tested provided satisfactory disease control after a single application. Even with four applications of CuOCl over a 20-day period, complete control was not achieved. Moreover, spray applications in the field every 5 days are not logistically feasible in Colima. No disease symptoms were noted on flowers or fruit of Mexican lime during the course of these experiments; therefore, no spray schedules designed for fruit protection are currently necessary. The objective of the spray program is to depress inoculum levels within groves, and to curtail grove-to-grove spread of MLB. Although increased defoliation was associated with higher dosages (5.0-7.5 g Cu/ml) of CuOCl, defoliation levels were significantly lower than those observed on nontreated control flushes. The higher PFL on control flushes (18.5-23.3%) suggest that some economic loss due to decreased fruit yield and tree vigor may result from high levels of MLB.

The observed level of MLB, as well as vegetative flushing incidence, are lowest during the warmer, rainy season (2, 4, 9). Therefore, spray applications may not be necessary during this period. Control strategy is complicated, however, by the sporadic nature and frequency of Mexican lime growth flushes. For optimum levels of disease control and inoculum depression, sprays should be frequently applied whenever flushes may occur (Oct.-June). Such a program is economically and logistically unfeasible over the entire MLB-infested area of Colima (1). Many growers cannot afford sprays or spray equipment; the federally-run campaign must apply them. Further experiments on epidemiological aspects of MLB, as well as on optimization of control using products such as CuOCl/maneb and zinc/maneb, may result in greater levels of MLB control in the field.

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RESPONSE OF YOUNG CITRUS TREES TO IRRIGATION

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Abstract. **Young 'Valencia' orange trees were grown in a field lysimeter system under grass and no grass cover conditions. Irrigations were scheduled using tensiometers at 6, 12 and 24 inch depths in the tree root zones. Three irrigation treatments were scheduled when soil water tensions reached 10, 20 and 40 cb. Irrigation application was approximately twice as much for the grass than the no grass treatments during the early stages of tree growth. This difference was reduced in later months as the trees grew and were responsible for a greater proportion of the water use from a lysimeter. For the no grass treatments, tree growth was greatest when irrigations were scheduled at 20 cb. For the grass treatments, tree growth was greatest at 40 cb. Overall, tree growth was greatest for the no grass, 20 cb irrigation treatment than for any of the other treatments.**

Citrus is by far the major agricultural crop produced in Florida. Until freezing temperatures killed over 200,000 acres between 1981 and 1985, approximately 850,000 acres were in production. Much of the acreage killed is being replanted, either at existing grove sites, or at new sites in south Florida where the danger of freeze damage is less. As new groves are replanted, almost all will be irrigated to both hasten growth and provide some freeze protection. There is a need for information on young tree water use and irrigation requirements. Growers require information on young tree response to irrigation so that they can optimize irrigation schedules and obtain productive groves as quickly as possible. Florida's water management districts require information on young tree water use for water use permitting, and to determine the effects of irrigation practices on regional water budgets.

Several studies (8, 9, 11, 12, 13, 14, 16, 18, 22) indicate that under Florida conditions significant yield increases result when citrus is irrigated. Soil water distributions and water extraction patterns under irrigated and non-irri-

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gated mature groves in Florida have been determined (2, 5, 7, 10, 15, 17) and several estimates of water requirements of mature citrus have been reported (4, 6, 13, 19, 23). Tucker (24) summarized citrus irrigation management practices required for Florida conditions.

Doorenbox and Pruitt (3) presented estimates of young citrus tree water use based on canopy size. Tucker and Youtsey (25) gave general irrigation requirements for citrus nurseries. However, irrigation requirements for young trees under Florida conditions have not been reported. The purpose of this study was to determine the effect of irrigation schedules on young 'Valencia' orange trees under grass and no grass cover conditions.

Materials and Methods

Twenty-four Valencia orange (*Citrus sinensis* (L.) Osb.) trees on sour orange (*C. aurantium* L.) rootstock were planted in field lysimeters on July 1, 1984. Trees were 2-years old when obtained from a commercial nursery, and planted bare root. The soil in the lysimeters was Arredondo fine sand (Typic Quartzipsamments). Prior to planting, the soil in the lysimeters and in the buffer areas immediately surrounding them was fumigated for nematode and weed control. A commercial 10-4.3-8.2 (% N,P,K) fertilizer was broadcast at the rate of 100 lb. of N per acre.

The field lysimeter system consisted of 24 drainage type lysimeters with automated shelters to cover them during rainfall. The lysimeters were cylindrical steel tanks, 64 inches in diameter and 6 ft deep. The tanks were buried to ground level. Ceramic plates and a vacuum system allowed drainage water to be pumped from them. The lysimeter system allowed trees to be isolated from the effects of rainfall and each other, yet all were subject to the same climatic conditions so that the effects of different water applications on tree growth could be studied. Complete details of the lysimeter system construction and operation were given by Smajstrla (21).

Both ground cover and irrigation scheduling treatments were imposed. Grass versus no grass cover treatments were studied. For the no grass treatment, the soil surfaces within the lysimeters were maintained bare. For the grass treatment, a cover of Pensacola Bahiagrass was established. In both cases, the land areas between the lysimeters and a 0.25 acre area surrounding the lysimeters were maintained with a well-irrigated grass cover.

Irrigations were scheduled using soil moisture tensiometers. Tensiometers were installed at depths of 6, 12, and 24 inches in each irrigation treatment. The three irrigation treatments were scheduled when soil water tensions reached 10, 20, and 40 centibars (cb) on any one of the three tensiometers per treatment. Soil water tensions of 10, 20, and 40 cb correspond to soil water depletions of 30, 45, and 55%, respectively, of the available soil water for the Arredondo fine sand. For all treatments, irrigations were scheduled to restore the upper 24 inches of the soil profile to field capacity. This required applying different amounts of water for the three irrigation scheduling treatments. Thus 6, 9, and 11 gallons were applied at each irrigation for the 10, 20, and 40 cb treatments, respectively.

Immediately after planting, the trees and buffer grass areas were sprinkler irrigated to establish them. Irrigation scheduling treatments were initiated August 1, 1984. Trees were fertilized using a commercial citrus grade fertilizer as recommended by Sauls and Jackson (20). The fertilizer analysis was 6-2.6-5 (% N,P,K) with micronutrients. Micronutrients were 1.0% Mg, 0.02% B, 0.05% Cu, 0.3% Fe, 0.1% Mn, and 0.1% Zn. Fertilizer was applied on days when irrigations were scheduled so that it would be washed into the profile. Insects were controlled as needed using a commercially available spray.

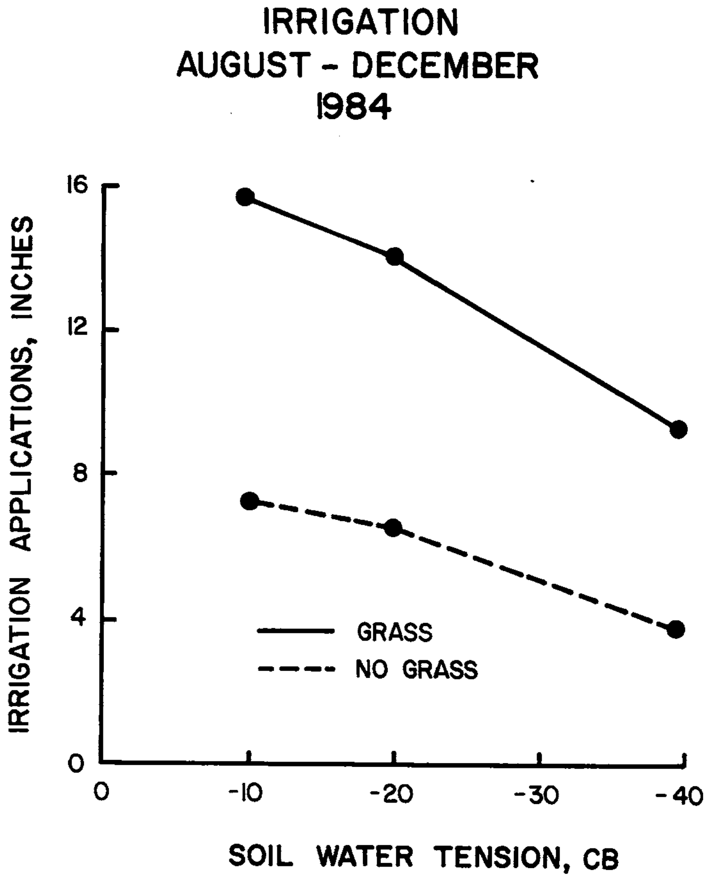

Fig. 1. Irrigation applied to young 'Valencia' orange on sour orange rootstock trees from Aug.-Dec. 1984 as a function of grass cover and soil water tension at which irrigations were scheduled. Each point is the mean of 4 replications (trees) per treatment.

Buffer area grass was fertilized and irrigated separately to maintain a well-watered actively-growing grass cover. Grass was maintained by mowing weekly to maintain an average height of approximately 2 inches. Mole crickets and other insects in the grass were controlled using a diazanon bait.

Irrigations were applied manually using a hose-end sprayer and flow meter. Tensiometers were read three times per week and irrigations were applied as required. Irrigation frequencies and amount applied were recorded. Complete descriptions of the instrumentation and methods of application were given by Aribi (1).

Growth measurements consisting of canopy height, canopy diameter, and trunk circumference were made every two weeks. Tree trunks were marked at about 6 inches above the bud union so that trunk circumference measurements were made at the same place each time.

Results and Discussion

Trees were established and growth was recorded from Aug. to Dec. 1984. A severe freeze in Jan. 1985 caused the loss of all leaves and branches except the main stem on all trees. Data collection was not re-initiated until March 1. Therefore, irrigation data are presented in two sets, before and after the freeze. Irrigation application data as a function of irrigation scheduling and grass cover treatment for Aug.-Dec. 1984 is presented in Fig. 1. Irrigation applications for the no grass treatments were less than half of those of the corresponding grass cover treatments for all soil water tensions. Water applications were consistently greatest for the 10 cb treatments and least for 40 cb treatments. There was approximately a 50% savings of irrigation water by controlling grass around young trees as they were being established.

Irrigation application data for Mar.-Oct. 1985 show less difference between the grass and no grass treatments, with the exception of the 40 cb treatment (Fig. 2). The smaller differences between the wetter 10 and 20 cb treatments indicate an increasing impact of the tree on irrigation requirements. Water requirement of the trees increased because greater root development allowed the trees to better extract water from the lysimeters.

Tree growth responses to the grass cover and irrigation treatments are shown in Figs. 3-5. Fig. 3 shows the effects of the treatments on tree height. At the beginning of this experiment, all tree heights were about equal. By Oct 1985, the grass and no grass cover treatments had affected tree heights in different ways. The greatest tree height was achieved as a result of irrigation at the 20 cb water tension for the no grass cover treatment. With grass cover, the greatest tree height was obtained with the 40 cb irrigation treatment.

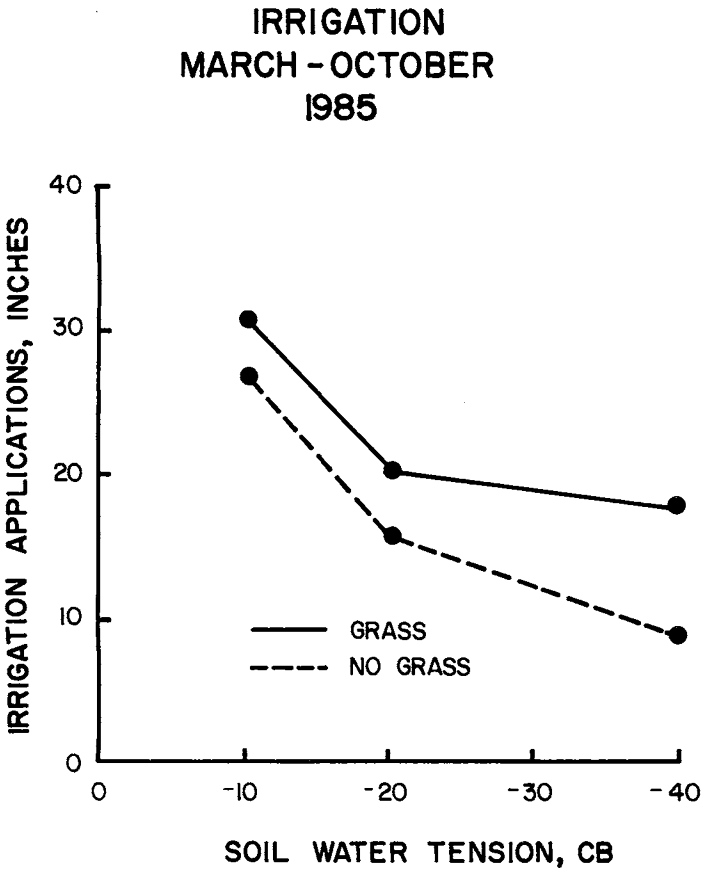

Fig. 2. Irrigation applied to young 'Valencia' orange on sour orange rootstock tree from March-Oct. 1985 as a function of young tree grass cover and soil water tension at which irrigations were scheduled. Each point is the mean of 4 replications (trees) per treatment.

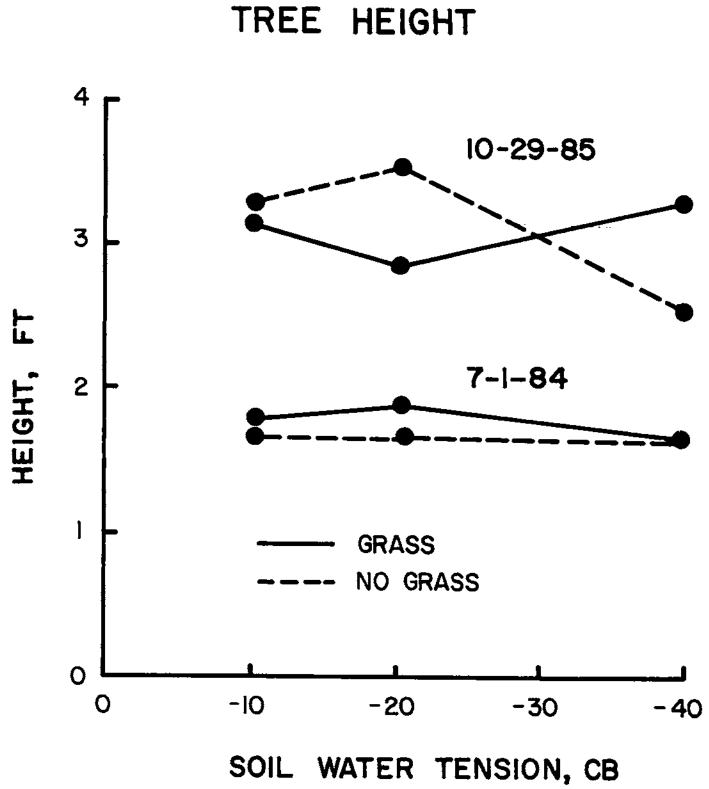

Fig. 3. Tree height at the beginning and end of the experimental period as a function of grass cover and soil water tension. Each point is mean of 4 replications (trees) per treatment.

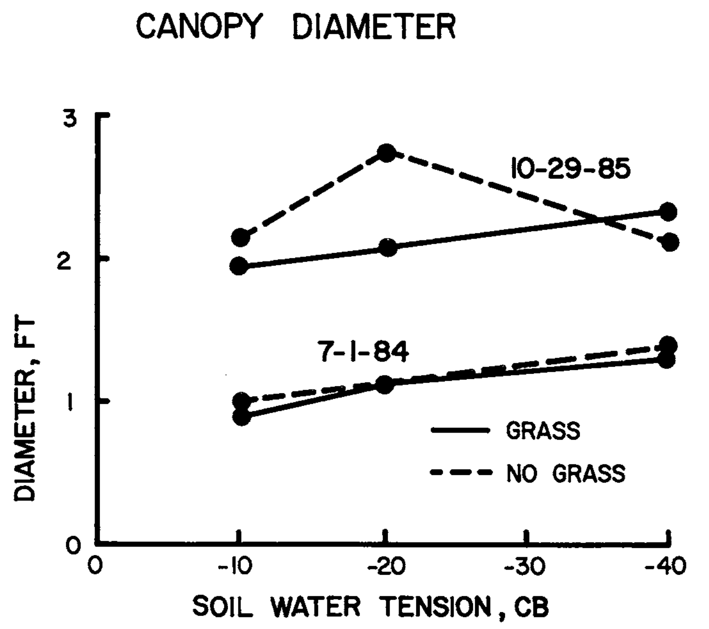

Fig. 4. Tree canopy diameter at the beginning and end of the experimental period as a function of grass cover and soil water tension. Each point is mean of 4 replications (trees) per treatment.

Other growth responses followed a pattern similar to the tree height. In Fig. 4, tree canopy diameters were greatest for the no grass cover treatment at 20 cb. For the grass cover treatments, although not statistically significant, a general trend toward increasing canopy diameters was observed from the 10 cb to the 40 cb irrigation treatments. In Fig. 5 tree trunk cross sectional area of trees

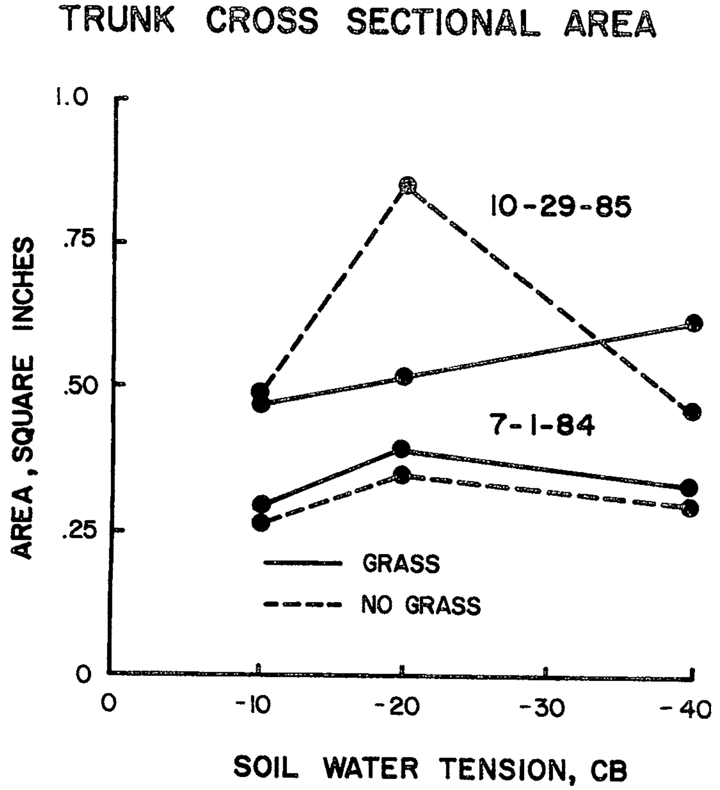

Fig. 5. Trunk cross sectional area at the beginning and end of the experimental period as a function of grass cover and soil water tension. Each point is mean of 4 replications (trees) per treatment.

with the 20 cb and no grass cover treatment was significantly greater than all others at the end of Oct. 1985. The trend toward increasing growth from the 10 cb to the 40 cb grass cover treatments was again observed.

The data in Figs. 3-5 indicate that young 'Valencia' orange tree growth may be maximized by controlling grass around the trees and by irrigating when the soil water tension in the top 24 inches of the root zone reaches 20 cb. None of the irrigation treatments in combination with the grass cover treatments were as productive because of the competition between the trees and the grass for both water and nutrients.

For the no grass treatments, neither the 10 cb nor the 40 cb irrigation treatments were as productive as the 20 cb treatment. The 10 cb treatment was observed to be continuously wet. Either leaching of nitrogen occurred or oxygen diffusion was restricted as evidenced by a yellowing of the tree canopies in these treatments. Trees receiving the 40 cb no grass treatment were not as productive as the 20 cb treatment because it was too dry. These trees were visibly stressed on days where there was a high evaporative demand.

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