positive control by killing vine parts in the soil layer where it was incorporated and by preventing penetration of this layer by shoots from roots surviving below it. One application of dichlobenil per year may be all that is required and it can be used effectively at any time. Disadvantages in the use of dichlobenil are the incorporation requirement and the survival of vines around the tree trunks. Surviving vines could be controlled with spot treatments of dichlobenil or contact herbicides.

The other soil sterilant-type herbicides tested were effective to varying degrees. GS-14254 was the most promising since it killed more vines and inhibited vine growth more than simazine plus paraquat, ametryne, and bromacil. Two applications per year, in spring and in summer, should result in good preemergence and early postemergence control with these herbicides. The use of a contact herbicide between these applications is helpful.

The relatively poor results with paraquat were due to the infrequency of applications. Vine recovery between treatments was too great. Ryan (1) showed that paraquat can effectively control milkweedvine by starving the root system when applied at intervals of 1 to 2 months. Paraquat and other contact herbicides can also be useful for spot treatments.

Among the growth regulators, 2,4,5-TP provided the best control with 2,4- DP next best. Two applications per year are needed for good control—the first in spring after vines have started growth and the second in late summer. Thus, mature vines would be treated when most susceptible and new seedlings would be easily killed. These chemicals could be useful for either broadcast or spot applications but, unfortunately, they are not registered for this use.

The results of these experiments have shown that several chemicals can effectively control milkweedvine. However, dichlobenil, bromacil, diuron, simazine, and paraquat are the only ones used in the field tests that are registered for use. The expense of treating large areas in mature groves with herbicides may discourage growers, but in severe infestations, this can be justified. Some growers may be further discouraged by the prospect of reinfection from other sources. It is not likely that the milkweedvine will be eradicated but a concerted effort by all growers would go a long way toward this end.

LITERATURE CITED

INCREASING YIELDS OF THE ‘MINNEOLA,’ ‘ROBINSON’ AND ‘OSCEOLA’ VARIETIES WITH GIBBERELLIC ACID SPRAYS AND GIRDLING

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ABSTRACT
Spray applications of gibberellic acid (GA) and girdling materially increased the yields of seedless fruit of Minneola’, Robinson’ and ‘Osceola’ tangelos; however, GA delayed development of orange peel color 1 to 2 weeks. Vigorous trees with a strong, heavy bloom responded best. GA, which occurs naturally in the fruit of citrus, is cleared for use on several varieties of citrus, including the ‘Orlando’ tangelo. Only minute amounts of GA applied to the bloom are required to increase yields. No increase of GA concentration is detectable at harvest. Even so, this material is not cleared for use on ‘Minneola’, ‘Robinson’ or ‘Osceola’.

Yields from these varieties were increased by girdling; however, commercial girdling is often
done poorly, resulting in less than the expected yield increase. Girdling old, virus-infected 'Minneola' has caused gumming and scaly bark at the cut and a few trees have declined. 'Robinson' were girdled only on individual limbs because this variety has had a dieback problem from an undetermined cause, but no girdling damage was found. Only a few 'Osceola' were girdled because of the limited number available. Thus, girdling of 'Minneola' should be performed only on vigorous trees with strong blooms and used only in trial amounts on 'Robinson' and 'Osceola'.

INTRODUCTION

GA is used commercially in California to increase fruit size and yield of certain varieties of grapes and its ability to increase fruit set and yield has been widely tested. In Florida, it is used on a limited basis to increase yields of 'Orlando' tangelos. It is noteworthy that GA sprays substitute for the annual girdling of grapes and that the 'Orlando' tangelo yields as well or better from girdling than from GA sprays.

For these reasons, the influence of GA and girdling on the yields of 'Robinson', 'Osceola' and 'Minneola' was investigated as part of a program of research into the causes of unfruitfulness and development of corrective measures.

MATERIALS AND METHODS

Over the past several years, individual experiments involving spray applications of GA and girdling were conducted. The concentration, time of application and age are given in tables 1-6. GA was applied with a hand gun from a high pressure 150 gallon sprayer until foliage, flowers and young fruit were thoroughly wet.

Girdling was a single knife cut through the bark and into the young wood, using a hook-bladed, linoleum or pruning knife.

Yield estimates were made from counts within 2 x 2 foot frames (Fig. 1) placed at 8 points around the tree at a fixed height. The number of fruit per frame were counted from a point constant in distance from the frame. Yields are reported as the number of fruit per 32 square feet of fruiting area. Only fruit in the outer canopy were counted. Observations of fruit color and size were made without specific measurements. Frame counts can neither be converted to yields expressed on a box, weight or tree basis, nor can a percent increase in number of fruit per frame be interpreted as a similar increase in yield per acre because size of fruit was not considered and counts were made in the best fruiting area, the outer canopy. Moreover, counts were made prior to maturity to avoid the development of "holes" in the canopy caused by limbs bending from the weight of the fruit. This procedure is a rapid, economical, valid means of comparing certain tree responses to treatments.

With the exception of the girdling experiments with 'Robinson' and 'Osceola', individual tree plots and a randomized block design were used. Girdling of 'Orlando' and 'Osceola' was limited to large limbs. Four frame counts were made per limb. There were equal numbers of girdled and nongirded limbs on each tree and the mean values of the number of fruit per 16 square feet of fruiting area of each treatment compared.
RESULTS AND DISCUSSION

GA Sprays

A wide spectrum of citrus varieties set fruit when individual flowers were dipped into appropriate concentrations of GA (3, 4). The fruit set and yield of some of these same varieties are not increased when entire trees are sprayed (3). Thus, entire trees must be sprayed with GA before research results can be translated into commercial practice.

'Robinson'.—In 1967 a few 'Robinson' trees were sprayed with each of several concentrations of GA, Table 1. This was a preliminary experiment and the results were not tested statistically. Even the control trees set a large crop of fruit parthenocarpically. However, frame counts showed an increase in number of fruit produced by the GA spray. Also, concentrations of GA up to 25 ppm caused only slight damage. Gross observations indicated a delay of 1 to 2 weeks in development of peel color and slightly smaller fruit in the GA plots.

In 1970 a large experiment produced strikingly favorable results, Table 2. Control trees were virtually fruitless while treated trees fruited heavily. The large differences in yield were obvious to even casual observers. These trees were young-mature, in excellent condition and flowered profusely. The response was equally good at 10, 15, and 25 ppm of GA when application was made during full bloom. Trees sprayed with the same concentrations 2 weeks following petal fall produced more fruit than the unsprayed control trees but less than those sprayed in full bloom. Trees sprayed both in full bloom and following petal fall produced the same as those sprayed only in full bloom.

There was a slight delay in the development of orange peel color in the GA plots and some of the fruit were smaller, but all of the fruit was marketable and one could only conclude that the treatments had been effective. The entire untreated block of trees, which was without pollinators, produced very few fruit.

An experiment in this same block in 1970, Table 3, was much less effective, 2,4-D was added to the full bloom spray to increase fruit size. The bloom developed unevenly and it was difficult to determine occurrence of full bloom. Applications might have been made too early. The yield response to GA was favorable but the increase in the number of fruits developed was very small. In addition, the 2-4-D caused an appreciable leaf distortion of the new flush; however, the damage was temporary and at the end of the season all trees were in excellent condition.

Thus, the 'Robinson' responded favorably to GA, but results varied.

'Oseola'.—The 'Oseola' is sparsely planted and it was difficult to locate enough trees for the experiment. Therefore, only 1 experiment was conducted. The results, Table 4, were in-

| Table 1.--The influence of gibberellic acid (GA) on the fruiting of 'Robinson' tangerine as indicated by mean frame counts. 1967.
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1 The mean number of fruit per 32 square feet of fruiting area, 10 trees per treatment.

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<th>Table 2.--The influence of gibberellic acid (GA) on the fruiting of 'Robinson' tangerine as indicated by mean frame counts. 1969.</th>
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Means followed by unlike letters differ at the 0.05 level of statistical significance.

1 The mean number of fruit per 32 square feet of fruiting area, 10 trees per treatment.

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<th>Table 3.--The influence of GA and 2,4-D on the fruiting of 'Robinson' tangerine as indicated by frame counts. 1970.</th>
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Means followed by unlike letters differ at the 0.05 level of statistical significance.

1 The mean number of fruit per 32 square feet of fruiting area, 10 trees per treatment.
creased yield from application of GA. 'Osceola' produces a large quantity of bouquet bloom. This is bloom occurs on old growth flushes, rather than that interspersed with new leaves. The bloom was heavy and tremendous numbers of fruit were set; however, many fruit dropped in June and the yields, while higher than those from the untreated trees, were lower than could be expected from trees that size. As with other varieties tested, development of peel color was slightly delayed.

'Minnieola'.—Unlike 'Robinson' and 'Osceola', which have been introduced recently, the 'Minnieola' has been a commercial variety for many years. This variety, also called 'Honeybell' and 'Big Red' tangelo, produces very fine large, highly colored fruit that have recently been in good demand for the gift fruit trade.

In 1969 a series of experiments was conducted in 3 groves selected for differences in tree condition. Grove A represented young-mature trees in the 8-15-year range. The foliage was in excellent condition, shoot growth was vigorous and bloom was heavy and strong. A strong bloom is defined as one containing many large flowers on vigorous new shoots. A weak bloom consists of smaller flowers with slender pedicels borne on slender new twigs with leaves smaller than usual. Many flowers of the latter type fall early and the young fruit drop before 2 weeks after petal fall. With a strong bloom the young fruits persist for 2 or 3 months before falling. Trees in this planting produced a large parthenocarpic crop of fruit without pollinators or treatment of any kind; however, those treated with 10, 15 and 25 ppm of GA fruited even better, Table 5. All 3 concentrations of GA worked well, but leaf drop at the highest concentraction was less noticeable than for 'Robinson'. In fact, 2 trees were sprayed at each of several higher concentrations, the highest being 50 ppm. At this concentration, which would cause severe defoliation of the 'Orlando', only a small leaf drop was noted.

On the other hand, in the following year (1970), fewer flowers were produced and the bloom was very weak. Many of the flowers fell prior to petal fall. As a result, untreated trees produced very few fruit and those treated with GA improved yield only slightly, Table 6. This
condition was brought on, at least in part, because the crop was not utilized fresh but held late and sold for juice, due to a freeze which damaged some of the fruit.

In Experiment B, trees of about the same age as those in Experiment A were used but they had suffered moderately severe freeze damage. A block of the best trees, which had been 10 to 15% defoliated by a freeze, were used. The bloom was moderately strong. From the results given in Table 5, it is apparent the yield response to GA was good, but not as good as in Experiment A where the condition of the foliage was much better.

In Experiment C the trees were much older, over 20 feet tall, and the trees had less vigor, as indicated by less shoot elongation than in the young-mature trees. However, the trees were in good condition and the vigor was normal for trees of that age. The bloom was heavy but weaker than the young-mature trees in good condition. It is obvious from the results, Table 5, that these trees fruited poorly and GA did not improve their yield. This was not unexpected because experience has shown GA is ineffective on old 'Orlando' trees. It should not be inferred these trees were in poor condition. Trees of self-fruitful varieties such as 'Valencia' and 'Marsh' grapefruit of similar age and condition would fruit well.

No research was conducted in those plantings containing Experiments B and C respectively in 1970.

General evaluation of GA as an aid in increasing yields.—For the past 2 years, a number of 'Orlando' tangelo plantings have been sprayed with GA since the material has been cleared for use on this fruit and because research has demonstrated that yields increase from applications ranging from 10 to 25 ppm. The results have often been unsatisfactory, even though very good results were also obtained. Gross observations of 11 plantings indicated that either poor coverage, poor tree condition or both could have contributed to the poor results. Initial recommendations were that the material was systemic and that only moderate coverage was required. Apparently, this was interpreted to mean a poor coverage was effective. In some instances, at least ⅔ of the foliage was not wet. For the best results, all of the foliage and flowers should be wet and application made during a period extending from full bloom to petal fall. Spray is more effective toward the end of the bloom than during the initial stages.

In all weakly parthenocarpic varieties, every effort must be made to avoid physiological stress such as is brought on by unfavorable temperatures, insufficient water, lack of fertilizer and loss of leaves due to pests or other reasons. Undoubtedly, the most common cause of severe physiological stress related to fruit setting is low soil moisture. The bloom occurs during Florida's dry season and unless adequate irrigation is applied, severe stress will occur. At times, growers have permitted trees to partially defoliate during drouth and this almost invariably results in heavy fruit drop. Perhaps the second most common cause of physiological stress is loss of leaves from mites and cold damage. Spider mites are particularly damaging. Mite damage during the fall and winter frequently results in heavy leaf drop when followed by cold, dry winds. All of the varieties investigated are more cold-hardy than sweet oranges and, therefore, often planted in colder locations. This is a reasonable procedure but the value of the added cold-hardiness is reduced by their sensitivity to loss of foliage. There is evidence that insufficient nitrogen is being used on 'Orlando' tangelo trees (1), but no research evidence is available on which to base fertilizer requirements of 'Robinson', 'Osceola' and 'Minneola'. Nevertheless, good foliage and vigorous growth require the careful maintenance of an adequate program of mineral nutrition.

Clearance of GA.—Despite the fact GA occurs naturally in the fruit and foliage of citrus, as well as many other plants, GA sprays for increasing fruit set and yields are cleared only for the 'Orlando'. GA sprays applied during the petal fall have not caused detectable increases in GA in mature fruit. Efforts are being made by the producers of GA to get it cleared for use on the other varieties but this has not been accomplished as yet. It is also cleared for use on some varieties for uses other than fruit setting.

Girdling

Experimental data indicate girdling of 'Orlando' tangelos resulted in consistent increases in yield of seedless fruit (2,5) and girdling has been reasonably effective as a commercial practice; however, the difficulty in getting the job done properly has reduced this practice. Nevertheless, the consistent success obtained by gir-
Girdling suggests it might be used with other varieties.

'Minneola'.—'Minneolas' have been girdled experimentally for several years. The initial results were somewhat unfavorable. Fruiting was increased but scaly bark and an eruption of gum occurred around the cut (2). For this reason, girdling of 'Minneolas' has not been recommended. Undoubtedly, the unfavorable response was due to the presence of virus, and young trees from good budwood sources have not presented this problem. Additional research was conducted in 1969 in the same experiments that included gibberellie acid sprays. As with 'Orlando', girdling during full bloom resulted in large increases in yield in almost all cases. The one exception was Experiment C, Table 5, which consisted of large, old trees. Similar poor responses have been observed in large, old 'Orlando' trees in Florida and in large, old navel orange trees in both Florida (2) and California (6). All evidence indicates vigorous trees between 5 and 20 years of age respond most favorably to girdling, but as the vigor of the tree declines so does the response to girdling. In California (6), it is reported that old navel trees which did not respond to girdling did so following a heavy pruning which increased their vigor. It may be that successful girdling of old trees will require a rejuvenation by pruning if yields are to be increased through girdling.

'Robinson'.—Growers have been reluctant to attempt girdling on the 'Robinson' because of the dieback often encountered in this variety. However, as trees of this variety have grown older, it has become obvious that severe pruning did not increase dieback and there appeared no relationship between cuts made in the tree and the dieback. Even so, individual large limbs rather than the entire trunk were girdled in order to safeguard against any disease that might be encountered at the girdle. The response to girdling was favorable, Table 7, and without undesirable effects. Girdling is not recommended for this variety because experience with it is limited. If growers wish to girdle trees, they should do so on a small experimental basis until they find the practice is safe and profitable.

'Oseola'.—Experiments similar to those with 'Robinson' were conducted with 'Oseola', the research being limited to girdles on large limbs because of the sparsity of available trees. The practice produced favorable results without noticeable damage. Girdling of this variety should only be practiced on a limited basis until further experience is obtained.

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SOME EFFECTS OF AIR-BORNE FLUORINE ON GROWTH AND YIELD OF SIX CITRUS VARIETIES

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Florida Agricultural Experiment Station Journal Series No. 3733.

Abstract

Young trees of 'Hamlin', 'Pineapple', and 'Valencia' orange, 'Orlando' tangelo, 'Dancy' tangerine, and 'Marsh' grapefruit were grown for about 28 months in a Blanton fine sand in 76 ft. by 29 ft. giant pots at six locations, five of which were exposed to different levels of airborne gaseous fluorine compounds. Mean fluor-