EFFECTS OF SUBSURFACE DRAINING JEANERETTE SOIL ON CANE AND SUGAR YIELDS

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ABSTRACT

Subsurface drains were installed in Jeanerette (Typic Argiaquoll) soil in Iberia Parish, Louisiana, in 1978 to determine soil and crop response to subsurface drainage and to determine if crop production efficiency could be increased with subsurface drainage. Plastic drains which emptied into sumps equipped with electric pumps for discharging drain outflow into a surface drainage ditch were installed for the experiment. The 4-acre experimental site included three fields with four, three, and two drain lines spaced 45, 90, and 135 feet apart, respectively, and one field with no subsurface drainage.

Sugarcane was planted in the fall of 1979. The plant crop was harvested in December 1980 and the first and second ratoons were harvested in November 1981 and 1982, respectively.

Average annual rainfall for the area is 60 inches. Rainfall during the experiment was 66, 45, and 73 inches in 1980, 1981, and 1982, respectively, which was 10 percent above, 25 percent below and 22 percent above average, respectively.

Water tables were lowest in the fields with 45- and 90-foot drain spacings and highest in the nondrained field. Sugar yields indicated no advantage in spacing drains closer than 90 feet.

Sugar yield from the 45- and 90-foot drain spacing fields averaged 1500 lbs/A (33%) more than the nondrained field. The 135-foot drain spacing field yielded 843 lbs/A (20%) more than did the nondrained field. Subsurface drained sugarcane fields yielded 5.3 T/A (19%) more than the nondrained field. The increase in sugarcane yields was attributed to larger and heavier stalks from the subsurface drained fields. Plant population was similar for all fields.

Sugar yields on drained and nondrained fields differed more in ratoon crops than in the plant crop. If the differences were due to subsurface drainage alone, then drainage was more effective in boosting yields in ratoon crops.

The data showed a marked increase in crop production efficiency. Sugar yield data from the nondrained area showed that 500 acres of cane would be required to produce 1000 tons of sugar annually. For the subsurface drained areas, the same quantity of sugar could be produced on 366 acres - 25 percent less land. If the differences were due to subsurface drainage alone, subsurface drainage could result in considerable savings in operating costs for sugar production in Louisiana.

INTRODUCTION

Large amounts of precipitation on low lying, nearly level topography cause severe water table problems in the crop growing areas of the lower Mississippi Valley. Annual precipitation frequently exceeds 60 inches and monthly precipitation frequently exceeds 10 inches. Much of this precipitation runs off but the infiltration that does occur frequently causes the water table to rise nearly to the soil surface. The water displaces oxygen in the soil, thus causing soil conditions that adversely affect the development and growth of plant roots. The water table problem is more severe during the winter and early spring months (December through April) when evapotranspiration is low and precipitation is high. A high water table during this period may be particularly adverse to crops like sugarcane which is a stubble crop.

The purpose of this experiment was to determine the soil and crop response to subsurface drainage and to determine if crop production efficiency could be increased with subsurface drainage.

LITERATURE REVIEW

Experiments with subsurface drainage for sugarcane in Louisiana were conducted in the late 1800's. A Louisiana Experiment Station Bulletin in 1889 reported 25 and 30 percent increases in cane and sugar yields, respectively, with subsurface drainage (7). In a later bulletin, it was reported that, due to improper outlets, sediment had accumulated in the tiles causing them to gradually become ineffective (8).

In 1972, Camp and Carter (1) installed a subsurface drainage experiment near Houma, LA with five different drainage treatments, each with the drains emptying into sumps equipped with electric pumps for discharging drain outflow into surface drainage ditches. The success of these drainage systems prompted them to install several other drainage systems to determine soil and crop response to subsurface drainage on several different soil types. The results from these experiments have been reported (2, 4, 5).

Subsurface drainage experiments for sugarcane have also been reported from other countries. Pao and Hung (9) obtained a marked reduction in number and length of stalks, cane yield, sucrose content and root weight with the water table at 20 inches as compared with one at 60 inches. Gosnell(6) reported that a 10-inch water table inhibited sprouting of sugarcane at planting and ratooning and caused large reductions in plant population, stalk length, cane yield, and sugar yield. A 20-inch water table gave intermediate results. There was no difference in growth of cane between 30-, 40-, and 50-inch water tables, which gave the best results.

In small replicated plot experiments in Louisiana, Carter (3) found that a 12-inch water table during the dormant and early growth period (December - March) significantly decreased cane and sugar yields. This experiment demonstrated that the dormant and early growth periods were critical times when subsurface drainage was needed.

MATERIALS AND METHODS

A Jeanerette (Typic Argiaquoll) silty clay loam site on the M. A. Patout and Son's farm in Iberia Parish, Louisiana was selected for this experiment. The site consisted of four fields of slightly undulating land, each about four acres (200 x 800 feet) in size. Three fields were subsurface drained, each with different drain spacings, and one field, without subsurface drains, was used as a check. The three subsurface drained fields had four, three, and two drain lines spaced 45, 90, and 135 feet apart, respectively (Figure 1). Subsurface drainage was accomplished by installing 4-inch diameter drain tubes wrapped with Typar[1/] filter during the summer of 1978. A drain tube plow equipped with a laser grade control system was used for installation. The corrugated, perforated, polyethelyne drain tubes were installed an average of three feet below the soil surface on 0.15% slope. Sumps were installed to collect water from the drains because the drainage ditch was not deep enough to allow gravity drain outlets. Electric pumps discharged water from the sumps into the drainage ditch. Water level recorders were installed midway between two drains in each drainage treatment and in the center of the undrained area to monitor the water table. These recorders remained in place throughout the 3-year experiment except for short periods (about one month from mid-November to mid-December) in the fall of 1980, 1981, and 1982 when they were removed for harvest. A recording rain gauge was installed on site to collect precipitation data.

Sugarcane variety NCo 310 was planted in all fields in the fall of 1978. Due to a stand failure, the crop was replanted in the fall of 1979. Conventional practices including planting on 12-inch high rows spaced 70 inches apart were used. Herbicide was applied at planting and again each spring. In addition, the fields were cultivated to insure good weed control. Pesticides for controlling the sugarcane borer were applied as needed. Fertilizer was applied each spring using recommended rates.

The plant crop was harvested in the fall of 1980. First and second ratoons were harvested in 1981 and 1982, respectively. A mechanical harvester cut, topped, and placed the cane stalks in 3-row windrows after which the leaves were removed by burning.

[1/]Mention of trademark, proprietary products or vendor does not constitute a guarantee or warranty of the product by the U. S. Department of Agriculture and does not imply its approval to the exclusion of other products or vendors that may also be suitable.

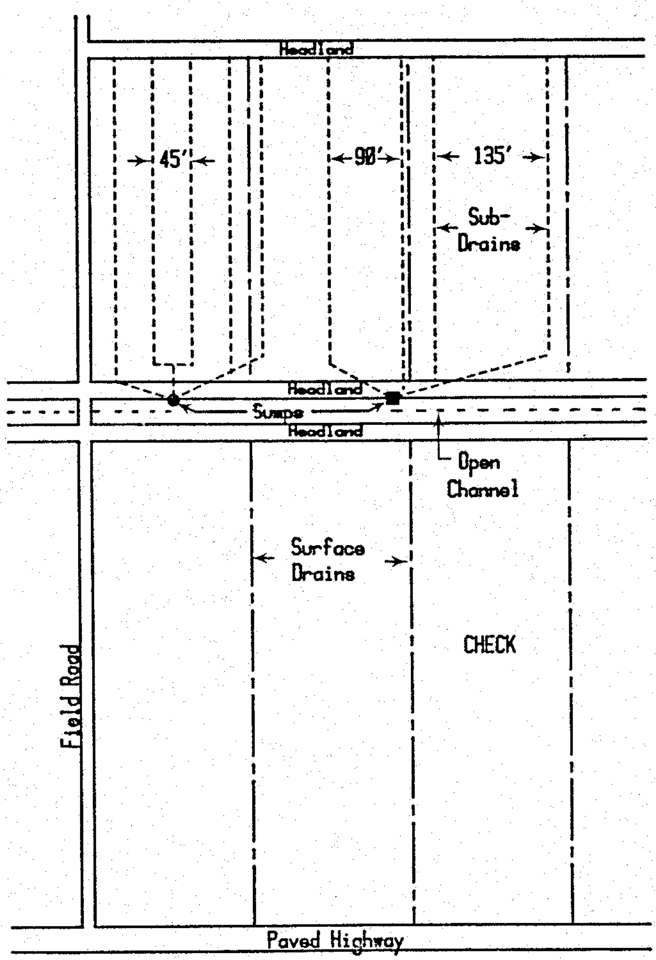

Figure 1. Field layout of subsurface drainage experiment in Iberia Parish, Louisiana.

Yields were estimated by taking a trailer load of cane from four measured areas (each approximately 0.25 acres in size) in each treatment. The cane was weighed and subsampled for juice quality determinations at the sugar mill.

Plant populations were estimated by counting the stalks in four different 100-foot sections of rows in each treatment. Mean stalk weight was calculated from cane weight and number of stalks per unit area.

RESULTS AND DISCUSSION

Annual rainfall for each of the three years was 66, 45, and 73 inches for 1980, 1981, and 1982, respectively (Table 1). Annual rainfall averages 60 inches; thus, rainfall was 10% above, 25% below, and 22% above average in 1980, 1981, and 1982, respectively.

The water table in all fields fluctuated throughout the experiment, but the water table in the nondrained field fluctuated much closer to the soil surface than those in the drained fields. Examples of water tables in drained and nondrained fields are shown in Figure 2.

Table 1. Monthly and annual rainfall at the Patout experimental site in Iberia Parish, Louisiana.

Month	year		
	1980	1981	1982
	inches		
January	6.24	1.37	2.54
February	.58	3.15	4.79
March	9.47	.85	1.60
April	10.14	3.40	6.61
May	11.06	1.28	4.73
June	1.09	8.70	4.43
July	4.30	6.98	8.40
August	3.45	6.18	8.45
September	7.12	3.15	8.80
October	4.78	2.13	4.36
November	6.08	3.05	2.44
December	1.67	4.62	14.95
Total	65.09	45.06	72.60

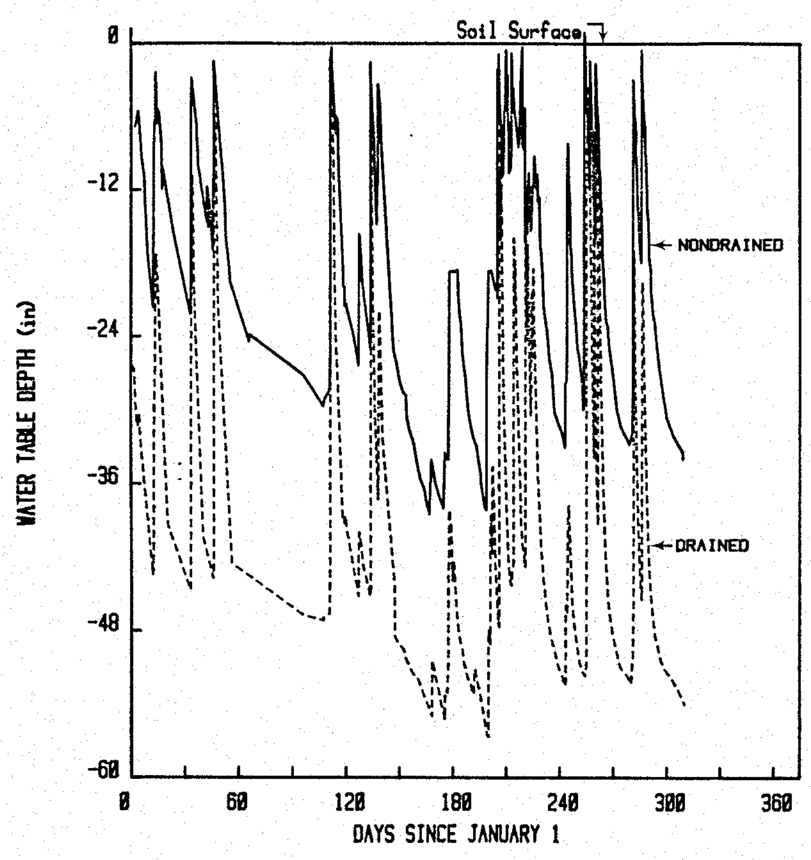

Figure 2. Water tables from nondrained and drained (90-foot spacing) fields in Iberia Parish, Louisiana, 1982.

The sum of excess water (SEW) was proposed by Sieben (10) as a way to determine excess soil water stress due to a high water table. He determined the amount of time and how far within a foot (base line) of the soil surface the water table was during the year and reported the data as depth-days. Any depth below the soil surface can be used as a base line. Since sugarcane in Louisiana is planted on high seedbeds, SEW determined from a base line of 18 inches may be near optimum for calculating SEW for use as an indicator of water table stress. In analyzing the data from this experiment, two different base lines (12 and 18 inches) were used. For a given base line, the higher the number (inch-days), the more severe the water table stress. SEW calculations were made both for the water tables in the 90-foot drain spacing treatment and for the nondrained treatment (Table 2). Water table data during the latter part of 1981 and 1982 were not included in the SEW calculations because the water table recorders were removed from about mid-November to mid-December each year for harvest. As shown in Table 2, water stress in the nondrained field was much more severe than it was in the drained field. The stress was also more severe in 1980 and 1982, the years with above average rainfall, than in 1981 when rainfall was below average.

Table 2. Water table stress as indicated by the SEW concept for sugarcane in Jeanerette silty clay loam soil in Iberia Parish, Louisiana.

Year	Water stress (inch-days)			
	Nondrained		Drained[1]	
	SEW_{12}	SEW_{18}	SEW_{12}	SEW_{18}
1980	332	728	110	296
1981	183	380	5	29
1982	337	871	33	92

[1]90-foot drain spacing

Sieben (10) reported that cereal crop yields begin to decline as SEW_{12} increased from 40 to 80 inch-days. SEW_{12} values exceeded 80 inch-days in the non-drained fields each year and exceeded 80 inch-days in the drained field in 1980. Previous work (unpublished) in Louisiana indicated that the SEW_{12} threshold for sugarcane yield decline may be greater than the 40 to 80 inch-days suggested by Sieben for cereal crops.

Among the four fields, cane and sugar yields were highest for the subsurface drained fields with 45- and 90-foot drain spacing (Table 3). Yields were lowest on the nondrained field except in 1980 when cane yield for the nondrained field was higher than that for the 135-ft drain spacing field. The highest average sugarcane yield (35.2 T/A) was produced on the 45-foot drain spacing field, which was 7 T/A (26%) more than the yield for the nondrained field.

The similar cane and sugar yields measured from the 45- and 90-foot drain spacing treatments for this 3-year period indicated that the 90-foot spacing may be adequate for draining this soil. When similar crop response is measured from different drain spacing treatments, the wider drain spacing is preferred from an economic standpoint, since the unit cost for installing subsurface drains varies inversely with drain spacing.

The 3-year average sugar yield from fields with the more closely spaced drains (45- and 90-foot spacing) was 1500 lbs/A (33%) more than the yield from the nondrained field (Table 3). This higher sugar yield was due to higher cane yields and higher sugar per ton of cane from the drained field. Average sugar yield from the 135-foot drain spacing field was 5094 lbs/A or 843 lbs/A (20%) more than the nondrained field (Table 3).

There were small differences in plant population, but relatively large differences in stalk weight among the fields (Table 3). This indicates that subsurface drained fields had larger stalks, but no more stalks than undrained fields.

It is interesting to note that the highest yields measured during this experiment were in 1981, the year with below average rainfall. Annual rainfall in 1981 was 45 inches which is slightly above the 40 inches needed to satisfy annual evapotranspiration (ET). Even with this relatively low rainfall, the subsurface drained fields yielded higher than the surface drained fields. In an average year, rainfall is 60 inches, which exceeds ET requirements by 20 inches.

Sugar yield differences between drained and nondrained fields were more pronounced in ratoon crops than in the plant crop. Data in Table 3 show that yields between the 90-foot drain spacing and check treatments differed by 669 lbs/A, 1759 lbs/A, and 2197 lbs/A in plant, first ratoon, and second ratoon, respectively. Differences in yield between the 45-foot drain spacing and the nondrained fields were similar to those between 90-foot drain spacing and nondrained fields. These data indicate that subsurface drainage may be more effective in boosting sugar yields in ratoon crops than in the plant crop.

If differences observed are attributable to subsurface drainage, the value of the large increase in sugar yield would pay, within four years, for drain installation costs of about $325 to $350/A for 100-foot spacings at the current sugar price of $.20/lb. The drain outlet problem experienced in the late 1800's has been solved by using sumps, as shown by the success of this and other experiments conducted in Louisiana in recent years.

Table 3. Cane yield, sugar yield, plant population and stalk weight from a subsurface drainage experiment on Jeanerette silty clay loam soil in Iberia Parish, Louisiana.

Treatment	Year	Cane Yield (T/A)	Sugar Yields (lbs/T)	Sugar Yields (lbs/A)	Plant Population (Plants/A)	Stalk Weight (lbs/stalk)
45'	1980	35.8	146	5261	38,850	1.85
45'	1981	40.1	178	7114	37,331	2.15
45'	1982	29.6	165	4820	23,875	2.50
Average		35.2	163	5732	33,352	2.17
90'	1980	34.8	152	5281	37,147	1.90
90'	1981	41.3	172	7119	31,218	2.65
90'	1982	28.2	177	4979	28,958	1.94
Average		34.8	167	5793	32,441	2.16
135'	1980	29.2	173	5063	34,858	1.68
135'	1981	34.8	192	6701	33,568	2.08
135'	1982	24.6	144	3519	30,652	1.62
Average		29.5	170	5094	33,026	1.79
Check	1980	33.6	138	4612	33,517	2.00
Check	1981	30.8	174	5360	37,679	1.65
Check	1982	19.2	143	2782	25,991	1.47
Average		27.9	152	4251	32,396	1.71

Crop production efficiency can be enhanced considerably with subsurface drainage. Using data from this experiment, a sugarcane grower with 500 acres of land without subsurface drainage could produce about 1000 tons of sugar/year (average yield of 4251 lbs/A from Table 3). If the land were drained (90-foot drain spacing), the same quantity of sugar could be produced annually on only 366 acres, a reduction of more than 25 percent in land. Thus, considerable savings in operating costs for sugarcane production could be obtained by using subsurface drainage.

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