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EFFECTS OF PLANT DENSITY ON MAIZE YIELD ON THE ATHERTON TABLELAND, QUEENSLAND

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SUMMARY

From 1953 to 1961, the open-pollinated maize variety Kairi Durum grown at 11,900 plants per ac showed an average yield advantage of approx. 6 bus over lower density stands.

Yields of the hybrid GH128 were sensitive to plant density in 1959, but were independent of treatment in 1961, when abnormally dry conditions prevailed, and in 1962, when tropical rust was prevalent. With currently available hybrids, plant densities above 14,000 plants per ac are not recommended, due to the possibility of lodging.

I. INTRODUCTION

To ensure maximum maize yields, it is important to have a plant density which is optimum for the particular level of soil fertility, climatic conditions and maize variety used. Most maize farmers on the Atherton Tableland use a plant density of between 6,000 and 10,000 plants per acre, and since soil moisture is rarely a limiting factor for maize growth on the Tableland, there would appear to be good reason for increasing the plant population with associated attention to soil fertility when aiming at higher yields (Kelly 1964). Maize fertilizer trials have pointed to the necessity of having an even and correct plant stand in order to obtain maximum returns from fertilizer applications.

This paper reports the results of several maize plant density experiments carried out at the Queensland Department of Primary Industries Research Station, Kairi, from 1953 to 1962 in conjunction with fertilizer trials (van Haeringen 1965).

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II. METHODS AND RESULTS

(a) Open-pollinated Variety—Kairi Durum

During the period 1953-1958, combined maize fertilizer and spacing experiments were carried out annually on land which was subject to rotational cropping (4 years Rhodes grass/lucerne pasture followed by 5 years maize). Each year, identical experiments were carried out at two different stages of the rotation, viz. first and third year maize after pasture. The treatments were:—two within-row spacings of 12 and 15 in., and four levels of nitrogen: 0, 40, 80, and 40 + 40 lb nitrogen per acre as split applications, giving eight treatment combinations. A randomized block design with four replications was employed. In all experiments reported in this paper, a between-row spacing of 44 in. was employed. Table 1 indicates the relationship between within-row spacing and plant density; the 12- and 15-in. spacings provided plant densities of 11,900 and 9,500 plants per acre.

TABLE 1

RELATIONSHIP BETWEEN WITHIN-ROW SPACING AND PLANT DENSITY, FOR ROWS 44 IN. APART

Plant Spacing (in.)	Plant Density (plants/ac)
6	23,800
8	17,800
10	14,300
12	11,900
14	10,200
16	8,900
18	7,900
20	7,100

The results (Table 2) indicate that the higher plant density was significantly superior in 4 of the 5 years, an average advantage of 5·2 bus/ac being recorded. No significant response to nitrogen occurred. In this series of experiments, cobrot incidence and percentage lodging were independent of plant density.

TABLE 2

YIELD OF MAIZE AT TWO DENSITIES ON ROTATED MAIZE LAND, 1953–1958
(bus/ac)

—	1st Year after Pasture		3rd Year after Pasture	
Plants per Acre	11,900	9,500	11,900	9,500
1953	16·8	13·2	19·4	14·6
1954	68·8**	61·2	72·3**	60·6
1955	73·6**	68·1	74·4**	71·0
1957	51·0	49·2	70·1**	61·4
1958	32·2**	29·1	28·0**	25·9

** Indicates significant differences at 1% level

From 1957 to 1961, two spacings, 18 and 12 in., equivalent to 7,900 and 11,900 plants per acre, were employed, using 10 replications on land of good fertility.

The higher density treatment significantly outyielded the lower density treatment in 4 out of 5 years, the average superiority being 6·1 bus/ac. Only in one year did the treatment differ significantly in the percentage of lodged plants. There was no difference with regard to cobrot incidence. The results are set out in Table 3.

TABLE 3

YIELD CHARACTERISTICS OF MAIZE AT TWO DENSITIES, 1957–1961

Plants per Acre	Percentage Healthy Cobs		Percentage Lodged Plants		Yield (bus/ac)	
	11,900	7,900	11,900	7,900	11,900	7,900
1957	92	93	4	3	64·7**	50·7
1958	85	87	8**	4	32·0**	28·3
1959	93	92	6	6	54·7**	47·7
1960	95	95	7	8	61·1**	56·4
1961	79	79	4	3	36·2	35·1

** Indicates significant differences at 1% level

(b) Hybrid Variety—GH128

By the end of the 1950's hybrids had to a large extent replaced the open-pollinated varieties used on the Atherton Tableland. GH128 was the most widely used hybrid, and was employed in these experiments.

In 1959, two observation trials were carried out in which two series of plant densities were compared on soil of high fertility and on land of only fair fertility. Plot size was 0·3 ac and the treatments were replicated three times. The results (Table 4) suggest that real advantages accrued at the higher plant densities on both types of soil. No differences occurred in the percentages of lodged plants or of diseased cobs.

TABLE 4

YIELD OF HYBRID MAIZE AT DIFFERENT DENSITIES, 1959 SEASON
(bus/ac)

Plants per Acre	11,900	7,900	14,300	9,500
Soil of fair fertility ..	56·2	47·6		
Soil of good fertility ..			75·5	60·6

In both 1961 and 1962, two combined fertilizer-plant density experiments were conducted on rotated land and on land which had grown maize continuously for at least 40 years.

The experiment on the rotated maize land embraced five plant densities from 23,800 to 10,200 plants per acre and two levels of nitrogen application, 0 and 50 lb nitrogen per acre, making 10 treatment combinations. These were arranged as randomized blocks with four replicates. The 1961 season was abnormally dry, a serious moisture shortage occurring during the second and third months of growth. In the 1962 season, the incidence of tropical rust (*Puccinia polysora*) put a ceiling on yields. Yields averaged 31·5 and 54·7 bus/ac in 1961 and 1962 respectively, but no significant treatment differences were recorded. In 1962, severe lodging occurred at the highest plant density.

The experiment on land previously growing continuous maize included four plant densities, from 17,800 to 10,200 plants per acre, and five levels of nitrogen fertilizer from 0 to 100 lb nitrogen per acre. There were three absolute replications of all combinations, arranged in a triple rectangular lattice. Yields averaged 31·1 and 46·4 bus/ac in 1961 and 1962 respectively; again yields were independent of treatment.

III. DISCUSSION

Numerous experiments have been conducted in maize-growing areas to determine optimum plant density. Dungan, Lang, and Pendleton (1958), in reviewing this field, referred to the complexity of the problem, owing to the effects of individual seasonal differences and of the constant changes in the productivity of land, and in the inherent constitution of maize varieties. Nevertheless, real progress in increasing yielding efficiency can be achieved by attention to plant density.

The experiments with the open-pollinated Kairi Durum variety showed consistent yield advantages from a density of 11,900 plants per acre, which is higher than normally employed on the Atherton Tableland. It is generally recognized that hybrids may be planted closer than open-pollinated maize varieties because of their even development. In the observation trials with the hybrid GH128 in 1959, yield increases due to closer planting were substantial.

In the experiments conducted in 1961 and 1962 with GH128, densities above 10,200 plants per acre were compared. Unfortunately, in both years maximum yields were not obtained, due to drought conditions in 1961 and severe infestation of tropical rust in 1962; yields were independent of treatment. However, in the 1962 experiment on rotated maize land, densities of 14,300 plants and above per acre increased the percentage of lodged plants, and high harvest losses would have reduced yields considerably had the experiment been machine-harvested.

In all experiments except those of the abnormally dry year of 1961, closer planting resulted in taller plants, reduction in stalk diameter and reduced cob size; in the open-pollinated varieties, increased percentage of barren plants was also apparent. These factors were not important, however, since the effect of increased plant density exerted compensatory influence on total yield. Incidence of weeds was also negatively associated with plant density.

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