HORTICULTURAL CONSIDERATIONS OF CITRUS IRRIGATION

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Citrus in Florida is planted on sandy soils with low water holding capacity, making irrigation necessary despite an annual rainfall of 50-55 inches. Growers use irrigation to promote tree growth, increase fruit production, and enhance cold protection. Horticultural considerations of citrus irrigation are based on tree response to irrigation rates, timing, coverage, and management practices. Not all citrus cultivars respond to irrigation to the same extent. Research has shown that Hamlin orange, Marsh grapefruit, certain mandarins and hybrids will respond more to the same irrigation rates than will Valencia and Pineapple oranges. During periods of water shortage, cultivars that show more response to irrigation should receive higher priority than cultivars that respond less to irrigation.

1. Tree Growth. Tree growth expressed as the increase in trunk circumference of 4 cultivars under 4 irrigation rates over a 7 year period are summarized in Table 1. Trunk growth response to rain and irrigation in descending order are Marsh grapefruit, Hamlin, Valencia and Pineapple oranges. Trunk growth of Marsh grapefruit and Hamlin orange varied directly with increasing rates of irrigation. Trunk circumference growth of Valencia and Pineapple oranges showed essentially no difference between irrigation rates of 82 and 112 inches over a 7 year period.

To evaluate the efficiency of rain and irrigation water on tree growth, trunk circumference increase was calculated for each inch of water applied whether it came from rain only or from rain plus irrigation. The data show that rain plus irrigation had higher efficiency in tree growth than rain alone. The data also show that different irrigation rates did not affect the horticultural efficiency (growth or yield per inch of water) of the cultivars except Hamlin orange. With Hamlin, horticultural efficiency in trunk growth increased with increasing rates of irrigation.

2. Fruit Production. Fruit production increased with irrigation, but there was a wide difference in the magnitude of response among the different cultivars (Table 2). Trends in fruit production are similar to that found in tree growth. In terms of fruit production, Marsh grapefruit and Hamlin orange respond more to irrigation than do Valencia and Pineapple oranges.

From the standpoint of fruit production, horticultural efficiency increased with irrigation over the non-irrigated control, but as irrigation rates increased, the efficiency per unit of water decreased. The highest horticultural efficiency was at 5.6 inches per year (28 inches over a 5 year period). Total production and growth were usually greater with higher irrigation rates. However, yield per unit of water applied decreased with irrigation rates above 28 inches over this 5 year period. Fruit price and irrigation cost will determine if higher rates of irrigation are justified. With higher fruit prices, additional irrigation would give additional profits, but with low fruit prices, additional irrigation may not be economically justified.

3. Juice Quality. Most Florida citrus is sold on the basis of pounds of soluble solids. Irrigation will increase fruit production and often increase the soluble solids, but irrigation can also dilute the juice and decrease the soluble solids. This is well illustrated with Hamlin orange in both the boxes per acre and yield of soluble solids per inch of water at the two high irrigation rates (Tables 2 and 3). With Hamlin, note that both total soluble solids yield and yield per inch of water decreased at the highest irrigation rate (Table 3). Excessive irrigation should be avoided for processed fruit. It is a challenge to manage the irrigation and fertilization programs to produce the maximum soluble solids per acre. Fruit price and the cost of irrigation will dictate the best management practice to use.

Horticultural Considerations of Citrus Irrigation Systems

Comparisons were made for drip, jet (microsprinkler), and overhead sprinkler irrigation systems in separate and combination studies. These investigations showed fruit production was increased with all 3 irrigation systems (Table 4). The horticultural efficiencies of the irrigation systems clearly favors the sprinkler irrigation system. Fruit production per inch of water for the non-irrigated controls varied from 5.6 to 6.4 boxes per acre. For drip and jet irrigation systems, they ranged from 6.6 to 6.7 and 6.2 to 7.1 boxes per acre respectively. Sprinkler irrigation ranged from 7.6 to 9.7 boxes per acre. These data show the importance of ground covered by the irrigation water. The sprinkler irrigation system covered 100 percent of the ground. It is apparent that the drip and jet irrigations in these studies did not provide enough ground coverage. The lack of coverage cannot be made up by applying more water, as shown by the lower horticultural efficiencies of drip and jet irrigation systems.

In citrus, economic and environmental considerations will not permit us to go back to sprinkler irrigation. Improvement in the design of the drip and jet irrigation systems should be made. Once an inadequately designed system is installed, there is not much a grower can do to improve the management of that system.

Management of drip and jet irrigation systems is more critical than sprinkler irrigation systems. Drip and jet irrigation systems are supposed to conserve water and maximize fruit production. It is our observation that too many growers are over irrigating with drip and jet irrigation systems and therefore not attaining as much water conservation as these systems are designed for. The management of drip and jet irrigation systems can be improved. Ways to improve management are to start with a properly designed system and irrigate for moderate durations that do not drive water below the main rooting zone.

References

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Table 1.

Effects of rain and irrigation of growth of trunk circumference of oranges and grapefruit (Total over 7 years).

		Valencia		Pineapple		Hamlin		Marsh	
Total Rain	Total Irri- gation	Total growth	Growth per inch of water	Total growth	Growth per inch of water	Total growth	Growth per inch of water	Total growth	Growth per inch of water
inches		inches		inches		inches		inches	
334	0	4.2	0.013	2.2	0.007	5.1	0.015	6.8	0.020
334	36	5.1	0.014	4.6	0.012	6.1	0.016	7.7	0.021
334	82	6.4	0.015	5.0	0.012	7.2	0.017	8.2	0.020
334	112	6.5	0.015	5.1	0.011	8.6	0.019	10.0	0.022

Table 2.

Effects of rain and irrigation on fruit production
of oranges and grapefruit (average yield per year over 5 years)

		Valencia		Pineapple		Hamlin		Marsh	
Average Rainfall	Average Irrigation	Yield per year	Yield per inch of water	Yield per year	Yield per inch of water	Yield per year	Yield per inch of water	Yield per year	Yield per inch of water
inches		Boxes/acre		Boxes/acre		Boxes/acre		Boxes/acre	
48.2	0	379.4	7.9	410.6	8.5	647.2	13.4	791.6	16.4
48.2	5.6	466.6	8.7	455.8	8.5	768.4	14.3	1003.4	18.6
48.2	12	485.4	8.1	462	7.7	856.4	14.2	1075.6	17.9
48.2	18.4	520.4	7.8	493.2	7.4	865.6	13.0	1109.2	16.7

Table 3.

Effects of rain and irrigation on yield or soluble solids of orange and grapefruit (average yield per year over 5 years).

		Valencia		Pineapple		Hamlin		Marsh	
Average Rainfall	Average irrigation	Yield per year	Yield per inch of water	Yield per year	Yield per inch of water	Yield per year	Yield per inch of water	Yield per year	Yield per inch of water
inches		Pounds/acre		Pounds/acre		Pounds/acre		Pounds/acre	
48.2	0	1932	40.1	2002	41.5	3084	63.9	3016	62.6
48.2	5.6	2282	42.4	2100	39.0	3591	66.7	3752	69.7
48.2	12	2338	38.8	2058	34.2	4116	68.3	3962	65.8
48.2	18.4	2506	37.6	2390	35.9	3913	58.7	4011	60.2

Table 4.

A comparison of horticultural efficiencies of drip, jet and overhead sprinkler irrigation systems.

Irrigation system	Emitters per acre	Cultivar	Duration	Average Rainfall	Average Irrigation per year	Yield per year	Yield per inch of water
			Years	Inches		Boxes/acre	
NI control	0	Valencia	5	51.4	0	328.8	6.4
Sprinkler	16			51.4	5.4 (sprinkler)	432.8	7.6
				51.4	11.8 (sprinkler)	482.4	7.6
NI control	0	Valencia	5	50.4	0	301	6.0
Drip	388			50.4	13.4 (drip)	429	6.7
Jet	194			50.4	29.8 (jet)	494	6.2
NI control	0	Marsh	4	51.75	0	350	5.6
Drip	280			51.75	5.75 (drip)	377	6.6
Jet	140			51.75	7.25 (jet)	421	7.1
Sprinkler	17			51.75	10.5 (sprinkler)	601	9.7

NI = No Irrigation