Table 2. *Percentage control* of citrus blackfly larvae on dooryard citrus treated with insecticides by foliar spray on April 4-6, 1977, (4 replicates).

Insecticide 0.6 g a.i./liter	Instars alive pretreatment %	%[z] control of instars at weeks posttreatment			
		2 weeks		4 weeks	
		Instars		Instars	
		2+3	4	2+3	4
Phosmet 50WP	86.3	98.6a	80.4ab	98.4a	82.7a
Diazinon 4EC	89.3	91,1a	94.8a	62.7bc	69.0ab
Methidathion 2EC	93.9	74.4ab	56.1c	81.8ab	93.0a
Carbophenothion 4EC	89.1	49.6bc	55.8c	77.9ab	56.0bc
Chlorpyrifos 2EC	89.4	66.2b	100a	52.1bcd	83.8a
Fenithrothion 8EC	86.8	71.0ab	71.1bc	26.3de	7.8e
Endosulfan 2EC	91.9	21.5d	14.2d	47.3cd	35.5cd
Chlorpyrifos-methyl 4EC	85.1	28.7cd	55.3c	13.8e	22.1de
Untreated Check	83.0	0d	0d	0e	0e

[z]Adjusted by Abbott's formula to untreated check. Means in a column not followed by the same letter are significantly different (P=0.05) by Duncan's multiple range test.

instar; this stage is often referred to as a pupa which becomes non-feeding late in the stadium.

Table 1 shows the results of the first experiment. All treatments provided significant control of 2nd and 3rd instars, but the ethion and ethion + oil treatments were not effective for control of 4th instars. Ethion without oil, however, provided significantly higher control as compared to the check at 4 weeks posttreatment. Dimethoate and azinphosmethyl provided control of all 3 life stages but oxydemetonmethyl only provided acceptable control of the earlier instars.

In the second experiment (Table 2), phosmet provided the best overall control. All treatments provided significant control of a life state at least once during the test. In general, fenithrothion, endosulfan, and chlorpyrifos-methyl were not effective treatments even though fenithrothion did give 71% control at 2 weeks. Diazinon, methidathion, carbophenothion, and chlorpyrifos each provided adequate control of this pest, but chlorpyrifos appeared to be more effective in controlling 4th instars than 2nd and 3rd instars.

In summary it appears that the citrus blackfly can be effectively controlled with many insecticides. Several of these currently have labels for use on citrus, being registered for control of other citrus pests. With the efficacy of these compounds established, expansion of existing labels to include citrus blackfly should be realized.

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COMPARISON OF LOW VOLUME CITRUS SPRAY PROGRAMS APPLIED BY AIRCRAFT AND AIRBLAST SPRAYER IN FLORIDA[1]

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Abstract. **In a three-year study, three methods of aerial application were compared with two ground rigs in the application of complete, low volume spray programs to 16-year-old 'Marsh' grapefruit trees in St. Lucie County. The influence of application methods on annual packout grades and pest control as well as cumulative effect on tree condition and foliar nutrient levels at the end of three years is presented.**

Although an increasing amount of experimental work with aircraft for control of specific citrus pests has been reported during the past 18 years (5-12, 15-23, 26-32), in only three instances have aircraft been evaluated for application of a complete citrus spray program (5, 14, 33). Cooper and Schirard (14) developed a pest control program for young trees but abandoned it as trees matured. Sutton (33) developed a program for mature trees and, based on fresh fruit packout, it was considered a success. Brooks (5) reported the failure to provide control of insects and diseases over a period of two years with a concentrate aerial spray program compared to a dilute spray program using a ground-operated airblast sprayer.

The growing popularity of concentrate spraying and continued interest in aerial application prompted us to compare

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the performance of aircraft and ground rigs in the application of complete spray programs over a 3-year period.

Materials and Methods

An 80-acre block of singled-bedded, 16-year-old 'Marsh' grapefruit trees, topped to 15 feet in 1969, was selected for the experimental area. Each plot was 3 acres in size and the 5 treatments and control plots were replicated four times in a randomized block design.

An Aereo Commander Thrush, Piper Pawnee, and a Bell 47G helicopter were compared to Kinkelder and John Bean tractor-drawn airblast sprayers for application of a complete low volume spray program.

All machines were adjusted to apply the same quantity of chemical per acre (Table 1). Only the volume of water varied: aircraft applied a finished spray of 10 gallons per acre (GPA), the Speed Sprayer model 757 DOV 130 GPA, and the Kinkelder 48 GPA.

Table 1. Materials and rates per acre applied in the experimental low volume spray program.

Spray	1970	1971	1972
Dormant:			
Ferbam 95 WP	9 lbs	9 lbs	8 lbs
97% oil	1.5 gal	1.5 gal	2 gal
Post–bloom:			
Techmangam 75 WP	1 lb	5 lbs	
Sequestrene (Mn)			5 qts
Zinc Oxide 75 WP	1 lb	7.5 lbs	
Sequestrene (Zn)			5 qts
TC 904 (Cu)	2 gal	2 gal	
Kocide 101			3 lbs
Solubor		1.75 lb	
Carzol 95 SP	7.5 oz		
Acarol 2E		5 pt	5 pt
Sodium Molybdate		10 oz	
Summer:			
Ethion 4E	7.5 pt	7.5 pt	
97% oil	7 gal	7 gal	6 gal
Lead arsenate	2 lb		
Tri-basic copper 53%		3 lbs	
Nuzox			2 lbs
Techmangam 75 WP			1 lb
Acaraben 4E			2.5 pt
Fall:			
Tribasic copper 53%	3 lb		
Carzol 95 SP	15 oz		
97% oil		6 gal	
Acarol 2E			
(aerial plots only)		5 pts	

The Thrush was fitted with 6 AU3000 Micronair rotary atomizers and was flown at 100 miles per hour (mph) at tree-top height between tree rows. The Pawnee was fitted with 42 D8-45's faced down and was flown at tree-top height between tree rows. The helicopter was fitted with a U-shaped boom carrying 34 D4-25's and was flown at 25 mph at tree-top height over tree rows. Following the 1972 dormant spray, the helicopter was no longer available and those plots did not receive the post-bloom and summer sprays.

Each plot had 6-10 rows of trees and, depending on plot location, trees to be monitored were situated in the center row or in a row that provided a minimum of 3 buffer rows between it and the adjacent treatment.

Citrus rust mite populations were measured at 3- to 4-week intervals by determining per cent infested of 10 leaves and of 10 fruit randomly selected on 10 trees per plot. Russetting, melanose lesions, and greasy spot were evaluated with a 0-5 rating system that reflected the fraction of peel surface discolored by speckle or mudcake melanose, by greasy spot, or by russet. The surveyor visually estimated the peel area that would be affected if all of the scattered lesions and blemishes on the fruit's surface were compressed into one area. The following rating and its U. S. Grade Standard equivalent were used to rate 100 mature, hanging fruit per plot:

Peel Blemish Rating System

Grade Equivalent	Rating	Rating Description
U. S. Fancy	0	blemish absent
U. S. Fancy	1	up to 1/10th of peel surface
U. S. No. 1	2	between 1/10th and 2/10th
U. S. No. 1	3	between 2/10th and 1/3rd
U. S. No. 2	4	between 1/3rd and 1/2
U. S. No. 2	5	more than 1/2 of peel surface

Leaf drop was measured by placing a 3 ft X 3 ft catch frame beneath the canopy of four trees in each treatment plot. A frame was positioned in a different compass quadrant under each tree and its "catch" of fallen leaves was counted and removed weekly during 1972 and January 1973.

The canopy density of 10 trees in the center row of each plot was rated during December 1972 according to the following system:

1 Excellent—cannot see scaffold limbs.
2 Fair—can see scaffold limbs, but not beyond.
3 Poor—outline of adjacent tree observed through the one being rated.

Foliage was assayed for manganese and zinc levels in the third year of the experiment. Duplicate samples of leaves were collected in February 1972, prior to the last application of micronutrients delivered in the post-bloom spray. Samples of spring-flush leaves from non-fruiting terminals were also gathered in July, 1972, processed as described by Anderson et al. (1), and analysed by atomic absorption.

The incidence of greasy spot disease on foliage was recorded at monthly intervals from November 1972 through February 1973 using a method described by Cohen (13).

Results and Discussion

Fruit infested with rust mite never exceeded 44% in any treated plot during the 3 years of the experiment. These moderate infestation levels occurred as single episodes during the growing season in contrast to the greater frequency of moderate to high per cent infestation levels recorded in the untreated plots. The extent of control was reflected in the absence of blemished fruit at harvest (Table 2). All application methods were equal and were superior to the control plots.

Table 2. Effectiveness of low volume spray equipment for prevention of russetting caused by citrus rust mite on grapefruit.

Equipment	1970[z]		1971	
	US Fancy + No. 1	US No. 2	US Fancy + No. 1	US No. 2
Thrush micronair	100.0 a	0.0	99.0 a	1.0
Pawnee boom/nozzle	100.0 a	0.0	99.2 a	0.8
Bell helicopter	100.0 a	0.0	99.5 a	0.5
Speed sprayer 6X	99.5 a	0.5	100.0 a	0.0
Kinkelder 20X	100.0 a	0.0	99.3 a	0.7
Control	86.3 b	13.7	89.2 b	10.8

[z]Percentage fruit meeting U.S. Marketing Service color standards for Fancy and No. 1 Florida grapefruit. Mean separation between averages by Duncan Multiple range test: 5% level.

Melanose control was erratic during the two years of survey. Liquid copper was applied during April 1970 and 1971 and tribasic copper in August of 1970 and July of 1971. These copper treatments were neither optimumly timed nor of the recommended metallic content necessary to provide adequate control.

While all equipment failed to provide control in 1970, melanose was significantly reduced by all spray machines during 1971 (Table 3). Aircraft matched airblast sprayers in performance. Melanose was not severe in the experimental area during 1972 and untreated fruit was as free of peel blemish as fruit receiving copper treatment.

Table 3. Effectiveness of low volume spray equipment for prevention of melanose on grapefruit.

Equipment	1970		1971[z]	
	US Fancy + No. 1	US No. 2	US Fancy + No. 1	US No. 2
Thrush micronair	83.0	17.0	90 a	10
Pawnee boom/nozzle	79.5	20.5	93 a	7
Helicopter	76.1	23.9	94 a	6
Speed Sprayer 6X	82.1	17.9	95 a	5
Kinkelder 20X	71.5	28.5	89 a	11
Control	72.3	27.7	71 b	29

[z]Percentage fruit meeting U.S. Marketing Service color standards for Fancy and No. 1 Florida grapefruit. Mean separation between averages by Duncan Multiple range test: 5% level.

The incidence of greasy spot on fruit peel was suppressed in all treatment plots with mid-July and late July-early September applications of copper-oil and neat oil, respectively (Table 4). A severe infection possibly may not have been controlled as easily with aircraft but the performance was nevertheless comparable to the airblast sprayers. However, airblast sprayers were more effective than aircraft in protecting foliage from greasy spot infection (Table 5).

Table 4. Effectiveness of low volume spray equipment for prevention of pink pitting of grapefruit.

Equipment	1971[z]		1972	
	US Fancy + No. 1	US No. 2	US Fancy + No. 1	US No. 2
Thrush micronair	99.3 a	0.7	100 a	0
Pawnee boom/nozzle	99.5 a	0.5	100 a	0
Helicopter	99.5 a	0.5	99 b	1
Speed Sprayer 6X	99.2 a	0.8	100 a	0
Kinkelder 20X	99.4 a	0.6	100 a	0
Control	95.0 b	5.0	98 c	2

[z]Percentage fruit meeting U.S. Marketing Service color standards for Fancy and No. 1 Florida grapefruit. Mean separation between averages by Duncan Multiple Range Test: 5% level.

The more sparsely foliated canopies (Table 5) were generally those suffering the most defoliation. Although fallen leaves were not scrutinized to determine cause of abscission, it appeared likely that the comulative effect of the 3-year pest control program by ground rig maintained significantly better tree canopy condition because of more effective control of greasy spot.

Although zinc levels (Table 6) were significantly higher in foliage receiving nutritional sprays applied by airblast sprayers than aircraft, elemental zinc content for all application methods was within the range considered satisfactory by Reitz *et al.* (25).

Retention of manganese in leaves was greatest with the Kinkelder application. All other methods were less effective

Table 5. Effectiveness of low volume spray equipment for tree canopy maintenance.

Equipment	No. Leaves[z] dropped per ft[2]	Tree[y] canopy density	Foliar[x] greasy spot rating
Kinkelder 20X	15.0 bcd	1.6 a	0.17 a
Speed Sprayer 6X	10.0 a	1.7 a	0.33 ab
Pawnee boom/nozzle	16.8 cde	2.1 bc	0.77 bc
Thrush micronair	15.2 bcd	2.2 bcd	0.99 bc
Helicopter (control)	19.4 e	2.2 bcd	1.15 c
Control	17.8 de	2.6 d	1.47 c

[z]Mean separation between averages in same column by Duncan Multiple Range Test: 5% level.
[y]1 = excellent; 2 = fair; 3 = poor.
[x]0 = blemish absent to 5 = over half of surface blemished.

Table 6. Effectiveness of low volume spray equipment for maintaining zinc and manganese levels for tree nutrition.

Equipment	Leaf Zn (ppm)[z][y]	Leaf Mn (ppm)[x]
Kinkelder 20X	42.6 a	36.3 a
Speed Sprayer 6X	33.4 b	27.1 b
Pawnee boom/nozzle	27.8 cd	23.8 bc
Thrush micronair	30.4 c	26.9 b
Helicopter (control)	25.9 de	21.0 cd
Control	24.1 e	17.8 de

[z]Mean separation between averages in same column by Duncan Multiple Range Test: 5% level.
[y]Satisfactory range (Zn): 20-50 ppm.
[x]Satisfactory range (Mn): 20-50 ppm.

with no differences among them. Bar Akiva et al. (4) and California citrus growers (2, 24) have used aircraft applications to correct deficiencies of Mg and Zn, respectively. Our research suggests that the method would be satisfactory in a regular maintenance program for Mn and Zn.

The ability of aircraft to control rust mite as reported before (5, 7-9, 16, 19, 33) was confirmed by our test results. This method of application also appears promising for delivery of foliar nutritional materials. Literature citations were found to be evenly divided in reference to control of certain citrus diseases (5, 18, 22, 23). In this experiment, aircraft application controlled the diseases greasy spot and melanose as effectively as treatments applied by airblast sprayer.

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RESIDUES OF 2,4-DICHLOROPHENOXYACETIC ACID HERBICIDE (2,4-D) IN VALENCIA ORANGES FOLLOWING POST-HARVEST DIP[1]

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Abstract. **2,4-Dichlorophenoxyacetic acid (Dow Chemical Company Formula 40) as a postharvest dip has been shown to be effective in reducing stylar end breakdown and** Alternaria **rot in mature Valencia oranges. Residues were determined in the pulp and peel of whole fruit after storage at 4.4°C for 0, 8 and 10 weeks; residues ranged from 1.0 to 6.8 ppm for peel and 0.01 to 0.17 ppm for pulp.**

2,4-Dichlorophenoxyacetic acid (2,4-D) has long been used as a postharvest application to extend storage life of lemons (3). The U.S. Environmental Protection Agency (U.S.E.P.A.) has now approved a tolerance of 5.0 ppm of 2,4-D applied as a water solution of the alkanolamine salts (Dow Formula 40) for all types of citrus, in order to prevent peel necrosis due to senescence and desiccation, and to aid in control of postharvest decay (3). Reduced decay is due to improved disease resistance by the fruit. This is in contrast to action on pathogens by fungicides, such as benomyl (Benlate®), which have been shown to be effective in controlling varied types of decay causing organisms in citrus (2).

This report describes the residues which were measured and reported to the U.S.E.P.A. in order to obtain the above described tolerance.

Materials and Methods

Approximately 3 cartons (4/5 bushel) were treated at 0, 500 and 1000 ppm as a one-half minute dip in water solutions of 2,4-D alkanolamine salt (Dow Formula 40). The fruit were not dried but sent immediately to cold storage (4.4°C) for 0, 8 and 10 weeks after which they were held at −8°C until residue analyses were performed.

Pulp and peel were analyzed separately by hydrolyzing 25 g of each in 35 ml of pH 12 NaOH solution at 100°C for 15 minutes. This releases all conjugates which may be present giving 2,4-D sodium salt. The solns were cooled and adjusted to pH 1 with 5N H_2SO_4, after which they were extracted with 3 20 ml portions of ethyl ether; the extracts were combined. After the ether fraction was reduced to 20 ml (ambient temp.) it was extracted 4 times with 5 ml portions of 0.2 M K_2HPO_4; these portions were combined and adjusted to pH 1 with 5N H_2SO_4 after which the 2,4-D was extracted into 3 5 ml portions of benzene, the portions again combined. After drying with Na_2SO_4 the benzene was gently evaporated to dryness at room temp.

The butoxyethyl ester was made of the 2,4-D free acid by adding 0.1 ml 5% acetyl chloride in butoxyethanol and heating at 100°C for 15 minutes. The esterification solution was diluted with 2 ml of benzene, the mixture washed twice with 2 ml portions of 0.2 M NaOH (discarded) then twice with 2 ml portions of water (discarded). Anhydrous Na_2SO_4 was added and the solution analyzed within 24 hours by electron capture gas chromatography.

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