For most growers, potash rates based on ratio to nitrogen will continue to be the most used guide. Results of this experiment give support for the fertilizer recommendations made for calcareous soils in Florida Agricultural Experiment Station Bulletin 536A. In addition, the results do indicate greater difficulty in maintaining adequate leaf potassium at high rather than low nitrogen. Therefore relatively higher potassium mixtures (at least 5 K_2O to 4 N) should be used with high nitrogen application rates than would be necessary with low nitrogen rates. At low nitrogen rates, it may be inferred that a ratio of 1 N to 1 K_2O would be adequate, although this exact ratio was not included in the experiment at the low nitrogen rate.

Finally, fertilizer practice in these situations must be adjusted to produce fruit of greatest market value. Growers whose market demands highest quality fresh oranges may find it necessary to limit fertilizer application rates to minimum amounts. At the other extreme, growers who simply aim to produce the greatest number of pounds of soluble solids per tree will seldom be ill advised to fertilize heavily and aim for greatest possible total fruit yield.

Summary

Three levels of nitrogen and three levels of potassium fertilization were applied to bearing Valencia orange trees on a typical calcareous soil in the Indian River area of Florida over a six-year period. The higher levels of nitrogen fertilization resulted in dense, dark green foliage compared with the low levels, while potassium fertilization had little effect upon tree appearance. Both low nitrogen and high potassium fertilization resulted in noticeable magnesium deficiency symptoms in the foliage. Yield of fruit was significantly reduced by low nitrogen from the second year of the experiment, but low potassium did not significantly influence yield until the sixth year of the experiment. Both high nitrogen and high potassium increased the acidity of the juice and delayed maturity. High nitrogen increased the amount of green color on the fruit. Increasing nitrogen tended to decrease fruit size, while increasing potassium tended to increase fruit size, with indications that the potassium effect was of greater influence. Other effects on fruit quality were of minor significance.

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CURRENT STUDIES ON THE EFFICIENCY OF EQUIPMENT FOR THE APPLICATION OF PESTICIDES TO CITRUS TREES IN FLORIDA

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Equipment for the application of agricultural pesticides is equally as important as the pesticides. During recent years failure to obtain satisfactory pest and disease control in tops of trees with effective pesticides has indicated a need for better equipment for spraying the tops of citrus trees. Since 1938, application equipment and methods have been evaluated periodically (1, 2, 3, 4, 5, 6, 7, 8, 9), and, although improvements have resulted, tall trees with interlocking branches are still difficult to spray. An additional study of this problem has been needed and preliminary results are reported here.

The purpose of this study is twofold: (1) to measure the ability of sprayers to obtain uniform and thorough application of spray materials to all parts of citrus trees; and, (2) to improve the application of sprays to Florida citrus by modification of existing machines

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and to evaluate, under Florida conditions, equipment used in other citrus areas.

Current investigations have emphasized tests to compare the distribution of air and spray delivered by different sprayers and attachments, and construction of improved air-spray directing equipment.

Air Distribution

The first step was to study the distribution of air delivered at different heights and distances by various commercial machines and attachments. Next, an air-spray directing attachment (CES II), shown in Figure 1, was designed and constructed at the citrus Experiment Station to direct more spray into the tops of trees. This attachment fits air-blast sprayers and provides two air and spray outlets at about four and nine feet above the fan assembly. Each outlet is provided with oscillating vanes and spray nozzles. The vanes are adjustable vertically to compensate for tree height.

Data shown in Figure 2 were obtained by measuring air velocity at one-foot intervals

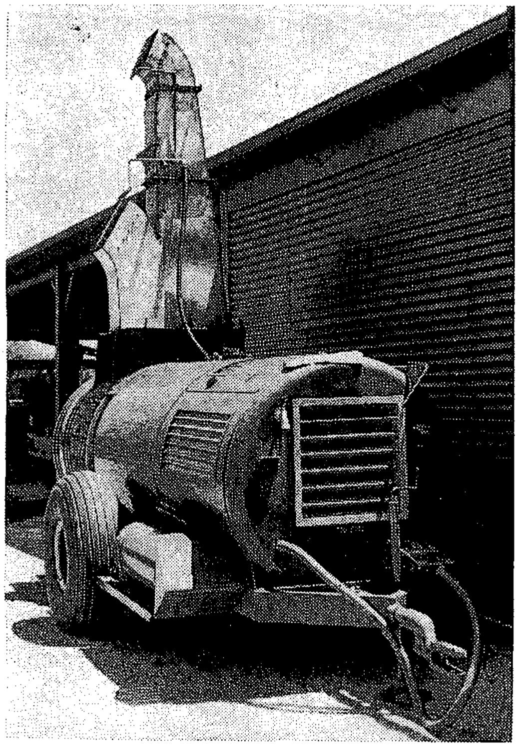


Fig. 1. Air-Spray Directing Attachment Designed and Constructed at the Citrus Experiment Station for Use on Air-Blast Sprayers.

from the sprayer with a velometer placed in the airstream at one-foot intervals above the ground. These data show the 35-m.p.h. curves obtained with the machine operating double head, single head with a volute attachment and with the C. E. S. attachment. The C. E. S. attachment extended the 35-m.p.h. curve about ten feet higher and about four feet further horizontally from the fan than did the volute attachment.

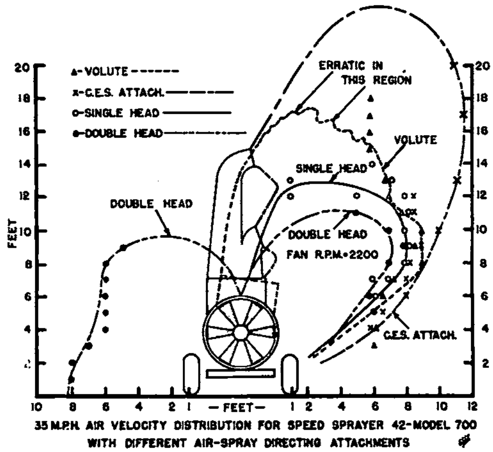


Figure 2. Comparison of the Distribution of Air Velocity Delivered from a Speed Sprayer Operating Double Head, Single head with Volute and C.E.S. Attachment.

Spray Distribution

Tests were made to measure distribution of spray materials from different sprayers and attachments. A leaf print technique devised by Blodgett and Meador (10) was used for this purpose. This technique made it possible to detect and compare the distribution of copper spray deposits on individual leaf surfaces. Dilute sprays used in these tests contained 1.5 pounds of basic copper (53% metallic) per 100 gallons and concentrate sprays (6X) contained nine pounds of copper.

Spray coverage comparisons were made from samples of 35 leaves picked from the inside and outside top portions and from the skirt (3-4 feet above the ground) of three or more trees for each sprayer. Prints were rated separately for distribution of spray deposited on the upper and lower surfaces of the leaves. A rating of 0 (very poor) to 3 (very good) was made by comparing each leaf print with a set of standard leaf prints shown in Figure 3.

Preliminary tests were conducted with each machine to find the nozzle arrangement that

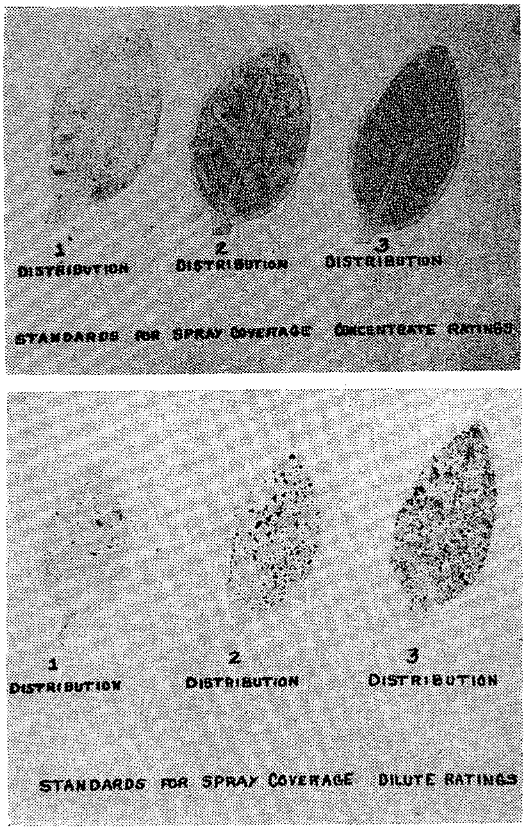


Figure 3. Leaf Print Standards for Comparing Distribution of Dilute and Concentrate Sprays on Citrus Foliage.

gave maximum coverage before the sprayer was entered in comparative efficiency tests. All machines were also calibrated to deliver approximately the same number of gallons per tree. And all machines except the hydraulic sprayer and the helicopter were propelled at one m.p.h.

A grove of 30-year-old Marsh grapefruit that had been hedged two years before was used in the first test to compare the distribution and density of dilute and concentrate spray deposited in the tops of trees by the C. E. S. and oscillating volute attachments. These attachments were mounted on a John Bean Speed Sprayer Model 42-E-1 with the fan operating at 2200 r.p.m. The sprayer was calibrated to deliver 30 gallons of dilute spray and 3.75 gallons of concentrate (6X) spray per tree with each attachment. One tank of spray was applied with each machine at each concentration. Data were taken from three trees of uniform size.

Data presented in Figure 4 show the average spray deposit ratings for upper and lower leaf surfaces from the top inside and the top outside portions of trees. These data show that better spray coverage was obtained with the C. E. S. attachment than with the oscillating volute.

A grove of large grapefruit trees with branches overlapping in all directions was used in the second test to compare a Speed

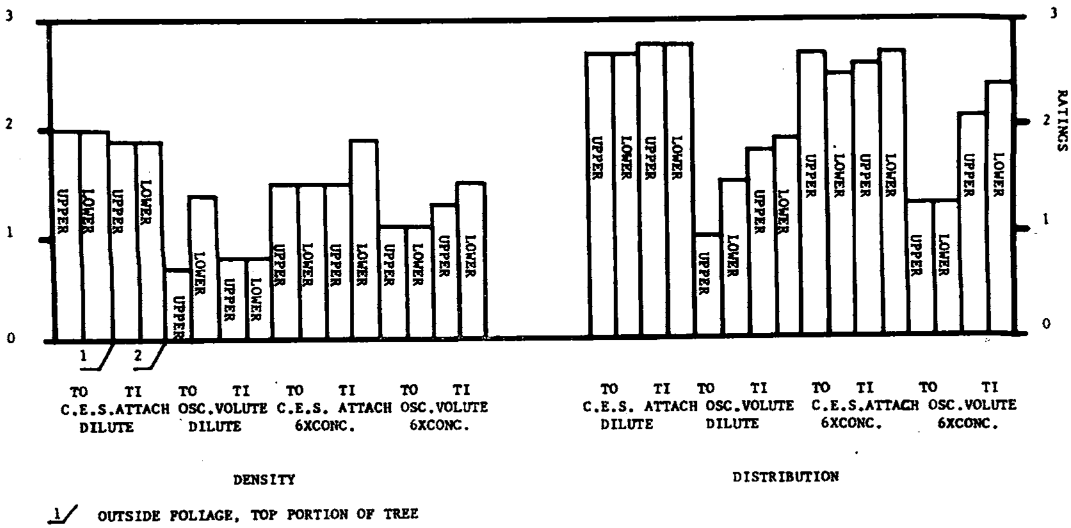
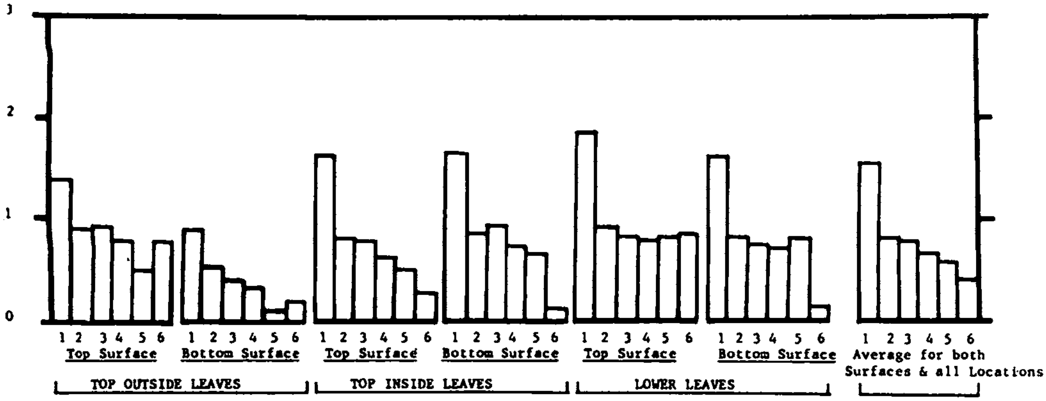


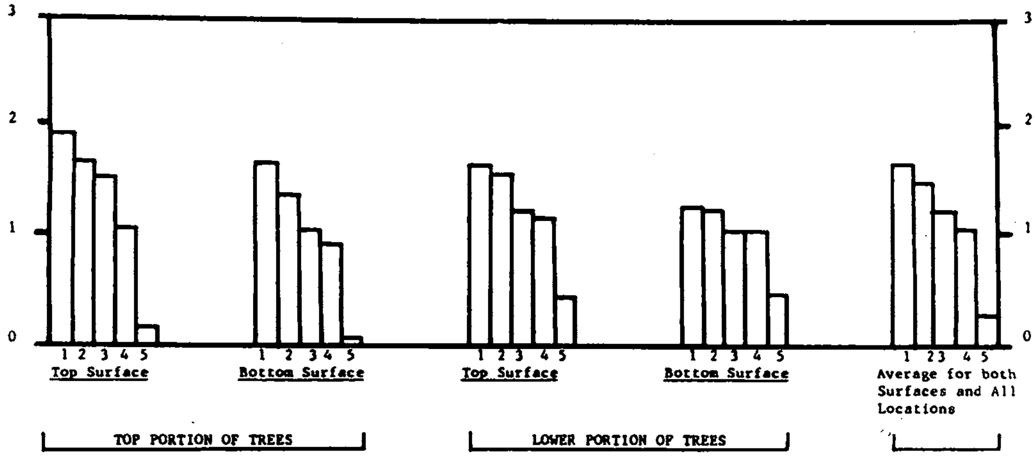
Figure 4. Comparisons of the Average Distribution and Density of Dilute and Concentrate Sprays Applied with the C.E.S. and Volute Attachments. (Ratings of 0 is poor, 1 is fair, 2 is good and 3 is excellent)

Sprayer Model 700 B operated double head; single head with volute and single head with C. E. S. attachment; a Hardie Model DF-40 operating single head; a Friend Model 420 operated single head; and a helicopter with a spray boom. The helicopter made two passes over the trees in the same direction. About 35 gallons of dilute copper spray was applied to each tree with the air blast sprayers and about two gallons of concentrate (12X) per tree with the helicopter. Leaf samples were taken from top inside, top outside and skirt portions of



TREATMENTS
1. Speed Sprayer air-blast with C.E.S. Attachment
2. Speed Sprayer air-blast with Volute Attachment
3. Friend Air-blast Single Head
4. Hardie Air-blast Single Head
5. Speed Sprayer air-blast Double Head
6. Helicopter

Figure 5. Comparison of Spray Coverage Obtained with 6 Sprayers on Large Grapefruit Trees with Overlapping Branches in All Directions.



TREATMENTS
1. Speed Sprayer Air-blast with Single head C.E.S. Attachment
2. Speed Sprayer Air-blast with Single head Volute Attachment
3. Speed Sprayer Air-blast Double Head
4. Hydraulic with Hand Gun
5. Check

Figure 6. Comparison of Spray Coverage Obtained with 4 Sprayers on Large Grapefruit Trees Hedged on Two Sides and Overlapping Branches on the Other Sides.

two trees in each of the three replicates. Sample trees were selected for uniform size near the center of each plot.

Results presented in Figure 5 show that all machines but the C. E. S. attachment gave poor coverage in all portions of the trees. The C. E. S. attachment produced fair coverage in all areas except the bottom surface of leaves located in the top outside.

A third test was conducted on grapefruit trees with branches interlocking in the row but hedged between the rows. Compared in this test were a 20 g.p.m. hydraulic hand sprayer equipped with single nozzle guns and a Speed Sprayer adjusted to spray double head, single head with volute and single head with C. E. S. attachment. Blocks of three row plots were replicated four times and about 40 gallons of spray were applied to each tree. Separate samples of leaves for printing were taken from the top one-third and from the skirt portions of two trees in each of three replicates. These trees were located in the center row and near the center of each plot.

Results of Figure 6 show that better spray coverage was obtained with the single head than with double head or with hand guns. The average distribution of spray on leaves collected from all locations was only fair. These data also show the distribution of spray drift on different portions of unsprayed check trees. Most of it was recorded from the lower portion of these trees.

Discussion

An attachment for air-blast sprayers was designed and constructed to direct air and spray into the tops of trees. Preliminary results showed that this attachment, as well as a standard volute, improved spray distribution. The C. E. S. attachment directed more air to the tops of trees than any other equipment tested. Since the success of air-blast equipment is dependent upon air to distribute the spray, these results show that the C. E. S. attachment has sufficient promise to warrant further investigations. This attachment, however, cannot be recommended for general use until current results have been confirmed with actual insect and disease control data.

Single head air-blast sprayers resulted in better average distribution of sprays than did double head applications with the same machines. Results from one test showed that poor distribution of spray was obtained with all machines and methods used in a grove of large grapefruit trees with branches overlapping in all directions. In this test, branches overlapping the path of sprayers were scarred with all machines and occasionally some were broken in the path of the C. E. S. attachment. Since poor spray coverage was obtained in this grove, it would indicate that hedging such groves would help in improving spray distribution and may possibly result in improving fruit quality.

Results presented and described in another test show the C. E. S. and volute attachments are as efficient for distributing concentrate sprays as they are for dilute sprays, although the C. E. S. attachment was superior to the volute for distributing both dilute and concentrate sprays. These data, as well as data from other tests, show there was little difference in the distribution of spray deposited on the upper and lower surface of leaves.

Comparisons of the distribution of spray deposits between top and skirt portions of trees generally show that the machine giving the best distribution of spray in the top portion, also gave the best distribution on the skirt portion of the same trees. While the helicopter gave the poorest coverage of all machines tested, it did compare favorably with most machines on covering the top surfaces of leaves in top and skirt areas, but it gave poor coverage on the lower surface of leaves in all areas of the tree.

Acknowledgments

The authors wish to thank the Speed Sprayer Division of Food Machinery and Chemical Corporation for a grant in aid, without which much of this work would not have been possible. Acknowledgment is also made to Minton Equipment Company, Pounds Tractor Company, Haines City Citrus Growers Association for loan of equipment, as well as citrus growers who permitted the use of their groves for these tests.

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CHEMICAL CONTROL OF PERENNIAL GRASSES IN CITRUS GROVES

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Weeds found in most Florida citrus groves have been successfully controlled by the usual cultural practices, but in recent years this situation has been somewhat altered. Many species, particularly grasses, that produce rapid, vigorous growth have become especially noxious. Certainly, the planting of many groves in old pasture sites has contributed to this problem. Also, increasing costs and decreasing availability of labor have placed a limit on the expense that can be justified for weed control in groves.

Simanton and King (6) studied the weed problems in Florida citrus groves and listed bermudagrass *(Cynodon dactylon* (L) Pers.), maidencane *(Panicum hemitomon* Schult), paragrass *(Panicum purpurascens* Raddi), guineagrass*(Panicum maximum* Jacq.), and torpedograss *(Panicum repens* L.) as serious pests. Burt (1) and Burt and McCown (2, 3) reported that repeated applications of Dowpon[1] at 2 to 5 pounds per acre (lb/A) and Karmex[2] at 8 to 12 lb/A demonstrated considerable promise for the control of weeds in groves.

The purpose of this paper is to present the results of field experiments designed to evalu-

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[1] 74% 2,2-dichloropropionic acid (dalapon) as the sodium salt.

[2] 80% 2-(3, 4-dichlorophenyl)-1, 1-dimethyl urea (diuron)

Table 1. Chemical control of bermudagrass in citrus groves.

Herbicide	Rate (lb/A)	Grass Control (%)[1/] at Intervals After Treatment: 1 mo.	3 mos.	12 mos.	Tree Injury (0-10)[2/] at Intervals After Treatment: 1 mo.	3 mos.	12 mos.
Dowpon	6.75 + 6.75[3/]	67	78	62	0	0.1	0
Dowpon	3.37 + 3.37 + 3.37 + 3.37[3/]	33	85	47	0	trace	0
Dowpon + Karmex	6.75 6.24	77	27	8	0.7	0.1	0
Dowpon + Karmex	3.75 + 3.75[3/] 3.12 + 3.12	73	20	0	0	0	0

1/ Figures are an average of three replications.

2/ Figures are an average of three replications. 0 represents a completely normal tree and 10 a dead tree. Ratings less than 1.0 would have less than 10 percent of the foliage showing injury and would be classified as very minor injury.

3/ Applications with a two-week interval.