The Agriculture Program
The Texas A&M University System

Soil & Crop Sciences

Influence of Irrigation Water Quality on Peanut Production in the Texas High Plains

Final Report

Submitted to:
Texas Peanut Producers Board
National Peanut Board

March 2002

Investigators:
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INTRODUCTION

The Southern High Plains of Texas has experienced a significant increase in peanut acreage over the past four years. Much of this increased acreage and interest in peanut production has been associated with the cross-county transfer and cropping flexibility provisions of the 1996 Farm Bill. In 1998, more than 190,000 acres of peanuts were planted in the area which comprises about 16 counties. The six counties of Andrews, Gaines, Dawson, Terry, Yoakum and Cochran produced over 169,000 acres of peanuts in 1998, representing 89% of the total South Plains acreage. Peanut production from this region accounts for approximately 57% of total statewide production.

Because of the dependence on irrigation in the region, water quantity and quality are a constant concern. Marginal quality water is becoming a problem throughout many areas of Texas, but especially the High Plains region. Three primary factors affect water quality: total soluble salts (salinity), sodium hazard (SAR) and toxic ions (chloride, sulfate, sodium and boron). The susceptibility of crops to marginal quality water varies, with cotton exhibiting significantly more tolerance to salinity and toxic ions than either corn or grain sorghum (USDA, Handbook 60). Literature regarding water quality effects on peanut is extremely limited. Greenhouse experiments conducted in Israel indicated that yield of peanut grown in artificially salinized plots was reduced to 50% at salinity levels of 4.7 mmhos/cm, and 20% at salinity levels of 3.8 mmhos/cm. (Shalhevet et al., 1969). Boron fertility studies conducted by McGill and Bergeaux (1966), and Morrill et al. (1977) indicated sensitivity of peanut to excess soil boron, with a range of 0.6 to 1.5 kg B/ha resulting in reduced yields and potential toxicity.

Due to the rapid increase in peanut acreage in west Texas, and the need to maintain proper crop rotation, many producers are utilizing moderately productive farmland. Field observations during the past several seasons has showed peanut to be extremely sensitive to marginal quality irrigation water (Lemon, 2001). This study was initiated to assess the influence of water quantity and quality on peanut yield and grade in the Texas High Plains.

MATERIALS AND METHODS

A study of 205 field sites was conducted in 2001 in Dawson, Gaines, Terry and Yoakum Counties to assess the influence of irrigation water quality and quantity on yield and grade of peanut. Soil and water samples were obtained from each location between June 15 and June 30.

Water samples represented water entering the pivot. It is common to have one to several wells comprising a system, thus samples were collected at the pivot point after the system had been flushed for one hour. Water samples were collected in sterile plastic bottles. Samples were analyzed within two days of collection at the Texas Cooperative Extension Soil, Water and Forage Testing Laboratory in College Station, TX. The irrigation water analysis included soluble cations (Ca, Mg, Na, K), soluble anions (B, Cl, SO_4, NO_3), pH, and electrical conductivity (EC).

Soils represented the Amarillo series, and consisted of Amarillo fine sandy loam (fine-loamy, mixed, thermic Aridic Palenstalfs), and Amarillo loamy fine sand (fine-loamy, mixed, thermic Aridic Palenstalfs) intergrades. These soils have less than 0.5% organic matter and a pH of 7.5 to 7.9. This series possesses a significant clay accumulation at 14 to 16 inches deep. Soil samples were collected from the surface 6 inches according to Texas Cooperative Extension guidelines and analyzed for nutrient status (N, P, K, Ca, Mg, Na, Zn, Mn, Fe, Cu, S, B). In addition, samples were subjected to a detailed salinity analysis utilizing the saturated paste extract to determine soluble cations (Ca, Mg, Na, K) and anions (Cl, SO_4) and electrical conductivity.

All locations were planted between the last week of April and the first week of May with different market-type varieties (runner - Flavor Runner 458, Sunoleic 97R, Virugard; virginia - NC7 and VC 2). Management programs were different across locations, but followed general Texas Cooperative Extension Service guidelines for west Texas. Fields were dug and combined by the producer or custom harvesting operators. Across locations, days from planting to digging ranged from 155 to 175 days. Fields experiencing severe water quality related problems were dug early to prevent additional pod loss.

Regression analyses were used to determine relationships between various soil and water parameters, and peanut yield and grade. Multiple regression analyses were performed, but were deemed inappropriate due to excessive multicolinearity and overall lack of significance. Only significant linear regressions are presented.

RESULTS AND DISCUSSION

Peanut Yield

Regression analyses indicated significant yield correlations associated with boron in irrigation water, soil SAR and well capacity. Peanut yield response to boron in irrigation water is presented in Figure 1. Yields were negatively correlated with increasing boron concentrations ($P<0.0819$). Boron concentrations ranged from 0.14 to 1.39 mg/l across locations. The regression equation [yield = 4516 – 553 (boron)] indicated that for each 0.1 mg/l increase in boron concentration, yield was reduced by approximately 55 lbs./acre. A clustering of data points at 0.75 mg/l boron suggested a possible critical threshold level. Critical boron levels in irrigation water for cotton and grain sorghum are 3 mg/l, and 2 mg/l for corn (McFarland et al. 2002).

Similar to boron, peanut yield was significantly reduced with increasing soil SAR (Fig. 2, $P<0.0334$). Sodium adsorption ratios in soil ranged from 0.56 to 9.22 across the 205 locations. The critical soil SAR value for cotton, grain sorghum and corn is 10 (McFarland et al. 2002).

Based on regression analysis, for each one unit increase in SAR, peanut yield was reduced by approximately 96 lbs/acre. The sodium adsorption ratio is a calculated value used to express the relative proportion of sodium compared to calcium and magnesium. The distribution of data points was clustered between SAR values of 2.0 to 4.0. Although fewer data points exist beyond this range, the regression suggests that the critical SAR for peanut is less than that for cotton, grain sorghum and corn.

Peanut yield was significantly reduced with increasing irrigation water salinity or EC (Fig. 3, $P<0.0047$). Irrigation water salinity values ranged from 609 to 3,100 umhos/cm, representing a broad range in salinity, but well below the critical EC value for cotton which is 5,100 umhos/cm. McFarland et al. (2002) considered EC values of greater than 2,100 umhos/cm to be potentially injurious to peanut. Regression analysis support this critical threshold level.

Peanut producers in the Southern High Plains traditionally set their yield goals in excess of 5,000 lbs/acre. Well capacity is critical in meeting this goal since peanut is a fully irrigated crop in west Texas. Yield was positively correlated with increasing well capacity (Fig. 4, $P<0.0009$). Within the study, well capacities ranged from 3.8 gallons/minute/acre to 10.7 gallons/minute/acre.

Peanut Grade

Peanut kernel quality was significantly correlated with irrigation water sodium and soil sodium concentrations. Total sound mature kernels (TSMK) were reduced with increasing sodium in irrigation water (Fig. 5, $P<0.0311$). Sodium levels ranged from 37 to 306 mg/l across locations, and peanut grades ranged from 64 to 82 TSMK. The soil sodium concentration ranged from 19 to 482 across locations, and also correlated with reduced grades (Fig. 6, $P<0.0175$). Grade reductions associated with increasing sodium concentrations in both water and soil, may be related to reduced Ca uptake by the kernels. Increased levels of Na, Cl, Mg and K associated with saline water may have an antagonistic interaction with soil solution Ca. Several studies have reported the detrimental effects of high concentrations of K and Mg on peanut kernel quality (Bolhuis and Stubbs, 1955; Hallock and Allison, 1980; Lynd and Ansman, 1989).

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Figure 1. Peanut Yield as Influenced by Boron in Irrigation Water

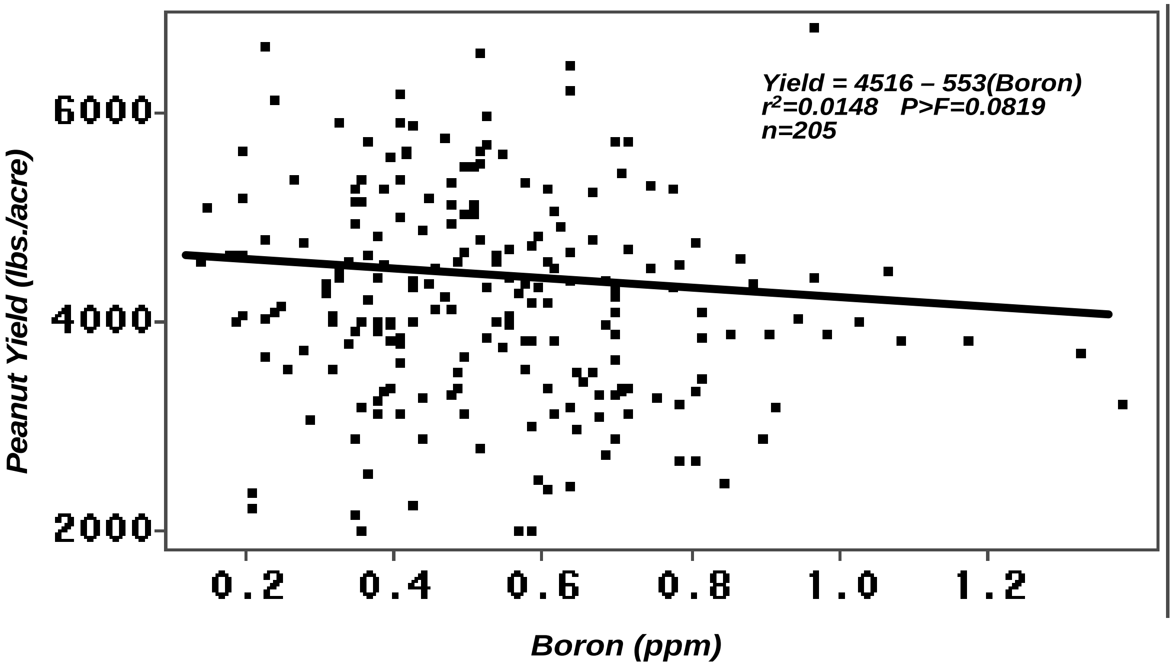

Figure 2. Peanut Yield as Influenced by Soil SAR

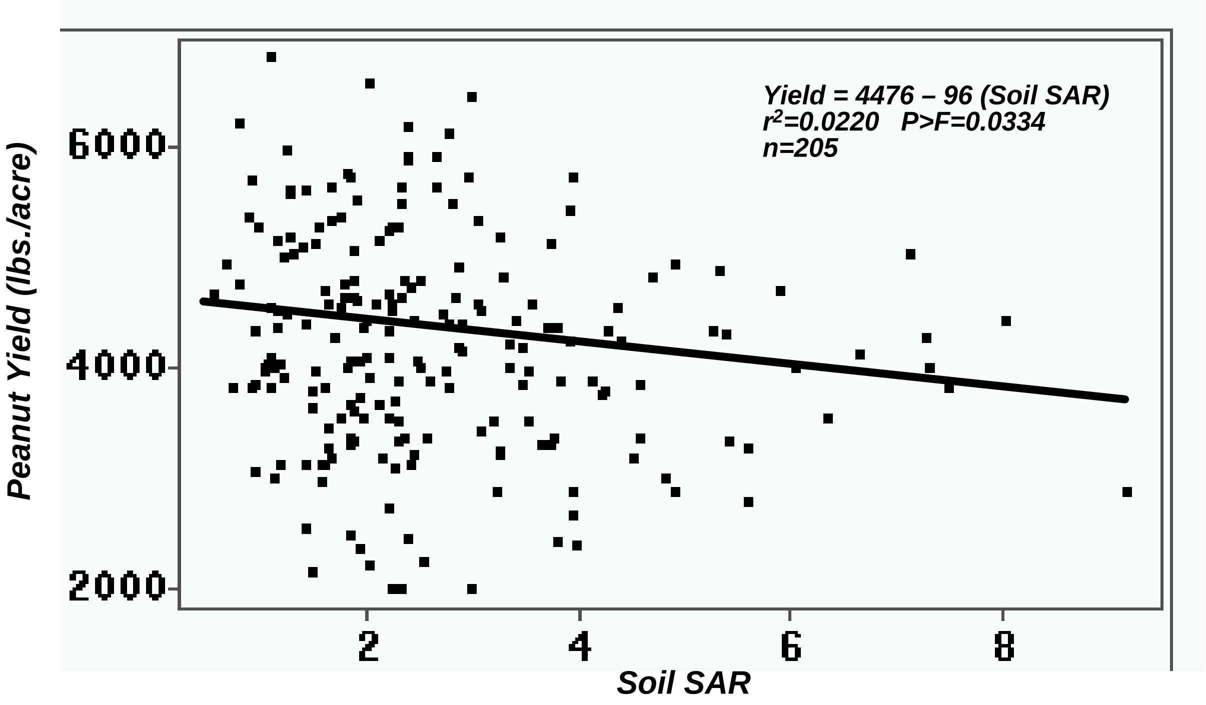

Figure 3. Peanut Yield as Influenced by Irrigation Water Salinity (EC)

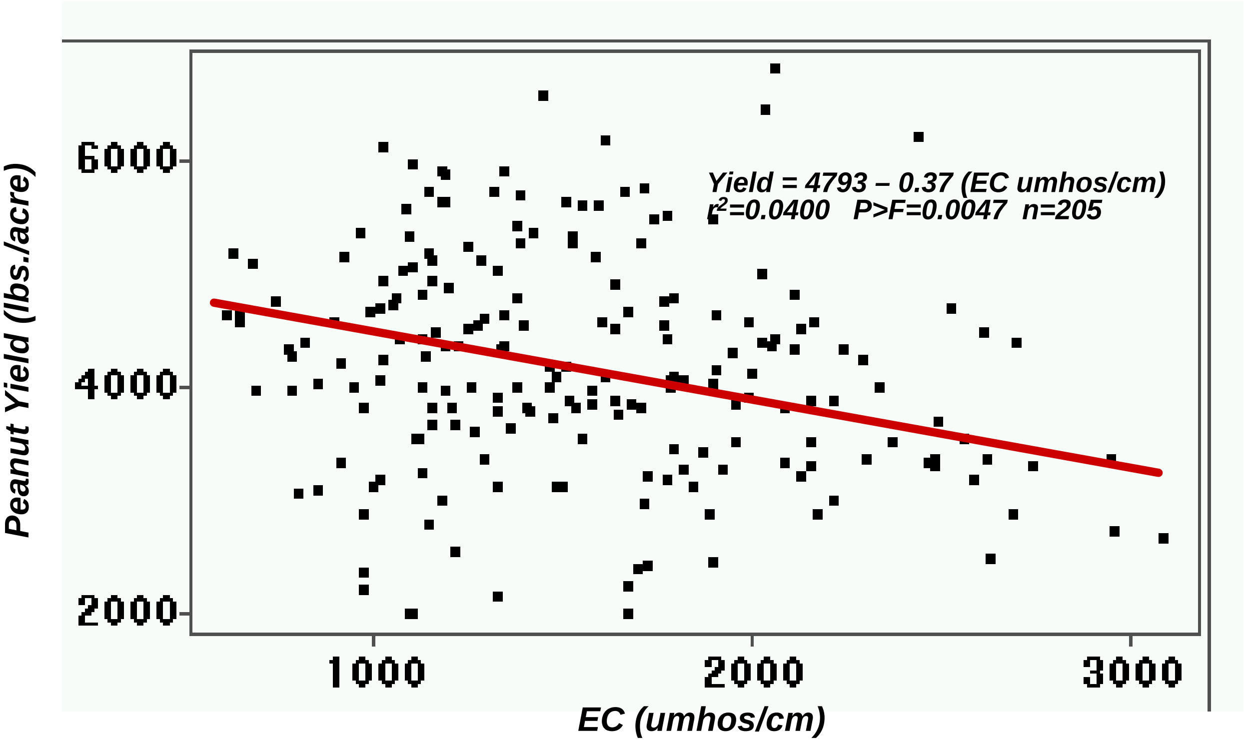

Figure 4. Peanut Yield as Influenced by Irrigation Well Capacity

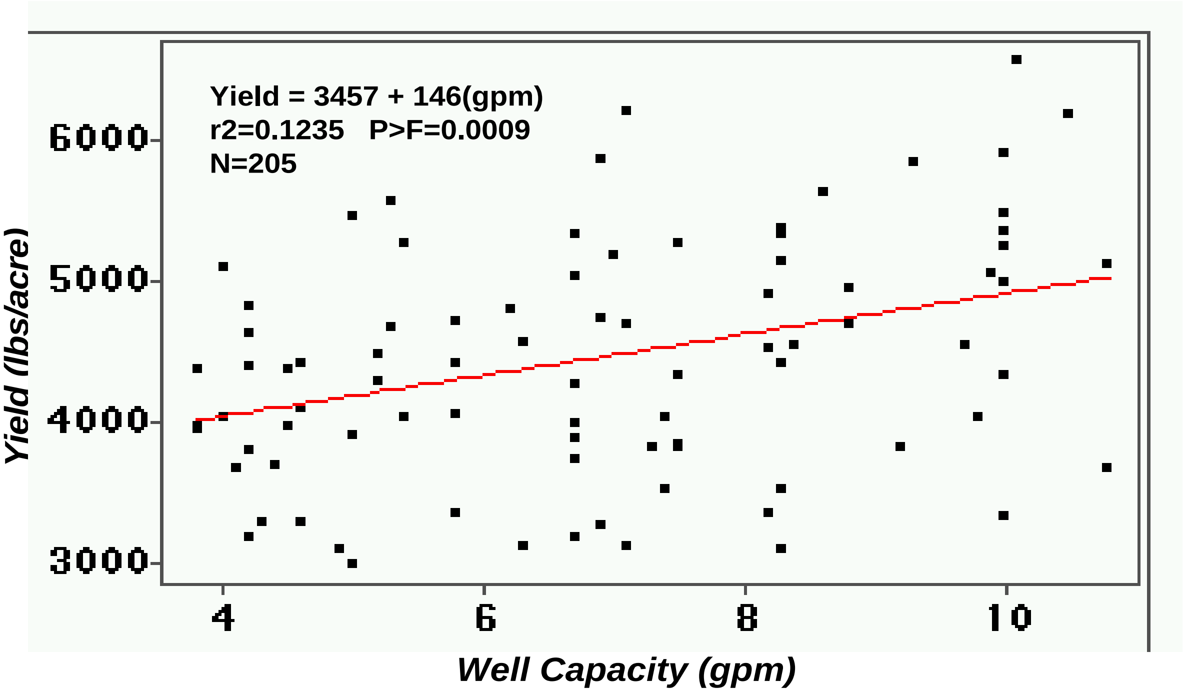

Figure 5. Peanut Grade as Influenced by Irrigation Water Sodium Concentration

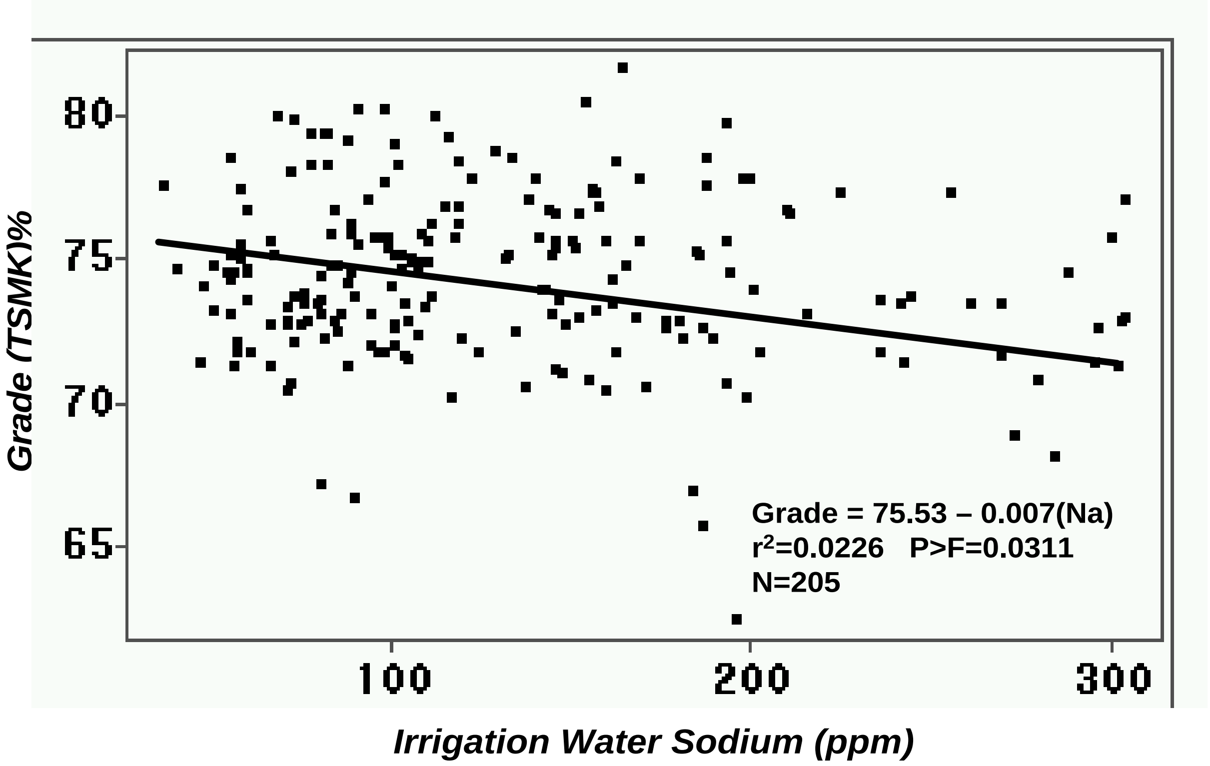

Figure 6. Peanut Grade as Influenced by Soil Sodium Concentration