PERFORMANCE OF HYBRID MAIZES *(Zea mays* L.) IN FIELD TRIALS

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SUMMARY

The grain yields of hybrid maizes, Zea mays L., were determined on some fifty sites over a period of four years. The hybrids PX 610 and Cargill 666 gave the highest yields of grain.

INTRODUCTION

The Gisborne area has, for many years, been regarded as New Zealand's traditional maize Zea mays L. growing district. However, as a result of lower prices for sheep and dairy products, and moves to diversify production, farmers in South Auckland, the Waikato, the Bay of Plenty, Manawatu and Marlborough have been growing more maize for grain. Yields, high by world standards, in excess of 10,000 kg/ha have not been uncommon.

As increasing numbers of farmers showed interest in growing maize for grain in recent years, field research comparing the yield of maize varieties intensified.

In 1967 Graham reported that the N.Z. Department of Agriculture was then the only agency producing seed maize for use in New Zealand and that three varieties of double hybrid seed maize were available. These resulted from the crossing of single hybrid lines imported from the University of Wisconsin, Wisconsin, U.S.A.

Since 1968 the breeding and production of hybrid seed maize has been undertaken by commercial organisations. Three firms propose to market twelve selections of seed maize in New Zealand for 1971 planting. These have been almost exclusively bred from single hybrid lines imported from the United States. The pedigrees of maize hybrids are confidential to the producers and are identified only by varietal codes.

Maize varieties are classified into comparable groups on the basis of relative maturity rating (RM). RM is based on the time taken for the plant to develop from planting to maximum dry grain weight (grain maturity), and is subdivided into two parts - the period from planting to mid silk and the period from mid silk

to grain maturity. RM ratings quoted for each variety are based on standards set in the U.S.A. and are relatively, but not directly, applicable to growth rates and maturity times experienced in New Zealand.

The actual number of days for varieties to reach maturity is influenced by genotype and the environment.

Hybrid - W575 - used in New Zealand for some years as a basis for variety comparisons has a quoted RM rating of 110 days. This is composed of 60 days to midsilk (grain formation period) and 55 days grain filling period. At Rukuhia the same variety requires 90 days for the former period and 53 days for the later period - a total of 143 days. (S.J. McCormick pers.comm.) The grain filling period (53-55 days) is similar for all varieties in both New Zealand and the U.S.A. Date of planting and seasonal effects have been shown to influence maturity time (Cumberland et al 1971).

Growers have been advised to use varieties which make maximum use of the full growing season available in any district (Graham, 1967; Cumberland et al 1970). Grain moisture content (GMC) can be used as a measure of maturity of maize. Maximum dry grain weight is normally achieved with GMC at about 35%. At this stage individual grains are well formed, slightly soft and can be dented with a finger nail. Grain on the cob dries naturally at about 3% GMC per week and is normally harvested at 25% - 38% GMC. Grain losses due to diseases and pests and harvesting damage may result from harvesting grain too wet (above 35 % GMC) or too dry (below 18% GMC). Grain harvested at higher GMC levels has to be dried to 14% GMC for storage.

This paper reviews trials which have been conducted since 1967 by the Field Research Section, Research Division, N.Z.D.A.. A total of fifty-one trials, which have produced analysable grain yield data, have been included. A comparison of the grain yield from 11 varieties is presented. Some information on the dry matter (silage) yield and the incidence and effect of lodging on some varieties is also presented.

METHODS

The trials reviewed were conducted in the four seasons since 1967. There were approximately ten trials each season except 1969-70 when there were twenty-one. They were widely dispersed geographically throughout New Zealand's maize growing districts. Ten trials were conducted in each of the South Auckland, Waikato (incl. Bay of Plenty), Hawkes Bay, and Manawatu districts, and the remainder were sited near Blenheim, Nelson and Gisborne.

Each trial included from 2 to 9 varieties. Twenty-one varieties tested, of which 18 were sufficiently well represented to be evaluated. Almost all trials included W575 and since 1969 most have also contained PX610. Consequently all varieties have been compared with W575. Those varieties which proved to be low

yielding and offered little attraction for commercial exploitation were excluded from trials after 1968/69. All remaining varieties have been compared with PX 610.

TECHNIQUES

Many members of the Field Research Section, Research Division, N.Z.D.A. were involved and techniques varied. However, in general trials were replicated, randomized block or factorial design. All used a plot of three or four rows of maize (commonly at 76 cm centres) 10-30 m. long. Edge effects were minimized by the use of non-harvested guard rows. All trials were sown and harvested by hand with the exception of the South Auckland trials for which commercial planting and harvesting machinery was used.

In all trials representative samples of the grain from each plot was collected at harvest, sealed in air-tight containers and subsequently dried for moisture content determinations. (Three trials in the Gisborne district were exceptions - they were crib dried before shelling).

Trial crops were maintained free from weeds and pests by use of standard control techniques. Fertilizers were applied to most crops and on no sites were nutrient deficiencies regarded as factors limiting growth.

Where it was possible to do so, variety yields were corrected to 15% GMC for comparisons within and between trials. Lack of data prevented this in three trials. Failure to adjust for GMC in these trials has tended to favour slightly the later maturing varieties.

STATISTICAL TECHNIQUES

The plant populations achieved in 1967 and 1968 were of the order of 50,000 plants/hectare. For many trials a covariance analysis was necessary to adjust yields to compensate for poor germination and establishment of some varieties. Since 1969 trials were planted at higher populations. Most covariance analyses did not prove to be significant. As the result of the application of adjustments to variety yields the comparisons between varieties are not dependent on the realised populations.

Statistical analyses of the comparisons of varieties with standards (W575 and PX 610) were carried out on a randomised block basis. One or more additional varieties were included where appropriate, to increase the reliability of the estimate of the variance. Logarithmic transformation was applied to one analysis involving those varieties which were rejected after 1968/69. It gave an improved F-value and it appears that it may be a device worthy of further exploitation for this crop.

RESULTS

Grain Yields

Twenty-one varieties were compared with W575. After the 1967/68 and 1968/69 trial seasons some varieties which were either poor yielding or unlikely to continue to be, or to become, commercially available were excluded from further trials. Those excluded included W260, W269, W273, W463, W474 and W537. Three other varieties were tested, but are not included in the results because they have been included in the few trials and they are not expected to be commercially available. They are Pioneer 3617 and Kelvedon 59A (both gave yields similar to that of W575), and Morden 67 (which yields inferior to that of W575).

Comparisons between W575 and ten other varieties are given in Table 1.

TABLE 1: A Comparison of Ten Maize Varieties With W575

Variety	RM (Days)	No.Trials	Grain Yield (15% GMC kg/ha	CV%
KC 3	80	10	7,900 b B	
W 575	110		10,900 a A	10.7%
W346	90	12	8,700 b B	
W 575	110		10,000 a A	8.8%
W 415	95		9,400 a	
W 575	110	7	9,700 a	6.3%
Cargill 666	105	9	10,700 a A	
W 575	110		9,600 b B	7.3%
W 601	110	6	9,900 a	
W 575	110		9,300 a	7.6%
PX 50	110	12	10,000 a	
W 575	110		9,700 a	7.5%
W 563	110	12	10,000 a	
W 575	110		9,700 a	7.5%
PX 610	115	18	11,200 a A	
W 575	110		10,200 b B	6.6%
W 647	115	11	10,200 a	
W 575	110		10,400 a	8.6%
KT 626	120	7	9,500 a	
W 575	110		10,000 a	6.7%

This table shows that the standard - W575 - was superior to KC3 and W346 (sig. 1%). Varieties Cargill 666 and PX610 are superior to W575 (sig. 1%). In the trials W575 did not differ significantly from the other varieties.

In 24 trials PX610 was tested, and it has been possible to make comparisons, using PX610 as a standard, with other varieties. The results of these comparisons are shown in Table 2.

TABLE 2: A Comparison of Nine Maize Varieties With PX 610

Variety	RM (Days)	No. Trials	Grain Yield (15% GMC) kg/ha	CV%
KC 3	80	12	7,900 b B	
PX 610	115		10,900 a A	8.8%
W 346	90	12	8,700 b B	
PX 610	115		10,200 a A	8.8%
W 415	95	7	9,400 b B	
PX 610	115		10,600 a A	9.8%
Cargill 666	105	9	10,700 a	
PX 610	115		10,900 a	7.3%
W 601	110	6	9,900 a	
PX 610	115		10,500 a	7.6%
PX 50	110	12	10,000 b A	
PX 610	115		10,800 a A	7.5%
W 563	110	12	10,000 b A	
PX 610	115		10,800 a A	7.5%
W 647	115	7	9,700 b A	
PX 610	115		10,600 a A	6.7%
KT 626	120	7	9,500 b B	
PX 610	115		10,600 a A	6.7%

This table shows that PX610 was superior to KT626, W415, W346, KC3 (sig. 1%), W647, W563 and PX50 (sig.5%). PX610 was similar to Cargill 666 and, although evidence is limited (6 trials) to W601. In Table 1 PX610 was shown to be superior to W575 (sig. 1%).

Cargill 666, which has only been available for testing during the past two seasons, was not tested widely enough to permit comparisons with varieties other than PX610 and W575 (Tables 1 and 2). Cargill 666 was not tested in the Gisborne or Manawatu districts.

To establish whether there were regional differences, yield data were divided into three by regions, and individual regional analyses conducted. The three regions (divided on the basis of marked climatological differences) were:

1. Auckland, Waikato, Bay of Plenty.

2. Gisborne, Hawkes Bay, Manawatu.

3. Marlborough, Nelson.

It was found that for those varieties where regional comparisons were possible regional results were consistent with overall results. One exception was that in the W575 - W346 comparisons significant differences did not occur in the Nelson-Marlborough region.

Silage Dry Matter Yields

In six trials random samples of the crop were harvested by hand for silage dry matter (DM) determinations. Whole plants, harvested for this purpose were stripped of cobs. Each part of the plant (cob or stalk and leaf) were weighed separately, and a subsample of each sealed in an airtight bag for subsequent dry matter determinations.

Total dry matter yields are shown in Table 4. The total DM shown was the cob DM and leaf and stalk DM together. In all trials the cob yielded about 50%-65% of the total DM.

These data suggest that W415 and W346 are inferior in terms of DM production. PX610 appears to be similar to Cargill 666 and slightly better than W575 and W601. These results reflect very closely the ranking of varieties on the basis of grain yield.

Lodging

Three trials which included time of planting comparisons were assessed for incidence of lodging. This was done by counting the number of plants lying in such a position that cobs could not normally be collected by harvesting machinery. In all three trials there was more lodging with later planting of all varieties.

TABLE 3: Incidence of Lodging.

	Percentage Plants Lodged							
	Trial 1 Auckland 1969	Trial 2 Auckland 1969	Trial 3 Manawatu 1969	Trial 4 Auckland 1970 (early planting)	Trial 4 Auckland 1970 (late planting)	Trial 5 Auckland 1970	Trial 6 Ruakura 1970	Trial 7 Manawatu 1970 (early planting)	Trial 7 Manawatu 1970 (late planting)
KC3	21	12	6						
W346	18	6	2	5	10	7		2	3
W415			0	4	7	14	2	2	6
Cargill 666			1	5	19	13	4	1	12
W601			1	15	26	26			
PX50	6	1				6	2		
W563	16	5	0						
W575		6	2	9	37	26	2	2	16
PX610	8	2	0	2	6	19	5	0	6
W647									
KT626	6	3		3	5	11	12		

There were too few observations of some varieties to make accurate comparisons of varietal proneness to lodging. However, it appears that PX 610 and Cargill 666 were less prone to lodging than W 575. KC 3 appeared to be very prone to lodging. (Other field trials not reported here have also confirmed this.)

DISCUSSION

Varieties PX610 and Cargill 666 were superior in terms of grain yield (adjusted to 15% GMC) to other varieties tested. The use of these varieties can be recommended for all maize growing districts in New Zealand. In Gisborne and the Manawatu Cargill 666 was not tested to confirm its superiority. The yield data presented in this paper were analysed on a regional basis and with only one exception regional data closely reflected combined analyses for all New Zealand data. Indeed for Cargill 666, South Auckland, Waikato, Hawkes Bay and Marlborough results were similar. It seems reasonable to predict that the performance of Cargill 666 in Gisborne and Manawatu would follow this pattern.

Varieties W601, W563 and W575 have been ranked next after PX610 and Cargill 666 in terms of grain yield.

It is interesting to note that all of these varieties fall within a group of medium RM ratings. Table 1 and 2 show a trend whereby varieties W575 and PX610 (110,115 day RM respectively) are superior to all varieties with lower and higher RM ratings, with the obvious exception of Cargill 666.

The emergence of Cargill 666 as a high yielding variety having a slightly lower RM rating should prove of interest to growers concerned with the economics of the crop. It has been emphasised elsewhere (Cumberland et.al.,1971) that maximum grain yield does not necessarily result in maximum profit. Differences in GMC at harvest, between varieties, have been shown to be fairly closely related to RM ratings. Varieties requiring a longer time to mature and which take more days to reach the mid silk stage are normally less fit at harvest than varieties taking a shorter time to mature. Cargill 666 (105 day RM) may prove to be more profitable than PX610 (115 day RM) in some cases. This is likely to apply where the growing season is short due to climatic and other environmental limitations.

Grain quality standards have not been established for New Zealand maize grain which at present is mostly, if not exclusively, used for stock feeds. The anticipated use of maize, to replace wheat, for starch production, may result in grain quality standards being set for this end use. It seems possible that drying processes, rather than growing techniques, will have a greater effect on the crop meeting such quality standards.

Table 4 shows that (with the limited measures taken) the ranking varieties on the basis of DM production fairly closely follows ranking for grain yield. A wide variation in DM yields between trials

reflected similar variations in grain yields. Some extremely high DM yields (in excess of 30,000 kg.ha DM) were recorded in most districts.

TABLE 4: Silage Yields. Dry Matter kg/ha.

	Silage Yields DM kg/ha		
	Auckland 1969	Manawatu 1 1970	Manawatu 2 1970
KC 3	10,000	10,900	12,400
W 346	12,200	12,200	13,500
W 415		13,100	15,400
Cargill 666		16,700	
W 601		18,300	16,000
PX 50			
W 563	14,600	16,300	19,000
W 575		19,300	19,500
PX 610	13,500	20,700	23,900
W 647			
KT 626			

Table 3 prepared from a limited number of trials shows the incidence of lodging. Differences between sites suggest that environmental effects influenced lodging to a large extent. Between variety differences were not particularly consistent. It would appear that with the exception of KC3 which in many trials and crops has proved to be a weak stalked variety, prone to lodging, there are no varieties which consistently experience lodging.

The higher incidence of lodging with later planting (where times of planting are compared) requires further study. It is believed that this effect may be confounded by the need, in these investigations, have early and late planted maize in the close proximity. The causes and effects of senescence and the interaction of fungal diseases, may contribute to lodging in later plantings.

In some trials a number of other agronomic observations and measurements were made. Parameters such as: cob numbers per plant; cob position; cob shedding; cob size; crop height and leafiness are not considered as important as grain yields, grain moisture content and lodging in determining the profitability of maize crops. Recorded observations of these other factors were few and no marked varietal differences have been noted.

The introduction, and commercial release in 1971, of two hybrids XL 306 and XL 45, without prior comparative testing in New Zealand is viewed with considerable concern. Claims for the superiority of these varieties cannot be substantiated.

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