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LEAVING SUGARCANE TRASH UNDISTURBED ON A LATERIC SOIL COMPARES FAVORABLY WITH CURRENTLY USED TRASH-DISPOSAL METHODS

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INTRODUCTION

In a previous paper Landrau and Samuels (1)[2] reported that yields of sugarcane in a Vega Alta silty clay at Río Piedras were increased significantly for 2 years after the fourth-ratoon crop as a result of aligning the trash instead of burning or burying it. Lugo-López, et al. (2), further reported on the effect of the various trash-disposal or trash-handling procedures upon the physical and chemical properties of the soil at the same location. Soil organic matter was found to be significantly lower in the burned-trash plots than in the aligned- and in the buried-trash plots. Furthermore, permeability and infiltration appeared to be slower in the burned-trash plots.

Landrau and Samuels (1) reported no differences in sugarcane yields attributable to treatments in four crops of a second trash-disposal experiment under way at Isabela. This paper reports on the soil conditions at the experimental field at Isabela where treatment differentials had been established for the 5 years, 1947–52. Furthermore, yield data reported previously (1) are brought up to date to include the past two cropping seasons.

MATERIALS AND METHODS

Soil Description

The trash-handling or trash-disposal experimental field at Isabela was established in 1946 at the Substation Farm in an area of Coto clay, a yellowish-brown lateritic soil derived from limestone. This soil is rather ex-

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[2] Numbers in parentheses refer to Literature Cited, p. 8.

tensive throughout the northwest coastal plains. A profile to a depth of 42 inches examined on March 2, 1951, revealed a medium-brown clayey surface soil about 8 inches in depth with medium-size fragmental to rounded structural aggregates. The 8- to 18-inch transitional layer had well-defined fragments with a tendency to be cubical. A gradual color change from brown to light yellow was observed in going into the deeper layers. Porosity was highly visible down to 42 inches. Underlying this layer was the limestone parent rock. Coto clay is a soil with good physical conditions for crop growth, but of moderately low fertility.

Field Work

The procedures for the handling of the trash in each treatment were as follows:

(1) *Trash aligned:* The trash was aligned in alternate banks.

(2) *Trash aligned and furrowed:* The trash was aligned in alternate banks and a shallow furrow was opened on the clean banks.

(3) *Undisturbed trash:* The trash in the plot was left lying on the field after harvesting and removing the cane.

(4) *Trash burned:* The trash was spread evenly over the plot and then burned.

The treatments were repeated every year after harvest. Each treatment was replicated nine times. The plots were 150 feet long by 20 feet wide and the cane rows were 4 feet apart. The plots were arranged following a simple randomized-block layout.

The variety of cane used was P.R. 905, which has proved to be one of the superior varieties for the area. Three crops were harvested from the original planting, and a new planting was made in the spring of 1949. The field as a whole received a yearly application of 1,200 pounds to the acre of a 15–3–10 fertilizer. After the second ratoon of the new crop cycle was harvested, infiltration tests were run in the field and soil samples were taken from each plot for laboratory analyses.

Bulk samples were taken from the upper 6 inches of soil. Each composite sample consisted of 10 units. Undisturbed core samples, 3 inches in diameter and 3 inches in length, were also taken at a 1- to 4-inch depth by using a Bradfield soil sampler. The buffer-compartment method was used to determine the infiltration rate. In this method iron rings 9, 18, and 27 inches in diameter are jacked into the soil. A ¼-inch head of water is maintained in the center ring by means of a self-dispensing 2,000-cc. burette. The same hydraulic head is maintained in the outer compartments to minimize lateral movements of water from the inner ring where measurements are taken hourly. The tests are run for eight consecutive hours.

Analytical Work

Permeability measurements were made in undisturbed soil cores by recording the rate at which water moved through a saturated column of soil at a known hydraulic head. Quick drainage was determined by placing the saturated core in a Buchner funnel, setting a 60-cm. tension and measuring the water drained after a 15-minute period. The water retained at pF 1.78 was measured by bringing the soil core to equilibrium with a 60-cm. tension and determining the variation in weight of the core. The maximum saturation was calculated from the above data.

The soil core was finally dried in the oven at 110°C. As the sampler used had a definite known volume, the bulk density of the soil was calculated by dividing the net dry weight by its volume. The pore space was then calculated by assuming a specific gravity for the soil particles of 2.65. The term "air porosity", as used in this paper, refers to the difference between the theoretical pore space and the water porosity as indicated by the volume of water retained at pF 1.78. Water retained at pF 2.7 and pF 4.2 was determined by submitting saturated soil samples in special plates to pressures of 0.5 and 15 atmospheres, respectively. The available water was considered as the difference in water retention between pF 1.78 and pF 4.2.

The pH was determined electrometrically using a Macbeth pH-meter. Total nitrogen was determined by the standard Kjeldahl method and the organic matter by the chromic acid titration method. The carbon-nitrogen ratio was subsequently calculated from the above data.

RESULTS AND DISCUSSION

Yields

Yield data for the first crop cycle and two crops of the second one are presented in table 1. The treatment differentials were established after the first plant cane crop was harvested. The plots for this plant crop were all treated uniformly and no significant cane-yield differences were observed. No significant differences due to treatments could be measured in the following five crops. The undisturbed-trash treatment, which had the lowest labor requirements, gave yields which compared favorably with those from the other treatments the labor costs of which were higher. In areas where drainage is not a limiting factor, it may prove to be economically advantageous to leave the trash undisturbed on the surface of the soil. Cultivation costs, particularly weeding, could thus also be decreased. In addition, direct evaporation losses from the soil could be reduced by the trash mulch on its surface. Vicente-Chandler (4) reduced soil-moisture losses by evaporation over 50 percent by mulching with sugarcane trash

TABLE 1.—*Mean yields of sugarcane for 6 crops at the Isabela experimental field, as affected by the trash-disposal method used*

Treatment of trash	Mean yield of cane for the plant cane, 1946–47	Mean yield of 96° sugar for indicated crop				
		First ratoon, 1947–48	Second ratoon, 1948–49	New planting, 1949–50	First ratoon, 1950–51	Second ratoon, 1951–52
	Cwt./acre	*Cwt./acre*	*Cwt./acre*	*Cwt./acre*	*Cwt./acre*	*Cwt./acre*
Aligned	803	98	83	101	80	92
Aligned and clean banks furrowed	793	94	75	101	74	90
Undisturbed	818	104	82	98	74	86
Burned	762	96	70	107	72	91
L.S.D. at the 5-percent level	97	13	30	12	10	11
L.S.D. at the 1-percent level	132	18	41	17	13	15

under the conditions that prevail at Aguirre, in southern Puerto Rico. Furthermore, the mulched soil was cooler in the plow layer and evidence was obtained showing that mulching reduced the rather large variations in soil temperature likely to occur in bare surface soil throughout the day.

Soil Properties

The results of the chemical analyses of the soils taken from the Isabela trash-handling experimental field are shown in table 2. The general pH values ranged from 4.7 to 6.0 with a mean value of 5.2 for the whole field, disregarding treatments. There were no significant differences between the means of the treatments. The mean nitrogen content of the soils under all treatments combined was 0.183 percent. There were no significant differences between the mean nitrogen content of the soils from the experi-

TABLE 2.—*Mean pH, nitrogen, organic-matter content, and C/N ratio of soils from the experimental field at Isabela, as affected by the trash-disposal method used*

Treatment of trash	pH	Nitrogen	Organic matter	C/N ratio
		Percent	*Percent*	
Aligned	5.18	0.188	2.71	8.6
Aligned and clean banks furrowed	5.22	.181	2.51	8.1
Undisturbed	5.14	.183	3.54	8.1
Burned	5.28	.183	2.66	8.4
L.S.D. at the 5-percent level	0.19	0.009	0.30	0.97
L.S.D. at the 1-percent level	.26	.013	.41	1.31

TABLE 3.—*Rate of infiltration of soils where sugarcane trash was aligned, aligned and furrowed, left undisturbed, or burned for 5 consecutive years, Isabela experimental trash-disposal field*

Treatment of trash	Infiltration rate in inches of water per hour at hour indicated							
	1st	2d	3d	4th	5th	6th	7th	8th
Aligned	4.75	2.88	2.87	2.57	2.36	2.93	2.26	2.70
Aligned and clean banks furrowed	2.97	1.87	1.79	1.74	2.19	1.99	1.93	1.80
Undisturbed trash	2.77	1.70	1.55	1.56	1.54	1.69	1.43	1.39
Burned	3.11	1.50	1.31	1.44	1.52	1.13	1.10	1.10
L.S.D. at the 5-percent level for the eighth hour								0.53
L.S.D. at the 1-percent level for the eighth hour								.72

mental plots, whether the trash was aligned, aligned and the clean bank furrowed, undisturbed, or burned.

No significant differences were observed in the soil organic-matter content of the plots where the trash was differently handled for 5 years. Difficulties were encountered in sampling for organic-matter determinations in the four treatments. Although all surface trash was removed before sampling, there was considerable variation in the organic-matter content of soil samples taken within a given plot. The plots where the trash was burned yearly have received considerably less organic materials than those where it was handled otherwise, but the organic-matter content after 5 years remained more or less the same. The mean C/N ratios were narrow for all treatments. They further indicated that the carbonaceous materials decomposed quickly.

Table 3 gives the mean infiltration rate of the soil determined for each of 8 hours on plots where the trash was differently handled for the past 5 years. In general, the soil-infiltration rate was faster in the plots where the trash was aligned than in those where it was otherwise handled. The differences between the means of the treatments were significant. In all cases, however, the rate of infiltration at the eighth hour was from moderate to moderately rapid. In an area where supplemental irrigation is necessary as in Isabela, a moderately rapid rate of infiltration may be a handicap. In this connection, the value of leaving the trash untouched over the surface soil may be of tremendous importance, insofar as it reduces the water losses by direct evaporation.

The results of the permeability tests and other soil-moisture measurements performed are reported on table 4. In general, there were no significant differences in the moisture characteristics of the soils undergoing the various trash-disposal treatments. The lack of significant differences in

TABLE 4.—*Permeability and other soil-moisture data gathered from 1- to 4-inch-depth soil cores collected at the experimental field at Isabela, as affected by the trash-disposal method used*

Treatment of trash	Permeability	Water drained at 60 cm. in 15 minutes	Maximum saturation	Water retained at pF—			Available water (water retained at pF 1.78 minus water retained at pF 4.2)
				1.78	2.7	4.2	
	In./hr.	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Aligned	18.37	11.27	55.75	39.10	30.78	23.78	15.32
Aligned and clean banks furrowed	10.40	9.90	54.22	41.02	30.12	23.60	17.42
Undisturbed	16.69	8.20	53.20	40.42	31.88	26.28	14.15
Burned	—	12.22	54.95	40.32	31.52	23.28	17.05
L.S.D. at the 5-percent level	39.23	5.16	3.02	4.93	3.47	2.87	3.98
L.S.D. at the 1-percent level	59.44	7.42	4.34	7.08	4.99	4.13	5.73

regard to these physical properties of the soil are in line with the lack of differences in the organic-matter level of the soils, in spite of the differences in methods of trash handling used. In a previous report (3) from a somewhat similar experiment at Río Piedras, where different organic-matter levels resulted from various trash-handling procedures, observations were made indicating that permeability and water retention at low tensions were higher with higher organic-matter accumulations.

Table 5 presents data on bulk density, total porosity, and air porosity of soils taken from the variously treated plots. The bulk-density values range from mean values of 1.13 gm./cc. for the soil from the plots where the trash was burned to 1.21 for the soil where the trash was undisturbed. The

TABLE 5.—*Bulk density, pore space, and air capacity of soils from the sugarcane experimental field at Isabela, as affected by the trash-disposal method used*

Treatment of trash	Bulk density	Pore space	Air porosity (pore space-volume of water retained at pF 1.78)
	Gm./c.c.	*Percent*	*Percent*
Aligned	1.15	56.50	17.40
Aligned and clean banks furrowed	1.18	54.45	13.50
Undisturbed	1.21	54.22	13.80
Burned	1.13	57.50	17.18
L.S.D. at the 5-percent level	0.11	3.77	7.03
L.S.D. at the 1-percent level	.16	5.41	10.09

mean porosity value for the soil from all plots considered together was 55.69 percent by volume with deviations of only 1.81 and 1.47 above and below. The air porosity was higher from plots where the trash was burned and aligned, and lower from those where it was aligned and plowed and left undisturbed over the surface. The differences, however, were not significant.

SUMMARY AND CONCLUSIONS

The production of sugar was not influenced by the various methods of handling sugarcane trash (aligning, aligning and furrowing, leaving undisturbed, or burning) on a field of Coto clay, a highly permeable lateritic soil at Isabela in northwestern Puerto Rico. No significant differences due to treatments were observed in organic-matter or nitrogen content, pH, C/N ration, permeability, quick drainage, water retained at various tensions, bulk density, or porosity, determined from soil samples taken after harvesting the sixth crop. The minimum infiltration capacity of the soils from the plots where the trash was burned or undisturbed was moderate, while that of the soils where the trash was aligned, or aligned and the clean banks furrowed, was moderately rapid.

The yields from plots where the trash was left undisturbed over the surface were as high as those where it was either burned, aligned, or aligned and the clean banks furrowed. Trash disposal is generally expensive. By leaving the trash undisturbed, cultivation costs can be reduced considerably. Weeds are usually smothered under the trash. In areas where drainage problems are not very acute, it may prove economically advantageous in the long run to follow this practice. Furthermore, direct moisture-evaporation losses from the soil will probably be reduced by mulching the whole surface soil.

RESUMEN Y CONCLUSIONES

El método de disponer de la paja después de la cosecha de la caña de azúcar no afectó la producción en un campo experimental ubicado en Isabela, en la zona noroeste de Puerto Rico. El suelo del campo era del tipo arcilla Coto, laterítico y muy permeable. Los tratamientos con la paja fueron:

1. Alineada a lo largo del banco roturado
2. Alineada a lo largo del banco sin roturar
3. Dejada en su sitio después del corte
4. Quemada.

No se registraron diferencias significativas debido al efecto de los tratamientos sobre permeabilidad, desagüe rápido, humedad retenida a varias tensiones, densidad aparente y porosidad en las muestras de suelos tomadas después de cosechar el segundo retoño del segundo ciclo. La infiltración

mínima fué moderada en las parcelas donde se quemó la paja y donde ésta no se movió; en aquéllas donde la paja se alineó y en donde la paja se alineó y roturó el banco, la infiltración fué moderadamente rápida.

Los rendimientos de las parcelas donde la paja de caña se dejó sin mover sobre la superficie fueron tan altos como los de aquéllas en las que se quemó, se alineó, y se alineó y roturó el banco. La manipulación de la paja generalmente resulta costosa. Dejándola sin mover se pueden reducir bastante los costos de cultivo. El número de desyerbos también resulta menor. En zonas donde no haya problemas graves de desagüe puede resultar, a larga, económicamente ventajosa la práctica de dejar la paja sobre la superficie sin mover. Además, las pérdidas de humedad por evaporación directa del suelo, podrían reducirse efectivamente cuando se deja la paja sobre el campo.

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