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EFFECT OF IRRIGATION ON LEAF WATER POTENTIAL, GROWTH AND YIELD OF MANGO TREES

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Abstract. **An experiment was conducted in a commercial 'Tommy Atkins' mango (*Mangifera indica* L.) orchard during the spring and summer of 1988 to determine the effect of irrigation on tree growth and yield. Eight-year old mango trees were subjected to three levels of irrigation between 28 March and 10 May using a solid-set sprinkler system. All trees were irrigated on March 28. Thereafter, the three treatments consisted of: trees irrigated at approximately 7-day intervals (7DI), 10.06 cm (3.96 inches) total irrigation; trees irrigated at approximately 14-day intervals (14DI), 3.35 cm (1.32 inches) total irrigation; and trees receiving no irrigation (NI). The orchard received 7.62 cm (3.0 inches) of precipitation during the experimental irrigation period. Irrigation treatments were discontinued on 10 May, shortly before the beginning of the rainy season. Predawn water potential of the 7DI trees remained nearly constant at –3.0 bars while predawn water potential of the NI trees decreased over time, but was never less than –5.0 bars. Predawn water potential of the 14DI trees fluctuated between that of the 7DI and NI treatments. There was some variability among treatments in net photosynthesis and transpiration, but irrigation generally had no effect on these variables. There were no differences in shoot growth among treatments. The NI trees had the smallest fruit on most harvest dates and total yield of the 14DI treatment was reduced relative to the 7DI treatment. The 7DI trees had the largest fruit for most harvest dates and the greatest yields on the earlier harvest dates. This may be advantageous since Florida mango market prices are highest early in the season.**

Mango is one of the world's most widely planted fruit crops, and is grown in over 87 countries (3). In the United States, mango production is centered in Dade County, Florida, where approximately 1,000 hectares produced a crop valued at $4,500,000 in 1986 (4). Mango acreage and production in Dade County has been increasing in recent years (4).

Although mangos have a long history of cultivation (22), there is little scientific basis for irrigation scheduling for this crop. In Dade County, mango fruit set and early fruit development occur from February to May. Soil moisture deficits are common during these months due to low precipitation rates, high evaporative conditions and poor moisture-holding capacity of the native soils (10, 17, 18). Despite these conditions, many growers do not irrigate at that time of year.

Water stress can adversely affect fruit growth (2, 8, 9, 12, 15), since cell growth and cell wall synthesis are sensitive to even slight reductions in plant water status (13). Although several studies indicate that irrigation increases yields in subtropical evergreen fruit trees (1, 2, 9, 11, 12, 14, 15), there are conflicting reports regarding the need for irrigation in mango. Several reports indicate that established mango trees are relatively drought tolerant (6, 7, 20, 22, 26). However, Marloth (19) observed a reduction in the current season's vegetative growth, on which the following season's crop is borne, due to water stress. Yan and Chen (25) found that vegetative growth and photosynthesis of potted mango trees were reduced when soil moisture content was below 40%. Panicle development, fruit set and fruit growth of mango increase with adequate soil moisture (2, 21, 24, 26). In Egypt, Azzouz et al. (2) reported that mango fruit number and fruit size increased with increasing irrigation frequency. In Florida, Young and Sauls (26) observed no yield differences between irrigated and non-irrigated mango trees except in very dry years. However, one Florida mango grower reported increased yields due to larger fruit size in irrigated trees (K. Mitchell, personal communication). The objective of this study was to determine the effects of irrigation on leaf water potential, vegetative growth and yield of mature mango trees under South Florida conditions.

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Materials and Methods

Three irrigation regimes were imposed on 8-year old 'Tommy Atkins' mango trees in a 4.0 hectare (10 acre) commercial orchard between 5 April and 10 May, 1988. The orchard was located about 11 km (7 miles) north of Homestead, Florida on a Rockdale fine sand-limestone soil (5, 16). Tree spacing was 4.57 x 7.62 m (15 x 25 feet) within and between rows, respectively. The experimental design was a randomized block with 10 trees per block and three blocks per irrigation treatment.

Water was applied through a solid-set, under-tree sprinkler system with an output of approximately 0.59 cm (0.22 inches) of water per hr. Trees were irrigated for 6 hr, providing 3.35 cm (1.32 inches) per cycle. The three treatments were: irrigation at approximately 7 day intervals (7DI), for a total of 10.06 cm (3.96 inches); irrigation at approximately 14-day intervals (14DI), for a total of 3.35 cm (1.32 inches); and no irrigation (NI). The entire orchard was irrigated on 28 March; irrigation treatments were initiated on 5 April when only the 7DI treatment was irrigated. Differential irrigation was achieved by removing the sprinkler heads as required in the 14DI and NI treatments. Sprinkler heads were removed to create one row of buffer trees around the NI and 14DI treatments.

The orchard received 2.54 cm (1 inch) and 5.08 cm (2 inches) of rain on 25 April and 1 May, respectively. Irrigations were postponed during these times. The summer rainy season began on 15 May, at which time irrigation treatments were terminated. A total of 27.4 cm (10.8 inches) of precipitation occurred at the site between 15 May and 6 June, 1988.

Spring shoot growth was measured on four shoots around the periphery of each tree, with one shoot randomly selected from each tree quadrant. Shoots were initially measured on 7 April with final measurements on 7 June, 1988. Predawn (0430-0630 hr) leaf water potential was determined on five dates between 2 April and 10 May using the pressure chamber technique (23). Determinations were made on three leaves per tree on two trees per block.

Net photosynthesis and transpiration were determined between 1200-1500 hrs on five dates between 12 April and 15 May with a portable infrared gas analyzer system (Analytical Development Co., Hoddeson Hertz, England). Determinations were made on two well-exposed leaves on separate non-bearing shoots on three trees in each block.

Mature fruit were harvested on 29 May, 6 June, 14 June, 23 June, 3 July and 17 July. Fruit were considered mature when they were well filled out around the stem end (26). For the first four harvests, fruit were weighed separately for each tree and fruit weight and yield per unit area were calculated. For the last two harvests the number of fruit per tree and total yield were determined.

Results and Discussion

Predawn leaf water potential in the 7DI treatment remained nearly constant at –3.0 bars over the course of the irrigation period (Fig. 1). For the NI treatment, water potential decreased after one week and remained more negative than that of the irrigated treatments, but was never lower than –5.0 bars (Fig. 1). Leaf water potential of trees in the 14 DI treatment also decreased after one week, but then increased as a result of irrigation and precipitation (Fig. 1). Although there was some variability in net photosynthesis and transpiration among treatments (data not shown), irrigation generally had no effect on these variables.

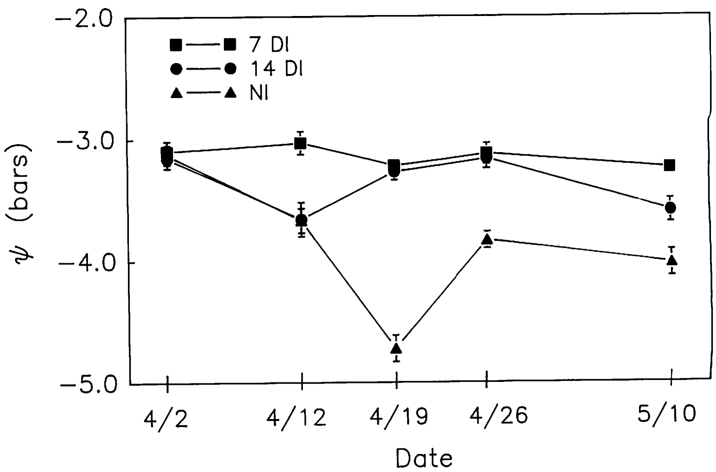

Fig. 1. Predawn leaf water potential (ψ) of 'Tommy Atkins' mango trees in response to irrigation treatment. Means of three leaves on each of six trees per treatment ± SE. Where not shown, SE bars are within the area of the symbol.

There was no difference in mean shoot growth among the three treatments (data not shown). Individual shoot growth varied greatly within treatments, but was approximately 8.0 cms (3.15 inches) per shoot over the 2-month period.

Although leaf water potentials were more negative in the 14DI and NI treatments, the lack of differences among treatments in net photosynthesis, transpiration and vegetative growth indicated that tree vigor was unaffected by irrigation treatment.

In general, the 7DI treatment produced larger fruit (Fig. 2a), and had greater yields on the first three harvest dates (Fig. 2b), the period when fruit market prices are highest (Fig. 2c). The reductions in leaf water potential resulted in delayed fruit filling, and hence reduced yields, for the 14DI and NI treatments during the earlier harvest dates (Fig. 2b). The more negative leaf water potentials also resulted in smaller fruit size for the NI treatment on most harvest dates (Fig. 2a). Total yield of the 14DI treatment was lower than the 7DI treatment but not lower than the NI treatment (Fig. 2b). Precipitation in late May and June was presumably sufficient to replenish soil moisture and eliminate any differences among treatments in leaf water potential. Therefore, it appears that the reduction in fruit size in the NI and 14DI treatments is due to a reduction in cell division rather than a reduction in tissue hydration.

While mango fruit prices fluctuate yearly, seasonal prices generally follow the trend shown in Fig. 2c (M. Hunt, J. R. Brooks and Son, Inc., personal communication). Highest seasonal prices occur during the first 3 weeks of the harvest season (Fig. 2c) and generally range between $20.00 and $30.00 a bushel (M. Hevener, J. R. Brooks and Son, Inc., personal communication). Since fruit prices are highest during the earliest part of the harvest season, and since fruit maturity is determined by the fullness of the fruit at the stem end, earlier fruit filling due

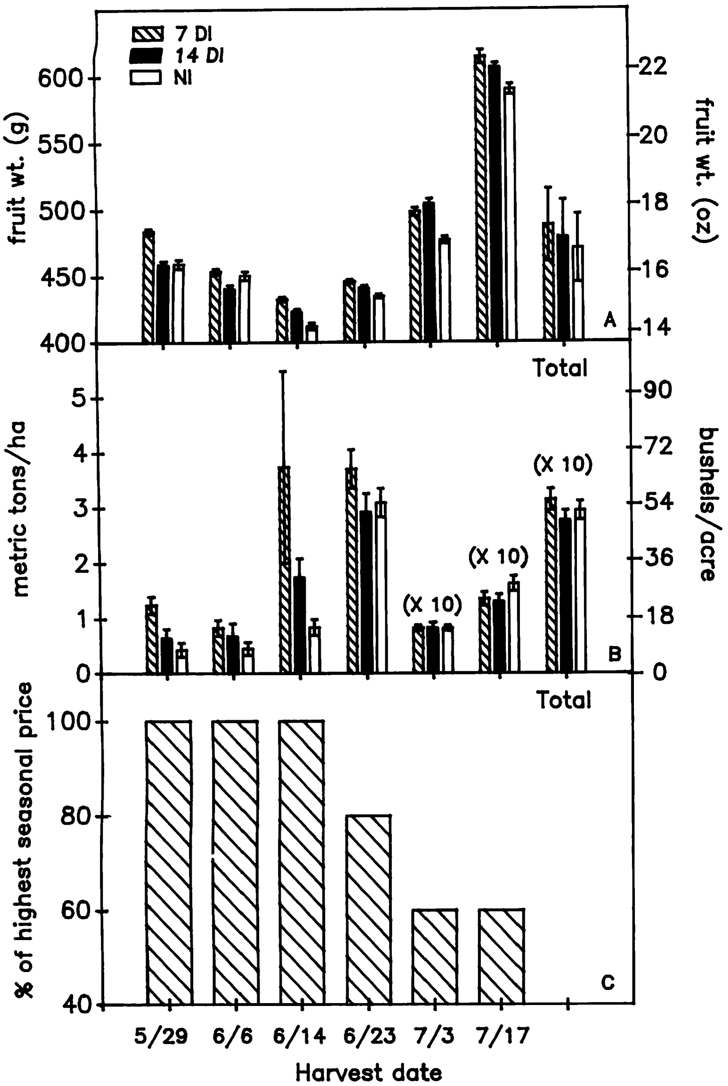

Fig. 2. Response of 'Tommy Atkins' mango to varying irrigation levels. (A) Fruit weight, n = 30 ± SE. (B) Yield, n = 30 ± SE. Yields shown on 7/3 and 7/17 and total yield shown are 10% of the actual yield for those dates. (C) Percent of highest seasonal price of 'Tommy Atkins' mango fruit as a function of harvest date.

to irrigation may have considerable economic impact. Although a detailed economic analysis was not conducted in this experiment, the cost of irrigation (fuel, maintenance and labor) for the 7DI treatement was estimated to be $150.00 for the entire orchard (M. Hunt, J. R. Brooks and Son, Inc., personal communication). This cost would be more than offset by the increase in gross returns resulting from higher yields of early maturing fruit in the 7DI treatment (Figs. 2b, 2c).

Fruit growth in mango appears sensitive to soil moisture deficits based on this study. Further studies conducted over several years are necessary, however, to access more accurately the effects of irrigation on mango growth and yield in South Florida.

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