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EFFECTS OF PLANT DENSITY ON THE PRODUCTION OF A PLANT CROP OF RED SPANISH PINEAPPLE IN PUERTO RICO

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INTRODUCTION

Planting distances and systems used in pineapple fields in Puerto Rico are based on customary practices and former experience rather than on a sound scientific basis. The double row system of planting, which does not interfere with mechanized cultural and harvesting operations, is generally used.

An average of 13,000 and 17,000 plants per acre are usually used under commercial conditions for the Red Spanish and the Smooth Cayenne varieties, respectively. The main pineapple production area lies in the central northern-coastal plains extending from Vega Baja to Arecibo. The Red Spanish variety is used in about 75 percent of the area under cultivation. In 1967 (1) Puerto Rico produced 71,192 short tons of pineapple fruit in a harvested area of some 4,700 acres, with a farm value of \$ 3,774. 000.

Plant density studies with different pineapple varieties have been performed in Australia, Swaziland, South Africa and Taiwan by various research workers (2, 3, 4, 7). The results obtained under their local conditions have been useful in improving the pineapple industry in those countries. It is important to know how crops, and even varieties, respond to spacing in a particular area so that principles may be established that could be a useful guide in the commercial cultivation of pineapple.

There are currently no reliable data on pineapple production costs per unit of area. However, there are certain fixed costs per unit area, irrespective of the number of plants grown and fruits harvested. Since Puerto Rico must compete with other pineapple producing countries, where labor costs are lower ; it is of utmost importance to find out the best spacing under local conditions from the standpoint of yield, fruit size, quality, and other cultural problems. The work herein reported was undertaken to determine the effect of planting distance on the fruit yield of the plant crop and on the behavior of the ratoon crop.

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EXPERIMENTAL PROCEDURE

In January, 1967 a field experiment was established on a Bayamón clay loam at Sabana Seca, Manatí. The pH of the topsoil was 4.9. The experimental site is located in the most important pineapple growing region of Puerto Rico. All field operations, except the planting distance were performed following the conventional methods used by the cooperators, i. e., the Pineapple Production Program of the Land Authority of Puerto Rico.

The 40 plots were arranged in a randomized incomplete block design. Each plot consists of eight double rows, 40 feet long; the plants are 22 inches apart between rows and 52 inches between the double row. The distance between plants within the row varies from 8 to 28 inches, according to the treatment differentials which are as follows: 8", 13", 18", 23" and 28". Medium sized slips (10" 20") were planted to achieve a planting density ranging from 6,000 to 18,000 plants per acre.

Leaf analyses from the so called « D »-leaf (the youngest full-grown leaf) were performed with material from eight months old plants. Nitrogen, P, K, Ca, Mg, S, Fe and Mn, were determined using standard laboratory methods. The plants were forced into flowering using B O H solution (beta-hydroxy-ethyl-hydrazine) 11 months after planting.

The plant crop was harvested at 17 months. Data on fruit yield, slipsucker production and occurrence of multiple tops were recorded. Also fruit quality indices such as total solids in solution (degrees Brix) pH, and total acidity (as mg-citric acid/100 ml of juice) were obtained.

RESULTS AND DISCUSSION

Fruit Yields

Close planting significantly increased total yields of a plant crop to a maximum of 28.8 tons at 18,000 plants per acre (Table 1, Figure 1). Changes in spacing from 28 inches to 8 inches between plants within the row increased yields progressively to a maximum increase under the conditions of this experiment of 17.3 tons per acre. Spacing between plants within the row have shown remarkable influence on pineapple yields (2, 3, 4, 5, 6, 7, 8), on other areas.

Plant spacing definitely exerted significant effects on mean fruit-weight (Table 1). The smaller fruits (3.28 lb.) were obtained at eight inches spacing and the larger (3.99 lb.) at 18 inches. As expected, as the spacing increases the mean fruit-weight also increases.

Fruit Diameter and Core Size

The spacings under study showed no significant effect on fruit and core diameter. The plants at eight inches spacing yielded fruits with a diameter of 13.7 cm and a core of 2.54 cm in size; while those at 28 inches spacing were 14.3 and 2.51, respectively. Since the canning and fresh fruit market does not necessarily require fruits larger than 12.7 cm in diameter, then production under close spacing, yielded as desirable a fruit as that produced at wider spacings.

TABLE I

Effect of spacing between plants within the row on the plant crop yield of Red Spanish pineapple grown in a Bayamón clay loam

Treatment		Fruit/acre	Treatments significantly excelled
Number	Spacing inches		
1	8	Tons 28.76	5, 4, 3, 2**
2	13	21.39	5, 4, 3**
3	18	17.41	5, 4**
4	23	13.36	5*
5	28	11.44	
Mean Weight of Fruit			
		lbs.	
3	18	3.99	1, 2**
5	28	3.89	1**, 2*
4	23	3.84	1**
2	13	3.66	1**
1	8	3.28	

** Indicates significance at the 1-percent level.

Fruit Juice Quality Values

Neither of the five spacing, under study showed a significant effect upon total solids, pH and total acidity of the juice. The highest degree Brix value was 13.36 for the eight inches spacing ; the lowest was 13.07 for the 18 inches spacing. The highest acid content of 735 mg was obtained from fruits produced from plants at 18 inches spacing ; and the lower value of 663 mg at plants 8 inches. These values satisfy the requirements for the canned fruit.

Slip and Sucker Production

Space between plants significantly reduced the number of slips and suckers per plant (Table 2). These results confirm previous from other investigators (2, 3, 7). As the suckers production decrease the yield of the ratoon crop may be influenced unfavorably. The production of planting material is very important in pineapple production. Very close spacing such as 8 inches between plants may result in very low yield of slips. This may be particularly important in the case of some varieties which seldom produce sufficient slips for the next planting.

Multiple Crown

The occurrence of multiple tops occurs particularly in the Smooth Cayenne variety. In Hawaii, it is believed that closer spacing in the row lowers the incidence of multiple topping which causes problems in certain seasons (2). In this experiment,

TABLE 2
*Effect of spacing between plant within the row on the slip
and sucker production of Red Spanish Pineapples*

Treatment		Mean number of slips per plant	Treatment significantly exceeded
Number	Spacing (inches)		
5	28	7.36	1, 2**
4	23	6.79	1**
3	18	6.64	1**
2	13	6.04	1**
1	8	5.04	

Mean number of suckers per plant			
Number	Spacing (inches)	Mean number	Treatment significantly exceeded
5	28	2.51	1, 2, 3**
4	23	2.28	1**
3	18	2.13	1**
2	13	2.07	1**
1	8	1.60	

** Indicates significance at the 1-percent level.

highly significant differences between treatments were found. As plant spacing increased the percent of multiple crowns also increased (Table 3). The higher incidence (1.95 %) was found at the 23 inches interval between plants. This is the first time that this observation is recorded in the Red Spanish variety.

TABLE 3
*Influence of plant density on the formation of multiple
crowns of Red Spanish Pineapples*

Treatment		Multiple Crowns Percent	Treatments significantly exceeded
Number	Plant/acre 1 000		
4	7	1.95	1**, 2*, 3*
5	6	1.78	1*, 2*
3	9	0.87	
2	12	0.63	
1	18	0.16	

** Indicates significance at the 1-percent level.

Other Findings

Data on « D » leaf tissue analyses for N, P, K, Ca, Mg, S, Fe and Mn are given on (Table 4). There are only significant differences among the mean leaf values for potassium and iron. The higher plant population the less potassium and iron present in the leaf-tissue. Nevertheless the potassium leaf values for all plant densities appear to be sufficient to meet the requirement of the plant. Su (7) stresses the need of increasing the amount of fertilizer as the plant density increases.

TABLE 4

Influence of plant population on nutrient status at 8 months old Red Spanish Pineapples

Treatment		* D * — leaf nutrient content, dry weight basis								
Spacing	Plants/acre	N	P	K	Ca	Mg	S	Fe	Mn	B
Inches	Number	Percent	Percent	Percent	Percent	Percent	Percent	Ppm	Ppm	Ppm
8	18,000	2.08	.16	4.19	.23	.32	.12	135	658	16
13	12,000	2.11	.16	4.50	.25	.33	.14	180	604	14
18	9,000	2.16	.16	4.75	.24	.32	.14	248	542	13
23	7,000	2.17	.17	4.78	.25	.40	.16	459	711	15
28	6,000	2.15	.17	4.71	.24	.36	.14	383	656	11

In this experiment there were no weeding problems in the close plantings but slightly late-ripening occurred. In the wider spacings more weeds and abundant lodging were observed. These conditions are detrimental to pineapple growing.

The behavior of the ratoon crop in regard to yield, quality and fruit size is under observation in order to find out which spacings will afford higher farm profits.

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SUMMARY

Using the conventional double row system, a field trial in which five plant spacings within the row (8", 18", 23" and 28") replicated eight times, was established. The row width and the spacing between the double rows were kept at 22' and 54', respectively.

The plant crop has shown the following results : foliar analysis for N, P, K, Ca, Mg, Fe and Mn was performed ; but only potassium and iron content gave significant results. The higher the plant population the less potassium and iron present in the leaf-tissue.

Dense planting significantly increased total fruit yield to a maximum of 28.8 tons at 18,000 plants per acre. Also, the mean fruit-weight was a significantly reduced as plant population increased.

Slip and sucker production was significantly reduced as plant density increased. The occurrence of multiple tops was affected by planting distance. A plant spacing within the row increased, the percent of multiple crowns also increased.

The five plant spacings under the study did not show-significant effect upon fruit juice quality values.

RÉSUMÉ

ÉTUDE DE DENSITÉ DE PLANTATIONS SUR L'ANANAS RED-SPANISH A PUERTO RICO

On a utilisé la plantation classique en lignes jumelées, avec les écartements suivants :

- sur la ligne : 20, 46, 58, 71 cm ;
- l'écartement des lignes a été dans tous les cas de 55 cm ;
- l'écartement entre les rangées a été dans tous les cas de 140 cm (chemin).

L'analyse foliaire (N, P, K, Ca, Mg, Fe, Mn) a donné des résultats significatifs pour K et Fe : les teneurs en ces éléments sont d'autant plus faibles que la densité de plantation est importante.

L'accroissement de densité accroît le rendement jusqu'à un maximum de 64,5 T/ha, correspondant à une densité de 49 000 pieds/ha ; le poids moyen du fruit décroît lorsque la densité augmente. La production de rejets (bulbilles et cayeux) diminue de façon significative lorsque la densité augmente.

Lorsque l'écartement sur la ligne diminue, la proportion de plantes à couronnes multiples augmente.

Les 5 écartements étudiés n'ont pas donné de différences sur la qualité des jus.

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Relationship between plant population and yield for Red Spanish Pineapple variety.

