Irrigation As An Integral Management Tool in Pecans

By James B. Aitken and Carl R. Camp

In recent years, many pecan growers have invested in various types of irrigation systems. The use of irrigation in pecan production can be very helpful and profitable if used wisely and properly. These systems will not just supply needed water but may also be used for applying nutrients and pesticides. This paper will review some background research and present research data from 1982.

The utilization of soil water by crops and scheduling of irrigation have been and continue to be studied from many directions. A comparison of sprinkler and drip irrigation on young pecan trees using various water application levels was reported by Daniell *et al*[4]. Both methods of irrigation increased pecan yields over the non-iirrigated. Production on Stuart pecans was maximized with the use of 5-8 two-gallon (7.5 L) per hour emitters per tree[2]. Research in Georgia[3] has shown that in order to supply an adequate supply of water to mature pecan trees within a 12 hour period, a system should be designed to supply 2400 gallons (9084 L) of water per acre in 12 hours. This capacity will not be needed on young trees, but will be useful as the trees mature. Irrigating pecans has not only increased yield, but has greatly reduced the percentage of 'sticktights' in the Desirable variety[10]. Over-irrigation can have a detrimental effect on nut quality in much the same way as a moisture deficiency[8]. The influence of two moisture levels on nut fill with two types of irrigation was studied in South Carolina[1].

Irrigation scheduling in both arid and humid climates has been investigated by many researchers[5,6]. The Class A evaporation pan has been used to estimate potential water use by a tree. Recently, the use of soil moisture tension or matric potential to determine water use by a tree. Recently, the use of soil moisture tension or matric potential to determine water needs has gained attention. Soil moisture tension is measured with instruments known as tensiometers which are placed at various depths within the active root zone of the tree[9]. Irrigation scheduling involves not only the amount of water to apply, but also the time at which it is applied. Research in Israel[7] has shown that the rate of application has a direct effect upon the lateral movement of water in the soil.

Utilizing the irrigation system as a means of applying fertilizer has been evaluated in some areas[6,9]. Much more research is needed in the area of chemigation on pecan trees.

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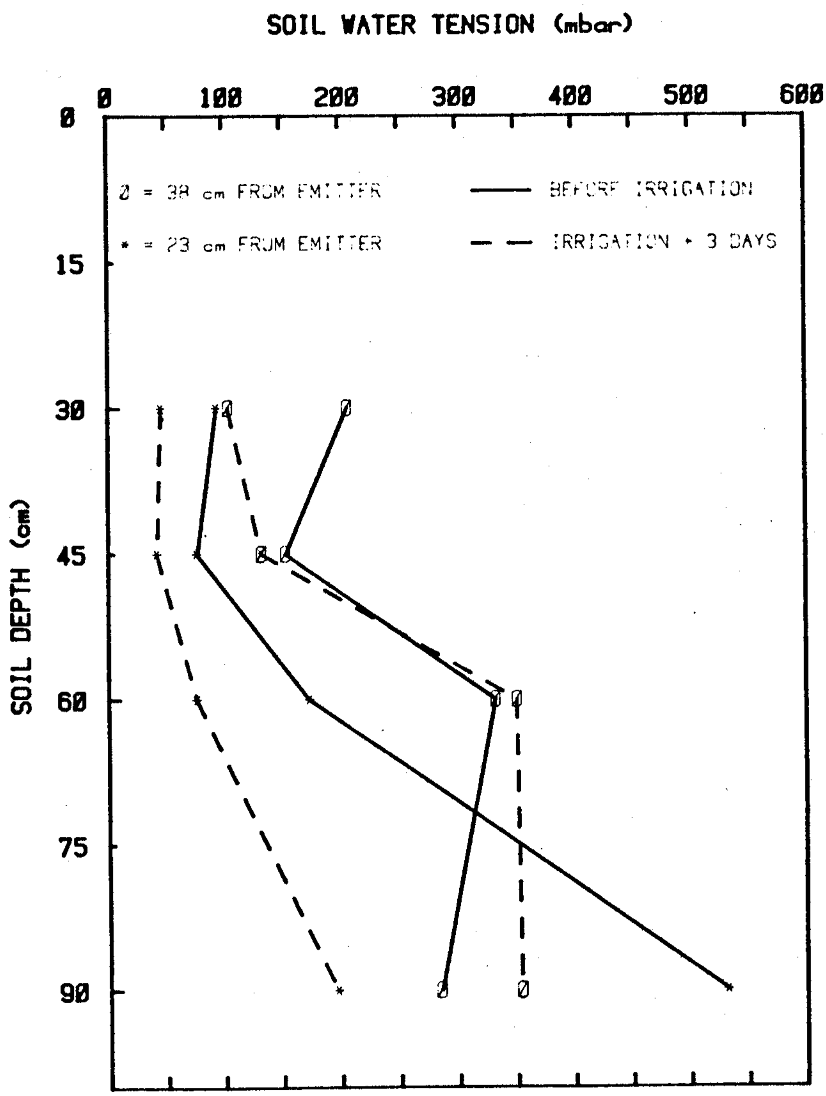
Figure 1. Soil water tension at varying depths at different distance from emitter before and after irrigation.



Research Parameters

Soil water management studies were conducted in a variety evaluation block of 8-year old pecan trees. Two types of irrigation were used: (1) low volume using 180 and 360 degree spray heads delivering 16 gallons per hour (gph) (60.6 L/h) with two heads per tree; and (2) drip emitters delivering one gph (3.8 L/h) with four emitters per tree. Irrigation was initiated when the soil moisture tension at the 24-inch (60 cm) depth reached either four or 14 centibars (cb). Two irrigation scheduling treatments were managed using tensiometers. The tensiometers were spaced four feet (120 cm) from the low volume spray head and 15 inches (38 cm) from the drip emitter in each plot. Water was applied to each plot as needed using volumetric valves and water meters to monitor application. Yield data were obtained by hand harvesting each tree and shellout data obtained using a commercial cracking and shelling facility.

Fertigation studies were conducted on five-year old pecan trees. Each plot contained 10 trees with three replications per treatment. Two one gph (3.8 L/h) emitters per tree were used for nutrient applications. Fertilizer solution consisting of 20 lbs (9.1 kg) 15-0-14 dissolved in 25 gallons (95 L) of water was injected into the system at the rate of one gallon per minute (3.8 L/m) using an Amiad fertilizer injector. Treatments were as follows:

1. Surface application in a 10 ft (3 m) band of 24-0-24 to give a total of 72 lbs/acre (80.6 kg/ha) each of N and K in a split application.

2. Surface application as above of 36 lb/acre (40.3 kg/ha) each of N and K followed by three drip applications of 15-0-14 totaling 36 lbs/acre (40.3 kg/ha) each of N and K.

3. Six drip applications each containing 12 lbs/acre (13.4 kg/ha) of N and K providing a total of 72 lbs/acre (80.6 kg/ha) each of N and K.
4. Four drip applications each containing 12 lb/acre (13.4 kg/ha) of N and K providing a total of 48 lbs/acre (53.8 kg/ha) each of N and K.

Tensiometers utilizing mercury columns instead of vacuum gauges were used to measure soil water tension in the root zone beneath emitters during soil wetting and drying cycles. These tensiometers were placed in a grid around the emitters on one side of a tree as shown in Figure 4 at depths of 12, 18, 24, and 36 inches (30, 45, 60, and 90 cm). The grid layout was replicated beneath three trees.

Soil type in all studies was a Lakeland sand. All trees received necessary cultural practices as needed to maintain growth except for the irrigation or nutrient variable as it occurred.

Results and Discussion

The influence of soil moisture on tree growth levels was measured using mean trunk diameter increase between the beginning and end of season. No significant difference was observed between nonirrigated and any of the irrigation treatements as shown in Table 2. Rainfall during the growing season could have been sufficient to reduce growth difference. The amount of water needed to maintain the various soil moisture levels differs greatly between low volume and drip systems. However, the amount of water applied per unit of wetted area on the soil surface was not much different. The low volume system applies water to a much greater surface area than drip. Root density per unit volume of soil was not determined in 1982 but will be monitored in the future since this may help explain some of the results obtained in 1982.

The Desirable pecan variety was selected to study the influence of soil moisture levels on nut yield and quality. The yield of the nonirrigated and the low volume-low moisture treatments were significantly lower than both drip and low volume-high moisture treatments (Table 2). Actual soil moisture content for the 14 cb treatment may not have been equal for the low volume and drip system due to different locations of the tensiometer in the two systems. This point will be discussed later under soil water movement. There

Figure 2. Soil water tension measured before and after irrigation at 45 cm depth at various distances from tree.

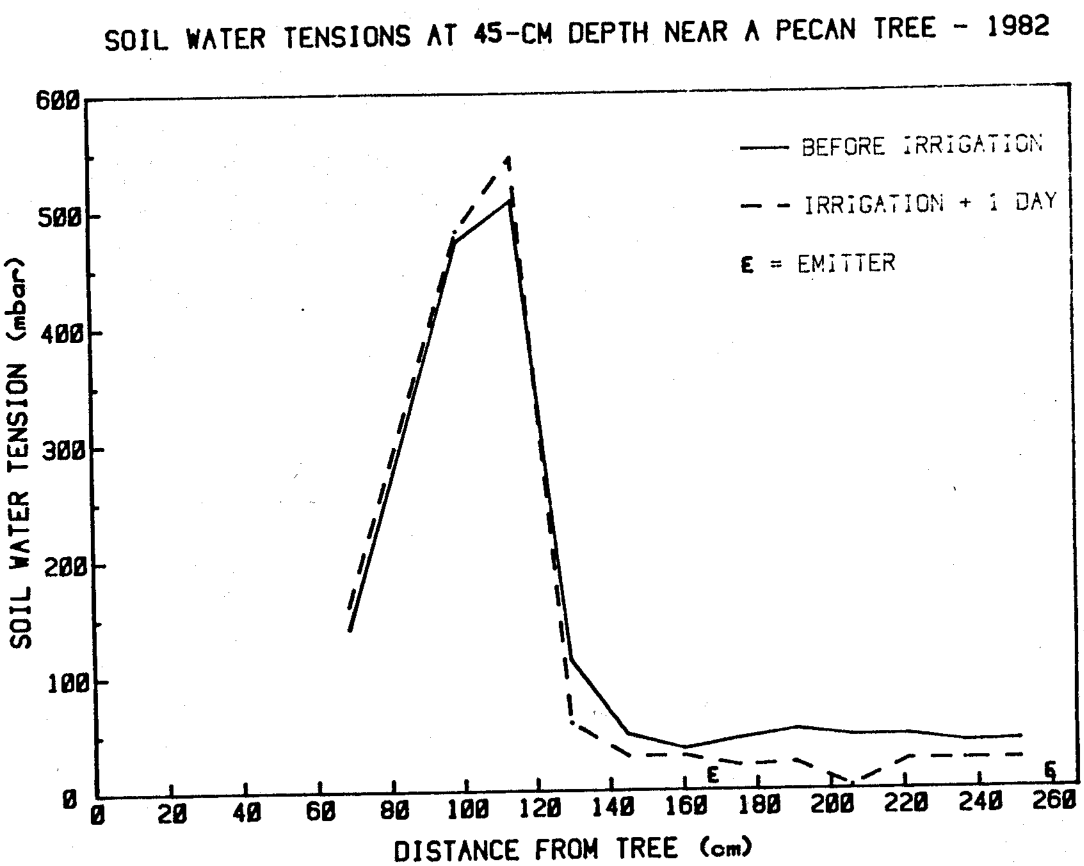
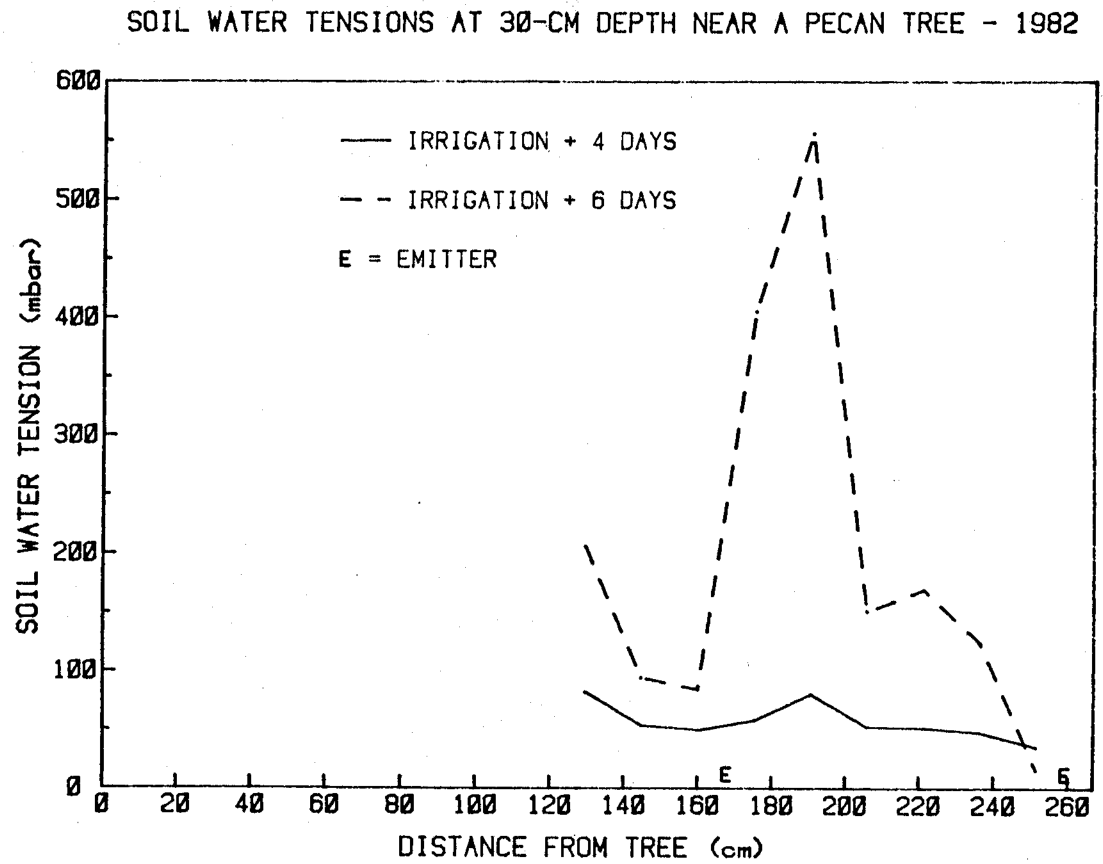


Figure 3. Soil water tensions at various distances from tree and depth of 30 cm four and six days after irrigation.



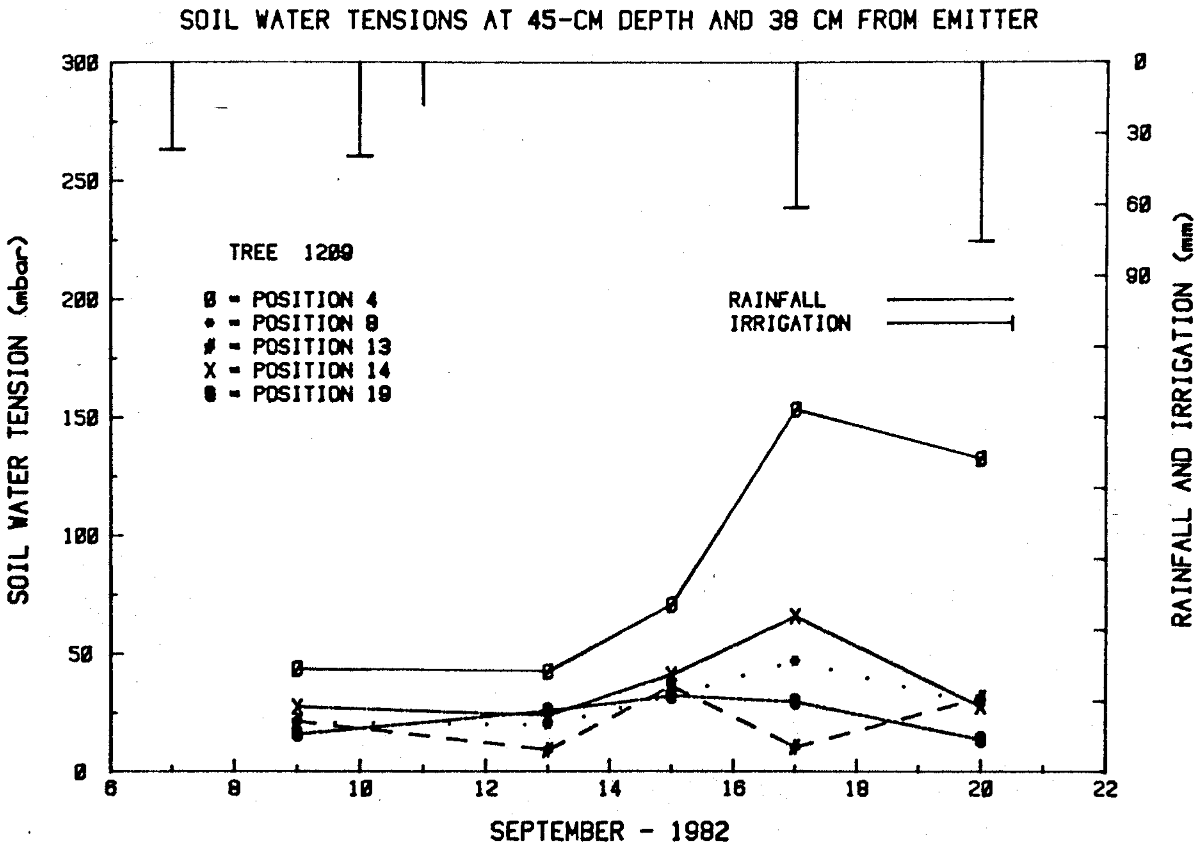


Figure 5. Comparison of various tensiometer positions 38 cm from emitter on soil water tension at 45 cm depth.

Table 1. Influence of soil moisture tension (cb) on mean trunk diameter increase across all varieties using two irrigation systems and water application rates by treatment for full season. 1982.

Irrigation Treatment	Mean trunk diameter increase, in.	Total water applied (gals/tree)	Rainfall equivalent, inches	Gallons/ sq ft wetted area
A. Low volume				
4 cb	0.622 a*	5055	8.94**	21.89
14 cb	0.673 a	4073	7.20	16.64
B. Drip				
4 cb	0.610 a	511	0.90	18.07
14 cb	0.699 a	407	0.72	14.39
C. Nonirrigated	0.689 a	—	—	—

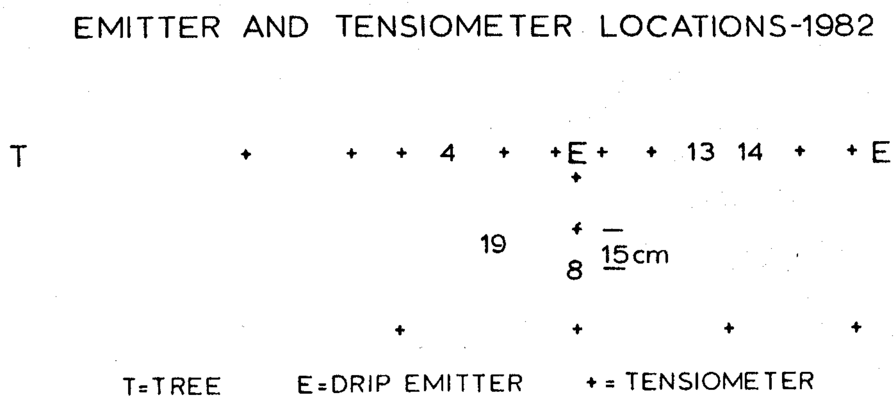
° Means followed by a common letter are not significantly different at the .05 level using Duncan's Multiple Range Test.
°° Rainfall equivalent represents the total gallons applied per acre converted to acre-inches. Natural rainfall for this same time period was 13.85 inches.

Table 2. Influence of soil moisture tension (cb) on yield and nut quality on 9-year old Desirable pecan trees. 1982.

Irrigation Treatment	Yield lb/tree	Nuts/lb	% Shellout
A. Low volume	14.72 b*	52.50 a*	52.5 a*
14 cb	2.33 a	52.27 a	49.6 a
B. Drip			
4 cb	12.14 b	52.27 a	52.2 a
14 cb	10.25 b	50.27 a	50.8 a
C. Nonirrigated	12.75 a	48.64 a	52.8 a

° Means within a column followed by a common letter are not significantly different at the .05 level using Duncan's Multiple Range Test.

Figure 4. Schematic diagram of tensiometer locations.



was no significant difference in nuts/lb or percent shellout between the treatments. The 1982 season was much wetter than the 1981 season. This may have caused the drastic change in the shellout percentage from 1981 when a large difference existed between treatments.

Application of N and K as 15-0-14 through the drip system provided some interesting results (Table 3). No significant difference in leaf N and K or trunk diameter increase existed among treatments. The lower nutrient rate provided results comparable to those for the high nutrient rates. Use of the lower nutrient rate would mean lower production cost for the grower.

Studies in soil water distribution following irrigation applications have revealed several interesting facts. The soil water tension was monitored at various depths using tensiometers located at two distances from the emitter (Figure 1). When tension levels at each depth are compared before and after irrigation, it is very evident that the tensiometers 23 cm (9 in.) from the emitter measured a response to water application at all depths (Figure 1). The tensiometers located 38 cm (15 in.) from the emitter at the 60 and 90 cm (24 and 36 in.) depths were actually outside the wetted zone. If tensiometers used for scheduling irrigation were located at 38 cm from emitters, as they were in the tree growth, yield and quality studies, over-irrigation could easily occur. To accurately monitor soil water tension in sandy soils, the tensiometers should be located 23 cm (9 in.) from the emitters.

Soil water tensions were measured at the 45-cm (18 in.) depth in a straight line from near the tree out to the second emitter both before irrigation and one day after irrigation as shown in Figure 2. Little difference was noted from measurements at any point with time but a great difference was noted between locations. Soil water tension was highest at a location 120 cm from the tree, dropped rapidly to a low level at a distance of 140 cm and maintained this low level out to a distance of 260 cm from tree. This may indicate that the major portion

Table 3. Influence of fertigation treatment on leaf N and K levels and on trunk diameter increase on young pecan trees. 1982.

Treatment	Leaf level, N	K	% Trunk diam increase, in.
1. 100% fertilizer surface applied in band as split application	2.53	1.37	0.354
2. 50% fertilizer surface applied and 50% applied in 3 drip applications	2.62	1.37	0.571
3. 100% fertilizer applied through drip in 6 applications	2.30	1.24	0.772
4. 67% fertilizer applied through drip in 4 applications Reduced fertilizer rate	2.46	1.19	0.539
Statistical analysis (0.5 level)	N.S.	N.S.	N.S.

of the active root system at the 45-cm (18 in.) depth is located between 80-120 cm (32-48 in.) from the tree.

In contrast to the previous data in Figure 2, soil water tension at the 30-cm (12 in.) depth measured four and six days after irrigation at the same points relative to the tree show a different water extraction pattern (Figure 3). Tensions varied little at locations between 140 and 240 cm (55 and 94 in.) from tree at four days after irrigation. However, two days later a rapid increase in soil water tension occurred at locations between 160 and 210 cm (63 and 83 in.) from the tree or in an area just outside the first emitter. This indicates that a very active root system is operating at the 30 cm (12 in.) depth for pecan trees in this type of soil. This location also corresponds to the drip-line area where maximum root activity should be occurring.

The variation in depth of maximum root activity points out that roots nearer the surface tend to follow the drip-line or move out as the tree spreads its canopy. To study this further, soil water tensions were monitored at the 45-cm (18 in.) depth using tensiometers which were spaced 38 cm (15 in.) from the emitters in different directions. Figure 4 shows all of the tensiometer positions with those used for this study numbered to correspond to the data in Figure 5. In reviewing the data in Figure 5, the graph for position 4 confirms the data presented in Figure 2 showing greatest root activity nearer the tree at this depth. Little variation occurred at the other positions apparently due to reduced root activity in these areas. The data in Figure 5 represents only one tree and should be evaluated in this perspective.

Summary

Results of soil water management, fertigation and water movement studies are presented with the following conclusions:

1. Equal tree growth was obtained with all water treatments.

2. Yield but not quality is influenced by moisture levels.

3. When nutrients were applied through the drip irrigation system, lower nutrient rates provided levels of N and K in leaves as well as trunk growth equivalent to the higher nutrient rates.

4. Location of the active tree root system varies in distrance from the tree with soil depth.

5. Tensiometer location for scheduling irrigation in sandy soils should be 23 cm (9 in.) from the emitter at depths of 30-60 cm (12-24 in.).

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