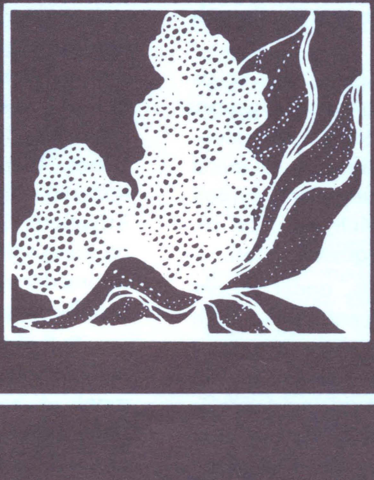
Yields, Growth, and Management Requirements of Selected Crops as Influenced by Soil Properties


The Texas Agricultural Experiment Station · J. E. Miller, Director · College Station, Texas · The Texas A&M University System

CONTENTS

SUMMARY

The role and importance of soil properties on adaptability, management requirements, and performance of different crops have been frequently cited in the literature. However, research data on adaptability and management requirements as influenced by soil properties have rarely been presented. This publication is a summary of about 20 years of field research studying the requirements of different crops on soils with markedly different physical and chemical properties.

Under normal rainfall on fertile medium-textured soils many crops in South Texas can be grown with no irrigation, or with one irrigation applied during the critical demand period. Extensive root growth allows the plants to exploit a deep reservoir of available water. Frequently rainfall supplies available water before the effective root zone is in need of replenishment. Studies using drainage lysimeters have shown that during dry years about 10 percent of the water used by crops came from water tables, which are often 4 to 7 feet deep on these soils. The development of a deep root system and use of water from water tables by annual crops can reduce irrigation needs on medium-textured soils.

On soils such as the Harlingen and Mercedes clays, crops require greater management and need more frequent irrigations to maintain adequate levels of available moisture in the effective root zone. Restricted root growth because of mechanical and/or chemical impedance means the growing plants exploit a shallow reservoir of available water which must be replenished frequently during periods of inadequate rainfall.

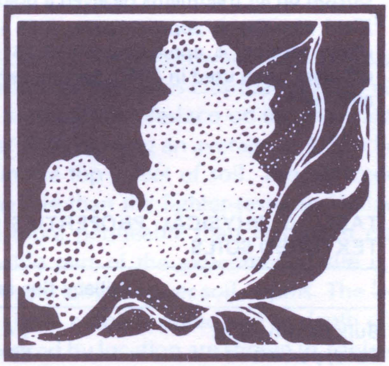
The Mercedes and Harlingen clay soils, under proper management, are excellent cotton soils. Recent studies with early maturing cotton types have shown that three irrigations can produce yields of 1½ to 2 bales of cotton in 130 to 140 days under adverse conditions. Cotton root-rot incidence is rarely in evidence; therefore, losses due to this crop disease on these soils are negligible. In contrast, timely rainfall and a deep reservoir of available water on fertile, medium-textured soils often supply the moisture requirements of cotton. In fact, irrigation and excessive rainfall on these soils tend to produce rank cotton, which often means significant yield reductions. Planting early maturing cotton such as Tamcot SP-37 after a winter crop induces stress which reduces vegetative growth and, produces better fruiting and yields. Cotton root-rot can cause significant yield reductions on these soils.

Tomatoes on vertisol type soils, unlike cotton, produce very poor yields. In the spring, pear type tomatoes on these soils have high incidence of blossom-end rot. However, tomatoes on medium-textured soils under proper management produce high yields with low incidence of blossom-end rot.

Crops such as grain sorghum, sweet sorghum, and sugarcane can be produced on medium- and fine-textured soils. However, the water management requirements are markedly influenced by soil properties. As pointed out earlier, crops on clay soils require frequent light irrigations. Because of their low permeability, the salinity hazards on soils such as Harlingen and Mercedes clay soils are considerably greater. Occasionally, additional water must be added to keep salt accumulation as low as possible in the effective root zone. This is especially important for crops like sugarcane which have a high water and irrigation management requirement. On adequately drained, medium-textured soils and sometimes even on clay soils rainfall is sufficient to leach salts below the effective root zones. Grain sorghum and sweet sorghum on medium-textured soils often produce as much without irrigation as with irrigation. Timely rainfall and a deep available water reservoir on these soils often supply the needs of these crops. However, during dry years, a timely irrigation at the preboot to boot stage usually supplies the water need of these crops.

Soil physical properties such as compaction or removal of surface soil can significantly alter the management requirements of crops grown on these fields. Removal of surface soil often exposes a less fertile clay or clay loam surface for crop production. Soils with these type surfaces or compacted zones require more frequent light irrigations and special fertility management.

Yields, Growth, and Management Requirements of Selected Crops as Influenced by Soil Properties



*C. J. Gerard, B. W. Hipp and S. A. Reeves**

The effect of soil properties on performance of many crops has been frequently cited. Despite these citations little has been written describing the actual performance of crops on different soils. Maletic and Hutchings (17) stated that irrigation induces changes in physical, chemical, and biological soil characteristics which are interrelated and complex. They pointed out that land selected for irrigation should be permanently productive under the anticipated changes in physical regime under irrigation. Danielson (6) emphasized high use efficiency of irrigation water by minimizing water penetration below the root zone. He further emphasized that knowledge of rooting depth is important in designing irrigation systems, and Kramer, Biddulph, and Nakayama (16) stated that the most important feature of annual crop root systems is their rapid extension into previously unoccupied soil. It is this continuous invasion of new soil masses that enables plants to grow for days or weeks without rain or irrigation. Numerous researchers have emphasized the importance of soil texture and structure, available water, and salinity on water absorption and root growth. There are many generalizations and theoretical discussions in the literature of the effect of soil properties on plant growth. However, many of these discussions overgeneralize and present little or no field data demonstrating the significance of soil properties on performance and management of different crops. It is the purpose of this publication to present and discuss data describing the role and significance of soil properties in the production of several crops.

EXPERIMENTAL PROCEDURES

Cotton

The influences of moisture regimes on yields of cotton grown on medium-textured, moderately permeable Willacy and Hidalgo soils were studied in 1949-50, 1955-57, 1959, and 1961-63 (9). Treatments on Willacy loam soil are described in Table 1. Cotton irrigation studies described in Table 2 were also conducted on Harlingen clay, a fine-textured soil, in 1960, 1961, and 1964 (7, 8). Physical properties of the two

*Respectively, professor, The Texas Agricultural Experiment Station, Vernon; and associate professors, The Texas Agricultural Experiment Station, Weslaco.

TABLE 1. DESCRIPTION OF MOISTURE LEVEL TREATMENTS FOR COTTON GROWN ON WILLACY LOAM SOIL

Moisture level	Description of treatments
A	Irrigated when the water content of top 2 feet of soil approached 65 percent of available water before bloom stage; no irrigation thereafter.
B	Irrigated when water content of top 2 feet of soil approached 35 percent of the available water before bloom stage; during bloom irrigated when the water content of top 2 feet approached 65 percent of available water until most of the bottom bolls were mature.
C	Irrigated when the water content of top 2 feet of soil approached 35 percent of the available water until the bottom bolls were mature. After this, until ¾ of the bolls were mature, irrigated when the water content of the top 2 feet of soil approached 65 percent of available water.
D	Irrigated throughout the season when the water content of top 2 feet of soil approached 20 percent of available water.

soils are indicated in Table 3. Studies concerning the responses of early and late maturing cotton varieties to moisture levels were conducted from 1972 to 1974 on Harlingen clay at Progreso (7, 11) and on Willacy loam soils at Weslaco in 1975.

The medium-textured soils are moderately to well-drained deep sandy loam, sandy clay loam, or clay loam soils which hold a good reserve of soil moisture. The sand content of these soils decreases with depth from 70 percent in the surface foot to about 40 percent in the fifth foot; the clay content increases from 15 percent in the surface foot to about 30 percent in the fifth foot.

The fine-textured soils exhibit high swelling and shrinkage, severe cracking when dry, and very poor surface and internal drainage. The sand, silt, and clay contents are relatively constant to a depth of 5 feet.

Moisture regimes were based on available water in the top 2 feet of soil. Soil moisture at different depths was determined using the neutron scattering technique. The experimental designs were randomized block or Latin square designs.

Grain Sorghum

Irrigation-plant population experiments on grain sorghum were conducted on Harlingen clay soils near Progreso, Texas, in 1968 and 1969. The soil was uniformly treated with 100 pounds of P_2O_5 per acre in 1968 and 1969. DeKalb F-64 grain sorghum was planted at rates of 125,000 and 250,000 plants per acre on single and double rows on top of 38-inch beds, respectively. In 1968 and 1969, planting dates for these experiments were April 4 and April 24, respectively. Moisture level treatments were in a Latin square design. Water was metered onto plots, and moisture use was estimated by the neutron scattering technique. The influence of planting date on yields was investigated in 1969.

In 1970 near Progreso, the influence of plant population on Harlingen clay soil was investigated. Grain sorghum variety DeKalb F-64 was planted April 23, 1970. Single- and double-row plantings at 100,000 and 200,000 plants per acre were compared. In addition, the influences of 90,000 to 450,000

TABLE 2. DESCRIPTION OF MOISTURE LEVEL TREATMENTS FOR COTTON ON HARLINGEN CLAY SOIL[1]

Treatment	Description
A	No water was applied after first bloom.
B	Irrigation brought the surface 5 feet of soil to field capacity when the average moisture content of top 2 feet approached 75-50 percent[2] of the available moisture.
C	Irrigation brought the surface 5 feet of soil to field capacity when the average moisture content of the surface 2 feet approached 50-25 percent[2] of the available moisture.
D	Irrigation brought the surface 5 feet of soil to field capacity when the average moisture content of surface 2 feet approached 25-0 percent[2] of available moisture.

[1]Cotton on all treatments received a preplanting irrigation.

[2]Field capacity is approximately 4.75 inches per foot; 15 atmosphere tension is approximately 3.25 inches per foot. First percentages were used in 1960. Second percentages were used in 1961 and 1964.

TABLE 3. PHYSICAL PROPERTIES OF MEDIUM- AND FINE-TEXTURED SOILS

	Willacy fine sandy loam	Harlingen clay
Bulk density, g/cc	1.4 to 1.6	1.4 to 1.6
Sand, percent	60	2
Silt, percent	20	38
Clay, percent	20	60
Available water, in/ft	1.5 to 2.0	1.5
Infiltration rate, in/hr	>2.0	<0.1

plants per acre on yields were evaluated on double-row plantings. These experiments were in randomized block designs.

On March 22, 1973, and April 1, 1974, at the Texas Agricultural Experiment Station at Weslaco, Oro-T sorghum was planted on Willacy loam soil at rates of about 70,000 to 100,000 plants per acre in single 40-inch rows. Six drainage lysimeters, large metal boxes (60 inches by 80 inches and 48 inches deep) holding undisturbed soil, were buried 10 inches below the soil surface to permit cultivation, planting, and normal field operations. Suction cups at the bottom of lysimeters were used to extract and maintain normal soil moisture conditions at a soil depth of 5 feet. Lysimeter installation was more fully described in previous publications (5, 10). Grain sorghum was furrow-irrigated using a water meter and aluminum gated pipe.

In 1974, sorghum was drip-irrigated to supply 0, 50, 100, and 150 percent of sunken pan evaporation. Sunken pan evaporation was evaluated daily at an official National Weather Service Station about 500 yards from the experimental site. Sunken pan evaporation is about 60 percent of a Standard Class A pan evaporation. Drip irrigation levels were applied under pressure using Submatic emitters. Yields of sorghum were determined in each lysimeter and in similarly treated areas of sorghum adjacent to the lysimeters.

Tomatoes

Irrigation spacing experiments with different types of tomatoes were conducted on Willacy fine sandy loam soils from 1959-64 (12). Irrigation spacing studies with Chico tomatoes were conducted on this soil in 1962, 1963, and 1964. This report will be restricted to these particular years. Additional results were previously discussed (12, 13). Experiments were in randomized block designs. Yields and blossom-end rot of pear tomatoes were evaluated.

The influences of moisture levels and other factors on production of pear tomatoes were conducted on Harlingen clay soils from 1965 to 1969. Experimental designs for these investigations were in randomized block or Latin square designs. Yields and extent of yield loss as a result of blossom-end rot of pear tomatoes were determined.

Sugarcane

During 1972, 1973, and 1974, a furrow and drip irrigation experiment was conducted on Mercedes clay loam to clay soil located about 3 miles northeast of Weslaco on the May farm. The soil at this site is variable, holding an average of 3.7 inches of available moisture in the top 2 feet of soil. The Mercedes clay loam is less permeable than the lighter-textured Willacy and Hidlago soils but more permeable than Harlingen clay soil. The more permeable part of the experimental site is a medium-textured soil, especially at lower soil depths. The less permeable part of the site is a fine-textured soil to depth of 5 feet. Properties as influenced by location are shown in Table 4.

All plots of cane were irrigated after planting in November 1971 and after cutting of plant cane and ratoon cane crops in November 1972 and January 1974, respectively. The plots were treated for weed control and fertilized with 80, 100, and 120 pounds of nitrogen per acre in 1972, 1973, and 1974, respectively. Descriptions of treatments are given in Table 5. Sugarcane under drip irrigation treatments was watered to replace water lost by evaporation as measured from a sunken pan. Unless rainfall supplied potential pan evaporation (considered potential evapotranspiration) (14, 15), cane plots were drip-irrigated with Submatic emitters on Monday, Wednesday, and Friday. On Monday, metered water was applied to desired plots to replace percentages of pan evaporation recorded on the previous Friday, Saturday, and Sunday. Water was applied on Wednesday to replace percentages of recorded pan evaporation the previous Monday and Tuesday, and water was applied on Friday to replace percentages of recorded pan evaporation on the previous Wednesday and Thursday. Cane grown under the furrow irrigation treatment described in Table 5 was irrigated when about 20 to 30 percent of the available water remained in the top 2 feet. The water was metered onto each plot. Because of high rainfall in 1972 and 1973, furrow-irrigated sugarcane was only watered three and two times, respectively; however, it was irrigated six times in 1974, a dry year. Rainfall and irrigation water on different treatments for 1972, 1973, and 1974 are reported in Table 6. Height of cane from soil level to last visible dewlap at the top was determined at various time intervals. Yields as influenced by treatments and soil properties were evaluated.

TABLE 4. SOIL PROPERTY EVALUATIONS AT SITE OF THE SUGARCANE IRRIGATION STUDIES, LOWER RIO GRANDE VALLEY OF TEXAS

		1973	1974	
Soil depth, in	Density, gm/cc	Ks[1] cm/hr	Ks[1] cm/hr	Salinity mmhos/cm
		High permeability		
0-6	1.39	0.29	0.17	1.4
6-12	1.51	0.04	4.27	1.2
12-24	1.34	10.45	6.27	1.2
24-36	1.46	3.63	3.22	1.1
36-48	1.45	2.73	3.27	1.0
48-60			1.76	
		Moderate permeability		
0-6	1.34		2.54	1.2
6-12	1.33		1.23	1.4
12-24	1.45		3.34	1.3
24-36	1.47		0.30	1.7
36-48	1.50		0.67	1.2
48-60			3.43	
		Low permeability		
0-6	1.31	0.04	1.10	1.4
12-24	1.33	0.10	6.65	1.4
24-36	1.43	0.51	5.98	1.9
36-48	1.46	0.66	0.24	3.8
48-60	1.51	0.04	0.03	6.1
			0.02	

[1]Saturated hydraulic conductivity.

TABLE 5. DESCRIPTION OF FURROW AND DRIP IRRIGATION TREATMENTS ON SUGARCANE IN 1972, 1973, AND 1974, LOWER RIO GRANDE VALLEY OF TEXAS

	Pan evaporation	
Type of irrigation treatment	1972, percent	1973-74, percent
Non-irrigated[1]	0	0
Drip	25[2]	50[2]
Drip	50	75
Drip	75	100
Drip	100	125
Furrow[3]		

[1]This treatment was irrigated at planting on November 16, 1971, and in December 1972 and January 1974, after plant cane was cut.

[2]Refers to percent of pan evaporation.

[3]Cane was furrow irrigated when available water in top 2 feet was depleted to 30 percent. Sufficient water was applied to replenish available water in top 5 feet of soil.

Soil moisture under different treatments was determined with vacuum gauge tensiometers and neutron scattering equipment. Salinity and root growth as related to treatments and soil type and depth were evaluated in 1972, 1973, and 1974.

Sweet Sorghum

The influence of relative degrees of soil removal during leveling and of moisture levels on yields of sweet sorghum on Willacy fine sandy loam soil were evaluated in 1967. The

TABLE 6. AMOUNT OF WATER USED UNDER DIFFERENT DRIP AND FURROW IRRIGATION TREATMENTS IN 1972, 1973, AND 1974, LOWER RIO GRANDE VALLEY OF TEXAS

Treatments	Pan evaporation, percent	Water applied, in	Rainfall, in	Soil water use, in	Total water use, in
		1972*			
Non-irrigated	0	0.00	30.76		30.76
Drip	25	5.47	30.76		36.23
Drip	50	10.93	30.76		41.69
Drip	75	16.40	30.76		47.16
Drip	100	21.86	30.76		52.62
Furrow		13.71	30.76		44.47
		1973			
Non-irrigated	0	0.00	41.52	3.26	44.78
Drip	50	7.72	41.52	2.47	51.71
Drip	75	11.58	41.52	1.85	54.95
Drip	100	15.44	41.52	2.79	59.75
Drip	125	19.30	41.52	2.71	63.53
Furrow		7.13	41.52	2.36	51.01
		1974			
Non-irrigated	0	0.00	24.17	0.30	24.47
Drip	50	12.91	24.17	+0.50	36.58
Drip	75	19.36	24.17	+0.19	43.34
Drip	100	25.82	24.17	+0.75	49.24
Drip	125	32.27	24.17	+0.12	56.32
Furrow		31.48	24.17	0.13	55.78

*Soil water use was estimated as approximately equal to runoff in 1972. This runoff occurred during a 17-day period in June. Total rainfall in this period was 10.75 inches. Runoff during this period was estimated at 50 percent, which was the average amount of soil water used from about planting or after cutting in case of ratoon crop and harvesting.

sweet sorghum variety Rio was planted in April 1967. Individual sorghum plants were thinned to 3 inches between plants. Plots were irrigated with aluminum gated pipe and the water measured with a Sparling flow meter. Soil moisture at 6-, 18-, 30-, 42-, and 54-inch depths was determined at weekly intervals by the neutron scattering technique before and after each irrigation. The importance of the relative degree of cut areas on yields of sweet sorghum was compared.

RESULTS AND DISCUSSION

Cotton

Medium-Textured Soils. The influence of soil moisture regime on cotton grown on medium-textured soils varied from year to year. Cotton that was not irrigated after planting produced from more than 500 pounds in 1949 to about 1,000 pounds of lint cotton per acre in 1961. The maximum yield increase due to supplemental irrigation varied from a high of about 400 pounds of lint cotton per acre in 1962 to almost no response in 1950 and 1961.

The relation between rainfall during the first 40 days after appearance of first bloom and maximum increases[1] in yield due to irrigation on medium-textured soils is indicated in Figure 1. The data presented include only the years during which

[1]Maximum increase in yield for any specific year = maximum yield due to irrigation minus yield of non-irrigated cotton.

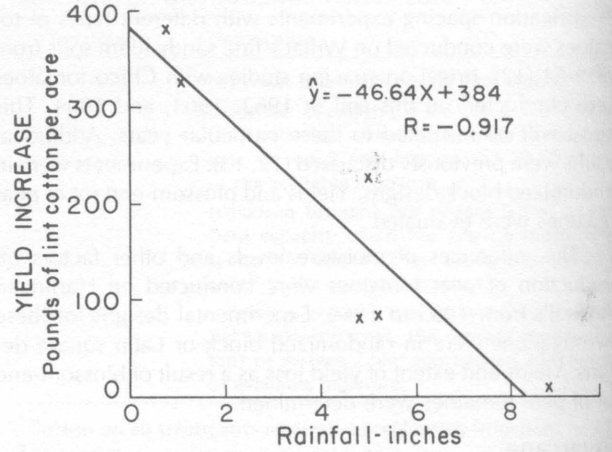


Figure 1. Relation between maximum increase in yield of cotton as a result of irrigation on medium-textured soils and rainfall during the first 40 days after appearance of first bloom.

there was a treatment that did not receive a post-planting irrigation. There was a high inverse relation between rainfall during this critical moisture demand period and yield response to irrigation. In comparison, the relation between total rainfall during the growing season and maximum yield increase due to irrigation only accounted for about 58 percent of the variability ($r = -0.762$).

The relation between yield and applied water plus rainfall after first bloom is indicated in Figure 2 for medium-textured soils. This response curve, which is typically parabolic, indicates that a minimum of 8 to 10 inches of water is required during the blooming and fruiting period to produce satisfactory to maximum yields.[2] Data in Figures 1 and 2 indicate that additional water produced little or no further increase in yield. During the blooming and fruiting period, rainfall supplied 5 to 6 of the needed 8 to 10 inches of water in about half of the years.[3] This helps to explain why yields of cotton on medium-textured soils are not significantly increased by irrigation during certain years in the Lower Rio Grande Valley of Texas.

In addition, rainfall in excess of 8 to 10 inches can confound the response of cotton to irrigation and cause significant reduction in cotton yields on medium-textured soils (Figure 3). Yields of Stoneville cotton on medium-textured soil ranged from 300 pounds per acre during the wet year of 1972 to 1,250 pounds per acre during the dry year of 1969. During wet years, cotton on medium-textured Willacy loam soil developed excessive vegetative growth, with a height of 6 to 7 feet, and produced very low yields. The influences of soils, climatic conditions, and management on response of early- and late-maturing varieties will be discussed later.

[2]Refers to yield of about 1,000 pounds of lint cotton per acre.

[3]Rainfall data from R. B Orton, State Climatologist, Weather Bureau Airport Station, Austin, Texas, and D. J. Haddock, Advisory Agricultural Meteorologist, National Weather Bureau Agricultural Service Office, Brownsville, Texas.

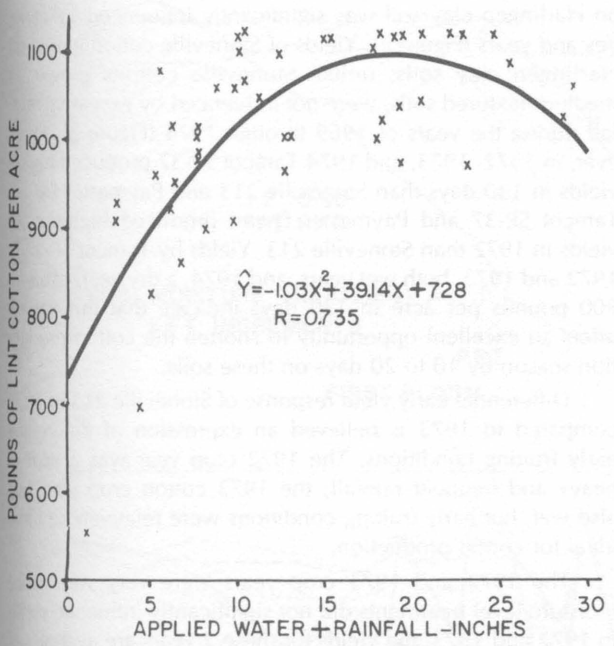


Figure 2. Relationship between yield of lint cotton and water applied plus rainfall during blooming and fruiting period on medium-textured soil.

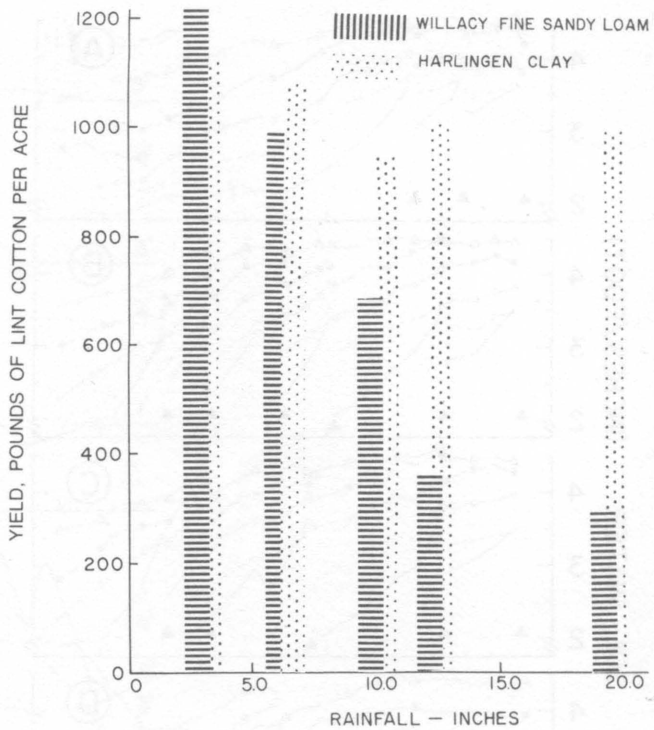


Figure 3. Influence of soil type and rainfall during blooming and fruiting period on cotton yields.

Typical root distribution by cotton on medium-textured soils is indicated in Table 7. Soil depletion studies by Amemiya, Namken, and Gerard (1) (Figure 4) and root distribution studies indicate that cotton irrigated during the early stages of plant growth appears to develop a shallower root system than cotton that is not irrigated prior to the fruiting stages of plant growth. They reported that cotton grown on medium-textured soils in the Lower Rio Grande Valley of Texas may extract water from depths below their primary root zone (0 to 3 feet) but that the rate of water extraction from these depths may not be sufficient to maintain plant growth during periods of peak demand because of lack of sufficient absorbing roots.

TABLE 7. TYPICAL ROOT DISTRIBUTION OF COTTON PLANTS ON MEDIUM AND FINE-TEXTURED SOILS, LOWER RIO GRANDE VALLEY OF TEXAS

	Percent roots at various depths, feet				
	0-1	1-2	2-3	3-4	4-5
Willacy fine sandy loam	62.1	22.8	7.9	4.9	2.3
Harlingen clay	99.0	0.7	0.2	0.1	0.0

Fine-textured soils. Cotton yields as influenced by soil moisture regimes on the fine-textured soil ranged from slightly over 300 pounds for treatments that did not receive any postplanting irrigation to more than 1,100 pounds per acre on the high moisture level plots. The maximum yield increases due to postplanting irrigations were 638, 727, and 465 pounds of lint cotton per acre in 1960, 1961, and 1964, respectively.

The importance of available water to cotton during the blooming and fruiting stages of plant growth on fine-textured soils is indicated in Figure 5. The relation between yields and the total amount of water applied (rainfall and irrigation) after first bloom indicates that a high level of available water must be maintained during the blooming and fruiting period to produce satisfactory yields (1,000 pounds or more of lint cotton per acre).

As pointed out previously, during certain years rainfall supplies 5 to 6 inches of water during the blooming and fruiting period. According to the yield curve in Figure 2, this amount of water plus available soil moisture would produce over 900 pounds of lint cotton per acre or approximately 80 to 90 percent of the yield potential on medium-textured soils. In contrast, the same amount of water plus available soil moisture would produce only about 500 pounds of lint cotton per acre, or 50 percent of the yield potential on the fine-textured soil (Figure 5).

The influence of soil moisture regime and stage of plant growth on moisture depletion from different depths on fine-textured soils is indicated in Figure 6. Dates of first bloom, irrigations, and significant rains are also indicated. The soil moisture depletion patterns in 1960 and 1961, years in which summer rainfall was scant, were almost identical. Moisture depletion at different soil depths is an index of active root development and relative wetness or dryness of the soil, according to Vazquez and Taylor (19) and Taylor and Haddock (18). Moisture depletion under dry treatment was restricted to the surface foot until 90 to 100 percent of the available water in that area was depleted. Significant amounts of water were not extracted from the third foot until the plants ceased growing and were severely wilted.

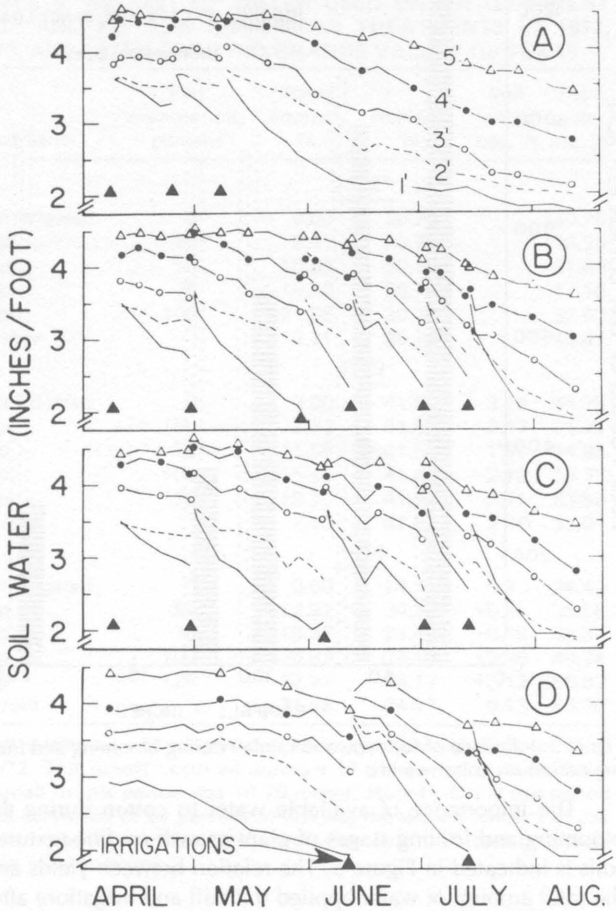


Figure 4. Soil water changes for a 5-foot profile on Willacy loam soil as influenced by soil moisture treatments and cotton in 1959. (See Table 1 for treatment description.)

Soil moisture depletion under frequently irrigated cotton was largely restricted to the top foot before and following the first irrigation. Extraction of water from the second and third feet increased as the plants increased in growth. Root development apparently increased in the second foot during the blooming and fruiting period. Percentage of roots by weight did indicate slightly higher percentages of roots in the second foot under moisture regimes where the cotton was irrigated during the blooming and fruiting period. However, moisture depletion patterns are probably better indices of root activity than the percentage by weight data shown in Table 7.

The results indicate that non-irrigated cotton was able to extract significant amounts of water from the second and third feet or below its primary root zone (surface foot). However, moisture extraction from the second and third feet was not sufficient to meet the needs of plants, especially for about 10 to 20 days after initiation of blooming when the available soil moisture supply of the surface foot was depleted. This was reflected in the cessation of growth and reduction in yield of cotton grown under dry treatments.

Studies with early maturing cotton types. Yields of cotton on Harlingen clay soil was significantly influenced by varieties and years (Figure 7). Yields of Stoneville cotton grown on Harlingen clay soils, unlike Stoneville cottons grown on medium-textured soils, were not influenced by excessive rainfall during the years of 1969 through 1974 (Figure 3). However, in 1972, 1973, and 1974 Tamcot SP-37 produced higher yields in 130 days than Stoneville 213 and Paymaster Dwarf. Tamcot SP-37 and Paymaster Dwarf produced higher early yields in 1972 than Stoneville 213. Yields by Tamcot SP-37 in 1972 and 1973, both wet years, and 1974, a dry year, of about 800 pounds per acre in 130 days indicate that this variety offers an excellent opportunity to shorten the cotton production season by 10 to 20 days on these soils.

Differential early yield response of Stoneville 213 in 1972 compared to 1973 is believed an expression of differential early fruiting conditions. The 1972 crop year was a year of heavy and frequent rainfall; the 1973 cotton crop year was also wet, but early fruiting conditions were relatively dry and ideal for cotton production.

The 1972 and 1973 crop years were very wet. Since moisture level treatments did not significantly influence yields in 1972 and 1973, the yields for these 2 years are averages of all moisture levels; however, the yield data for 1974, a dry year, are from the highest moisture level, or cotton that received the equivalent of three irrigations during the blooming and fruiting period (Figure 7). Rainfall of 5.7 inches during this

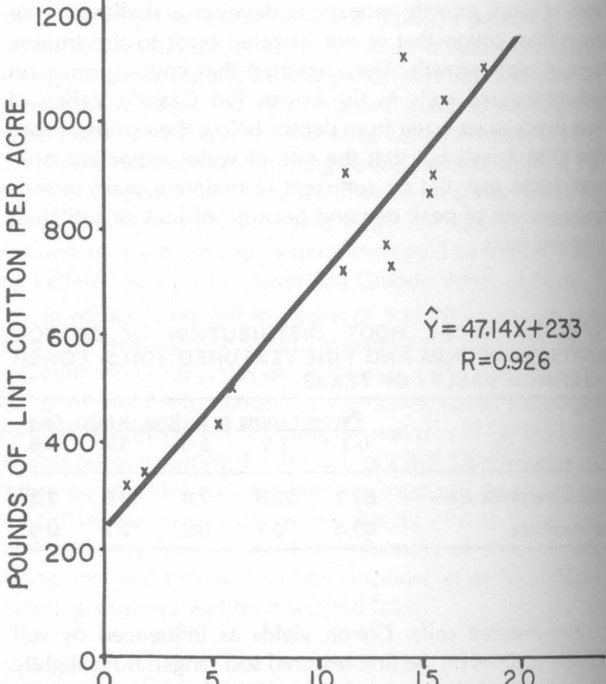


Figure 5. Relationship between yield of lint cotton per acre and water applied plus rainfall during blooming and fruiting period on Harlingen clay soil.

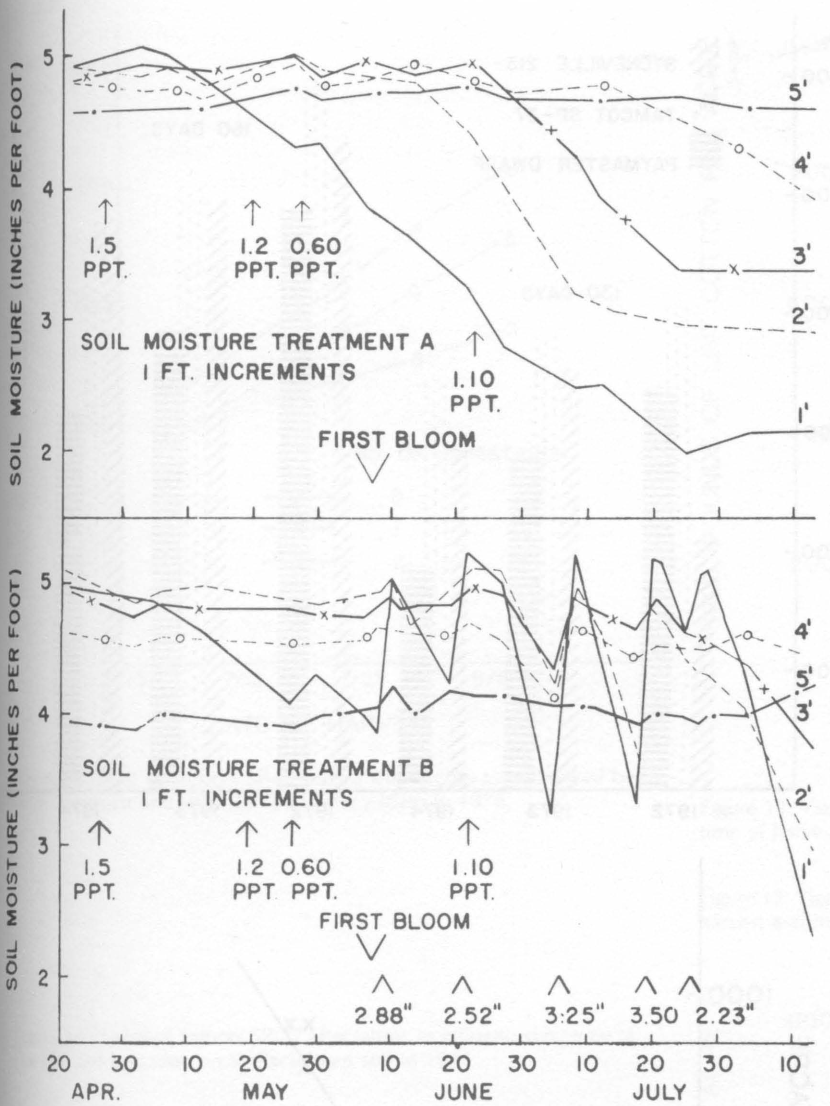


Figure 6. Soil water changes for a 5-foot profile on Harlingen clay soil as influenced by soil moisture treatments and cotton in 1960. (Treatment descriptions are in Table 2.)

period in 1974 was considered equivalent to one irrigation. Irrigation requirements for cotton production on clay soils have been reported to number four to six irrigations during the blooming and fruiting period (9). Early and total yields of all varieties declined from 1972 and 1974 (Figure 7). This was especially true of Paymaster Dwarf. Lower plant densities may have contributed to lower yields by this variety. Lower yields in 1974 by all varieties may also have been partially caused by stress for available soil moisture.

Yields of Stoneville 213 and Tamcot SP-37 in 1974 were a linear function of applied water plus rainfall during the blooming and fruiting period (Figure 8). This predictive yield equation is almost identical to the yield equation shown in Figure 5 (9). These equations emphasize the dominant role of water in cotton production on clay soils. The equivalent of three irrigations produced about 900 to 1,000 pounds per acre of lint cotton. On clay soils a 130- to 140-day cotton crop required 25 to 40 percent less water than a 150- to 160-day cotton crop.

Yields of Tamcot SP-37 and Stoneville 213 cottons, as influenced by treatments and varieties on Willacy fine sandy loam soil, are reported in Figures 9 through 12. Tamcot SP-37 was significantly earlier and higher yielding than Stoneville 213 and, despite high rainfall in July, produced over 800 pounds of lint cotton per acre. Highest yields of Tamcot SP-37 grown after winter fallow and winter crop were about 700 and 830 pounds per acre with no and one irrigation, respectively (Figures 9 and 10). In fact irrigated Tamcot SP-37 grown after winter fallow produced only 60 to 70 percent of the yield of non-irrigated Tamcot SP-37. On the other hand, average maximum yields of Stoneville 213 were only about 60 to 70 percent of maximum yields of Tamcot SP-37 (Figure 11). Irrigation of Stoneville 213 grown after winter fallow reduced yields by 40 to 60 percent (Figure 12). One irrigation caused a slight increase in yields of Stoneville 213 grown after a winter crop (Figure 11).

In summary, there is a complex interaction between varieties, irrigation, and previous cropping history. Reductions in cotton yields on soils that promote vegetative growth can be partially alleviated by planting early maturing cotton types such as Tamcot SP-37 after a winter crop. Stress for nitrogen

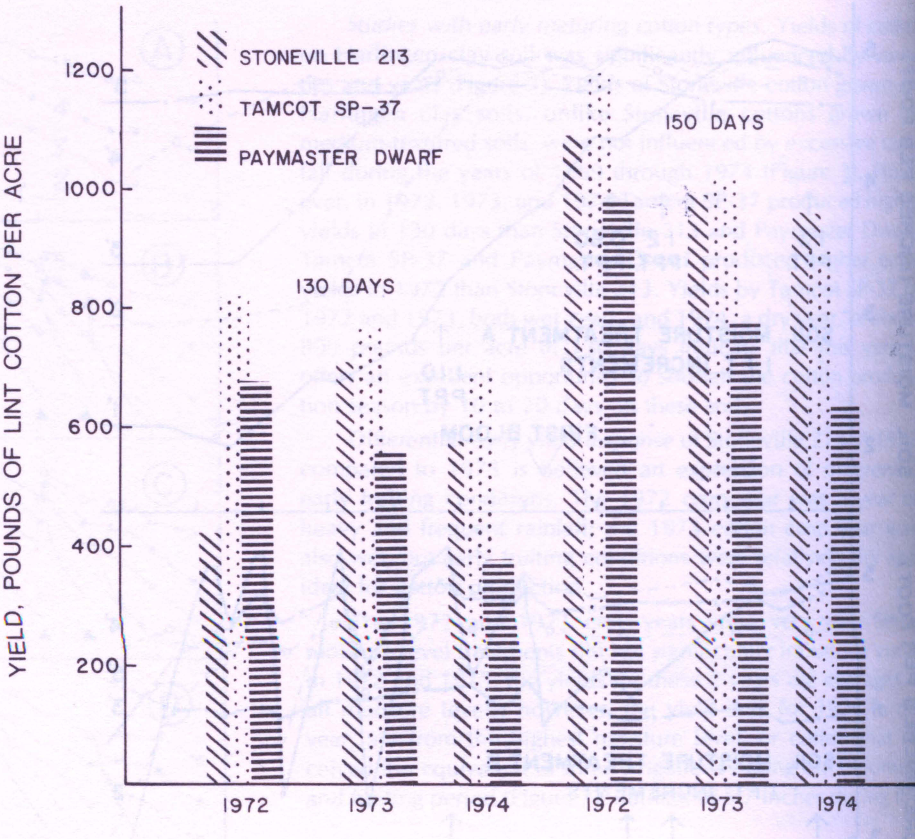


Figure 7. Influence of varieties and years on 130- and 150-day lint cotton yields.

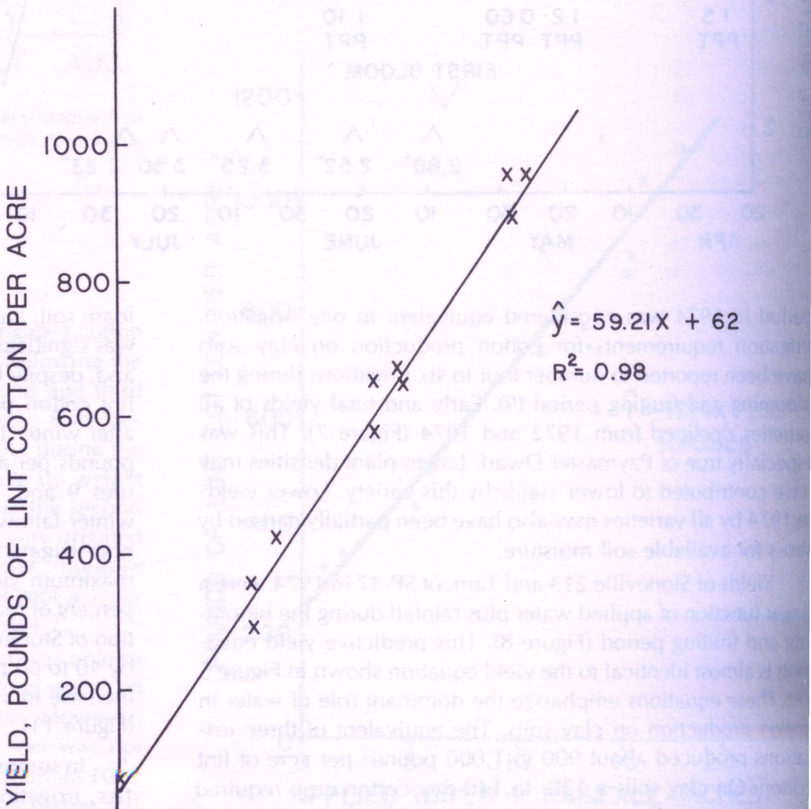


Figure 8. Relation between yield of lint cotton and water applied plus rainfall during blooming and fruiting period on Harlingen clay in 1974.

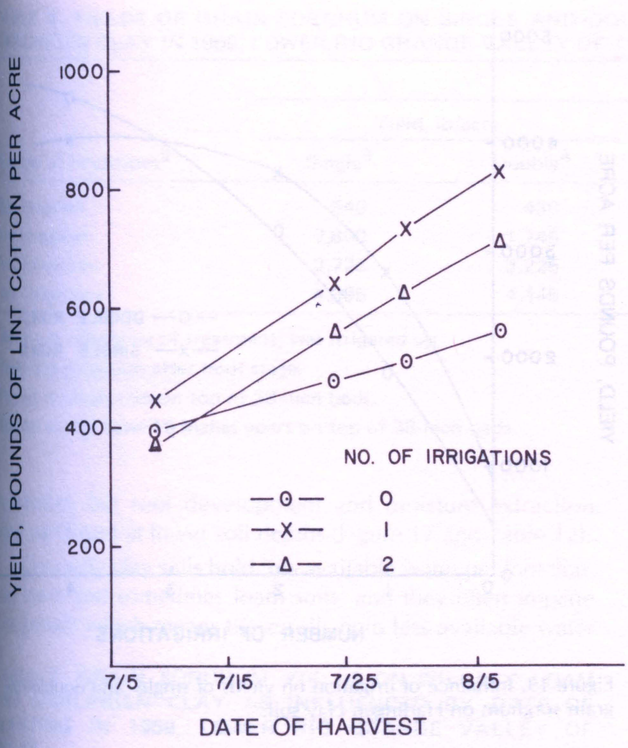
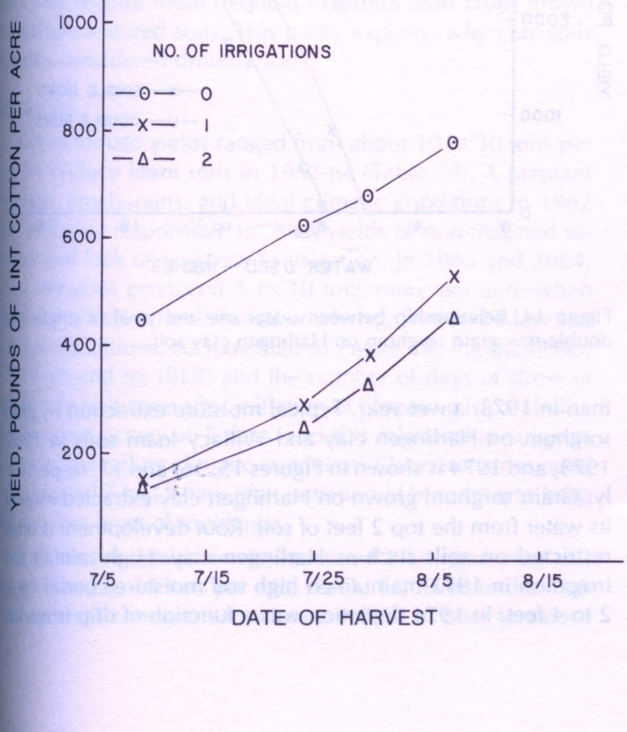


Figure 9. Yields of Tamcot SP-37 after a winter crop as influenced by time of harvest and irrigation on Willacy loam in 1975.

Figure 10. Yields of Tamcot SP-37 after fallow as influenced by time of harvest and irrigation on Willacy loam soil in 1975.



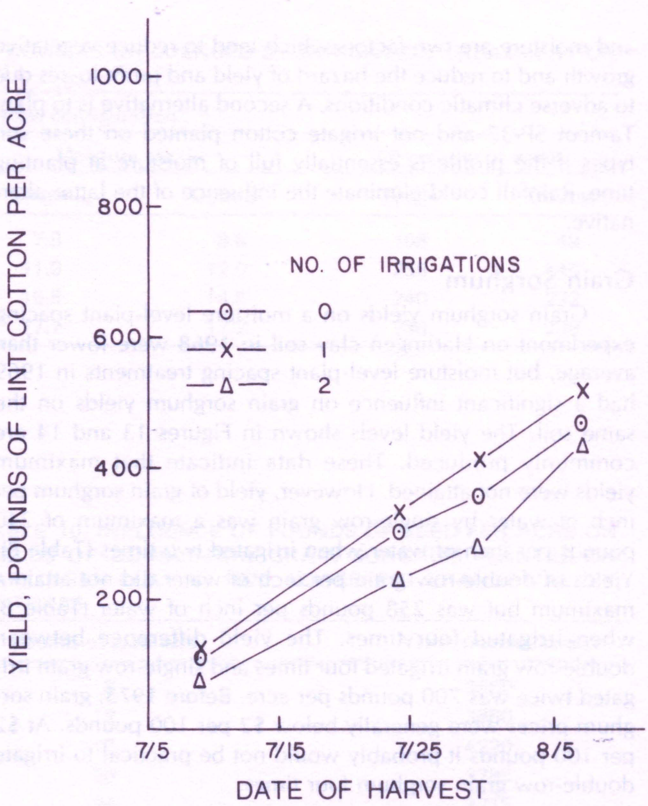
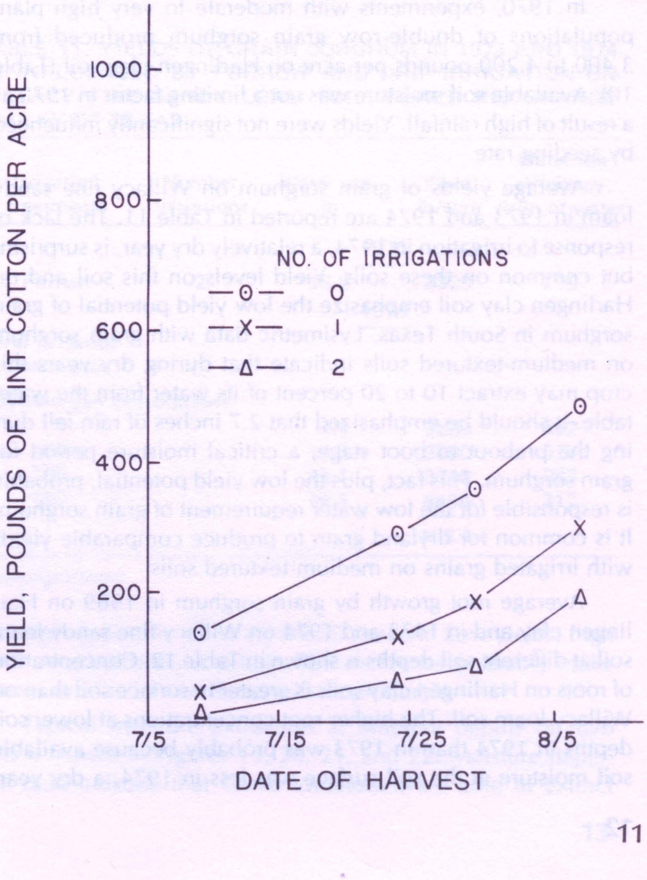


Figure 11. Yields of Stoneville 213 after winter crop as influenced by time of harvest and irrigation on Willacy loam soil in 1975.

Figure 12. Yields of Stoneville 213 after fallow as influenced by time of harvest and irrigation on Willacy loam soil in 1975.



and moisture are two factors which tend to reduce vegetative growth and to reduce the hazard of yield and profit losses due to adverse climatic conditions. A second alternative is to plant Tamcot SP-37 and not irrigate cotton planted on these soil types if the profile is essentially full of moisture at planting time. Rainfall could eliminate the influence of the latter alternative.

Grain Sorghum

Grain sorghum yields on a moisture level-plant spacing experiment on Harlingen clay soil in 1968 were lower than average, but moisture level-plant spacing treatments in 1969 had a significant influence on grain sorghum yields on the same soil. The yield levels shown in Figures 13 and 14 are commonly produced. These data indicate that maximum yields were not attained. However, yield of grain sorghum per inch of water by single-row grain was a maximum of 240 pounds per inch of water when irrigated two times (Table 8). Yields of double-row grain per inch of water did not attain a maximum but was 258 pounds per inch of water (Table 8) when irrigated four times. The yield difference between double-row grain irrigated four times and single-row grain irrigated twice was 700 pounds per acre. Before 1975, grain sorghum prices were generally below $2 per 100 pounds. At $2 per 100 pounds it probably would not be practical to irrigate double-row grain sorghum four times.

In 1969, date-of-planting studies were conducted on Willacy loam and Harlingen clay soils with single- and double-row grain sorghum. Yields of over 5,000 pounds per acre were produced on Willacy loam soil (Table 9). Burleson, Cowley, and Dacus (4) reported similar yields on loam type soils in South Texas.

In 1970, experiments with moderate to very high plant populations of double-row grain sorghum produced from 3,400 to 4,200 pounds per acre on Harlingen clay soil (Table 10). Available soil moisture was not a limiting factor in 1970 as a result of high rainfall. Yields were not significantly influenced by seeding rate.

Average yields of grain sorghum on Willacy fine sandy loam in 1973 and 1974 are reported in Table 11. The lack of response to irrigation in 1974, a relatively dry year, is surprising but common on these soils. Yield levels on this soil and on Harlingen clay soil emphasize the low yield potential of grain sorghum in South Texas. Lysimetric data with grain sorghum on medium-textured soils indicate that during dry years this crop may extract 10 to 20 percent of its water from the water table. It should be emphasized that 2.7 inches of rain fell during the preboot to boot stage, a critical moisture period for grain sorghum. This fact, plus the low yield potential, probably is responsible for the low water requirement of grain sorghum. It is common for dryland grain to produce comparable yields with irrigated grains on medium-textured soils.

Average root growth by grain sorghum in 1969 on Harlingen clay and in 1973 and 1974 on Willacy fine sandy loam soil at different soil depths is shown in Table 12. Concentration of roots on Harlingen clay soils is greater in surface soil than on Willacy loam soil. The higher root concentrations at lower soil depths in 1974 than in 1973 was probably because available soil moisture at the soil surface was less in 1974, a dry year,

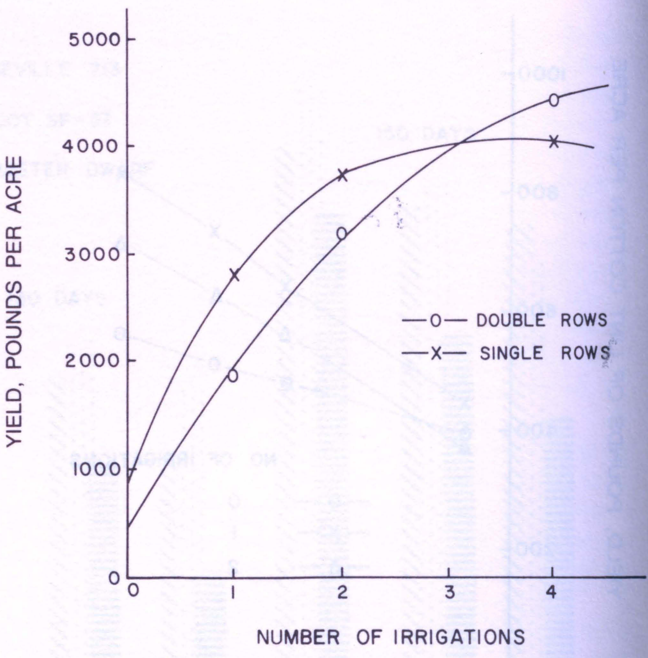


Figure 13. Influence of irrigation on yields of single- and double-row grain sorghum on Harlingen clay soil.

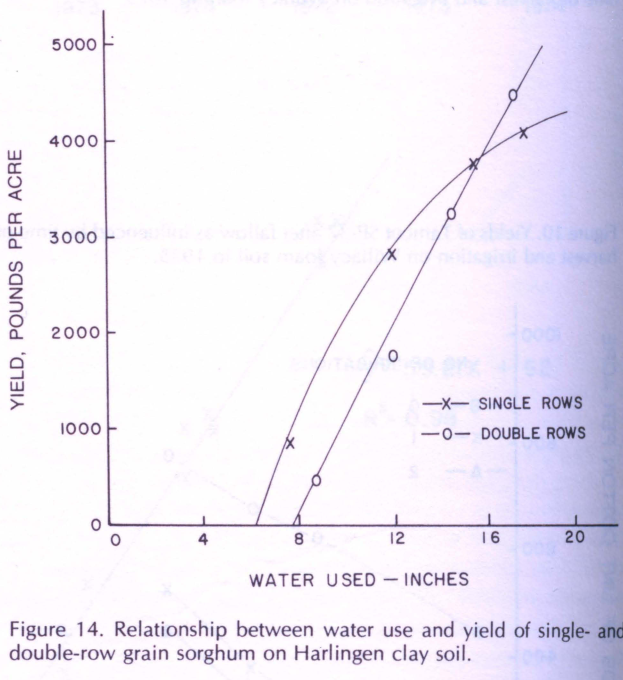


Figure 14. Relationship between water use and yield of single- and double-row grain sorghum on Harlingen clay soil.

than in 1973, a wet year. Typical moisture extraction by grain sorghum on Harlingen clay and Willacy loam soils in 1969, 1973, and 1974 is shown in Figures 15, 16, and 17, respectively. Grain sorghum grown on Harlingen clay extracted most of its water from the top 2 feet of soil. Root development is often restricted on soils such as Harlingen clay. High rainfall and irrigation in 1973 maintained high soil moisture conditions at 2 to 4 feet. In 1974 depletion was a function of drip irrigation

TABLE 8. YIELDS OF GRAIN SORGHUM ON SINGLE AND DOUBLE ROWS AS INFLUENCED BY IRRIGATION TREATMENT ON HARLINGEN CLAY IN 1969, LOWER RIO GRANDE VALLEY OF TEXAS[1]

	Row configuration					
	Yield, lb/acre		Moisture use, in		Lb grain/in of water	
Number of Irrigations[2]	Single[3]	Double[4]	Single	Double	Single	Double
Non-irrigated	840	430	7.8	8.8	108	49
One irrigation	2,800	1,745	11.9	12.0	235	145
Two irrigations	3,725	3,225	15.5	14.5	240	222
Four irrigations	4,065	4,445	17.7	17.2	230	258

[1]Sorghum, regardless of treatment, was irrigated up.
[2]Refers to irrigation after boot stage.
[3]Refers to single row on top of 38-inch beds.
[4]Refers to two rows 10 inches apart on top of 38-inch beds.

treatments, but root development and moisture extraction were significant at lower soil depths (Figure 17 and Table 12).

Generally clay soils hold less available water per foot than clay loam and sometimes loam soils, and they often impede root growth which means these soils hold less available water in the effective root zone. Because of this fact, crops grown on these soils require more frequent irrigation than crops grown on medium-textured soils. This partly explains why clay soils are often considered drouthy soils.

TABLE 9. GRAIN SORGHUM YIELDS ON WILLACY LOAM AND HARLINGEN CLAY AS INFLUENCED BY DATE OF PLANTING IN 1969, LOWER RIO GRANDE VALLEY OF TEXAS

Date of planting	Willacy loam, lb/acre[1]	Date of planting	Harlingen clay, lb/acre[2]
3/14/69	5160	3/21/69	3300
3/17/69	4640	4/28/69	3725
4/17/69	3/		

[1]Double-row grain sorghum.
[2]Single-row grain sorghum.
[3]Late plantings were eaten by birds.

Tomatoes

Chico tomato yields ranged from about 10 to 30 tons per acre on Willacy loam soils in 1962-64 (Table 13). A preplant irrigation, timely rains, and ideal climatic conditions in 1962 were probably responsible for high yields of non-irrigated tomatoes and lack of response to irrigation. In 1963 and 1964, Chico tomatoes produced 3 to 10 tons more per acre when irrigated than when not irrigated or when grown under low soil moisture conditions. As indicated in Figure 18, the incidence of blossom-end rot (BER) and the number of days of stress in the primary root zone after initiation of blooming is parabolic. The intercept occurs at 7 days, and this relationship suggests that under prevailing climatic conditions Chico tomatoes need to be irrigated 7 to 15 days after initiation of blooming to keep BER at a low level of incidence.

Pear tomato yields on fine-textured Harlingen clay soil ranged from 2 to 10 tons per acre (Table 14). Even under high moisture level conditions incidence of BER of pear tomatoes was high, generally 20 to almost 50 percent. Low yields, high water requirements, and high BER incidence probably make tomato production on these soils unprofitable.

Typical moisture extraction at different depths on two soils is shown in Figures 19, 20, 21, and 22. Moisture depletion data indicate that Chico tomatoes were able to extract

TABLE 10. INFLUENCE OF POUNDS OF SEED PER ACRE ON YIELDS OF DOUBLE-ROW GRAIN SORGHUM PLANTED ON HARLINGEN CLAY IN 1970, LOWER RIO GRANDE VALLEY OF TEXAS

Pounds of seed/acre	Yield, pounds/acre
8	3860
12	3860
16	4220
20	3785
24	3715
28	3770
32	3690
36	3410
	N.S.*

*Not significant.

TABLE 11. YIELDS OF GRAIN SORGHUM IN 1973 AND 1974 AS INFLUENCED BY FURROW AND DRIP IRRIGATION ON WILLACY FINE SANDY LOAM SOIL, LOWER RIO GRANDE VALLEY OF TEXAS

Irrigation treatments	Number irrigations	Water use, in	Yield, lb/acre	Water use efficiency, lb/in of water
			1973	
Furrow	2	18.2	3820	209
			1974	
Drip irrigation treatments				
(percent pan evaporation)				
0		7.4	3860	552
50		11.0	3580	325
100		13.1	3710	283
150		14.1	4405	312
			N.S.*	

*Not significant.

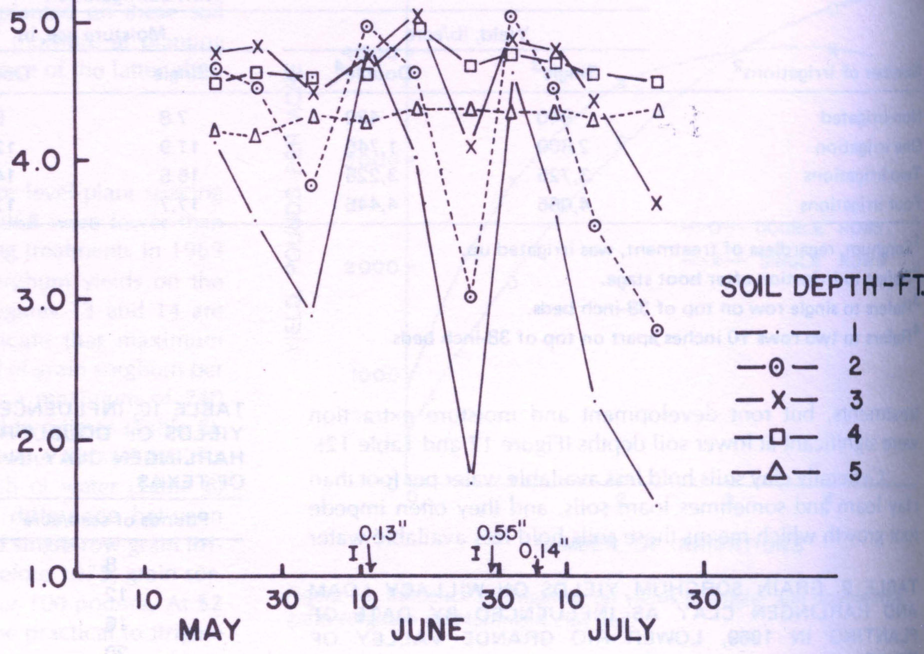


Figure 15. Soil water changes for a 5-foot profile on Harlingen clay soil as influenced by irrigated single-row grain sorghum.

moisture from 3 to 4 feet on medium-textured Willacy loam soils (Figures 19 and 20). However, moisture extraction on fine-textured Harlingen clay soil was largely restricted to the top foot. Significant moisture depletion from the second foot did not occur until about 30 days after the first bloom in the case of the dry treatment (Figure 21) and 60 days after first bloom in the case of the wet treatment (Figure 22). Root growth by tomatoes on the two soils show that root development is more extensive on Willacy loam than on Harlingen clay soil (Table 15).

Sugarcane

Yields as influenced by treatments ranged from 24 to 55 tons per acre in 1972, 1973, and 1974 (Table 16). The average maximum yields harvested in 1972, 1973, and 1974 were 52, 55, and 52 tons per acre, respectively. Yields were significantly influenced by irrigation treatments in 1972 and 1974 but not in 1973 (Table 16). The 1972 and 1973 crop years had high rainfall, but the 1974 crop year was unusually dry. The average yields for 3 years are reported in Table 17. The tons of sugar-

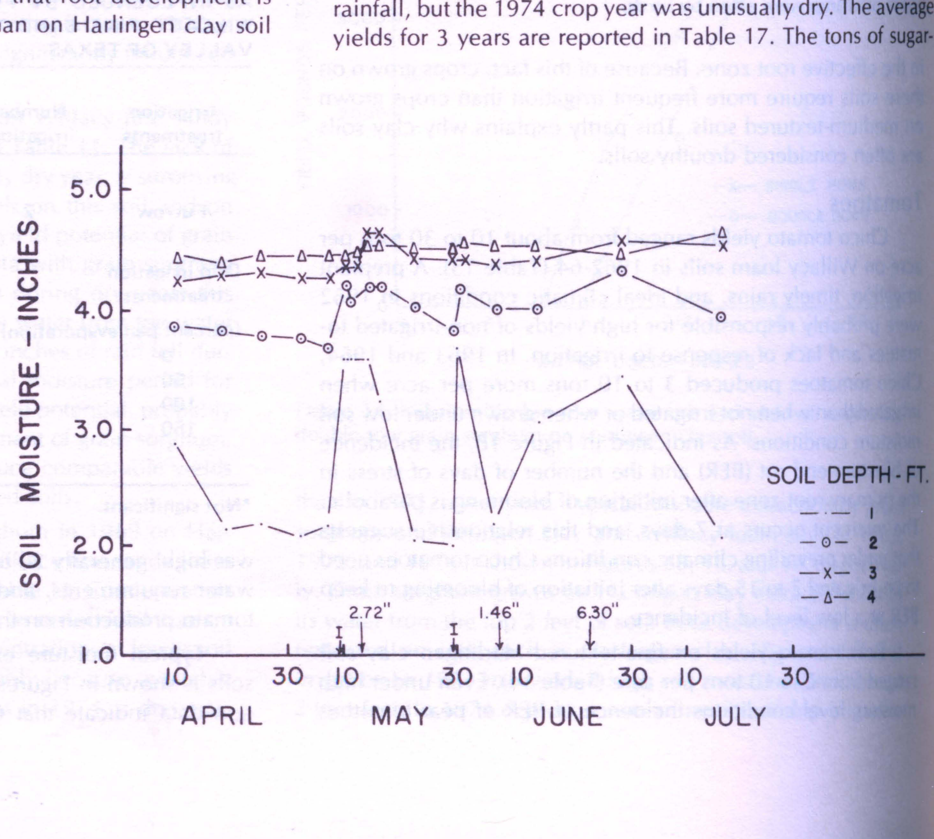


Figure 16. Soil water changes for a 4-foot profile on Willacy loam soil as influenced by irrigated single-row grain sorghum during a wet year (1973).

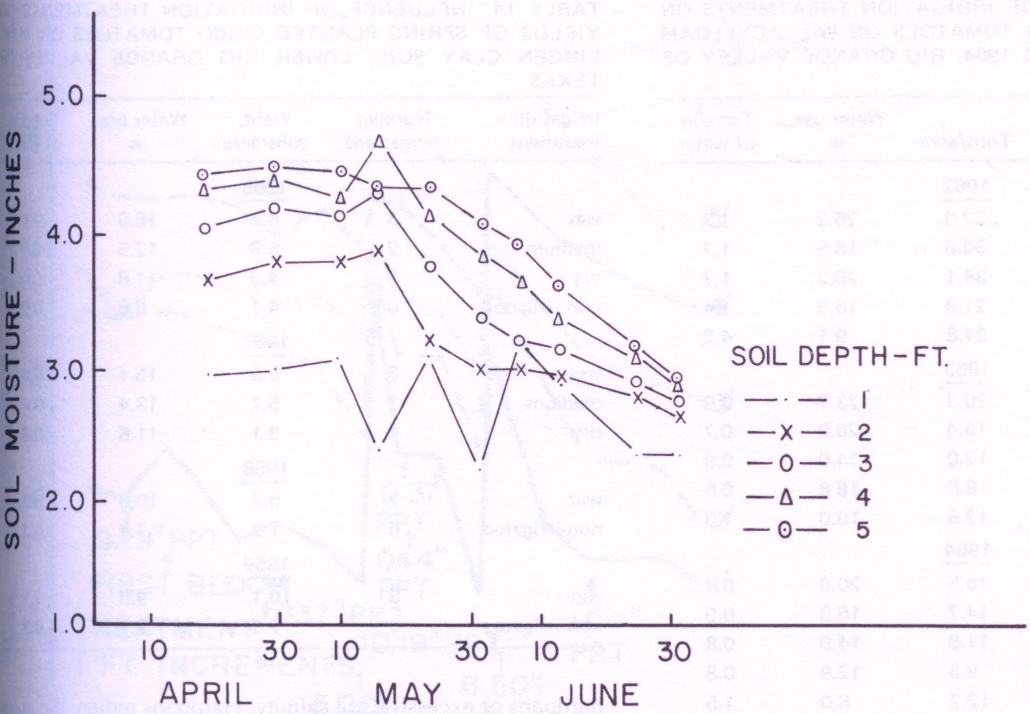


Figure 17. Soil water changes for a 5-foot profile on Willacy loam soil as influenced by drip-irrigated grain sorghum during a dry year (1974).

cane produced per inch of water ranged from 0.8 to almost 1.2 tons. Each inch of water produced 1 ton or more of cane in the yield range of 20 to 50 tons per acre (Figure 23). However, one inch of water produced slightly less than 1.0 ton per inch of water when yields were above 50 tons per acre (Figure 23). Cane often lodges when it attains a yield level of 40 to 50 tons per acre. After attaining this production level, response of cane to applied water may be limited by such factors as lodging, soil properties, and inherent varietal differences.

TABLE 12. ROOT GROWTH BY GRAIN SORGHUM ON HARLINGEN AND WILLACY FINE SANDY LOAM SOILS IN 1969 AND 1973-74, RESPECTIVELY, LOWER RIO GRANDE VALLEY OF TEXAS

Depth, inches	Percent roots, Harlingen clay	Percent roots, Willacy fine sandy loam	
	1969	1973	1974
0-6	58	48	27
6-12	16	22	29
12-24	17	13	13
24-36	8	10	18
36-48	1	8	12

The effect of soil properties and irrigation treatments on yields of cane in 1974 is tabulated in Table 18. The soil property differences of medium-textured soil and fine-textured soil are indicated in Table 4. The clay content of the medium-textured soil decreases with depth. The soil is moderately permeable to a depth of 4 feet, and the salinity of this soil is low to a depth of 4 feet. The fine-textured soil is low in permeability, and electrical conductivity, expressed in mmhos per cm, increased to 4 and 6 at 3 and 4 feet, respectively (Table 4). Without proper irrigation, yields of cane were markedly less on clay soils than on medium-textured soils. Comparison of yields of non-irrigated, irrigated at 50 percent pan evaporation, and furrow irrigated sugarcane on the medium-textured soil emphasizes this observation (Table 18). The furrow irrigated cane, irrigated six times in 1974, produced 50 tons per acre on medium-textured soil but only 31.5 tons per acre on fine-textured soil (Table 18). Six irrigations produced high cane yields on the medium-textured soil, but cane on the fine-textured soil should have nine or ten irrigations instead of six.

Growth data. The influences of treatments and soil properties on the growth of cane in 1974 are reported in Figures 24,

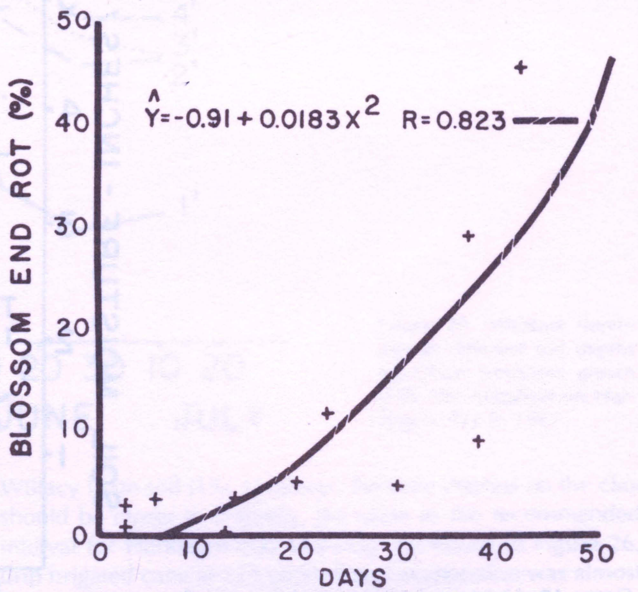


Figure 18. Relationship between percent of blossom-end rot of Chico tomatoes and number of days after initiation of blooming before irrigation or significant rain on medium-textured soil.

TABLE 13. INFLUENCE OF IRRIGATION TREATMENTS ON SPRING PLANTED CHICO TOMATOES ON WILLACY LOAM SOIL IN 1962, 1963, AND 1964, RIO GRANDE VALLEY OF TEXAS

Irrigation treatments	Number irrigations	Tons/acre	Water use, in	Tons/in of water
		1962		
wet	5	32.0	25.2	1.3
medium	3	30.6	18.5	1.7
dry	2	34.1	20.2	1.7
very dry	1	21.9	15.5	1.4
not irrigated	0	37.8	9.1	4.2
		1963		
wet	6	20.3	23.7	0.9
medium	3	13.4	20.0	0.7
dry	1	12.0	14.0	0.9
very dry	1	8.8	16.8	0.5
not irrigated	0	12.6	10.0	1.3
		1964		
wet	5	16.5	20.0	0.8
medium	3	14.7	16.9	0.9
dry	2	11.6	14.9	0.8
very dry	1	9.8	12.9	0.8
not irrigated	0	12.2	8.0	1.5

TABLE 14. INFLUENCE OF IRRIGATION TREATMENTS ON YIELDS OF SPRING PLANTED CHICO TOMATOES ON HARLINGEN CLAY SOIL, LOWER RIO GRANDE VALLEY OF TEXAS

Irrigation treatment	Number irrigations	Yield, tons/acre	Water use, in	Tons/in of water
		1965		
wet	3	6.5	16.9	0.4
medium	2	5.9	12.5	0.5
dry	1	4.9	11.8	0.4
non-irrigated	0	4.1	8.8	0.5
		1967		
wet	3	5.3	15.1	0.4
medium	2	5.7	13.4	0.4
dry	1	3.1	11.6	0.3
		1968		
wet	2	3.2	10.8	0.3
non-irrigated	0	1.2	7.4	0.2
		1969		
wet	3	10.1	9.0	1.1
non-irrigated	0	2.3	7.1	0.3

25, and 26. In a hot, dry year (such as 1974), it is often difficult to maintain favorable moisture conditions for cane growth. Short cane was evident in many growers' fields because of low moisture conditions. Low moisture conditions may be caused by improper or infrequent irrigations or may result from soil hardpans or excessive soil salinity. Hardpans reduce the available soil water reservoir, causing stress and retarding cane growth between irrigations. Salty soils act as dry soils because salinity reduces the amount of water available for plant growth. Clay soils are less permeable to water and impede root development. Plants on clay soils often do not have the available water reservoir that plants have on more permeable loam and clay loam soils. The differential growth of non-irrigated

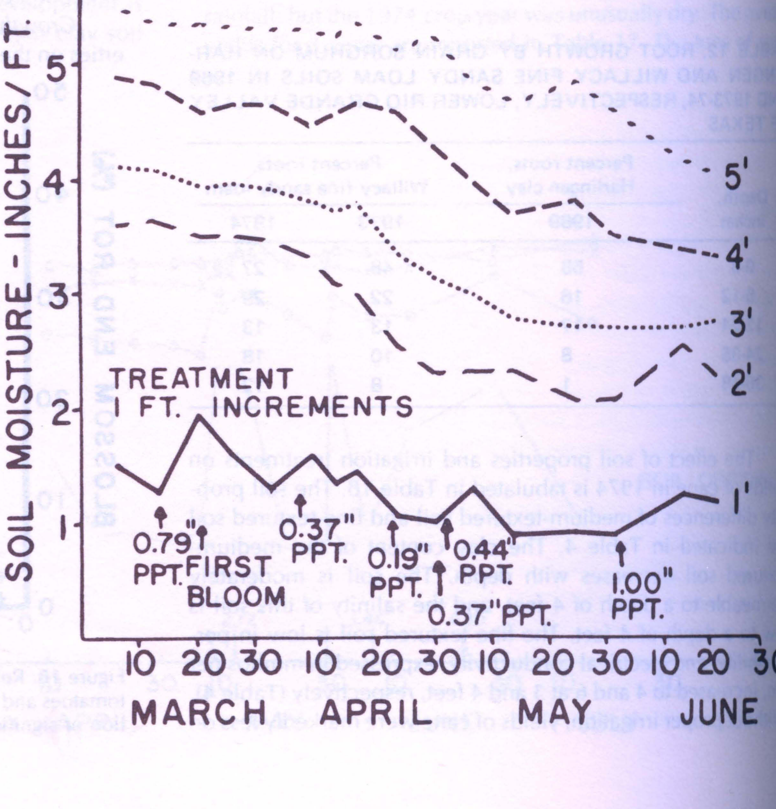


Figure 19. Moisture depletion at different soil depths by non-irrigated Chico tomatoes grown on Willacy loam soil in 1962.

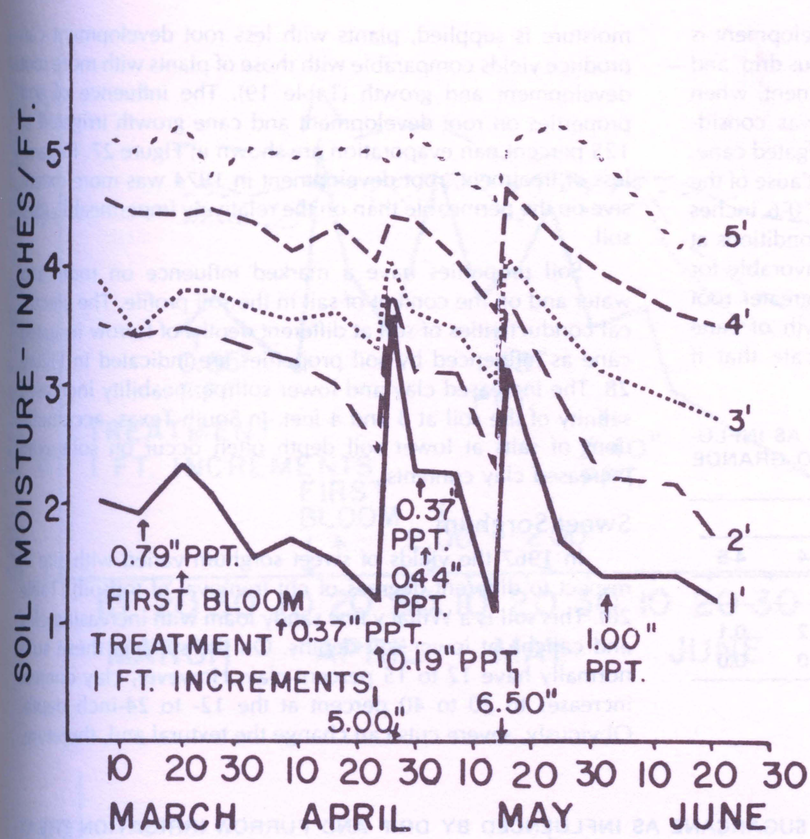


Figure 20. Moisture depletion at different depths by Chico tomatoes grown on Willacy loam and irrigated twice in 1962.

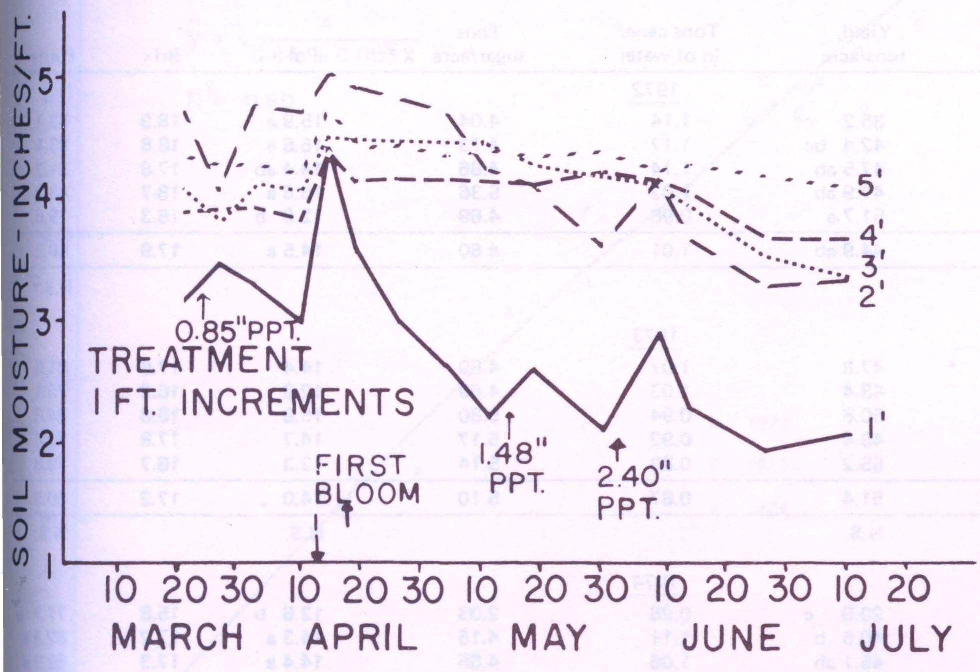


Figure 21. Moisture depletion at different soil depths by Chico tomatoes grown with one irrigation on Harlingen clay in 1967.

and furrow irrigated cane on clay and medium-textured soils emphasizes the effect of soil types on cane growth (Figures 24 and 25). Six irrigations produced excellent growth and yield of cane on medium-textured soil but were not adequate for maximum growth and yield of cane on fine-textured soils (Figure 25). The time interval between irrigations was about 3 weeks, which is the approximate interval recommended for Willacy loam soil (15). However, the time interval on the clay should be closer to 2 weeks, the same as the recommended interval for Harlingen clay soil (15). As shown in Figure 26, drip irrigated cane at 125 percent pan evaporation was almost the same height on the medium- and fine-textured soil, indicating that under favorable water management cane growth and yields were almost identical under different soil conditions.

Root development and soil salinity. Root development is influenced by type of irrigation, such as furrow versus drip, and by soil types (Table 19). Sugarcane root development, when drip irrigated at 125 percent pan evaporation, was considerably greater than root development by furrow-irrigated cane. These differences were especially great in 1974 because of the unusually dry weather. Low root development at 0-6 inches under furrow irrigation is a reflection of dry soil conditions at the time of sampling. Sampling at a time more favorable for soil moisture conditions would have resulted in greater root development at 0-6 inches. The yields and growth of cane irrigated at 125 percent pan evaporation indicate that if moisture is supplied, plants with less root development can produce yields comparable with those of plants with more root development and growth (Table 19). The influence of soil properties on root development and cane growth irrigated at 125 percent pan evaporation are shown in Figure 27. Regardless of treatment, root development in 1974 was more extensive on the permeable than on the relatively impermeable clay soil.

Soil properties have a marked influence on roots and water and on the content of salt in the soil profile. The electrical conductivities of soil at different depths of furrow irrigated cane as influenced by soil properties are indicated in Figure 28. The increased clay and lower soil permeability increased salinity of the soil at 3 and 4 feet. In South Texas, accumulations of salts at lower soil depth often occur on soils with increased clay contents.

TABLE 15. ROOT DISTRIBUTION OF TOMATOES AS INFLUENCED BY SOIL TYPE AND DEPTH, LOWER RIO GRANDE VALLEY OF TEXAS

Soil	Soil depth, feet 0-1	1-2	2-3	3-4	4-5
	Percent				
Willacy loam[1]	85.6	13.3	0.8	0.2	0.1
Harlingen clay[2]	96.3	3.7	0.0	0.0	0.0

[1]Data from Bloodworth, Burleson, and Cowley (2).

[2]Root distribution determined using radioactive P.

Sweet Sorghum

In 1967 the yields of sweet sorghum varied with site in respect to different degrees of cut (removal of topsoil) (Table 20). This soil is a Willacy fine sandy loam with increasing clay and caliche at lower soil depths. On the surface, these soils normally have 12 to 15 percent clay. However, clay content increases to 20 to 40 percent at the 12- to 24-inch depth. Obviously, severe cuts can change the textural and, therefore,

TABLE 16. YIELDS AND QUALITY OF NCO 310 SUGARCANE AS INFLUENCED BY DRIP AND FURROW IRRIGATION TREATMENTS IN 1972, 1973 AND 1974, LOWER RIO GRANDE VALLEY OF TEXAS[1]

Treatments	Pan evaporation, percent	Yield, tons/acre	Tons cane/ in of water	Tons sugar/acre	Pol	Brix	Purity
			1972				
Non-irrigated	0	35.2 c[2]	1.14	4.04	15.9 a	18.9	83.7
Drip	25	42.4 bc	1.17	4.73	15.6 a	18.8	83.1
Drip	50	47.5 ab	1.14	4.86	14.4 ab	17.8	81.2
Drip	75	47.9 ab	1.02	5.36	15.6 a	18.7	83.2
Drip	100	51.7 a	0.98	4.69	12.9 b	16.3	79.6
Furrow		44.9 ab	1.01	4.60	14.5 a	17.9	80.9
							N.S.[3]
			1973				
Non-irrigated	0	47.8	1.07	4.89	14.4	17.6	81.6
Drip	50	48.4	1.03	4.69	12.8	16.2	79.1
Drip	75	50.8	0.94	5.80	15.8	18.8	84.0
Drip	100	49.4	0.92	5.17	14.7	17.8	82.6
Drip	125	55.2	0.83	5.14	13.3	16.7	79.6
Furrow		51.4	0.87	5.10	14.0	17.2	80.9
		N.S.			N.S.		N.S.
			1974				
Non-irrigated	0	23.9 c	0.98	2.03	12.6 b	15.8	77.7 b
Drip	50	40.5 b	1.11	4.16	14.3 a	17.2	82.9 a
Drip	75	45.1 ab	1.06	4.65	14.4 a	17.3	82.9 a
Drip	100	49.3 ab	1.00	4.85	14.0 a	17.0	82.3 a
Drip	125	52.1 a	0.93	5.41	14.6 a	17.4	83.5 a
Furrow		43.5 ab	0.78	4.64	14.7 a	17.7	83.3 a

[1]Appreciation is expressed to B. Ashby Smith, research chemist, USDA Food Crops Utilization Research Laboratory, for milling and subsequent analyses of cane samples.

[2]Values with common letters are not significantly different at the 5 percent level of Duncan's Multiple Range Test.

[3]Not significant.

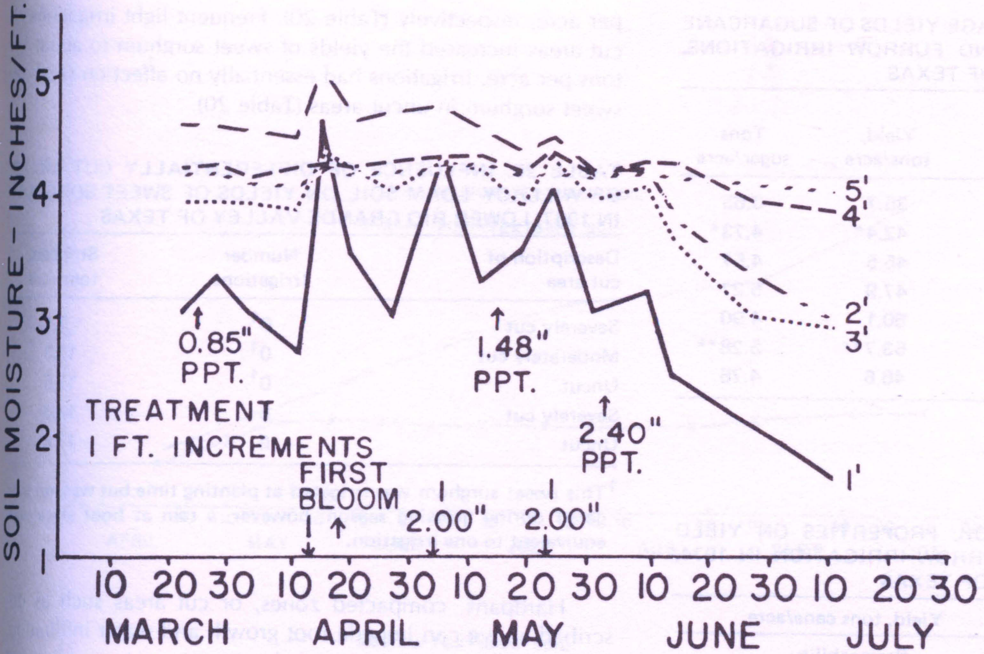


Figure 22. Moisture depletion at different soil depths by Chico tomatoes grown with three irrigations on Harlingen clay in 1967.

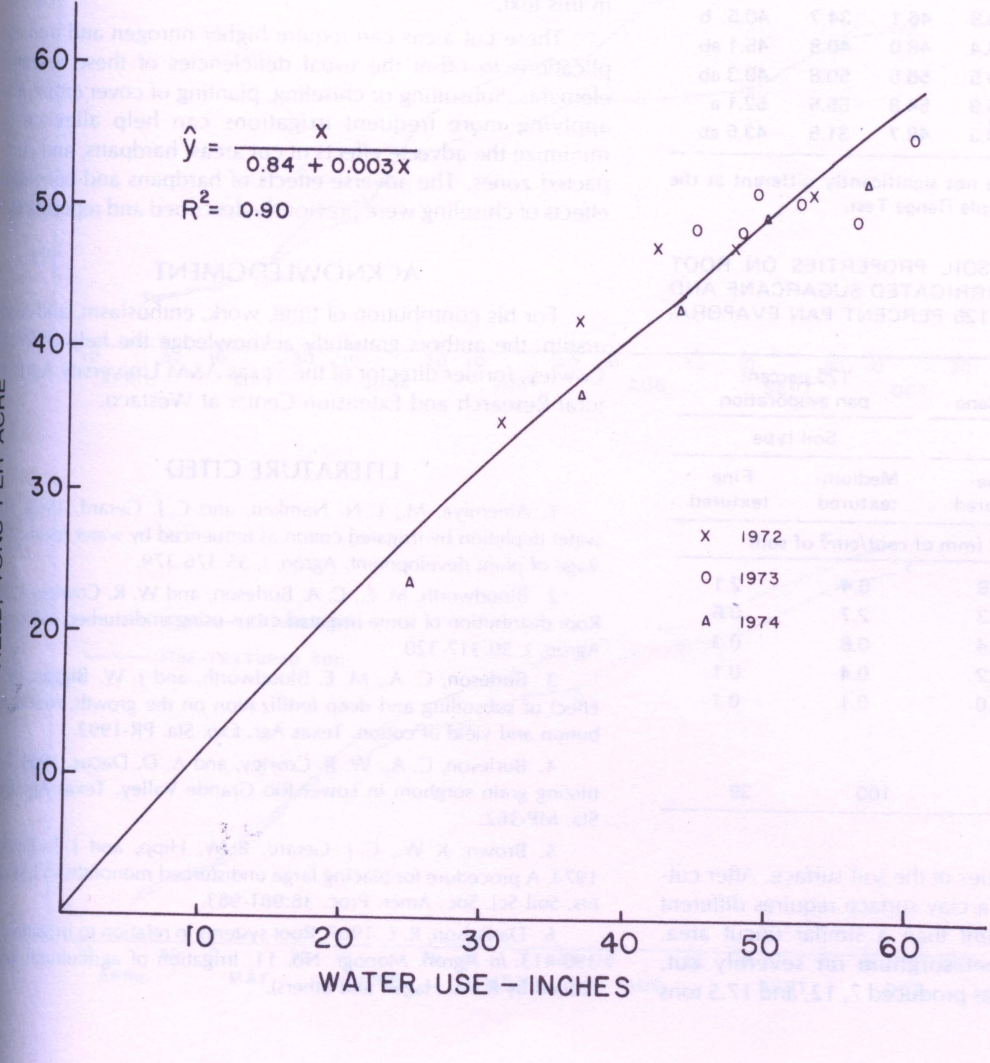


Figure 23. Relationship between water use and sugarcane yields.

TABLE 17. THREE-YEAR AVERAGE YIELDS OF SUGARCANE AS INFLUENCED BY DRIP AND FURROW IRRIGATIONS, LOWER RIO GRANDE VALLEY OF TEXAS

Treatment	Percent pan evaporation	Yield, tons/acre	Tons sugar/acre
Non-irrigated	0	35.7	3.65
Drip	25*	42.4*	4.73*
Drip	50	45.5	4.57
Drip	75	47.9	5.27
Drip	100	50.1	4.90
Drip	125**	53.7**	5.28**
Furrow		46.6	4.78

*Evaluated in 1972 only.
**Evaluated in 1973 and 1974 only.

TABLE 18. INFLUENCE OF SOIL PROPERTIES ON YIELD RESPONSES TO DRIP AND FURROW IRRIGATION IN 1974, LOWER RIO GRANDE VALLEY OF TEXAS

Treatments	Pan evaporation, percent	Yield, tons cane/acre			
		Permeability			
		High	Moderate	Low	Avg.
Non-irrigated	0	26.0	27.4	18.3	23.9 c[1]
Drip	50	40.8	46.1	34.7	40.5 b
Drip	75	46.4	48.0	40.8	45.1 ab
Drip	100	40.5	56.5	50.8	49.3 ab
Drip	125	45.9	54.8	55.5	52.1 a
Furrow		50.3	48.7	31.5	43.5 ab

[1]Values with common letters are not significantly different at the 5 percent level of Duncan's Multiple Range Test.

TABLE 19. INFLUENCE OF SOIL PROPERTIES ON ROOT DEVELOPMENT BY FURROW-IRRIGATED SUGARCANE AND SUGARCANE IRRIGATED AT 125 PERCENT PAN EVAPORATION IN 1974

Depth, inches	Furrow irrigated Cane		125 percent pan evaporation	
	Soil type		Soil type	
	Medium-textured	Fine-textured	Medium-textured	Fine-textured
	Root growth (mm of root/cm^3 of soil)			
0-6	1.0	0.8	6.4	2.1
6-12	2.1	1.3	2.7	0.6
12-24	0.9	0.4	0.8	0.3
24-36	0.5	0.2	0.4	0.1
36-48	0.7	0.0	0.1	0.1
Percent relative growth	49	27	100	39

chemical and physical properties of the soil surface. After cutting, soil with a clay loam to a clay surface requires different fertility and water management than a similar uncut area. Yields of non-irrigated sweet sorghum on severely cut, moderately cut, and uncut areas produced 7, 12, and 17.5 tons per acre, respectively (Table 20). Frequent light irrigations of cut areas increased the yields of sweet sorghum to about 14 tons per acre. Irrigations had essentially no affect on yields of sweet sorghum in uncut areas (Table 20).

TABLE 20. INFLUENCE OF DIFFERENTIALLY CUT AREAS OF WILLACY LOAM SOIL ON YIELDS OF SWEET SORGHUM IN 1967, LOWER RIO GRANDE VALLEY OF TEXAS

Description of cut area	Number Irrigations	Stripped, tons/acre
Severely cut	0[1]	7.1
Moderately cut	0[1]	12.3
Uncut	0[1]	17.5
Severely cut	5	14.3
Uncut	5	17.6

[1]This sweet sorghum was irrigated at planting time but was not irrigated during growing season; however, a rain at boot stage was equivalent to one irrigation.

Hardpans, compacted zones, or cut areas such as described above can impede root growth and water infiltration. Soils with hardpans, compacted zones, or cut areas are just like soils that have shallow reservoirs of available water such as the Harlingen clay and Mercedes clay soils described earlier in this text.

These cut areas can require higher nitrogen and iron applications to offset the usual deficiencies of these essential elements. Subsoiling or chiseling, planting of cover crops, and applying more frequent irrigations can help alleviate or minimize the adverse effects of cut areas, hardpans, and compacted zones. The adverse effects of hardpans and beneficial effects of chiseling were previously described and reported (3).

ACKNOWLEDGMENT

For his contribution of time, work, enthusiasm, and leadership, the authors gratefully acknowledge the help of W. R. Cowley, former director of the Texas A&M University Agricultural Research and Extension Center at Weslaco.

LITERATURE CITED

1. Amemiya, M., L. N. Namken, and C. J. Gerard. 1963. Soil water depletion by irrigated cotton as influenced by water regime and stage of plant development. Agron. J. 55:376-379.

2. Bloodworth, M. E., C. A. Burleson, and W. R. Cowley. 1958. Root distribution of some irrigated crops using undisturbed soil cores. Agron. J. 50:317-320.

3. Burleson, C. A., M. E. Bloodworth, and J. W. Biggar. 1957. Effect of subsoiling and deep fertilization on the growth, root distribution and yield of cotton. Texas Agr. Exp. Sta. PR-1992.

4. Burleson, C. A., W. R. Cowley, and A. D. Dacus. 1959. Fertilizing grain sorghum in Lower Rio Grande Valley. Texas Agr. Exp. Sta. MP-362.

5. Brown, K. W., C. J. Gerard, B. W. Hipp, and J. T. Ritchie. 1974. A procedure for placing large undisturbed monoliths in lysimeters. Soil Sci. Soc. Amer. Proc. 38:981-983.

6. Danielson, R. E. 1967. Root systems in relation to irrigation, p. 390-413. *In* Agron. Monogr. No. 11, Irrigation of agricultural lands (Edited by R. M. Hagan and others).

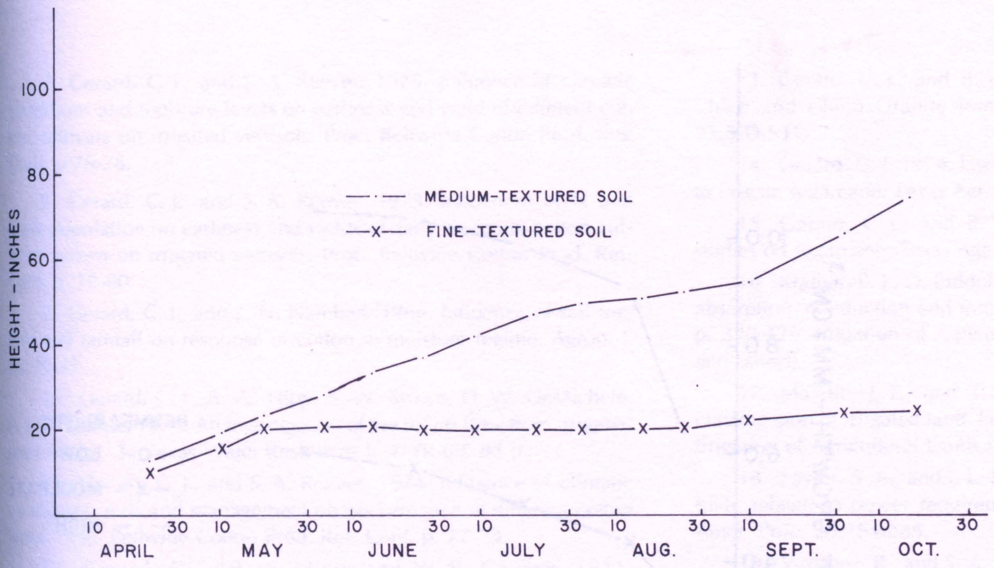


Figure 24. Growth on non-irrigated cane as influenced by soil properties during 1974, a dry year.

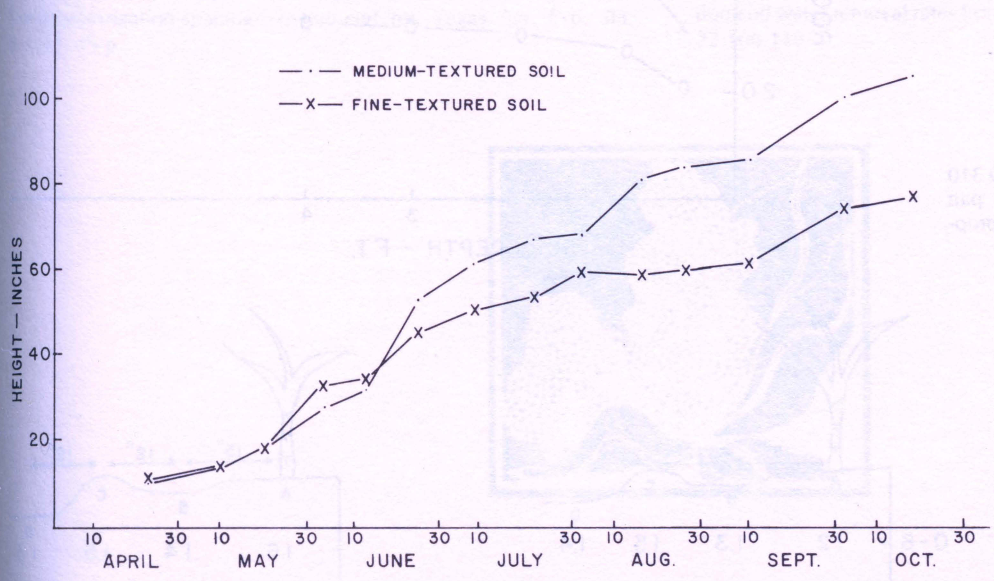


Figure 25. Growth of furrow-irrigated cane as influenced by soil properties in 1974, a dry year.

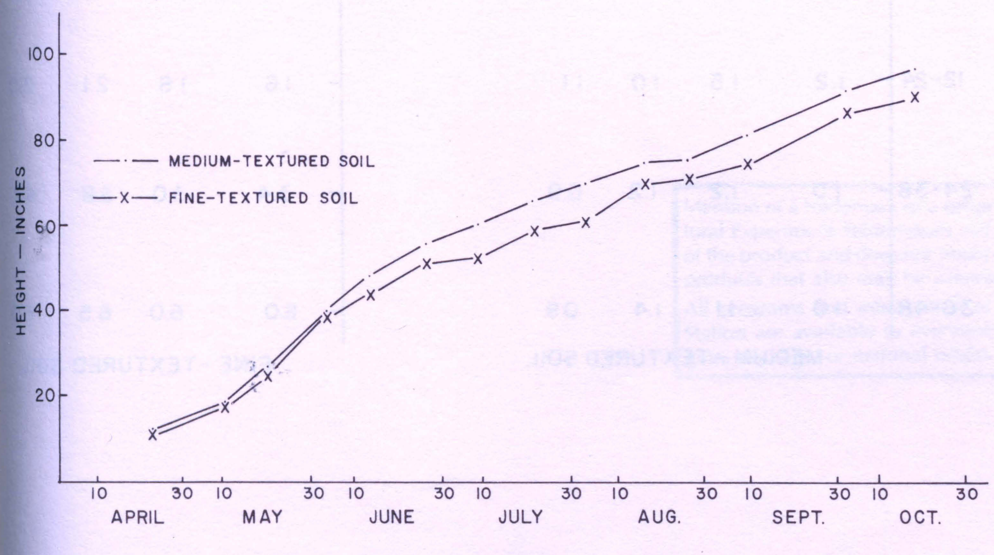


Figure 26. Growth of sugarcane drip-irrigated at 125 percent pan evaporation as influenced by soil properties in 1974, a dry year.

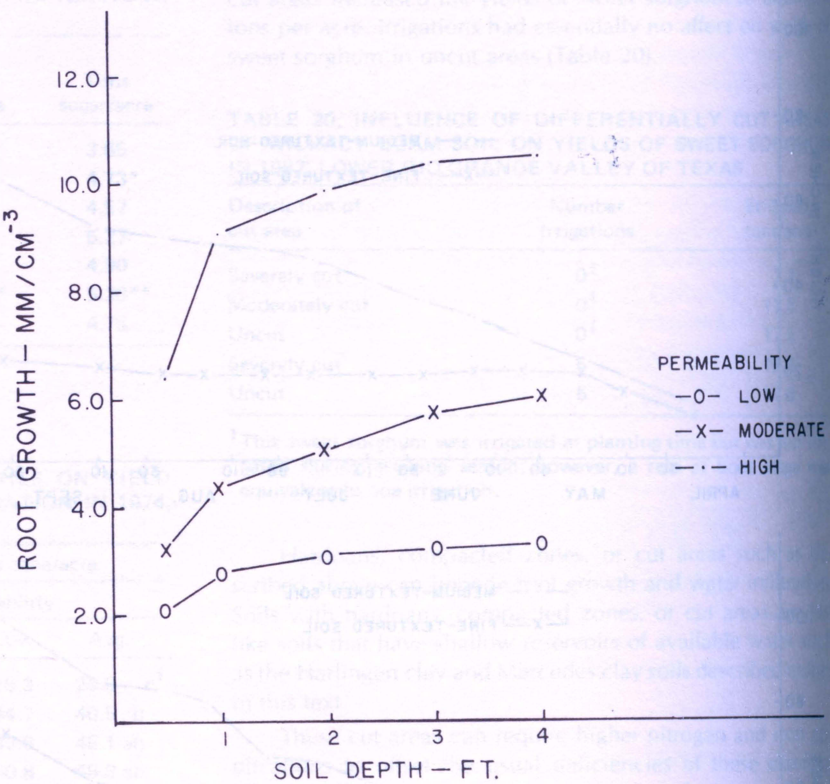


Figure 27. Root development of NCO 310 cane drip-irrigated at 125 percent pan evaporation as influenced by soil properties in 1974, a dry year.

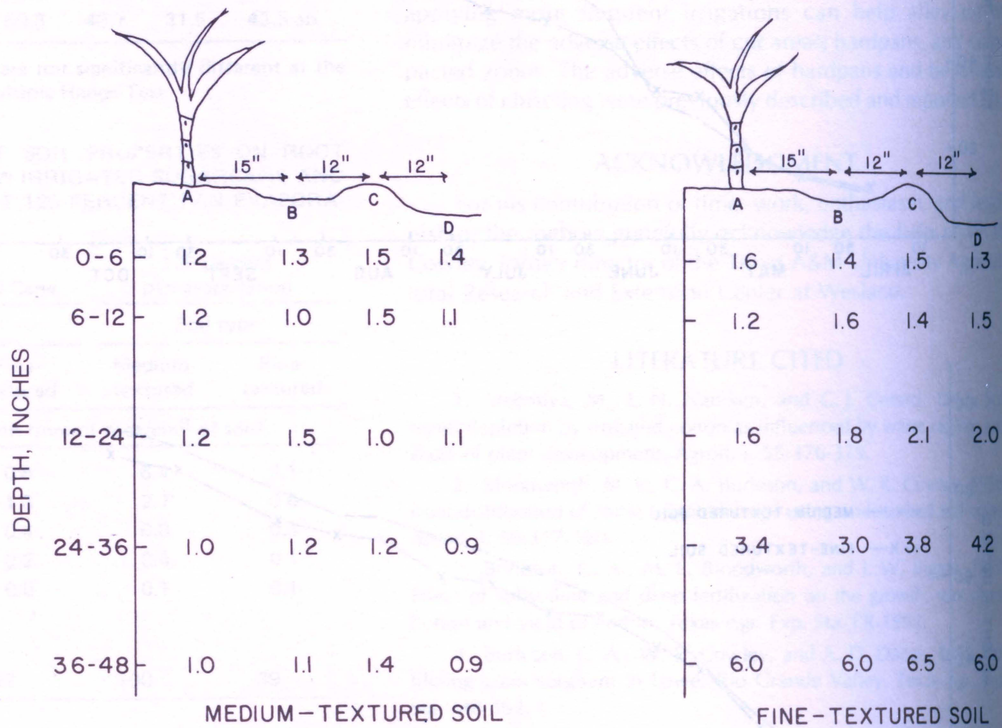


Figure 28. Soil salinity of furrow-irrigated cane in mmhos/cm at different depths and locations with respect to cane plants and soil properties in 1974, a dry year.

7. Gerard, C. J., and S. A. Reeves. 1975. Influence of climatic conditions and moisture levels on earliness and yield of different cotton cultivars on irrigated vertisols. Proc. Beltwide Cotton Prod. Res. Conf. p 76-78.

8. Gerard, C. J., and S. A. Reeves. 1975. Influences of N and plant population on earliness and yields of early maturing cotton cultivars grown on irrigated vertisols. Proc. Beltwide Cotton Prod. Res. Conf. p. 78-80.

9. Gerard, C. J., and L. N. Namken. 1966. Influence of soil texture and rainfall on response of cotton to moisture regime. Agron. J. 58:39-42.

10. Gerard, C. J., B. W. Hipp, K. W. Brown, D. W. DeMichele, P. J. H. Sharpe. 1974. An investigation of the return flow from irrigated land. Chapt. 2., Texas Water Resources Inst. TR-60. 84 p.

11. Gerard, C. J., and S. A. Reeves. 1974. Influence of climatic conditions, soils and management on performance of different cotton types. Proc. Beltwide Cotton Prod. Res. Conf. p. 77-78.

12. Gerard, C. J., B. W. Hipp, and W. R. Cowley. 1971. Tomatoes-irrigation-spacing-blossom-end rot. Texas Agr. Exp. Sta. B-1113. 19 p.

13. Gerard, C. J., and B. W. Hipp. 1968. Blossom-end rot of Chico and Chico Grande tomatoes. Proc. Amer. Soc. Hort. Sci. 93:521-531.

14. Gerard, C. J. 1974. Use of tensiometers and pan evaporation to irrigate sugarcane. Texas Agr. Exp. Sta. Tech. Rep. No. 74-2. 18 p.

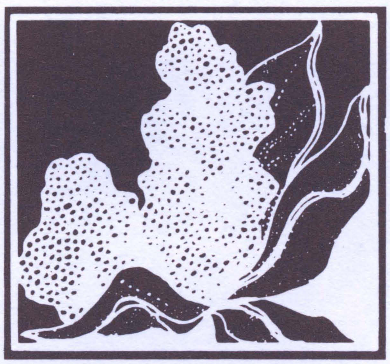
15. Gerard, C. J., and B. W. Hipp. 1975. Irrigation and soil studies on sugarcane. Texas Agr. Exp. Sta. Tech. Rep. No. 75-2. 50 p.

16. Kramer, P. J., O. Biddulph, and F. S. Nakayama. 1967. Water absorption, conduction and transpiration. *In* Agron. Monogr. No. 11, p. 320-329. Irrigation of Agricultural Lands (Edited by R. M. Hagan and others).

17. Maletic, J. T., and T. B. Hutchings. 1967. Selection and classification of irrigated land. *In* Agron. Monogr. No. 11, p. 125-156. Irrigation of Agricultural Lands (Edited by R. M. Hagan and others).

18. Taylor, S. A., and J. L. Haddock. 1956. Soil moisture availability related to power requirement to remove water. Soil Sci. Soc. Amer. Proc. 20:284-288.

19. Vazquez, R., and S. A. Taylor. 1958. Simulated root distribution and water removal rates from moist soil. Soil Sci. Soc. Amer. Proc. 22:106-110.



2M—1-77
Texas Agricultural Experiment Station
J. E. Miller, Director
College Station, Texas