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Scheduling Irrigation of Pecans in Louisiana

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Abstract

Research to alleviate moisture and nitrogen stress was conducted. An eleven year old pecan orchard near Baton Rouge, Louisiana was trickle irrigated. Fertilizer was injected into the irrigation system on the irrigated trees and applied on the surface by hand on the non-irrigated trees. Soil moisture was monitored with gypsum blocks and daily irrigation amount determined with a Class A evaporation pan. Irrigation was initiated at an estimated 30 percent soil moisture depletion. Nitrogen fertilizer at the rate of 0.9 kg per year tree age was applied to all trees and an addtional 110 g per year tree age was applied as sidedress to half of the trees. The tests were run for three years. Results indicate an interaction between cultivar, irrigation and sidedressing. Therefore, fertilizer injection through the trickle irrigation system may be used to advantage on select cultivars. The removal of either moisture or nitrogen stress makes the other factor important. 'Sumner,' 'Caddo,' and 'Candy' were the top producers, while 'Cherokee,' and 'Tejas' were the low producers.

Introduction

One of the major problems associated with commercial pecan production is the alternate year bearing cycle. One season, production may be at reasonably high levels but the following year production will be low. The cycle may follow individual trees, cultivars or entire orchards. High yields one year tend to inhibit production the following year. Higher levels of management may reduce the influence of the alternate year bearing cycle.

To reduce the alternate year bearing variation, research to alleviate moisture and nitrogen stress was conducted. Nitrogen fertilizer was injected into the irrigation system. Response to irrigation, fertilization and the irrigation fertilizer interaction was analyzed for six cultivars. Annual variation in production was also studied. Current recommendations for insect and disease control, tree spacing and pruning were followed.

To determine when and how much to irrigate, a procedure estimating the daily water balance was used. Daily soil water estimates were made from an initial measurement of soil moisture, and additions and deletions to soil moisture were made with time. Additions used were effective rainfall and net irrigation, and deletions were crop water use. Irrigation was initiated at a pre-determined soil moisture. Forecasts of irrigation date made in advance with extrapolated crop water use estimates were refined from updated data including that from soil moisture sensors. To help in the record keeping of irrigation scheduling, computers were first used at the Snake River Project in Idaho and have since been used for row crop in arid (7) and subhumid areas (6). Computer-aided irrigation scheduling was done recently for pecan (8, 9). Irrigation scheduling for pecans requires that evapotranspiration estimates given by depth or an areal basis be converted to volume per tree-day. Fereres et al. (4) recommended using a volume estimate that was 87 percent of the potential evapotranspiration estimate if 50 per-

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cent of the ground was shaded, 98 percent if 60 percent shaded and 100 percent if more than 70 percent was shaded. The recommendation was made for a tree spacing of 7.3 x 7.3 m with deciduous orchards. The Ben Hur orchard was approximately 60 percent shaded; therefore, a factor of .98 was recommended. With the wide spacing normally used with pecans in Louisiana (9.1 x 9.1 m) and representative potential evapotranspiration, estimates of 0.51-.64 cm daily irrigation volumes of 416-519 l were required. In consideration of the closer spacing used (4) and the large magnitude of the water use estimate, it was decided to use shaded tree area to estimate irrigation volume.

Materials and Methods

The orchard was located on an old alluvial floodplain at Ben Hur Research Farm near Baton Rouge, Louisiana. Four blocks of trees were planted in 1972 with a spacing of 9.1 x 9.1 m. Surface vegetation between trees was removed and the area clean tilled and treated with herbicide. Each block contained 98 (14 x 7) trees, guard trees around the perimeter and five rows of 12 trees each within the research area. Each row of trees had two replications of six cultivars, one replication in the top half and the other in the bottom half of the row. Trees were arranged randomly in each replication of cultivars. The six cultivars were 'Caddo,' 'Candy,' 'Cape Fear,' 'Cherokee,' 'Sumner' and 'Tejas.' Trickle irrigation equipment was installed in two blocks. One trickle irrigation lateral was parallel to and within about 1.8 m of each tree row. Four emitters, designed for a discharge of 7.6 lph at 110 kPa were centered on the tree and spaced at intervals of 1.5 m were buried 15 cm, and water was delivered to the emitter at the soil surface by 0.64 cm poly tubing. At the onset of the research in 1983, two rows were sidedressed and three not sidedressed. In the last two research years, 1984 and 1985, each block had two rows that were sidedressed and two rows that were not sidedressed. The change was made to facilitate analysis of variance. Ammonium nitrate fertilizer was injected with a positive displacement pump. Fertilizer recommendations (1) are 0.9 kg of complete fertilizer (8-8-8) or the equivalent per year of tree age. In addition to the above recommendation, a treatment of 110 g of nitrogen (n) per year of tree age was applied as sidedress to half of the trees. The sidedress application was applied as ammonium nitrate and broadcast by hand in July on the non-irrigated treatment and through the system on the irrigated plots in four applications two weeks apart. The first application was made the middle of July.

Soil moisture blocks 2.5 cm in diameter were placed at two sites in each of the four blocks at depths of 15, 45 and 75 cm. Recommended procedures were used in installation and use (5). Aluminum pipe 1.5 m long and 5 cm in diameter was installed at eight locations around the perimeter of the orchard to monitor water table level.

Procedure

Initially, the criterion to initiate irrigation was one bar of estimated average profile soil moisture tension. This tension corresponds approximately to a silt loam soil moisture depletion of 30 percent (5). The root profile depth assumed was 91 cm. The irrigation criteria and profile depth closely follows that used by Miyamoto (8, 9). When criterion was satisfied, irrigation was done daily. Potential evapotranspiration estimates were made from Class A evaporation data taken at a site within 152 m of the orchard. A pan coefficient of 0.85 was used following Burman et al. (2). Conversion of the potential evapotranspiration estimate into an estimate of the water volume required for irrigation was done, as previously discussed, with canopy area, estimated by shaded area taken near solar noon. Using a shaded

diameter of 7.9 m, potential evapotranspiration of 0.51-0.64 mm converts to 250-310 l. Readings from the soil moisture blocks were taken twice a week during the irrigation season. Although the water table, as monitored in the aluminum tubes, was high in the spring and early summer, by the end of July it was below four feet. Subsoil moisture may have influenced the response that could be derived from irrigation at this site.

In 1983, irrigation was done for three days the first of September and for 17 days in October. Average application was 4.8 mm. Irrigation criteria were nearly reached two other times earlier in the season, but timely rains occurred, delaying irrigation. The criterion for irrigation was changed in 1984 to approximate 50% depletion of available soil water. It was thought that more response to irrigation would be shown at the 50% depletion level compared with the 30% depletion level, and there would also be less probability of any negative effect. Irrigation was applied on three days at the end of July and first of August, and again for 11 days from September 10 to 20. Average application was 0.56 mm. Irrigation was applied for 11 days in 1985, six days the second week of August, three days the end of August and two days the end of September. Average application was 3.3 mm for a total irrigation amount of 36.3 mm. Average application was slightly less than the planned application. Following standard procedure, at complete nut fall, pecans were gathered from under each tree. Data were taken on total weight of nut per tree, average nut weight, percent meat and color.

Results and Discussion

In 1983, nut yield was high, with an overall average of 10.4 kg of unshelled nut per tree. 'Candy' and 'Caddo' produced significantly (99% level) higher than the other cultivars with 17.1 and 15.6 kg per tree, respectively. Although not statistically significant, the cultivar 'Caddo' was influenced in a negative manner by irrigation. There was a significant effect of irrigation on nut weight for the third highest producing variety, 'Sumner.' Two cultivars, 'Candy' and 'Caddo,' had significant decreases with sidedressing in percent nut that was meat. 'Caddo' had the largest percentage of meat in the nut with 60%. The short period of irrigation in September when demand was still fairly high and nut fill was taking place did not seem to provide enough of a treatment difference to influence yield. The latter period of irrigation was late in the season, demand was low and nut fill had already occurred.

Nut yield per tree was very low in 1984, averaging 1.8 kg per tree. There was no significant effect due to irrigation (Table 1). 'Sumner,' 'Cape Fear' and 'Caddo' were the three largest producers with 3.7, 3.3 and 3.0 kg per tree, respectively. 'Sumner,' 'Caddo' and 'Candy' cultivars had a response to sidedressing (4.4 vs 2.9, 3.7 vs 1.8 and 2.5 vs. 0.9 kg, for sidedressed and not sidedressed, by variety, respectively), while the other cultivars demonstrated no response to sidedressing.

Table 1. 1984 Average Pecan Tree Nut Yields, kgs/tree.

Variety	Irrigated	Non-irrigated
	Sidedressed	
Caddo	4.7 A	2.7 CDE
Candy	3.0 BCD	2.0 DEFG
Cape Fear	1.6 EFGH	1.6 EFGH
Cherokee	0.6 HI	1.5 EFGHI
Sumner	4.7 A	4.0 AB
Tejas	0.4 HI	0.5 HI
	Not Sidedressed	
Caddo	1.0 FGHI	2.6 CDE
Candy	0.8 GHI	1.0 FGHI
Cape Fear	0.9 FGHI	1.0 FGHI
Cherokee	0.6 HI	1.6 EFGH
Sumner	2.2 DEF	3.7 ABC
Tejas	0.4 HI	0.2 I

Means in Upper and Lower Sections of Columns Not Followed by at Least One of the Same Upper Case Letter Differ Significantly (p 0.05) according to Duncan's New Multiple range Test.

As shown in Table 1, there was an interaction between cultivar, irrigation and sidedress fertilization. The 'Caddo' cultivar responded to irrigation when sidedressed with nearly twice the yield. However, both the 'Caddo' and 'Sumner' cultivars had yield decreases with irrigation when not sidedressed. In 1985, 'Sumner,' 'Caddo' and 'Candy' were the top producers with 14.7, 13.3 and 10.8 kg per tree, respectively (Table 2). There was a significant decrease in percentage of nut meat with sidedressing. The non-irrigated sidedressed treatment also had darker meat. The top producer, 'Sumner,' demonstrated a positive response to irrigation and sidedressing.

There was no significant difference in tree production or individual nut weight due to irrigation or sidedressing as a single factor. 'Sumner' had the largest nut for all three years of the study. For the last two years of the study, the 'Sumner' nut was 59% larger than the average nut in weight, and 'Cherokee' and 'Tejas' nuts were 36 and 48% larger, respectively. 'Cherokee' and 'Tejas' had the darkest meat and 'Cape Fear' the lightest in color.

Two operational problems should be discussed. The battery-operated controllers continued to cause problems. This may be due, in part, to high humidity, dew and frequent rain. The primary difficulty was in keeping battery contact, although circuit boards are also prone to failure. It is planned to replace the present model of controller with another make. Low infiltration caused ponding of water on the surface between the tree rows. Flat terrain aggravated this problem. Although largely due to rainfall, some runoff occurred from irrigation.

Table 2. 1985 Average Pecan Tree Nut Yields, kgs/tree.

Variety	Irrigated	Non-irrigated
	Sidedressed	
Caddo	15.2 AB	11.6 CDE
Candy	7.5 G	11.7 CDE
Cape Fear	12.2 BCDE	7.1 FG
Cherokee	10.1 EF	7.1 FG
Sumner	17.6 A	13.1 BCDE
Tejas	1.1 H	1.9 H
	Not Sidedressed	
Caddo	11.4 DE	15.2 AB
Candy	10.7 DE	13.1 BCDE
Cape Fear	10.3 DEF	10.3 DEF
Cherokee	7.5 G	9.8 EFG
Sumner	14.7 ABC	13.5 BCD
Tejas	0.7 H	1.0 H

Means in Upper and Lower Sections of Columns Not Followed by at Least One of the Same Upper Case Letter Differ Significantly (p 0.05) according to Duncan's New Multiple Range Test.

Conclusions

Conditions were marginal for irrigation because of the frequent rainfall and the presence of subsoil moisture available to a deep-rooted perennial tree. As indicated by the interaction between cultivar, irrigation and sidedressing, the use of the irrigation system to apply nitrogen fertilizer may be of value. The significant interaction of the higher-producing cultivars when irrigated and sidedressed suggests that fertilizer was more effectively utilized when applied through the system. The removal of either the water stress or fertilizer limitation to production may make the other factor important. Data indicate that irrigation should not be recommended under design conditions if sidedressing is not done. 'Sumner,' 'Caddo' and 'Candy' were the top producers, while 'Cherokee' and 'Tejas' were the low producers.

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Cultivar Effect on Adventitious Root Development of Clonal Apple Rootstocks

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Spur 'Redchief' and 'Granspur' and non-spur 'Imperial Double Red Delicious' and 'Granny Smith' apples on MM 106 and MM.111 were planted in the field. Half were set in the field with the bud union 2.5 cm above the soil line with the other half the bud union was 20 cm above the soil line. The latter group of trees had a wooden trough filled with a sand-peat mix to a level 2.5 cm below the bud union. Following the first season's growth, the roots were exposed by washing. Trees on MM.111 rootstocks developed fewer burrknots and produced more roots per burrknot.

The main thrust of the study was to determine if scion cultivars affected development of roots from a buried rootstock shank. Both non-spur cultivars formed burrknots and new roots on 100% of the buried rootstock shanks, with 50% or more of the nodes (rooting sites) exhibiting new root growth. The spur type 'Redchief Delicious' trees had new roots developing on only 25% of the rootstock shanks while developing new roots at only 5.5% of the potential sites. The contrast between the spur and non-spur 'Granny Smith' cultivars was not as great but the differences were still significant with a greater number of burrknots rooting per shank on the standard habit trees. The non-spur type cultivars had higher ratio of roots per burrknot per stock cross-sectional area than the spur types.

This study suggests that the scion cultivar influences first season root development on the buried rootstock shank. The spur-type cultivars retarded new root development. Thus the cultivars may explain why some combinations fail to anchor firmly during the early years in the orchard.

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