.67	4737.68	93.26	23.36
	7	8	59.76	25.90	40391.58	8193.51	40321.75	8194.32	69.83	27.13
	12	8	11.22	6.74	45298.03	12210.08	45152.72	12205.20	145.31	29.29
32	0	9	12.80	8.80	25294.08	2671.37	25165.30	2651.37	128.77	26.10
	7	9	12.20	4.04	41607.64	5088.95	41528.99	5084.54	78.65	16.93
	12	9	17.95	9.15	41215.78	5354.08	41015.76	5337.78	200.02	72.12
33	0	11	4.00	0.00	14609.91	2198.62	14504.77	2180.65	105.14	41.97
	7	11	15.56	6.30	46587.42	5742.70	46489.31	5731.06	98.11	22.91
	12	11	12.43	3.92	40435.96	7717.38	40300.67	7717.63	135.28	21.16
34	0	9	4.00	0.00	10730.91	1275.72	10629.35	1257.97	101.56	40.31
	7	9	24.61	7.36	61399.14	6052.72	61326.76	6052.17	72.38	22.03
	12	8	10.38	3.23	51999.13	19290.91	51890.58	19296.41	108.55	35.24

Table IIIa: continued

Variable			α -Thujone		Total Terpenoids		Total Monoterpenes		Total Sesquiterpenes	
Family #	Trial Day	<i>N</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>
35	0	9	5.41	1.41	20098.21	2975.98	19946.58	2948.41	151.64	31.76
	7	9	8.85	3.41	43756.33	5148.80	43675.53	5158.32	80.80	15.64
	12	9	14.48	10.48	53602.58	11592.75	53484.66	11578.43	117.92	28.10
36	0	10	4.00	0.00	15597.69	1509.15	15495.36	1493.28	102.33	26.31
	7	10	12.91	4.90	52538.25	8716.70	52452.60	8706.94	85.66	21.15
	12	10	9.20	3.57	48457.09	8971.33	48301.05	8935.81	156.04	59.17
37	0	11	4.90	0.90	30142.46	4123.20	30022.00	4115.85	120.46	19.99
	7	11	16.78	7.40	67442.82	10953.89	67394.44	10952.59	48.38	6.09
	12	11	6.50	1.68	57032.63	7680.70	56945.09	7681.07	87.54	16.01
38	0	10	4.00	0.00	17779.00	3448.69	17717.03	3435.80	61.97	16.24
	7	11	16.12	5.72	44966.44	7364.53	44898.97	7356.51	67.47	10.47
	12	11	11.58	4.07	36604.44	9196.58	36491.79	9188.46	112.65	20.13
39	0	14	5.80	1.80	13731.05	1949.35	13646.28	1943.68	84.77	14.86
	7	15	17.74	4.41	49220.06	5190.75	49091.61	5188.30	128.45	21.08
	12	15	7.99	2.27	49644.11	3989.01	49516.10	3986.15	128.01	17.62
40	0	7	4.00	0.00	18188.27	2595.27	18063.48	2569.18	124.79	31.89
	7	6	7.40	3.40	38611.20	14474.09	38537.24	14484.58	73.96	18.17
	12	7	6.83	2.83	63783.05	13849.41	63687.86	13853.08	95.19	20.89

Table IIIa: continued

Variable			α -Thujone		Total Terpenoids		Total Monoterpenes		Total Sesquiterpenes	
Family #	Trial Day	<i>N</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>
41	0	12	4.00	0.00	15219.51	3293.62	15130.63	3274.02	88.88	23.02
	7	12	21.61	6.16	61576.99	8523.94	61479.00	8527.75	97.99	25.47
	12	13	16.67	4.84	53848.91	9655.76	53755.79	9650.61	93.12	17.46
42	0	8	6.24	2.24	15603.92	3347.66	15501.66	3333.82	102.27	21.08
	7	8	15.00	9.67	58917.04	9179.37	58851.54	9179.35	65.50	18.34
	12	8	18.95	6.61	47947.36	12915.57	47864.65	12912.70	82.71	9.91
43	0	9	7.67	3.67	15353.83	2522.47	15246.81	2516.55	107.02	26.74
	7	10	29.30	10.43	74603.54	14505.28	74506.41	14496.19	97.13	22.21
	12	10	21.89	7.85	53536.88	13410.12	53319.18	13419.11	217.70	96.67
44	0	9	6.81	2.81	14338.53	2015.40	14237.62	2001.21	100.92	23.77
	7	10	16.75	5.05	64863.68	10096.23	64785.28	10088.81	78.40	11.58
	12	10	8.86	4.86	43472.86	5570.34	43390.83	5571.10	82.03	9.59
45	0	8	4.43	0.43	19123.03	2221.27	19029.66	2228.05	93.37	16.49
	7	9	18.77	6.54	78369.57	34052.16	78241.13	33992.93	128.44	61.85
	12	9	9.61	3.46	55518.02	10468.67	55410.65	10462.78	107.37	15.97

Table IIIb: continued

Variable			β -Phellandrene		β -Pinene		δ -3-Carene		α -Pinene		Limonene	
Family #	Trial Day	<i>N</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>
1	0	7	11515.38	3256.31	1906.89	697.88	730.59	166.27	763.41	128.15	356.87	71.24
	7	6	30890.15	7997.58	6270.96	2444.21	3225.89	994.33	2179.04	546.82	879.20	190.21
	12	7	35502.77	8565.61	11536.55	6477.92	4498.49	2324.34	3062.30	1210.73	1008.99	223.92
2	0	7	10611.30	2956.90	1426.42	513.15	1103.13	301.47	693.51	183.79	382.34	88.94
	7	6	45517.50	14350.17	4941.85	1721.69	8574.55	2189.41	3349.31	1171.78	1250.81	400.41
	12	7	55904.29	14677.43	7934.58	1798.72	8453.20	2229.73	4314.20	981.42	1568.41	355.07
3	0	8	8181.47	2019.58	1542.28	417.92	1912.95	829.74	764.09	184.18	633.57	277.35
	7	8	24619.94	3855.39	7413.22	1951.91	8552.68	2683.79	2215.25	436.29	879.31	141.22
	12	8	27432.23	5182.08	9743.49	3808.56	9234.50	2981.08	2734.11	704.59	1237.45	239.61
4	0	14	13689.75	1813.57	2774.46	647.70	1114.22	221.13	1064.35	144.08	530.65	61.95
	7	14	32945.08	3749.40	5741.21	1214.03	7802.21	2629.43	2377.60	281.81	1454.87	296.07
	12	14	28795.19	3762.69	4861.57	1356.03	5955.10	1406.05	2205.06	336.47	1240.52	349.23
5	0	13	17637.96	2810.41	3875.82	1304.06	1928.21	548.27	1818.46	690.42	811.22	116.45
	7	13	48720.25	7559.89	8422.05	2211.10	7505.01	1711.18	4792.16	1562.71	1438.11	197.49
	12	13	52102.68	16099.94	7024.12	2446.27	8984.76	3728.80	4191.46	1116.25	1500.61	338.57
6	0	10	11968.91	2958.23	1718.15	446.45	1506.18	577.34	817.93	171.88	759.95	300.03
	7	10	27255.40	4556.60	5548.17	1380.30	4860.14	1075.11	2072.21	329.52	1159.47	319.52
	12	10	34786.69	6372.04	8480.12	3514.17	5600.11	1500.86	2966.88	761.37	1637.51	414.03

Table IIIb: continued

Variable			β -Phellandrene		β -Pinene		δ -3-Carene		α -Pinene		Limonene	
Family #	Trial Day	<i>N</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>
7	0	8	13761.18	4188.69	2415.63	748.05	1537.02	614.37	1585.78	659.08	2136.81	410.61
	7	8	33910.94	8334.61	10064.58	5115.70	6283.81	1250.25	8699.10	6388.71	3075.94	760.22
	12	7	28284.72	8488.49	8023.69	4933.08	5589.63	1811.80	9421.04	7774.94	3154.51	1372.04
8	0	10	6051.66	1258.90	1230.70	274.26	1027.81	435.34	459.05	89.45	753.84	157.37
	7	8	35507.00	4305.25	10094.39	2210.31	6175.54	1250.53	3144.55	397.41	1950.07	571.85
	12	10	31657.97	7544.89	13196.92	5998.51	4532.27	1247.42	3439.92	1282.30	2178.97	1142.25
9	0	13	21612.78	5340.65	2558.54	748.00	3065.44	1054.75	1423.16	348.74	779.41	168.12
	7	13	35507.89	5294.23	4009.67	1303.85	11180.95	2727.55	2253.99	462.50	1498.36	435.07
	12	13	34059.84	6484.39	4971.21	1861.70	10418.51	3487.78	2725.70	549.05	1520.01	541.80
10	0	5	10222.32	3387.54	1995.80	1323.15	777.25	298.61	826.08	252.60	617.92	157.05
	7	5	19919.83	2365.78	3154.42	965.09	3138.73	875.69	1551.11	291.90	1073.61	351.73
	12	5	18681.95	5593.69	2244.72	983.60	2154.06	768.90	1212.32	341.81	882.03	266.05
11	0	10	13169.02	3498.52	860.44	339.41	1404.66	400.79	790.01	225.76	1256.23	465.63
	7	10	25959.90	4418.96	2140.71	911.70	4873.62	859.97	1540.69	329.52	2307.09	942.16
	12	10	30080.05	7895.26	2802.16	1439.98	6081.73	1484.59	1757.34	516.17	2381.61	1098.17
12	0	9	18999.94	4097.52	1217.64	347.13	1732.22	507.55	1080.61	217.91	1074.48	377.01
	7	9	25575.98	5137.38	2373.69	391.25	4758.24	859.45	1597.58	217.41	1249.97	364.78
	12	9	23790.90	5613.92	3036.88	1260.17	3982.99	1082.98	1685.82	506.68	1193.78	300.29

Table IIIb: continued

Variable			β -Phellandrene		β -Pinene		δ -3-Carene		α -Pinene		Limonene	
Family #	Trial Day	<i>N</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>
13	0	7	12339.57	3233.40	1674.36	527.66	1387.89	375.08	1074.09	288.34	435.17	140.37
	7	7	17375.17	3201.72	2690.92	814.25	4673.57	1136.01	3289.40	2276.52	497.19	80.14
	12	7	22993.60	4574.23	2039.99	386.94	3982.68	1075.46	2130.87	659.18	630.34	110.20
14	0	7	15642.71	2500.62	2111.84	382.24	2828.93	668.59	1026.06	132.79	695.43	198.09
	7	6	37044.68	9029.42	6922.21	1944.82	10405.21	1925.71	2558.48	594.70	2065.88	1132.43
	12	7	27637.76	4372.75	6081.02	1726.36	7111.41	2032.21	2304.32	426.92	1151.51	298.54
15	0	12	12281.39	1853.96	634.48	169.88	2477.62	576.74	713.69	121.61	500.31	109.20
	7	12	36207.53	6529.08	2342.09	768.74	11511.56	2316.29	1953.92	317.08	991.09	132.39
	12	12	40630.08	10439.01	3535.19	1378.37	13274.09	3769.88	2329.32	526.93	1063.95	205.54
16	0	8	12742.28	1783.38	3087.86	713.18	2775.12	871.88	1248.58	215.85	2447.94	635.58
	7	7	34594.78	7602.95	8435.71	2396.68	8464.67	1894.50	3193.93	854.49	2891.99	993.54
	12	8	26231.27	3328.86	6126.61	1869.97	7139.70	2317.31	2268.27	379.68	2595.93	676.09
17	0	6	8709.07	1741.15	2052.11	757.10	3034.55	1255.75	825.11	150.99	317.82	51.74
	7	6	19821.80	5684.09	6003.68	1333.81	6556.00	2018.99	1856.03	398.21	586.20	124.94
	12	6	39339.88	11257.77	10833.82	2102.33	19075.14	6778.82	3603.82	549.94	1149.86	302.44
18	0	9	16570.19	2699.53	1085.58	157.28	1728.69	412.13	1048.62	143.01	580.04	86.66
	7	9	40425.92	7488.70	5039.80	1157.08	7076.60	953.44	2595.40	436.29	1163.20	232.22
	12	9	32939.22	8539.74	3693.09	1126.28	4750.83	553.34	2093.50	484.11	986.36	224.69

Table IIIb: continued

Variable			β -Phellandrene		β -Pinene		δ -3-Carene		α -Pinene		Limonene	
Family #	Trial Day	<i>N</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>
19	0	11	10486.74	1488.07	1336.68	280.61	1648.88	405.76	715.24	93.86	416.09	39.77
	7	12	31549.01	4322.35	4543.29	812.63	9474.60	2219.45	2150.13	305.94	1014.15	172.31
	12	11	38282.20	5222.95	5669.89	1347.98	10296.26	3707.08	2825.78	337.41	1580.04	372.89
20	0	8	7203.55	1727.76	1228.39	324.55	808.81	223.87	501.08	111.66	573.59	198.20
	7	8	36300.98	9228.70	7130.39	1441.38	7128.86	1728.21	2746.70	621.64	2058.01	611.29
	12	8	28172.01	8856.32	8348.83	3773.05	4609.13	979.38	2488.66	884.25	1822.22	644.00
21	0	10	17468.34	4365.56	7840.19	2862.05	1832.82	364.05	1983.43	688.69	1070.79	466.53
	7	10	34095.35	7525.59	9370.99	2199.29	6256.01	1742.85	2830.13	689.35	1825.43	618.80
	12	10	22085.99	4907.04	6676.98	1907.56	6049.34	1999.43	2114.17	409.51	1366.95	461.80
22	0	10	9955.22	1545.40	1236.00	252.24	1181.51	272.50	658.18	110.64	394.43	61.29
	7	10	33676.87	3404.76	4550.63	996.34	6272.36	1736.85	2130.95	261.22	968.52	82.33
	12	10	24941.54	8731.93	3726.48	1253.68	3707.46	884.14	1635.93	515.47	1017.57	241.08
23	0	7	17976.81	4796.95	1737.85	762.91	1924.88	481.11	1053.35	307.91	568.31	185.36
	7	7	22055.41	4301.56	3076.93	918.94	7076.74	2359.02	1416.26	259.61	624.09	109.37
	12	7	47921.23	13603.66	5442.17	2678.64	13018.91	5407.61	3520.77	1112.01	2202.12	1103.33
24	0	15	22244.68	9062.57	2282.82	796.94	2124.30	806.24	1428.92	551.55	855.52	284.35
	7	13	46627.93	10788.86	6113.06	1948.17	6165.22	1541.46	3481.26	965.59	1289.52	291.87
	12	15	40206.29	9807.48	7012.00	3114.81	8103.47	3412.82	3247.19	1033.14	1284.95	272.01

Table IIIb: continued

Variable			β -Phellandrene		β -Pinene		δ -3-Carene		α -Pinene		Limonene	
Family #	Trial Day	<i>N</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>
25	0	12	7588.86	1651.50	1867.15	693.63	823.07	215.06	3601.28	1051.60	389.48	85.56
	7	12	20627.50	3585.82	4258.36	1308.51	3225.26	572.48	12250.30	3170.52	702.84	104.60
	12	12	20718.23	3470.66	3936.67	876.28	4199.32	1121.83	13810.23	4229.84	724.63	113.36
26	0	7	9241.92	2422.92	1223.92	397.65	1419.70	455.36	646.67	173.57	1856.45	1141.95
	7	7	18295.43	3193.00	2941.48	649.30	4799.25	1293.39	1299.71	220.42	2185.32	869.84
	12	7	21087.64	3480.55	3125.78	1048.94	6368.26	1631.05	1482.46	330.62	2139.96	878.78
27	0	8	9781.49	1821.41	3171.41	1135.45	3528.29	934.23	4374.63	1790.90	1197.27	268.17
	7	8	18430.74	4418.72	6631.08	1793.90	7063.21	1766.20	5021.44	1555.59	905.85	239.69
	12	8	36153.39	15457.99	9003.12	3178.32	13055.31	5077.88	9401.54	5224.93	1627.88	599.83
28	0	13	12025.57	1974.24	1167.52	202.96	1004.33	235.33	881.17	190.53	467.21	86.84
	7	13	24274.39	2789.74	3854.50	475.15	3403.60	689.89	2567.73	866.59	833.32	153.51
	12	13	30315.05	9966.44	3412.12	675.86	5171.90	2165.06	3781.86	1962.95	879.47	239.12
29	0	7	31410.72	6092.08	5820.83	3287.21	3656.86	902.48	2644.33	623.51	1821.41	821.47
	7	7	42395.28	9158.09	6387.08	1868.11	9955.20	4196.71	3041.17	546.26	1843.35	842.72
	12	7	39229.80	11716.73	6047.46	2075.65	9425.98	5484.12	2811.63	619.58	1587.86	555.74
30	0	7	10124.89	997.93	1361.13	291.67	954.43	234.13	631.04	64.85	513.25	175.81
	7	7	41958.41	9579.28	9377.73	5371.09	7588.25	1536.38	3203.48	1406.40	1437.94	308.48
	12	7	31958.27	4732.18	6279.72	1690.81	4449.36	774.00	2382.89	387.36	1542.61	725.38

Table IIIb: continued

Variable			β -Phellandrene		β -Pinene		δ -3-Carene		α -Pinene		Limonene	
Family #	Trial Day	<i>N</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>
31	0	8	10456.64	1965.98	1422.85	229.83	1578.71	277.22	967.18	269.97	411.89	91.57
	7	8	25058.10	4672.64	4436.12	989.97	6226.75	1180.00	2170.34	625.93	745.47	118.50
	12	8	47240.84	9324.88	11019.01	2448.30	13571.14	4087.94	5036.03	1259.07	1842.52	427.94
32	0	9	11529.98	1242.70	1739.04	482.19	1903.94	815.66	1681.14	826.27	408.95	37.45
	7	9	27480.50	3469.88	3817.85	997.67	7128.47	1051.24	2884.08	1136.11	748.11	78.52
	12	9	38571.08	9677.46	8291.04	3415.76	10444.58	3506.19	6452.84	3520.73	1176.41	249.65
33	0	5	11840.39	1923.13	895.15	350.47	3285.34	1524.98	812.02	118.68	1746.53	411.20
	7	5	43175.61	18080.54	2572.26	501.16	9533.52	3442.78	2572.10	975.86	4274.09	2180.65
	12	5	28120.33	5020.12	4543.97	2827.61	5580.57	1402.96	2014.95	468.74	3001.02	649.19
34	0	8	11195.42	2870.26	534.13	131.29	4603.78	1452.89	722.72	153.25	471.15	130.51
	7	8	26637.18	6101.96	1984.25	1071.29	9330.90	2595.92	1406.53	311.75	852.72	165.27
	12	8	17821.93	2182.07	2714.81	1224.42	6187.04	1364.82	1280.42	215.83	984.13	386.95
35	0	9	13332.84	3042.42	2450.22	619.59	2447.44	581.18	1000.61	224.96	714.56	361.43
	7	9	21792.04	2636.23	6625.41	1089.60	8068.41	1903.39	1907.99	247.07	943.64	268.80
	12	9	31860.32	5305.16	8181.54	1219.96	10275.82	2862.75	2651.26	440.37	1688.81	428.67
36	0	13	8436.18	907.62	797.64	105.58	1773.67	289.11	563.92	46.80	282.56	31.91
	7	13	23685.90	2601.55	4377.72	739.89	7073.23	1222.61	1593.43	174.29	692.99	79.46
	12	13	17821.37	2415.45	3446.09	731.12	5389.13	938.88	1347.15	190.59	555.26	65.61

Table IIIb: continued

Variable			β -Phellandrene		β -Pinene		δ -3-Carene		α -Pinene		Limonene	
Family #	Trial Day	<i>N</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>
37	0	6	18932.79	4823.95	4259.79	1634.63	2823.28	816.97	1452.03	424.83	682.13	206.59
	7	6	32465.90	4095.05	8129.88	2189.61	8445.18	2043.69	2531.49	522.76	870.35	117.29
	12	6	21448.94	6961.65	4100.44	1343.67	5111.32	2535.89	1476.43	443.33	617.62	165.20
38	0	7	10110.21	1953.54	2662.06	1350.63	1441.11	797.29	1996.49	1350.42	867.19	532.86
	7	7	24380.35	4889.78	7727.23	2625.85	6994.29	2875.21	4233.88	2234.24	1265.40	395.90
	12	7	19554.24	3170.28	5850.94	2444.11	6631.05	2468.95	3259.45	1830.65	634.25	98.01
39	0	11	8784.71	993.40	898.80	233.54	1138.03	187.06	637.78	78.61	1197.65	319.75
	7	10	36925.32	6785.21	3165.74	846.57	8459.63	2310.38	2150.22	396.80	2570.48	894.54
	12	11	30533.18	5620.34	3420.73	1682.68	7742.33	2137.59	2149.03	555.34	2314.73	610.51
40	0	11	9499.81	912.17	2868.40	622.42	630.98	180.19	1038.21	150.94	732.93	302.65
	7	11	28333.60	3710.93	10489.49	1460.79	4614.71	960.27	3333.24	498.10	1183.12	297.51
	12	10	17806.33	2518.13	7312.99	1427.46	4421.26	1519.78	3380.95	1423.96	875.79	202.56
41	0	11	12574.81	2841.73	1645.21	377.37	2741.32	843.36	926.87	186.57	517.26	106.40
	7	10	34532.86	6502.32	5783.94	1500.50	11708.94	3588.18	2439.54	503.13	962.35	179.32
	12	11	28409.73	5996.51	5633.86	1201.26	8943.55	2801.15	3442.45	1368.42	1130.49	207.88
42	0	9	9715.00	2720.72	1047.13	390.93	2767.43	1194.95	599.85	170.99	502.27	152.43
	7	8	21995.06	3695.31	3837.78	800.48	6930.41	1566.27	1585.07	258.48	963.81	220.41
	12	8	27443.74	5921.35	6389.98	3243.16	9467.69	2698.57	2224.93	763.92	1179.29	333.06

Table IIIb: continued

Variable	β-Phellandrene			β-Pinene			δ-3-Carene			α-Pinene			Limonene		
Family #	Trial	Day	N	x	se	x	se	x	se	x	se	x	se	x	se
43	0	6	6	10860.49	2929.36	1000.96	126.79	781.71	320.01	578.16	118.94	353.65	97.00		
	7	6	6	38472.54	11210.80	3726.91	1561.78	4016.10	2104.58	1878.84	600.12	967.15	267.63		
	12	6	6	21893.89	3620.66	2539.13	768.47	2761.05	1969.28	1157.60	220.70	555.05	80.58		
44	0	5	5	9417.12	3365.75	1565.49	557.85	523.31	234.32	578.62	210.24	487.33	231.96		
	7	4	4	49384.92	8518.92	9147.54	2166.71	4220.17	1492.40	3619.83	769.91	2064.24	706.39		
	12	5	5	25233.97	4434.63	4706.03	656.35	1970.84	650.68	1695.30	267.85	1246.52	500.29		
45	0	7	7	12623.96	1565.52	1465.83	219.98	1596.38	529.57	805.57	84.68	1016.94	427.84		
	7	7	7	51974.33	8530.38	8081.59	1839.25	10250.56	3304.85	3638.96	452.88	2353.10	600.70		
	12	7	7	24921.79	2406.90	3784.79	967.31	4971.78	1690.64	1759.68	172.05	1643.75	614.69		

Variable	Myrcene			Terpinolene			α-Phellandrene			Borneol			Bornyl Acetate		
Family #	Trial	Day	N	x	se	x	se	x	se	x	se	x	se	x	se
1	0	7	7	373.45	94.91	196.31	45.77	212.08	63.55	20.41	7.52	13.27	9.27		
	7	6	6	958.83	235.14	492.96	99.92	563.50	157.51	13.83	4.61	96.46	25.33		
	12	7	7	1194.32	344.19	662.85	233.03	681.36	177.11	29.66	9.87	76.79	9.64		
2	0	7	7	596.65	173.07	220.08	42.99	198.29	55.55	19.89	8.10	52.24	19.72		
	7	6	6	1881.06	498.65	1231.93	306.76	925.92	307.67	23.67	8.57	58.40	9.64		
	12	7	7	2082.29	440.50	1284.81	433.99	1108.78	319.99	39.98	15.08	90.29	13.16		

Table IIIb: continued

Variable	Myrcene		Terpinolene		α -Phellandrene		Borneol		Bornyl Acetate	
Family #	Trial Day	<i>N</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>
3	0	8	401.95	108.49	187.86	50.62	144.73	38.42	19.64	7.19
	7	8	1202.34	296.68	1250.11	353.71	477.86	86.46	14.16	5.09
	12	8	1199.04	241.48	1085.26	336.89	543.77	118.29	35.34	12.89
4	0	14	583.23	103.39	208.07	38.86	236.97	36.89	27.70	10.81
	7	14	1230.26	153.72	1057.02	234.56	638.05	78.70	21.12	4.25
	12	14	1036.91	133.06	917.90	151.07	534.17	73.99	17.28	3.87
5	0	13	719.06	93.09	392.79	60.76	322.58	49.86	68.95	14.73
	7	13	1731.41	259.67	1080.72	210.13	954.17	153.53	39.95	7.46
	12	13	1824.34	536.63	1221.50	419.17	1072.74	344.95	51.47	11.12
6	0	10	493.10	106.20	390.95	104.15	214.01	57.25	15.50	4.86
	7	10	1004.48	145.26	786.60	127.58	523.91	88.37	21.68	3.79
	12	10	1323.09	233.68	894.63	192.93	669.55	124.69	25.52	7.07
7	0	8	702.32	166.76	475.45	157.99	250.40	80.92	59.22	20.23
	7	8	1553.01	396.22	1078.36	237.63	681.47	168.82	25.18	13.67
	12	7	1364.74	479.36	844.04	245.88	585.97	184.41	16.56	12.56
8	0	10	267.90	60.82	193.16	55.83	106.24	24.74	11.86	6.15
	7	8	1360.27	160.87	1009.60	142.81	674.96	84.50	32.28	11.28
	12	10	1183.06	311.45	634.81	134.98	604.07	156.35	18.48	3.58

Table IIIb: continued

Variable Family #	Trial Day	N	Myrcene			Terpinolene			α -Phellandrene			Borneol			Bornyl Acetate		
			x	se		x	se		x	se		x	se		x	se	
9	0	13	864.75	211.16		492.35	117.62		405.76	100.09		54.45	13.80		114.01	41.12	
	7	13	1483.86	291.49		1573.66	353.16		694.28	116.47		49.14	11.31		91.07	18.91	
	12	13	1408.46	310.96		1327.54	377.49		670.68	146.90		95.38	21.14		235.96	143.40	
10	0	5	986.56	571.87		290.57	105.82		199.46	59.03		15.88	8.66		67.54	22.14	
	7	5	796.60	148.20		551.89	95.18		384.14	40.17		12.41	4.33		40.68	11.10	
	12	5	1229.27	478.81		1164.97	507.89		391.61	105.54		12.08	4.07		70.95	29.34	
11	0	10	486.34	129.48		272.40	48.96		237.18	63.43		12.46	3.54		91.22	68.98	
	7	10	950.15	196.88		841.94	147.92		494.80	87.88		21.76	8.05		63.23	13.49	
	12	10	1052.11	277.06		786.91	168.67		571.31	158.15		14.53	5.27		78.22	27.24	
12	0	9	756.64	166.81		379.09	54.46		338.39	71.01		17.44	5.36		113.23	63.29	
	7	9	930.30	153.10		688.74	92.47		455.70	87.86		34.48	10.58		117.90	25.42	
	12	9	896.12	187.49		646.35	123.79		450.00	118.41		28.30	7.97		163.00	33.38	
13	0	7	508.10	140.12		269.51	84.42		222.88	62.36		43.61	30.29		54.09	23.69	
	7	7	670.64	113.13		842.02	251.50		335.66	62.56		15.28	6.17		59.00	21.00	
	12	7	764.49	168.34		590.21	151.67		444.89	104.92		9.49	2.63		58.93	25.57	
14	0	7	606.10	77.59		387.29	61.63		297.80	43.07		43.36	28.57		64.40	23.47	
	7	6	1339.08	275.68		1267.85	146.17		743.83	177.25		19.25	7.80		77.80	8.59	
	12	7	1078.14	178.73		979.93	211.18		533.37	86.24		57.22	17.29		169.63	56.42	

Table IIIb: continued

Variable			Myrcene		Terpinolene		α -Phellandrene		Borneol		Bornyl Acetate	
Family #	Trial Day	<i>N</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>
15	0	12	531.73	73.08	454.46	81.97	232.94	32.90	41.45	17.33	56.39	13.33
	7	12	1421.31	228.84	1640.57	296.93	698.19	135.14	37.70	9.64	71.64	9.61
	12	12	1615.44	388.92	1745.60	441.47	792.48	201.24	29.80	7.11	89.96	14.57
16	0	8	582.40	79.39	520.67	121.22	243.44	30.83	33.17	5.24	147.74	29.67
	7	7	1386.43	282.97	1330.27	226.96	698.82	148.39	17.94	4.54	99.70	18.13
	12	8	1056.14	173.44	950.62	233.70	487.63	72.62	26.21	6.19	139.42	35.14
17	0	6	401.06	74.63	349.76	55.05	161.99	30.85	16.13	8.69	13.52	6.76
	7	6	857.27	158.35	973.96	246.46	363.98	92.13	7.29	1.14	38.52	8.65
	12	6	2041.39	585.47	2341.15	806.09	770.90	223.79	28.52	10.88	96.49	28.63
18	0	9	1268.69	215.36	372.44	62.57	301.02	50.76	38.74	13.94	87.21	21.01
	7	9	1782.11	395.44	1355.54	237.95	836.69	161.54	55.06	27.30	73.60	15.54
	12	9	1679.68	404.60	698.48	110.66	624.13	178.42	50.24	12.44	90.53	21.03
19	0	11	451.54	80.42	389.22	64.61	197.12	29.60	66.68	24.35	37.38	12.67
	7	12	1257.67	181.53	1313.06	286.82	616.46	88.79	37.42	13.26	49.44	9.77
	12	11	1517.30	249.91	1408.94	443.68	769.68	123.47	47.47	7.59	124.80	13.76
20	0	8	327.76	96.52	149.20	57.52	127.62	38.78	21.02	10.81	14.20	10.20
	7	8	1460.33	330.40	944.77	197.29	770.30	231.11	37.40	9.56	92.12	31.45
	12	8	1098.48	311.69	569.97	98.45	530.91	182.66	65.72	29.94	53.22	20.57

Table IIIb: continued

Variable			Myrcene		Terpinolene		α -Phellandrene		Borneol		Bornyl Acetate	
Family #	Trial Day	<i>N</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>
21	0	10	670.27	140.91	426.76	77.91	307.82	72.15	45.83	18.36	59.28	16.23
	7	10	1500.86	434.49	1495.45	475.50	698.94	176.54	27.32	11.76	52.76	9.84
	12	10	909.84	193.75	945.48	228.75	408.98	100.32	80.12	30.55	77.44	8.49
22	0	10	368.78	48.41	238.60	41.51	188.43	28.47	7.70	1.91	93.14	20.84
	7	10	1198.35	111.99	1023.50	185.87	647.74	69.75	35.98	6.79	181.49	36.85
	12	10	876.62	249.30	646.33	132.42	469.36	173.10	31.12	9.40	151.74	40.80
23	0	7	696.31	165.04	373.07	56.17	342.71	81.48	35.39	20.68	58.18	14.98
	7	7	855.77	135.88	931.56	233.05	439.52	98.36	19.65	6.33	68.40	10.72
	12	7	1908.43	567.35	1691.53	620.50	942.27	292.84	35.26	18.26	103.86	24.56
24	0	15	885.76	266.84	666.55	141.49	383.70	133.77	56.53	16.04	114.12	38.23
	7	13	1679.94	392.93	1175.73	215.72	981.18	249.08	18.62	4.36	112.15	31.99
	12	15	1545.99	394.11	1228.60	427.86	786.87	213.53	28.40	6.24	101.37	23.82
25	0	12	490.47	117.88	528.93	137.13	141.37	33.06	87.94	30.57	1219.41	474.98
	7	12	885.00	147.06	885.79	109.27	384.99	72.97	96.76	34.78	625.45	208.09
	12	12	933.64	171.22	780.15	154.09	389.11	74.56	98.09	32.45	516.11	204.15
26	0	7	481.79	153.22	318.42	71.77	174.58	45.86	19.76	6.28	58.04	20.84
	7	7	764.66	140.76	810.44	190.90	350.41	64.65	15.21	3.39	67.38	16.66
	12	7	889.52	172.44	883.03	189.20	406.43	77.14	27.42	6.80	84.33	21.68

Table IIIb: continued

Variable	Myrcene		Terpinolene		α -Phellandrene		Borneol		Bornyl Acetate	
Family #	Trial Day	N	x	se	x	se	x	se	x	se
27	0	8	922.63	209.01	1149.27	223.12	193.43	29.87	548.29	247.60
	7	8	958.07	153.47	1387.48	281.62	359.34	98.51	238.47	133.23
	12	8	1712.73	600.33	2287.80	704.67	741.12	329.12	225.21	131.80
28	0	13	523.65	90.14	233.60	37.83	235.12	37.30	18.61	6.84
	7	13	920.16	111.28	712.11	202.45	474.23	60.52	18.52	3.71
	12	13	1098.22	319.22	795.15	238.22	588.11	207.97	25.75	5.35
29	0	7	1429.12	302.50	810.25	167.66	553.23	104.28	104.84	72.27
	7	7	1653.29	402.98	1732.37	449.08	878.87	221.59	106.89	74.70
	12	7	1602.43	476.02	1302.79	593.64	759.48	247.05	47.89	15.83
30	0	7	448.90	61.92	192.77	26.87	192.40	16.38	18.53	6.28
	7	7	1545.39	386.23	1248.03	161.38	806.56	195.43	30.77	12.07
	12	7	1171.34	144.67	624.70	118.76	597.06	87.70	46.53	13.70
31	0	8	431.31	65.54	219.33	25.07	195.41	44.52	176.76	136.35
	7	8	919.44	149.83	1015.60	114.30	502.85	98.77	134.52	87.63
	12	8	1991.86	408.02	1689.94	530.28	926.44	204.38	292.33	192.50
32	0	9	545.44	63.68	646.14	201.13	235.79	23.42	31.46	10.84
	7	9	1057.52	102.31	1253.38	207.33	510.95	64.40	19.20	3.18
	12	9	1878.49	453.07	1464.08	425.13	737.86	200.49	52.16	19.22
									509.13	351.53

Table IIIb: continued

Variable Family #	Trial Day	N	Myrcene			Terpinolene			α -Phellandrene			Borneol			Bornyl Acetate		
			x	se		x	se		x	se		x	se		x	se	
33	0	5	566.40	90.60		412.36	149.91		219.73	43.05		5.43	1.43		61.82	36.80	
	7	5	1751.10	634.56		1278.18	409.53		814.61	333.63		64.96	26.61		106.57	44.00	
	12	5	1058.14	125.12		634.96	122.98		497.19	92.67		21.23	6.12		76.99	31.15	
34	0	8	478.75	107.63		462.44	130.66		337.48	168.97		9.72	4.97		90.50	49.49	
	7	8	978.94	208.09		1281.01	341.70		501.51	125.12		31.35	15.96		63.48	26.19	
	12	8	713.21	91.73		810.28	122.65		317.72	49.07		23.75	8.55		94.20	23.31	
35	0	9	645.82	158.75		562.18	157.08		236.17	65.26		30.93	15.37		39.88	14.59	
	7	9	952.68	142.17		1134.26	246.44		421.42	62.57		9.02	2.67		66.88	10.43	
	12	9	1388.45	221.24		1511.92	333.64		621.73	104.87		29.26	8.18		62.38	11.39	
36	0	13	388.81	35.31		323.06	94.59		160.47	16.56		12.98	3.11		37.29	9.53	
	7	13	983.38	93.19		1165.01	218.05		475.95	54.51		20.09	6.26		75.06	14.01	
	12	13	751.88	94.60		852.69	209.54		331.27	47.96		20.32	5.98		66.25	8.55	
37	0	6	813.33	225.02		463.58	108.53		349.60	92.65		104.21	51.18		75.60	36.45	
	7	6	1250.84	187.43		1264.83	248.48		608.80	92.11		23.73	4.62		47.09	17.97	
	12	6	803.86	292.39		765.36	414.42		403.09	145.40		15.75	7.03		63.68	13.08	
38	0	7	489.21	104.87		270.76	97.18		164.41	46.73		42.95	18.99		336.82	247.57	
	7	7	1108.55	228.85		930.26	358.34		481.18	98.21		32.48	9.11		246.28	166.46	
	12	7	844.00	175.67		825.16	282.42		369.90	74.24		62.93	33.50		826.76	766.07	

Table IIIb: continued

Variable Family #	Trial Day	N	Myrcene			Terpinolene			α -Phellandrene			Borneol			Bornyl Acetate		
			x	se		x	se		x	se		x	se		x	se	
39	0	11	506.60	60.25		240.76	51.37		169.96	18.24		17.48	5.16		28.74	13.33	
	7	10	1482.68	249.65		1211.62	303.30		681.81	127.83		28.56	7.08		44.72	8.40	
	12	11	1299.28	234.79		991.00	232.29		589.05	116.49		17.94	5.39		70.88	13.41	
40	0	11	429.26	41.03		298.79	53.95		177.58	22.28		35.89	17.96		196.99	143.60	
	7	11	1075.31	129.86		847.99	130.85		567.77	75.10		35.51	9.49		174.55	82.43	
	12	10	730.08	84.56		814.76	166.09		327.31	44.04		51.80	24.17		210.09	126.97	
41	0	11	539.16	111.74		425.71	92.72		227.18	52.65		35.15	9.39		31.55	15.32	
	7	10	1369.99	326.32		1709.64	531.30		668.57	137.69		17.56	3.55		53.76	11.35	
	12	11	1202.82	230.25		1195.90	326.54		553.77	126.69		95.35	51.21		102.16	28.55	
42	0	9	507.56	170.66		339.73	125.79		177.41	48.61		22.64	8.70		62.15	24.83	
	7	8	979.89	214.25		983.80	175.36		399.46	70.93		27.21	7.54		80.20	33.12	
	12	8	1219.67	284.14		1143.21	303.13		526.42	118.28		25.50	6.70		110.52	14.42	
43	0	6	452.39	140.08		338.98	107.37		197.08	53.05		15.48	5.89		39.43	22.78	
	7	6	1142.60	319.45		987.85	327.22		695.45	220.18		30.20	12.32		52.43	17.23	
	12	6	665.08	134.63		568.04	257.14		396.35	73.35		27.38	12.72		58.38	4.19	
44	0	5	371.35	125.35		91.51	36.57		167.75	67.10		14.70	5.61		29.98	25.51	
	7	4	1645.82	342.99		573.07	176.71		908.44	187.16		22.26	6.96		44.93	15.07	
	12	5	805.09	146.93		303.32	67.37		479.17	92.20		18.59	8.31		68.71	33.87	

Table IIIb: continued

Variable			Myrcene		Terpinolene		α -Phellandrene		Borneol		Bornyl Acetate	
Family #	Trial Day	<i>N</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>
45	0	7	499.99	63.60	435.64	60.76	231.45	30.38	40.25	16.66	60.86	17.16
	7	7	1840.96	297.77	1624.63	412.02	1033.29	199.86	27.67	10.36	73.11	19.72
	12	7	900.75	112.47	855.73	178.70	435.83	52.86	21.74	8.53	63.25	16.62
Variable			Camphene		Camphor		δ -2-Carene		p-Cymene		Linalool	
Family #	Trial Day	<i>N</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>
1	0	7	92.94	22.71	11.12	3.99	4.00	0.00	78.01	59.18	40.30	14.02
	7	6	225.45	49.54	25.04	7.65	4.00	0.00	71.53	21.44	23.73	10.30
	12	7	267.23	64.99	11.42	3.63	4.44	0.44	78.34	18.63	62.72	14.10
2	0	7	66.74	26.83	6.72	1.83	4.00	0.00	17.27	6.55	53.87	16.33
	7	6	332.19	114.35	20.88	5.74	4.00	0.00	57.14	18.55	102.00	38.43
	12	7	404.32	97.59	27.80	13.08	4.00	0.00	122.90	50.60	111.02	26.19
3	0	8	86.30	22.37	6.01	1.67	4.00	0.00	67.47	18.83	50.08	25.59
	7	8	178.83	29.87	11.89	2.97	4.00	0.00	43.13	6.89	45.21	16.06
	12	8	213.96	37.63	16.40	4.74	4.00	0.00	79.06	13.05	71.83	18.49
4	0	14	118.23	15.86	7.52	2.22	4.00	0.00	47.62	10.08	52.51	14.74
	7	14	240.14	26.34	21.75	6.17	4.00	0.00	95.73	36.93	60.10	12.18
	12	14	221.27	28.77	25.06	5.35	4.00	0.00	91.98	13.86	86.75	12.80

Table IIIb: continued

Variable		Camphene		Camphor		δ-2-Carene		p-Cymene		Linalool		
Family #	Trial Day	N	x	se	x	se	x	se	x	se	x	se
5	0	13	167.54	32.21	23.42	8.57	4.00	0.00	63.83	8.29	120.68	19.66
	7	13	354.46	56.18	22.29	4.78	4.00	0.00	75.54	12.40	90.93	17.74
	12	13	385.76	101.22	34.61	7.12	4.00	0.00	89.32	14.99	92.72	15.65
6	0	10	80.78	23.78	16.86	11.51	4.00	0.00	27.58	10.46	73.47	22.48
	7	10	196.53	30.70	18.23	5.54	4.00	0.00	32.24	6.63	54.57	15.82
	12	10	254.16	43.30	20.62	5.55	4.00	0.00	69.64	13.34	95.71	15.34
7	0	8	170.24	84.69	11.35	4.79	4.00	0.00	43.46	18.85	90.00	34.56
	7	8	393.29	174.09	27.34	8.55	4.00	0.00	45.37	8.78	85.81	27.04
	12	7	324.99	148.59	24.14	6.88	4.00	0.00	82.76	27.07	78.44	16.38
8	0	10	37.00	12.03	4.35	0.35	4.00	0.00	10.65	3.87	50.00	15.82
	7	8	251.73	27.64	19.98	10.53	4.00	0.00	63.01	8.41	69.24	11.05
	12	10	245.22	66.92	24.62	3.31	4.00	0.00	62.02	10.77	82.06	14.15
9	0	13	179.33	37.20	14.91	6.21	4.00	0.00	43.73	12.57	132.48	28.96
	7	13	245.44	42.88	21.46	6.93	4.91	0.91	67.10	9.66	75.20	10.68
	12	13	299.37	47.47	23.59	4.85	5.37	1.37	92.22	19.37	114.37	9.79
10	0	5	84.11	28.49	5.95	1.95	5.15	1.15	22.79	12.32	58.29	21.41
	7	5	141.46	19.10	19.91	7.13	4.00	0.00	31.38	5.80	45.51	13.66
	12	5	114.77	48.59	23.96	8.67	4.00	0.00	34.06	12.15	92.08	55.47

Table IIIb: continued

Variable Family #	Trial Day	N	Camphene		Camphor		δ -2-Carene		p-Cymene		Linalool	
			x	se	x	se	x	se	x	se	x	se
11	0	10	102.93	28.55	6.86	1.68	4.00	0.00	44.39	10.32	52.92	20.80
	7	10	165.73	30.00	21.33	4.33	4.00	0.00	42.19	5.93	38.73	12.38
	12	10	200.05	52.10	30.27	5.14	4.00	0.00	67.68	7.99	50.41	15.17
12	0	9	143.04	28.36	11.13	4.88	4.00	0.00	42.36	13.80	104.63	35.22
	7	9	183.21	30.72	31.05	9.11	4.00	0.00	53.58	14.89	60.08	13.10
	12	9	180.42	39.68	21.05	5.74	4.00	0.00	72.90	17.31	99.93	20.38
13	0	7	103.62	23.10	8.45	2.55	4.00	0.00	20.80	8.95	33.41	11.02
	7	7	145.67	30.99	25.83	9.79	4.00	0.00	24.66	5.66	25.92	8.47
	12	7	165.39	29.69	29.17	7.96	4.00	0.00	40.32	5.42	20.35	4.79
14	0	7	126.38	12.84	12.80	6.56	4.00	0.00	32.74	5.16	100.67	20.79
	7	6	237.62	47.91	20.80	4.54	4.00	0.00	38.27	6.14	110.74	49.34
	12	7	223.92	41.18	27.39	4.92	4.00	0.00	87.63	39.17	105.16	23.14
15	0	12	88.04	16.11	8.42	2.93	4.00	0.00	43.34	21.25	106.07	22.91
	7	12	230.93	37.77	30.07	5.04	5.34	0.96	60.83	10.58	83.90	21.46
	12	12	254.54	58.37	21.84	5.42	4.93	0.93	62.60	9.14	96.98	14.20
16	0	8	120.67	15.82	15.54	4.43	4.00	0.00	67.44	13.63	43.81	9.10
	7	7	247.67	58.48	24.98	6.58	4.00	0.00	55.21	5.47	53.41	15.62
	12	8	195.75	26.17	20.67	8.12	4.00	0.00	67.52	15.91	81.25	12.38

Table IIIb: continued

Variable Family #	Trial Day	N	Camphene			Camphor			δ -2-Carene			p-Cymene			Linalool		
			x	se		x	se		x	se		x	se		x	se	
17	0	6	85.12	14.46		15.79	5.91		4.00	0.00		66.06	29.79		98.26	37.92	
	7	6	146.54	36.25		24.92	6.20		4.00	0.00		37.04	8.08		101.73	43.52	
	12	6	299.86	70.63		24.01	8.04		4.70	0.70		88.42	27.23		157.05	27.55	
18	0	9	129.28	20.79		9.77	3.93		4.00	0.00		50.23	12.90		115.79	20.88	
	7	9	277.83	53.81		19.82	5.92		4.00	0.00		50.72	5.95		89.83	30.40	
	12	9	237.77	56.39		23.12	6.16		4.00	0.00		94.41	21.96		118.74	28.52	
19	0	11	80.77	17.49		6.39	1.63		12.07	8.07		35.38	11.72		18.26	7.22	
	7	12	221.90	30.03		19.92	4.87		4.00	0.00		47.41	5.96		30.00	5.74	
	12	11	283.65	31.94		22.25	5.56		4.00	0.00		93.83	16.20		42.27	9.48	
20	0	8	45.67	15.93		5.95	1.95		4.00	0.00		17.78	6.77		43.03	20.32	
	7	8	266.38	67.13		15.89	3.93		4.29	0.29		36.87	6.50		63.45	11.90	
	12	8	219.46	70.75		13.36	3.61		4.00	0.00		73.68	16.10		75.99	11.54	
21	0	10	164.68	46.80		10.07	2.67		4.00	0.00		38.98	15.18		57.02	11.19	
	7	10	262.15	66.69		19.09	5.07		5.83	1.83		54.12	12.52		65.05	28.58	
	12	10	176.86	32.22		22.49	4.70		4.00	0.00		67.46	19.14		72.79	27.00	
22	0	10	78.89	9.98		5.71	1.15		4.00	0.00		46.47	31.38		29.59	9.75	
	7	10	223.43	21.68		22.54	4.64		4.00	0.00		62.23	8.73		89.92	22.92	
	12	10	169.28	51.20		20.84	7.16		4.00	0.00		47.93	7.75		66.10	17.85	

Table IIIb: continued

Variable Family #	Trial Day	N	Camphene		Camphor		δ -2-Carene		p-Cymene		Linalool	
			x	se	x	se	x	se	x	se	x	se
23	0	7	142.49	35.80	12.03	5.90	4.00	0.00	29.93	11.52	70.26	17.90
	7	7	148.26	26.35	23.63	7.28	4.00	0.00	33.34	4.05	46.37	7.83
	12	7	343.39	93.48	35.91	9.50	6.40	2.40	95.89	22.36	109.52	26.06
24	0	15	160.38	60.67	11.03	3.93	4.00	0.00	70.65	32.71	87.74	16.08
	7	13	331.77	80.20	37.02	8.81	4.00	0.00	56.63	11.48	62.50	9.54
	12	15	296.31	71.43	32.66	7.01	4.17	0.17	87.59	11.28	94.76	14.70
25	0	12	409.26	131.38	12.51	4.81	4.00	0.00	20.99	8.42	82.30	23.00
	7	12	396.09	81.87	19.48	4.50	4.00	0.00	38.15	4.85	66.59	18.72
	12	12	397.38	98.96	19.69	3.97	4.00	0.00	55.05	7.61	74.68	21.23
26	0	7	75.13	21.99	10.59	2.27	4.00	0.00	27.94	5.46	72.06	18.29
	7	7	136.15	18.08	22.80	12.25	4.00	0.00	32.11	7.30	56.63	6.83
	12	7	147.10	25.97	20.85	5.80	4.00	0.00	50.35	10.83	60.17	9.10
27	0	8	999.87	444.95	99.91	43.31	4.00	0.00	32.46	6.42	142.94	35.08
	7	8	482.68	216.00	59.74	23.16	4.00	0.00	37.74	9.19	56.21	10.67
	12	8	523.31	183.20	37.18	14.06	4.00	0.00	54.87	16.24	85.59	17.70
28	0	13	100.51	15.62	14.20	7.95	4.00	0.00	9.28	2.89	43.17	10.42
	7	13	181.13	16.29	43.23	19.39	4.00	0.00	51.77	7.63	51.55	12.68
	12	13	231.05	63.91	56.13	29.60	4.00	0.00	66.04	13.78	55.13	10.39

Table IIIb: continued

Variable Family #	Trial Day	N	Camphene			Camphor			δ -2-Carene			p-Cymene			Linalool		
			x	se		x	se		x	se		x	se		x	se	
29	0	7	330.26	77.70		31.54	10.21		4.00	0.00		121.46	22.29		101.61	33.59	
	7	7	310.30	60.70		15.45	4.05		4.00	0.00		55.33	8.61		49.23	10.08	
	12	7	301.16	63.86		19.09	6.63		4.00	0.00		68.00	19.93		78.33	17.88	
30	0	7	60.66	21.92		8.99	4.22		4.37	0.37		14.44	7.33		50.17	25.02	
	7	7	294.06	83.17		32.79	7.83		4.00	0.00		66.68	10.99		52.29	10.91	
	12	7	240.81	31.27		27.84	10.08		4.00	0.00		95.52	19.86		113.57	47.39	
31	0	8	160.65	84.36		18.86	9.40		4.00	0.00		36.33	8.72		41.31	15.50	
	7	8	207.34	40.39		28.35	5.63		4.00	0.00		39.40	5.46		36.12	17.39	
	12	8	525.12	171.94		32.98	11.08		4.84	0.84		102.15	24.13		119.25	44.59	
32	0	9	114.93	18.95		5.87	1.87		4.00	0.00		95.42	43.85		53.41	13.66	
	7	9	202.04	26.09		22.54	6.42		4.39	0.39		61.04	17.06		44.19	10.70	
	12	9	411.51	136.12		26.91	8.20		4.00	0.00		120.37	35.84		97.85	19.47	
33	0	5	96.41	14.50		4.30	0.30		4.00	0.00		33.42	17.07		80.67	39.02	
	7	5	277.54	108.00		12.78	4.95		4.71	0.71		44.54	10.57		90.15	55.30	
	12	5	210.15	34.17		17.95	5.30		4.93	0.93		108.56	40.52		55.62	27.10	
34	0	8	87.66	21.62		7.91	3.56		4.00	0.00		56.21	16.98		33.02	9.07	
	7	8	157.06	36.75		23.59	4.50		4.00	0.00		50.16	7.26		34.04	6.74	
	12	8	129.45	12.11		30.06	9.15		4.00	0.00		78.82	18.12		77.48	21.79	

Table IIIb: continued

Variable Family #	Trial Day	N	Camphene		Camphor		δ -2-Carene		p-Cymene		Linalool	
			x	se	x	se	x	se	x	se	x	se
35	0	9	95.60	28.23	4.37	0.37	4.00	0.00	20.47	6.48	103.28	32.85
	7	9	169.87	16.63	24.66	7.20	4.19	0.19	43.87	8.75	48.60	6.83
	12	9	235.66	38.14	25.34	4.62	4.00	0.00	69.31	10.85	88.10	19.01
36	0	13	74.47	7.84	8.39	2.61	4.00	0.00	48.52	12.14	76.12	8.33
	7	13	168.45	18.63	34.26	6.43	4.45	0.45	41.22	6.09	106.18	20.38
	12	13	138.97	17.31	20.66	3.28	4.00	0.00	71.95	13.75	88.30	16.26
37	0	6	137.77	44.72	10.49	2.94	4.00	0.00	30.42	7.59	113.65	40.45
	7	6	218.19	35.94	16.29	4.71	4.00	0.00	60.54	7.42	60.28	17.46
	12	6	150.89	40.78	17.07	6.56	4.00	0.00	71.45	30.29	51.73	12.66
38	0	7	125.52	65.76	7.39	2.42	4.00	0.00	19.20	8.21	57.08	16.06
	7	7	234.49	64.98	17.88	7.68	4.00	0.00	43.35	6.16	51.96	14.24
	12	7	309.35	168.85	26.96	8.24	4.00	0.00	60.80	17.38	51.56	22.62
39	0	11	89.85	10.40	10.59	3.17	4.00	0.00	40.55	9.97	51.05	9.29
	7	10	229.56	41.13	17.77	4.57	4.00	0.00	71.83	12.95	65.87	10.77
	12	11	218.90	42.49	21.14	5.67	4.00	0.00	80.02	15.62	48.89	8.55
40	0	11	120.53	33.54	20.28	6.05	4.00	0.00	18.65	6.45	79.04	20.08
	7	11	237.63	24.13	20.15	3.27	4.00	0.00	42.55	8.59	82.71	12.49
	12	10	186.78	35.49	15.61	5.03	4.00	0.00	58.30	7.89	61.55	11.33

Table IIIb: continued

Variable Family #	Trial Day	N	Camphene		Camphor		δ -2-Carene		p-Cymene		Linalool	
			x	se	x	se	x	se	x	se	x	se
41	0	11	112.95	24.95	4.35	0.35	4.00	0.00	57.59	21.19	56.11	18.47
	7	10	234.36	45.98	22.56	6.77	4.00	0.00	59.62	9.78	50.80	15.25
	12	11	280.67	78.69	21.47	6.82	4.00	0.00	72.48	9.28	87.03	19.39
42	0	9	67.00	20.34	5.15	0.77	4.00	0.00	18.97	7.18	44.31	14.88
	7	8	161.68	27.13	11.06	3.51	4.00	0.00	65.65	15.16	51.43	11.24
	12	8	199.06	46.36	16.67	4.60	4.67	0.67	60.01	10.17	54.69	9.03
43	0	6	88.01	22.45	4.00	0.00	4.00	0.00	23.28	10.06	37.11	12.82
	7	6	218.30	60.00	27.50	5.17	4.00	0.00	55.68	9.84	47.69	14.43
	12	6	131.78	20.76	40.13	17.10	4.00	0.00	46.29	9.03	41.44	8.59
44	0	5	52.03	29.44	9.44	4.01	4.00	0.00	7.26	3.26	29.54	21.67
	7	4	348.90	69.57	13.28	2.58	4.00	0.00	63.50	4.94	43.00	9.23
	12	5	173.26	32.59	51.83	19.95	4.00	0.00	50.64	11.57	59.72	24.59
45	0	7	99.65	12.41	5.89	1.23	4.00	0.00	31.04	6.81	62.17	13.26
	7	7	341.32	49.61	31.39	9.29	4.00	0.00	71.63	8.71	57.62	10.96
	12	7	175.58	13.81	23.79	5.58	4.00	0.00	72.06	14.00	71.96	24.53

Table IIIb: continued

Variable	Trial Day		Ocimene		Pulegone		Sabinene		α -Terpinene		γ -Terpinene	
			<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>
1	0	7	42.96	18.70	26.14	13.05	180.61	44.83	15.06	7.25	8.87	4.87
	7	6	20.27	11.94	91.50	26.20	647.92	150.56	21.72	12.30	26.33	10.54
	12	7	64.80	19.89	63.22	12.01	733.61	234.63	40.52	13.00	56.44	19.32
2	0	7	61.40	23.40	27.40	7.91	168.79	29.84	15.78	5.88	28.15	7.87
	7	6	22.27	5.59	79.26	8.24	1184.05	386.50	126.09	61.26	91.35	27.17
	12	7	83.38	49.89	56.93	12.29	1164.44	365.26	149.92	50.31	111.21	26.98
3	0	8	19.41	9.21	39.57	12.82	159.48	32.91	9.32	3.28	19.14	9.32
	7	8	17.24	10.89	47.43	17.87	751.69	185.11	83.35	27.36	86.87	32.29
	12	8	36.55	17.84	47.69	12.76	775.39	231.77	101.49	39.11	99.47	29.33
4	0	14	99.64	36.50	65.84	22.87	203.62	29.46	8.90	2.92	13.49	3.71
	7	14	36.97	11.25	57.56	7.25	700.62	95.28	51.26	14.60	86.76	29.10
	12	14	47.49	16.79	103.92	34.28	652.86	94.08	55.21	10.32	68.85	12.81
5	0	13	107.28	26.45	95.47	42.32	273.85	48.43	21.38	4.80	44.87	10.69
	7	13	57.70	20.83	135.35	38.94	1071.11	179.17	65.48	12.54	88.31	19.74
	12	13	70.55	27.84	87.38	20.18	1223.38	405.91	66.56	17.48	111.36	35.56
6	0	10	64.09	32.07	16.74	4.67	209.22	63.94	17.85	7.42	20.61	8.35
	7	10	39.89	13.30	55.09	6.32	612.12	100.24	54.52	11.54	54.34	10.18
	12	10	104.23	32.69	61.38	21.16	753.05	160.42	78.04	28.49	75.18	14.97

Table IIIb: continued

Variable	Family #	Trial Day	N	Ocimene		Pulegone		Sabinene		α -Terpinene		γ -Terpinene	
				x	se	x	se	x	se	x	se	x	se
7		0	8	74.86	17.42	93.93	72.47	252.27	74.48	15.45	5.62	22.82	9.71
		7	8	51.60	16.02	78.08	5.65	861.53	233.45	68.41	39.40	62.58	17.71
		12	7	49.47	17.63	82.05	31.77	677.17	212.47	64.70	31.82	66.97	21.83
8		0	10	71.00	32.30	36.90	25.94	127.92	30.61	11.73	3.42	9.24	4.20
		7	8	15.26	3.52	90.03	23.34	784.86	96.64	96.38	18.62	64.11	10.41
		12	10	53.34	23.80	60.73	12.97	676.89	165.14	77.27	24.99	56.60	12.78
9		0	13	84.30	45.28	28.89	8.45	357.83	60.99	23.00	8.37	52.85	21.07
		7	13	28.31	10.34	53.11	6.23	972.86	207.65	49.11	13.97	120.00	31.02
		12	13	33.88	14.73	93.92	19.11	854.07	238.79	50.48	16.81	116.30	32.15
10		0	5	141.38	93.15	39.14	11.64	161.71	39.02	21.40	10.76	22.06	11.56
		7	5	65.45	32.34	61.19	19.83	418.59	59.87	94.73	20.34	41.01	7.60
		12	5	263.30	194.17	51.96	17.08	739.94	435.32	44.54	16.87	40.93	16.17
11		0	10	5.18	1.18	39.55	12.74	255.82	67.64	12.39	4.53	27.69	7.35
		7	10	5.63	1.19	89.97	25.51	584.89	106.56	34.53	7.14	43.85	10.77
		12	10	4.67	0.67	70.11	14.82	647.22	166.61	38.42	11.68	70.26	16.71
12		0	9	139.26	48.15	43.30	11.67	312.19	54.14	20.75	8.45	37.78	12.57
		7	9	45.06	13.66	44.18	7.02	549.51	106.28	33.44	9.56	50.51	10.91
		12	9	73.30	21.21	65.36	11.60	526.36	126.72	54.87	25.46	57.70	11.26

Table IIIb: continued

Variable Family #	Trial Day	N	Ocimenene		Pulegone		Sabinene		α -Terpinene		γ -Terpinene	
			x	se	x	se	x	se	x	se	x	se
13	0	7	120.74	79.44	86.28	72.04	177.87	36.05	10.03	6.03	30.00	11.00
	7	7	16.74	7.98	44.24	12.53	428.95	84.45	34.17	20.78	45.48	11.70
	12	7	11.47	7.47	24.96	8.41	505.75	112.98	29.46	10.05	45.96	14.60
14	0	7	41.69	24.38	110.18	88.75	263.01	30.00	20.42	7.89	39.83	7.64
	7	6	45.62	35.48	122.87	19.11	821.87	151.09	108.26	47.96	97.47	19.90
	12	7	55.44	20.32	139.93	73.40	621.03	120.49	76.54	10.92	87.58	20.76
15	0	12	79.33	34.33	80.30	60.92	251.19	31.65	17.91	5.70	37.14	9.36
	7	12	52.30	24.53	102.31	23.99	985.82	174.53	52.40	10.57	121.43	22.19
	12	12	73.89	36.27	80.28	11.03	1076.87	304.54	68.53	16.71	147.04	34.84
16	0	8	10.83	5.04	45.07	11.06	289.01	41.07	28.69	8.13	39.85	9.73
	7	7	7.20	2.17	71.74	13.13	872.52	164.72	124.95	38.75	88.54	17.24
	12	8	25.52	14.23	56.60	16.47	620.72	114.68	70.75	15.13	79.96	25.78
17	0	6	60.24	27.45	107.17	85.03	185.15	37.29	10.05	4.72	33.73	13.53
	7	6	62.05	32.23	28.93	16.74	537.62	85.15	34.40	11.77	68.90	18.37
	12	6	118.11	33.48	109.83	48.62	1287.74	388.80	93.21	30.27	205.35	68.47
18	0	9	92.10	49.35	35.40	15.39	240.12	29.98	15.03	5.57	24.68	8.71
	7	9	46.14	35.27	85.12	29.30	898.30	151.26	45.32	9.07	76.16	9.75
	12	9	39.29	25.04	36.98	10.00	615.75	156.55	43.71	11.38	69.15	10.94

Table IIIb: continued

Variable Family #	Trial Day	N	Ocimene		Pulegone		Sabinene		α -Terpinene		γ -Terpinene	
			x	se	x	se	x	se	x	se	x	se
19	0	11	58.03	13.77	210.62	151.99	168.86	30.51	8.62	3.11	26.72	7.27
	7	12	38.59	13.04	76.32	12.51	856.29	145.55	51.39	10.92	96.19	21.07
	12	11	95.51	39.35	64.70	12.32	883.95	219.75	72.95	15.59	123.36	36.53
20	0	8	207.19	110.09	20.40	16.40	110.33	34.26	9.17	3.44	5.79	1.79
	7	8	283.31	95.45	57.43	12.99	880.84	252.13	45.54	10.34	74.61	16.94
	12	8	224.21	74.75	44.88	14.23	565.83	196.70	37.14	9.93	56.92	14.43
21	0	10	57.29	21.52	123.01	66.63	372.20	93.95	12.24	3.59	36.11	11.57
	7	10	52.16	38.61	84.09	24.53	979.73	319.24	57.82	20.71	105.95	44.12
	12	10	44.68	23.85	52.51	17.82	518.14	131.26	38.78	11.41	70.92	20.37
22	0	10	29.68	17.40	131.29	85.26	173.92	25.54	13.43	6.33	11.50	4.18
	7	10	88.28	46.51	56.24	12.38	704.46	89.46	59.46	9.20	68.80	15.86
	12	10	100.43	48.08	49.86	12.16	500.61	166.06	39.02	13.27	51.83	10.11
23	0	7	30.40	17.26	119.64	99.42	298.28	70.37	22.04	8.63	39.85	15.53
	7	7	28.31	17.29	68.28	27.00	558.65	97.02	28.38	8.39	65.64	18.69
	12	7	43.60	21.28	120.84	32.09	1277.22	431.17	97.52	34.00	138.51	49.82
24	0	15	125.76	34.86	181.49	98.99	422.66	161.62	29.95	10.06	40.81	12.36
	7	13	69.10	22.37	46.09	11.52	1053.04	246.86	155.23	67.06	78.10	18.58
	12	15	79.27	19.65	50.15	12.22	921.83	276.22	119.51	50.82	94.66	35.33

Table IIIb: continued

Variable Family #	Trial Day	N	Ocimene			Pulegone			Sabinene			α -Terpinene			γ -Terpinene		
			x	se		x	se		x	se		x	se		x	se	
25	0	12	164.46	62.38		43.37	28.92		121.29	29.07		13.98	4.34		23.35	7.96	
	7	12	32.23	6.78		49.67	8.49		470.47	87.71		24.30	3.94		34.99	7.67	
	12	12	78.96	27.29		51.08	12.42		470.56	99.31		24.38	7.89		55.10	10.30	
26	0	7	23.84	9.12		14.61	5.19		185.59	46.90		7.67	2.68		24.52	8.02	
	7	7	8.21	2.55		44.01	11.70		444.52	84.20		26.70	9.59		48.74	14.18	
	12	7	17.65	8.07		62.86	10.65		540.71	113.01		35.07	11.53		66.78	16.79	
27	0	8	240.96	125.07		40.02	11.18		330.67	48.50		39.37	10.82		72.13	10.06	
	7	8	23.41	8.51		70.04	18.64		567.91	112.52		52.51	16.43		70.49	18.06	
	12	8	57.65	21.79		56.90	19.43		1119.88	437.25		159.99	90.58		151.50	55.74	
28	0	13	31.76	13.09		21.00	7.01		187.43	27.16		18.16	5.92		25.96	7.42	
	7	13	24.74	10.70		36.69	7.71		480.85	56.91		31.73	9.61		34.96	8.50	
	12	13	57.99	21.78		44.60	7.71		619.68	240.95		43.99	18.92		65.56	21.41	
29	0	7	164.01	50.54		60.63	20.47		529.66	130.47		34.72	7.75		73.24	12.54	
	7	7	60.83	17.89		71.49	17.71		1048.11	308.14		58.08	20.72		104.49	41.35	
	12	7	107.64	57.86		47.30	5.45		908.07	363.53		57.52	24.58		112.34	52.80	
30	0	7	52.22	40.19		37.60	16.10		191.13	17.64		11.88	7.88		14.00	6.62	
	7	7	8.63	3.69		107.34	21.90		1010.68	261.07		62.64	43.02		76.67	16.81	
	12	7	81.26	55.63		92.18	19.78		674.38	135.40		36.82	10.53		66.54	9.79	

Table IIIb: continued

Variable Family #	Trial Day	N	Ocimene		Pulegone		Sabinene		α -Terpinene		γ -Terpinene	
			x	se	x	se	x	se	x	se	x	se
31	0	8	27.29	15.20	41.57	26.85	248.78	33.52	9.37	4.20	12.58	5.65
	7	8	19.06	8.40	76.61	17.63	611.57	101.98	18.89	4.35	56.29	9.79
	12	8	86.43	44.60	82.59	15.89	1262.88	322.87	77.30	17.84	159.94	44.52
32	0	9	50.82	33.16	42.28	15.24	375.10	111.77	16.49	10.32	40.92	24.91
	7	9	27.08	11.62	59.19	6.32	943.99	258.88	50.75	7.23	90.33	9.67
	12	9	74.76	30.97	120.95	69.04	929.97	241.20	66.28	22.57	123.62	33.22
33	0	5	37.68	14.75	21.75	17.75	200.64	26.51	4.00	0.00	36.16	24.55
	7	5	48.32	16.64	123.00	33.59	1097.69	379.60	70.39	29.08	101.66	33.30
	12	5	60.57	53.35	63.58	13.67	577.64	88.49	27.80	7.54	59.17	14.13
34	0	8	4.00	0.00	26.87	16.92	294.28	88.45	12.74	5.82	47.58	14.61
	7	8	4.17	0.17	97.73	35.28	702.02	160.09	51.27	14.05	100.82	29.10
	12	8	46.49	18.86	47.92	10.77	443.88	70.17	27.79	5.73	67.87	13.78
35	0	9	85.96	30.76	20.64	14.00	264.74	52.04	11.17	5.51	28.12	10.18
	7	9	21.30	6.38	39.29	9.46	628.18	109.57	35.34	8.94	73.39	19.80
	12	9	69.45	26.06	59.79	11.76	868.47	177.23	59.98	14.19	117.88	25.11
36	0	13	104.92	25.94	28.93	8.38	214.39	55.28	11.32	4.73	30.72	10.60
	7	13	119.83	21.89	64.46	11.72	765.43	160.18	38.62	6.89	78.11	12.23
	12	13	117.89	37.48	67.60	13.00	672.21	232.50	23.71	8.67	63.04	13.62

Table IIIb: continued

Variable Family #	Trial Day	N	Ocimene		Pulegone		Sabinene		α -Terpinene		γ -Terpinene	
			x	se	x	se	x	se	x	se	x	se
37	0	6	62.13	26.82	135.98	68.19	334.52	79.54	19.22	7.73	36.38	13.09
	7	6	31.11	23.34	51.82	11.29	761.16	127.24	43.83	5.40	71.85	20.02
	12	6	21.20	9.53	30.61	9.37	479.35	196.81	30.14	14.88	61.55	28.80
38	0	7	46.40	20.86	45.94	36.23	212.69	50.86	4.30	0.30	12.98	5.86
	7	7	65.64	33.90	45.73	11.43	647.68	178.66	34.41	11.86	65.58	29.92
	12	7	50.64	19.23	42.34	12.96	527.20	127.24	35.57	9.72	64.89	23.46
39	0	11	136.56	42.73	36.98	10.08	173.72	23.16	5.87	1.87	19.98	6.46
	7	10	123.82	37.51	80.46	12.76	847.81	178.30	43.52	10.59	84.45	24.61
	12	11	104.78	23.54	119.13	71.38	731.14	144.50	52.12	16.44	84.87	20.81
40	0	11	92.91	58.98	77.93	55.54	135.68	21.62	11.15	3.27	14.69	6.29
	7	11	59.39	32.91	34.95	6.02	622.04	91.73	50.98	11.07	46.08	11.13
	12	10	27.97	10.14	45.99	10.30	417.02	58.72	31.38	6.59	50.02	15.23
41	0	11	55.51	31.98	66.30	47.25	307.30	82.38	7.02	3.02	19.24	7.93
	7	10	47.78	30.73	57.27	7.98	996.64	276.68	68.42	22.51	121.47	39.21
	12	11	84.40	31.23	47.73	6.92	755.69	179.89	53.86	16.29	102.23	29.32
42	0	9	13.68	5.47	33.03	18.02	212.22	55.72	17.19	5.93	28.99	13.92
	7	8	10.27	4.49	47.11	11.71	590.90	101.13	32.20	8.90	62.37	16.07
	12	8	20.88	8.48	42.15	7.24	728.75	192.44	49.82	11.23	100.82	21.74

Table IIIb: continued

Variable			Ocimene		Pulegone		Sabinene		α -Terpinene		γ -Terpinene	
Family #	Trial Day	<i>N</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>
43	0	6	155.11	114.17	14.78	7.77	202.41	49.33	6.83	2.83	13.58	6.18
	7	6	64.55	45.34	65.28	21.06	765.83	221.48	33.12	13.82	58.34	25.76
	12	6	86.17	39.12	56.29	17.01	409.45	84.91	25.13	11.85	49.23	23.03
44	0	5	88.03	84.03	4.00	0.00	177.48	66.60	29.87	12.22	6.85	2.85
	7	4	42.97	34.76	48.76	10.40	1054.84	242.07	67.22	23.06	55.10	12.97
	12	5	47.52	29.43	72.85	37.50	469.97	92.35	35.82	8.88	25.38	10.98
45	0	7	108.35	36.23	104.43	91.70	299.03	44.80	10.42	4.34	21.96	8.63
	7	7	38.03	12.84	103.20	21.14	1345.15	270.32	97.84	34.96	106.78	37.28
	12	7	49.42	30.07	61.58	12.59	602.12	82.91	39.56	8.80	58.39	14.86

Variable			Terpineol		α -Caryophyllen		α -Copaene		α -Cubebene		α -Humulene	
Family #	Trial Day	<i>N</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>
1	0	7	57.96	13.67	26.32	6.88	15.76	10.17	6.58	2.58	26.47	14.04
	7	6	32.66	17.19	24.33	13.20	7.71	3.71	4.00	0.00	4.55	0.55
	12	7	123.53	26.10	44.21	12.00	32.58	9.51	4.00	0.00	28.13	13.06
2	0	7	67.12	19.39	20.72	6.24	17.27	8.68	15.56	4.52	41.42	13.29
	7	6	46.33	13.85	17.93	3.02	11.69	4.40	10.98	3.93	16.77	4.79
	12	7	100.70	14.34	44.99	12.43	13.02	5.02	19.01	13.18	46.56	21.02

Table IIIb: continued

Variable Family #	Trial Day	N	Terpineol		α -Caryophyllen		α -Copaene		α -Cubebene		α -Humulene	
			x	se	x	se	x	se	x	se	x	se
3	0	8	68.01	16.10	35.39	10.07	21.32	8.44	8.09	2.41	79.91	27.72
	7	8	37.87	26.71	34.69	13.99	13.49	5.83	12.82	4.41	16.67	6.47
	12	8	63.01	16.79	22.66	4.00	18.91	7.67	4.41	0.41	57.77	28.87
4	0	14	84.90	18.80	29.62	7.04	29.72	7.86	15.47	3.28	57.57	18.41
	7	14	92.28	25.77	72.10	37.06	26.90	9.96	9.46	2.62	47.77	13.63
	12	14	95.33	15.43	40.08	6.60	29.10	6.83	8.69	2.54	60.88	16.44
5	0	13	96.20	16.84	25.25	5.50	30.27	6.70	17.36	4.21	74.91	14.01
	7	13	48.16	8.50	25.64	4.25	26.43	8.14	7.00	2.77	44.98	10.61
	12	13	107.74	18.10	44.46	8.87	27.26	6.33	7.51	3.51	57.76	19.02
6	0	10	81.16	29.35	14.08	4.68	23.86	8.63	12.93	7.20	20.14	8.88
	7	10	34.03	10.93	20.32	4.47	9.15	2.86	4.60	0.60	22.10	5.78
	12	10	75.45	12.05	42.78	6.56	20.15	6.09	15.75	9.26	53.52	20.75
7	0	8	84.29	26.69	23.13	7.02	13.90	6.53	4.00	0.00	51.27	11.32
	7	8	29.82	12.37	33.51	7.28	10.75	3.65	4.55	0.55	17.05	7.53
	12	7	74.17	25.32	24.44	6.03	7.48	2.26	6.47	1.97	33.02	13.36
8	0	10	43.36	8.13	48.04	27.46	5.06	1.06	4.00	0.00	47.85	24.80
	7	8	40.08	11.46	27.37	4.30	4.15	0.15	5.60	1.60	9.54	4.21
	12	10	60.51	14.57	37.40	6.28	13.02	4.34	5.03	1.03	24.32	10.22

Table IIIb: continued

Variable Family #	Trial Day	N	Terpineol		α -Caryophyllen		α -Copaene		α -Cubebene		α -Humulene	
			x	se	x	se	x	se	x	se	x	se
9	0	13	162.44	39.85	41.69	8.23	35.25	19.07	27.03	11.07	66.99	19.75
	7	13	92.28	31.73	30.79	3.00	14.91	4.43	7.08	1.66	29.34	7.34
	12	13	105.97	16.05	44.42	9.29	28.11	10.03	15.56	5.81	70.69	33.65
10	0	5	182.78	57.90	36.31	18.25	55.89	26.35	13.73	8.75	81.82	17.11
	7	5	49.98	26.36	31.83	8.43	37.70	15.22	5.65	1.38	23.63	8.19
	12	5	200.38	61.17	119.18	50.76	93.98	47.78	10.06	4.44	71.36	35.35
11	0	10	51.82	16.58	25.37	9.48	8.36	2.53	8.47	2.50	81.51	41.54
	7	10	29.75	7.38	22.83	3.62	9.00	3.38	5.36	1.36	21.22	6.11
	12	10	60.28	15.43	24.36	8.02	11.39	4.02	5.12	0.85	28.22	10.21
12	0	9	74.01	25.77	60.48	26.57	29.90	11.65	7.75	2.49	56.24	23.64
	7	9	41.43	17.15	23.94	5.09	17.93	8.47	16.07	6.15	44.37	26.74
	12	9	94.83	37.67	45.26	15.62	27.71	15.40	5.57	1.08	16.27	8.71
13	0	7	50.23	10.49	21.76	7.71	20.57	10.72	20.03	8.29	32.92	12.41
	7	7	49.18	22.64	19.40	5.23	4.28	0.28	5.32	1.32	7.83	1.93
	12	7	59.01	7.97	22.19	4.07	7.87	2.73	5.05	1.05	16.14	8.00
14	0	7	81.14	28.77	31.30	12.37	14.60	6.77	5.40	0.71	42.77	16.89
	7	6	57.24	14.89	33.48	8.41	19.65	9.32	5.07	1.07	14.33	9.29
	12	7	115.16	31.29	68.63	20.27	37.64	10.88	9.12	4.25	51.28	14.59

Table IIIb: continued

Variable Family #	Trial Day	N	Terpineol		α -Caryophyllen		α -Copaene		α -Cubebene		α -Humulene	
			x	se	x	se	x	se	x	se	x	se
15	0	12	85.73	26.82	39.27	7.49	31.18	12.45	12.74	3.72	70.20	26.81
	7	12	58.27	14.90	24.10	5.82	17.19	5.37	5.58	1.17	31.70	20.26
	12	12	90.61	22.72	27.09	4.17	28.42	9.14	10.75	4.04	18.50	4.85
16	0	8	84.68	19.70	22.59	6.43	11.65	3.59	16.56	6.83	43.21	10.30
	7	7	26.94	13.29	22.67	6.52	7.71	2.33	4.00	0.00	7.18	2.12
	12	8	59.51	12.28	19.37	4.49	13.93	5.13	4.92	0.92	46.78	22.17
17	0	6	66.44	36.91	29.85	14.01	10.17	6.17	4.21	0.21	38.79	21.32
	7	6	30.38	9.92	18.62	3.30	9.73	4.44	7.36	3.36	24.74	14.90
	12	6	90.64	27.17	45.11	9.94	31.53	8.93	13.31	8.07	28.76	11.22
18	0	9	114.67	35.77	32.76	9.45	41.44	18.36	23.09	10.76	70.25	28.99
	7	9	60.94	24.92	37.92	9.24	14.57	7.54	5.56	1.56	27.10	8.89
	12	9	135.08	26.76	65.55	13.34	32.32	10.17	8.68	2.03	36.50	13.48
19	0	11	69.60	14.25	35.32	7.58	7.95	2.85	5.98	1.33	51.58	25.61
	7	12	44.99	7.14	24.34	6.32	5.64	1.64	4.90	0.48	14.47	3.89
	12	11	88.46	18.13	34.71	7.22	11.52	3.58	13.90	7.04	32.06	8.72
20	0	8	17.82	6.76	12.30	4.62	5.97	1.97	4.00	0.00	14.14	7.25
	7	8	47.32	15.18	33.59	6.05	10.38	3.91	4.00	0.00	12.25	3.32
	12	8	124.54	42.74	51.62	18.04	25.24	12.70	13.76	5.49	26.84	12.66

Table IIIb: continued

Variable Family #	Trial Day	N	Terpineol			α -Caryophyllen			α -Copaene			α -Cubebene			α -Humulene		
			x	se		x	se		x	se		x	se		x	se	
21	0	10	57.92	15.51		16.43	5.46		6.94	1.59		6.20	1.49		45.04	15.98	
	7	10	38.89	15.58		31.41	6.92		10.32	4.66		8.63	3.35		16.50	8.02	
	12	10	155.17	65.67		45.63	10.92		26.48	12.26		5.93	1.93		39.88	25.67	
22	0	10	63.59	18.86		21.12	7.04		4.00	0.00		5.52	1.52		15.73	7.05	
	7	10	81.99	23.59		27.64	6.53		25.89	10.03		4.25	0.25		22.87	5.43	
	12	10	67.67	16.78		31.16	6.63		11.73	5.00		8.34	2.91		11.20	3.24	
23	0	7	75.92	24.54		26.66	9.19		29.69	11.40		14.88	6.37		51.02	17.36	
	7	7	45.13	13.60		29.78	4.22		8.68	2.33		8.75	4.38		7.86	2.67	
	12	7	71.47	29.34		48.28	14.34		22.08	9.55		7.75	2.57		33.07	11.23	
24	0	15	116.76	18.50		37.92	7.67		28.66	6.99		14.06	4.16		46.37	12.20	
	7	13	37.25	10.02		36.50	6.45		16.88	8.11		11.05	3.29		19.11	7.94	
	12	15	129.21	23.05		54.95	7.79		31.51	8.93		5.99	1.29		35.17	12.05	
25	0	12	117.61	22.98		34.26	8.62		44.74	11.46		8.44	3.43		22.65	10.65	
	7	12	45.56	13.53		24.23	6.76		12.97	4.63		7.21	2.74		13.69	2.89	
	12	12	96.40	15.93		38.26	8.61		21.27	5.82		5.97	1.53		18.34	5.26	
26	0	7	101.83	24.29		20.26	8.35		12.37	3.98		8.80	3.11		35.19	14.99	
	7	7	31.28	8.34		25.41	8.89		6.72	2.72		7.94	3.25		10.01	3.10	
	12	7	77.40	17.03		33.02	6.97		9.29	3.58		5.57	1.57		18.73	7.21	

Table IIIb: continued

Variable Family #	Trial Day	N	Terpineol		α -Caryophyllen		α -Copaene		α -Cubebene		α -Humulene	
			x	se	x	se	x	se	x	se	x	se
27	0	8	107.81	24.34	59.72	18.64	48.38	13.05	15.66	3.91	59.13	15.80
	7	8	46.89	9.95	21.18	6.13	16.53	5.60	10.48	4.83	15.04	6.21
	12	8	95.48	20.62	44.05	7.89	21.34	10.97	6.11	2.11	33.25	14.12
28	0	13	65.75	15.42	31.17	5.19	20.26	5.99	8.56	2.44	30.01	8.91
	7	13	47.48	10.17	24.48	3.95	13.72	4.48	5.66	1.12	21.40	8.24
	12	13	91.53	29.53	42.28	6.23	23.00	12.90	4.39	0.39	36.86	11.37
29	0	7	169.61	56.63	78.87	22.89	73.99	27.91	48.04	14.88	120.81	35.74
	7	7	44.40	17.71	44.09	9.04	30.19	13.33	8.87	2.50	31.93	8.86
	12	7	114.48	20.87	75.84	17.56	26.97	9.65	28.93	17.49	57.97	34.64
30	0	7	59.00	11.80	20.04	7.38	15.15	11.15	5.19	0.84	28.22	14.42
	7	7	52.66	15.39	21.49	4.99	5.29	1.29	6.25	2.25	16.26	7.16
	12	7	140.13	41.75	41.75	5.98	27.39	18.45	14.84	5.22	55.50	25.98
31	0	8	38.13	10.55	24.57	7.54	4.00	0.00	9.37	5.37	29.84	17.64
	7	8	41.22	8.97	29.24	8.32	4.76	0.50	5.17	1.17	7.50	2.05
	12	8	123.26	18.99	46.17	11.15	22.57	8.99	18.58	4.45	63.51	29.95
32	0	9	66.31	11.26	40.28	15.62	13.88	5.37	22.29	13.62	70.04	39.35
	7	9	40.22	7.80	22.14	8.27	7.92	2.17	5.44	1.23	12.93	4.44
	12	9	115.54	30.60	72.01	26.87	30.91	7.96	11.01	2.91	123.56	42.41

Table IIIb: continued

Variable Family #	Trial Day	N	Terpineol		α -Caryophyllen		α -Copaene		α -Cubebene		α -Humulene	
			x	se	x	se	x	se	x	se	x	se
33	0	5	53.37	21.91	33.13	4.42	27.86	16.88	10.77	6.77	39.93	17.31
	7	5	48.90	26.12	29.40	8.35	15.68	6.71	7.53	2.42	10.11	2.56
	12	5	54.48	15.39	51.00	23.40	15.01	9.68	16.76	12.76	34.60	15.05
34	0	8	59.04	25.02	39.01	14.23	4.00	0.00	9.19	3.56	30.98	11.93
	7	8	32.26	8.59	27.76	8.57	4.00	0.00	5.55	1.18	7.33	2.29
	12	8	101.27	25.38	50.74	11.64	22.61	9.82	19.59	7.30	38.64	13.89
35	0	9	68.73	21.76	22.80	7.59	27.41	14.61	16.57	7.69	52.03	16.45
	7	9	21.44	11.95	15.42	5.06	10.97	4.64	10.32	2.52	14.16	5.70
	12	9	89.35	26.12	26.54	5.53	26.52	11.54	9.72	4.75	23.22	5.94
36	0	13	79.40	17.18	30.57	10.76	25.54	7.02	11.44	2.49	39.94	13.77
	7	13	71.57	17.23	41.40	7.38	27.72	6.14	9.58	2.04	17.45	4.90
	12	13	85.21	12.28	35.92	8.33	23.93	6.88	9.02	2.24	37.83	12.10
37	0	6	123.02	64.39	42.38	15.18	38.01	22.18	12.65	7.68	49.01	23.83
	7	6	64.25	40.58	32.63	10.26	20.09	15.32	4.00	0.00	10.35	5.93
	12	6	80.90	32.22	37.72	13.71	17.24	11.15	4.00	0.00	18.06	9.17
38	0	7	86.69	36.29	18.05	6.51	20.55	9.18	4.00	0.00	27.82	11.41
	7	7	54.04	18.64	18.78	3.66	7.47	1.73	7.96	3.96	6.65	1.44
	12	7	73.80	30.00	41.92	18.71	15.27	7.14	8.40	4.40	48.48	31.13

Table IIIb: continued

Variable Family #	Trial Day	N	Terpineol			α -Caryophyllen			α -Copaene			α -Cubebene			α -Humulene		
			x	se		x	se		x	se		x	se		x	se	
39	0	11	59.69	12.69		30.06	8.65		11.12	4.78		7.71	2.50		52.28	22.10	
	7	10	42.37	7.87		21.15	3.49		7.99	2.45		8.11	3.02		21.72	7.04	
	12	11	77.10	14.34		31.68	5.50		19.24	6.66		6.02	2.02		41.78	15.70	
40	0	11	104.76	26.80		27.86	8.06		22.60	5.95		6.11	2.11		21.99	7.34	
	7	11	55.11	13.79		39.02	5.35		14.06	3.16		5.65	0.94		17.25	5.09	
	12	10	104.17	12.08		36.01	5.03		16.34	5.08		4.00	0.00		30.27	11.09	
41	0	11	85.98	25.32		18.55	6.12		26.42	9.82		14.06	6.21		65.01	23.81	
	7	10	41.16	14.68		25.18	4.07		24.51	14.16		9.14	2.54		12.92	3.09	
	12	11	102.86	15.98		47.12	12.06		29.47	6.58		6.52	1.99		38.22	10.20	
42	0	9	40.64	11.69		18.00	7.23		4.00	0.00		5.11	1.11		24.16	8.05	
	7	8	41.17	13.95		23.57	7.11		4.95	0.95		18.68	13.86		13.53	4.76	
	12	8	45.19	17.31		35.98	5.99		8.82	4.24		4.00	0.00		21.89	8.22	
43	0	6	58.97	22.04		36.41	16.22		21.30	16.63		13.39	9.39		29.68	18.31	
	7	6	41.51	16.68		33.04	6.63		14.56	9.05		5.83	1.83		23.08	10.41	
	12	6	67.34	19.96		30.58	9.50		17.11	5.10		5.78	1.78		8.03	4.03	
44	0	5	44.11	11.74		9.40	5.40		4.00	0.00		4.00	0.00		4.00	0.00	
	7	4	33.17	6.55		19.53	6.83		4.00	0.00		4.78	0.78		15.25	6.80	
	12	5	48.47	9.94		35.29	5.92		4.00	0.00		4.35	0.35		7.37	3.37	

Table IIIb: continued

Variable			Terpineol		α -Caryophyllen		α -Copaene		α -Cubebene		α -Humulene	
Family #	Trial Day	<i>N</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>
45	0	7	52.32	11.40	9.25	2.27	9.49	3.81	7.03	3.03	41.11	16.12
	7	7	37.77	8.84	39.04	11.28	5.92	1.92	10.71	4.01	18.73	3.98
	12	7	46.65	12.35	32.33	9.95	16.17	7.18	8.74	4.00	29.46	17.75
Variable			α -Thujone		Total Terpenoids		Total Monoterpenes		Total Sesquiterpenes			
Family #	Trial Day	<i>N</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>		
1	0	7	4.00	0.00	16725.75	3848.80	16650.62	3844.29	75.13	24.23		
	7	6	10.31	3.60	46811.89	11556.30	46771.29	11552.37	40.59	16.13		
	12	7	8.65	4.65	59877.94	19146.12	59769.02	19150.91	108.92	24.57		
2	0	7	4.00	0.00	15920.05	4092.26	15825.09	4083.37	94.96	18.49		
	7	6	6.71	2.71	69884.62	20755.86	69827.25	20759.86	57.37	11.58		
	12	7	8.15	4.15	85249.18	20036.17	85125.61	20038.76	123.57	27.18		
3	0	8	4.00	0.00	14509.16	3340.92	14364.45	3323.99	144.71	39.51		
	7	8	6.63	1.44	48078.15	8978.64	48000.49	8990.21	77.66	24.95		
	12	8	7.17	2.10	54923.76	12181.01	54820.01	12195.80	103.75	34.22		
4	0	14	4.00	0.00	21180.29	2692.25	21047.90	2676.99	132.38	27.13		
	7	14	13.92	4.37	55008.89	6696.99	54852.65	6672.24	156.23	50.70		
	12	14	10.04	3.19	47318.91	5952.90	47180.17	5949.41	138.75	22.85		

Table IIIb: continued

Variable			α -Thujone		Total Terpenoids		Total Monoterpenes		Total Sesquiterpenes	
Family #	Trial Day	<i>N</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>
5	0	13	4.00	0.00	28817.07	4314.63	28669.28	4317.82	147.78	20.47
	7	13	12.52	4.30	76892.26	10801.41	76788.21	10795.38	104.05	18.07
	12	13	4.97	0.97	80481.95	22640.57	80344.96	22640.99	136.99	25.57
6	0	10	4.00	0.00	18638.21	4306.05	18567.20	4300.66	71.01	11.40
	7	10	6.21	1.98	44545.62	6436.66	44489.45	6433.52	56.17	10.17
	12	10	4.80	0.80	58240.72	11744.05	58108.52	11746.94	132.20	31.61
7	0	8	8.09	4.09	24288.59	6010.66	24196.29	5996.46	92.30	18.90
	7	8	19.07	9.99	67545.01	21192.79	67479.15	21185.17	65.86	13.53
	12	7	12.46	5.32	59168.88	22039.49	59097.47	22043.68	71.41	14.60
8	0	10	7.59	3.59	10659.07	2164.84	10554.11	2134.56	104.96	51.41
	7	8	11.51	5.01	61584.87	6432.43	61538.22	6429.20	46.66	7.25
	12	10	11.21	4.56	59019.34	16597.68	58939.56	16597.17	79.78	11.22
9	0	13	4.00	0.00	32629.37	8065.72	32458.40	8025.85	170.97	48.10
	7	13	11.27	4.44	60166.01	10319.81	60083.89	10315.41	82.12	10.98
	12	13	10.37	2.97	59391.97	13255.12	59233.19	13261.43	158.78	44.30
10	0	5	12.53	5.90	16944.42	5007.38	16756.67	4990.49	187.75	43.39
	7	5	9.62	5.25	31705.07	3395.14	31606.26	3422.86	98.82	31.43
	12	5	7.37	3.37	29955.80	6824.11	29661.23	6781.87	294.57	93.34

Table IIIb: continued

Variable			α -Thujone		Total Terpenoids		Total Monoterpenes		Total Sesquiterpenes	
Family #	Trial Day	N	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>
11	0	10	4.00	0.00	19311.23	4968.80	19187.51	4923.12	123.72	52.69
	7	10	6.50	1.67	40319.38	7452.56	40260.97	7447.00	58.41	10.99
	12	10	7.70	2.32	46926.13	12262.16	46857.04	12255.79	69.10	19.22
12	0	9	4.00	0.00	26800.51	5698.55	26646.14	5660.22	154.37	53.86
	7	9	15.02	6.95	38995.98	6589.63	38893.67	6583.82	102.31	40.85
	12	9	4.00	0.00	37223.70	8765.77	37128.88	8767.60	94.81	34.87
13	0	7	4.00	0.00	18753.98	4479.83	18658.70	4458.69	95.28	27.67
	7	7	7.58	1.95	31338.10	5971.78	31301.27	5968.99	36.83	5.48
	12	7	4.00	0.00	34636.61	5872.33	34585.36	5875.51	51.25	10.72
14	0	7	4.00	0.00	24634.83	3168.91	24540.76	3150.55	94.07	32.32
	7	6	23.50	4.47	64205.07	13639.35	64132.54	13622.48	72.53	23.92
	12	7	13.56	6.20	48828.32	7642.44	48661.65	7623.66	166.67	42.53
15	0	12	4.00	0.00	18883.31	2631.57	18729.92	2610.52	153.38	37.19
	7	12	10.99	3.70	58748.77	9288.91	58670.19	9292.68	78.57	26.28
	12	12	10.30	2.95	67179.08	16170.70	67094.32	16176.10	84.76	14.54
16	0	8	4.00	0.00	24676.78	3569.81	24582.77	3557.15	94.01	19.44
	7	7	4.17	0.17	62737.13	12122.20	62695.58	12120.16	41.55	8.47
	12	8	9.87	3.84	48398.92	7073.20	48313.92	7069.49	85.00	25.04

Table IIIb: continued

Variable			α -Thujone		Total Terpenoids		Total Monoterpenes		Total Sesquiterpenes	
Family #	Trial Day	<i>N</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>
17	0	6	4.00	0.00	16700.15	2527.18	16617.14	2509.69	83.01	35.07
	7	6	18.90	7.98	38220.58	5878.50	38160.15	5855.96	60.44	23.36
	12	6	16.73	4.60	81895.33	19290.48	81776.61	19280.17	118.72	28.76
18	0	9	4.00	0.00	24083.83	3608.92	23916.28	3563.29	167.55	52.36
	7	9	5.41	1.24	62148.65	9675.71	62063.50	9663.73	85.15	19.68
	12	9	9.74	3.52	49176.84	11375.32	49033.80	11368.35	143.04	19.93
19	0	11	4.00	0.00	16545.71	2087.90	16444.88	2088.20	100.84	30.20
	7	12	10.44	2.81	53552.01	7478.67	53502.65	7476.91	49.35	9.38
	12	11	9.40	2.92	64398.88	10264.91	64306.69	10268.83	92.19	10.56
20	0	8	4.00	0.00	11482.77	2676.06	11446.36	2671.16	36.41	8.52
	7	8	6.30	1.56	60512.33	13294.86	60452.10	13299.71	60.23	10.55
	12	8	12.14	4.17	49328.75	14604.25	49211.30	14606.68	117.46	23.02
21	0	10	4.00	0.00	32717.67	8573.29	32643.06	8560.82	74.61	16.11
	7	10	5.49	1.49	59950.48	11344.40	59883.62	11348.87	66.86	18.16
	12	10	6.25	2.25	42063.26	8883.30	41945.34	8885.38	117.92	34.34
22	0	10	4.00	0.00	14960.44	2156.38	14914.07	2148.39	46.37	13.42
	7	10	11.56	2.99	52239.94	5040.70	52159.29	5041.80	80.65	16.90
	12	10	6.22	2.22	38390.36	12042.84	38327.93	12047.07	62.43	10.33

Table IIIb: continued

Variable			α -Thujone		Total Terpenoids		Total Monoterpenes		Total Sesquiterpenes	
Family #	Trial Day	<i>N</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>
23	0	7	4.67	0.67	25738.62	6600.34	25616.37	6566.01	122.25	36.25
	7	7	12.14	4.61	37681.54	6543.35	37626.48	6547.28	55.06	6.07
	12	7	9.06	3.51	79247.07	23275.15	79135.88	23267.77	111.19	32.00
24	0	15	4.00	0.00	32425.14	12140.84	32298.13	12142.69	127.02	19.07
	7	13	16.26	7.06	69675.13	15524.75	69591.59	15519.05	83.54	22.38
	12	15	11.71	3.02	65594.59	18151.25	65466.97	18153.76	127.62	20.52
25	0	12	4.14	0.14	17865.32	4068.89	17755.23	4045.41	110.09	27.33
	7	12	8.55	2.45	45190.44	7682.50	45132.34	7681.90	58.10	13.02
	12	12	5.89	1.56	47523.20	9480.07	47439.35	9481.38	83.85	17.77
26	0	7	5.31	1.31	16070.94	4597.75	15994.32	4584.39	76.63	19.76
	7	7	18.88	13.27	32453.39	6135.98	32403.32	6137.41	50.07	10.02
	12	7	4.00	0.00	37648.38	7142.30	37581.77	7139.19	66.61	13.24
27	0	8	4.00	0.00	28254.42	5079.73	28071.53	5045.92	182.89	44.04
	7	8	12.13	5.79	42955.06	6760.18	42891.83	6755.93	63.24	14.72
	12	8	14.45	5.38	77000.93	26089.49	76896.17	26079.97	104.76	29.67
28	0	13	4.00	0.00	17229.45	2375.17	17139.45	2367.18	90.00	17.45
	7	13	6.92	2.12	38173.06	3456.99	38107.79	3454.39	65.27	12.17
	12	13	7.50	1.52	47621.75	13818.25	47515.22	13816.22	106.53	22.87

Table IIIb: continued

Variable			α -Thujone		Total Terpenoids		Total Monoterpenes		Total Sesquiterpenes	
Family #	Trial Day	<i>N</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>
29	0	7	6.96	2.96	50305.97	9963.81	49984.27	9911.56	321.71	69.11
	7	7	8.20	3.92	70011.27	15863.78	69896.20	15878.67	115.07	24.91
	12	7	7.73	3.73	64881.47	19525.84	64691.76	19525.69	189.71	43.20
30	0	7	4.00	0.00	15078.43	1401.68	15009.83	1380.60	68.60	28.22
	7	7	11.95	6.15	69098.59	17845.43	69049.30	17847.84	49.29	13.34
	12	7	4.00	0.00	50900.86	7549.32	50761.38	7558.02	139.48	45.74
31	0	8	6.11	2.11	16675.81	2348.64	16608.03	2359.46	67.78	19.71
	7	8	13.56	4.86	42528.97	6828.98	42482.30	6825.29	46.67	7.66
	12	8	7.42	2.43	86713.36	16433.02	86562.54	16434.37	150.83	29.87
32	0	9	4.00	0.00	19887.32	2649.62	19740.83	2659.18	146.50	50.13
	7	9	18.31	5.89	46671.99	4140.50	46623.56	4145.44	48.43	8.24
	12	9	8.88	3.29	71915.81	19230.72	71678.32	19223.99	237.49	46.44
33	0	5	4.00	0.00	20533.25	3296.67	20421.56	3284.22	111.68	26.40
	7	5	4.50	0.50	68129.91	23682.38	68067.19	23673.77	62.72	13.14
	12	5	10.62	4.06	46917.79	8073.12	46800.41	8061.83	117.38	40.93
34	0	8	10.60	6.60	19633.17	4854.16	19549.99	4844.28	83.19	17.58
	7	8	7.39	2.24	44377.02	9203.23	44332.38	9197.39	44.64	10.33
	12	8	9.28	3.46	32143.38	4123.99	32011.81	4121.98	131.57	22.99

Table IIIb: continued

Variable			α -Thujone		Total Terpenoids		Total Monoterpenes		Total Sesquiterpenes	
Family #	Trial Day	<i>N</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>
35	0	9	5.61	1.61	22292.16	4808.51	22173.35	4780.55	118.81	29.80
	7	9	14.56	6.81	43097.34	5878.04	43046.46	5875.54	50.88	8.14
	12	9	7.13	1.72	60051.95	9800.75	59965.95	9796.99	86.00	17.21
36	0	13	4.00	0.00	13569.24	1262.70	13461.75	1257.48	107.49	22.32
	7	13	12.74	3.16	41744.26	4395.30	41648.10	4401.11	96.16	15.79
	12	13	12.48	4.63	32054.13	4347.29	31947.44	4356.74	106.70	21.45
37	0	6	4.00	0.00	31109.96	8011.46	30967.92	7981.05	142.04	43.20
	7	6	11.53	4.12	57100.03	8477.25	57032.97	8462.80	67.06	31.15
	12	6	8.92	3.15	35891.34	12261.81	35814.31	12262.68	77.02	23.60
38	0	7	4.00	0.00	19077.81	5011.03	19007.39	5006.20	70.42	23.39
	7	7	5.76	1.76	48711.28	11094.69	48670.42	11091.56	40.86	7.65
	12	7	5.16	1.16	40225.03	8695.19	40110.95	8676.55	114.08	51.65
39	0	11	4.00	0.00	14354.53	1533.82	14253.34	1523.74	101.18	27.64
	7	10	11.32	4.37	58402.52	10643.48	58343.56	10642.87	58.97	7.07
	12	11	11.34	3.25	50780.29	9809.17	50681.57	9803.70	98.72	19.19
40	0	11	4.00	0.00	16671.01	1702.84	16592.46	1691.48	78.56	16.38
	7	11	16.09	5.99	52002.93	5948.70	51926.95	5949.61	75.98	11.15
	12	10	11.61	5.17	37032.40	4498.42	36945.78	4500.02	86.62	15.01

Table IIIb: continued

Variable			α -Thujone		Total Terpenoids		Total Monoterpenes		Total Sesquiterpenes	
Family #	Trial Day	<i>N</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>	<i>x</i>	<i>se</i>
41	0	11	4.00	0.00	20568.63	4426.51	20444.58	4419.30	124.05	38.75
	7	10	14.22	4.00	61037.19	12549.15	60965.45	12554.76	71.74	21.51
	12	11	10.14	3.05	52453.97	10043.84	52332.64	10050.22	121.33	21.96
42	0	9	4.00	0.00	16281.62	4795.32	16230.34	4785.79	51.28	12.68
	7	8	25.41	21.41	38946.66	5717.52	38885.94	5712.95	60.72	21.48
	12	8	5.72	1.72	51130.09	13213.89	51059.39	13210.48	70.70	14.26
43	0	6	4.00	0.00	15331.16	3731.45	15230.39	3706.61	100.77	52.80
	7	6	8.28	2.76	53436.66	14955.68	53360.15	14949.69	76.51	24.80
	12	6	9.22	3.53	31649.94	6259.28	31588.42	6261.40	61.51	13.00
44	0	5	4.00	0.00	13725.17	4852.23	13703.76	4848.72	21.40	5.40
	7	4	11.15	7.15	73460.69	13741.14	73417.13	13736.80	43.56	11.90
	12	5	15.03	7.32	37633.03	6238.96	37582.02	6235.87	51.01	8.24
45	0	7	4.00	0.00	19647.03	2333.72	19580.14	2329.57	66.89	18.36
	7	7	19.32	6.67	83226.63	12472.69	83152.23	12463.97	74.40	13.73
	12	7	4.00	0.00	40654.92	4722.02	40568.23	4728.06	86.69	25.62

CHAPTER 3 APPENDIX

Appendix I. Heritability calculations example

Cov Parm	Dependent	Variable	Height Age 10	
	Estimate	Standard Error	Z Value	Pr Z
FAM	354.24	106.53	3.33	0.0004
REP(SITE)	129.23	68.803	1.88	0.0302
Residual	2639.34	129.92	20.32	<.0001

Variable heritability calculation	Height Age 10
FAM	354.24
REP(SITE)	129.23
Residual	2639.34
Heritability value	0.45

Variable SE	Height Age 10
FAM	106.53
REP(SITE)	68.803
Residual	129.92
Heritability value	0.14

Heritability as well as standard error was calculated by taking the estimate for the main effect family (Fam) multiplying by 4 due to families being only half-siblings. Then the sum of the main effects family (FAM), replication within site (REP(SITE)), and the residual from each output were summed and then divided into the value created before.



Photo 2: Bark Texture 1 Smooth



Photo 3: Bark Texture 2 Smooth-Medium



Photo 4: Bark Texture 3 Medium



Photo 5: Bark Texture 4 Medium-Rough



Photo 6: Bark Texture 5 Rough