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CONTROLLING PREHARVEST DROP OF PINEAPPLE ORANGES WITH 2,4,5-TRICHLOROPHENOXYPROPIONIC ACID

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The Pineapple orange is the most widely grown midseason sweet orange variety in Florida. The fruit matures in early winter, with the harvest season beginning usually in November and continuing into March. Where picking has been delayed until March, it has not been uncommon to find trees which have lost from 50 to 75 percent of their crop, by actual count, as preharvest fruit drop. The prevention of this heavy preharvest drop could therefore lengthen the season, allow a more orderly movement of the crop, and facilitate the delivery of fruit of a higher sugar content to the concentrate plants.

In 1947 Stewart and Klotz (5) reported reductions in preharvest drop of Valencia oranges resulting from the use of sprays of 2,4-dichlorophenoxyacetic acid (2,4-D). Unlike the favorable results reported from California, experimental results from the use of 2,4-D in Florida have been somewhat variable. Results of early experimental work at the Citrus Experiment Station on seedy grapefruit, Valencia, Conners Seedless and Pineapple oranges were conflicting and inconsistent. Gardner et al., (1) indicated the sodium salt of 2,4-D was effective in reducing preharvest drop of Pineapple oranges. The foliage distortion which frequently resulted from applications of 2,4-D, however, was undesirable.

While in search for other compounds which might be used to reduce preharvest drop, 2,4,5-trichlorophenoxypropionic acid (2,4,5-TP) was tried and found to be effective. This compound had been used to reduce pre-harvest drop and to improve skin color of apples (2,6), and Reese and Horanic (3) previously used the triethonolamine salt of 2,4,5-TP for controlling preharvest drop of Pineapple oranges.

EXPERIMENTAL

Field experiments with 2,4,5-TP have been conducted for the past three seasons; results will be reported in seasonal sequence. The first field trials were conducted during the 1951-52 season, when 2,4,5-TP was applied to both Pineapple and Valencia oranges as the triethanolamine salt[1] at the concentrations of 20 and 40 ppm. of acid. Single-tree plots were used with five replicates for each treatment.

Sprays were applied December 20, 1951 to Pineapple orange trees at the rate of approximately 15 gallons of spray solution per tree. Counts of the number of dropped fruit were made at intervals of one week, from December 20, 1951 to March 14, 1952, at which time the fruit was picked. After picking, the fruit was delivered to the Citrus Experiment Station packinghouse where the fruits from each tree were counted. To the number of fruit picked was added the number of dropped fruit to give the total production. The percentage of dropped fruit per tree was then calculated. Sprays of either 20 or 40 ppm. 2,4,5-TP resulted in highly significant reductions in numbers of dropped fruit, as is shown in Table 1. However, no significant difference in amount of dropped fruit was found between these two treatments.

A second experiment was also initiated using Pineapple oranges so that some indication as

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[1] Supplied by Dow Chemical Company in a compound sold under the trade name of "Color-Set."

Table 1.- Percent of Preharvest Dropped Fruit of Pineapple Oranges Sprayed with 2,4,5-Trichlorophenoxypropionic Acid. 1951-52.

Replicates	Treatment		
	Unsprayed Check	20 ppm.	40 ppm.
1	30.7	15.7	5.6
2	65.8	14.5	8.1
3	77.2	6.1	8.6
4	55.3	8.4	7.3
5	67.1	3.9	7.2
Weighted Avg. Percent Drop per Tree	58.2	9.7	7.4

L.S.D. for drop means = 20.6 at the 1% level.
L.S.D. for drop means = 14.7 at the 5% level.

Spray applied Dec. 20, 1951 - Fruit picked March 14, 1952.

to the effectiveness of late spraying could be ascertained. Sprays were applied February 8, 1952 at concentrations of 10 and 20 ppm. 2,4,5-TP. A summary of the percentage drop for each tree for the period from February 8 to March 14, 1952 is presented in Table 2. Highly significant reductions in percent of dropped fruit again resulted from sprays applied at both concentrations at this rather late date. A slightly higher percentage of dropped fruit resulted where trees were sprayed with only 10 ppm., as compared to 20 ppm., but this difference was not statistically significant.

A comparison of the percentage of dropped fruit from trees sprayed with 20 ppm. on December 20, 1951 and February 8, 1952 gives an indication of the effectiveness of these sprays with respect to time of application (Table 3). It is not possible to compare the percentage drop figures at the two spray dates

Table 2.- Percent of Preharvest Dropped Fruit of Pineapple Oranges Sprayed with 2,4,5-Trichlorophenoxypropionic Acid.

Replicates	Treatment		
	Unsprayed Check	10 ppm.	20 ppm.
1	26.6	8.6	11.5
2	61.1	27.7	9.7
3	74.6	16.9	13.2
4	51.1	16.7	20.3
5	63.8	—	—
Weighted Avg. Percent Drop per Tree	54.1	17.7	13.8

L.S.D. for drop means = 35.6 at the 1% level.
L.S.D. for drop means = 25.5 at the 5% level.

Trees sprayed Feb. 8.
Fruit picked March 14, 1952.

Table 3.- Percent of Preharvest Dropped Fruit of Pineapple Oranges Sprayed with 2,4,5-Trichlorophenoxypropionic Acid as Affected by Time of Spray Application.

Replicates	Time of Spray Application			
	Dec. 20, 1951		Feb. 8, 1952	
	Unsprayed check	20 ppm.	Unsprayed check	20 ppm.
1	30.7	15.7	26.6	11.5
2	65.8	14.5	61.1	9.7
3	77.2	6.1	74.6	13.2
4	55.3	8.4	51.1	20.3
5	67.1	3.9	63.8	—
Weighted Avg. Percent Drop per Tree	58.2	9.7	54.1	13.8

Fruit picked March 14, 1952.

directly because the number of days represented by the percentage drop values are not the same. Hence a comparison must be made of the percentage drops from the sprayed trees and the unsprayed check trees for each timing period. Trees sprayed December 20 had a lower percentage of dropped fruit, while the unsprayed check trees had a higher percentage of dropped fruit when compared to trees sprayed February 8, indicating better results were obtained from the earlier spray application.

Valencia oranges were sprayed with 2,4,5-TP at 20 ppm. on February 21, 1952 and at 20 and 40 ppm. on April 3, 1952. Single-tree plots were used with six replicates for each treatment. Applications of 2,4,5-TP had no effect on preharvest drop of Valencia oranges, irrespective of the rate or time of application (Table 4).

During the 1952-53 season Pineapple oranges were again used for field trials. In

Table 4.- Percentage of Preharvest Dropped Fruit of Valencia Oranges Sprayed with 2,4,5-Trichlorophenoxypropionic Acid as Affected by Time and Rate of Application.

Replicates	Unsprayed Check Trees	Applied Feb. 21/52 20 ppm.	Unsprayed Check Trees	Applied April 3/52	
				20 ppm.	40 ppm.
1	11.31	14.03	8.02	10.39	6.20
2	9.94	12.32	7.18	8.44	6.35
3	6.01	12.06	3.92	8.95	6.78
4	6.47	7.52	4.99	5.75	3.82
5	9.31	11.21	6.58	7.45	2.89
6	7.02	15.32	4.29	11.42	6.81
Weighted Avg. Percent Drop per Tree	8.24	11.91	5.83	8.73	5.48

Fruit picked June 10, 1952.

these trials a wider range of concentrations was used. During this time 2,4-D was also included, so that a comparison between the two materials could be made. The 2,4,5-TP sprays (as the triethanolamine salt) were applied November 23, 1952 at concentrations of 10, 20, 40 and 60 ppm. The 2,4-D was applied at the generally recommended concentration of 25 ppm. at the same date. Conditions during the period of the 1952-53 experiment apparently were less conducive to fruit drop than during the previous year, since there was much less dropped fruit from the unsprayed check trees. The fruit was harvested approximately 15 days earlier in 1952-53; this fact also accounts for some of the difference in percentage drop between the unsprayed check trees during the two yearly periods. The results of the 1952-53 field trials are presented as a summary in Table 5. There was no significant difference in percentage drop irrespective of the concentrations used, but the 10 and 60 ppm. rates appeared to be somewhat less effective than 20 or 40 ppm. Sprays of 2,4,5-TP applied at 20 and 40 ppm. and 2,4-D applied at 25 ppm. resulted in effective reductions in percentage preharvest drop as compared to the unsprayed check trees.

In the 1953-54 season, 2,4,5-TP was applied to Pineapple oranges on October 27, 1953 at rates of 10, 20 and 40 ppm., with and without "NuGreen" and wettable sulfur. Stewart and Heild (4) have reported favorable responses from "NuGreen" used in combination with 2,4-D and 2,4,5-trichlorophenoxyacetic acid. The fruit from trees included in this experiment was harvested March 16, 1954. The percentages of preharvest drop as affected by the treatments applied are summarized and presented in Table 6. "NuGreen" (5 lbs./100 gal.) appeared to increase the effectiveness of 2,4,5-TP, especially where applied at 10 ppm. At this concentration 2,4,5-TP alone did not reduce the percentage of preharvest drop greatly over the unsprayed check trees, but a very marked reduction resulted when this concentration was used in combination with "NuGreen." When "NuGreen" was used in combination with 2,4,5-TP at 20 ppm., a lower percentage drop was obtained than when 2,4,5-TP at 20 ppm. was used alone, but the difference was less striking than that which occurred at the lower concentration. The inclusion of wettable sulfur in this mixture apparently did not alter the effectiveness of either material.

When 2,4,5-TP was applied after sundown, some of its effectiveness was lost. Sprays applied in bright light were significantly more effective in reducing preharvest drop than those applied after sundown.

Table 5.- Percent of Preharvest Dropped Fruit of Pineapple Oranges as Affected by Rate of Application of 2,4,5-Trichlorophenoxypropionic Acid.

Replicates	Rate of Application					
	2,4,5-Trichlorophenoxypropionic Acid				2,4-D	Unsprayed Check
	10 ppm.	20 ppm. + 10# W. Sulfur	40 ppm.	60 ppm.	25 ppm.	
1	24.7	6.9	6.4	16.5	4.4	9.5
2	31.4	7.7	5.4	4.2	12.0	14.9
3	11.7	8.0	5.5	11.9	8.6	44.5
4	14.4	15.5	10.1	9.2	10.6	30.3
5	7.9	4.5	Missing	18.4	9.2	48.4
Weighted Avg. Percent Drop per Tree	18.9	7.6	6.6	12.8	9.0	28.0

L.S.D. = 23.7 at 1% level
17.4 at 5% level

Sprays applied November 23, 1952 — Fruit harvested February 27, 1953.

Discussion

At the concentrations of 2,4,5-TP which were used in these experiments, 20 and 40 ppm. sprays have consistently reduced the preharvest drop. Since any difference between them has not been significant, 20 ppm. is apparently adequate. A concentration greater than the minimum required to accomplish the desired result is not recommended. If used in combination with "NuGreen," even concentrations as low as 10 ppm. may be satisfactory. Since these results with "NuGreen" are for a single season, it is not known whether this combination will be consistently reliable. Whether "NuGreen" sprays applied without the growth regulator will reduce preharvest drop has not been ascertained.

The time of application of these sprays was not varied over a very wide range and no early spraying was done. Indications are, however, that sprays applied from October to the middle of November will give best results. Highly significant reductions in percentage of dropped fruit did result even where sprays were applied as late as February 8. In cases where Pineapple oranges are to be held late for concentrate processing, spraying of such trees even as late as February would appear very desirable. The inclusion of 2,4,5-TP with the fall or early winter rust-mite spray would cost very little and would be especially desirable where Pineapple oranges are to be held

Table 6.- Percent of Preharvest Drop of Pineapple Oranges as Affected by 2,4,5-Trichlorophenoxypropionic Acid Sprays and Combinations with NuGreen and Sulfur.

Replicates	Treatments								
	10 ppm.	10 ppm. + 5# NuGreen per 100 Gals.	20 ppm.	20 ppm. + 5# NuGreen per 100 Gals.	20 ppm. + 5# NuGreen & 10# W. Sulfur per 100 Gals.	20 ppm.[1]	40 ppm.	Unsprayed Check	Unsprayed Check
1	71.7	20.9	23.4	26.6	18.4	46.7	20.1	82.2	58.7
2	67.8	20.1	32.6	21.4	8.3	23.7	19.7	61.9	84.3
3	49.3	28.1	30.9	17.9	19.2	19.2	25.3	62.9	67.0
4	44.3	24.1	12.8	18.3	16.4	31.5	31.5	72.5	65.7
5	30.9	25.2	34.5	18.9	23.8	40.5	12.0	25.8	65.1
Weighted Avg. Percent Drop per Tree	55.9	24.0	25.8	20.9	18.2	32.1	21.8	64.1	67.9

1 Spray applied after dusk.
L.D.N.S. between treatment means = 8.9 at 1%.
L.D.N.S. between treatment means = 5.0 at 5%.

late in the season. Under such conditions, considerably larger box yields should result.

The effectiveness of 2,4,5-TP on varieties other than Pineapple oranges is not known. In one experiment reported above, it was not effective when used on Valencia oranges. In another experiment, it was not effective when applied to "off-type" Pineapple oranges[2] when applied late in the season. Indications thus far are that, like 2,4-D, 2,4,5-TP is fairly specific for Pineapple oranges.

To date no evidence of leaf curling or distortion has been observed even when concentrations as high as 60 ppm. of 2,4,5-TP have been applied. Whether this is characteristic of this compound or whether the conditions under which it has been used to date have not been favorable for leaf curl is not known.

Summary

The triethanolamine salt of 2,4,5-trichlorophenoxypropionic acid applied as a spray to Pineapple orange trees resulted in a marked reduction in numbers of fruit lost due to preharvest drop.

A concentration of 20 ppm. of the acid appeared to be adequate to give good drop control. Ten ppm., when used in combination with 5 pounds of "NuGreen" per 100 gallons, also resulted in satisfactory drop control.

Time of application within a reasonable period does not appear to be critical. Significant reduction in percentage of dropped fruit was obtained from sprays applied as late as February.

Leaf curling and malformation of the leaves commonly associated with 2,4-D have not as yet been observed with 2,4,5-TP at concentrations up to 60 ppm.

[2] Work done in cooperation with Minute Maid Corporation. Oranges in this grove were not characteristic of any named variety but were called Pineapple oranges.

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