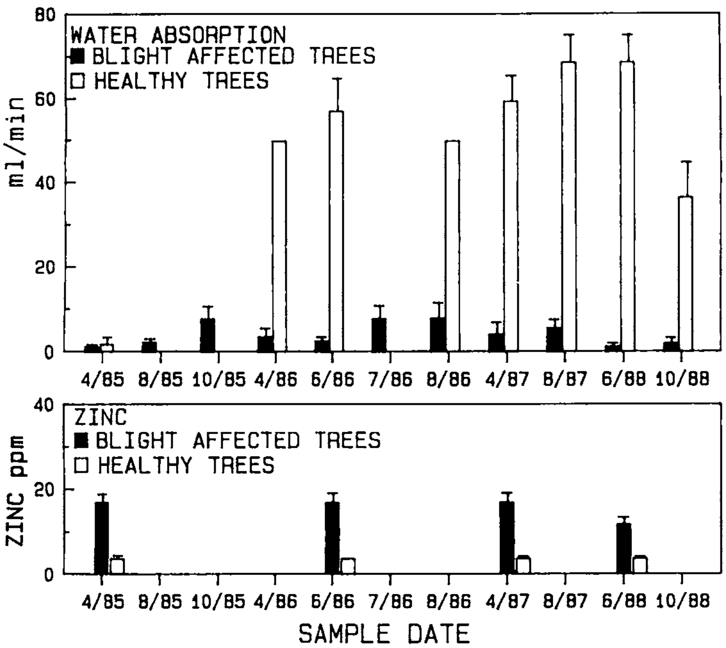

Fig. 5. Water uptake in syringe injection and wood zinc levels of 'Valencia' on rough lemon trees in Arcadia. Lines on top of the bars show standard error of the mean.

diagnosis of tree status when there are no visible symptoms and when the water injection test is not backed up with a zinc test. The cause for variation in water uptake is not clear and probably will not be found until the cause of blight is known.

Acknowledgement

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ECONOMIC COMPARISON OF SOUTHERN AND NORTHERN CITRUS PRODUCTION IN FLORIDA

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Abstract. **After the December 1983 and January 1985 freezes, Florida's Citrus Industry was in a state of transition with respect to planting decisions. Central to production decisions was the relative efficiency of Florida versus other supply sources. In addition, the freezes prompted Florida growers to question the relative advantages of production in northern and southern locations. The long-run aspect of investment in citrus for the competing regions in the state was addressed in a 1985 FSHS paper. This paper discusses the relative costs of production, provides detailed budgets, and re-evaluates some of the important risk factors associated with production in the two areas. New data has allowed for improved analysis of grower investment decisions among production areas.**

Beginning with the four tree-killing freezes of the early-to-mid 1980's, the Florida Citrus Industry has experienced a wide variety of changes in the past decade. With change comes uncertainty, and uncertainty impacts directly on the decision-making environment confronted by citrus growers and others considering investing in citrus.

Examples of change include the rapidly-expanding citrus plantings in South Florida on the flatwood soils of the lower east coast and Southwest areas of Florida in conjunction with the replanting of frozen groves in North Florida, also known as the "Interior" production area. The industry has also witnessed changes in cultural practices which have had unprecedented impacts on grove productivity in the past five years. These changes include denser tree-spacing, topping and hedging, microsprinkler and drip irrigation and fertigation, cold protection and new varieties and rootstocks.

Changes occurring beyond the grove also impact citrus investment decisions. Consumer issues are becoming more

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important. Concerns over food safety and resulting *chemophobia* can suddenly shift demand for specific agricultural products. Also, future labor availability is becoming more of a concern. In addition, growers face increasing environmental constraints in terms of water-use permits, water availability and quality issues, chemical availability and the impact on production and profit of reduced chemical inputs.

Trends and events which impact citrus markets and the marketing of citrus influence price and thus citrus investment decisions. The markets in which fresh and processed citrus products are sold are changing. For example, consumer purchasing patterns are changing in terms of preference for convenient ready-to-serve juices over frozen concentrated juices (2). This shift enables imported juice to compete favorably in some U.S. markets due to the reprocessing of imported FCOJ in dairy processing facilities in the Northeast United States. Consumer demand for variety is being met through a proliferation of fruit juice blends and drinks as well as imported fruits from the Southern hemisphere during the fresh citrus marketing season. Increased competition for consumers' expenditures on liquids is also being realized from soft drinks and bottled water. In addition, forecast increases in orange-juice production in Brazil and Florida during the next decade are expected to exceed world orange-juice consumption at recent price levels creating downward price pressure during the first half of the 1990's. The last half of the 1990's is expected to see increases in real prices for orange juice but not as high as 1988-89 price levels (1).

International economic and political factors are having increasingly significant impacts on the economic health of the Florida Citrus Industry (3). In addition to macroeconomic forces which manifest in currency exchange rates, international trade issues which will potentially impact citrus-investment decisions include trade negotiations such as GATT, the U.S.-Israeli free trade agreement, Japanese market access, the uniting of Europe into one trading area, and potential reductions in the U.S. citrus tariff structure. Thus, international issues may significantly affect the future profitability of the Florida Citrus Industry.

There are many reasons for focusing attention on citrus investment decisions, including the planting or replanting of a grove, location of the grove investment, as well as cultural and management practices designed to maximize profit and return-on-investment. Investment decisions will depend on goals of the investor, available resources (both financial and physical), expected returns and risk. In the absence of perfect foresight, sound investment planning and management decisions will be the keys to maximizing the potential for profit in the future. While many factors enter the citrus-investment decision matrix, this paper focuses on a comparative analysis of the decision to invest in orange groves in the southern and north-central growing regions of Florida.

Comparative Cash-Flow Analysis

Citrus grove investments in South Florida and North Florida are analyzed using fifteen-year cash-flow budgets to determine the profit potential for citrus enterprises in these two regions. For illustrative purposes, 'Hamlin' oranges are assumed to be planted on purchased land in each region. Assumptions used in the analysis are presented in Table 1.

Land preparation costs differ between regions. The cost of land in South Florida is assumed to be $2050 per acre while in North Florida it is $3450 per acre. However, each acre purchased cannot be totally planted. It is assumed in this analysis that only 70 percent of a South Florida acre will be planted in grove but that 95 percent of a North Florida acre will be planted. The unplanted land in each region must go toward ditching, canals, retention ponds, etc. The actual land acquisition, preparation, and irrigation costs on a planted acre basis total $5786 in the South and $5350 in the North. These costs are higher in the South despite less expensive land costs because of higher land preparation costs and the lower proportion of purchased and that can actually be planted to grove.

Groves in both regions are planted at a density of 150 trees per acre. Annual tree losses, tree removal costs, and tree planting costs for each region are presented in Table 1.

Average tree loss rates for all trees are 2.01% in the North and 2.23% in the South. The assumed yields used in this analysis are presented in Table 2. An analysis conducted in 1985 (4) assumed that South Florida had a substantial tree-growth-advantage that would increase fruit yields in the region above expected North Florida yields by 9.5 percent. However, actual observation of new plantings in the North and South regions during the past five years indicates no real growth advantage in the South when the same cultural and management practices are used. Also, some growers believe that actual per-tree yields in the North may exceed those in the South between ten and fifteen years after planting. Consequently, yields are assumed to be the same for both regions in this analysis (Table 2). Yields in the North region are reduced six percent, however, to account for the probability of yield loss due to freezes.

Citrus trees are assumed to yield no fruit until year 4 in this analysis because the first year of the investment

Table 1. Grove Assumptions Used in Investment Analysis.

	South Florida	North Florida
Proportion of Land Planted	70%	95%
Initial Capital Investment per Planted Acre:		
Land[z]	$2,929	$3,632
Land Preparation	$1,857	$ 368
Irrigation[y]	$1,000	$1.350
Total:	$5,786	$5350
Value of 15 year old grove per acre	$12,500	$12,500
Trees Planted Per Acre	150	150
Annual Tree Loss:		
Years 1-3	2.50%	2.50%
Years 4-10	1.75%	1.50%
Years 11+	3.50%	3.00%
Annual Expected Freeze Loss in Yield	0	6%
Tree Removal Cost	$3.00	$3.00
Planting Tree Cost (Tree, Wrap, Stake, etc.)		
Solidset	$5.00	$6.75
Reset	$6.31	$8.06

[z]South Florida Land Cost per planted acre is $2050 ÷ .70. North Florida Land cost per planted acre is $3450 ÷ .95.
[y]Irrigation costs are for microsprinkler systems and include well, pump, tubing, sprinklers, and controls.

Table 2. Assumed yield used in investmnt analysis.

Tree Age (yr)	Pound Solids Per Box (lb)	Boxes per Tree[z]
1	0	0
2	0	0
3	0	0
4	4.50[y]	.50
5	5.00	1.00
6	5.25	1.60
7	5.50	2.50
8	5.75	3.30
9	6.00	4.25
10	6.00	4.75
11	6.00	5.25
12	6.00	5.50
13	6.00	5.50
14	6.00	5.50
15	6.00	5.50

[z]North Florida yields are reduced 6% to account for the probability of yield losses due to freeze.
[y]Trees are not planted until year 2. Year 1 activities include land preparation and permit acquisition.

involves only land and permit acquisition and land preparation activities. Trees are not set until year 2 of the analysis.

Grove care costs for young trees are presented in Table 3 (5, 6). These costs are similar for both regions, varying eight cents per tree at most. Grove care costs for a mature 'Hamlin' orange grove used in this analysis are presented in Table 4. Total costs differ by only $10 per acre across regions. However, individual input expenses vary substantially. Cultivation and herbicide and irrigation expenses are higher in the South, while spraying costs are higher in the North.

Fifteen year cash flow budgets are presented in Table 5 and Table 6 for South and North Florida, respectively. The assumed price received by growers is $1.20 per pound solids delivered-in with a pick and haul cost of $1.75 per box. Net annual operating income is negative for both groves until year 6. However, as the groves mature, net cash operating income reaches a level of about $3000 per acre by year 11, which continues through the mature life of the grove. The South Florida grove is slightly more profitable despite marginally higher production costs. This is because of the yield differential assumed between regions to account for freeze probabilities.

When the original investment cost is included in the first year of the analysis, the annual net cash flow for that year decreases. This decreases the cumulative net cashflow through the life of the grove investment. This can be seen in Table 5 and Table 6. Also, the net cash flow includ-

Table 3. Annual Grove Care Costs for Young Trees.

	Year 1	Year 2	Year 3	Year 4
	per tree			
Solidset				
South Florida	$3.31	$3.77	$3.62	$3.66
North Florida	$3.27	$3.74	$3.57	$3.58
Reset	$2.13	$2.47	$1.84	—

Table 4. Annual Grove Care Costs for a Mature Orange Grove.

	South Florida	North Florida
Cultivation and Herbicide	$174.01	$134.35
Spraying	146.75	208.84
Fertilization	150.79	162.26
Hedging	24.54	20.94
Irrigation and Ditch Maintenance	140.61	102.08
Miscellaneous (5%)	31.83	31.42
Supervision and Overhead (10%)	66.85	65.99
Total	$735.39	$725.88

ing the initial investment outlay is presented graphically in Figure 1. Both groves begin to have a positive cash flow in year 6. However, all establishment costs are not recovered until much later in the life of the grove. The cumulative cash flows for both groves are presented in Figure 2. Cumulative cash positions do not become positive until year 11 of the life of the grove in the analysis. After that point, cumulative returns per acre from the mature grove are significant.

Investment Analysis

The cashflow analysis presented to this point has assumed that prices and costs will remain constant over the life of the investment. This inflationless scenario is fairly unrealistic. However, it is preferable to analyze citrus investment in constant dollars rather than assume some constant inflation rate. Further, the analysis has ignored the time value of money. A dollar received today is worth more than a dollar received ten years from now, because the dollar received today can be invested. One dollar put in a savings account earning six percent interest would be worth $1.79 ten years from now. Similarly, a dollar received in ten years would be equivalent to only 56 cents today. It is important, then to discount future costs and returns so that all dollars spent or earned over the life of the investment are put in terms of current dollars for comparison purposes.

If the cash flow analysis presented earlier is discounted so that all returns are in present dollars, the results change significantly. A comparison of the cumulative returns for the South Florida grove presented earlier in Figure 2 with those same returns discounted using five and ten percent discount rates is presented in Figure 3. If no discounting is used, then cumulative returns become positive in year 11, as before. When returns are discounted at a rate of five percent, cumulative returns don't become positive until year 12. Finally, when returns are discounted at a ten percent rate, cumulative returns remain negative until year 14.

The final cumulative net cash positions at the end of year 15 for the three scenarios differ greatly. In nominal dollars, the citrus grove will have generated $16,190 above costs per acre over the fifteen years. When the cash flow is discounted at five percent it is reduced to $6251 in present dollars. When it is discounted at ten percent it generates a present value of only $1070 above costs per acre.

Two points should be made here. First, future returns should be discounted in this type of analysis because of the time value of money. This method allows comparison among competing investments with different cash-flow

Table 5. Cash budget analysis for establishing a 'Hamlin' orange grove in South Florida—per acre.

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15
	(dollars)														
Adjusted gross revenue	0	0	0	260	598	1017	1677	2338	3172	3562	3959	4137	4163	4214	4287
Operating expenses															
Grove care costs	0	506	577	557	566	574	593	630	667	676	693	701	718	735	735
Tree replacement costs	0	31	45	55	46	42	29	38	37	37	61	65	67	65	62
Plant young trees—solidset	0	750	0	0	0	0	9	0	0	0	0	0	0	0	0
Property taxes	15	16	17	19	20	22	23	25	27	29	31	33	36	38	41
Interest on operating costs	1	78	38	38	38	38	39	42	44	44	47	48	49	50	50
Total operating expense	16	1381	678	668	669	676	694	735	775	785	832	848	871	889	889
Net annual operating income	–16	–1381	–678	–408	–72	341	983	1603	2397	2777	3128	3289	3293	3325	3397
Less: initial cap. investment	5786	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual net cash flow	–5802	–1381	–678	–408	–72	341	983	1603	2397	2777	3128	3289	3293	3325	3397
Cumulative net cash flow	–5802	–7182	–7860	–8269	–8340	–7999	–7017	–5414	–3017	–241	2887	6176	9469	12793	16190

Table 6. Cash budget analysis for establishing a 'Hamlin' orange grove in North Florida—per acre.

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15
	(dollars)														
Adjusted gross revenue	0	0	0	221	542	952	1566	2177	2971	3346	3727	3905	3936	3989	4060
Operating expenses															
Grove care costs	0	492	563	537	539	556	568	594	630	642	678	690	702	726	726
Tree replacement costs	0	33	45	58	45	40	37	36	36	35	60	64	65	63	61
Plant young trees—solidset	0	1013	0	0	0	0	9	0	0	0	0	0	0	0	0
Property taxes	15	16	17	19	20	22	23	25	27	29	31	33	36	38	41
Interest on operating costs	1	93	38	37	36	37	39	42	44	44	47	48	49	50	50
Total operating expense	16	1646	663	651	641	655	666	694	734	748	814	834	851	877	878
Net annual operating income	–16	–1646	–663	–430	–99	297	901	1483	2237	2598	2913	3072	3085	3112	3181
Less: initial cap. investment	5350	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual net cash flow	–5366	–1646	–663	–430	–99	297	901	1483	2237	2598	2913	3072	3085	3112	3181
Cumulative net cash flow	–5366	–7012	–7675	–8105	–8204	–7907	–7006	–5523	–3287	–689	2224	5296	8381	11493	14674

patterns. When returns are discounted, the analysis changes substantially. Second, the results of the analysis depend on the discount rate used. Since inflation does not enter this analysis, perhaps the five percent discount rate should be used. However, the rate used by an individual investor should be similar to the return that can be generated above inflation in other alternative investments. If, for example, a potential investor could generate a ten percent return on an investment above inflation, then the citrus investment should also be analyzed using a ten percent discount rate to offer an accurate comparison.

Sensitivity Analyses

The preceding analysis is based on the assumption that the grove investor must purchase land. Many individuals

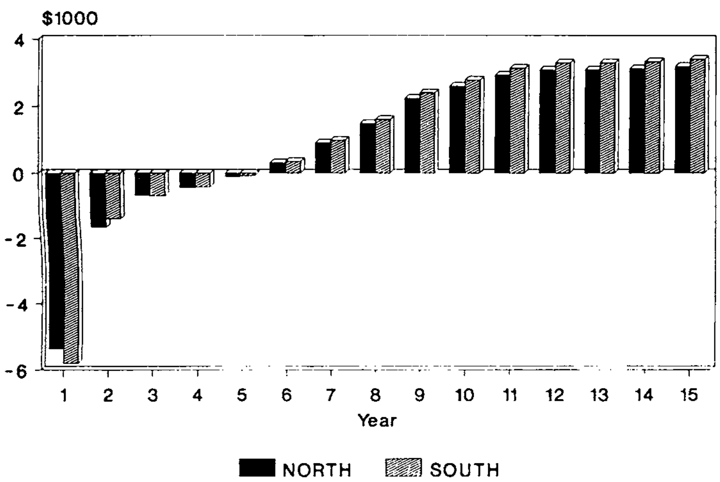

Fig. 1. Net Cash Flow per Acre.

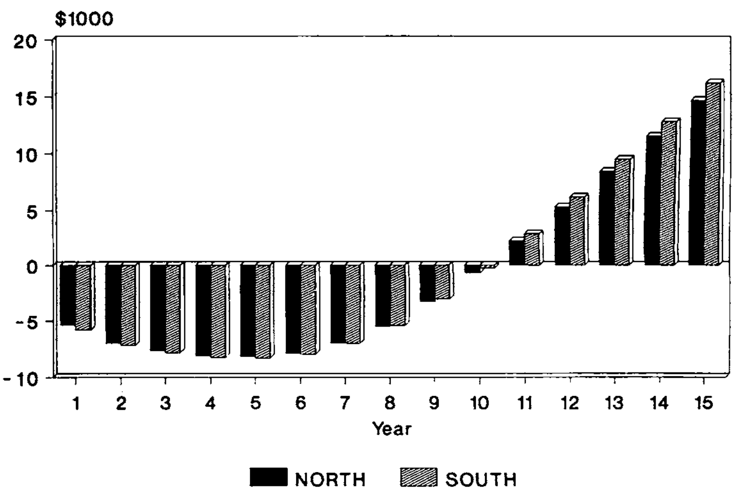

Fig. 2. Cumulative Cash Flow per Acre.

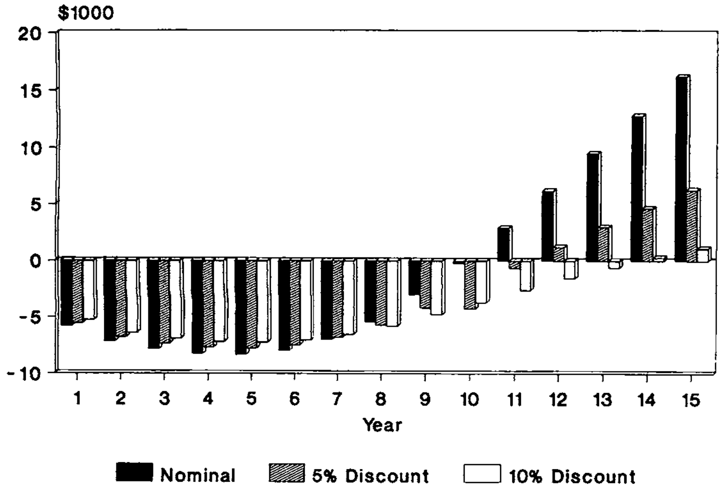

Fig. 3. Cumulative Grove Returns. South Florida—Nominal and Discounted.

Table 7. Sensitivity of Grove Returns to Price.

Price[z]	South	North
	----- Internal Rate of Return (%)-----	
$1.20	11.59	11.02
$1.10	9.61	9.03
$1.00	7.35	6.70

[z]$ per pound solids.

Table 8. Sensitivity of Grove Returns to changes in Production costs.

Changes (%)	South	North
	----- Internal Rate of Return (%) -----	
+20	9.95	9.28
+10	10.77	10.15
—	11.59	11.02
−10	12.42	11.90

already own land that is suitable for citrus production. Also, there are groves in North Florida that still have not been replanted after the killing freezes in the early to mid 1980's.

The investment analysis presented above was repeated under the assumption that the investor owns land suitable for citrus production. The cumulative, discounted, cash-flow comparison of the owned land versus purchased land cases is presented in Figure 4. Less capital is required in year 1 which results in a positive cumulative cash flow in year 10 when land is owned. This is two years earlier than when land is purchased.

The sensitivity of the investment analysis to the price per pound solids was also investigated. The results of this sensitivity analysis are presented in Table 7. The return on investment as measured by the internal rate of return (IRR) is substantial for both groves, although it is slightly higher for Southern groves. These rates of return are especially encouraging for citrus investors, since these are rates of return above inflation. Even when the price per pound solids falls to $1.00, the return on investment above inflation is still near seven percent.

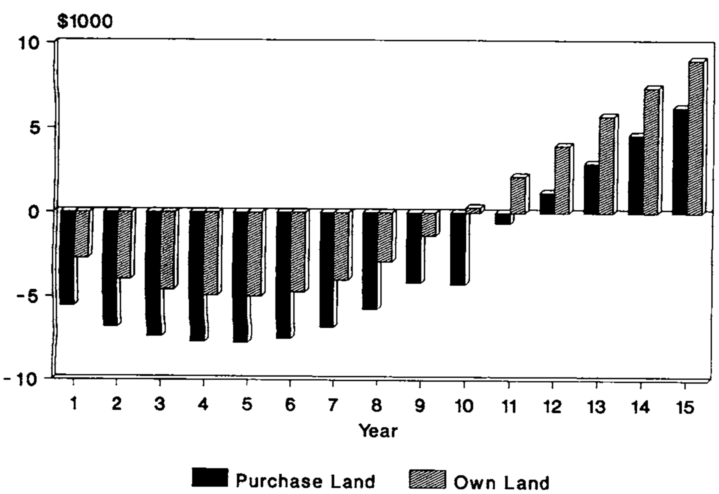

Fig. 4. South Florida Cumulative Returns. Own vs. Purchase at 5% Discount Rate.

An analysis of the sensitivity of the results to changes in total grove production costs also shows good rates of return to citrus investment, given the assumptions made in this paper. The results of this analysis appear in Table 8. If costs were to increase twenty percent above the levels used in this analysis, citrus investments would return between nine and ten percent above inflation, compared to the eleven percent return that would be realized under the base cost assumptions.

Finally, the value of the grove at the end of the fifteen year period has been excluded from this cash-flow analysis. A residual value of $12,500 was assumed to be the value of a fifteen year old grove to calculate a truer return on investment. This residual land value was not included in the earlier analyses because many individuals invest in citrus as part of an ongoing business, and would not consider selling the grove at the end of year 15. When the increase in the value of the grove is considered in the analysis, the internal rates of return above inflation are 14.75 percent and 14.41 percent for the South and North groves, respectively.

Conclusions

The decision to invest in a citrus grove is quite complex. Because of the long-term nature of the investment and the inability of investors to forecast the future with certainty, many assumptions must be made in order to analyze the profitability of the potential investment. Under the assumptions made in this paper, citrus production generates favorable rates of return relative to many other investment opportunities.

The decision of whether to invest in the North or South Florida regions must be left to individual investors. However, the results of this analysis suggest that citrus production in the South will return slightly more than it will in the North. This is primarily because of the reductions in yields assumed for Northern groves due to freeze risk. However, the method to account for freeze losses in this analysis is useful only in the long run. The real risk of freezes will be reflected in annual cash-flows. Individual investors must gauge their own ability to withstand the possibility of negative cash flows in production years which may lead to the loss of investment assets. This particular risk has not been incorporated into the analysis presented in this paper.

Finally, potential investors must recognize the time value of money when considering investment opportunities. It is demonstrated in this paper that real cumulative cash flows may not become positive until between twelve and fourteen years from the time land is purchased. Thus, investors looking for quick returns on their investments may want to consider something other than new citrus groves. Still, for individuals looking for long term investments, citrus groves offer the opportunity for substantial returns on investment.

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DEPOSITION OF DIFFERENT SPRAY VOLUMES ON CITRUS TREES

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Additional index words. citrus, airblast sprayer, copper, colorimetry, uniformity, sample location.

Abstract. **An FMC orchard air sprayer (Model 1087) was used to apply spray solutions at volume rates of 9,400, 4,700, 2,350, 940, and 470 liters/ha. The solutions contained Cupric Hydroxide as deposition tracer which was applied at the rate of 6.714 kg/ha to 6 × 6 tree plots of 'Valencia' orange in a randomized complete block layout with 4 replications. Leaf samples were taken from one quadrant of each of 4 center trees (from each plot), at 2 heights and 2 radii (outside and inside of the tree canopy). Tracer copper deposit per leaf surface area was determined by colorimetry.**

Mean copper deposit and variability of deposition (CV) increased as spray volume decreased. Deposition was greater, higher in the tree and on the outside of the canopy compared to lower level and inside the canopy. Interactions between spray volume and height and spray volume and radii were significant.

Citrus trees are routinely sprayed with insecticides, acaricides, fungicides, nutrients, and growth regulators using different types of sprayers and various combinations of spray volume, liquid pressure, and sprayer speed. Adoption of any spraying parameter combination is influenced by the sprayer characteristics, tree size, chemical formulation, nature of the spray target, spraying time, weather conditions, and overall economics of the application. A proper combination can result in substantial savings in material, labor, fuel, and machinery costs while providing satisfactory pest control with minimal environmental contamination.

While recommended dilute spray volume for Florida citrus ranges from 4,700 to 14,100 liters/ha for trees less than 3 m to more than 5.5 m in height (5), there has been a growing interest in low volume (concentrate) spraying in the past few decades.

Griffiths et al. (4), Stearn et al. (9), and Brooks et al. (2) used concentrated sprays to control citrus mites and scales. Overall, they found that a 6X concentrated spray at 1/8 dilute volume gave as satisfactory results as dilute spray; however, their results varied with different sprayers and spray materials.

Brooks and Whitney (3) compared 6 low volume sprayers with a standard high volume sprayer for spraying citrus. They found the latter superior to others for citrus rust mite control. Brooks (1), using a helicopter and a conventional airblast sprayer (94 vs. 11,750 liters/ha), found virtually no difference in rust mite control. However, the latter gave significantly better control of other pests and fungal diseases.

It is apparent from the literature that some combination of sprayer type, target pest, and pesticide formulation can give satisfactory pest control; however, it is not clear what is responsible for the success or failure of a spray application. To find an answer to this question, we attempted to quantify spray deposition on the tree canopy for different spray volumes and relate it to citrus rust mite control (7). We found that spray volumes ranging from 235 to 4,700 liters/ha did not have a significant effect on mean deposition and citrus rust mite control. In general, variability of deposition increased as spray volume decreased.

In view of the above findings, we conducted additional field studies in 1988 to validate previous results. The spe-

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