ling, irrespective of symptom development, were cultured in the laboratory to determine whether viable fungus was present. In all captan treatments the roots were free of *Phytophthora*, whereas in all treatments without captan the roots were infected with the fungus. A further check on these results was made by transplanting all the seedlings from the first series of replications to soil in individual 6-inch pots. After 6 months of growth, no infection was evident in any of the captan series, thus confirming the laboratory diagnosis.

From other tests it was learned that captan does not kill the fungus within the roots. Infected seedlings remained infected, even though they were held in the captan water for a 20-hour period. It is important to note that healthy seedlings were protected from *Phytophthora* infections, rather than *Phytophthora* infections being controlled on infected seedlings. The action of captan in water was one of protection, not eradication.

For the practical application of this information, it is suggested that captan 50W be used at the rate of ½ lb. per 100 gal. in all the water used during transplanting operations.

PHYSIOLOGICAL EFFECTS AND CHEMICAL RESIDUES RESULTING FROM 2,4-D AND 2,4,5-TP SPRAYS USED FOR CONTROL OF PREHARVEST FRUIT DROP IN 'PINEAPPLE' ORANGES

R. L. PHILLIPS AND W. R. MEAGHER[1]

ABSTRACT

Preharvest fruit drop of 'Pineapple' oranges was markedly reduced over a period of 15 weeks by foliar sprays of 2,4-D and 2,4,5-TP applied in November at a concentration of 20 ppm. An increase in the rate of fruit drop following a freeze on January 31, 1966, was much greater with untreated trees than with sprayed trees.

Fruit from the treated trees were lower in soluble solids and higher in acid than those from the controls throughout the experiment. This resulted in a delay in maturity of about 3 weeks for 2,4,5-TP and about 4 weeks for 2,4-D. Fruit size was not affected.

Total residues in citrus feed, produced from treated fruit in February, was approximately 300 ppb. Total residues in the peel reached highs of from 185 to 200 ppb in 2 to 5 weeks after treatment and then declined. Negligible amounts were found in the juice and seeds.

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Florida Agricultural Experiment Stations Journal Series No. 2526.

INTRODUCTION

The 'Pineapple' orange is the major midseason variety in Florida. Harvesting of the fruit is frequently delayed until it is well past maturity. This results in juice with a high solids/acid ratio which can be blended with lower lower ratio juice in the early part of the 'Valencia' harvest. The fruit may also be used fresh in a time of low supply. Heavy preharvest fruit drop often results from this practice unless an abscission controlling spray has been used. 2,4-D and 2,4,5-TP have been tested for this purpose in Florida (2,7,8) and were found to be effective on 'Pineapple,' 'Temple,' and seedling oranges but not on 'Valencia' or 'Hamlin' oranges. Positive results have been obtained with 'Valencias' under California conditions, however (9). 2,4-D is presently recommended for controlling fruit drop in both states (1,3), but 2,4,5-TP has not yet been cleared by Federal regulatory agencies for this use.

Studies have been made (5,6) to determine the effect of time of harvest of 'Pineapple' oranges on subsequent crops. Although pounds soluble solids per box increased with later harvests, total solids per tree were not greater in some years because of greater fruit drop as the season progressed. Late harvesting of 'Pineapple' oranges may also reduce subsequent yields, with the greatest effect occurring when heavy crops are harvested late.

The purpose of the present study is to further evaluate the effects of 2,4-D and 2,4,5-TP on fruit drop of citrus and to determine their chemical residues at various intervals after treatment.

Methods and Materials

Application of materials.—The growth regulators used were isopropyl 2,4-D; propyleneglycol butyl ether ester of 2- (2,4,5-TP) and triethanolamine salt of 2- (2,4,5-TP). The last compound was made in the laboratory and formulated with X-77 spreader. These chemicals were diluted to contain the equivalent of 20 ppm free acid for spray application.

A mature 'Pineapple' orange grove north of Lakeland was selected for both physiological and residue studies. A randomized complete block design with 6 replications of 4-tree plots of the 3 spray treatments and an unsprayed control was used. Buffer trees were used between all plots to prevent contamination of adjacent treatments. The sprays were applied on November 11, 1965.

Further residue studies were conducted in a block of 'Pineapple' oranges at the Citrus Experiment Station in Lake Alfred. These trees were sprayed in groups of 4 with no replication on October 26, 1965.

Physiological Studies.—Fruit drop per tree was determined biweekly for 6 weeks and weekly thereafter until February 28, 1966, at which time the remaining fruit was harvested. The strength of attachment of the fruit to the stem at the abcission zone was determined by a straight pull test of the stems on 10 fruit per tree. The number of stems that tore the peel was noted.

Internal fruit quality was determined by juice analysis of weekly samples from both locations. Fruit size was found by counting the number of fruit in 1 box from each tree.

Residue Investigation.—On February 14, 1 box of fruit per tree was collected from the Lakeland plots. The juice was extracted in the canning plant and the peel and pulp were converted to citrus feed. Total residues in the feed were determined after heating at 130° C to remove all moisture.

From the Lake Alfred plots, fruit samples were collected daily for the 15 days, thenceforth weekly. Seeds, juice, and peel were separated in the laboratory for determinations of total residue.

Results and Discussion

Physiological Effects.—Preharvest fruit drop of 'Pineapple' oranges was markedly reduced by all 3 chemicals throughout the duration of the experiment (Figure 1) The 2,4-D and 2,4,5-TP esters were equally effective at the rate used. The triethanolamine salt of 2,4,5-TP appeared to be slightly less effective than the esters, probably because it was not absorbed as readily by the leaves (4).

The cumulative fruit drop, based on total yield, increased rather steadily for the first 11 weeks. A freeze which formed ice crystals in the fruit occurred on January 31. Shortly after the freeze, the rate of fruit drop increased

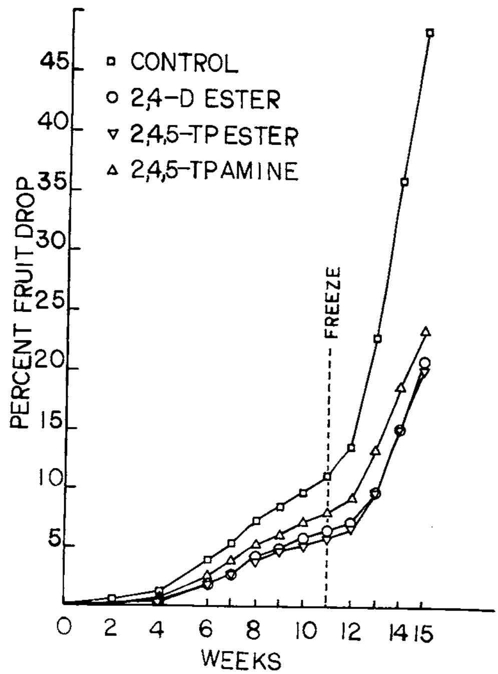

Fig. 1.—Cumulative drop of 'Pineapple' oranges by weeks from November 11, 1965, to February 28, 1966. Based on total fruit yield per treatment. Chemicals were applied November 11, 1965 at Lakeland.

rapidly. The increase in drop was more delayed for the sprayed trees, and the difference in fruit drop between untreated and sprayed trees increased greatly following the freeze. These results indicate that the materials could be used for holding frozen fruit on the tree until it could be picked.

At all times during the experiment, the Brix/acid ratio was lower for fruit from the treated trees than for fruit from the controls (Figure 2). The results were a delay in fruit maturity of about 3 weeks for the 2 forms of 2,4,5-TP and about 4 weeks for 2,4-D. Delayed maturity could be useful in lengthening the season for 'Pineapple' oranges.

The reason for the higher ratio of the untreated control was its higher Brix (Figure 3) and lower acid (Figure 4) content. Degrees Brix was considerably reduced by the 3 spray treatments. Pounds soluble solids per tree were not reduced, however, since less fruit remained on the control trees, especially late in the season. On February 14, the last date on which both maturity and fruit drop data were taken,

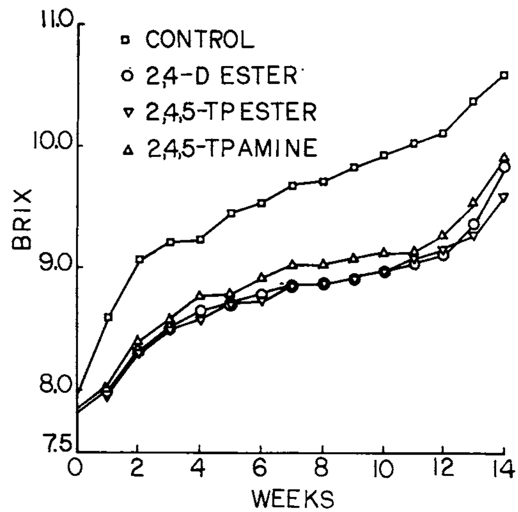

Fig. 3.—Degrees Brix of 'Pineapple' oranges from November 11, 1965, to February 14, 1966. Chemicals were applied on November 11, 1965 at Lakeland.

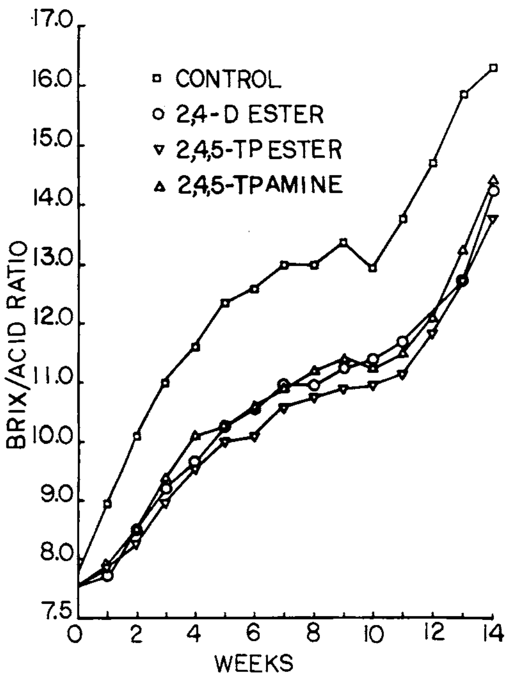

Fig. 2.—Brix/acid ratios of 'Pineapple' oranges by weeks from November 11, 1965, to February 14, 1966. Chemicals were applied on November 11, 1965 at Lakeland.

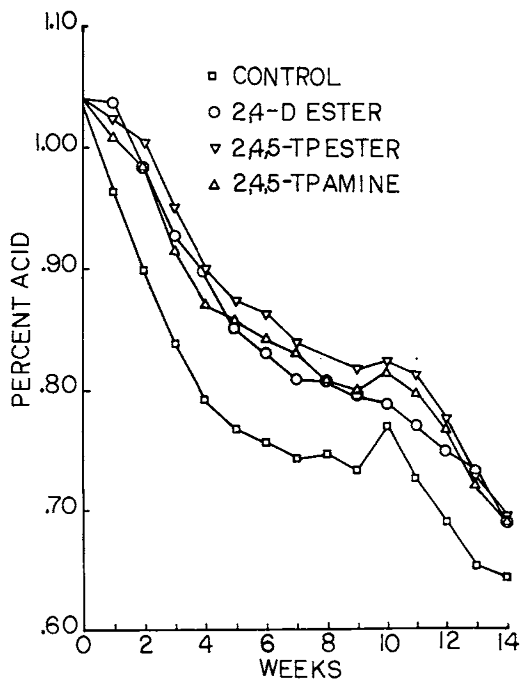

Fig. 4.—Per cent acid of 'Pineapple' oranges by weeks from November 11, 1965, to February 14, 1966. Chemicals were applied on November 11, 1965 at Lakeland.

pounds-solids per tree was slightly higher for the treated trees. This difference undoubtedly increased in the next 2 weeks because of the greater difference in fruit drop. In contrast, the per cent acid was higher for the treated fruit, throughout the experiment.

Fruit from the sprayed trees were attached more firmly to their stems than those from the controls. When a pulling force was applied, plugging (tearing of the peel) occurred in 79 to 90% of the treated fruit, whereas only 57% of the control fruit were plugged. Plugging did not appear to be a problem when the fruit was "snap-picked," however. Fruit size was not affected by any of the spray treatments.

Residue Investigation.—Total residues in the dried citrus pulp feed, shown in Table 1 along with data for both 'Pineapple' and 'Temple' oranges from the previous year, were approximately 300 ppb with 'Pineapple' oranges and slightly higher for 'Temple' oranges. This difference might be attributed to the rougher skin texture of 'Temple' orange which could retain more of the spray material. The residues of 2,4,5-TP appear to be slightly higher than those of 2,4-D.

The total residue in the peel (Figure 5) was about 120 ppb immediately following spray application, reached highs of from 185 to 200 ppb between 2 and 5 weeks, and then declined to lows of 125 to 140 ppb at the end of 13 weeks. If the effectiveness of the chemicals is related to the concentration of their residues, we might expect maximum strength of fruit attachment to coincide with the peak of residue in the peel of sprayed fruit and an increase in fruit drop to follow a decline in residue.

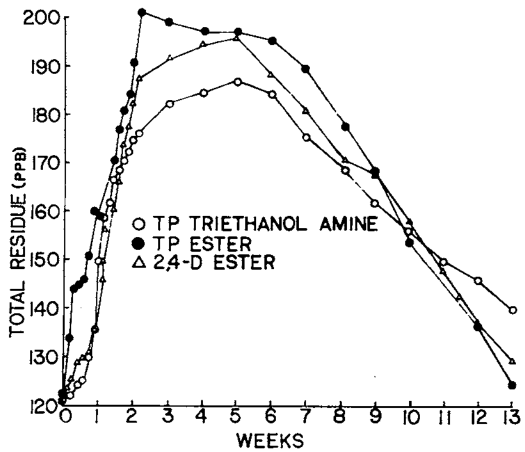

Fig. 5.—Total residue in the peel of 'Pineapple' oranges by weeks from October 26, 1965, to January 25, 1966. Chemicals were applied on October 26, 1965 at Lake Alfred.

Negligible amounts of residues were found in the juice and seeds. The seeds consistently contained 0.5 to 0.7 ppb residue, while the juice contained 0.6 to 0.8 ppb. Essentially all of the residue was in the peel.

It is evident that the original objective has been achieved with respect to residues. The residues for 2,4-D and for 2,4,5-TP were essentially identical in our studies. The residue tolerance for 2,4-D in citrus established by the U. S. Food and Drug Administration is 5 ppb (based on fruit weight). The residues obtained from these treatments, as expressed in parts per billion, were all well below the figure.

Table 1. Total residues in feed.

	2,4-D ester residues (ppb)	2,4,5-TP ester residues (ppb)	2,4,5-TP amine residues (ppb)
'Pineapple,' Lakeland, 1966	280	320	300
'Pineapple,' C.E.S., 1965	280	330	310
'Temple,' Fort Pierce, 1965	320	360	330

It is especially important in a time of labor shortage to increase the efficiency of harvesting operations through a more orderly movement of the crop. Growers may achieve this by applying 2,4-D as recommended (1). It is suggested that half of the 'Pineapple' orange groves be sprayed each year and the untreated groves be picked first. This should prevent the normal gap between the 'Pineapple' and 'Valencia' crops and delay heavy fruit drop in the event of a freeze. 2,4,5-TP should not be used until it has been cleared for this purpose; otherwise, the crop could be condemned. 2,4,5-TP is currently being used on apples and apricots and its used on citrus is expected.

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EFFECT OF AIR-BORNE FLUORIDES ON 'VALENCIA' ORANGE YIELDS[1]

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Abstract

A field experiment with bearing 'Valencia' orange trees on rough lemon rootstock was carried out to study the effects of different levels of air-borne fluorides on yield, fruit quality, and leaf growth. The experimental trees were in a grove exposed to relatively high levels of air-borne fluorides. Six trees were enclosed in individual plastic greenhouses. Fluorides were removed from the air entering 3 greenhouses by dry calcium carbonate filters, while unfiltered ambient air was moved through the other 3 greenhouses. Three additional trees were not enclosed and were used as outdoor checks.

The leaves of trees in the unfiltered greenhouses absorbed much less fluorine than those of the outdoor checks, even though there was little difference in the fluorine content of the air. This appears to be due to the fact that the leaves were kept dry inside the greenhouses. Greenhouse trees receiving unfiltered air produced significantly less fruit in 1965-66 than those receiving filtered air, and the outdoor check trees yielded significantly less fruit than the unfiltered greenhouse trees.

Leaf size decreased as leaf fluorine increased. There was a trend toward higher acid and lower Brix/acid ratio of the juice with increasing fluorine in the leaves, but these differences were not significant.

Introduction

Fluorine is found in green plants throughout the world, usually at levels too low to cause injury. Although many soils contain several hundred parts per million of fluorine, relatively little of this is in available form and much of that which is absorbed by the roots tends to remain in the root system. During the past 15 years, gaseous fluorides have become a serious problem as air pollutants in areas adjacent to certain types of manufacturing plants. These include phosphate manufacturing plants, aluminum plants, steel plants, and ceramic plants. All of these plants employ processes that release varying amounts of gaseous fluorides into the air, the amounts depending on the materials

Florida Agricultural Experiment Stations Journal Series No. 2528.
[1]This work was supported in part by a grant furnished jointly by the citrus industry, the Florida phosphate industry, and the Florida Citrus Commission.
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