THE EFFECTS OF PLANT POPULATIONS AND ROW SPACINGS ON THE GRAIN YIELD OF MAIZE *(Zea mays L.)*

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SUMMARY

Field trials indicated that populations of 62,000-70,000 plants per hectare (25-28,000/acre) would maximize grain yields from maize planted in 76 cm (30") spaced rows. Under high fertility and reliable moisture conditions the population could be lifted to 75,000 plants per hectare (30,000/acre).

In trials where 38 cm (15") spaced rows were compared to 76 cm spaced rows at similar populations, 38 cm spaced rows gave higher grain yields of 8 to 13 percent.

INTRODUCTION

There has been only limited research in New Zealand into the agronomy of the maize crop and most of this has been accomplished in recent years. There is no published data on the effects of plant populations on grain yields except for a brief mention by Cumberland et. al. (1970). Current recommendations given for establishing a suitable crop for grain production have been arrived at from the extrapolation of American evidence, unpublicised field trials and first hand experience.

Aldrich and Leng (1965) have indicated that most corn belt experimental stations and seed companies in the United States of America recommend plant populations of 37-50,000 plants per hectare (p/ha) (15-20,000/a), although in some situations populations of 60-70,000 p/ha (24-28,000/a) have proved worthwhile (Hight 1967, Lutz et. al. 1971). In North Carolina Nunez and Kamprath (1969) obtained little increase in grain yield from plant populations greater than 52,000 p/ha (21,000/a) while in Kansas, Stickler (1964) suggested 50-60,000 p/ha under irrigation and 40,000 p/ha on dry land maximised grain yields. In Manitoba on the northern fringe of the corn belt Giesbrecht (1969) found for short early maturing hybrids that where moisture was adequate 75,000 p/ha (30,000/a) maximized grain yield but in drier years 60,000 p/ha were sufficient.

In New Zealand Walker (1929) recommended populations of 35,800 p/ha (14,500/a) in 90 cm rows (36") for tall hybrids and 43,200 p/ha (17,500/a) in 76 cm (30") rows for shorter hybrids. Later Walker (1946) and Chamberlain (1956, 1961) both recommended sowing maize in 76-90 cm spaced rows at a rate of 44,500-54,400 p/ha (18-22,000/a).

More recently Graham (1967) indicated that crops were commonly sown in rows 90 cm apart with an average sowing of 54,400 p/ha. Given 15 percent loss in plants between sowing and maturity the harvest populations would range from 37-47,000 p/ha (15-19,000/a).

Today, most maize in New Zealand is planted in 76 cm spaced rows. Research in the United States by Lutz et.al. (1971) and Stickler (1964) showed that grain yield could be increased by decreasing the row width to 40 cm and 50 cms respectively, but Giesbrecht (1969) in Canada found no effect. Nunez and Kamprath (1969) found 53 cm wide rows gave higher grain yields than 106 cm rows under drought conditions. There has been no research conducted on row spacing in New Zealand.

Concurrent with renewed farmer interest in maize growing in the late 1960's research work was increased. In 1967-68 12 trials, conducted by the Field Research Section, Research Division, N.Z.D.A. measured the grain yields from a range of maize hybrids. In these comparisons the difficulty of maintaining similar plant populations in all plots led to consideration of the populations of individual plots rather than just the varietal means. Regression analysis of plant population and grain yield showed that of the 12 trials seven had significant plant population : grain yield relationships. By plotting the regression co-efficient against the mean plant population for each trial, three groups of trials with differing mean plant populations could be distinguished.

1. Trials with plant populations less than 35,000 p/ha (14,000/a) having low grain yields and low regression co-efficients (one trial sig. 5%).

2. Trials with plant populations between 40,000-53,000 p/ha (16-21,500/a) having high regression co-efficients, all of which were significant (five trials sig. 1%, one trial sig. 5%).

3. Trials with plant populations between 53,000-60,000 p/ha (21,500-24,500/a) showed no significant relationship between plant population and grain yield.

Results of this analysis indicated that to validly compare maize hybrids in that season above 50,000 p/ha

were needed to avoid the problem of plant population x yield interactions. As a result of this evidence research testing the effect of plant population on the grain yield of maize was commenced.

RESULTS

1968-69 Trials:

In the 1968-69 season six trials of replicated randomized block design were conducted and analysed by the analysis of variance technique. The trials compared from 2-4 populations and some also tested two hybrids. All trials were sown in 76 cm rows except two FH 20/1 & 2) which were sown in 71 cm (28") rows. The plant populations tested were in the range from 45-90,000 p/ha.

Results of five trials, for only one hybrid, W575, are show in Fig. 1 except for one trial (N (FB) 74/1) in which Morden 88 was used.

The results indicate that within the range tested as the plant population in 76 cm rows increased so did the grain yield. The increases in the individual trials ranged from 1700 to 2800 kg/ha (21-37%) above the grain yield from the low populations. Overall the grain yield rose by 75 kg/ha for every increase of 1,000 p/ha.

1969-70 Trials:

A greater range of populations was investigated in the 1969-70 season. Eight trials were conducted in most of which the hybrid PX 610 was used (W575 was used in N (FF) 131/1, N (FR) 131/2). The results from six trials are shown in Fig. 2 with one result from the previous year being added (FA 50/1).

In 1969-70 South Auckland, Waikato and Bay of Plenty experienced the driest summer for many years. The effect of this dry season on grain yield is shown by comparing trials FA 50/1 and FA 50/2 conducted at the same site but in different years.

In the three lower yielding trials there was no significant effect on grain yield as the population was increased. The trend in the yield-population relationship was slightly negative. In the Waikato and Bay of Plenty trials (131/1, 131/2) there was little increase in grain yield above a population of 60,000 p/ha but at Gisborne the grain yield was maximized at the highest plant population tested (69,000 p/ha).

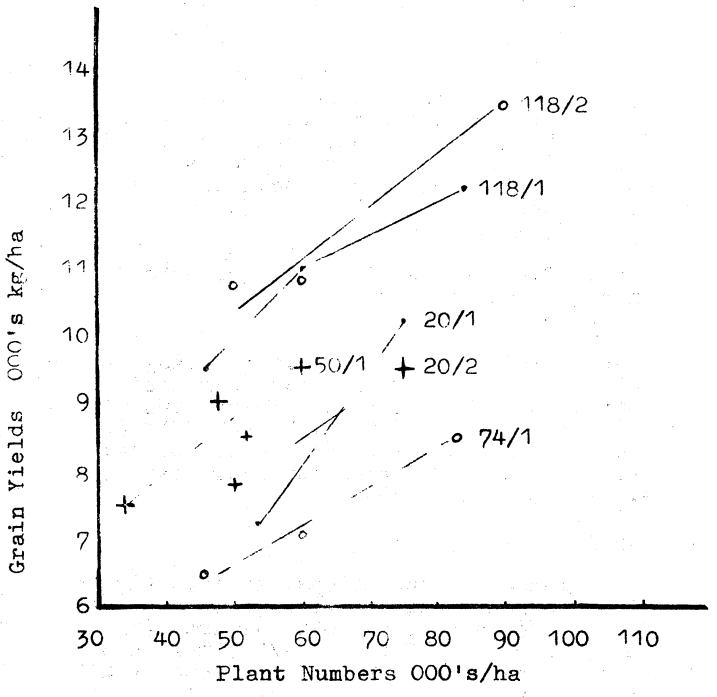

Fig. 1 Effects of plants populations, in rows at 76 cm centres; on maize grain yields kg/ha (lines of best fit.) 1968:69 field trials at Auckland 50/1 Waikato 118/1 119/2, Hawkes Bay 20/1 20/2 and Marlborough 74/1

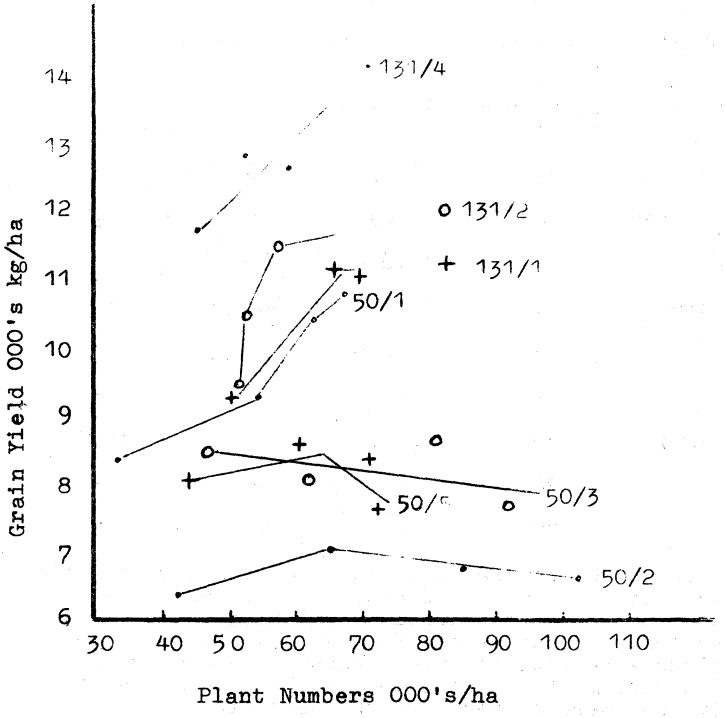

Fig. 2 Effects of plant populations, in rows at 76 cm centres, on maize grain yields kg/ha (lines of best fit.) 1969:70 field trials at Auckland 50/1, 50/2, 50/3 50/5 Tauranga 131/2, Waikato 131/1 and Gisborne 131/4.

Effect of Row Spacing:

Plant populations can be increased by planting either more plants per row or more rows. Five trials were conducted in which maize sown in 38 cm rows was compared to that sown at the same population in 76cm rows. The results are presented in Table 1.

TABLE 1: Grain Yield kg ha - 15% moisture. From 76 cm and 38 cm spaced rows.

Location	Plant popn. (000's)	76 cm	38 cm	Increase	C.V.%
Hawkes Bay	75	9,530	10,980	1,450	9.1
Hawkes Bay	76	10,040	11,160	1,120	5.9
Waikato	61	10,870	11,990	1,120	8.6
Gisborne	56	12,610	13,360	750	8.7
	69	13,870	-	-	-
	79	-	15,670	-	-
Wanganui	66	11,670	-	-	13.7
	70	-	13,140	-	-
	100	-	15,170	-	-

In all cases the 38 cm sowings gave higher grain yields than the 76 cm sowings. Yields were 8 to 13 percent better at comparable populations. In two experiments (Gisborne and Wanganui) where two populations were sown in 38 cm spaced rows the grain yields were further increased as the populations in 38 cm rows were lifted. The highest yield was 15,670 kg/ha (250 bus/a) at a plant population of 79,000 p/ha in 38 cm spaced rows at Gisborne.

DISCUSSION

From these results, it is concluded that 62,000 - 70,000 p/ha are required at harvest to maximize grain yields from maize planted in 76 cm spaced rows. Under high fertility and reliable moisture conditions it would appear that harvest populations of about 75,000 p/ha could be recommended. These plant populations are 10-25,000 p/ha above the general recommendation for the American corn belt.

All the trials conducted in 1969-70, except the one at Gisborne, suffered from drought stress. In these trials it was noticeable that the increase of

grain yield to plant population was much less than in the previous season but even so the maximum yield was maintained over a wide population range. There was no sharp decline in grain yield as plant population was increased. This indicated that reasonably high plant populations can be recommended to take advantage of average and good seasons without jeopardizing grain yields in dry years.

Since losses of plants of 10 to 30 percent between sowing and harvest have been recorded in Auckland district crops, the sowing rate for the recommended populations would be 74-100,000 p/ha. Average plant losses in the American corn belt are 15-20 percent (Aldrick and Leng 1965). In some trials the plant loss increased as the plant population rose but this did not always occur. Plant losses were more affected by site than plant population.

Plant lodging observations from the trials indicated that for the hybrid PX610 there was no extra lodging with higher populations. Greater lodging effects were due to trial sites and different hybrids. The hybrid KC3 lodged more severely in the Auckland district trials than PX610. Aldrich and Leng (1965) indicated that, particularly in wet years, higher populations lodge more readily.

In all trials except one, in which two hybrids were sown both reacted similarly to changes in plant population. The exception occurred where the hybrid W575 gave increased grain yield when the plant population was raised from 59,000 to 89,000 p/ha but W647 did not.

By use of special machinery for inter-row cultivation or by chemical weed control maize can now be planted in rows closer than 76 cms. While further research is required the initial evidence indicates that narrower rows would give worthwhile increases in grain yield. This is in agreement with the results of Lutz et.al. 1971 and Stickler (1964) in America. At the present time there is a lack of machinery in this country to plant and harvest narrow rows of maize. Suitable machinery is available in America and some farmers sow in 50 cm rows (Hight 1967).

In this research the improvement in grain yield of maize sown in 76 cm rows due to increases in plant population was as high as 37 percent above the yields from populations in the accepted harvest range of 45-50,000 p/ha. In trials where 38 cm and 76 cm 8 row sowings were compared the maximum grain yield increases from the lowest populations in 76 cm rows to those in 38 cm rows were 2,800-4,480 kg/ha (45-71 bus/a) or 30 to 52 percent of the initial yields.

There is obviously a very worthwhile gain to be obtained in maize grain yields from the simple measure of increasing the plant populations above those commonly used. The effect on grain yield will vary with the site, climate and hybrid used.

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