THE EFFECT OF BUDWOOD, ROOTSTOCK, IRRIGATION, AND FERTILIZATION ON THE YIELD OF FLORIDA LEMON OIL

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Abstract. **Comparisons of peel oil contents for 21 different lemon budwood selections showed increases of 4.3 lb/ton of fruit by the proper choice of budwood. No significant differences were found in the yield of peel oil from the same 'Bearss' lemon budwood on 7 different rootstocks. The peel oil contents of 'Bearss' lemons showed significant increases in yields with increased nitrogen application and increased irrigation frequency. Potash had no significant effect on fruit production or peel oil content. By the proper choice of budwood, fertilization, and irrigation practices, it is possible to increase the theoretical income from lemon oil by approximately $580/A/yr and fruit income by approximately $80/A/yr.**

Hood (7), in 1916, probably made the first attempt to determine the peel oil content of Florida oranges. Later, Giacometti (4) sought to morphologically classify the various strains of 'Parson Brown' oranges by studying the primary, secondary, and tertiary oil glands in these fruits. Thin-skinned fruit contained fewer oil glands than thick-skinned fruit. Hendrickson et al. (5, 6) have more recently demonstrated that budwood and rootstocks are variables which influence the peel oil content of oranges.

Bartholomew (1, 2) and Bitters (3) have studied California citrus fruit and found that peel oil content is directly correlated with the surface area of the fruit and that rootstock influenced the amount and type of oil found in the rind of oranges. In the present study, data are presented to show how budwood, irrigation, and fertilization influence the peel oil content of lemons. For the first time, it will be demonstrated that cultural practices such as irrigation and fertilization influence the peel oil content of lemons.

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Materials and Methods

Peel oil content was determined in accordance with the procedure of Hendrickson et al. (6). In this method, 2 or 4 discs (2 cm diam) were cut from 16 or more fruit at the equatorial section of the fruit. The fruit was weighed and the longitudinal and equatorial diameter was measured. Pounds of peel oil per ton of fruit were calculated by determining the volume of oil per unit weight of fruit, extrapolating for the equivalent volume in a ton of fruit, and finally converting to weight by using the density of the oil.

Rootstock and budwood studies on lemons were made on 5 tree plots with 5 replications per selection. Twenty-one varieties were used in these studies, because of their high fruit weight yields (9), but only 8 selections were reported to show the extremes in yield. The cultural studies on lemons (10) were made at 2 levels of soil moisture and 3 rates each of ammonium nitrate (N) and potassium sulfate (K). A split plot design was used with the soil moisture levels (irrigation) as main plots and the N and K rates as subplots. Each main plot was composed of 9 side by side 6-tree subplots arranged in a 3 x 3 N and K factorial design. Treatments were replicated 4 times.

Results and Discussion

Budwood vs. oil yield. The peel oil content of the fruit from 8 different lemon budwood selections on a common rootstock (Table 1) showed increases of 4.3 lb. of oil/ton fruit for 2 different seasons by comparison of lowest and highest oil yields. Approximately 85% of the lemons planted in Florida are the 'Bearss' variety which give high yields of oil. Oil yields were higher in 1971 than in 1970 and fruit yields were lower in 1971 than 1970. Whether oil yields are related to fruit yields or only to seasonal differences should be determined by further studies. Kesterson et al. (8) have shown that peel oil content is variable from season to season. Data clearly demonstrates that by proper choice of budwood, oil yield can be increased.

Rootstock vs. oil yield. The same 'Bearss' lemon budwood was used on 7 different rootstocks: Cleopatra mandarin, Florida rough lemon, 'Helseth' (rough lemon), macrophylla, sour orange, tri-

Table 1. Effects of scion and rootstock selections on the yield of lemon peel oil.

Variety	Selection	Peel oil[z]	Rootstock	Peel oil[y]
		lb /T frt.		lb /T frt.
Bearss	E-403	17.32	Cleopatra mandarin	15.67
	E-404	16.95	Troyer citrange	15.44
Lisbon	E-418	15.89	Sour orange	15.27
Villafranca	Alp-31	15.73	Helseth (rough lemon)	14.90
Italian	Alp-26	14.98	Florida rough lemon	14.87
Harvey	Alp-3	13.23	Trifoliata	14.27
Arizona	Alp-28	13.20	Macrophylla	14.18
Avon	Alp-4	13.00		
Sig.[x]		*		N.S.

[z]Average of 2 year's data.

[y]One year's data.

[x]N.S. - not significant. *significant at .05 level. **significant at .01 level.

foliata, and 'Troyer' citrange, and studied for one processing season to determine if rootstock influences oil yield from lemons. The results of this study are shown in Table 1. No significant differences were found in the yield of peel oil for any of the rootstock selections. Bitters and Scora (3) and Hendrickson et al. (5) obtained similar results in studies for the peel oil content of 'Valencia' oranges. There was a decrease in the oil yield as fruit matures on a per ton of fruit basis, but this is due to the fact that the weight of the fruit increased at a greater rate than the surface area.

Cultural practice vs. oil yield. A previous study in 1969 by Hendrickson, Kesterson, and Ting (6) attempted to relate oil yield to cultural practice, but failed to show a significant relationship due to improper experimental design. This work has been continued and results of a 3-year fertilization study on 'Bearss' lemons (10) involving low, intermediate, and high levels of N and K_2O at 2 levels of irrigation are shown in Table 2. On a per ton of fruit basis, it has been clearly demonstrated that N increases oil yield while K suppresses oil yield. When converted to a per acre basis, the preferred method to evaluate cultural practices, increased N applications gave higher fruit yields and peel oil content. Potash had no significant effect on fruit production or peel oil content. A significant increase in peel oil production due to increased irrigation was found in 2 of the 3 years. Several other elements such as phosphorus, magnesium, manganese, copper, zinc, boron, and iron have shown no consistent trend in oil yield and will require further study before conclusions can be drawn.

Economic importance. In order to demonstrate that cultural practices are economically important to lemon oil production, maximum and minimum yields of lemon oil (lb/A) will be used. Since each particular case in point will be different, it then becomes necessary to adjust cost and selling price to that of current cultural practice and actual market price. The theoretical potential for lemon oil production due to cultural practices has been summarized in Table 3. All calculations were made on the basis of 3-year averages taken from Table 3, 15.1 lb. of oil/ton fruit (5-yr avg of unpublished data), fruit price of $2.75/box, lemon oil at $6.75/lb., fertilizer ($150/T ammonium nitrate), and irrigation (11) costs at the time the study was conducted.

Increased fruit yields in the amount of 26 and 30 boxes/A were obtained for the medium (ME)

Table 2. Effects of irrigation, N, and K on yield of 'Bearss' lemon oil (avg of 3 years).

Treatment	Fruit production B/A/yr	Peel oil lb/T frt.	Peel oil lb/A
Irrigation			
LO (60c.-bar)[y]	173	18.62	167
HI (10c.-bar)	205	18.63	190
Sig.[z]	N.S.	N.S.	*
N (lb/A/yr)			
LO - 160	174	18.02	157
ME - 290	200	18.65	184
HI - 420	205	18.94	193
Sig.	**	*	*
K_2O (lb/A/yr)			
LO - 160	192	18.94	184
ME - 290	186	18.51	172
HI - 420	198	18.43	181
Sig.	N.S.	N.S.	N.S.

[z]N.S. - not significant. *significant at .05 level. **significant at .01 level.

[y](c.-bar) soil moisture tensions at 12 to 18 inch depth:

a) 1.5 to 3 inches irrigation at 60 centibar treatments.

b) 6 to 9 inches irrigation at 10 centibar treatments.

and high (HI) applications of N with an added value of $71.50 and $82.50 per acre, respectively. Increased oil yields are due to N response (ME 8.3 lb /A and HI 14.6 lb /A) and increased fruit yields (ME 17.7 lb /A and 20.4 lb /A). Budwood selection accounted for an average increase of 4.3 lb. oil/ton fruit between extremes of lowest and highest oil content, while overhead irrigation increased oil content by 22 lb /A.

Utilizing the most up-to-date and efficient technology available for the recovery of essential oils, the Citrus Industry should be capable of recovering at least 50% of the theoretical oil yield. Assuming that only one-half of the potential value can be attained in actual practice, these data clearly demonstrate the importance of cultural practices as related to processing.

Table 3. Economic potential of lemon oil from cultural practice.

	Theoretical oil increase lb/A/yr	Cost of additional input/A/yr	Theoretical income/A/yr	Theoretical profit/A/yr
		LO vs. ME nitrogen		
N (130 lb/A/yr)	26.0	$29.55	$175.50	$145.95
Budwood	39.6	0.00	267.30	267.30
Irrigation (6"/A/yr)	22.0	57.62	148.50	90.88
				$504.13
		LO vs. HI nitrogen		
N (260 lb/A/yr)	35.0	$59.10	$243.00	$183.90
Budwood	40.5	0.00	273.38	273.38
Irrigation (6"/A/yr)	22.0	57.62	148.50	90.88
				$548.16

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EVALUATION OF FUNGICIDES FOR CITRUS SCAB CONTROL

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Abstract. **The relative effectiveness of fungicide sprays for controlling sour orange scab (Elsinoe fawcetti) was determined for foliage on a highly susceptible clone of rough lemon and for fruit on the 'Temple' orange variety. Difolatan or Benlate, when applied at the appropriate times, generally gave better scab control than copper fungicides or ferbam. High rates of Difolatan applied dormant provided sufficiently long action to reduce infection of fruit that set 6 to 8 weeks after spraying. In contrast, Benlate gave consistently good scab control only when applied shortly before fruit set. Amongst other materials tested, only Topsin M and Thynon showed substantial activity against scab.**

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Copper fungicides, applied just prior to spring growth (delayed dormant) and at bloom (2/3 petal fall) have long been recommended in Florida for the control of sour orange scab caused by *Elsinoe fawcetti* Bitanc. and Jenkins (6, 7). The results of trials commencing in the 1950's, indicated that ferbam could be substituted for copper fungicides (1), thereby making it the preferred material where there was likely to be a toxic accumulation of copper in the soil. Ferbam has been reported to be more effective than copper fungicides for scab control (2).

Today, 2 additional fungicide materials, Benlate and Difolatan, are available for controlling scab on citrus. Benlate has given better scab control than either copper fungicides (4) or ferbam (3). Difolatan is also very effective against scab (5) but, unlike Benlate, it can cause damage to fruit and young foliage. Therefore, it can only be safely applied when the trees are dormant and, even then, only if the previous crop has been harvested. High rates of Difolatan applied as a single application at the delayed dormant stage have provided better scab control than standard schedules of ferbam and/or copper (5).

This paper reports the results of 3 years of fungicide evaluation against scab, using small rough lemon trees for tests on shoot infection and 'Temple' orange trees for tests on fruit.

Materials and Methods

Fungicides. The materials tested were: Tribasic copper sulfate, 53% Cu; cupric hydroxide (Kocide 101) 53% Cu; copper salts of fatty and rosin acids (Citcop 4E), 0.32 lb. Cu per gal; captafol (Difolatan 4F); benomyl (Benlate 50W); thiophanate-methyl (Topsin M 70 W); ferbam (Vancide Fe 95W); chlorothalonil (Bravo 6F); mancozeb (Manzate 200 80W); dithianon (Thynon 75W), and triforine (Cela W 524). Triton B-1956 spreader-sticker was added to all spray mixes at the rate of 6 oz per 100 gal.

Fungicide screening on rough lemon foliage. These tests were made on 1 to 2-year-old trees of a highly scab-susceptible clone of rough lemon planted at a spacing of 12 x 10 feet. This clone (author's accession No. 27) was atypical for rough lemon in being relatively cold hardy and highly resistant to Alternaria leaf spot, which is a disease that would have rendered ordinary Florida rough lemon less suitable for the purpose because of the resulting defoliation and dieback. The inherently high vigor exhibited by this clone enabled trees to recover quickly as soon as conditions became less favorable for infection. This meant that the same trees could be used for further fungicide tests after allowing only a short period for recovery. After the trees had recovered sufficiently, a further intensification of disease severity was promoted, before using them again for fungicide tests, by pruning back the trees to stimulate the emergence of new shoots and by applying overhead irrigation to ensure infection of such shoots.

Essentially, the fungicides were tested for their ability to reduce the inoculum supply from old scab lesions. Materials were applied with a pressure-retaining sprayer to single-tree plots, replicated at least 5 times in randomized block designs. The spray was directed at both leaf surfaces to ensure thorough coverage of the old scab lesions. The treatments were applied only when there was little or no shoot extension; either when the trees were actually dormant or in between successive growth flushes during the growing season. After the next growth flush had fully expanded, 50 of the new shoots were picked from each tree and examined for the presence or absence of scab pustules.

Fungicide Tests on 'Temple' Orange Trees

Fungicides were applied dilute by handgun at 500 psi to a 1961 planting of 'Temples' at the rate of 6 to 8 gal spray per tree. Randomized block designs were used for all experiments, with 2-tree plots replicated 4 times in 1972, 3-tree plots replicated 6 times in 1973, and 2-tree plots replicated 5 times in 1974.

Each year, different procedures were used to determine disease severity on the fruit. In 1972, the whole crop from each tree was graded for presence of scab, whereas in 1973, the disease severity was based on the number of infected fruit present in a random sample of 100 fruit picked from each tree. In 1974, exceptionally mild winter temperatures led to an early cessation of dormancy and the bloom was very extended. Thus, a completely different procedure had to be followed to provide data separately for fruit that set shortly after treatments were applied and for fruit that originated from a second major bloom in late April. Fruit was picked immature for this purpose; at a time when all scab infection and development had ceased, but before the 2 major sets would have become indistinguishable from each other because of similarity in fruit size. Samples of 100 fruit per tree from the February bloom were picked in early June and from the April bloom in mid-July.

Results

Fungicide Evaluations on Rough Lemon Foliage (Table 1)

Test 1. Treatments were applied on February 28, 1973; shoot growth commenced in early March; and disease assessments were made on April 2. Rainfall from February 28 to March 21, which represented approximately the period of shoot susceptibility, was 1.05 inches (5 rain days). No

Table 1. Effectiveness of fungicide sprays for preventing scab infection of the next growth flush on heavily diseased rough lemon trees.

Materials	Amount per 100 gal	Percentage new shoots with scab pustules[z] Test number 1	2	3	4
Difolatan 4F	0.25 gal	--	0.5a	13.0a	--
Difolatan 4F	0.5 gal	0.7a	--	--	1.1a
Benlate 50W	0.25 lb.	--	--	46.0 b	--
Benlate 50W	0.5 lb.	0.7a	2.6a	--	0.4a
Topsin M 70W	0.37 lb.	--	--	68.0 c	--
Topsin M 70W	0.75 lb.	0.3a	--	--	4.2a
Ferbam 95W	1.2 lb.	60.0 b	41.5 bc	67.8 c	27.3 b
Tribasic copper sulfate	1.5 lb.	44.5 b	23.6 b	--	34.8 b
Kocide 101	1.5 lb.	--	--	94.7 de	--
Citcop 4E	0.5 gal	--	--	96.3 de	--
Bravo 6F	0.17 gal	--	31.3 b	87.3 d	--
Bravo 6F	0.33 gal	--	--	--	36.7 b
Cela W 524 20EC	1.0 pint	--	63.2 c	98.3 e	--
Thynon 75W	1.0 lb.	--	--	39.2 b	--
Manzate 200 80W	1.5 lb.	--	39.8 bc	92.7 de	--
Control unsprayed		77.2 c	48.5 bc	95.9 de	56.2 c

[z]Values in each column followed by the same letter do not differ significantly at the 5% level.

supplementary overhead irrigation was applied in this test.

Test 2. Sprays were applied on April 30, 1973; the next growth flush started to grow out in early-May; and disease data were obtained on May 30. Rainfall from April 30 to May 19 was 1.86 inches (4 rain days) and overhead sprinkler irrigation (0.25 inch each time) was applied on May 2, 7, and 17.

Test 3. Sprays were applied on August 8, 1973; new growth appeared erratically from mid to late August; and disease severity was recorded on September 13. Rainfall from August 8 to September 3 totalled 7.11 inches (16 rain days) and no supplementary irrigation was applied.

Test 4. At the time of spraying on March 5, 1974, new shoots were already beginning to grow out. Disease severity on the new shoots was determined on April 18. Rainfall from March 5 to April 9 totalled 2.68 inches (7 rain days). The trees were irrigated by overhead sprinklers (0.25 inches each time) on March 11, 18, 28, and April 2.

Benlate, Topsin, and Difolatan were about equally effective in controlling scab, except in Test 3 where the disease pressure was extra heavy. Here, Difolatan, even at the low rate used, gave better control of scab than any of the other materials. Control of scab with copper fungicides and ferbam was relatively poor in all tests. Amongst the other materials tested, only Thynon showed any substantial activity against scab.

Effectiveness of Fungicides for Preventing Scab on 'Temple' Fruit

1972 experiment (Table 2). Dormant sprays were applied on February 28 and the bloom applications were made on April 13 at 2/3 petal fall. Shoot growth commenced in mid-March. Rainfall during the period of shoot expansion amounted to only 1.57 inches (3 rain days) and relatively little shoot infection occurred. Mostly, the bloom did not open until after the new leaf growth had expanded beyond the scab susceptibility stage. Fruit infection therefore resulted mainly from over-wintering scab lesions and not from the few lesions produced on the new flush of growth. Scab control on the fruit in this experiment therefore mostly reflected the ability of fungicides to reduce *inoculum availability* from the previous year's scab lesions, when

Table 2. Fungicidal control of scab on 'Temple' fruit in 1972.

Materials	Amount per 100 gal and time of application^z		% fruit with scab^y
Difolatan 4F	1.0 gal	dormant	3.8a
Benlate 50W	0.25 lb.	dormant	19.0 b
Benlate 50W	0.25 lb.	bloom	4.0a
Tribasic copper sulfate	1.5 lb.	dormant	12.3ab
Tribasic copper sulfate	1.5 lb.	bloom	3.8a
Ferbam 95W	1.2 lb.	dormant	18.2 b
Ferbam 95W	1.2 lb.	bloom	6.8a
Benlate 50W 0.25 lb. dormant + Benlate 50W 0.25 lb. bloom			4.2a
Tribasic copper sulfate 1.5 lb. dormant + Ferbam 1.2 lb. bloom			8.9a
Control unsprayed			18.1 b

^z Dormant spray February 28 and bloom spray April 13.

^y Values followed by the same letter do not differ significantly at the 5% level.

applied either 6 to 8 weeks before (dormant spray) or just before (bloom spray) fruit set.

Difolatan was the only spray applied dormant that provided a sufficiently long lasting effect to reduce scab infection of the fruit. In this experiment, the 2/3 petal fall applications of Benlate, Ferbam, and Tribasic copper sulfate all gave good control of scab and there were no significant differences between these treatments.

1973 experiment (Table 3). Sprays were applied either dormant on February 27 or at full bloom on March 30. As in the 1972 experiment, nearly all the new leaf growth had become resistant to scab by the time the bloom began to appear. Rainfall during March totalled 3.58 inches (7 days), and more leaf infection, therefore, occurred than in 1972.

All dormant sprays significantly reduced scab severity on the fruit. This was due mainly to their effectiveness in preventing infection of shoots that emerged shortly after spraying, thereby relieving inoculum pressure on the young fruit. When

Table 3. Fungicidal control of scab on 'Temple' fruit in 1973.

Materials	Amount per 100 gal	Time of application^z	% fruit with scab^y
Difolatan 4F	1.0 gal	dormant	0.7a
Benlate 50W	0.5 lb.	dormant	3.1abc
Benlate 50W	0.5 lb.	bloom	2.1ab
Tribasic copper sulfate	1.5 lb.	dormant	8.5 bcd
Tribasic copper sulfate	1.5 lb.	bloom	13.5 de
Ferbam 95W	1.2 lb.	dormant	5.0abcd
Ferbam 95W	1.2 lb.	bloom	12.0 cd
Control unsprayed			23.8 e

^z Dormant spray February 27, Bloom spray March 30.

^y Values followed by the same letter do not differ significantly at the 5% level.

dormant sprays were omitted and the materials were applied only at full bloom, Benlate gave significantly better scab control than either Tribasic copper sulfate or ferbam.

1974 experiment (Table 4). Shoot growth had already commenced and some bloom had already appeared by the time the treatments were applied on February 20. By mid-March this early bloom had virtually ceased and it was not until late April that the main bloom appeared. Rainfall totals were 0.88 inch (2 rain days) for February, 1.85 inches (4 rain days) for March, 0.70 inches (2 rain days) for April, and 7.02 inches (9 rain days) for May. More fruit infection occurred than in the preceeding 2 years.

Because growth had already commenced, it was decided to use only a low rate of Difolatan, to reduce the risk of spray injury. Even at this low rate, Difolatan was just as successful as Benlate in controlling scab on the early set of fruit. Both fungicides controlled scab on the early fruit more effectively than Tribasic copper sulfate, Ferbam, or Bravo. However, none of the fungicides reduced significantly the amount of scab on the late April-early May set of fruit. No phytotoxicity was caused by the Difolatan treatment applied in this experiment.

Discussion

In general, the results are consistent with previous reports concerning the superiority of Difolatan (5) and Benlate (3, 4) over ferbam and copper fungicides for scab control. Nevertheless, it is important to note that a single spray of Benlate applied dormant or too long before major fruit set will not always provide satisfactory scab control on the fruit. Under conditions where Benlate failed in this respect, as in the 1972 experiment, the high rate of Difolatan applied dormant still provided good scab control. Dormant sprays of Benlate can at times be beneficial, as shown by the results of the 1973 experiment. However, this material only performed consistently well where it was applied shortly before fruit set. Thus, if only one Benlate spray is to be applied for scab control, this would best be delayed until the trees reach full bloom. Risk of damage to fruit and young leaves precludes the safe use of Difolatan after growth commences. This material does, however, have important usage as a dormant spray, provided the previous crop has been harvested.

The number of sprays required for scab control has to be based on local circumstances. Much would depend on the scab history of the grove. Where disease pressure is heavy, it might be necessary to follow a dormant Difolatan spray with a Benlate spray at full bloom. Two such spray applications would be particularly desirable in years when there is a long delay between the dormant application and bloom. Furthermore, if the bloom extends over a very long period, as it did in 1974,

Table 4. Fungicidal control of scab on 'Temple' fruit in 1974.

Materials[z]	Amount per 100 gal	% fruit with scab[y] Early crop[x]	Main crop
Difolatan 4F	0.25 gal	8.6a	22.6a
Benlate 50W	0.25 lb.	7.4a	27.5a
Bravo 6F	0.16 gal	48.1 c	59.4a
Ferbam	1.2 lb.	17.3ab	33.0a
Tribasic copper sulfate	1.5 lb.	32.3 bc	37.5a
Control unsprayed		41.7 bc	47.0a

[z]Sprays applied only on February 20.

[y]Values within each column followed by the same letter do not differ significantly at the 5% level.

[x]Early crop set from late-February to early-March and the main crop set from late-April to early-May.

then an additional fungicide spray might be required for scab control later in the bloom period.

Scab tends to be very localized in citrus groves and even neighboring trees often show considerable differences in disease severity. This creates a major problem in assessing fungicidal effectiveness against scab in the conventional type of grove experiment. A partial solution to the problem is to use multiple-tree plots for each treatment with large numbers of replications, but this limits the number of treatments that can be conveniently handled in each grove test. Another difficulty with fungicide testing against scab is that disease severity can vary considerably from year to year, depending mainly on rainfall during the critical and relatively short periods of shoot and fruit susceptibility. Thus, a test with a new fungicide may have to be repeated several times before it is possible to study its performance under heavy, naturally induced disease pressure.

Because of the uncertainties of grove testing, it is advantageous to screen out the less effective or ineffective candidate materials without having to include them in grove experiments. The procedure described herein using closely planted heavily infected small rough lemon trees, supplied with overhead sprinkler irrigation, appeared adequate for such initial screening purposes. Materials that gave good scab control in the grove tests on 'Temple' trees also provided good scab control on foliage in the rough lemon tests. Admittedly, the rough lemon test was rather severe on the long recommended copper fungicides and ferbam. Experience has shown, however, that these materials are often inadequate where conditions are very favorable for scab. Now that Difolatan and Benlate can be used for scab control, a higher standard of requirements needs to be set for candidate fungicides than hitherto, when only copper fungicide and ferbam were available for controlling this disease. On this basis, the only new materials included in the tests reported here that would appear to have any potential for scab control would be Thynon and Topsin M.

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DISTRIBUTIONAL PATTERNS OF SELECTED HERBICIDE APPLICATORS

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Abstract. **Most herbicide applicators are generally calibrated accurately in terms of gal per treated acre. Distribution of the output over the treated area is rarely determined, however. A field survey of 18 herbicide applicators using several nozzle types and spacings showed distribution of material across the width of the treated area is not uniform. Amounts of material applied to a treated area varied several fold according to boom clearance, type of nozzle, nozzle spacing, and distance of the boom end from a mature or reset tree.**

Herbicides have been used in Florida citrus for at least 15 years. They were used until recently exclusively on young trees to control grasses and broadleaf weeds. Early recommendations called for a slight overlap of the spray pattern (2). In 1961, the first commercially made applicator for Florida citrus was designed and current models vary little from the original machine (3). Very little has been written concerning designs of herbicide booms, especially as to distribution patterns. Work in 1961 by C. I. Hannon and others (1) gave considerable attention to the applicator itself, but no mention was made of the distribution pattern.

Recently, a different type of weed problem has developed. Vines, especially milkweed, have become a major problem in mature citrus groves. Growers have been using a number of applicators utilizing