EVALUATION OF FOUR LOW-CHILL PEACH (*Prunus persica* L. Batsch) CULTIVARS IN THREE CLIMATIC ZONES IN FLORIDA

By

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A THESIS PRESENTED TO THE GRADUATE SCHOOL
OF THE UNIVERSITY OF FLORIDA IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF SCIENCE

UNIVERSITY OF FLORIDA

2006

This thesis is dedicated to my parents Kermit and Irene Wert and to my brother Terry Wert for the love and support they have given me.

ACKNOWLEDGMENTS

I would first like to thank my parents Kermit and Irene Wert and my brother Terry Wert for all the love, support, and encouragement they have given me. I would also like to thank all of my friends down here and at home for their support through thick and thin, good and bad. For the immense amount of help they have provided me throughout this process, I am indebted to my committee members, Dr. Jeffery Williamson, Dr. Jose Chaparro, and Dr. Robert Rouse. For their help and support, a most sincere thank you goes to Paul and Donna Miller; without their help I do not think this would have been possible. I would also like to thank my harvesting crew for helping me pick and process endless quantities of peaches. I thank all the people in Fifield Hall who took peaches off of my hands when I needed to get rid of them.

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CULITIVARS IN THREE CLIMATIC ZONES IN FLORIDA

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December 2006

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Four low-chill peach cultivars ('Flordaprince', 'Flordaglo', 'UFGold', and 'TropicBeauty') were grown in three different locations in Florida. These locations were in north-central, central, and southwest Florida. The effects of different climatic conditions were observed on vegetative and reproductive growth, and on fruit quality and yield. Climate was observed to have an effect on the different cultivars within each location.

'TropicBeauty' was observed to have greater fruit weight and size; however, it also had longer fruit development period (FDP), lower blush, and higher amounts of blind nodes than other cultivars. 'UFGold' had lower mean fruit weight and smaller fruit size, but had a higher SSC:TA ratio, higher yields, and set higher amounts of floral buds than other cultivars. Blush values were higher for 'Flordaprince' than for the other cultivars. In several cultivars fruit weights were higher, and blush values were lower than previously reported.

Differences among the locations were observed for amounts of fruit blush, SSC:TA ratios, blind nodes, and blossom end ratings. Generally higher blush values and SSC:TA ratios were observed in southwest Florida along with fruit with more pronounced blossom ends. Higher amounts of blind nodes were also observed in southwest Florida, and chilling accumulation was lowest at this location. The length of the FDP was influenced by mean temperature during fruit development at all three locations. A longer FDP was observed in north-central Florida where temperatures were lowest, and a shorter FDP was observed in southwest Florida where temperatures were highest.

There was an accidental application of excess fertilizer at the north-central Florida location. Rates were at least 2.5 times greater at this location. This higher rate of nitrogen may have affected fruit quality and development. Mean blush values were lower, fruit weights were higher, SSC values were lower, and the SSC:TA ratio was lower compared to the other two locations. Fruit yield adjusted for trunk cross-sectional area (TCA) was also higher in north-central Florida compared to the other locations.

It could be recommended that cultivars which exhibit large numbers of blind nodes and greater percentage of fruit with extended tips be grown in locations further north. Cultivars that do not have these problems should be planted further south to acquire the higher blush values and SSC:TA ratios that are preferred in the market provided their chilling requirement is met. Through the higher nitrogen rates applied at the north-central location it could be concluded that current recommendations for amounts of nitrogen fertilizer are too low for production in Florida and rates probably need to be increased. Further research needs to be done in nitrogen rates in peach to determine the optimum amount needed to increase fruit size and yield without sacrificing fruit quality.

CHAPTER 1
LITERATURE REVIEW

General Information

The peach is classified as a member of the genus *Prunus* and a member of the species *persica*. Other common members of the *Prunus* genus include Japanese plum (*Prunus salicina*), European plum (*Prunus domestica*), nectarine (*Prunus persica*), apricot (*Prunus armeniaca*), almond (*Prunus dulcis*), sour cherry (*Prunus cerasus*), and sweet cherry (*Prunus avium*). The peach was first classified by Carolus Linneaeus in 1753; the present name of *Prunus persica* was given to the peach by August Johann Georg Batsch in 1801 (Faust and Timon, 1995) and has been used since.

The peach fruit has a double sigmoid growth curve, with three distinct stages of growth (Connors, 1919). The first stage occurs after bloom and lasts until initiation of pit hardening. Rapid fruit growth occurs during this stage and it is generally associated with cell division (Addoms et al., 1930; Ragland, 1934). The beginning of pit hardening starts the second stage of growth, or lag phase, in which the diameter of the fruit increases very little but dry weight of the fruit increases due to endocarp lingification (Tukey, 1933). This stage has also been associated with a rapid increase in the development of the embryo (Tukey, 1933). Once pit hardening is complete the third stage of growth occurs in which a rapid increase in fruit diameter continues until harvest. This stage is generally associated with cell expansion (Ragland 1934).

There are many types and combinations of types of peaches grown today. There are fruits that can have yellow, white, or red flesh, with yellow being the most common.

Fruits can have either melting or nonmelting flesh, the difference being the amount of endo-polygalacturonase enzyme between the types. Nonmelting flesh peaches contain very low levels of endo-polyglacturonase, and the flesh remains firm (Pressey and Avants, 1978). Melting flesh peaches have normal levels of endo-polygalacturonase, allowing the flesh to soften and "melt" from the pit. The nonmelting trait is particularly useful for processing. Melting flesh types tend to fall apart during processing, while nonmelting flesh peaches maintain their integrity and stay firm. The majority of cultivars on the market are generally round, though there are peaches which are flat, these are called 'Peento' peaches and are usually named in the market as "saucer peaches." The adherence of the pit or stone to the flesh is classified as clingstone or freestone. The pit of a freestone peach is easily removed from the flesh, with little or no flesh adhering to the pit, once the peach becomes soft ripe; for the clingstone peach it is not possible to cleanly separate the pit from the adjoining flesh. There are types which fall between the two; these are called either semifree or semicling, again depending on adhesion of the flesh to the pit at the soft ripe stage. Peaches can also be classified as to the amount of acidity at harvest. Low acid types are generally called "honey" peaches; these peaches generally have a high amount of sugar and, as the name implies, low amounts of acid. High acid types are, as the name implies, higher in acid. The higher acid cultivars are generally found in the U.S. market and low acid types are preferred by the Asian market (Byrne et al., 2000).

The nectarine is a peach without fuzz. A single gene is the difference between the two, but this gene affects several different characteristics (Byrne et al., 2000). Nectarines are generally smaller, rounder, redder, higher brix, have a higher acid content, and are denser (Byrne et al., 2000). Nectarines and peach can be prone to a condition called skin speckles or sugar speckles. Skin speckles have been shown to vary with the amount of sugar within the flesh of the nectarine or peach (Topp and Sherman, 2000; Wu et al., 2003). Generally, nectarines are two brix° units higher than peaches. The higher brix° in nectarines makes them more prone to skin speckles. Skin speckles appear as rough spots lacking pigment on the cheeks and tip of the fruit (Topp and Sherman, 2000). Skin speckling has been associated with increased transpiration rates in the parts which contained the speckles (Wu et al., 2003).

History and Importation

The generic name of *Prunus* is Latin for Plum (Faust and Timmon, 1995). The Romans acquired the peach from Persia, so it was thought the origin of the peach was from there (Faust and Timmon, 1995); hence it was given the specific name *persica*. It is now thought that the cultivated peach is native to China (Yu-lin, 1985). The peach probably made its way to Persia, from China, in the first or second century B.C., by way of caravans (Faust and Timmon, 1995). It was not long after the importation of the peach to Persia that Romans acquired it; from there it spread throughout Europe. During the Spanish conquest of the Americas, the Spaniards brought the peach to Mexico, and also introduced it into what is now the state of Florida. From Mexico the peach spread into what are now the states of New Mexico, California, and Arizona (Faust and Timmon, 1995). Importation into Florida was about 1565 in the area around Saint Augustine. From the importation into Florida it spread North and West to what are now the states of Louisiana, Arkansas, Georgia, the Carolinas, New Jersey and New York during the 1600's, 1700's, and 1800's (Faust and Timmon, 1995).

During the mid 1800's there were a few direct imports from China to the U.S. These peaches were commonly given the name of Chinese Cling (Faust and Timmon, 1995). It is believed that one of these Chinese Cling peaches may have been pollinated by an 'Early Crawford' peach tree to give rise to the modern American peach genotypes 'Elberta' and 'Georgia Belle' (Faust and Timmon, 1995).

Three importations of peaches with low-chill genes from South Asia came into the United States during the mid 20th century, and have been used extensively in the University of Florida peach breeding program. One group was imported into Charleston, South Carolina; the second group was imported into Hawaii (Hawaiian group); and the third group was imported as seed from Okinawa (Sherman and Lyrene, 2003).

Low-Chill Peach Market

The low-chill peach in the state of Florida fills a market window that would otherwise be devoid of peaches. The time period between April and May has relatively few peaches in the market. During this time period importations from the southern hemisphere have declined, and domestic peaches have not matured. The early blooming peaches with short fruit development periods (FDP) developed by the University of Florida peach breeding program could fill this market window. There is a negative correlation between the temperature and the length of the FDP (Topp and Sherman, 1989a). Therefore, cultivars planted in the southern portions of the state should ripen earlier than the same cultivars in the northern portions of the state. Rouse and Sherman (2002a) demonstrated that cultivars which normally ripen in the Gainesville area of Florida around early to mid May ripened in mid to late April in South Florida. This early-ripening germplasm could fill the April to May market window keeping a constant flow of peaches in the market between the end of importations and the start of domestic production in other sections of the country.

Peaches have a large amount of variation for chilling requirement. A chilling unit as defined by Weinberger (1950a) is one hour at 45°F (7.2°C) or below. Peach cultivars are known that have chilling requirements varying from ~50 cu ('Red Ceylon') to more than 1100 cu ('Mayflower') (Okie, 1998). Within Florida, cultivars are classified as being low-chill (<300 cu), medium-chill (300 to 525 cu), or high-chill (>525 cu) (Williamson et al., 2005). Chilling requirement is essential to the survival and reproduction of peach trees. Dormancy prevents the tree from growing during transient warm periods that are favorable for growth during the winter when subsequent frosts and freezes could kill developing flower buds and cambium (Weinberger, 1950b). Once chilling is satisfied trees must acquire the appropriate amount of heat units to initiate growth. As defined by Muñoz et al. (1986, p. 520), a heat unit is "the time needed for the completion of a developmental process weighted by the prevailing temperature above a base temperature." In this case we are talking about initiation of growth after endodormancy. Peaches with the lowest chilling generally flower first. Peach cultivars with a high chilling requirement from northern areas are not adapted to subtropical areas like Florida because they are not exposed to enough chilling to break endodormancy (Sherman and Lyrene, 2003).

In the state of Florida, the chilling can vary from 700 chill units in the western part of the panhandle to as few as 50 chill units or less in areas of the southern tip of the state. This means that cultivars with different chilling requirements need to be developed to fill each of these climatic zones. The low-chill peach breeding program at the University of

Florida was started by R.H. Sharpe in 1953. His goal for the program was to “develop commercially acceptable peach and nectarine cultivars ripening in sequence from late April until early June for the 100 to 600 chill unit zones” (Sherman and Rodriguez – Alcazar, 1987, p. 1235). By “commercially acceptable” he meant that the peach cultivars had to be low-chill, have a FDP of 70 – 100 days, be firm, yellow-fleshed, and be of at least moderate size (Sharpe, 1961). Another criteriaon used in the Florida peach breeding program is a high amount of red over color or “blush”. This along with a bright yellow ground color is desired by U.S. consumers (Anderson and Sherman, 1994). The genes for low-chilling were obtained from the South Asian and Hawaiian peach germplasm mentioned previously. The peaches imported during the mid 1500’s by the Spanish were not used in the University of Florida peach breeding program because they ripened too late in the season and were of moderate chilling.

Temperature Effects on Other Fruits

Temperature can have major effects on many different aspects of the development of fruit crops. Of the various environmental factors, temperature can have the greatest effect on fruit growth (Correlli-Grappadelli and Lakso, 2004). It can affect the color as well as its perceived sweetness. Effects on fruit shape and size have also been noted. Work done in Ireland on apple has shown that the two environmental factors which seamed to be the most important in the growth of the fruit were sunlight and night temperature (Blanpied and Kennedy, 1967). But temperature affects more than just quality parameters. There have been several reports on effects on floral buds and fruit development. Reductions in yields have also been reported. The problem with determining the effects of temperature on development of fruit and other aspects of tree development is that, it can be confused with rootstock and soil effects (Monselise and Goren, 1987).

Red Skin Color and Anthocyanin Concentration

Anthocyanins are a class of pigments responsible for the red coloration of some flowers and fruits. The six major groups of anthocyanidins are: pelargonidin, cyanidin, peonidin, delphinidin, petunidin, and malvidin, with cyanidins being the most common type of anthocyanin. Cyanidin glycosides are typically responsible for the scarlet reds, pelargonidin glycosides for orange-red colors, and delphinidin glycosdes for bluish-red colors (Lancaster, 1992).

Some of the most documented effects of temperature on growth and development have been in relation to the development of red skin color and synthesis of anthocyanins. Temperature can have a major effect on the synthesis of anthocyanin and subsequently fruit color. During the last month of fruit maturation, the red pigmentation in the skin, which is important for consumer acceptance in several different types of fruit, increases with cooler night temperatures rather than warmer night temperatures (Sherman et al., 2003).

There has been considerable work done in apples in relation to changes in skin coloration, concentration of anthocyanins in the apple peel, and the relationship between the two with temperature. Fruit maturity in apple orchards can be influenced by several factors including temperature and environmental conditions during development (Warrington et al., 1999). Night temperatures coincide better with coloration than day temperatures (Uota, 1952). It was concluded that the pigments responsible for the formation of anthocyanin are affected by temperatures during the late part of the growing season. Color development can be prompted by even a small number of cool night temperatures and warm sunny days (Curry, 1997). A similar result was found in which skin coloration was decreased by warm night temperatures (Blankenship, 1987).

In contrast Arakawa (1991) observed that as temperatures increased during fruit development, the amount of anthocyanin increased as well. Similar results were obtained by Reay and Lancaster (2001) in ‘Gala’ and ‘Royal Gala’ apples where they observed that anthocyanin accumulation increased less at 10°C than at 20°C but only for early harvests. Alternating temperatures have also shown to have an effect on skin coloration and anthocyanin accumulation. It was observed in detached ‘Granny Smith’ apples that alternating temperatures, at which there was a period of low temperature followed by a period of high temperature, favored the accumulation of anthocyanin (Reay, 1999). A similar effect was observed in ‘Crisps Pink’ apple (Marais et al., 2001). But this is contrasted by Tromp (1999) who reports, temperature difference during the harvest period had little if any effect on the development of ‘Elstar’ and ‘Cox’s Orange Pippin’ skin color. Similar results were found by Fragher (1983) in ripe apples.

Climate effects on skin color and anthocyanin accumulation in apple have been reported by several other authors. It has been observed that when the prevailing weather conditions are cooler and moister, anthocyanin content in the skin can be higher at harvest (Igelesias et al., 2002). A similar result was found in which apples grown in a semi-arid, cool, and high irradiant climate favored the accumulation of anthocyanins more than if they were grown in a moist, warm, and low irradiant climate (Li et al., 2004).

Different cultivars and strains of cultivars can have different reactions to temperature. Iglesias et al. (1999) reported significant differences among seven strains of

'Delicious' apple for fruit coloration. When the seven strains were tested for three seasons, the apples achieved the highest coloration during the season where weather conditions were cooler and moister.

Red pigmentation in the skin of different pear cultivars has been observed to be affected by the passage of cold fronts during the end of fruit development (Steyn et al., 2004a). As with apples, cultivar differences were observed. The cultivar 'Rosemarie' developed better color while 'Bon Rouge' had no response to temperature change (Steyn et al., 2004a). It was concluded that cold fronts passing through the area during fruit development helped the development of red coloration in the pears. Other observations indicate an interaction of both the synthesis and degradation of anthocyanin occurs at different temperatures, and this interaction determines the color of red pear fruit (Steyn et al., 2004b). One factor which could reduce the rate of anthocyanin synthesis and hence final coloration of the organ could be substrate limitation. If substrate limitation reduces the rate of anthocyanin synthesis than coloration of the organ would occur at lower temperatures (Steyn et al., 2004b).

High temperatures can have a major effect on anthocyanin accumulation and subsequent coloration in grape skins. Anthocyanin accumulation in 'Merlot' grape was observed to be deterred by abnormally high temperatures (Spayd et al., 2002). This confirms an earlier report by Kliewer (1970) using 'Cardinal' grapes which showed a marked difference between those that ripened at low verses high temperature. He reported that color formation in grapes was more uniform at lower temperatures.

Varying effects have also been observed in other fruits. Flesh and surface coloration of strawberries can be darker and redder when grown at warmer temperatures

(Wang and Camp, 2000). Blackberry juice color increased when fruits were grown at lower temperatures (Naumann and Wittenburg, 1980). A similar result was found in pomegranate (Shulman et al., 1984). For cranberries, colorimeter readings of red color intensity were higher in cooler areas (Hall and Starke, 1972).

Many reports have been published regarding the influence of both temperature and climate on fruit coloration and anthocyanin development. Conflicting reports abound in the literature, among fruits and cultivars. In apples alone, increased coloration has been observed at higher temperatures, lower temperatures, and alternating temperatures. There appears to be no one single answer for the effect of temperature and climate on coloration in fruit.

Titratable Acidity and Soluble Solids

Soluble solids concentration (SSC) can be used as an estimate of sugar content. In addition to sugars, the components that make up the SSC can include organic acids, amino acids, phenolic compounds, and soluble pectins (Mitcham et al., 1996). SSC is measured using a refractometer and is expressed in terms of °Brix or percent SSC. Titratable Acidity (TA) is a measure of the amount of acid found within a commodity. An estimation of TA is generally determined by taking a known volume of juice and titrating it to a pH of 8.2 (Mitcham et al., 1996). Depending on the fruit, TA is expressed as either the percent of malic, citric, or tartaric acid (Mitcham et al., 1996). The ratio between both the SSC and TA can give a good estimation of the perceived sweetness of an organ. For a given SSC value, fruit with lower TA are perceived as being sweeter and those with a higher TA are perceived as being tarter.

Both TA and SSC can be affected by high and low temperatures. A reduction in TA at locations with higher temperatures has been observed for several different types of fruit. A decrease in TA has been observed in strawberry (Wang and Camp, 2000), grape (Kliewer, 1968; Spayd et al., 2002), blackberry (Naumann and Wittenburg, 1980), and pomegranate (Shulman et al., 1984) at warmer temperatures. In citrus, juice sacks had lower levels of TA at harvest and higher TA levels during early fruit development for fruit grown at warmer temperatures (Richardson et al., 1997).

The SSC of the whole fruit of Satsuma mandarin was reported to be greater when grown at warmer temperatures (Richardson et al., 1997). A later article reported that the increase in SSC was evident at early stages of citrus fruit development (Marsh et al., 1999). Both pomegranate (Shulman et al., 1984) and persimmon (Mowat et al., 1997) had higher SSC in warmer regions compared to cooler regions. Similar results were observed in apple (Warington et al., 1999).

Conversely Islam and Khan (2000), Kano (2004), Nauman and Wittenburg (1980), Tromp (1999), and Tukey (1952) all reported higher fruit SSC as temperatures decreased for various fruits (tomatoes, watermelon, blackberry, apple, and cherry, respectively). An early report in tomato may explain why higher temperatures reduce SSC in some fruits. It was concluded that when night temperatures were low, translocation of sugar out of the leaves and into the fruit was higher, and that these sugars were not being used for growth, thus fruit were sweeter (Went and Cosper, 1945).

Fruit Development Period (FDP)

The FDP is the period from the peak time of bloom to the peak harvest time. There are several factors which can affect the FDP. Included in this is the prevailing temperature in the area and the genetic tendencies of the cultivar. Each cultivar has a characteristic FDP. However, this can be affected by the temperatures during fruit development. Tufts in (1929) observed three different apricot orchards in California with cool, intermediate, and warm temperatures. He noticed that apricots of the same variety ripened earlier at the warmest site. The difference was six to eight day's between warm and intermediate sites, and two to three weeks between the warm and cool sites (Tufts, 1929). Like peach, apricot and cherry, have double sigmoidal growth curves with three distinct stages of development. Any one of these stages can be affected by temperatures. Tukey (1952, p. 162) stated that "warm temperatures immediately following full bloom (during stage I) decrease the number of day's until fruit maturity. However, warm temperatures late in the season (stage III) noticeably lengthen the number of days to maturity." A similar finding for apricot was also observed (Baker and Brooks, 1944). Another study in apricot in which a shelter was built around a limb, and heated at night to 20°F above the outside ambient temperature; it was observed that the warmer temperatures within the shelter shortened the first phase of fruit development by 22 day's (Lilleland, 1936). Lilleland concluded that this decrease in the length of the first growth phase of the apricot was in response to its environment, presumably the warmer night temperatures in the shelter. The length of the entire FDP decreased for fruits within the shelter compared to fruits outside of the shelter. In another shelter containing a spur with only fruit the FDP was reduced by twenty eight days compared to fruit outside of the shelter. Lilleland (1936) concluded that fruit growth can be affected independently from the rest of the tree by exposure of only fruits to fluctuations in temperature. Later Baker and Brooks (1944) reported that this reduction in the FDP is due to additional heat units early in the season.

Stone fruit are not the only fruits which can be affected by warmer temperatures. Usually warmer temperatures reduce the number of days to fruit maturity from full bloom, but it has been shown that this is not always the case. Harvest began one month earlier for figs grown in warmer areas than figs grown in cooler areas (Botti et al., 2003). In grapes it was observed that higher temperatures during the day increased the number of degree days for ripening of 'Pinot noir' fruits from veraison to fruit maturity, compared to lower day time temperatures (Kliewer and Torres, 1972). Cooler temperatures can also have an effect on ripening of fruits. Premature ripening of 'Bartlet' pears has been reported when temperatures were cool one month prior to normal ripening (Wang et al., 1971).

The FDP, of any fruit can be affected by several different things including bloom time, temperature during fruit development, and genetic influence. Stone fruit can be affected at all three stages of development. Increased temperature during the first stage of growth can shorten the FDP considerably, while during the third stage it can lengthen it. Higher temperatures during later developmental stages have also increased the FDP of other fruits such as grapes.

Fruit Size, Yield, and Shape

Several effects of temperature on fruit size (both weight and diameter) have been reported. Effects on fruit size can in turn have an effect on harvestable yield. Environment can influence several factors related to raspberry fruit size, including; ovule number and durpelet set and weight (Dale, 1986). Significant increases in fig weight and diameter have been observed at warmer locations (Botti et al., 2003). Sour cherry fruits that received a very high temperature treatment, (25°F above the average outdoor night temperature), had the smallest fruits compared to a medium (10°F) and high (20°F) temperatures treatments (Tukey, 1952). Reuther et al. (1969) found that citrus fruit grown in warmer areas generally were larger than those in cooler areas. Warm springtime temperatures have also been reported to affect citrus fruit enlargement (Cooper et al., 1963). In a production study for cranberry in five regions in the U.S. the number of days needed to accumulate 0.5 g of fresh mass was determined (DeMoranville et al., 1996). It was shown that in New Jersey high temperatures limited growth of the fruit and that the opposite was true in Oregon and in Washington where low temperatures limited fruit growth.

Documented effects in yield of several commodities have been observed. In cranberry fruit yield was affected the most by temperature (Degaetano and Shulman, 1987). They found that temperatures above 32.2°C during the time period when flowers were opening and during berry formation were detrimental to yields. Raspberry yield has been observed to be affected by the interaction of cultivar and above ground temperatures (Prive et al., 1993). Citrus yields can be adversely affected by the maximum temperature during the time of June drop (Jones and Cree, 1965).

Several reports have been published for different commodities concerning climatic and temperature effects on the shape of fruit. Higher temperatures generally produce rounder fruit and lower temperatures produce fruit that are more elongated (Sherman et al., 2003). Several studies on peppers have shown that low night temperature can affect the shape of the developing fruits. More flattened pepper fruits have been observed at a lower night temperature of 12°C verses fruit grown at a temperature of 18°C (Aloni et al., 1999). They also found that at the lower temperature the fruits were parthenocarpic. Both deformed fruits and parthenocarpic fruits were also observed at lower temperatures in an earlier study by Rylski and Spiglman (1982) who also worked with peppers. Seedless pepper fruits were again observed at lower temperatures and larger fruits at higher temperatures by Polwick and Sawheney (1985). Conversely, apple fruit shape was not directly affected by environment but was affected by the number of seeds per fruit (Tromp, 1990).

Citrus fruit shape has been observed to be influenced by temperature. The condition of “sheepnosing” or “stem end tapering” in grapefruit is reported to be an effect of low temperatures. In a controlled environment study by Wutscher (1976) where grapefruit plants were exposed to a fixed day temperature and three different night temperatures, the lower the night temperatures resulted in greater fruit elongation. Temperature effects have also been seen in Valencia oranges and mandarins. Fruit grown in warmer areas were rounder compared to those grown in cooler areas which were flatter (Nauer et al., 1974). Similar effects were also reported for navel oranges (Nauer et al., 1972), and grapefruit and lemons (Nauer et al., 1975).

Fruit size, yield, and shape can all be affected by temperature. In several reports fruit size was increased under warmer temperature conditions. In contrast there are several reports where fruit size was reduced at warmer temperatures. Reduction in fruit size due to unfavorable temperatures during growth can lead to reduced yields. Lower temperatures have been shown to produce flattened pepper fruits and “sheepnosing” in citrus fruits. Warmer temperatures have produced larger pepper fruits and citrus fruits which were rounder.

Floral Development

Development of flowers and floral buds can be affected by the prevailing temperature in an area. In work with persimmon George et al. (1994) found that larger flowers were produced at lower temperatures. Abnormalities in floral development at lower temperatures have also been reported in pepper. They include abnormal development of the petals, stamens, and gynoecia (Polwick and Sawhney, 1985). On the other hand, it has been found in some flowers that increased temperatures promote flowering. Higher day temperatures promoted flowering of 'Elegance' chrysanthemum, but higher night temperatures delayed flowering (Cockshull et al.,1981). Winter temperatures in different areas can also play a role in the development of flower buds in blackberry. Continuous floral bud development occurred during the winter at sites that were above 2°C (Oregon), but not at sites with winter temperatures below 2°C (West Virginia and Arkansas) (Takeda et al., 2002).

Bud failure in almonds is a genetic disorder which is passed on through vegetatively propagated material, and is influenced by high temperatures (Kester and Asay, 1978). It is similar to blind wood in peaches. Bud failure is due to higher temperatures during the previous summer (Kester and Asay, 1978). They state: "that bud failure potential increased as one shifts from a low temperature location to a high temperature location, however shifting from a high temperature location to a low temperature location did not decrease the bud failure potential, but masked the symptoms."

Other Aspects of Development

There are many other aspects of plant development which can be affected by temperature and climate. It has been reported in cranberry that bud formation and production of non-fruiting stems are favored by warmer temperatures (Degaetano and Shulman, 1987). Coagulation of soluble tannins in persimmon fruit has been reported to occur throughout the fruit development period in warm climates verses twenty three weeks after full bloom in cool climates (Mowat et al., 1997). Temperatures during fruit development have also been reported to effect the development of fruit translucency in pineapple (Chen and Paull, 2001).

Increased temperatures have also been shown to affect the development of shoots and leaves. Apricot limbs which were placed in a heated shelter had more growth than those which were not in the shelter (Lilleland, 1936). High night temperatures have been shown to affect the coloration of sour cherry leaves, with leaves grown at warmer temperatures having less green color than at cooler temperatures (Tukey, 1952).

Numerous reports have been documented for temperature effects on citrus. Variations in peel thickness have been associated with variations in temperature and have been reported by several authors (Cohen et al., 1972; Hilgeman, 1966; Iwasaki et al., 1986; and Young et al., 1969). Temperature also affects peel color of citrus. Orange peel color in citrus is mainly due to the accumulation of carotenoids in the peel. The effect of temperature on carotenoid accumulation in citrus peel was demonstrated in a controlled environment experiment by Young and Erickson (1961). They found that 12°C soil temperature, 7°C night temperature and 20°C day temperature produced highly colored fruits. They also observed an increase in any one of these temperature parameters caused a reduction in the orange color of the peel. Similar results were obtained in ‘Redblush’ grapefruit by Young et al. (1969). This was substantiated in the field by Reuther et al. (1969) when it was reported that when night temperatures were higher during the months of December to February, color development in the peel occurred at a slower rate.

Climate and Temperature and Their Effect on Peaches

Fruit color, size, shape, firmness, and taste are some of the characteristics which are most important in determining fruit value (Porter et al., 1996). Effects of temperature on the development of different parts of the peach tree have been documented. Time of bloom, length of the FDP, fruit size, fruit shape, proportion of blind nodes, as well as other aspects of fruit and tree development can be influenced by the prevailing temperatures in the localities where peaches are grown.

Endodormancy, Chilling, and Bloom

As stated earlier different cultivars of peaches have different chilling requirements to release them from endodormancy. This limits where certain cultivars of peaches can be grown. Higher chill cultivars in the 700+ range are more suited to traditional peach growing areas like central Georgia and South Carolina. When grown in areas like Florida where the winters are mild, these cultivars will not receive adequate chilling and will not flower. Low-chill cultivars which receive < 300 chill units (Williamson et al., 2005) are more suited to subtropical areas like Florida. A chill unit has been defined as one hour at 45°F (7.2°C) or below (Weinberger, 1950a). Other models have been developed in an attempt to obtain better estimates of chilling for different regions. Another model uses the amount of hours between 32°F (0°C) and 45°F (7.2°C), and the Utah model developed by Richardson et al. (1974) categorizes the hours even more thoroughly. Richardson et al. (1974) proposed that one chill unit is accumulated when temperatures are 37°F (2.5°C) to 48°F (9.1°C), one half of a chill unit is accumulated when temperatures are 35°F (1.5°C) to 36°F (2.4°C) or 49°F (9.2°C) to 54°F (12.4°C); below 34°F (1.4°C) no chill units are accumulated. They also proposed the idea of negative chill units or chilling negation, where between 61°F (16°C) and 65°F (18°C) a half of a unit is lost and at temperatures above 65°F (18°C) a whole chill unit is lost (Richardson et al., 1974). It has been reported that a condition of secondary dormancy can be induced when temperatures are 20°C or greater (Erez and Lavee, 1971). On the other hand Maxwell and Lyons (1969) did not find chilling negation at temperatures above 70°F

(21.1°C). They also observed that temperatures of 50°F (10°C) can satisfy the cold requirement for peaches with South Asian parentage. Rest breaking ability has also been reported in temperatures above 45°F by several other authors (Erez and Lavee, 1971; Gurdian and Biggs, 1964). Another model reported by Sherman et al. (1978) seems to give a good estimate of chilling in the southeast U.S. Their model uses the number of hours below 7.2°C during the coldest month in the winter season at a location, and this number is multiplied by 2.5. Other models have reported success using December/Janurary (Weinberger, 1956) and Janurary (Sharpe, 1969) mean temperatures.

If for some reason adequate amounts of chilling are not accumulated in an area in the spring a condition called "prolonged dormancy" can occur. As defined by Weinberger (1950b, p. 129) "prolonged dormancy of peaches is a condition in which leaf and flower buds are delayed beyond the usual time of opening in the spring, even though favorable growing temperatures occur." Effects of prolonged dormancy are a delay in bloom, a period of bloom which is spread out several weeks, buds on the tips of shoots blooming long before those at the base of the shoot, vegetative buds breaking in the center of the tree first and then laterals, and in severe cases flower buds abscise before opening (Couvillon, 1995; Sherman et al., 2003; Weinberger, 1950b). Other problems with prolonged dormancy of peaches can include reduced fruit set and fruit that have a pronounced tip (Byrne and Bacon, 1992, Campbell et al., 1995, Koffmann and Patten, 1992; Rouse and Sherman, 2002a; Rouse and Sherman, 1989a). It has been suggested that the effect of temperature on the pronounced tip is more attributed to higher temperatures during early development of the fruit rather than prolonged dormancy

(Sherman and Rodriguez-Alcazar, 1994). Other problems with lack of chilling are that the fruit may have a greener ground color or reduced firmness (Byrne and Bacon, 1992).

Bloom period can be affected by temperature. Rouse and Sherman (1989a) reported that bloom in the area around the Lower Rio Grande Valley of Texas was earlier by 7 to 10 day's as compared to Gainesville Florida. This area is warmer than Gainesville. Similar results were reported by Topp and Sherman (1989a). Floral development can be affected adversely by high temperatures. Kozai et al. (2004) reported that flower development was suppressed at temperatures above 25°C.

Fruit Development Period (FDP) and Fruit Size

The FDP or period of time between peak bloom to peak harvest differs among cultivars. The FDP can be highly temperature dependent (Anderson and Sherman, 1994). Generally speaking peaches with a longer FDP usually have larger fruit and peaches with a short FDP have smaller fruit. It is difficult to breed a large peach with a short FDP (Porter et al., 1996). The effect of temperature on the FDP of peach is cultivar specific and differs among the cultivars (Boonprakob et al., 1992).

Night temperature can have a substantial effect on maturity of 'Early Redhaven' peach (Batjer and Martin, 1965). During early development, warmer temperatures accelerated fruit maturity and cooler temperatures delayed it. It has also been reported that low temperatures following bloom can prolong the FDP, this was also observed to be cultivar specific (Blake, 1930).

Topp and Sherman (1989a) observed that a decrease of 1°C in the mean temperature during the growing season increased the FDP by 5 day's. They also reported that temperatures two months following full bloom were the most important. Similar results were obtained by Boonprakob et al. (1992) for 30 to 45 days after full bloom, and by Rouse and Sherman (1989a). The quickest time from bloom to harvest for peaches has been observed at a night temperature above 10°C and day temperatures below 38°C (Sherman et al., 2003).

Since fruit size and the FDP are correlated there should be a reduction in fruit size in warmer locations verses cooler locations, which was also reported by Topp and Sherman (1989b) where they observed that a 1°C increase in mean monthly FDP temperature caused a decrease in the diameter of the fruit by 0.7 mm. The date of the first commercial harvest at a location can be more variable than the date of full bloom, this is due to temperature fluctuations during fruit development (Topp and Sherman, 1989a).

Fruit set is another component which can be affected by the prevailing temperatures in an area. Exposure of trees to several different temperature regimes, for three weeks resulted in a complete reduction in fruit set at 21 - 29°C (day/night) and a reduction in the FDP at 15 - 23°C verses 12 – 20°C (Erez et al., 2000). The accumulated temperatures during the FDP can be defined in terms of heat units. The growth during fruit development is dependent on the accumulation of these heat units; the more units accumulated, the faster the growth (Sherman et al., 2003).

As was reported earlier for sour cherries (Tukey, 1952) and apricot (Baker and Brooks, 1944) that high temperature increased the FDP, an increase of the FDP was also reported by Batjer and Martin (1965) for peaches. Trees subjected to a 70°F (21.1°C) night temperature late in the season had a four day increase in FDP.

Fruit Shape

The stylar tip on the fruit can also be affected by temperature. It has genetic tendencies in some cultivars and can be more pronounced in some areas. Generally, more pronounced tips have been observed in warmer locations, and rounder tips in cooler locations (Topp and Sherman, 1989b; Salvador et al., 1998).

Yield

There are two main components which can determine fruit yield, the total number of fruit which are set and the final size of these fruit (Campbell et al., 1995). Fruit set can be affected by temperature during early states of fruit development right after bloom or at the time of bloom. Night temperature seems to be particularly important. Different cultivars can react differently to higher temperatures. Some low-chill peach cultivars like 'Flordaprince' and 'TropicBeauty' have a high tolerance to high night temperatures and have the ability to set a full crop almost every year, while other cultivars which are not heat tolerant can have little or no crop set (Rouse and Sherman, 2002b). The effect of temperature on fruit set can be very important in areas where low-chill peaches are grown. It has been stated that stone fruits can't be grown in tropical areas because year round warm conditions can cause a reduction in fruit set (Diaz, 1992). This was shown by Kozai et al. (2004) where they reported that temperatures above 25°C had a significant effect on set of 'Hakuho' peach.

Post Harvest Quality Characteristics

The various post harvest quality characteristics such as red blush, ground color, firmness, SSC, and TA, can all be affected by temperatures within a region or locality. One of the characteristics most affected is the degree of red blush. The red pigments comprising surface blush of peaches are composed of anthocyanins. More intense blush has been observed in the Lower Rio Grande Valley of Texas compared to Gainesville Florida for several cultivars of low-chill peaches (Rouse and Sherman, 1989a). This difference was attributed to the warmer prevailing temperatures in that area. On the other hand it has been reported that there is no correlation between temperature and red blush (Topp and Sherman, 1989b). But Topp and Sherman (1989b) did find that firmness increased as temperatures increased. Greater surface blush coverage in warmer areas and lower TA in cooler areas has also been observed by Salvador et al. (1998).

Blind Nodes

A blind node as defined by Boonprakob and Byrne (1990) is the "condition in which a node has no obvious vegetative or reproductive buds." It is generally associated with higher temperatures during bud formation during the late summer months and is more prevalent in warmer peach producing areas verses cooler peach producing areas. Some cultivars of peach have a genetic tendency for blind nodes and this condition is expressed in areas which have high temperatures during shoot growth (Sherman and Rodriguez-Alcazar, 1994). High daily temperatures seem to favor the formation of blind nodes (Boonprakob and Byrne, 1990). In particular mean temperatures above 22°C have been reported to favor high amounts of blind nodes (Boonprakob and Byrne, 2003).

Other Aspects

There are other aspects of development which can be altered by the prevailing temperature in a given area where peaches are grown. Peach pubescence can be longer for the same varieties when grown in areas with warmer temperatures during fruit growth compared to areas with cooler temperatures (Sherman et al., 2003). Another aspect of growth that can be affected by temperature is vegetative growth of the tree. Vegetative growth can be ten times higher for the low-chill versus the high-chill genotypes (Campbell et al., 1995). Since vegetative growth occurs during the same time that the fruit are maturing, excessive growth can shade out fruit and reduce coloration of the skin of the fruit in the interior portions of the canopy. Furthermore, more labor is required to prune vigorous trees, either during the summer or winter. Buds also have a tendency to be laid down closer to the terminals of the shoots. If these buds are set higher up in the canopy prior to pruning because of excessive growth they may be pruned off.

In some areas where the temperatures are high during the fall the trees do not defoliate as they normally would in cooler locations. When this occurs, zinc sulphate is sprayed on the trees to induce leaf fall (Diaz et al., 1986).

Factors Other Than Temperature That Affect Fruit Quality

There are factors other than temperature that can affect the quality of fruit. Levels of fertilizer, light interception, thinning, and location of the fruit within the canopy can all affect the final size, color and flavor of the fruit.

Thinning

Fruit thinning generally takes place just prior to or at the beginning of the second stage of fruit growth referred to as “pit hardening”. It was reported by Tukey and Einset (1938) that fruit thinning early during stage one of growth resulted in the largest size, best red color, and least reduction in yield compared to other treatments where, either no thinning was done, or thinning was done at other stages of growth. Wider spacing of the fruit on shoots resulted in larger fruit with greater SSC (Corelli-Grappadelli and Coston, 1991). Most likely this was due to reduced competition for assimilates among fruits. Forty leaves per fruit gave the best fruit size and quality in a leaf area study conducted by Weinberger (1931) in which the amount of leaf area in relation to the size of the fruits was observed.

Canopy Position

Location of the fruit within the canopy has an effect on various quality parameters. Significant differences in fruit weight, blush color, SSC, and firmness were all compared between the upper and lower portions of the canopy (Farina et al., 2005). Fruit from the upper portions were significantly larger, redder, and had a higher SSC than those at the bottom of the canopy. Redder fruit were also reported in the upper canopy as compared to the lower canopy (Bible and Singha, 1993). Dry weight and SSC of fruits have also been shown to be higher in the upper portions of the canopy (Dann and Jerie, 1988).

High Nitrogen

Several authors have shown that high levels of nitrogen can have an effect on both yield and color of fruit. The effect of nitrogen on yield has been reported by Shoemaker and Gammon (1963). They reported that the highest yield was recorded with the highest nitrogen concentration and the lowest yield was recorded with the lowest nitrogen concentration. They also reported that the trees which received the highest nitrogen level had the highest amounts of red color, they concluded that this was from the increased crop load opening up the tree to more light. Similar results were observed by Saenz et al. (1997), who also reported larger fruit. High nitrogen treatments have been shown to decrease Brix°, increase TA, decrease anthocyanin, and increase green ground color (Jia et al., 1999). They also reported in sensory tests that fruit from the high nitrogen treatment were rated as being, sour, bitter and astringent. Greener fruit with higher nitrogen rates were observed by Meheriuk et al. (1995). They also reported that the increased nitrogen rates did not increase fruit weight or red blush. Increased rates of nitrogen fertilization can increase the FDP of the peach. Trees with higher nitrogen rates had a 7 to 12 day delay in harvest (Saenz et al., 1997). This confirms an earlier report that on average a 6.5 day increase in FDP was observed with a heavy application of nitrogen (Blake, 1930).

Light

The amount of light which the fruit receives can have a pronounced effect on the amount of red blush. Reflective mulch was used to increase light levels and shade cloth to reduce light levels in peach trees (Lewallen and Marini, 2003). The reflective mulch increased the amount of red blush on the fruits; they also reported more fruit with an orange ground color with the reflective much and more fruits with a yellow to yellowish green ground color in the shaded trees. In an experiment where peach fruits were covered with aluminum foil, the development of anthocyanin was markedly increased when the foil was removed and the fruit were exposed to short periods of direct sunlight (Erez and Flore, 1986). They also reported a reduction in the color of the fruit when trees were shaded with shade cloth.

CHAPTER 2
MATERIALS AND METHODS

Locations

Three sites representing different climates from north-central to south Florida were chosen to grow several cultivars of low-chill peach trees. The north-central site was located in Archer, Florida (Lake fine sand, 29.52N – 82.53W), the second or central location was in Winter Garden, Florida (Calander fine sand, 28.57N – 81.58W Elev. 32.0 m), and the third or southwest location was in Immokalee, Florida (Immokalee fine sand, 26.43N – 81.41W). Four cultivars, (‘Flordaglo’, ‘Flordaprince’, ‘TropicBeauty’, and ‘UFGold’) were planted at each site. All trees were grafted onto a greenleaf nematode resistant rootstock (Fl 9-04). Trees were planted in February, 2002, at all locations using a north/south row orientation at a distance of 4.57 m between trees (346 trees/hectare) in a randomized complete block design, with five replications and single tree plots, within each location.

Cultural Practices

Frost Protection and Pruning

Overhead irrigation was used for frost protection at the north-central site during bloom in 2004 and 2005. Neither the central or southwest locations received any frost protection. All trees were winter pruned in early to mid-January each year. Trees were pruned to an open vase form and headed back to a height of ~2.5 meters. The trees were also summer pruned in early June of both years as needed.

Irrigation

Trees at the north-central location received overhead irrigation and they were not water stressed at any time during either season. Within the central location, trees were irrigated by microsprinkler emitters for twenty five minutes each morning before dawn. During 2004, over a two-week period between mid to late March, a substantial leak occurred in the main irrigation line and the trees did not receive any irrigation during that period. Microsprinkler emitters were also used at the southwest location. There were two microsprinkler emitters per tree at the central location, and one per tree at the southwest location.

Weed Control

Weeds controlled at all locations by maintaining a herbicide band under the canopy of the trees and among trees in the row. The application band was three to four meters wide. Weed control was accomplished at the north-central and central locations with glyphosate and a water conditioning agent (blend of polyacrylic, hydroxyl carboxylic, and phosphoric acids). Applications were made with a five gallon backpack sprayer when needed. At the southwest location, both glyphosate and paraquat were used.

Fertilization

Fertilizer at the north-central location was applied by hand in three applications during the year, early February, early June, and late September. During both seasons, crossover fertilizer applications from an adjacent commercial blueberry field occurred eight times from a mechanical fertilizer spreader on the east side of the trees. These times were: early February, early March, late March, late May, early July, late July, late August, and early September. When the fertilizer was hand broadcast it was primarily placed under the west half of the tree to compensate for the unequal distribution of fertilizer from the mechanical applications. Fertilizer application times at the central location were the same as at the north-central location. Within the central location, reclaimed water was used for irrigation. Total amount of nitrogen applied via reclaimed irrigation water was obtained by calculating an average N concentration of reclaimed water (.0072428 g N/L) between July, 2005, and January, 2006. Additionally, emitter output, line pressure and irrigation schedule were used to determine total N applied from reclaimed water which was calculated at 33.86 kg/ha/season. Nitrogen fertilizer rates varied among locations. For 2004, they were 276 kg/ha at the north-central location, 103 kg/ha at the central location and 112 kg/ha at the southwest location. For 2005, N rates were 313 kg/ha at the north-central location, 114 kg/ha at the central location and again 112 kg/ha at the southwest location.

Temperature

The temperature was recorded at the north-central and central locations with a HOBO® H8 Pro Series temperature sensor (Onset Computer Corporation, Bourne, MA) starting the first week in November and ending in the last week of May. At the southwest location, temperatures were obtained from a FAWN (Florida Automated Weather Network) station. Chilling was determined at each location from early November to January 31.

Disease Control

Paraffinic hydrocarbon oil was use to control white peach scale (*Pseudaulacaspis pentagona* (Targioni Tozzetti)), as needed during the dormant season. Fruit were hand-thinned just prior to pit hardening to a distance of 15 cm between fruit. After thinning, phosmet and captan were applied to control plum curculio (*Conotrachelus nenuphar* (Herbst)) and peach scab (*Cladosporium carpophilum* (Thum.)), respectively.

Postharvest sprays at the north-central location, were a combination of copper sulfate (20% metallic Cu equivalent), a non-ionic surfactant (alkylphenol etozylate, sodium salts of soya fatty acids, and isopropyl alcohol), and phosphoric acid, which were applied every three weeks until mid-October to control bacterial spot (*Xanthomonas arboricola pv. pruni* (= *X. campestris pv. pruni*)). At the central location, trees were sprayed until late August and early July in 2004 and 2005, respectively. Chlorothalonil, or a combination of pyraclostroblin and boscalid, was applied as needed to control peach rust (*Tranzschelia discolor* (F. Chl.) Trans. and Litr.) at the north-central and central locations. For all pesticide applications trees were sprayed early in the morning. Spray was applied by using a hydraulic sprayer (John Bean sprayers, Modular Hydraulic Sprayer, Model DM10E200FERH, Hogansville, Ga), with a handgun, at 500 psi on all parts of the tree until run off occurred. At the southwest location, azoxystrobin and myclobutanil were used monthly to manage peach rust.

Measurements

Shoot Measurements

Three, one-year-old, shoots of average length were selected at random from each tree at a height between 1.5 to 2 m during mid-January of both years. This was after the completion of winter pruning, but prior to bud break. A 150 mm dial caliper (Spi 31-414) was used to measure the shoot diameter at the shoot base, and a 150 cm measuring tape was used to measure the length of each shoot from the base to the tip. Each node on each shoot was observed and determined to be vegetative only, vegetative with one floral bud, vegetative with two floral buds, or blind (neither vegetative nor floral buds present). The total number of each bud type was determined for all selected shoots on each tree. During the spring of 2005, it was noted that several nodes had groupings with either single, double, or triple floral buds without vegetative buds. The procedure was changed slightly to account for these node classifications.

Trunk Measurements

Every six months after leaf fall, and after fruit harvest, trunk circumference was measured. Readings were taken using a 150 cm dressmaker's tape at a pre-determined spot 15 cm above the soil surface. This information was used to calculate trunk cross-sectional area (TCA).

Bloom and Flower Counts

A visual estimation of the overall progress of bloom on each tree was done in 2004 and 2005. Bloom was rated twice each week (when applicable) using a 10% to 100% scale, and the date of petal fall was recorded. In 2004, biweekly flower counts were made on tagged shoots (when applicable). Flowers were considered open when both the anthers and stigmata were visible. The number of open flowers and fruitlets were counted on each shoot and recorded together. In 2004, the number of aborted flowers was not recorded, which gave only the number of flowers which set fruit. The procedure was changed slightly during 2005 to take into account the number of aborted flowers so the total number of open flowers on the selected shoots could be determined. Each node on each shoot was observed weekly to determine whether the flowers set or aborted. Both open flowers and fruitlets were recorded together. The date of 50 to 60% bloom or full bloom and first commercial fruit harvest was used to calculate the fruit development period (FDP).

Fruit Set Measurements and Thinning

During fruit development in late March of both 2004 and 2005 the numbers of fruit on the tagged shoots were counted to determine percent fruit set. Thinning was done manually and fruit were thinned to a distance of 10 to 15 cm. The number of fruit on each shoot was counted prior to thinning to determine fruit set, and the number of fruit removed in thinning was also recorded. During 2005, the number of fruit on tagged shoots were counted again prior to harvest to determine if pre-harvest fruit drop occurred.

Harvest

Total Yield

During the 2004 harvest, each of the trees were harvested individually, and the number and weight of both marketable and nonmarketable fruit were recorded. Nonmarketable fruit were delineated as those which were <4.5 cm, showed signs of wind scaring, catfacing, bacterial spot, insect predation, split pits, deep sutured fruit, or rotten fruit. Fruit were harvested at a firm ripe stage of development; harvest occurred twice each week at all locations. Fruit from the north-central location were counted and weighed directly in the field. Fruit from the central location were bought directly to the laboratory and counted and weighed. Marketable fruit were weighed, and the weight and the number of fruit were recorded for each tree at each harvest date. The same procedure was applied to the nonmarketable fruit.

After marketable fruit were weighed and counted at the north-central location, eleven representative fruit from each tree for each harvest date were selected at random and placed in peach trays that were obtained from a local grocery store. The trays were then placed in plastic Rubbermaid® containers for transport to the laboratory. Fruit from the central Florida location were harvested and transported to the laboratory, then weighed, and samples of eleven representative fruit were selected as described above.

During 2005, the procedure was changed slightly so that fruit from the central Florida location were weighed directly on site. Fruit selection and transport were the same. At the north-central location the east sides of the trees appeared to have fewer fruit than the west sides of the trees. This looked to be true for all four cultivars. To determine if there was a difference in location of fruit in the tree canopy, each tree was divided into east and west sectors, and counted and weighed as such.

Fruit Size, Weight, and Blush

Fruit sub-samples were placed directly into a walk in cooler (3 - 5°C) to remove field heat. Prior to fruit quality measurements fruit were removed from the cooler and allowed to warm to room temperature. Ten fruit from each sub-sample were measured in three different orientations: blossom end to stem end, cheek to cheek, suture to opposite suture side. Each 10-fruit sample was weighed and each fruit was rated for a visual estimation of the amount of red blush under fluorescent light.

Chromicity

In 2005, at early (first commercial) harvest and mid harvest (greatest number of fruit removed per tree), a Konica Minolta CR – 400/410 Chroma meter (Konica Minolta, Osaka, Japan) was used to test the chromicity values on the most blushed and least blushed area of five fruit from each 10-fruit sub-sample. The chroma meter was calibrated using a standard calibration plate prior to each use. The colorimeter measured three variables; L*, a*, and b*, where L* is the lightness of the object, -a* is the degree of greenness, +a* is the degree of redness, -b* is the degree of blueness and +b* is the degree of yellowness on a CIELAB color chart (Francis, 1970). The values of hue angle (h*) and chroma (C*) were computed from both a* and b*, where h* is a measure of the color of the sample and C* is a measure of the intensity of that color. The same five fruits that were used for chromicity measurements during 2005 were used for soluble solids concentration (SSC), titratable acidity (TA), pH, and pressure measurements.

During 2004 the five fruits were selected at random from the ten fruit sample for fruit size, weight, and blush at early and mid-harvest.

Blossom End

During the 2005 season, fruit blossom end tips were rated as recessed, flattened, or extended. Thirty fruit were selected at random from the marketable fruit for each tree during peak harvest and rated in the field for blossom end tip. Fruit which would be damaged in shipping were considered extended tip fruit.

Firmness, Soluble Solids Concentration, Titratable Acidity, and pH

Flesh firmness was measured using a penetrometer (McCormick Fruit Tech, Yakima, Wa) with a 6 mm probe attached to a drill press stand. Two measurements per fruit were taken (from the center of each cheek) from 5-fruit samples. The epidermis was removed from the test area prior to measuring flesh firmness. Fruit were peeled and flesh samples were collected from the cheek area of each fruit (avoiding the points were pressure measurements were taken, and the suture and opposite the suture). A composite flesh sample was obtained for each 5-fruit sub-sample. Flesh samples were quick frozen in a -80°C freezer and stored at -30°C. Flesh samples were removed from the freezer, allowed to thaw at room temperature, and homogenized in a blender. The slurry was centrifuged for twenty minutes at 14,000 rpm at 5°C. The samples were then filtered through two layers of cheese cloth into a 50 ml beaker. Six g of supernatant diluted with 50 ml of deionized water was used to measure TA. Samples were titrated to an end point of 8.2 using an automatic titrimeter (Fisher Titrimeter II, No. 9-313-10, Pittsburg, Pa), and expressed as ml NaOH. The normality of NaOH used was 0.1N. The remainder of the undiluted supernatant was used to test both the pH of the sample and the SSC. A Digital Refractometer (Reichert-Jung, Mark Abbe II Refractometer, Model 10480, Depew, NY) was used to measure the SSC of the undiluted sample and expressed in Brix°. The pH of the sample was measured using a pH meter (Corning Scientific Instruments, pH meter 140, Medfield, Ma).

Statistical Analysis

Statistical analysis was achieved using SAS 9.1 (SAS Institute Inc., Cary, NC). Means were determined using PROC GLM and means separations among and within locations were by Tukey's HSD at the $P \leq 0.05$ level.

CHAPTER 3
EVALUATION OF VEGETATIVE AND FLOWER BUD DEVELOPMENT, AND FRUITING OF FOUR DIFFERENT CULTIVARS OF LOW-CHILL PEACH

Introduction

Climate is one of several factors that can greatly influence growth and development of reproductive organs, which in turn can affect crop yield. George et al. (1994) reported that larger flowers were produced at lower temperatures in persimmon. Floral abnormalities from low temperatures have been reported in pepper (Polwick and Sawhney, 1985). Cockshull et al. (1981) reported that higher day temperatures promoted flowering for 'Elegance' chrysanthemum, but they also reported that higher night temperatures delayed it. Bud failure in almond is a condition where buds fail to emerge in the spring. This condition has been attributed to environmental factors such as warm temperatures (Kester and Asay, 1978).

Peaches initiate their floral and vegetative buds in the summer and fall prior to flowering. Generally a node with a single vegetative bud is flanked on both sides by a floral bud. However, different combinations of flower and vegetative buds can occur; nodes with a vegetative bud only, nodes with only one floral bud, or nodes that are blind. A blind node is a condition where there is no obvious vegetative or reproductive bud. Blind nodes are generally associated with higher temperatures during bud formation during the late summer months (Boonprakob and Byrne, 1990). This condition is more prevalent in subtropical or tropical regions, verses temperate regions. Boonprakob et al. (1996) concluded that blind node formation was due to failure of buds to differentiate.

Flower bud densities have been documented in peach and other stonefruit. Genotype has a greater effect on the floral bud density than the environment in areas that receive the same amount of chilling (Okie and Werner, 1996). Werner et al (1988) also observed the genotypic differences in floral bud density in peach, in that peach genotypes released from eastern breeding programs generally had more flower buds than those from western breeding programs. Alburquerque et al (2004) observed genotypic differences in apricot where early flowering varieties had the highest flower bud density and highest percentage of fruit set.

The objective of this experiment was to evaluate the performance of four low chill peach cultivars at three different locations in Florida with respect to several vegetative and reproductive characteristics. These included: 1) the relative amount of different bud types; 2) bud, flower, and fruit densities; and 3) dates of full bloom.

Materials and Methods

Locations

Three sites were chosen that represented different locations and climates from north-central to south Florida. The north-central site was located in Archer, Florida (Lake fine sand, 29.52N – 82.53W), the second or central location was in Winter Garden, Florida (Calander fine sand, 28.57N – 81.58W Elev. 32.0 m), and the third or southwest location was in Immokalee, Florida (Immokalee fine sand, 26.43N – 81.41W). Four cultivars, (‘Flordaglo’, ‘Flordaprince’, ‘TropicBeauty’, and ‘UFGold’) were planted at all three sites. All trees were grafted onto a greenleaf nematode resistant rootstock (Fl 9-04). Trees were planted in February, 2002, at all locations using a north/south row orientation at a distance of 4.57 m between trees (346 trees/hectare) in a randomized complete block design, with five replications and single tree plots.

Cultural Practices

General horticultural practices were used to control weeds, insects, and diseases. Trees were winter pruned in early January and summer pruned after harvest in early June as needed. Fertilizer at the north-central location was applied by hand in three applications during the year: early February, early June, and late September. Crossover applications of fertilizer from an adjacent commercial blueberry field occurred eight times from a mechanical fertilizer spreader on the east side of the trees. These times were: early February, early March, late March, late May, early July, late July, late August, and early September. When the fertilizer was hand broadcast at the north-central location, it was placed primarily under the west half of the tree to compensate for the unequal distribution of fertilizer from the mechanical applications.

Fertilizer application times at the central location were the same as at the north-central location. Within the central location reclaimed water was used for irrigation. Total amount of nitrogen applied via reclaimed irrigation water was obtained by calculating an average nitrogen (N) concentration of reclaimed water (0.0072 g N/L) between July 2005 and January 2006. Additionally, emitter output, line pressure, and irrigation schedule were used to determine total nitrogen applied per acre from reclaimed water that was calculated at 33.86 kg/ha/season. Nitrogen fertilizer rates varied among locations. For 2004, they were 276 kg/ha at the north-central location, 103 kg/ha at the central location and 112 kg/ha at the southwest location. For 2005, N rates were 313 kg/ha at the north-central location, 114 kg/ha at the central location and again 112 kg/ha at the southwest location.

Temperature

Temperatures were recorded at the north-central and central location with a HOBO® H8 Pro Series temperature sensor (Onset Computer Corporation, Bourne, MA) starting the first week in November and ending in the last week of May. At the southwest location, temperatures were obtained from a FAWN (Florida Automated Weather Network) station. Chilling was determined at each location from early November to January 31.

Bud Data Collection

Three one-year-old shoots of average length were selected at random from each tree at a height between 1.5 to 2 m. during mid-January of both years. This was after the completion of winter pruning, but prior to bud break. A 150mm dial caliper (Spi 31-414) was used to measure the diameter of the shoot at the base, and a 150 cm measuring tape was used to measure the length of each shoot from the base to the tip. Each node on each shoot was observed and determined to be vegetative only, vegetative with one floral bud, vegetative with two floral buds, or blind (neither vegetative nor floral buds present). The total number of each bud type was determined for all selected shoots on each tree.

During the spring of 2005, it was noted that several nodes had groupings with either single, double, or triple floral buds without vegetative buds. The procedure was changed slightly to account for these node classifications.

Bloom

A visual estimation of the overall bloom on each tree was done in 2004 and 2005. Bloom was rated twice each week (when applicable) using a 10% to 100% scale, and the date of petal fall was recorded. In 2004, biweekly flower counts were made on tagged shoots (when applicable). Flowers were considered open when both the anthers and stigmata were visible. The number of open flowers and fruitlets were counted on each shoot and recorded together. The number of aborted flowers was not recorded, which gave only the number of flowers that set fruit. The procedure was changed slightly during 2005 to take into account the number of aborted flowers so the total number of open flowers on the selected shoots could be determined. Each node on each shoot was observed weekly to determine whether the flowers set or aborted. Both open flowers and fruitlets were recorded together. Information regarding numbers of open flowers was unavailable from the southwest location for both years. After bloom, but before thinning, fruits were counted on each of the selected shoots to determine fruit set.

Node Characterization and Bud Density

From the information collected the following variables were calculated: percentage of nodes with vegetative buds, percentage of nodes with vegetative and floral buds, percentage of nodes with floral buds only (2005), percentage of blind nodes, vegetative buds/node (VB/N), floral buds/node (FB/N), flowers/node (FL/N), vegetative buds/cm (VB/cm), floral buds/cm (FB/cm), flowers/cm (FL/cm), fruit/cm (FT/cm), blind nodes/cm (BN/cm), and nodes/cm (N/cm).

Statistical Analysis

Statistical analysis was achieved using SAS 9.1 (SAS Institute Inc., Cary, NC). Means were determined using PROC GLM and means separation among and within the locations were by Tukey's HSD at the $P \leq 0.05$ level.

Results

Chilling and Bloom

Chilling was significantly different among locations. However, the numbers of chilling hours recorded during both years, were very similar for each location. The greatest number of chill hours was observed in north-central Florida followed by central and then southwest Florida (Figure 1).

In 2004, ‘UFGold’ bloomed later than the other cultivars at the north-central and central Florida locations. However, ‘UFGold’ bloomed earlier (January 31) at the southwest location than in central (February 9) or north-central (February 13) Florida (Table 1). Conversely, ‘TropicBeauty’ bloomed earlier at the central location (January 28) than at the southwest location (February 1). No significant differences for bloom date were observed among cultivars at the southwest site.

During 2005, significant differences in bloom period were observed among cultivars and sites. ‘Flordaprince’ bloomed earlier (January 30) in southwest Florida then in north-central (February 2) or central (February 14) Florida. ‘UFGold’ had an earlier bloom (February 1) at the southwest location compared to the north-central (February 12) and central (February 28) locations. Bloom in central Florida for both ‘Flordaglo’ and ‘TropicBeauty’ was later than for the other two locations.

Bloom of all cultivars at the central location during 2005 was delayed nearly one month compared to the previous year. Full bloom dates for ‘TropicBeauty’, ‘Flordaprince’, ‘Flordaglo’, and ‘UFGold’ were the 23rd, 24th, 28th, and 28th of February, respectively. ‘Flordaprince’ and ‘TropicBeauty’ bloomed earlier than either ‘Flordaglo’ or ‘UFGold’. At the north-central location, ‘UFGold’ bloomed later than the other cultivars. No significant differences were observed for bloom date among cultivars at the southwest site.

Bud Percentage

Nodes with only vegetative buds

No significant interactions between location and cultivar were found in either year for the percent of nodes with only vegetative buds. Therefore only the main effects are presented. During 2004, the percentage of nodes with only vegetative buds was significantly higher in ‘UFGold’ than in the other cultivars (Figure 2). There were a higher percentage of nodes with vegetative buds at the southwest location compared to the north-central and central locations (Figure 3). During 2005, a higher percentage of nodes with only vegetative buds were observed in ‘Flordaprince’ than ‘TropicBeauty’ (Figure 4). There were no differences observed among locations during 2005 (Figure 5).

Nodes with vegetative and flower buds

During 2004, the percentage of nodes with both vegetative and flower buds was greater for ‘Flordaprince’ and ‘Flordaglo’ than for either ‘UFGold’ or ‘TropicBeauty’ in north-central Florida; and greater than ‘UFGold’ in southwest Florida (Figure 6). Significant differences were not observed among cultivars at the central site. A higher percentage of nodes with vegetative and flower buds were observed at the north-central location than the central location for ‘Flordaprince’. A higher percentage of nodes with both vegetative and flower buds were observed at the north-central location for ‘Flordaglo’ compared to the other locations. The percentage of nodes with vegetative and flower buds was lowest for ‘UFGold’ at the southwest location.

During 2005, there were no significant differences observed among cultivars at the north-central location (Figure 7). Within the central location, ‘Flordaprince’ had a larger percentage of nodes with vegetative and flower buds than ‘UFGold’, and at the southwest location ‘TropicBeauty’ had a smaller percentage than the other cultivars. In general, lower percentages of nodes with vegetative and flower buds were observed at the central location compared to other locations.

Nodes with only flower buds

Nodes that had only flower buds were only measured during 2005 and only in north-central and central Florida. There were no significant interactions between location and cultivar. Therefore, only the main effects are presented. A higher percentage of nodes with only flower buds were observed for ‘UFGold’ than for the other cultivars (Figure 8). No differences were observed between locations (Figure 9). ‘TropicBeauty’ had a lower percentage of nodes with only flower buds than ‘UFGold’ or ‘Flordaglo’.

Blind nodes

During 2004 the percentage of blind nodes was greater for ‘TropicBeauty’ than for the other cultivars at all locations (Figure 10). Similarly, the percentage of blind nodes was greater for ‘TropicBeauty’ than for ‘UFGold’ in central Florida and greater than ‘Flordaprince’ in southwest Florida. A higher percentage of blind nodes were observed in the central than the southwest location for ‘Flordaprince’. A higher percentage of blind nodes were observed in ‘UFGold’ at the southwest location compared to the north-central location.

During 2005, at the north-central location, more blind nodes were observed for ‘TropicBeauty’ and ‘Flordaglo’ than for ‘UFGold’ (Figure 11). ‘TropicBeauty’ also had a larger percentage of blind nodes than ‘UFGold’ in central Florida and a larger percentage than all other cultivars at the southwest location. A lower percentage of blind nodes were observed in the north-central location than the other locations.

Buds per Node

Vegetative buds

During 2004, the number of vegetative buds per node was significantly less for ‘TropicBeauty’ than for the other cultivars at the north-central location (Table 2). Similarly they were less for ‘TropicBeauty’ than for ‘UFGold’ in central Florida, or for ‘Flordaprince’ at the southwest location. The number of vegetative buds per node was higher in southwest Florida than central Florida for ‘Flordaprince’. Higher values were observed at the north-central location than at the southwest location for ‘UFGold’ during 2004. During 2005 no significant differences were observed among the cultivars in north-central Florida (Table 3). However, ‘UFGold’ had fewer vegetative buds per node than the other cultivars at the central location and ‘TropicBeauty’ had fewer than the other cultivars at the southwest location. The number of vegetative buds per node was generally lowest for ‘Flordaprince’, ‘Flordaglo’, and ‘TropicBeauty’ in central Florida.

Flower buds

During 2004, more flower buds per node were observed for ‘Flordaglo’ than for either ‘UFGold’ or ‘TropicBeauty’ in north-central Florida, or for ‘UFGold’ at the southwest location (Table 2). ‘Flordaglo’ had a higher amount of flower buds per node than ‘Flordaprince’ in central Florida. Location differences were observed for several cultivars during 2004. The number of flower buds per node for ‘Flordaprince’ was higher in north-central Florida than in central Florida. Flower buds per node for ‘Flordaglo’ were also higher at the north-central location than at the other locations. ‘UFGold’ had higher flower bud counts per node at the north-central location than at the southwest location.

During 2005 significant differences among cultivars were not observed at the north-central location (Table 3). In central Florida more flower buds per node were observed for ‘UFGold’ than for ‘Flordaglo’ or ‘TropicBeauty’. ‘TropicBeauty’ had the least flower buds per node at the southwest site. Among locations the number of flower buds per nodes was higher for all cultivars at the north-central location.

Flowers

The number of flowers per node was not observed during 2004 and only at the north-central and central locations during 2005. Significant differences were not detected in north-central Florida (Table 3). In central Florida, more flowers per node were observed for ‘UFGold’ than for ‘Flordaglo’ or ‘TropicBeauty’. Between the two locations, the number of flowers per node was higher in north-central Florida than in to central Florida.

Bud Density

Vegetative buds

Vegetative bud density (buds/cm shoot length) during 2004 was greater for ‘UFGold’ than for ‘Flordaprince’ or ‘TropicBeauty’ at the north-central location, and greater than ‘TropicBeauty’ in central Florida (Table 4). At the southwest location ‘Flordaprince’ had a greater vegetative bud density than ‘TropicBeauty’. A lower density of vegetative buds was observed at the southwest location than to the other locations in both ‘Flordaglo’ and ‘UFGold’. Lower densities were observed for ‘TropicBeauty’ in southwest Florida compared to central Florida during 2004.

Significant differences were not observed during 2005 among cultivars at the north-central site (Table 5). However, lower values were observed for ‘UFGold’ than for the other cultivars at the central location, or for ‘TropicBeauty’ at the southwest location.

Higher densities of vegetative buds were observed at the southwest location for ‘UFGold’ followed by the north-central and central locations. Lower densities were observed for ‘TropicBeauty’ in southwest Florida compared to north-central or central Florida.

Flower buds

During 2004, greater flower bud density (flower buds/cm shoot length) was observed for ‘Flordaglo’ than for ‘UFGold’ in north-central Florida (Table 4). Within the central location, ‘Flordaglo’ had greater flower bud density than ‘Flordaprince’. Flower bud density was less for ‘UFGold’ than for ‘Flordaprince’ or ‘Flordaglo’ at the southwest location. The north-central location had a higher flower bud density for ‘Flordaprince’ than the central or southwest locations. Lower values for flower bud density were observed in ‘Flordaglo’ and ‘UFGold’ at the southwest location compared to the other locations.

During 2005, significant differences were not observed in the north-central site (Table 6). At the central location ‘UFGold’ had higher flower bud densities than either ‘Flordaglo’ or ‘TropicBeauty’. In southwest Florida ‘TropicBeauty’ had lower values than ‘Flordaglo’ or ‘UFGold’. High values for flower bud density were observed for ‘Flordaprince’ at the north-central location, and low values were observed at the southwest location for ‘UFGold’. Higher flower bud densities were observed in north-central Florida for ‘Flordaglo’ than in southwest Florida. Flower bud density was highest for ‘TropicBeauty’ at the north-central location followed by the central and southwest locations.

Flowers

Flower density (flowers/cm shoot length) was not observed during 2004. During 2005 flower density was observed at the north-central and central locations. No differences were observed among cultivars at the north-central location (Table 6). There were higher flower densities observed in ‘UFGold’ in central Florida compared to the other cultivars. Higher flower densities were observed in north-central Florida for ‘Flordaprince’, ‘Flordaglo’, and ‘TropicBeauty’ than in central Florida.

Fruit

No significant interactions were found between location and cultivar during either 2004 or 2005 for fruit density (fruit/cm shoot length). Therefore, only the main effects are presented. During 2004, higher fruit density was observed for ‘UFGold’ than for the other cultivars (Table 7). During 2005, higher fruit densities were observed for ‘Flordaglo’ and ‘UFGold’ than for ‘Flordaprince’ or ‘TropicBeauty’. There were no significant differences observed between the two locations during either year.

Blind nodes

During 2004, significant differences in the frequency of blind nodes (blind nodes/cm shoot length) were observed among cultivars at all locations. Blind node frequency at the north-central location was greatest for ‘TropicBeauty’ (Table 4). In central Florida, frequencies were greater for ‘TropicBeauty’ than for ‘UFGold’. At the southwest location, blind node frequencies were higher for ‘TropicBeauty’ than for ‘Flordaprince’ or ‘Flordaglo’. Blind node frequencies for ‘Flordaprince’, ‘Flordaglo’, and ‘TropicBeauty’ were highest at the central location.

During 2005, the frequency of blind nodes was lower for ‘UFGold’ than for either ‘Flordaglo’ or ‘TropicBeauty’ in north-central Florida (Table 5). Higher values were observed for ‘TropicBeauty’ than for ‘UFGold’ at the central location, and at the southwest site values for ‘TropicBeauty’ were higher than for all other cultivars. Lower amounts of blind nodes were observed in north-central Florida than in central or southwest Florida.

Nodes

No significant interactions for node density were observed between locations and cultivars during either year. Therefore, only main effects are reported. Significant differences were not detected among the cultivars during 2004 (Table 7). During 2005 a higher density of nodes was observed in 'TropicBeauty' than in 'Flordaprince'. During both years node density was higher in central Florida than at the other locations.

Discussion

Chilling and Bloom

The location where trees are grown can affect many aspects of development. Temperatures in an area can affect when bloom occurs and the development of buds during the summer and fall. There have also been several reports on the effect of temperature on fruit set of peach (Edwards, 1987; Erez et al., 2000; Rouse and Sherman, 2002b) and apple and pear (Tromp and Borsboom, 1994).

Chilling hours accumulated during the late fall and winter are important in breaking endodormancy of peaches (Weinberger, 1950a). The amount of chilling required varies by cultivar (Weinberger, 1950a) as well as by bud type (Scalabrelli and Couvillon, 1986). The cultivars observed in this experiment were low-chill, and require only 150 – 200 hours of chilling (Rouse and Sherman, 1989b; Sherman and Lyrene, 1997; Sherman and Lyrene, 1989; Sherman et al., 1982).

A delay in bloom at the central location was observed during 2005. This delay in bloom was probably the result of early defoliation from bacterial spot combined with severe winds from several hurricanes in the summer, 2004. During summer, 2004, the incidence of bacterial spot was very high at the central Florida location. Infection and defoliation had already begun in May, 2004. The trees were not sprayed at this time because fruit were still being harvested. The disease was already well established within the orchard and on several nearby plum trees when a spray program was initiated in early June. Wind and rain aid in the spread of this disease. During 2004, several major hurricanes (Category 2 or higher prior to landfall) passed through the area. Hurricanes Charley, Frances, and Jeanne all affected crops within the area. Leaf shredding and tearing was common at all three orchard site; however, the central location was directly hit by all three hurricanes. These storms likely increased the spread of bacterial spot within each tree and among trees. The high sustained winds and strong gusts shredded leaves and caused partial defoliation. The damaged leaves were likely points of infection for bacterial spot and some trees were completely defoliated from both bacterial spot and tropical storm force winds by the end of September. The early defoliation in 2004 resulted in a late summer/early fall growth flush that may have delayed the onset of dormancy and chill accumulation. Early defoliation from the combined affect of three major hurricanes, high incidence of bacterial spot, and late summer growth probably resulted in the marked delay in bloom experienced at the central location during 2005. Such a delay in bloom can be very detrimental to fruit set. Low yields may result when flowering and fruit set occur under warmer temperature conditions (Rouse and Sherman, 2002).

The progressive delay in bloom observed for ‘UFGold’ as the locations progressed further north may have resulted from this cultivar accumulating the necessary heat units for bloom at a faster rate at the southwest location. There was a twelve day difference between the north-central and southwest locations for date of full bloom in ‘UFGold’. Generally full bloom was within about three days of each other for ‘Flordaprince’, ‘Flordaglo’, and ‘TropicBeauty’ between north-central Florida and southwest Florida. Chilling in ‘UFGold’ may have been satisfied at all three locations at approximately the same time. However, in the southwest location, more heat units may have been accumulated in a shorter period of time than at the central or north-central locations resulting in earlier bloom in southwest Florida. Weinberger (1948) reported a two day delay in full bloom for ‘Elberta Peach’ between the Fort Valley area of Georgia (central GA.), and areas in northern Georgia. This earlier bloom may facilitate an earlier harvest in more southern locations. However it has been reported that the temperatures following bloom can be important in reducing FDP (Boonprakob et al., 1992; Topp and Sherman, 1989a; Weinberger, 1948).

Percentage of Vegetative, Floral, and Blind Nodes

The percentage of vegetative, floral, and blind nodes can indicate how well adapted cultivars are to different climatic zones, and indicate which cultivars have a high cropping potential. This can give an indication of what conditions are favorable or unfavorable for development of certain types of nodes, mainly blind nodes. A blind node is a condition where there is no vegetative or floral bud located at a node (Boonprakob et al., 1996). This can be caused by high temperatures during bud development (Boonprakob and Byrne, 1990).

During 2005, there were some nodes without vegetative buds that had at least one flower bud. There appeared to be a greater percentage of these node types set for ‘UFGold’ than for the other cultivars. The percentage of flower bud only nodes in ‘UFGold’ ranged form 31% at the north-central location to 39% at the central location.

Percentages ranged from 8% to 18% among the other three cultivars. This data supports the cultivar release information which states that 'UFGold' tends to set high amounts of flower buds (Sherman and Lyrene, 1997).

Cultivars such as 'UFGold' that set high percentages of nodes with only flower buds could have difficulty supporting heavy fruit loads. Such cultivars could set heavy fruit loads with very little foliage. These fruit will be reduced in size and quality, and may be damaged from excessive exposure to the sun. With the lack of foliage to support vegetative growth, shoots will remain thin. Growth of the terminal vegetative buds, on these shoots the following year will produce long thin branches that can hang close to the ground, where the shoots and foliage could be damaged by herbicides.

Lack of adequate foliage cover in the canopy can cause the exposed branches and scaffold limbs to sunburn. The damaged wood can later serve as an entry way for pathogens and insects. Lack of foliage can also cause problems with pruning and training trees. Since these shoots have very few vegetative buds, the number of potential pruning locations is reduced. These shoots will have to be cut back to the main scaffold limb. This can be problematic in training trees into the open-vase form, or when trying to keep trees compact. These problems may also occur in genotypes that have high frequency of blind nodes.

Differences for blind node percentages were observed during 2005 among locations and cultivars. The north-central location had the lowest percentages of blind nodes across all four cultivars during 2005. Warmer temperatures during bud development were probably the cause of higher blind nodes observed at the central and southwest locations. Blind nodes are generally caused by high temperatures during a period of rapid shoot growth (Richards et al., 1994). Average temperatures above 22°C, as well as other stresses imposed on trees, have been shown to be critical for the development of blind nodes (Boonprakob and Byrne, 2003). Average temperatures above 22°C are common in many areas of Florida, especially further south, during the summer months. However, genotypic differences appear to exist among cultivars. While cultivars had above 50% blind buds in central and southwest Florida, 'TropicBeauty' tended to have the highest percentage of blind nodes at all locations. 'UFGold' usually had a lower percentage of blind nodes than 'TropicBeauty'. This is in agreement with published information for 'UFGold' that states that few blind buds are set by this cultivar (Sherman and Lyrene, 1997).

There were other stresses that were imposed on the trees at the central location. Effects other than temperature may play an important role in the reduction of certain bud types and the increase in blind nodes for some cultivars. There was a significant reduction in the percentage of nodes that had both vegetative and flower buds during 2005. As stated earlier, defoliation from bacterial spot was more pronounced in central Florida, and during the summer and fall of 2004, several major hurricanes passed through central Florida. The stresses from the above mentioned factors along with the effect of temperature during the critical period of bud formation in late August and September may have caused the higher incidence of blind nodes and lower incidences of nodes with both vegetative and flower buds observed in central Florida.

Cultivars that exhibit a high percentage of blind nodes such as 'TropicBeauty' need to be planted in areas that do not receive the high summer temperatures during bud development. It is important to test cultivars in areas that receive high summer temperatures to determine how the cultivars are affected by different climate conditions.

Number of Buds per Node and Bud Density

The number of vegetative buds and flowers per node were lower during 2005 for several cultivars at the central location compared to either the southwest or north-central locations. Vegetative bud counts per node differed between years at the central and southwest locations. Two factors may have contributed to this. Stresses imposed from the passage of three hurricanes and high incidence of bacterial spot may be causes of the low bud and flower counts per node observed. The shredding and tearing of the leaves from the passage of the hurricanes, as well as senescence of leaves from bacterial spot may have affected vegetative and flower bud growth and development during late August and September as well as overall health of the tree.

Higher flower bud counts per node and lower densities of blind nodes at the north-central location may be a result of cooler temperatures during bud development in the summer and fall within this location compared to the central or southwest locations. There also may be genotype differences for different densities of nodes that are more prevent at different locations. Since blind nodes are caused by warmer temperatures, fewer blind nodes would be set at the north-central location and more flower or vegetative buds would be set. This would explain the higher flower bud counts per node.

Higher flower and fruit densities observed in some peach cultivars may be the result of genetic tendencies in some cultivars for higher fruit densities or fruit set. This has been observed in apricot. Alburquerque et al. (2004) observed the effect of climatic conditions and cultivar differences on several apricot cultivars. They concluded that final fruit set was influenced more by cultivar than by climate. The higher fruit density observed in ‘UFGold’ compared to ‘TropicBeauty’ might be a result of a genetic tendency for ‘UFGold’ to set high amounts of flowers and fruits and for ‘TropicBeauty’ to set low amounts of flowers and fruits.

General Conclusions

Testing to determine the adaptation of different cultivars at multiple locations can help to determine where certain traits are more pronounced. Warmer locations may increase the prevalence of blind nodes in cultivars. Cultivars should be tested in warmer areas to see if they are prone to this condition. Genetic tendencies may also exist for blind nodes and nodes with only floral buds in certain cultivars. Genotypic differences may also exist among cultivars for fruit density. Stresses from environmental factors and diseases may have an effect on the number and type of buds set at a node. The results obtained here on the occurrence of blind nodes in different climatic regions and prevalence of nodes with floral buds provides valuable information to breeders, when selecting germplasm for release or future crosses.

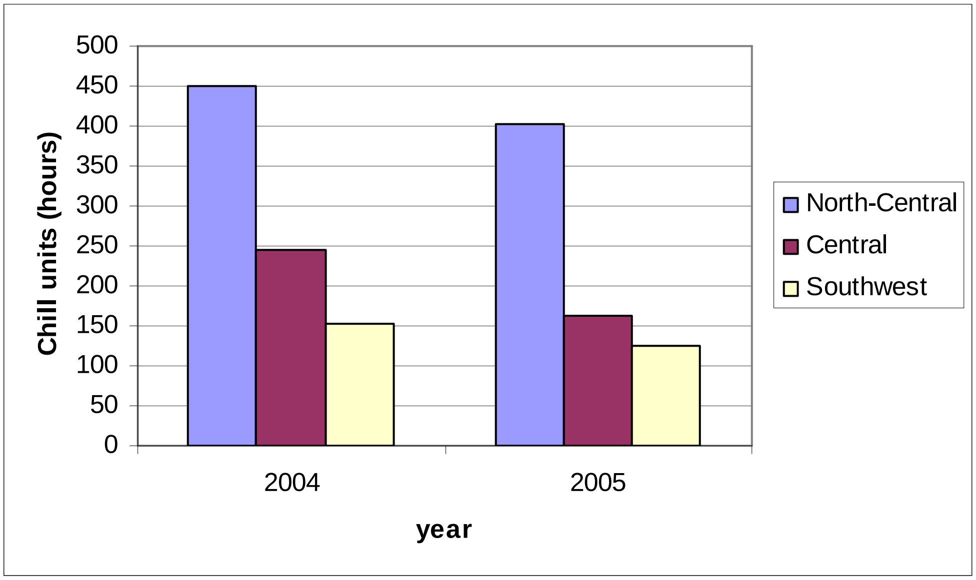

Figure 1. Total chill unit accumulation for hours below 7.2 °C among locations for the 2004 and 2005 seasons for four low-chill peach cultivars from early November to January 31 for each year.

Table 1. Mean date of full bloom for both 2004 and 2005 across three locations for four low-chill peach cultivars.

	2004 Season				2005 Season			
Cultivar	North-Central	Central	Southwest	Location Significance	North-Central	Central	Southwest	Location Significance
FlordaPrince	01-28-04b[z]A[y]	01-28-04bA	01-25-04aA	0.5758	02-02-05bB	02-24-05bA	01-30-05Ca	<.0001
FlordaGlo	01-31-04bA	02-02-04bA	02-02-04aA	0.7274	02-05-05bB	02-28-05aA	02-02-05Ba	<.0001
UFGold	02-13-04aA	02-09-04aA	01-31-04aB	<0.0001	02-12-05aB	02-28-05aA	02-01-05aC	<.0001
TropicBeauty	01-31-04bAB	01-28-04bB	02-01-04aA	0.0211	02-02-05bB	02-23-05bA	01-21-05aB	<.0001
Cultivar Signif.	<0.0001	<0.0001	0.0688		<0.0001	<0.0001	0.0431	

[z] Means within location followd by the same lowercase letter are not significantly different according to Tukey's Test ≤ 0.05.
[y] Means for cultivars across locations followed by the same uppercase letter are not significantly different according to Tukey's Test ≤ 0.05

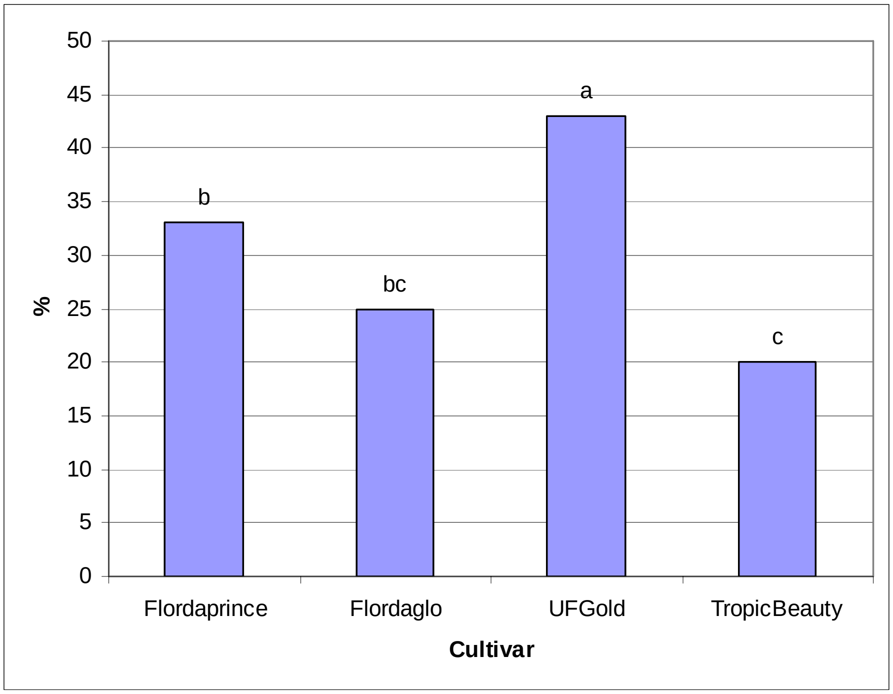

Figure 2. Main effects for the percentage of nodes with only vegetative buds during 2004 for four low-chill peach cultivars. Lowercase letters represent significant differences among cultivars using Tukey's Test P $\leq$ 0.05.

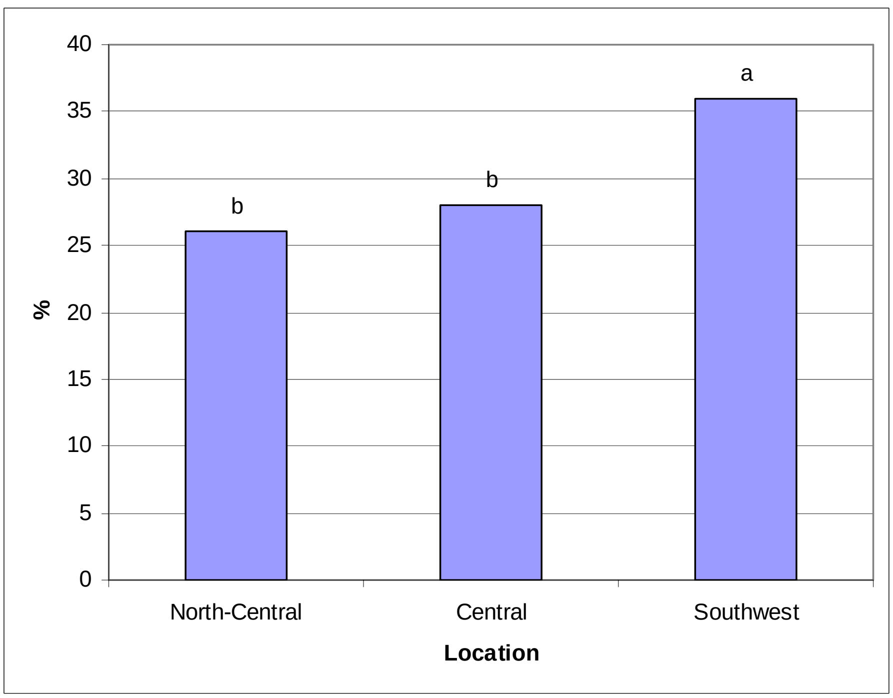

Figure 3. Main effects for the percentage of nodes with only vegetative buds during 2004 for three locations. Lowercase letters represent significant differences among locations using Tukey's Test P $\leq$ 0.05.

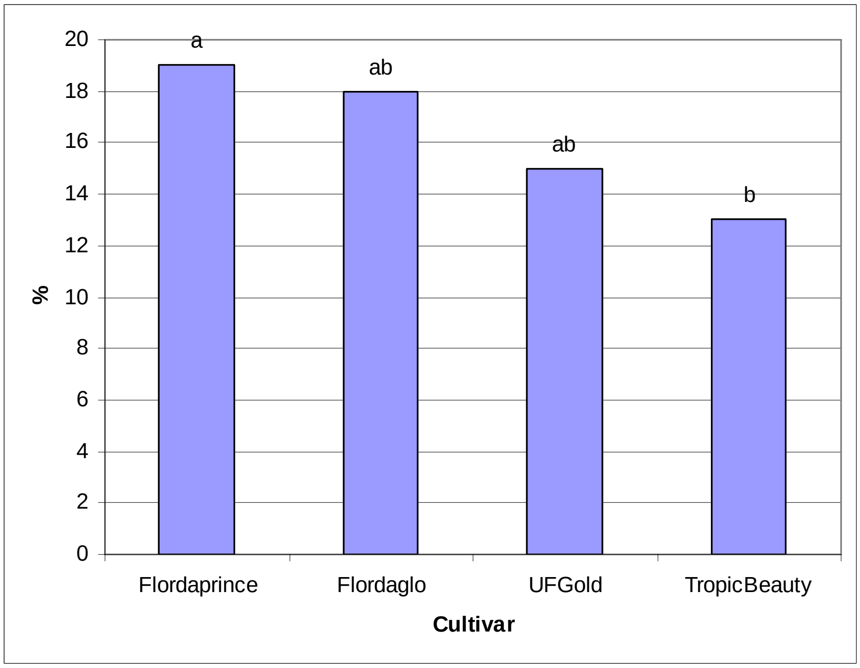

Figure 4. Main effects for the percentage of nodes with only vegetative buds during 2005 for four low-chill peach cultivars. Lowercase letters represent significant differences among cultivars using Tukey's Test P $\leq$ 0.05.

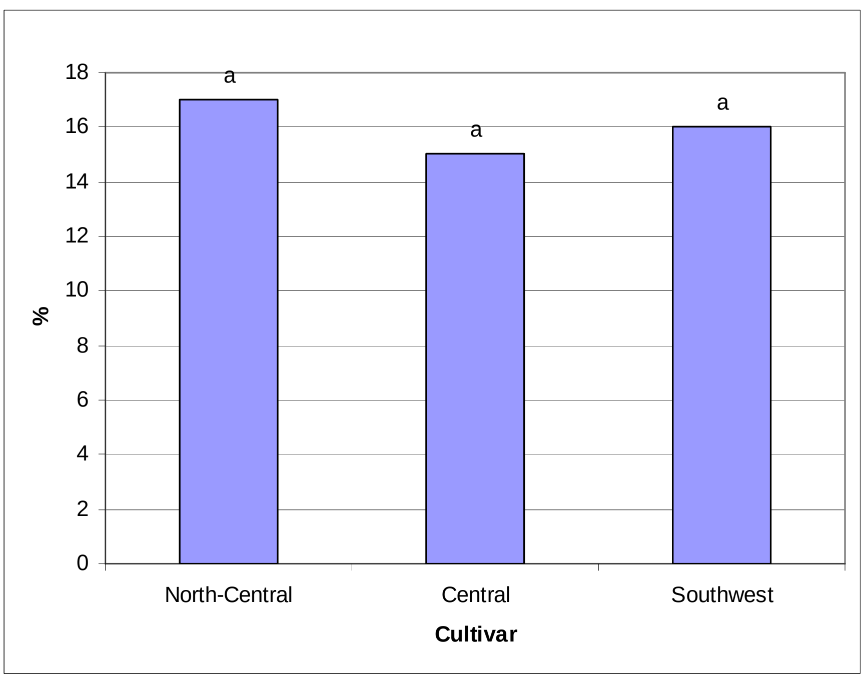

Figure 5. Main effects for the percentage of nodes with only vegetative buds during 2005 for three locations. Lowercase letters represent significant differences among locations using Tukey's Test P $\leq$ 0.05.

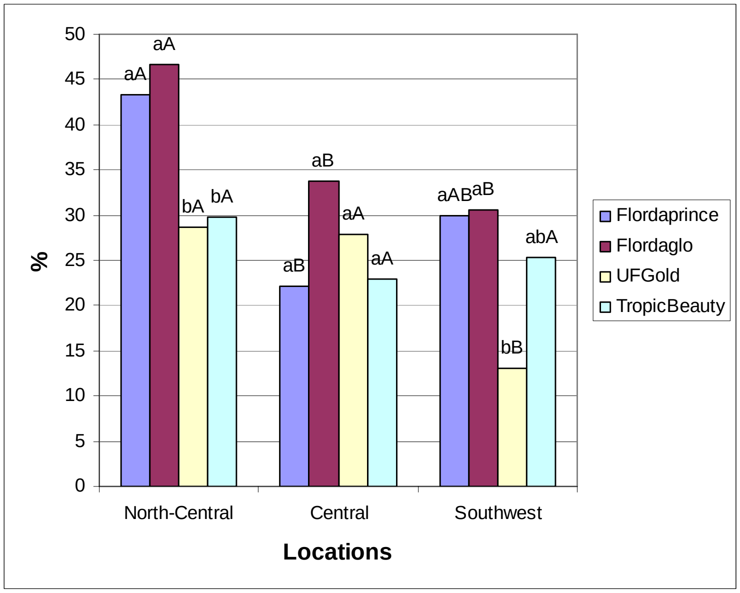

Figure 6. Percentage of nodes with both vegetative and flower buds for four low-chill peach cultivars during the 2004 season within three locations. Lower case letters represent significant differences among cultivars within a location using Tukey's Test $P \leq 0.05$. Uppercase letters represent significant differences among locations for each cultivar using Tukey's Test $P \leq 0.05$.

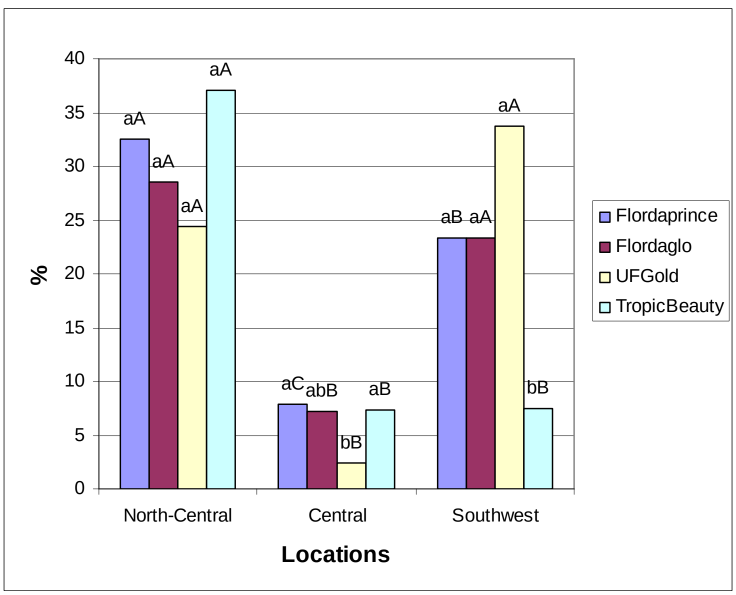

Figure 7. Percentage of nodes with both vegetative and flower buds for four low-chill peach cultivars during the 2005 season within three locations. Lower case letters represent significant differences among cultivars within a location using Tukey's Test $P \leq 0.05$. Uppercase letters represent significant differences among locations for each cultivar using Tukey's Test $P \leq 0.05$.

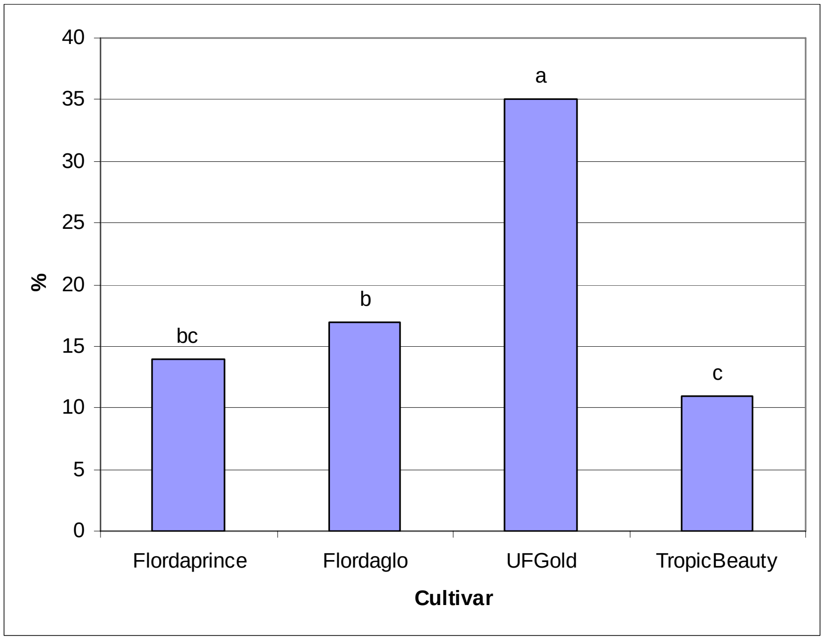

Figure 8. Main effects for the percentage of nodes with only flower buds during 2005 for four low-chill peach cultivars. Lowercase letters represent significant differences among cultivars using Tukey's Test P $\leq$ 0.05.

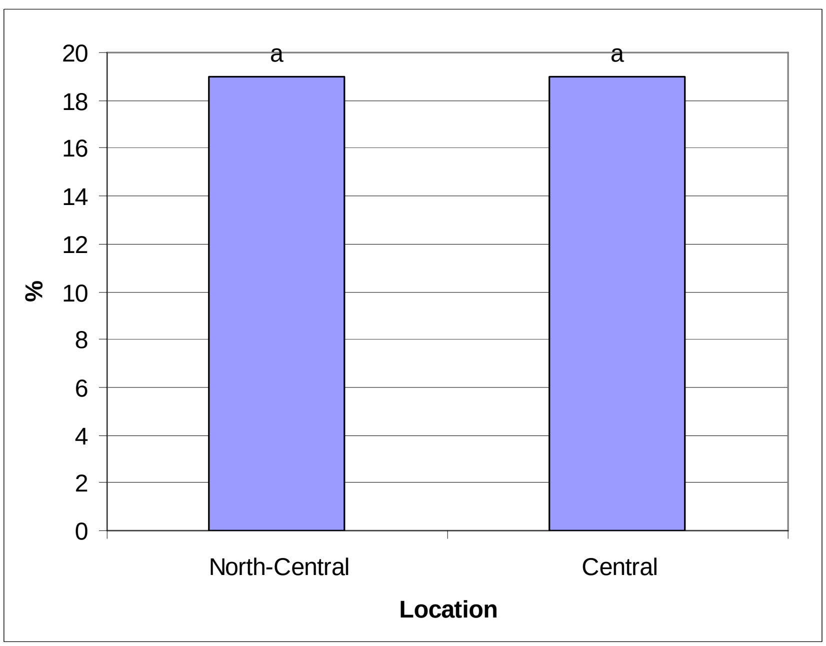

Figure 9. Main effects for the percentage of nodes with only floral buds during 2005 between two locations. Lowercase letters represent significant differences between locations using Tukey's Test P $\leq$ 0.05.

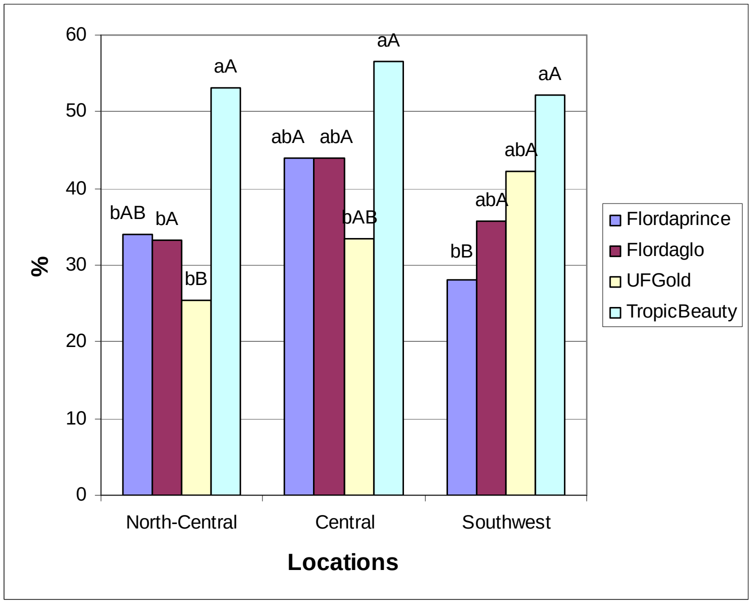

Figure 10. Percentage of blind nodes for four low-chill peach cultivars during the 2004 season within three locations. Lower case letters represent significant differences among cultivars within a location using Tukey's Test P $\leq$ 0.05. Uppercase letters represent significant differences among locations for each cultivar using Tukey's Test P $\leq$ 0.05.

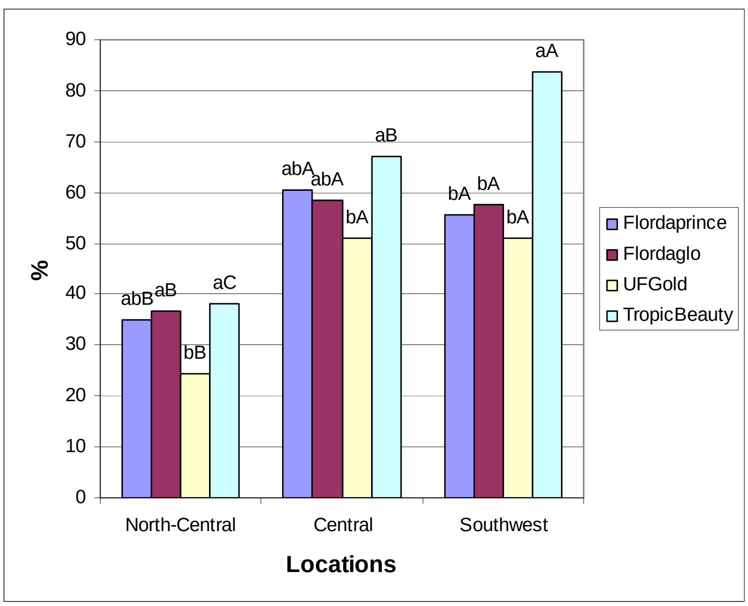

Figure 11. Percentage of blind nodes for four low-chill peach cultivars during the 2005 season within three locations. Lower case letters represent significant differences among cultivars within a location using Tukey's Test P $\leq$ 0.05. Uppercase letters represent significant differences among locations for each cultivar using Tukey's Test P $\leq$ 0.05.

Table 2. Mean vegetative and flower buds per node for the 2004 season, for four low-chill peach cultivars within three different locations.

	Vegetative Buds/Node			Flower Buds/Node		
	North-Central	Central	Southwest	North-Central	Central	Southwest
Flordaprince	0.66a[z]AB[y]	0.561abB	0.719aA	0.61abA	0.26bB	0.47abAB
Flordaglo	0.66aA	0.56abA	0.64abA	0.68aA	0.45aB	0.49aB
UFGold	0.75aA	0.67aAB	0.58abB	0.43bA	0.36abAB	0.21bB
TropicBeauty	0.47bA	0.44bA	0.48bA	0.47bA	0.33abA	0.41abA

[z] Means within location followed by the same lowercase letter are not significantly different according to Tukey's Test P ≤ 0.05.
[y] Means for cultivars across locations followed by the same uppercase letter are not significantly different according to Tukey's Test P ≤ 0.05.

Table 3. Mean vegetative and flower buds per node for the 2005 season, for four low-chill peach cultivars within three different locations.

	Vegetative Buds/Node			Flower Buds/Node			Flowers/Node		
	North-Central	Central	Southwest	North-Central	Central	Southwest	North-Central	Central	Southwest
Flordaprince	0.513a[z]A[y]	0.256aB	0.445aA	0.708aA	0.249cbB	0.310aB	0.475aA	0.052cbB	---[x]
Flordaglo	0.476aA	0.234aB	0.423aA	0.620aA	0.299bB	0.317aB	0.423aA	0.116bB	---
UFGold	0.441aA	0.098bB	0.490aA	0.781aA	0.430aB	0.402aB	0.423aA	0.202aB	---
TropicBeauty	0.491aA	0.244aB	0.163bB	0.825aA	0.181cB	0.100bB	0.549aA	0.031cB	---

[z] Means within location followed by the same lowercase letter are not significantly different according to Tukey's Test P ≤ 0.05.
[y] Means for cultivars across locations followed by the same uppercase letter are not significantly different according to Tukey's Test P ≤ 0.05.
[x] Data unavailable.

Table 4.Vegetative bud, flower bud, and blind node density for four low-chill peach cultivars for the 2004 season within three different locations.

	Vegetative Buds/ cm Shoot Length			Flower Buds/ cm Shoot Length			Blind Nodes/ cm Shoot Length		
	North-Central	Central	Southwest	North-Central	Central	Southwest	North-Central	Central	Southwest
Flordaprince	0.41b[z]A[y]	0.43abA	0.38aA	0.38abA	0.19bB	0.23aB	0.21bB	0.37abA	0.14bB
Flordaglo	0.43abA	0.46abA	0.32abB	0.44aA	0.35aA	0.23aB	0.22bB	0.38abA	0.17bB
UFGold	0.51aA	0.53aA	0.30abB	0.28bA	0.29abA	0.10bB	0.17bA	0.28bA	0.23abA
TropicBeauty	0.32cAB	0.37bA	0.25bB	0.32abA	0.27abA	0.21abA	0.36aB	0.51aA	0.28aB

[z] Means within location followed by the same lowercase letter are not significantly different according to Tukey's Test P ≤ 0.05.

[y] Means for cultivars across locations followed by the same uppercase letter are not significantly different according to Tukey's Test P ≤ 0.05.

Table 5. Vegetative bud and blind node density for four low-chill peach cultivars for the 2005 season within three different locations.

	Vegetative Buds/ cm Shoot Length			Blind Nodes/ cm Shoot Length		
	North-Central	Central	Southwest	North-Central	Central	Southwest
Flordaprince	0.31a[z]A[y]	0.26aA	0.32aA	0.21abC	0.66abA	0.42bB
Flordaglo	0.35aA	0.27aA	0.32aA	0.27aB	0.67abA	0.50bA
UFGold	0.30aB	0.11bC	0.41aA	0.17bB	0.59bA	0.45bA
TropicBeauty	0.35aA	0.27aA	0.16bB	0.28aB	0.79aA	0.88aA

[z] Means within location followed by the same lowercase letter are not significantly different according to Tukey's Test P ≤ 0.05.

[y] Means for cultivars across locations followed by the same uppercase letter are not significantly different according to Tukey's Test P ≤ 0.05.

Table 6. Flower bud and flower density for four low-chill peach cultivars for the 2005 season within three different locations.

	Floral Buds/ cm Shoot Length			Flowers/ cm Shoot Length		
	North-Central	Central	Southwest	North-Central	Central	Southwest
Flordaprince	0.44a[z]A[y]	0.27bcB	0.22abB	0.29aA	0.06bB	---[x]
Flordaglo	0.45aA	0.34bAB	0.24aB	0.31aA	0.13bB	---
UFGold	0.52aA	0.49aA	0.35aB	0.28aA	0.24aA	---
TropicBeauty	0.58aA	0.21cB	0.10bC	0.39aA	0.04bB	---

[z] Means within location followed by the same lowercase letter are not significantly different according to Tukey's Test $P \leq 0.05$.

[y] Means for cultivars across locations followed by the same uppercase letter are not significantly different according to Tukey's Test $P \leq 0.05$.

[x] Data unavailable.

Table 7. Main effects of fruit and node density for four low-chill peach cultivars, and three different locations, for the 2004 and 2005 seasons.

	2004		2005	
	Fruit/ cm Shoot Length	Nodes/ cm Shoot Length	Fruit/ cm Shoot Length	Nodes/ cm Shoot Length
Cultivar				
Flordaprince	0.06c[z]	0.64a	0.05b	0.81b
Flordaglo	0.14b	0.66a	0.13a	0.89ab
UFGold	0.23a	0.67a	0.16a	0.88ab
TropicBeauty	0.05c	0.70a	0.06b	0.97a
Location				
North-Central	0.11a[y]	0.66b	0.11a	0.69c
Central	0.12a	0.83a	0.09a	1.13a
Southwest	---[x]	0.52c	---	0.86b

[z] Means across cultivars followed by the same lowercase letter are not significantly different according to Tukey's Test $P \leq 0.05$.
[y] Means across locations followed by the same uppercase letter are not significantly different according to Tukey's Test $P \leq 0.05$.
[x] Data unavailable.

CHAPTER 4
FRUIT QUALITY AND YIELD OF FOUR LOW-CHILL PEACH CULTIVARS GROWN IN THREE LOCATIONS

Introduction

Several important fruit quality characteristics of peach are affected by climate and cultural practices. Percent blush coverage can be affected by the prevailing climate in a production region. Rouse and Sherman (1989a) reported a higher blush in the Lower Rio Grande Valley of Texas than in Gainesville, Florida, for several cultivars of low-chill peaches. This was attributed to the warmer prevailing temperatures in that area of Texas. However, Topp and Sherman (1989b) reported no correlation between temperature and red blush. Other characteristics such as stylar tip (Topp and Sherman, 1989b; Salvador et al., 1998) and fruit development period (FDP) (Anderson and Sherman, 1994; Topp and Sherman, 1989b; Rouse and Sherman, 1989a; Weinberger, 1948) can also be affected by temperature during development.

Different cultural practices can also affect fruit quality and yield. Higher rates of nitrogen (N) have been shown to impose a greener ground color (Meheriuk et al., 1995), increase the length of the FDP (Saenz et al., 1997), increase fruit yield (Shoemaker and Gammon, 1963), and increase astringency (Jia et al., 1999). Different tree training techniques, open vase or perpendicular Y, can increase light penetration and affect several quality attributes such as SSC, ground color, and flesh firmness (Farina et al., 2005). Fruit thinning can be important for some developmental aspects such as SSC (Corelli-Grappadelli and Coston, 1991) and fruit size (Tukey and Einset, 1938). Light interception is also important in red blush development (Erez and Flore, 1986) and ground color development (Lewallen and Marini, 2003).

Yield and some quality traits can also interact with each other; a good example of this was reported by (Rowe and Johnson, 1992) who found a relationship between total yield and fruit size. They found that larger fruit were produced at the expense of total yield; in essence this means that more fruit on the tree reduces fruit size (Rowe and Johnson, 1992).

The objective of this experiment was to observe fruit quality characteristics and yield of four low chill peach cultivars at three locations in Florida. Quality and developmental characteristics observed included blush, L*, C*, h*, SSC, SSC/TA ratio, fruit shape, fruit size, and FDP. Total fruit weight and number were also determined.

Materials and Methods

Locations

Three sites were chosen that represented different locations and climates from north-central to south Florida. The north-central site was located in Archer, Florida (Lake fine sand, 29.52N – 82.53W), the second or central location was in Winter Garden, Florida (Calander fine sand, 28.57N – 81.58W Elev. 32.0 m), and the third or southwest location was in Immokalee, Florida (Immokalee fine sand, 26.43N – 81.41W). Four cultivars (‘Flordaglo’, ‘Flordaprince’, ‘TropicBeauty’, and ‘UFGold’) were planted at all three sites. All cultivars were grafted onto a greenleaf nematode resistant peach rootstock (Fl 9-04). Trees were planted in February, 2002, at all locations using a north/south row orientation at a distance of 4.57 m between trees (346 trees/hectare) in a randomized complete block design, with five replications and single tree plots, within each location.

Cultural Practices

Overhead irrigation was used for frost protection at the north-central site during bloom in 2004 and 2005. Neither the central or southwest locations received any frost protection. All trees were winter pruned in early to mid-January each year. Trees were pruned to an open vase form and headed back to a height of ~2.5 meters. The trees were also summer pruned in early June of both years as needed. Trees at the north-central location received overhead irrigation and trees were not water stressed at any time during either season. At the central location, trees were irrigated by microsprinkler emitters for 25 minutes each morning before dawn. During 2004, over a 2-week time span during mid to late March, a substantial leak occurred in the main irrigation line and the trees did not receive any irrigation at that during that period. Microsprinkler emitters were also used at the southwest location.

Weeds were controlled at all locations by maintaining a herbicide band under the canopy of the trees and among trees. Weed control was accomplished at the north-central and central locations with glyphosate and a water conditioning agent (blend of polyacrylic, hydroxyl carboxylic, and phosphoric acids). Applications were made with a five gallon backpack sprayer when needed. At the southwest location glyphosate and paraquat were used.

Fertilizer at the north-central location was applied by hand in three applications during the year, early February, early June, and late September. During both seasons, crossover fertilizer applications from an adjacent commercial blueberry field occurred eight times from a mechanical fertilizer spreader on the east side of the trees. These times were: early February, early March, late March, late May, early July, late July, late August, and early September. When fertilizer was hand broadcast, it was placed primarily under the west half of the tree to compensate for the unequal distribution of fertilizer from the crossover applications. Fertilizer application times at the central location were the same as at the north-central location. Reclaimed water was used for irrigation at the central location. Total amount of N applied via reclaimed irrigation water was obtained by calculating an average N concentration of reclaimed water (.0072428 g N/L) between July 2005 and January 2006. Additionally, emitter output, line pressure, and irrigation schedule were used to determine total N applied per hectare from reclaimed water which was calculated at 33.86 kg/ha/season. Nitrogen fertilizer rates varied among locations. For 2004, they were 276 kg/ha at the north-central location, 103 kg/ha at the central location and 112 kg/ha at the southwest location. For 2005 these rates were 313 kg/ha at the north-central location, 114 kg/ha at the central location and again 112 kg/ha at the southwest location.

Paraffinic hydrocarbon oil was use to control white peach scale (*Pseudaulacaspis pentagona* (Targioni Tozzetti)), as needed during the dormant season. Fruit were hand-thinned just prior to pit hardening to a distance of 15 cm between fruit. After thinning, phosmet and captan were applied to control plum curculio (*Conotrachelus nenuphar* (Herbst)) and peach scab (*Cladosporium carpophilum* (Thum.)), respectively. Postharvest sprays at the north-central location, were a combination of copper sulfate (20% metallic Cu equivalent), a non-ionic surfactant (alkylphenol etozylate, sodium salts of soya fatty acids, and isopropyl alcohol), and phosphoric acid, which were applied every three weeks until mid-October to control bacterial spot (*Xanthomonas arboricola pv. pruni* (= *X. campestris pv. pruni*)). At the central location trees were sprayed until late August and early July in 2004 and 2005, respectively. Chlorothalonil or a combination of pyraclostroblin and boscalid was applied as needed to control peach rust (*Tranzschelia discolor* (F. Chl.) Trans. and Litr.) at the north-central and central locations. For all pesticide applications trees were sprayed early in the morning. Sprays were applied by using a hydraulic sprayer (John Bean sprayers, Modular Hydraulic Sprayer, Model DM10E200FERH, Hogansville, Ga), with a handgun, at 500 psi on all parts of the tree until run off occurred. At the southwest location azoxystrobin and myclobutanil were used monthly to manage peach rust.

Fruit Development Period

A visual estimation of the overall bloom on the tree was done in 2004 and 2005. Bloom was rated twice each week (when applicable) using a 10% to 100% scale, and the date of petal fall was recorded. FDP was determined from 50% to 60% bloom to first commercial harvest.

Harvest

Total yield and weight

During 2004, each tree was harvested individually and the numbers and weights of marketable and nonmarketable fruit were recorded. Nonmarketable fruit were delineated as those that were < 4.5 cm, showed signs of wind scaring, catfacing, bacterial spot, insect predation, split pits, deep sutured fruit, or rotten fruit. Fruit were harvested at a firm ripe stage of development; harvest occurred twice each week at all locations. Fruit from the north-central location were counted and weighed directly in the field. Fruit from the central location were bought directly to the laboratory and counted and weighed. Marketable fruit were weighed and the weight and the number of fruit were recorded for each tree at each harvest date. The same procedure was applied to the nonmarketable fruit.

After marketable fruit were weighed and counted at the north-central location, eleven representative sub-samples from each tree for each harvest date were selected at random and placed in peach trays that were obtained from a local grocery store. The trays were then placed in plastic Rubbermaid® containers for transport to the laboratory. Fruit from the central Florida location were harvested and transported to the laboratory, then weighed and eleven representative fruit samples were selected as described above.

During 2005, the procedure was changed slightly so that fruit from the central Florida location were weighed on site. Fruit selection and transport were the same. At the north-central location, it appeared that the east sides of the trees had fewer fruit than the west sides of the trees. This looked to be true for all four cultivars. To determine if there was a difference in location of fruit in the tree canopy, each tree was divided into two sectors, east and west, and fruit were counted and weighed as such.

Trunk measurements

Every six months after leaf fall and after fruit harvest, trunk circumference was measured. Readings were taken using a 150 cm dressmakers tape at a pre-determined spot 15 cm above the ground level. This was later used to calculate trunk cross-sectional area (TCA).

Fruit size, weight, and blush

Fruit sub-samples were placed in a walk-in cooler (3 - 5°C), where they were cooled to remove field heat. Prior to fruit quality measurements fruit were removed from the cooler the previous day and allowed to warm to room temperature. Ten fruit from each sub-sample were measured in three different orientations: blossom end to stem end, cheek to cheek, suture to side opposite suture. Each 10-fruit sample was weighed and each fruit was rated visually for the amount of red blush under fluorescent light.

Chromicity values

In 2005, at early (first commercial) harvest and mid harvest (greatest number of fruit removed per tree), a Konica Minolta CR – 400/410 Chroma meter (Konica Minolta, Osaka, Japan) was used to test the chromicity values on the most blushed and least blushed surface areas of five fruit from each 10-fruit sub-sample. The chroma meter was calibrated using a standard calibration plate prior to each use. For post harvest measurements in 2005, the same five fruits that were used for chromicity measurements were used for soluble solids concentration (SSC), titratable acidity (TA), pH, and pressure measurements. During 2004 five fruits were selected at random from the ten fruit sample for fruit size, weight, and blush at early and mid harvest.

Blossom end

During 2005, fruit blossom end tips were rated as either recessed, flattened, or extended. Thirty fruit were selected at random from the marketable fruit from each tree during peak harvest and rated in the field for blossom end tip. Fruit that would be damaged in shipping were considered extended tip fruit.

Firmness, soluble solids concentration, titratable acidity, and pH

Flesh firmness was measured using a firmness tester (IFAS Firmness Tester, Gainesville, FL) fitted with a 6 mm probe. Two measurements per fruit were taken (from the center of each cheek) from 5-fruit samples. The epidermis was removed from the test area prior to measuring flesh firmness. Fruit were peeled and flesh samples were collected from the cheek area of each fruit (avoiding the points where pressure measurements were taken, and the suture, and opposite the suture). A composite flesh sample was obtained for each 5-fruit sub-sample. Flesh samples were quick frozen in a -80°C freezer and stored at -30°C. Flesh samples were removed from the freezer, allowed to thaw at room temperature, and homogenized in a blender. The slurry was centrifuged for 20 minutes at 14,000 rpm at 5°C. The samples were then filtered through two layers of cheese cloth into a 50 ml beaker. Six g of supernatant diluted with 50 ml of deionized water was used to measure TA. Samples were titrated to an end point of 8.2 using an automatic titrimeter (Fisher Titrimeter II, No. 9-313-10, Pittsburg, Pa) and expressed as ml NaOH. The normality of NaOH used was 0.1N. The remainder of the undiluted supernatant was used to determine pH and SSC. A Digital Refractometer (Reichert-Jung, Mark Abbe II Refractometer, Model 10480, Depew, NY) was used to measure the SSC of the undiluted sample and was expressed as Brix°. The pH of the sample was measured using a pH meter (Corning Scientific Instruments, pH meter 140, Medfield, Ma).

Statistical Analysis

Statistical analysis was achieved using SAS 9.1 (SAS Institute Inc., Cary, NC). Means were determined using PROC GLM and means separations among and within the locations were by Tukey's HSD at the $P \leq 0.05$ level.

Results

Due to higher rates of N applied at the north-central location, direct comparisons could not be made between this location and the central and southwest locations. Variables from this location were placed in separate tables when significant interactions existed between location and cultivar. Statistical comparisons were used between the central and southwest locations.

Fruit Development Period

During 2004, 'UFGold' had the shortest FDP at the north-central and central locations (Tables 8 and 9). In central Florida, the FDP was longer for 'TropicBeauty' than for the other three cultivars and longer than either 'Flordaprince' or 'Flordaglo' in southwest Florida. 'Flordaglo' had a longer FDP within central Florida than southwest Florida. 'UFGold' had a longer FDP at the southwest location compared to the central location. Statistical comparisons could not be made between the north-central location and other locations because of the higher nitrogen rates used in north-central Florida. However, in general FDP was generally longer at this location than the other two locations. During 2005 within both north-central and central Florida, 'TropicBeauty' had the longest FDP and 'UFGold' the shortest (Tables 10 and 11). At the southwest location 'Flordaprince' had the shortest FDP. All cultivars had a significantly shorter FDP at the central location then at the southwest location. Direct comparisons could not be made between the north-central location and the other locations, however again FDP was longer in north-central Florida compared to the other locations. A consistent pattern for cultivar FDP was observed at both the north-central and central locations during both years. Generally, 'UFGold' had the shortest FDP, followed by 'Flordaprince', 'Flordaglo', and 'TropicBeauty' (Tables 8,9,10 and 11).

Fruit Number, Weight, and Set

No significant interactions were observed between location and cultivar for fruit number adjusted for trunk cross-sectional area (TCA), or for percent fruit set during 2004 and 2005. Therefore, only the main effects are presented for each variable.

During 2004, the adjusted number of fruit was greater in 'UFGold' than other cultivars (Table 13). Significant differences were not observed among locations. During 2005, the adjusted number of fruit was greater in 'Flordaglo' and 'UFGold' than in 'Flordaprince' or 'TropicBeauty'. Greater values for adjusted fruit number were observed at the central location compared to the north-central location.

During 2005, the percent of fruit set was lower in ‘TropicBeauty’ than in ‘Flordaglo’ or ‘UFGold’. Differences in the percentage of fruit set during 2005 were not significant among locations.

During 2004, adjusted fruit yield was greater for ‘UFGold’ than for ‘Flordaprince’ or ‘TropicBeauty’ within north-central Florida (Table 13). A lower adjusted yield was observed in central Florida for ‘Flordaprince’ compared to ‘Flordaglo’ or ‘UFGold’. During 2004, site differences were only observed in ‘UFgold’, a greater adjusted yield was observed at the north-central location than at the central location. During 2005, the adjusted yield was greater for ‘UFgold’ than ‘Flordaprince’ within north-central Florida. A greater adjusted yield was observed in central Florida for ‘Flordaglo’ and ‘UFGold’, than observed in ‘Flordaprince’ or ‘TropicBeauty’. At the southwest location, a greater adjusted yield was observed for ‘Flordaglo’ than for ‘Flordaprince’ or ‘UFGold’. During 2005, a greater adjusted yield was observed for ‘TropicBeauty’ at the southwest location than the other locations. The adjusted yield was high in ‘Flordaglo’ within the central Florida location.

Fruit Blossom End

No significant differences among cultivars were observed for the percent of fruit with flattened blossom ends in southwest Florida during 2005 (Figure 12). However, ‘Flordaglo’ had less fruit with flattened blossom ends than the other cultivars at both the central and north-central locations. The percentage of fruit that exhibited flattened blossom ends was similar at all three locations, and generally ranged from 40 – 70%.

Differences among cultivars were observed for fruit that had recessed blossom end at all locations. ‘TropicBeauty’ tended to have the lowest percent of fruit with this phenotype at all locations, although differences were not significant for all cultivars at all sites. Within central Florida, the percent of fruit with recessed blossom ends was higher for ‘Flordaglo’ than for ‘TropicBeauty’. At the southwest location ‘UFGold’ had a higher percent of fruit with recessed blossom ends than ‘Flordaprince’ or ‘TropicBeauty’. There was a general trend for a reduction in the percentage of fruit that showed recessed blossom ends as the locations progressed south for all cultivars.

There were no differences observed among cultivars within both the north-central and central areas of Florida for fruit with extended blossom ends. A higher percent of fruit with extended blossom ends was observed for ‘TropicBeauty’ than for the other cultivars at the southwest site. In southwest Florida, ‘UFGold’ had fewer fruit with extended tips than ‘Flordaprince’. Across locations there was a low percentage of fruit that exhibited extended blossom ends in north-central Florida. Generally, percentages of fruit with extended blossom ends increased as locations progressed south.

Post Harvest Quality

Titratable Acidity. No significant differences for TA were observed among cultivars during 2004 in central Florida (Table 14). In the north-central location, ‘TropicBeauty’ had a higher mean value for TA than ‘UFGold’ or ‘Flordaprince’ (Table 15). ‘UFGold’ had a lower TA at the southwest site compared to the other cultivars (Table 14). Differences between the central and southwest locations were only observed for ‘UFGold’, which had a higher TA at the central location.

During 2005 interactions between location and cultivar for TA, were not significant. Therefore, only the main effects are presented. Higher values for TA were observed in ‘Flordaglo’ and ‘TropicBeauty’ than in ‘Flordaprince’ or ‘UFGold’ (Table 16). Lower TA values were observed at the southwest location than at the central or north-central locations.

Soluble Solids Concentration. During 2004, there were no significant differences among cultivars for SSC at the southwest location (Table 14). In north-central Florida, 'TropicBeauty' SSC values were higher than 'UFGold' (Table 15). At the central Florida location, 'Flordaglo' had lower SSC than either 'Flordaprince' or 'UFGold' (Table 14). A difference between the central and southwest locations was only observed for 'Flordaprince' which had a higher SSC value at the central location. Although direct comparisons could not be made with the north-central location, several cultivars were observed to have lower SSC values at this location relative to the other locations. (Tables 14 and 15).

There were no significant differences observed among cultivars for SSC at either the north-central or central locations during 2005 (Tables 17 and 18). In southwest Florida 'UFGold' had a higher value for SSC than the other cultivars (Table 17). Differences were observed between the central and southwest locations for 'Flordaprince', 'Flordaglo', and 'UFGold'. These cultivars had higher SSC values in Southwest Florida than in central Florida. Statistical comparisons could not be made with the north-central location; however, values were lower for all cultivars at this location compared to the other two locations (Tables 17 and 18).

SSC:TA Ratio. During 2004, no significant interactions were observed between location and cultivar. Therefore, only the main effects are presented for this year. The ratio was higher in 'UFGold' compared to the other cultivars. A lower SSC:TA ratio was observed in the north-central location than the central or southwest locations.

During 2005, 'Flordaglo' had a lower SSC:TA ratio than either 'Flordaprince' or 'UFGold' at the north-central location (Table18). At both the central and southwest locations ‘UFGold’ had higher SSC:TA ratios than the other cultivars which were not different from one another (Table 17). Between the central and southwest locations, higher SSC:TA ratios were observed for all cultivars in the southwest location. Even though statistical comparisons were not made with the north-central location, SSC:TA ratios tended to be lower at this location compared to the other two locations (Tables 17 and 18).

Pressure. During 2004, fruit pressure readings were higher for ‘UFGold’ than for either ‘Flordaglo’ or ‘TropicBeauty’ at both the north-central and central locations, and higher than ‘Flordaprince’ at the central location (Tables 14 and 15). Pressure readings in southwest Florida were higher for ‘Flordaglo’ than for ‘Flordaprince’ or ‘TropicBeauty’ (Table 14). Between the central and southwest locations, fruit pressure readings were higher in ‘UFGold’ and ‘TropicBeauty’ within the central location.

During 2005, ‘UFGold’ had higher pressure readings than the other cultivars at the north-central location (Table 18). In the central Florida, higher pressure readings were observed for ‘Flordaglo’ than for either ‘UFGold’ or ‘TropicBeauty’ and both of these were greater than ‘Flordaprince’ (Table 17). Within the southwest site ‘UFGold’ had a higher pressure reading than either ‘Flordaglo’ or ‘Flordaprince’, and these were higher than ‘TropicBeauty’. Higher fruit pressure readings were observed in the central location than southwest location for ‘Flordaprince’, ‘Flordaglo’, and ‘TropicBeauty’.

Color

Percent blush

During 2004, a trend was observed between north-central and central Florida where higher percent blush values were observed for ‘Flordaprince’ and ‘Flordaglo’ than for ‘UFGold’ and ‘TropicBeauty’ (Table 20 and 21). However, in southwest Florida, higher values were observed for ‘TropicBeauty’ than for ‘UFGold which had the least blush (Table 20). Blush values were higher across all cultivars at the southwest location compared to the central location. Even though statistical comparisons could not be used for north-central Florida, it was observed that blush values tended to be lower at this location than at the other two locations (Tables 20 and 21).

During 2005 ‘UFGold’ had the least blush of any cultivar at all sites (Tables 22 and 23). Significant differences were observed among all cultivars at the southwest location. ‘Flordaprince’ had the highest percent blush cover, followed by ‘Flordaglo’, ‘TropicBeauty’, and ‘UFGold’ (Table 22). As in the previous year, blush values were highest for all cultivars at the southwest location. Even though direct comparisons could not be used it was observed that blush values tended to be lower at the north-central location than at the other locations (Tables 22 and 23).

Colorimeter

Colorimeter measurements were taken during 2005. Two measurements were taken representing the highest and lowest blushed surfaces on each fruit.

Light. L* values from the highest blushed surface of the fruit were lower in ‘Flordaglo’ than in ‘UFGold’ or ‘TropicBeauty’ in north-central Florida (Table 24). Within the central location ‘UFGold’ had higher L* values on the highest blushed area for all cultivars. At the southwest location, significant differences were observed among all cultivars. ‘UFGold’ had the greatest L* value on the highest blush surface of the fruit; followed by ‘TropicBeauty’, ‘Flordaglo’, and ‘Flordaprince’.

L* values for the lowest blushed surface were higher for ‘TropicBeauty’ than for the other cultivars in north-central Florida. ‘Flordaglo’ and ‘TropicBeauty’ had higher L* values on the lowest blushed surface than ‘Flordaprince’ or ‘UFGold’ at the central location. In southwest Florida, ‘UFGold’ had higher L* values on the lowest blushed surface of the fruit than any of the other cultivars.

Chroma. C* values on the highest blushed surface of the fruit were higher in ‘UFGold’ than in ‘Flordaglo’ at the north-central location. Within both the central and southwest locations, ‘UFGold’ had a higher C* value than the other cultivars on the highest blush surface of the fruit.

A trend for C* values on the lowest blushed surface of the fruit was observed for the cultivars at both north-central and central Florida locations. Significant differences were observed among all cultivars. ‘UFGold’ had the greatest C* value followed by ‘TropicBeauty’, ‘Flordaprince’, and ‘Flordaglo’. Within the southwest location ‘UFGold’ had C* values that were higher than the other cultivars and ‘Flordaglo’ C* values were lowest.

Hue. Hue values on the highest blushed surface of the fruit were lower for ‘Flordaglo’ than for ‘UFGold’ or ‘TropicBeauty’ at the north-central location. Within central Florida, ‘UFGold’ had higher h* values than the other cultivars which were not different from one another. At the southwest location higher h* values were observed for ‘UFGold’ and ‘TropicBeauty’ than for ‘Flordaprince’ or ‘Flordaglo’.

On the lowest blushed surface of the fruit ‘TropicBeauty’ had a higher h* value than ‘Flordaprince’. In central Florida, higher values were observed in ‘Flordaglo’ and ‘TropicBeauty’ than in ‘Flordaprince’ or ‘UFGold’. Significant differences were observed among cultivars within the southwest location. At this location ‘UFGold’ had the highest h* value followed by ‘TropicBeauty’, ‘Flordaglo’, and finally ‘Flordaprince’.

In general values for the highest blushed location on the fruits were tightly clustered together when hue and croma values were graphed together for all cultivars at all locations indicating little variation between cultivars and locations for this trait (Figure 13). Values for the lowest blushed location on the fruits tended to be more scattered for all cultivars within all locations indicating high variation for this trait among cultivars and locations.

Individual Fruit Weight

Differences were observed for individual fruit weights during 2004. ‘TropicBeauty’ had the greatest mean fruit weights at the central and southwest locations and greater fruit weight than ‘Flordaprince’ or ‘UFGold’ in north-central Florida (Tables 20 and 21). Within the central location, all cultivars were significantly different from each other. ‘TropicBeauty’ had the greatest fruit weight, followed by ‘Flordaglo’, ‘Flordaprince’, and ‘UFGold’ (Table 20). When the central and southwest locations were compared, fruit weights were greater for ‘Flordaglo’ and ‘TropicBeauty’ at the central location and higher for ‘Flordaprince’ and ‘Flordaglo’ at the southwest location. Even though direct statistical comparisons were not used, fruit weights were generally greater in the north-central location compared to the other locations (Tables 20 and 21).

During 2005 a trend was observed between north-central and central Florida where fruit weights were greatest for ‘TropicBeauty’, followed by ‘Flordaprince’ and ‘Flordaglo’, with the least weight for ‘UFGold’ (Tables 22 and 23). At the southwest site ‘TropicBeauty’ fruit weight was greater than ‘UFGold’ (Table 22). Between the central and southwest locations, across all cultivars, fruit weights were greater at the central location. Results at the north-central location were similar to the previous year in that fruit weights tended to be higher than at the other two locations (Tables 22 and 23).

Fruit Size

Cheek Diameter. Average cheek diameter was unavailable from the north-central and central sites during 2004 due to measurement error. At the only locality in where data was available, the southwest location, 'TropicBeauty' had the greatest cheek diameter (Table 20).

This data was available from all three locations during 2005. In north-central Florida 'TropicBeauty' had a higher cheek diameter than either 'Flordaglo' or 'UFGold' (Table 23). Higher cheek diameter was also observed in 'TropicBeauty' than the other cultivars in central and southwest Florida (Table 22). 'UFGold' tended to have the lowest cheek diameter at most locations. Between the central and southwest locations, cheek diameter was highest at the central location for all cultivars. Cheek diameters at the north-central location were generally observed to be higher; however statistical comparisons were not used (Tables 22 and 23).

Suture Diameter. Average suture diameter was larger for 'TropicBeauty' than for 'UFGold' during 2004 at the north-central location (Table 21). 'TropicBeauty' also had a larger suture diameter than the other cultivars in central and southwest Florida (Table 20). Larger suture diameters were observed in southwest Florida than in central Florida for 'Flordaprince' and 'UFGold'. Suture diameter was larger at the central location for 'TropicBeauty' than at the southwest location. Suture diameter was observed to be larger at the north-central location than at the central or southwest locations, but was not compared to these locations because of higher N rates applied there (Tables 20 and 21).

During 2005, 'TropicBeauty' had a larger suture diameter than 'Flordaprince' or 'UFGold' at the north-central location (Table 23). In central and southwest Florida a trend was observed with 'TropicBeauty' again having a larger suture diameter than the other cultivars (Table 22). This was followed by ‘Flordaglo’, ‘Flordaprince’, and ‘UFGold’. Suture diameters for ‘Flordaprince’, ‘Flordaglo’, and ‘TropicBeauty’ were generally larger in central Florida compared to southwest Florida. It was observed that the suture diameters at the north-central location were larger than at the central or southwest locations; however direct statistical comparisons were not made (Tables 22 and 23).

Fruit Length. During 2004, a trend was observed at all locations where ‘UFGold’ had shorter fruit length than the other cultivars (Tables 20 and 21). Fruit length was larger in southwest Florida for ‘Flordaprince’, ‘UFGold’ and ‘TropicBeauty’ (Table 20). Comparisons with the north-central location could not be made, however it was observed that fruit length tended to be greater at this location (Tables 20 and 21).

No significant interactions between location and cultivar were observed during 2005 for fruit length. Therefore only the main effects are presented. Fruit length was less in ‘UFgold’ compared to the other cultivars (Table 24). Fruit length was greater at the north-central location then at the southwest location.

Discussion

The yield and quality attributes of peaches, observed in this experiment, varied significantly within and among the different locations and cultivars. There are many factors that can affect fruit quality and yield. Cultural practices and climate at a given location can have a pronounced effect on fruit yield and quality. Cultural practices such as fertilizer rates and irrigation programs, pruning and thinning, can all have a significant affect on quality attributes such as fruit size, blush, and sugar content. Genotypic differences are also important, and many cultivars differ in their quality attributes. Some cultivars can have higher SSC or TA levels than other cultivars. Genetic, cultural, and climatic factors collectively can affect the final size, shape, color, as well as other quality indices.

Fruit Development Period

Similar patterns were found for fruit development for the same cultivars grown in different locations. A pattern for fruit development among cultivars was observed for both the north-central and central locations during 2004 and 2005. ‘TropicBeauty’ had the longest FDP followed by ‘Flordaglo’, Flordaprince’, and ‘UFGold’. This follows the release statements for length of FDP for the different cultivars. However in southwest Florida FDP of ‘TropicBeauty’ and ‘UFGold’ were similar. This may be because ‘UFGold’ did not receive adequate chilling in southwest Florida thereby extending the bloom period and resulting in an error in the estimation of full bloom. FDP of ‘UFGold’ was about 6 to 7 day’s shorter in north-central than in southwest Florida both years. Information pertaining to different patterns in fruit development at different locations, can help growers determine what cultivars would be suitable for their location to have continuous production of peaches during the important April and May market window in Florida. Although the relative pattern for fruit development of the cultivars was the same at the different locations, length of the FDP was different between the two locations and between both years at the central location.

The shorter FDP and later harvest in the central location can be attributed to the delayed bloom experienced during 2005 and warmer temperatures during the first stage of fruit development. The FDP for 2005 was shorter in the central location than in the other locations or during the previous year for the same location. The delayed bloom in 2005 may be attributed to several different factors, or a combination of factors, such as insufficient chilling, high incidence of bacterial spot, and the passage of several hurricanes through the region the previous fall, as discussed in the previous chapter.

Temperatures can have a pronounced effect on fruit development. In central Florida, chilling was unusually low in 2005. This lead to a full bloom date that was one month later than the previous year. Yet harvest at the central location was only delayed two weeks. Since bloom in 2005 was delayed nearly a month, the first stage of fruit development occurred at a time when temperatures were warmer resulting in an accelerated rate of development.

The difference in temperature during the first stage of fruit development between 2004 and 2005 probably accounts for the reduction in FDP observed. Temperatures during the early stages of development have been shown to affect the FDP of both peach (Batjer and Martin, 1965) and apricot (Lilleland, 1936). During 2004 within the central location, the length of the FDP followed the information released for each cultivar (Rouse and Sherman, 1989b; Sherman and Lyrene, 1997; Sherman and Lyrene, 1989; Sherman et al., 1982). In general, there was a ten day difference observed in the FDP at the central location between 2004 and 2005. Topp and Sherman (1989a) reported that a 1°C reduction in mean temperature over the entire FDP can result in a 5-day increase in FDP. Boonprakob et al. (1992) indicated that using the average daily temperature 30 to 45 days after full bloom was a good predictor for the length of the FDP. They reported a 2 to 6 day reduction in FDP for every 1°C increase in mean temperature, depending on the cultivar. The 30 day period following full bloom would have been predominantly in the month of February, 2004, and March, 2005. The average temperature for the month of February, 2004, was 16.65°C and the average temperature for the month of March, 2005, was 18.13°C. This is a 1.48°C temperature difference between the two years. This temperature difference most likely resulted in the reduction in FDP during 2005 at the central location.

The increased length in FDP may also be attributed to the higher rates of N applied. The amount of N applied during the course of a season can affect the FDP as well as many different fruit quality attributes. Within the north-central location, N application rates were more than twice that at the other locations. Higher N rates have been shown to affect the FDP of peaches (Saenz et al., 1997). The addition of higher N rates may have further contributed the longer FDP observed in the cultivars at this location.

The effect that the increased rates of N had at the north-central location was calculated for 2004 using the mean FDP of ‘Flordaprince’, ‘Flordaglo’, and ‘TropicBeauty’ at the three different locations. ‘UFGold’ could not be used because of the longer FDP observed in the southwest location may be attributed to insufficient chilling. The mean FDP of the three cultivars for the three locations was used to determine the mean temperature during fruit development. The difference in FDP and mean temperature was determined between central and southwest Florida. The difference in FDP and mean temperature over fruit development was used to calculate the increase in length of FDP for every 1°C; this difference was a 4.4 day increase for a 1°C decrease in mean FDP temperature. The difference in mean FDP temperature between the north-central and southwest locations was 2.56°C. This difference was multiplied by 4.4 to get an 11.3 day difference in FDP between the southwest and north-central locations. When the mean FDP at the north-central location was subtracted from the mean FDP at the southwest location the difference was 12.3 day’s. This shows only a one day increase in the length of FDP at the north-central location from the higher rates of N applied at that location. Therefore it is likely that the longer FDP in north-central Florida resulted from to cooler temperatures at that location rather than the higher rates of N.

Fruit Size, Shape, and Yield

Fruit size and shape varied considerably among the different cultivars at the different locations. In some cases, fruit size and shape were different from previously reported information. Mean fruit weight, cheek diameter, suture diameter, and fruit length tended to be greater for ‘TropicBeauty’ and lesser for ‘UFGold’ at all locations. It was previously reported that ‘TropicBeauty’ and ‘UFGold’ produce peaches averaging 100 g and 110 g respectively (Rouse and Sherman, 1989b, Sherman and Lyrene, 1997). Results obtained in this experiment showed that fruit average fruit weights of ‘TropicBeauty’ were over 100 g at all locations, and in some instances well over 100 g. The opposite was true for ‘UFGold’. ‘UFGold’ fruit weights close to those in the release statement were only achieved at the north-central location where the trees received higher N rates. In the central and southwest locations fruit weights were much less than the 110 g specified in the release statement.

Competition among fruits may be one possible explanation for the reduced fruit size due to the higher fruit set in ‘UFGold’. Generally there was a higher adjusted number of fruit per tree for ‘UFGold’ than for ‘TropicBeauty’. More carbohydrates may have been available to the ‘TropicBeauty’ fruit due to the lower fruit set, and this may have resulted in increased fruit size.

It is also possible that higher N rates than were applied in central or southwest Florida are needed to attain moderately large fruit for ‘UFGold’. Higher rates of N fertilizer applied in north-central Florida may have resulted in the larger fruit observed there for all cultivars. Average fruit weights, dimensions, and lengths were all greatest in north-central Florida. It has been reported that fruit size and weight can be affected by N rates. Saenz et al. (1997) reported an increase in fruit mass at higher N rates. Rates of N fertilization at the north-central location were at least 2.5 times higher than at the locations in central or southwest Florida. The fertilizer was also spread out over several light applications. This may have resulted in more N being available for plant uptake and less N leached below the root zone compared to only two or three applications.

Small fruit size for several cultivars in the central location during 2004 may be the result of water restriction from lack of irrigation during stage III of growth. During 2004, in the central location, low fruit weights were observed for ‘Flordaprince’ and ‘UFGold’ but not for ‘Flordaglo’ or ‘TropicBeauty’. Prior to harvest in 2004, the irrigation line for the entire planting of trees at the central location was damaged and irrigation was not applied for two weeks. The break in the irrigation line occurred during the last two weeks of March, 2004. It has been shown that water restrictions during stage III of development can affect fruit size (Li et al., 1989). ‘Flordaprince’ and ‘UFGold’ both have FDP’s that are shorter than ‘Flordaglo’ or ‘TropicBeauty’. ‘Flordaprince’ and ‘UFGold’ were probably further into stage III of fruit growth than ‘Flordaglo’ or ‘TropicBeauty’ during the non-irrigated period. Harvest of ‘Flordaprince’ and ‘UFGold’ began two weeks after the irrigation line was repaired while harvest of ‘Flordaglo’ and ‘TropicBeauty’ began three to four weeks after the repair. ‘Flordaglo’ and ‘TropicBeauty’ which have longer FDP’s probably received more water during stage III of fruit growth than either ‘Flordaprince’ or ‘UFGold’. The low fruit weights for ‘Flordaprince’ and ‘UFGold’ during 2004 were likely a result of reduced irrigation during fruit growth.

During 2004 it appeared that there may be a difference among the types of blossom end (i.e. recessed, flattened, or extended) among the cultivars and locations. This trait was observed during the 2005, season to determine if a difference existed among locations or cultivars. Temperature differences among the locations during fruit development may be the cause of the differences observed in the percentage of fruit with sunken and extended blossom ends. There appeared to be more fruit with recessed blossom ends at the north-central location and more fruit with extended blossom end at the southwest location. Peaches with extended blossom ends have been reported by various authors (Salvador et al., 1998; Topp and Sherman, 1989b). Pronounced blossom end development has been attributed to warmer temperatures in an area (Topp and Sherman, 1989b) and to inadequate chilling or prolonged dormancy (Byrne and Bacon, 1992; Campbell et al., 1995; Koffmann and Patten, 1992; Rouse and Sherman, 2002a; Rouse and Sherman, 1989a).

Cultivar differences may exist for the percentage of fruit with extended blossom ends. Some of the cultivars in this experiment such as ‘Flordaglo’ and ‘TropicBeauty’ had a higher percentage of fruit with a more pronounced tip in southwest Florida compared to other cultivars such as ‘UFGold’. New low-chill cultivars and selections should be tested in warm areas to determine the prevalence of this condition prior to their release since fruit that exhibit pronounced tips are easily damaged in shipment. Cultivars that exhibit this trait would probably be better suited for production in cooler climates.

Yield varied considerably among genotypes, locations, and years. It can be influenced by weather and cultural practices. Since yield is so variable, it is difficult if not impossible to determine an average yield for each cultivar. Generally, ‘Flordaglo’ and ‘UFGold’ had higher adjusted yields than ‘Flordaprince’ or ‘TropicBeauty’. One reason for the higher yields for these two cultivars is that greater amounts of flower buds were set in these two cultivars. This agrees with the release statements by Sherman and Lyrene (1997; 1989). By setting higher numbers of flowers than other cultivars, yield losses from late spring frosts and freezes can be minimized and higher yields can be accomplished. However, this can lead to increased costs from greater fruit thinning requirements.

Higher rates of N at the north-central location may have also contributed to the higher adjusted yield and adjusted fruit number at that location. It has been shown that higher N rates can affect yield (Saenz et al., 1997; Shoemaker and Gammon, 1963). This along with overall better health of the trees possibly contributed to the higher adjusted yield observed. Fruit size and weight were also greater at the north-central location. Larger fruit contributed to high yields obtained at the north-central location.

Color

Fruit color is important for market sale of peaches. Consumers want peaches that have a high blush and bright yellow ground color (Anderson and Sherman, 1994). Fruit color varied among the different cultivars and locations. Generally the highest blush was observed in ‘Flordaprince’ and the lowest was observed in ‘UFGold’. However blush values at several of the locations were lower than what is stated in the cultivar release statements, only at the southwest location did percent blush reach previously reported values for these cultivars. The release statements indicate that ‘Flordaprince’ has a blush of approximately 80% and ‘UFGold’ has a blush of about 70-90% (Sherman and Lyrene, 1997; Sherman et al., 1982). We observed fruit blush values around 40 % for ‘UFGold’ and around 60 % for ‘Flordaprince’ within the north-central location during both years.

Blush values in central Florida for ‘UFGold’ were approximately 45% during 2004 and 60% during 2005, and values for ‘Flordaprince’ were 60-65% during both seasons. Fruit blush values for ‘Flordaprince’ and ‘UFGold’ appear to be lower than previously reported.

Reduced blush in more northern locations and higher blush at the southwest location might be due to greater sunlight exposure to the fruit at the southwest location. Generally blush values observed in southwest Florida agreed with previously reported information (Rouse and Sherman, 1989b; Sherman and Lyrene, 1989; Sherman and Lyrene, 1997; Sherman et al., 1982). Higher UV irradiance from sunlight has been shown to increase both red color development and concentration of anthocyanin (Kataoka and Beppu, 2004). In the Northern Hemisphere, as locations progress further south, the intensity of solar radiation increases. The trees within the southwest location probably had a higher intensity of sunlight than the trees at the north-central location. This higher intensity of sunlight would at least partially account for the increased blush observed at the southwest location.

The amount of light entering the canopy is another factor which can have an effect on fruit quality. The dense canopy cover and excessive growth at the north-central location from the higher amounts of N fertilizer most likely contributed to the lower blush at that location. Trees at the central and southwest locations had less canopy cover and the fruit had greater exposure to light. Several reports have shown that increased light exposure can cause a higher red blush in peaches (Erez and Flore, 1986; Lewallen and Marini, 2003; Kataoka and Beppu, 2004).

Fruit Quality

There were several fruit quality traits that differed among cultivars. TA values were lowest in ‘UFGold’ across locations and the SSC:TA ratio was highest in this cultivar. SSC values for ‘UFGold’ were similar to the other cultivars. The higher value for the SSC:TA ratio for ‘UFGold’ can be attributed to the lower TA values. Also ‘UFGold’ tended to be firmer than other cultivars. ‘UFGold’ received some of is genetic background from clingstone germplasm and it is considered a nonmelting flesh peach. Nonmelting flesh peaches are firmer than melting flesh cultivars due to lower levels of endo-polygalacturonase. Differences in organic acids have been observed between peach and nectarine mutants, with higher levels reported for nectarine (Wen et al., 1995). Also the composition of organic acids in melting flesh peaches has been studied, with malic acid being the predominant acid (Byrne et al. 1991). Differences among the different maturity stages in nonmelting flesh peaches have also been studied, with lower levels of TA observed at more advanced maturity levels (Brooks, et al. 1993). However, information regarding differences between nonmelting and melting flesh peaches for levels of TA at the same stage of maturity is not available in the literature.

The lower values for SSC at the north-central location may be a result of higher N rates used at this location. During both years it was observed that the north-central location generally had lower SSC and SSC:TA ratios than the other locations across all cultivars. Fruit quality can be affected by high amounts of N. Jia et al. (1999) concluded high N rates inhibited sugar accumulation in peach. This is similar to what we observed. The trees at the north-central location had higher N rates and generally had fruit with lower sugar content as measured in brix° values. The increased rate of N probably contributed to lower overall brix° values in the fruit.

Higher brix° values in the central location during 2004 for three of the four cultivars may be the result of the break in the irrigation that occurred during stage III of fruit growth. Water restrictions during stage III of development can increase the brix° levels in fruit (Li et al., 1989). Since ‘Flordaprince’ and ‘UFGold’ were well into stage III of fruit growth, and ‘Flordaglo’ and ‘TropicBeauty’ were at the end of the second stage or the very beginning the third stage, brix° may have been increased for ‘Flordaprince’ and ‘UFGold’, but not ‘Flordaglo’ or ‘TropicBeauty’.

General Conclusions

The quality indices observed in this experiment varied within the different locations and by the different cultural practices used. Higher blush values at the southwest location may be attributed to higher incidence of sunlight at that particular location. The longer FDP observed at the north-central location can be attributed to cooler temperatures at that site compared to the other locations. Water restrictions during a critical growth stage at the central location during 2004 were probably the cause of the increase brix° levels observed in some cultivars. Competition among fruits in ‘UFGold’ may have been the cause of low fruit weights observed for this cultivar compared to the other cultivars in the experiment. Testing cultivars in several locations can help to determine the adaptation of certain cultivars for different areas.

The high N rates used in north-central Florida may provide valuable information on response of low-chill peach cultivars to higher than currently recommended nitrogen rates in Florida. It was observed that the higher rates of nitrogen within the north-central location resulted in longer FDP, increased yield, larger fruit size, and lower brix°. Greater yields may be possible by increasing nitrogen rates above current recommendations, or by applying nitrogen fertilizers in small frequent applications.

However, further testing needs to be done to determine the optimum amount of nitrogen needed to increase yield and fruit size, without reducing brix° values, blush values, and increasing the FDP.

Information on fruit development and on quality attributes such as brix° and fruit shape can help growers in choosing cultivars to fulfill certain market windows and market niches such as white flesh or donut peaches. FDP is very important in areas such as Florida where the production window is confined to April and May. If this timeframe is missed, then the crop will be harvested at a time when competition from other regions, such as California or South Georgia, will have lowered market prices for Florida fruit.

Table 8. Bloom dates, harvest dates, and fruit development period (FDP) for four low-chill peach cultivars for the central and southwest locations for 2004.

	Bloom Date	Harvest Date (first Commercial)	FDP[z] (Day's)
Central			
Cultivar			
Flordaprince	01-28-04b[y]A[x]	4-19-04cA	82.6bA
Flordaglo	02-02-04bA	4-25-04abA	84.2bA
UFGold	02-09-04aA	4-20-04bcA	72.0cB
TropicBeauty	01-28-04bB	4-29-04aA	93.0aA
Southwest			
Cultivar			
Flordaprince	01-25-04aA	4-15-04cB	80.8bA
Flordaglo	02-02-04aA	4-29-04aA	79.4bB
UFGold	01-31-04aB	4-20-04bA	87.2abA
TropicBeauty	02-01-04aA	4-30-04aA	89.6aA

[z] Fruit development period
[y] Means within location followed by the same lowercase letter are not significantly different according to Tukey's Test $P \leq 0.05$.
[x] Means for cultivars across locations followed by the same uppercase letter are not significantly different according to Tukey's Test $P \leq 0.05$.

Table 9. Bloom dates, harvest dates, and fruit development period (FPD) for four low-chill peach cultivars for the north-central location for 2004.

	Bloom Date	Harvest Date (first Commercial)	FDP[z] (Day's)
Cultivar			
Flordaprince	01-28-04b[y]	4-26-04c	90.4a
Flordaglo	01-31-04b	5-08-04a	97.8a
UFGold	02-13-04a	5-03-04b	81.4b
TropicBeauty	01-31-04b	5-11-04a	99.0a
Significance	<0.0001	<0.0001	0.0001

[z] Fruit development period
[y] Means across cultivars followed by the same lowercase letter are not significantly different according to Tukey's Test $P \leq 0.05$.

Table 10. Bloom dates, harvest dates, and fruit development period (FPD) for four low-chill peach cultivars for the central and southwest locations for 2005.

	Bloom Date	Harvest Date (first Commercial)	FDP[z] (Day's)
Central			
Cultivar			
Flordaprince	02-24-05a[y]A[x]	5-5-05bA	71.2bB
Flordaglo	02-28-05bA	5-13-05aA	74.0bB
UFGold	02-28-05bA	5-3-05bA	65.0cB
TropicBeauty	02-23-05aA	5-15-05aA	82.2aB
Significance	<0.0001	<0.0001	<0.0001
Southwest			
Cultivar			
Flordaprince	01-30-05aB	4-17-05bB	78.2bA
Flordaglo	02-02-05aB	5-7-05aB	95.0aA
UFGold	02-01-05aB	4-30-05abA	88.8aA
TropicBeauty	01-21-05aB	4-26-05abB	94.8aA
Significance	0.0431	0.0245	<0.0001

[z] Fruit development period
[y] Means within location followed by the same lowercase letter are not significantly different according to Tukey's Test $P \leq 0.05$.
[x] Means for cultivars across locations followed by the same uppercase letter are not significantly different according to Tukey's Test $P \leq 0.05$.

Table 11. Bloom dates, harvest dates, and fruit development period (FPD) for four low-chill peach cultivars for the north-central location for 2005.

	Bloom Date	Harvest Date (first Commercial)	FDP[z] (Day's)
Cultivar			
Flordaprince	02-02-05b[y]	5-02-05c	90.6b
Flordaglo	02-05-05b	5-10-05b	94.6b
UFGold	02-12-05a	5-03-05c	81.0c
TropicBeauty	02-02-05b	5-14-05a	102.2a
Significance	<0.0001	<0.0001	<0.0001

[z] Fruit development period
[y] Means across cultivars followed by the same lowercase letter are not significantly different according to Tukey's Test $P \leq 0.05$.

Table 12. Main effects of percentage fruit set during 2005 and adjusted marketable number of fruit for both 2004 and 2005 for four low-chill peach cultivars and three locations.

	2004	2005	2005
	Number/TCA^{z}	Number/TCA	Fruit Set (%)
Cultivar			
Flordaprince	0.66c^{y}	0.89b	49.8ab
Flordaglo	1.79b	1.82a	60.8a
UFGold	3.09a	2.32a	64.5a
TropicBeauty	1.20bc	0.96b	31.9b
Location			
North-Central	1.66a^{x}	1.22b	35.1a
Central	1.64a	1.75a	68.5a

^{z} Trunk cross-sectional area (cm^{2}).
^{y} Means across cultivars followed by the same lowercase letter are not significantly different according to Tukey's Test P $\leq$ 0.05.
^{x} Means across locations followed by the same uppercase letter are not significantly different according to Tukey's Test P $\leq$ 0.05.

Table 13. Adjusted yield for 2004 and 2005 for four low-chill peach cultivars within three locations.

	2004	2005
	Fruit Yield (kg)/TCA[z]	Fruit Yield (kg)/TCA
North-Central		
Cultivar		
Flordaprince	0.08b[y]A[x]	0.12bA
Flordaglo	0.21abA	0.17abB
UFGold	0.37aA	0.22aA
TropicBeauty	0.18bA	0.13abB
Central		
Cultivar		
Flordaprince	0.06bA	0.11bA
Flordaglo	0.22aA	0.28aA
UFGold	0.19aB	0.25aA
TropicBeauty	0.16abA	0.15bB
Southwest		
Cultivar		
Flordaprince	---[w]	0.17bA
Flordaglo	---	0.27aAB
UFGold	---	0.16bA
TropicBeauty	---	0.21abA

[z] Trunk cross-sectional area (cm^2).
[y] Means within location followed by the same lowercase letter are not significantly different according to Tukey's Test $P \leq 0.05$.
[x] Means for cultivars across locations followed by the same uppercase letter are not significantly different according to Tukey's Test $P \leq 0.05$.
[w] Data unavailable.

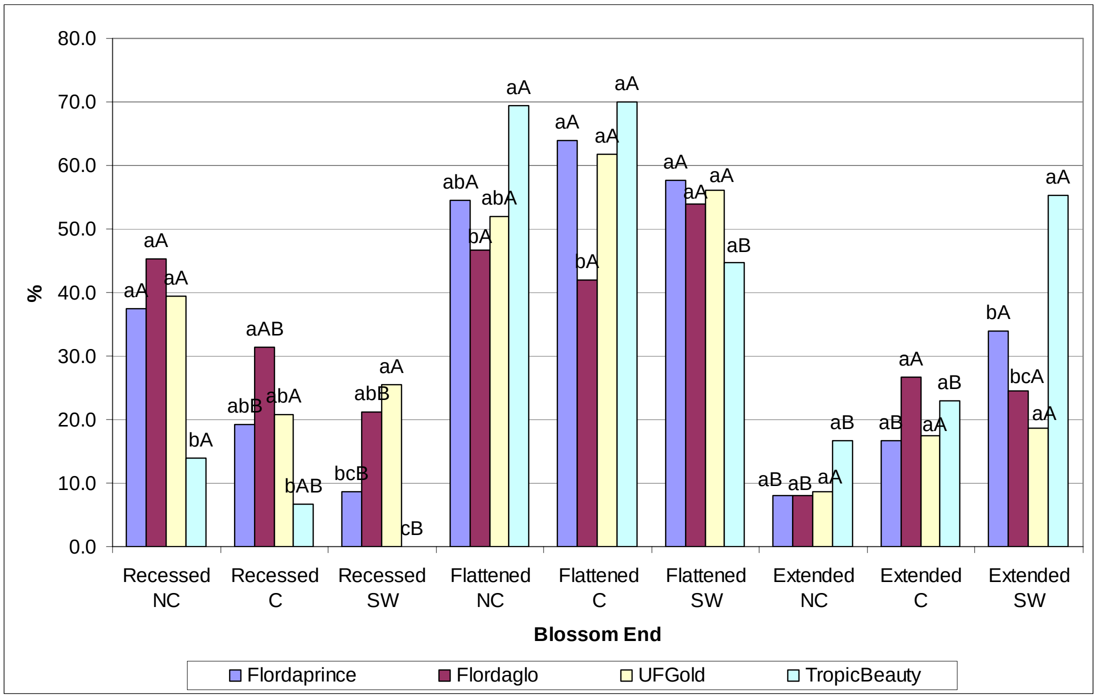

Figure 12. Percentage of peach fruit with sunken, flattened, and extended blossom ends within the North-central (NC), Central (C), and Southwest (SW) locations. Lower case letters represent significant differences among cultivars for a certain trait within a location according to Tukey's Test P $\leq$ 0.05. Uppercase letters represent significant differences among locations for a certain trait for each cultivar using Tukey's Test P $\leq$ 0.05.

Table 14. Post harvest quality measurements for four low-chill peach cultivars during 2004, within the central and southwest locations, for measurements of TA, SSC, and Pressure.

	TA[z]	SSC[y] (Brix°)	Pressure (N)
Central			
Cultivar			
Flordaprince	0.951a[x]A[w]	12.38aA	20.75cA
Flordaglo	0.972aA	10.59bA	27.21bA
UFGold	0.895aA	11.65aA	37.13aA
TropicBeauty	1.010aA	11.47abA	20.71cA
Southwest			
Cultivar			
Flordaprince	0.938aA	11.10aB	17.97bA
Flordaglo	1.012aA	11.28aA	23.87aA
UFGold	0.706bB	11.18aA	21.37abB
TropicBeauty	0.898aA	10.84aA	8.07cB

[z] Titratable acidity.
[y] Soluble solids concentration.
[x] Means within location followed by the same lowercase letter are not significantly different according to Tukey's Test $P \leq 0.05$.
[w] Means for cultivars across locations followed by the same uppercase letter are not significantly different according to Tukey's Test $P \leq 0.05$.

Table 15. Post harvest quality measurements for four low-chill peach cultivars during 2004, within the north-central location, for measurements of TA, SSC, and Pressure.

	TA[z]	SSC[y] (Brix°)	Pressure (N)
Cultivar			
Flordaprince	0.904bc[x]	10.29ab	19.05ab
Flordaglo	1.122ab	09.79ab	16.53b
UFGold	0.677c	09.17b	21.63a
TropicBeauty	1.136a	11.16a	16.71b

[z] Titratable acidity.
[y] Soluble solids concentration.
[x] Means across cultivars followed by the same lowercase letter are not significantly different according to Tukey's Test $P \leq 0.05$.

Table 16. Main effects for TA for four low-chill peach cultivars and three locations during 2005.

Cultivar	TA[z]
Flordaprince	0.880b[y]
Flordaglo	1.028a
UFGold	0.819b
TropicBeauty	0.969a
Location	
North-Central	0.984a[x]
Central	0.970a
Southwest	0.826b

[z] Titratable acidity.
[y] Means across cultivars followed by the same lowercase letter are not significantly different according to Tukey's Test P ≤ 0.05.
[x] Means across locations followed by the same uppercase letter are not significantly different according to Tukey's Test P ≤ 0.05.

Table 17. Post harvest quality measurements for four low-chill peach cultivars during 2005, within the central and southwest locations, for measurements of SSC, Ratio, and Pressure.

	SSC[z] (Brix°)	Ratio (SSC/TA)	Pressure (N)
Central			
Cultivar			
Flordaprince	11.52a[y]B[x]	12.96bB	19.55cA
Flordaglo	11.89aB	11.04bB	38.82aA
UFGold	11.95aB	14.92aB	29.29bA
TropicBeauty	12.03aA	11.56bB	26.62bA
Southwest			
Cultivar			
Flordaprince	12.80bA	15.56bA	13.47bB
Flordaglo	12.91bA	14.60bA	13.67bB
UFGold	14.37aA	20.17aA	31.24aA
TropicBeauty	12.29bA	14.75bA	7.89cB

[z] Soluble solids concentration.
[y] Means within location followed by the same lowercase letter are not significantly different according to Tukey's Test P ≤ 0.05.
[x] Means for cultivars across locations followed by the same uppercase letter are not significantly different according to Tukey's Test P ≤ 0.05.

Table 18. Post harvest quality measurements for four low-chill peach cultivars during 2005, within the north-central location, for measurements of SSC, Ratio, and Pressure.

	SSC[z] (Brix°)	Ratio (SSC/TA)	Pressure (N)
Cultivar			
Flordaprince	9.70a[y]	10.64a	16.45b
Flordaglo	9.44a	8.61b	19.78b
UFGold	9.48a	10.73a	30.24a
TropicBeauty	10.28a	10.09ba	15.78b

[z] Soluble solids concentration.
[y] Means across cultivars followed by the same lowercase letter are not significantly different according to Tukey's Test $P \leq 0.05$.

Table 19. Main effects for the ratio of SSC:TA for four low-chill peach cultivars and three locations during 2004.

Cultivar	Ratio (SSC/TA)
Flordaprince	12.21b[z]
Flordaglo	10.42c
UFGold	14.43a
TropicBeauty	11.32bc
Location	
North-Central	11.05b[y]
Central	12.17a
Southwest	13.05a

[z] Means across cultivars followed by the same lowercase letter are not significantly different according to Tukey's Test $P \leq 0.05$.
[y] Means across locations followed by the same uppercase letter are not significantly different according to Tukey's Test $P \leq 0.05$.

Table 20. Fruit blush, weight, and dimension measurements for four low-chill peach cultivars during 2004 within the central and southwest locations.

	Blush (%)	Individual Weight (g)	Cheek Diameter (cm)	Suture Diameter (cm)	Fruit Length (cm)
Central					
Cultivar					
Flordaprince	66.71a[z]B[y]	87.65cB	---[x]	5.13cB	5.52bB
Flordaglo	69.89aB	111.65bA	---	5.80bA	5.71baA
UFGold	58.89bB	73.54dB	---	4.92cB	5.09cB
TropicBeauty	57.00bB	138.28aA	---	6.30aA	5.93aB
Southwest					
Cultivar					
Flordaprince	95.33baA	93.88bA	5.45b	5.63baA	5.85bA
Flordaglo	91.47bcA	94.44bB	5.48b	5.60bA	5.74bA
UFGold	90.53cA	91.07bA	5.51b	5.63baA	5.45cA
TropicBeauty	98.20aA	113.24aB	5.97a	5.83aB	6.08aA

[z] Means within location followed by the same lowercase letter are not significantly different according to Tukey's Test P ≤ 0.05.
[y] Means for cultivars across locations followed by the same uppercase letter are not significantly different according to Tukey's Test P ≤ 0.05.
[x] Data unavailable.

Table 21. Fruit blush, weight, and dimension measurements for four low-chill peach cultivars during 2004 within the north-central location.

	Blush (%)	Individual Weight (g)	Cheek Diameter (cm)	Suture Diameter (cm)	Fruit Length (cm)
Cultivar					
Flordaprince	57.18a[z]	153.20b	---[y]	6.41bc	6.20ba
Flordaglo	60.00a	157.25ba	---	6.65ba	6.25a
UFGold	43.79b	132.81c	---	6.24c	5.96b
TropicBeauty	41.05b	163.96a	---	6.71a	6.25a

[z] Means across cultivars followed by the same lowercase letter are not significantly different according to Tukey's Test P ≤ 0.05.
[y] Data unavailable.

Table 22. Fruit blush, weight, cheek diameter, and suture diameter measurements for four low-chill peach cultivars during 2005 within the central and southwest locations.

	Blush (%)	Individual Weight (g)	Cheek Diameter (cm)	Suture Diameter (cm)
Central				
Cultivar				
Flordaprince	62.20a[z]B[y]	131.34bA	6.32bA	5.91bA
Flordaglo	52.90bB	129.42bA	6.26bA	5.95bA
UFGold	46.25cB	94.95cA	5.80cA	5.41cA
TropicBeauty	47.50cbB	152.86aA	6.69aA	6.47aA
Southwest				
Cultivar				
Flordaprince	89.80aA	86.26bcB	5.22cbB	5.59bB
Flordaglo	79.15bA	100.53baB	5.37bB	5.63bB
UFGold	62.25dA	75.16cB	5.08cB	5.28cA
TropicBeauty	72.45cA	107.61aB	5.72aB	5.98aB

[z] Means within location followed by the same lowercase letter are not significantly different according to Tukey's Test P $\leq$ 0.05.
[y] Means for cultivars across locations followed by the same uppercase letter are not significantly different according to Tukey's Test P $\leq$ 0.05.

Table 23. Fruit blush, weight, cheek diameter, and suture diameter measurements for four low-chill peach cultivars during 2005 within the north-central location.

	Blush (%)	Individual Weight (g)	Cheek Diameter (cm)	Suture Diameter (cm)
Cultivar				
Flordaprince	57.20a[z]	160.58b	7.02ba	6.63b
Flordaglo	59.18a	156.02b	6.83b	6.72ba
UFGold	37.40c	118.48c	6.37c	6.15c
TropicBeauty	45.80b	171.68a	7.13a	6.90a

[z] Means across cultivars followed by the same lowercase letter are not significantly different according to Tukey's Test P $\leq$ 0.05.

Table 24. Main effects for fruit length for four low-chill peach cultivars and for three locations during 2005.

Cultivar	Fruit Length
Flordaprince	6.17a[z]
Flordaglo	6.09a
UFGold	5.32b
TropicBeauty	6.18a
Location	
North-Central	6.14a[y]
Central	5.89ab
Southwest	5.81b

[z] Means across cultivars followed by the same lowercase letter are not significantly different according to Tukey's Test P ≤ 0.05.
[y] Means across locations followed by the same uppercase letter are not significantly different according to Tukey's Test P ≤ 0.05.

Table 25. Colorimeter measurement values for the 2005 harvest season for both the most blushed and least blushed location on each fruit, for L*,C*h* values at three different locations for four low-chill peach cultivars.

	L*		C*		h*	
	Most	Least	Most	Least	Most	Least
North-Central						
Cultivar						
Flordaprince	36.60ba[z]	64.18b	34.28ba	47.45c	28.66ba	76.37c
Flordaglo	35.82b	64.01b	31.59b	32.69d	27.72b	83.12ba
UFGold	39.05a	65.52b	35.28a	52.88a	31.59a	80.86bc
TropicBeauty	38.64a	68.56a	32.94ba	50.28b	31.90a	88.07a
Significance	0.0030	<0.0001	0.0441	<0.0001	0.0018	<0.0001
Central						
Cultivar						
Flordaprince	33.32b	65.91b	30.66b	49.36c	25.91b	75.63b
Flordaglo	34.85b	69.24a	32.29b	32.66d	27.14b	88.58a
UFGold	38.86a	63.90b	37.44a	55.82a	31.35a	74.31b
TropicBeauty	35.35b	69.42a	32.12b	52.72b	28.03b	85.86a
Significance	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Southwest						
Cultivar						
Flordaprince	30.45d	54.67c	25.90c	49.08b	23.08c	52.01d
Flordaglo	32.11c	59.53b	29.24b	34.85c	25.39b	57.74c
UFGold	36.61a	64.93a	34.96a	56.18a	28.94a	74.50a
TropicBeauty	33.74b	61.46b	25.20c	49.94b	27.95a	76.26b
Significance	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

[z] Means within location followed by the same lowercase letter are not significantly different according to Tukey's Test $P \leq 0.05$.

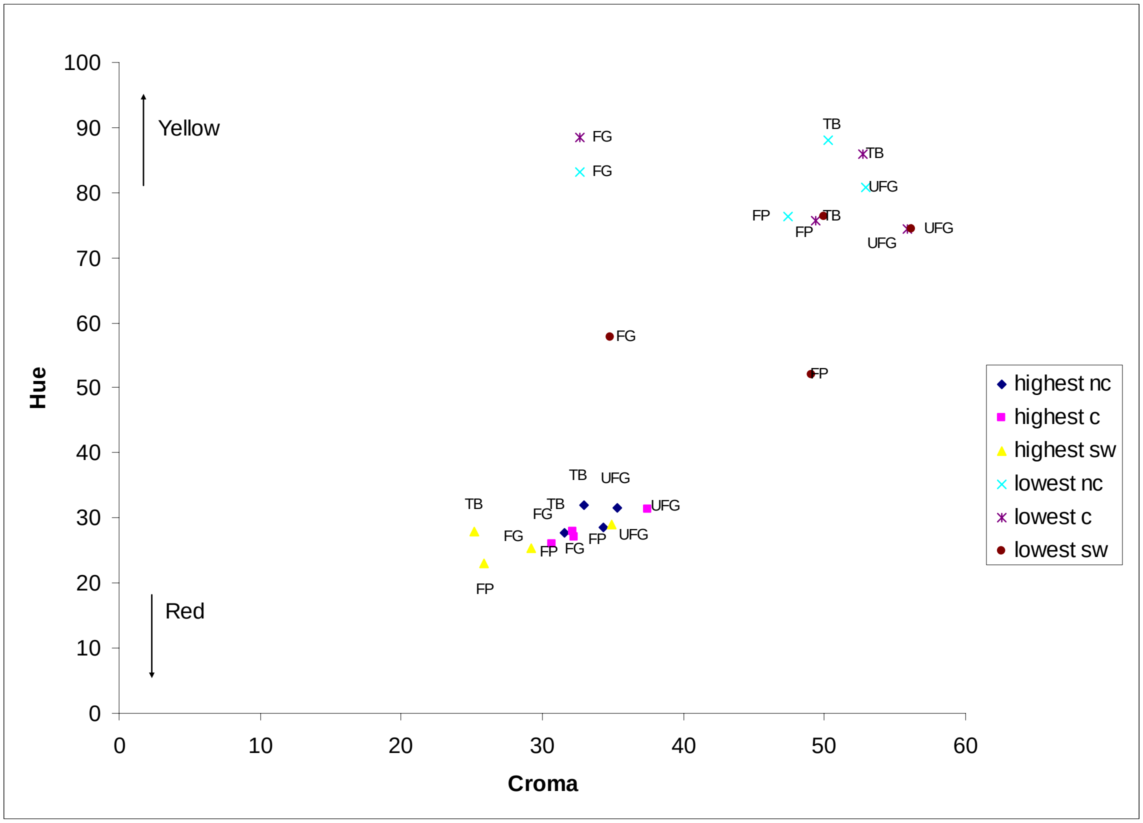

Figure 13. Hue and croma chart for the highest and lowest blushed locations on four low-chill peach cultivars at three locations in Florida.

CHAPTER 5
CONCLUSIONS

In this experiment trees planted in more southern locations produced trees with more blind nodes and fruit with more pronounced blossom ends, and higher blush values. A reduction in FDP attributed to an increase in the average temperature during fruit development was detected between north-central Florida and southwest Florida. Lower percentages of blind nodes and higher amounts of fruit with recessed blossom ends were observed in north-central Florida. 'UFgold' tended to set more fruit and had more nodes with only flower buds compared to the other cultivars. Generally higher amounts of blind nodes were observed in 'TropicBeauty' compared to the other three cultivars. Both environmental and disease factors may have contributed to the lower percentage of nodes with vegetative and flower buds and higher amounts of blind nodes observed in central Florida. Higher rates of N applied at the north-central location probably contributed to the higher fruit weights, lower blush values, lower SSC, and higher adjusted fruit number and yield at that location.

The time during which peach fruit mature in Florida has important economic considerations in Florida. Fruit ripening typically occurs during April/May when there are relatively few domestic peaches on the market and imports have stopped. This is a period when high prices can be achieved from quality fruit. Identifying suitable cultivars and locations in Florida to target this window is vital. Generally, there was an earlier harvest, shorter FDP, and higher blush in the southwest Florida location. The shorter FDP and earlier harvest can be attributed to warmer temperatures during fruit development in this area compared to more northern locations. The higher percent blush in the southwest location is most likely do to higher UV irradiance at this location. Higher UV irradiance has been shown to increase both red color development and concentration of anthocyanin (Kataoka and Beppu, 2004). Areas such as the southwest location would be good regions to start production to target the early/mid April market while prices are still high. 'Flordaprince' generally was one of the earliest-ripening peaches followed by 'UFGold'. 'Flordaprince' would be a good peach to start the early market window because it is one of the earliest to mature and has a high blush coverage, followed by 'UFGold' which has high fruit set, yield, and high SSC:TA ratio.

Fruit with extended blossom ends can be easily damaged during harvest and shipment. This trait is generally more pronounced in warmer areas. New cultivars and selections should be tested in southern areas for prevalence of fruit with this trait. Testing in warm areas will keep cultivars out of the market that are prone to this condition which can limit the amount of marketable fruit available for sale.

Trees with large amounts of blind nodes are difficult to prune because fewer nodes are capable of sprouting. Fruit born on shoots with blind nodes may also lack size due to insufficient photosynthates. It is important to know which genotypes are the most capable of producing high numbers of both vegetative and floral buds, and those more prone to producing blind nodes. This would allow the culling of genotypes with a propensity towards blind nodes. Greater densities of floral and vegetative buds are an advantage in areas such as northern Florida or southern Georgia that are prone to late spring freezes which can kill swelling or open flowers or shoots (Werner et al., 1988).

Stresses imposed on trees during bud formation, in late summer/early fall, from high temperatures or severe weather may reduce the number of buds per node and increase the likely hood of blind nodes. Higher temperatures in the southwest location resulted high amounts of blind nodes at that location, and probably contributed to the increased amounts of blind nodes at the central location. Another contributing factor at the central location was the passage of three hurricanes. Defoliation and wind damage, along with higher temperatures probably resulted in the reduced number of buds and flowers observed. This could be detrimental to tree survival if there are few vegetative buds are set and to crop yields if few flower buds are set.

The delayed bloom that was observed in 2005 in central Florida was probably a result of early defoliation from diseases and hurricanes. This caused a late season growth flush to occur that may have delayed the onset of dormancy and chill accumulation. Reliable spray programs need to be developed in order to combat disease problems such as bacterial spot and rust, especially in areas with a monsoonal climate, and which produce a heavy layer of dew on the leaves in the morning. If diseases are not controlled, the resulting defoliation can increase the likelihood of a delayed bloom such as the one experienced in the spring of 2005. If this occurs the early market window may be missed, or low fruit set may occur from fruit being set under warmer temperature conditions (Rouse and Sherman, 2002b).

Fertilizer recommendations for some areas of Florida may need to be increased. Greater amounts of nitrogen fertilizer may be needed or more applications may be needed throughout the growing season. It was observed in north-central Florida that fruit size and weight was larger than other locations and yields were higher. Nitrogen rates were at least two times higher in north-central Florida, compared to central or southwest Florida, and were probably the cause of the high fruit weights and yields observed. By applying nitrogen to the soil several times and at low rates, losses to leaching are reduced, and more is available for the plant to take in during the year.

Higher amounts of nitrogen fertilizer may also cause problems. At the north-central location lower percent blush values, lower SSC, and lower SSC:TA ratios were observed, compared to central or southwest Florida. The higher rates of nitrogen fertilizer at this location caused the trees to have excessive growth which probably reduced blush values. It has been reported that trees which have excessive growth during fruit development tend to have fruit which have less red blush due to excessive shading from foliage (Erez and Flore, 1986). Higher nitrogen rates have also been shown inhibit sugar accumulation and the reduction of organic acids (Jia et al., 1999). Higher nitrogen fertilizer rates need to be tested in order to get an equal balance between increased fruit size and adequate quality for market sale.

Information obtained through this study can help growers, breeders, and researchers in testing and evaluating different cultivars of peaches. Testing in several locations and optimizing cultural practices for new cultivars, can ensure optimum yields and quality.

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BIOGRAPHICAL SKETCH

Todd Walter Wert was born in Valparaiso, Indiana, and was raised in Crown Point, Indiana. He graduated from Crown Point High School in the spring of 1999 and starting in the fall of 1999 he began his undergraduate studies at Purdue University Calumet, a satellite campus of Purdue University. The following fall he transferred to Purdue University in West Lafayette, and obtained his Bachelor of Science degree in the spring of 2003 in horticultural science. In the fall of 2003 Todd applied to the University of Florida as a master's student in the Horticultural Sciences Department, and he obtained his Master of Science degree in the summer of 2006.