emitters is 40 percent of the area under the tree canopy.

The solution is:

$$D_R = (0.623)\ (0.25)\ [\pi\ (11.0^2] \quad [1]$$
$$= 59 \text{ gallons per tree per day}$$

Area to be wetted is

$$0.40\ [\pi\ (11)^2] = 152 \text{ ft}^2 \text{ per tree}$$

If the area wetted by a single emitter is 64 ft.^{2} [π $(4.5)^2$ for medium soil] then

$$N = \frac{152}{64} = 2.38 \text{ or } 3 \text{ emitters per tree.} \quad [2]$$

and

$$T = \frac{59}{(1)\ (3)} \cong 20 \text{ hours per day} \quad [3]$$

Summary

Interest in drip irrigation is growing rapidly in Florida. Design criteria for drip irrigation had its beginning in arid regions of the world, and while it has been extrapolated for use in humid regions, its suitability for application in Florida is considered marginal, at best.

The paper presents an analysis of criteria for design of drip irrigation in both humid and arid regions. Rationale for these two concepts is that root distribution and water needs are completely different for each situation, therefore, design may logically be based upon different factors.

Future research in both humid and arid regions should provide information leading to better solutions to drip irrigation design problems.

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MEASURE OF WATER STRESS IN CITRUS

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Abstract. **The Scholander pressure bomb was successfully used to measure water stress of 'Orlando' tangelo trees growing on different stocks. The water stress appeared to be dependent on the stock used. 'Orlando' tangelos growing on sour orange were under a greater water stress than those on sweet lime. Leaves of trees with citrus blight and "young tree decline" (YTD) were under a greater water stress than leaves from healthy trees.**

This study was supported in part by the Florida Water Resources Research Center, through the Office of Water Resources Research under Category B, Matching Grant B-014-FLA.

An increase in plant-water stress (decreasing plant-water potential) occurs when an imbalance exists between the amount of water absorbed by the roots and the amount lost through transpiration. The degree of stress that develops is a function of the plant's environment. The Scholander pressure bomb can be used to measure plant-water potential under field conditions (3). The potential is high during dark periods and decreases rapidly as transpiration increases during the day (2). The use of the pressure bomb for measuring water potential in citrus has been shown to be feasible (1). The method, however, has not been used to evaluate differences in water potential which might exist as the result of different stocks or stress induced by pathological water disturbances.

Methods and Materials

The instrument was essentially that designed by Scholander (3) with slight modifications. The chamber (Fig. 1D) was machined from a solid block of aluminum with additional brass fittings to compress a rubber disk around the petiole of the leaf to be tested. Other components consist of a pressure regulator (Fig. 1B), intake and outlet valve (Fig. 1E & F) and gauge (Fig. 1C).

The pressure regulator was added to protect the gauge from excessive pressures, and for adjusting the gas flow when low stress values were measured.

A leaf was first excised from the tree using a razor blade. Care was taken to choose a mature leaf from a non-bearing twig and one that was not exposed to direct rays of the sun. The leaf petiole was then placed in the rubber disk (Fig. 2) and the set screws were tightened to form a gas-tight seal. Care was exercised not to apply excessive pressure to the screws because this might have crushed the petiole at the seal and thus given a higher-than-actual reading. (This process requires some experience to learn the appropriate tension to apply to the screws.)

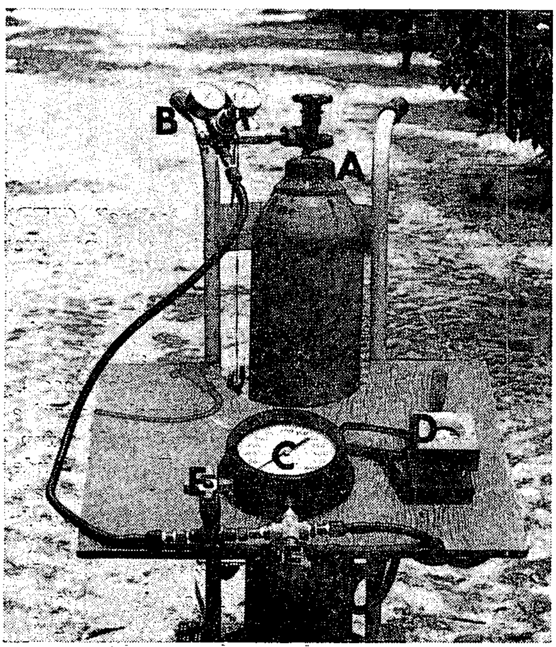

Fig. 1. Portable "Pressure Bomb" showing nitrogen tank (A), pressure regulator (B), gauge (C) for reading pressure in sample chamber (D), valve (E) for letting compressed nitrogen into chamber and outlet valve (F) for exhausting the nitrogen from the chamber after reading has been taken from gauge (C).

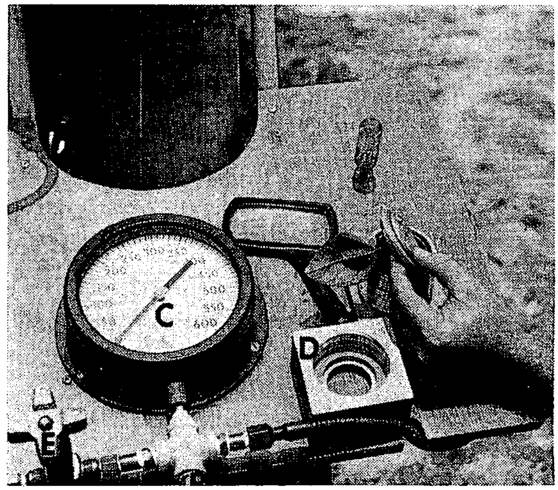

Fig. 2. Close-up of gauge (C) and leaf being placed in chamber.

The top of the cylinder was then tightened onto the disk and gas was introduced into the chamber by the intake valve (Fig. 1E). The operator used a magnifying glass to observe the first appearance of liquid in the xylar tissue (Fig. 3). A reading in pounds per square inch (psi) was taken from the pressure gauge and recorded.

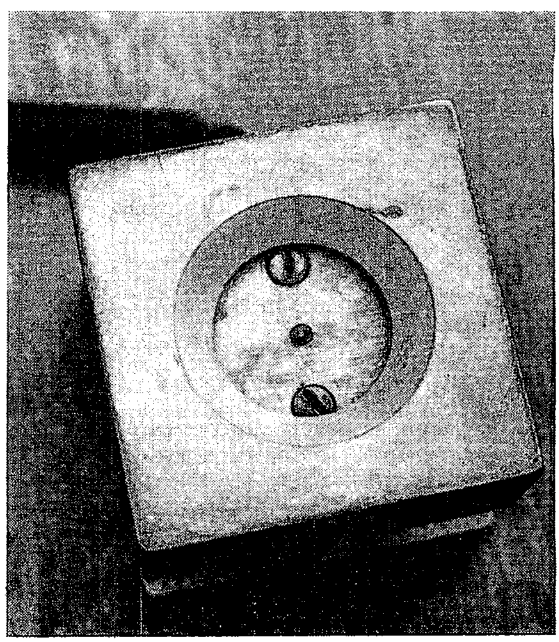

Fig. 3. Close-up of chamber showing the cut petiole of the leaf protruding through the hole in the cover of the chamber.

(These readings were then converted to Bars by dividing the gauge reading by 14.7 psi per Bar.) The pressure cylinder was then purged through the outlet valve and the cylinder top was removed to allow the leaf to be removed from the gasket to prepare for another leaf.

Trees from 3 locations were used in this study. Two 'Orlando' tangelo trees on sweet lime and 2 on sour orange, all thrifty in appearance, were selected from the IFAS Horticultural Unit near Gainesville. Four 'Valencia' trees on rough lemon stock, 2 with and 2 without YTD symptoms, were selected from the Cloud grove near Fort Pierce. The second group of 4 'Valencias' on rough lemon was from the Fort Pierce Agricultural Research Center. Two of these trees were diagnosed as having citrus blight.

Pressure bomb readings were taken at intervals of 2 to 5 minutes from each of the 4 tree quadrants sampled. Leaves were taken alternately from healthy and diseased trees until the 4 quadrants of all trees were sampled. Only representative results from trees at 3 locations are cited here. Considerable additional data was taken which further substantiated the findings reported.

Results and Discussion

Pressure bomb measurements made on leaves of 'Orlando' tangelo on sweet lime and sour orange stock in November, 1972 were under 2 different environmental conditions. Conditions referred to as moderate stress are representative of a clear day at 12 noon. Low stress was a partly cloudy day when soil moisture was near field capacity. Under both conditions water stress was greater on 'Orlando' growing on sour orange than on sweet lime (Table 1). This is not conclusive evidence that trees on these 2 rootstocks will differ consistently because the sample size was small. The consistent readings, however, suggest the pressure bomb might be a valuable instrument for evaluating rootstocks.

Plant-water stress was also measured on 2 trees with YTD and 2 healthy trees on February 15, 1972. All trees were 12 years old. These measurements were made several times during the day. The first measurement at 11:40 A.M. was on a clear day, referred to as a high stress day. Shortly after noon a cloud cover moved in, temperatures (80° F.) leveled off and atmospheric demand (stress) decreased. When readings were made during the high stress period, water stress on trees with YTD was over 2 times as great as that of healthy trees (Table 2). Readings taken in the afternoon indicated less stress as would be expected under cloudy conditions. However, trees with YTD were under a greater stress than healthy trees. As environmental conditions changed, stress in the trees changed within a matter of 2 to 3 minutes.

Temperature conditions changed rapidly and on

Table 1. Leaf-water potential of 'Orlando' tangelo on different rootstocks measured with the Scholander pressure bomb (in -Bars)[z]

Tree	Sweet Lime - - Quadrant - -				Av.	Tree	Sour Orange - - Quadrant - -				Av.
Moderate Atmospheric Stress Condition											
1	9.5	11.9	9.5	10.5	10.4	1	15.9	13.9	17.7	15.6	15.8
2	9.5	9.9	8.8	10.8	9.8	2	15.9	16.6	14.9	18.3	16.4
Low Atmospheric Stress Condition											
1	7.1	8.2	7.5	9.2	8.	1	10.5	12.9	13.9	13.6	12.7
2	8.2	8.5	6.8	8.2	7.9	2	9.5	11.5	12.2	11.5	11.2

[z]As plant-water stress increases, measured leaf-water potential decreases. All values in the table have a minus sign.

Table 2. Leaf-water potential of healthy and YTD affected 'Valencia' on rough lemon measured on February 15, 1973 (in -Bars)

Tree	Condition	Start Time	Quadrant NE	SE	SW	NW	Av.
1	YTD (1.0)[y]	1150	21.	14.	12.	14.	15.
		1420	6.8	9.9	12.	10.	9.7
		1645	9.2	6.8	6.5	7.8	7.6
		2300	2.4		5.1		3.4
2	Healthy	1150	10.2	7.5	6.5	6.8	7.7
		1420	6.8	6.1	9.5	11.	8.3
		1645	4.8	6.5	6.8	4.4	5.6
		2300	2.7		2.7		2.7
3	YTD (1.0)	1215	7.5	8.2	15.	10.	10.
		1450	11.	8.5	9.9	7.8	9.3
		1700	8.2	8.2	7.8	8.8	8.3
		2310	2.7	4.4	4.4		3.9
4	Healthy	1215	7.5	7.5	7.5	7.1	7.4
		1450	8.2	10.	8.2	8.5	8.8
		1700	4.4	4.1	6.8	6.8	5.5
		2310	3.1		2.0		2.6

[y] A rating of 1.0 represents a tree with some defoliation and die back, but the complete original outline of the tree is still clearly visible.

February 16 averaged 50° F. with relative humidity between 80 and 100%. Measurements were made comparing water stress of healthy and trees with citrus blight. Trees with citrus blight, 23 years of age, showed greater water stress than healthy-appearing trees (Table 3). Since the water stress was greater for the trees that were affected by blight or YTD, this would suggest that the vascular system supplying the leaves with water had been restricted.

Table 3. Leaf-Water potential of 'Valencia' on rough lemon, with and without citrus blight, measured at 12:30 P.M., February 16, 1973 (in -Bars)

Condition	Quadrant NE	SE	SW	NW	Av.
Healthy	9.5	5.1	5.4	5.7	6.5
Blight	15.	11.	20.	19.	16.
Healthy	8.5	7.5	9.2	6.8	8.0
Blight	13.	14.	19.	14.	15.

Clearly, water stress in 'Orlando' tangelos was related to the rootstock under the conditions of this experiment. Measurements taken under many different conditions always showed this difference to be consistent. Thus, it appears that the Scholander pressure bomb may serve as a tool for quantitizing effects different rootstocks have on the leaf-water potential of the scion. Water stress of 'Valencia' trees on rough lemon stocks differed greatly between healthy and sick trees. Even greater differences in leaf-water potential than those measured between healthy and YTD infected trees might have occurred if the YTD trees had not had fewer and smaller leaves. Thus, a disturbance in translocation of water may have already resulted in a partial defoliation of the YTD trees.

The Scholander pressure bomb can only be considered as one tool to aid in better understanding how a tree is affected by a particular pathological disturbance or different rootstock.

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ECONOMIC STRATEGY FOR REHABILITATING, SELLING, OR ABANDONING A 'VALENCIA' GROVE UNDER VARYING SITUATIONS

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Abstract. **Florida citrus growers face pressures from increased urban development, rough lemon decline, and damage due to freezes. The economics of citrus production, focusing on decisions required in keeping an individual grove in production, in respect to these problems, is examined. A hypothetical grove, described by a number of different conditions, is considered and the options of rehabilitating, selling, or abandoning the grove are evaluated with comparisons of the present value of the stream of income for 10- and 20-year periods for each alternative.**

Unprecedented pressures are being exerted upon Florida citrus growers. Urban development, rough lemon decline, plus the recurrent possibilities of freeze damage make it imperative that the citrus grower take a long, hard look at the projected returns from his grove. He must decide whether or not to continue production and if so, how.

The purpose of this paper is to present an economic decision-making framework to assist the grower in evaluating the alternative courses of action that may be available. Since many of the decisions become irreversible, involve considerable expenditure and loss of production, careful analysis of the options must be made.

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Method of Analysis

The expected costs and returns from a hypothetical grove will be budgeted over 10 and 20 years and analyzed under varying conditions. The variables will be the level of freeze damage, rough lemon decline and land values. The options considered will be to do nothing, rehabilitate, sell or abandon. The annual returns will be discounted to their present value to enable comparisons from the same base. It must be strongly emphasized that, in an analysis of this type, assumptions play a dominant role and projections into the future involve great uncertainty.

The hypothetical grove consists of 'Valencia' orange on 'Rough' lemon rootstock, 30 years of age, planted 70 trees per acre on soil with no inherent problems. Five alternative conditions are explored: Case I, Normal; Case II, Freeze Damage; Case III, Rough Lemon Decline; Case IV, Sale of Grove; and Case V, Grove Abandonment.

Case I Normal. This situation, with no serious problems, serves as a standard base. Yield is taken at 5.5 boxes per tree and assumed constant throughout the 20-year period with an on-tree price of $1.87 per box (5). The production cost used is an average of operating costs as reported by Brooke (3). This cost includes expenditures for labor, machinery, fertilizer, spray, state and county taxes, and miscellaneous items. It does not include charges for interest on grove valuation, land or management.

Table 1 shows the computation of annual costs and returns from the grove for the first 10 years. A gross return per acre of $720 minus the $200 operating cost produces an annual return of $520. Discounting at 10% this annual stream of income to its present value (PV) results in a 10-year total of $3196 and a 20-year total of $4429. Discounting to the present value is neces-