

AVOCADO CANOPY MANAGEMENT FOR GREATER YIELDS AND ORCHARD EFFICIENCY

Gregory J. Partida Jr., Ph.D.

Professor and farm manager, fruit industries; Plant and Soil Sciences Department, California State Polytechnic University, Pomona, CA 91768

Since 1980, when I became the orchard manager for Cal Poly Pomona University, I have had the opportunity to visit the different fruit tree growing areas of California by attending different grower workshops, UC field days, or my own arranged university class tours of orchards throughout the state. Managing the 120 acres of different tree crops at Cal Poly Pomona has provided me with a great opportunity to stay abreast with the changes that are constantly occurring in this important industry. During this time, California growers have faced increasing costs in water, land, labor, pesticides, taxes, higher insurance (Workers' Compensation), and urban encroachment. Growers were dealing with a six year drought in the 1980s, a devastating freeze during the 1990 winter, warm winter temperatures (for the past 4 years), lower crop yields, and small fruit sizes. As avocado growers we have been faced with all of the previous problems plus avocado root rot, Medfly quarantine, Persea mite, a new thrips species problem on fruit, devastating winds, increasing salt problems in the irrigation water, marketing problems, NAFTA, and reduced yields as a result of current orchard practices. Insufficient water and fertilizers along with increased tree size and crowding have all accentuated the problems of small fruit size and lower yields. This translates to lower returns to growers who are faced with increasing costs.

I can appreciate this concern because, as the recession hit California in the late 1980s and early 1990s, our university's farm budgets were greatly reduced. In order to maintain our agricultural programs in the College of Agriculture, we had to find ways to increase the farm's income without state support. To do this, we had to look for ways to increase yields by reducing costs. At the same time, we were trying to modernize a 54-acre ranch one mile east of Santa Paula which was donated to the College of Agriculture in 1976. This ranch has always been self-sufficient, and it proved to be an excellent training center for future agricultural leaders. The only state support this ranch received over the past 20 years was day-to-day management by Cal Poly Pomona faculty, staff, and students. The ranch has provided Cal Poly Pomona students with a "hands—on training" (or Cal Poly's philosophy: "Learn by Doing"), a better understanding of the orchard cultural practices required in citrus and avocado orchards, and opportunities to attend grower meetings in Ventura and Santa Barbara counties. The opportunity to be responsible for the day—to—day operations of a ranch under minimum supervision is an educational opportunity that could never be provided in a classroom.

A lot of different research projects have been sponsored over the years by the

University of California and the California Avocado Society in regard to tree diseases and insect problems, orchard development, importance of bees, varieties important in cross-pollination of Hass, irrigation systems, problems associated with poor water quality, new variety selections, postharvest problems, and fertilizer trials. However, there have been very few long term studies investigating the effects of tree crowding, tree size, and pruning to lower cultural costs and the potential for increasing yields. The pruning of avocado trees in California in order to maintain tree size and help improve overall orchard maintenance and efficiency has only been practiced by a few avocado growers in different regions of southern California.

During the mid-1980s, when I asked different avocado experts about pruning and maintaining avocado trees at a workable height I was told that avocado orchards were generally established with 136 trees (16' x 20') to the acre. Over a period of 15 to 20 years, the orchards were thinned by removing every other row of trees diagonally and, finally, every other row. The net result was an orchard with a final planting of 17 trees (51' x 51') to the acre. UC farm advisor Len Francis had shown during the 1970s that yields started to decline when the avocado trees started crowding, reducing the amount of canopy available to set fruit. His experimental study showed that when crowding was eliminated, fruit yields would continue to increase until the trees returned to a crowded condition. This study showed that sunlight penetration into the canopy of the trees is very important in increasing fruit production.

In 1984, armed with avocado cultural information provided by UC Extension bulletins, pamphlets, personal communication with farm advisors, and information gathered at different grower meetings, I started the tree thinning program on a 10—acre Hass avocado orchard. This orchard consisted of two blocks of trees that had been planted in 1963 or 1964. Bacon and Zutano avocados had been planted around the perimeter of the Hass orchards along the main road and property lines. The eastern block also contained about two acres of MacArthur avocados. It was obvious from the 40— to 60-foot tall trees that the tree thinning process should have started during the mid-1970s, and not in 1984.

I learned that the avocado trees had been heavily pruned or stumped to 3 or 4 feet following the winter of 1978 because of freeze damage. Within five years, these trees had regrown to a height of 35 to 50+ feet. Starting in the winter and summer of 1984, every other diagonal row of trees was cut down to the ground in the west 5—acre block. This project was done over a two—year period because student crews were involved. It took a combined total of four weeks to cut out or stump the trees.

During the winter of 1986, freezing temperatures of 26° to 27°F destroyed the canopy of avocados in the east block. There was minimal freeze damage in the west block because the irrigation system had been used for frost protection. The trees in this block had a heavy crop set. The trees in the eastern block had a very light crop because they were in the "infamous alternate-bearing mode." This was their off-year! As a result of the freeze damage, the decision was made to stump trees and to remove trees in the diagonal rows that didn't have fruit. During the spring and summer of 1986, the damaged trees in the eastern block were stumped to 3 to 4 feet. Every other tree in the diagonal rows was cut to the ground and killed. Looking back, it was unfortunate that all of the trees in this block were not stumped. The price per pound during this year

averaged between 14 to 25 cents.

During the winter and spring of 1987-1988, every other tree was removed in the west block. The alternate trees were not only completely removed (tree thinning had never been done), but most of the remaining trees in this block were stumped to 3 to 4 feet.

From these tree removal projects we learned first hand the magnitude of trying to cut down tall trees without damaging neighboring trees loaded with fruit. The different tasks involved in cutting down trees are numerous. Irrigation hoses with sprinklers had to be rolled up in order to avoid damaging them with falling branches and mowing equipment. Dragging the brush into the drive rows for mowing and getting the firewood out of the orchards was a challenge, especially since avocado firewood has little cash value. These major tasks were followed by the whitewashing of the stumps to avoid sunburning. The resulting vegetative growth (watersprouts) was selectively removed two or three times over a 6—month period. During this time, new scaffold branches were being selected to form the main fruiting branches of the trees. During the time period of 1987 through 1990, the stumped trees grew to a height of 30 to 40+ feet. The fruit bearing canopy of the trees was back to 30+ feet. When the trees started crowding, the fruit production went from about 12,000+ pounds per acre to approximately 4,000-6,000 pounds per acre. The yields were even lower when the trees were in their alternate bearing year. These lower crop yield years seemed to coincide with the years when the fruit prices were high.

During December 23-26, 1990, California citrus and avocado growers in many different geographic areas suffered tremendous tree losses because of the "freeze of the century." Areas of Santa Barbara and Ventura counties were hard hit by the freezing temperatures. Cal Poly Pomona's ranch in Santa Paula suffered only minor damage to some of the avocado trees in the eastern block. There was very little tree damage in the other block, and no damage to any of the lemon or orange trees. The freezing temperatures had stayed above the northern property line. The ranch was very fortunate because temperatures did not get much below 32°F during this very cold winter.

The freeze damage to the trees in the eastern block prompted the decision in February 1991 to re—stump the avocado trees (they had been stumped in 1987—88). The trees that were not damaged and had fruit on them were not pruned. The avocado prices this year averaged about \$1.35 to \$1.60 per pound. This was a great price if there was fruit on the trees. During the summer of 1991, after several discussions and armed with previous information gathered from farm managers and UC farm advisors, I made the decision to try to keep the avocado trees at a maximum height of 12 to 15 feet. All of the pruning and harvesting cultural practices were going to be done with pole pruners, climbing into the trees or off of a 12—feet tall ladder.

Since 1976, I have visited many different fruit tree orchards around the state that have tree spacings that vary anywhere from 40' x 40' (28 trees/acre), 20' x 24' (90 trees), 20' x 20' (108 trees), 16' x 20' (135 trees), 15' x 15' (192 trees), 10' x 10' (435 trees), down to 6' x 8' (907 trees). The different planting schemes are used for walnut, almond, pistachio, peach, plum, apple, pear, apricot, orange, lemon, grapefruit, grape, and kiwi plants. The typical avocado orchard planting recommendation is 16' x 20' at the initial

planting. After 20 years and three tree thinnings or tree removals, the final tree spacing is 51 feet between the trees. The orchards are started with approximately 136 trees to the acre, and if the orchard developmental program is followed, it results in 17 trees to the acre. At this final planting spacing all of the trees will be over 50 feet tall.

It really didn't make much sense after seeing apple and pear trees at high density plantings of 500+ trees per acre. Deciduous fruit tree growers have been using high density plantings and smaller trees for years. They have not always used or relied on dwarfing rootstocks; they have used pruning techniques, a combination of pruning and different trellising techniques, to maintain tree size and increase fruit yields per acre. These growers made a commitment to maintaining trees at a manageable size to help facilitate orchard cultural practices. Smaller trees should require less water, fertilizers, easier to apply pesticides, better pesticide coverage because of the smaller canopies, less herbicides per acre, and in appropriate situations pruning machines can be used to maintain the tree height and size.

Cal Poly University Pomona started its pruning endeavor during the spring of 1991. The avocado prices were extremely high after the freeze, so the pruning crews were told not to prune any trees with fruit or flowers. These trees were not touched for the next two years. Approximately one—third of the eastern block was left unpruned. This resulted in trees of varying heights throughout this block because damaged trees were stumped down to trunks 3 to 5 feet tall. The latent buds along the trunks pushed out vigorous vegetative growth throughout the summer. During the fall of 1991, late August and early September, the trees were pruned. Branches and limbs were selectively removed in order to provide a tree with an open vase (open center) system. This is a very typical pruning system used throughout deciduous orchards. Pruning can be best described as an art more than a science. The growing trees presented so many opportunities to vary the pattern, direction of growth, and severity of cuts that we agreed on what type of tree shape we wanted in two or three years. It is a well known fact that all growers will have their own ideas as to what is a well—pruned tree. The most important fact is that the avocado trees will benefit from being maintained through pruning.

During the spring of 1992, the stumped trees had regrown to an approximate height of 10 feet plus. The trees produced a heavy set of flowers throughout the canopy on branches that were about 10 to 12 months old. A very light pruning was done to the trees. The pruning consisted of opening up the centers of the trees, establishing the main scaffold branches, and keeping the height of the trees below 12 feet. All crossing—over and weak growing branches were removed from the center of the trees. However, before any branches were removed from the center the canopy was checked to make sure that a hole would not result. This was done to prevent unnecessary sunburning to the middle of the trees. If branches had to be left to protect the center of the tree, they would be removed at a later pruning.

The crop set on the pruned trees was estimated in March 1993 to be about 16,000 pounds of Hass to the acre. The trees were only about 10 feet high. At this point it became obvious that if the trees could be pruned and maintained at a reasonable height, fruit production would not only increase but harvesting costs would decrease because the harvesting crews would not have to spend three to four hours harvesting fruit out of 40+ feet canopies. Very little pruning took place in the main portion of this

block because of heavy rainfall during the spring break. The promise of higher avocado prices influenced us from going back in and pruning the trees after the fruit set. About three acres of trees in this block needed to be pruned, but we let the pruning be dictated by the avocado market again. This has proven to be a big mistake, because these trees are currently about 30 feet tall.

The tree crowding that was taking place in western block of Hass avocados was putting the fruit bearing areas of the trees at 30 to 40 feet high. The trees in this block were back to 40 feet tall approximately five years after they had been stumped down to 4 feet and the alternate trees had been killed. It was becoming apparent that thinning and stumping of the trees didn't keep the trees short for a very long period of time.

Spring of 1994 brought about a decision to bring all of the trees in the eastern block down to 12 to 15 feet in height. A commitment was made to maintain the trees at this lower level in order to facilitate harvesting and increase fruit production in the ten acres of avocados. Over two acres of trees were pruned during March and April. The pruning consisted of removing crossing—over branches, removing all dead wood and weak branches in the center of the trees, and cutting back the tall upright growing branches down to approximately 12 feet. The cuts that were made to the tall branches were made just above a branch that was growing laterally or downward. By making the cuts at this point, we had noticed from the previous year's pruning that it slowed down the upright growth of the trees. The vegetative growth did not shoot straight up again as vigorously as it had after the first pruning.

The yield in this portion of the eastern block was estimated to again be over 16,000 pounds to the acre. The trees that were producing all of these avocados were less than 15 feet tall. A mistake that had been made the first time was not pruning back the tops of the vigorous branches down to a lateral branch. The fruit was distributed throughout the entire canopy of the trees, from the tops of the trees down to a foot above the ground and throughout the center. In the other portion of the block, the trees were not pruned because of the heavy fruit set. These trees were approaching 20 feet in height, but we decided to let the fruit hang for better prices in late August and September. Big mistake! By the time we harvested in the fall, over 30% of the fruit had fallen to the ground. This lack of pruning resulted in trees growing to 25 to 30 feet tall and tree crowding. Trying to maintain the trees to 12 to 15 feet will be a challenge if the pruning practices are dictated by the avocado prices.

There are several prevailing ideas that suggest removing one limb per year, a portion of a tree, or every other tree, or every third tree. These types of tree modifications take place over several years. What these ideas don't take into consideration is all of the repetitive work that is required anytime that heavy pruning is done, whether it is limited or not. The irrigation system has to be rolled up, large branches falling across neighboring trees breaking other branches, cutting and removing the wood, and mowing or removing the debris of the smaller branches. After this is all done, the irrigation system must be put back into place. This is too much work and time consuming to be very efficient. To do this every couple of years is crazy. The decision to stump a portion of the western block was based on the knowledge of all of the work that is necessary to prune and maintain an orchard at a desired height. Starting in late August of 1994, one—fourth of the trees in the western block (starting at the west end) were stumped

down to 4 feet and these trees were going to be maintained at 15 feet or less. No market was dictating what was going to happen to the trees. The stumping of the trees in this section was completed during October. Trees in the eastern portion of this block had been stumped and thinned in 1989. The trees had been pruned to restructure the trees, but no effort had been made to maintain the trees at a specific height because they were going to be allowed to grow back to their normal height—the prevailing cultural practice of the time. This portion of the block contained a mixture of Hass, Zutano, and Bacon avocados. The Zutano and Bacon trees were going to be topworked over to Hass. Because of the pollination benefits of the "B" flower varieties, these trees were allowed to regrow.

During the spring and summer of 1995 a light pruning was done to most of the avocado trees in west block that had been stumped to 4 feet the previous year. The trees were pruned to a height of 12 to 14 feet and the insides of the trees were cleaned of crossing branches and deadwood. The trees in the eastern block were also pruned to the same height. The same pruning principles are used throughout the orchard. The trees in the eastern block were heavy again with fruit. The trees with a lot fruit were lightly pruned (the same trees had been pruned in 1994). Unfortunately, because of letting the market dictate the pruning these trees had grown over 25 feet in height. The 1995 crop was estimated to be over 14,000 pounds to the acre in these shorter trees—good yields, but not fitting into a tree management program. The total 1995 harvest for the Hass was 8,210 pounds per acre. The trees need to be pruned during the spring, and not after the fruit is harvested later during the year.

The trees located across from the Zutano or Bacon trees had very heavy crops. It was obvious that cross-pollination had played an important part in the crop set. It was also probable that during the previous years cross pollination had played an important part in the heavy crop set. It is amazing what is noticed when one starts to pay attention to what the trees are doing. It was very obvious that the effects of the pollinizers doesn't carry more than one or two trees. The Hass trees that were adjacent to the Bacon or Zutano trees were laden with fruit. The second Hass trees had only one—half to two—thirds of the crop set. The third Hass trees had even less fruit than those that were two trees removed from the pollinizers. If cross-pollination is going to be effective, it seems that the Hass trees are going to have to be adjacent to the pollinizers. The situation will be similar to what takes place in almond, pistachio, and kiwi plantings: eight female plants to one male. Females plants are all exposed to a male in order to guarantee a good crop set.

The overall harvest at the ranch for the 1996 crop year was 12,987 pounds to the acre. The spring conditions in 1995 had been favorable during the bloom period. It was observed that the Hass near the pollinators were again laden with fruit. During the spring and summer of 1996, the trees that had been stumped in the west block were pruned to 10 to 12 feet in height and the insides of the trees were cleaned of crossing branches and deadwood. This allowed sunlight into the center of the trees. These trees had an excellent crop set. The trees located near pollinizers had heavy crops. This crop set was approximately two years from the time the trees had been stumped to 4 feet. A decision was made during September to follow the yields of several trees scattered throughout the two blocks of avocado for the next five years.

MATERIALS AND METHODS

Current cultural practices used at Pine Tree Ranch are:

1. Irrigation three times per week during the warmer parts of the year, 7 to 8 hours per set. The microsprinklers put out about 9 gallons per hour. This is about 189 to 216 gallons per tree per week. The trees should be receiving a minimum of 200 to 250 gallons per week. During the cooler periods of the year, the trees are watered about once a week for 8 hours. The avocado orchard has always been watered heavily during the drier periods of the year because the trees are located in a very rocky soil, if it can be called soil. Water stress is one thing that has been avoided as much as possible over the years.

Three to four or more acre feet of water is the amount of water the irrigation specialists keep putting forth at the avocado grower meetings and in publications. Avocado growers are trying to grow a tropical tree in a desert! Some people can't seem to understand that the trees can't produce more fruit when they are only receiving two acre feet of water or less per year. Growers try to save on water and fertilizer costs, which has a direct effect on the health of the trees and results in lower yields.

2. Fertilization is three to four times per year. We apply 1.5 to 2.0 pounds of actual Nitrogen/tree/year, depending upon tissue analysis results in the fall.

Bees have never been brought in for pollination at this ranch. However, bees do play an important role in the distribution of pollen. Water is probably is the most limiting factor in the amount of fruit that the avocado trees can produce in California.

The Hass trees used in this study were selected in different areas of the blocks: some in the middle of the orchards, next to a known pollinating variety, and along the road across from lemon trees. The fruit was harvested in the latter part of January 1997 in order to avoid harvesting crews from picking fruit from the selected trees. A concern was the attack of the Persea mite on the Hass trees that had a heavy crop load during late August 1996. Trees with a light crop had very little mite damage. The heavier the crop load, the more serious the mite infestation. Trees with five or six field boxes of fruit lost most of their leaves. These trees lost 30% to 40% of their crop. Most of the fruit at this time was small (2 to 4 ounces). Because the mite infestation didn't started until late August, very little sunburning occurred to the fruit or trees. However, seeing all of the small fruit fall to the ground was disappointing. It was obvious that the trees next to a pollinator maintained more of their fruit than the trees that were not influenced by them. The 1996 crop had been harvested during May and June, so the old crop was not affected.

The fruit was small because it was stripped from the test trees one to two months earlier than normal. In this area the fruit doesn't generally start growing until the latter part of February. All of the fruit was collected and counted for each tree. A random sample of 25 individual fruit was weighed to get the approximate size. The fruit was collected and weighed in old citrus field boxes. These boxes have a tare weight of 10 pounds. Although they hold 50 pounds of citrus, 60 pounds of avocados is normal. The extra poundage is probably due to the avocado shape.

Table 1 shows the yields obtained from the Hass trees located in the western block.

These trees were stumped in the fall of 1994 and produced flowers during the spring of 1996. It is apparent from the first year's data that the shorter trees outproduced the tree that was 50 feet tall. This two-box average was the norm for the trees that were crowding and over 40 feet tall. It was taking the harvesting crews over three hours to harvest one 40+ feet tree because of having to work off of extension ladders and having to use picking poles to get fruit at the higher levels. It took less than one hour to pick the shorter trees that had a lot more fruit. The data indicate that tree #1 located next to a Bacon tree had the higher yield. Tree #4, which also had a high yield, was located about 30 feet away from an unidentified seedling avocado. The least productive tree in this block was the crowded 50 feet tall tree. It took over two hours to harvest the fruit from the tall tree versus less than an hour for the shorter trees.

The yields that were harvested in 1997 from the eastern block were greatly influenced by Persea mite populations. The trees that had been loaded with fruit became heavily infested with the mite in late July. As a result of the heavy mite population, the trees lost their foliage during August, resulting in a tremendous fruit drop. The fruit was also slightly smaller in block #5 than the fruit harvested in block #4. For some unexplained reason, the heavy fruit laden trees in the west block had a very light population of mites. Fortunately, because the defoliation of the trees took place in late August when the sun was no longer overhead, sunburning didn't occur to the exposed fruit or trees.

Table 1. Hass avocado yields on pruned trees in block #4 (western block) during January 1997. These trees were stumped to approximately 4 feet during the fall of 1994. Flowers were produced during the spring of 1996.

Number of fruit harvested per tree on Jan. 24 and 30, 1997**			
Tree # 1	Tree # 2	Tree # 3	Tree # 4
1,557 fruit	237 fruit	422 fruit	979 fruit
26' tall, full canopy next to Bacon	50' tall, fruit at the top mid-block	13' tall, 2nd tree in from bottom	13' tall, tree at bottom of block, next to lemons
average= 6.4 oz	6.9 oz	7.8 oz	6.6 oz
range= 4.0 - 9.0 oz	4.3 - 8.5 oz	5.9 - 9.5 oz	4.3 - 8.6 oz
17.3 boxes	2.6 boxes	4.7 boxes	11 boxes
<u>1,038 lbs</u>	<u>156 lbs</u>	<u>282 lbs</u>	<u>660 lbs</u>

*tree height 12'-50'

**total number of fruit divided by 90 fruit = field boxes (60 lbs) per tree

But the lack of foliage resulted in the trees' not being able to sustain the heavy crop set. In late August and early September, the trees that were next to the Zutanos lost from 40% to 60% of their fruit. It was discouraging; however, it was obvious that if it hadn't been for the cross-pollination all of the fruit would have been on the ground. Trees #1 and #2 would have probably had close to 1,000 fruit per tree, similar to tree #3. The outcrossing probably played an important role in sustaining the remaining fruit on the trees. It is seen in **Table 2** that although the trees #1 and #2 suffered heavy fruit fall,

they still produced more fruit than the tree that was not cross-pollinated.

Table 2. Hass avocado yields on pruned trees in block #5 (eastern block) during January 1997. These trees had been pruned or stumped after December 1990 freeze.

Number of fruit harvested per tree on Jan. 16, 1997**			
Tree # 1	Tree # 2	Tree # 3	Tree # 4
349 fruit	365 fruit	875 fruit	297 fruit
20' tall, across from Zutano, tree defoliated by Persea mite, dropped 3 - 4 boxes late Aug	20' tall, 4th tree down from Zutano, lost about 3 boxes because of mite damage	15' tall, mid-block, next to Bacon, no fruit drop, very little mite damage	20' tall, end of the block, across from lemon orchard, very few mites on leaves
average= 5.2 oz	6.5 oz	5.3 oz	7.2 oz
range= 4.0 - 6.6 oz	4.7 - 7.9 oz	3.3 - 7.6 oz	4.7 - 8.6 oz
3.9 boxes	4 boxes	9.7 boxes	3.3 boxes
<u>234 lbs</u>	<u>240 lbs</u>	<u>582 lbs</u>	<u>198 lbs</u>

*tree height 15'-30'

**total number of fruit divided by 90 fruit = field boxes (60 lbs) per tree

OBSERVATIONS

The information that was gathered during the past six years strongly indicates that maintaining avocado trees at 10 to 15 feet tall increases overall tree vitality and fruit production. The harvest data clearly show that shorter trees, with a full canopy, will out-produce the taller trees. It is important to note that pollinators are very important in not only helping increase fruit set, but also helping in fruit retention during tree stress periods. Having Bacon, Ettinger, Walter Hole, Fuerte, or even Zutano trees planted in a systemic system in the Hass orchards to help increase yields will be part of the cost of growing Hass. It will just be the cost of doing business, just like more water and better tree management.

Growers can't stay in business when water costs are over \$500 per acre foot, getting small fruit, and yield averages that range from 2,000 to 6,000 pounds to the acre. Getting over 10,000 pounds to the acre on smaller trees is a reality. Close, dense plantings of 10' x 10', 15' x 15', or whatever spacing is chosen to increase the number of trees per acre can only increase production. Initially, orchard costs will be higher in the higher density plantings, but the increase in yields will make up for the investment.

Pruning the avocado trees also produces healthier trees because the weak and dead branches are removed yearly. By keeping the trees at a chosen height, new growth of the trees is removed. This growth removal not only keeps the tree in check, but it also helps remove fruiting wood. By removing some of the fruiting wood the trees are actually being fruit thinned, which helps produce larger size fruit. The larger fruit get better prices, resulting in higher returns than a lot of small fruit. It boils down to increased yields per acre with bigger fruit sizes, which translates to higher profits.

The economics are pretty straightforward. As an industry, we can no longer keep doing what has been in the past. It is time to move forward and take the future into our own hands. It is foolish to continue to grow tall, low producing trees when people in other tree crops have been doing tree management for over a century.

Tree canopy management takes a commitment. Doing nothing should not be an alternative.