A comparison of maize silage hybrids in the Manawatu

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Abstract

Seven maize (*Zea mays L.*) hybrids (Janna, P3902, P3751, P3585, Furio, CG900 (overseas commercial hybrids) and CF1 (Crop & Food experimental hybrid)) were compared in a trial at Massey University, Palmerston North during the 1994/95 season. Hybrids were established at 75,000, 100,000 and 140,000 plants/ha in a factorial design trial with four replicates. Dry matter (DM) yield and yield components were measured in all plots while digestibility and nitrogen (N) content were measured in the 100,000 plants/ha plots only. Final yields ranged from 20,700 kgDM/ha (CF1) to 15,800 kgDM/ha (Janna). There was no interaction with plant population. Yield at the low plant population (16,500 kgDM/ha) was significantly lower than at the medium (18,800 kgDM/ha) and high (19,600 kgDM/ha) populations. The greatest contribution to DM yield was provided by the grain, followed by the stem, cob and leaf. There were significant hybrid differences in DM partitioning, but plant population had no effect. Total metabolisable energy (ME) content ranged from 10.30 to 11.32 MJ ME/kg DM. The ME content of CF1 was significantly higher than that of all other hybrids. Nitrogen content ranged from 1.07% to 1.16% and did not differ among hybrids. The best performing hybrid was CF1, which had the highest ME content and was one of the highest yielding of the hybrids. Although results are from a single trial they suggest that locally bred hybrids may have greater productivity than overseas hybrids currently in use.

Additional key words: Zea mays L., *hybrids, plant population, dry matter yield, metabolisable energy, nitrogen content.*

Introduction

Arable farmers have increased the area sown in maize for silage in response to increased demand from dairy farmers resulting from expansion of the dairy industry. The crop is normally sold on a cents/kg of dry matter (DM) basis with a target harvest whole - crop DM content of between 30-35% to optimise both yield and silage quality. However forage quality prior to ensiling is rarely quantified.

Farmers have considerable choice when selecting hybrids recommended for silage (Anon., 1995; Anon., 1996). Selection of hybrids is usually based on maturity rating and yield relative to hybrids of similar maturity. Most hybrids grown for silage in New Zealand are primarily grain hybrids, with desirable silage characteristics such as good green colour retention at harvest maturity. There have been few independent comparative studies of maize hybrids marketed for silage production in New Zealand. This study was therefore conducted to compare the yield and feed quality of a range of commercial and experimental hybrids. Another objective was to determine the effect of variation in the relative contribution of different yield components to yield on metabolisable energy (ME) content. Grain to stover ratio is frequently used to indicate the quality of maize for silage. Plant population was used to produce variation in yield components.

Materials and Methods

Six commercial hybrids and one experimental hybrid (Table 1) were established at three plant populations; 75,000, 100,000 and 140,000 plants/ha, in a randomised

Table 1. Relative maturity (RM) and owner/agent for each hybrid.

Hybrid	Owner/Agent	RM
Janna	Genetic Technologies, Ltd.	77
P3902	Genetic Technologies, Ltd.	87
Furio	Corson Grain, Ltd.	95
P3751	Genetic Technologies, Ltd.	97
CF1	Institute for Crop and Food Research	98
P3585	Genetic Technologies, Ltd.	103
CG900	Corson Grain, Ltd.	105

complete block factorial design with four replicates. The commercial hybrids are representative of those marketed for silage in the Manawatu, covering the range of maturities recommended for use in that region. The experimental hybrid (CF1) was produced from the cold tolerant maize breeding programme at Crop and Food Research Ltd., Palmerston North (Eagles and Hardacre, 1985) and is a cross between Iowa dent and cold tolerant tropical highland germplasm.

The trial was sown by hand on 5 November 1994 at Massey University into a well - cultivated Manawatu fine sandy loam soil. Plots consisted of four 4m rows, 0.7m apart with the outside two rows as borders. All seed was treated with a mixture of carboxin and thiram fungicide mix prior to sowing. Terbufos insecticide was broadcast over the seedbed immediately after sowing. After emergence plots were thinned to the required plant population in each treatment. Broadleaf and grass weeds were controlled with standard post emergence herbicides. Soil testing revealed marginal phosphate levels (Olsen P = 12). The site had been cropped with maize during the previous season. Consequently, 27 kg N/ha and 30 kg P/ha (150 kg/ha diammonium phosphate) was broadcast onto the seedbed after the final cultivation. Plots were side dressed with 100 kg N/ha (ammonium sulphate) two months after sowing.

Time to 50% sicking and blacklayer formation were determined by counting the number of plants in each plot which had achieved silk emergence and kernel blacklayer respectively, on a daily basis. Yield was determined by sampling plots at 30-35% whole - crop DM content. However this range was exceeded slightly for three of the hybrids. Six plants were harvested from each plot and dissected into components; stems, leaves, grain and non-grain cob (cob). After weighing, subsamples were taken for weighing, drying and calculation of DM content and yield. A dried subsample of each component from the 100,000 plants/ha treatment was analysed for in vitro digestibility and Kjeldahl N. Only one plant population treatment was submitted for analysis because of the absence of plant population effects on crop yield components. Relative maturity (RM) was calculated for each hybrid from time from sowing to 50% sicking and black layer formation by indexing each hybrid to the mean for all hybrids.

Rainfall was recorded during the season at the trial site. Temperature was recorded at AgResearch, Palmerston North, less than two km from the trial site.

Results

Temperatures during the 1994/95 maize growing season (Nov-April) were 0.7°C warmer than average (Anon., 1983). However, the early part of the season (November and December) was cooler than normal while the January to April period experienced well above normal temperatures. Rainfall (584 mm) was higher than normal (468 mm) but it was unevenly distributed. About 180 mm fell mainly in the week immediately after planting. This resulted in saturated soil conditions, surface ponding and patchy emergence in some plots.

Crop development

The length of the vegetative period differed significantly among hybrids as expected (Table 2). Janna took 84 days to reach 50% sicking while the latest hybrid, CG900, took 99 days. The time required to reach blacklayer ranged from 146 days for Janna to 173 days for CG900. RM values for each hybrid were similar at 50% sicking and blacklayer, indicating that the length of the grain development period was proportional to the length of the vegetative period. The RM calculated in this trial are similar to those given with the hybrid descriptions in Table 1, although the RM for the early hybrids are higher. This is probably a result of the limited number and maturity of hybrids used in this comparison.

Plant population had a small but significant effect on crop maturity with the low population treatment reaching 50% sicking and blacklayer one day earlier than the medium and high populations.

Yield and yield components

The effects of hybrid and plant population on yield are shown in Table 3. Only the main effects are presented because there were no significant interactions between hybrid and plant population. The highest yield was achieved by CF1 which was significantly higher than

Table 2. Time (days) from sowing to 50% silking and black layer for each hybrid, and corresponding relative maturities (RM) .

	50% Silking		Blacklayer	
Hybrid	Time	RM*	Time	RM*
Janna	84.0	90	146.0	89
P3902	88.0	95	156.0	95
Furio	93.0	100	167.0	102
P3751	94.0	101	166.0	101
CF1	95.0	102	166.0	102
P3585	98.0	106	173.0	105
CG900	99.0	106	173.0	105
$LSD_{(0.05)}$	1.6		1.2	

* Average of all hybrids = 100

Table 3. The effects of hybrid a) and plant population b) on yield and dry matter (DM) % at final harvest.

a)

Hybrid	Yield (kg DM/ha)	DM %[1]	stem %[2]	cob %[2]	leaf %[2]	grain %[2]
Janna	15,800	37.9	21.6	19.6	8.0	50.7
P3902	18,800	35.8	23.3	19.4	10.7	46.6
Furio	17,900	36.1	25.2	19.5	11.3	43.9
P3751	17,800	35.0	24.5	15.7	11.8	48.0
CF1	20,700	30.2	28.2	18.9	12.6	41.2
P3585	19,900	35.0	25.8	17.3	11.8	45.1
CG900	17,500	33.2	29.0	17.2	12.3	41.5
$LSD_{(0.05)}$	2,000	1.7	1.7	1.1	0.6	2.0

b)

Plant Population (plants/ha)	Yield (kg DM/ha)	DM %[1]	stem %[2]	cob %[2]	leaf %[2]	grain %[2]
75,000	16,600	35.0	25.6	18.9	10.4	45.1
100,000	18,800	34.5	25.2	18.5	11.2	45.6
140,000	19,600	34.7	25.3	17.4	12.1	45.2
$LSD_{(0.05)}$	1,300	NS	NS	0.7	0.41	NS

[1] % DM in the crop at harvest
[2] % contribution of each yield component to the total DM

all other hybrids except P3902 and P3585. Janna produced the lowest yield.

There were large differences among hybrids in the proportion of yield contributed by each component (Table 3). Grain was the most important component and ranged from 41.2% (Janna) to 50.7% (CF1). Janna had a significantly higher proportion of grain than all other hybrids and had a correspondingly lower proportion of stem and leaf. Conversely, the hybrids with low proportion of grain (CF1, CG900) had more stem and leaf. Stem material ranged from 21.6% to 29.0%, with less DM as cob (15.7% to 19.6%) and leaf (8.0% to 12.6%).

Yield increased significantly as population increased from 75,000 to 100,000 plants/ha but a further small yield increase at 140,000 plants/ha was not significant (Table 3). Plant population had no effect on the proportion of grain or stem, but increasing plant population resulted in decreased cob and increased leaf.

Forage quality

N content was generally low (Table 4), ranging from 1.05% to 1.16% (6.6% to 7.3% protein respectively). There were no significant hybrid effects. Metabolisable energy ranged from 10.30 to 11.32 MJ ME/kg DM. CF1 had significantly higher ME than all other hybrids (Table 4).

Simple linear correlations for the yield data (Table 5) showed that yield was not associated with the relative contribution to final yield of any yield component. Grain content was strongly, negatively correlated to stem and

Table 4. The effect of hybrid on whole plant metabolisable energy (ME) and nitrogen (N) content at 100,000 plants/ha.

Hybrid	ME (MJ/kgDM)	N (%)
Janna	10.73	1.16
P3902	10.46	1.07
Furio	10.72	1.05
P3751	10.72	1.09
CF1	11.32	1.16
P3585	10.28	1.08
CG900	10.51	1.07
$LSD_{(0.05)}$	0.55	NS

Table 5. Simple correlation coefficients for yield, yield components and metabolisable energy (ME) content.

	% Grain	%Stem	% Cob	% Leaf	ME
Yield	-0.44+	0.24	0.10	0.30	-0.02
% Grain		-0.81++	-0.09	-0.64++	-0.13
% Stem			-0.27	0.75++	0.32
% Cob				-0.32	0.32
% Leaf					0.36

+ Significant at P < 5% ++Significant at P < 1%

leaf contents, indicating the importance of DM redistribution from those components during grain fill. Stem and leaf proportions were strongly, positively correlated. Yield was not correlated to N or ME content, but ME content was weakly but significantly correlated with N content.

Discussion

The good yields obtained in this study were similar to on - farm yields measured in the Waikato region during the 1994/95 season (Densley, 1995) and greater than those reported by Douglas (1980) from obsolete hybrids with similar relative maturities. Yield differences among hybrids tend to reflect their maturity ranking (Graybill *et al.*, 1991). However, in the present study, P3902 produced a good yield for its early maturity and CG900 a poor yield for its late maturity. The yield achieved by the experimental hybrid CF1, suggests that it is worthy of further evaluation.

The results from this trial confirm the current recommendation to use a population of 100,000 plants/ha for the majority of commercial maize hybrids in New Zealand (Anon., 1994). Although further yield increases are possible at higher populations, they are economically marginal on the basis of seed costs (14.2 c/kg DM in this trial).

Whole crop DM content at harvest (30-38%) fell within the ideal range for maximum forage quality and yield (Wiersma *et al.*, 1993) in all hybrids. Harvest dates ranged from 14 March (Janna) to 28 March (P3585) indicating that all hybrids in this comparison are capable of reaching silage maturity in the Manawatu in seasons with average temperature.

The pattern of dry matter partitioning was similar to previous research (Thom *et al.*, 1981). Early maturing hybrids tended to have high grain content (Table 3), the result of increased time available for partitioning dry matter into the grain. However, plant population had little effect on dry matter partitioning, with a small increase in cob content and moderate increase in leaf content. The fact that grain content did not decline at the high plant population indicates that light, moisture and fertility conditions were favourable during most of the growing season (Duncan, 1975).

N content was low, highlighting an important common limitation of maize silage as a supplement for lactating animals. Milking cows require average dietary crude protein levels of 14.0% to achieve maximum milk yields (Cowan and Kerr, 1984), twice the levels obtained in this trial. Consequently, supplementing diets with maize silage at more than 30-35% of intake will depress milk production (Barry *et al.*, 1980).

ME content was high in all hybrids but generally within the range of typical values reported in New Zealand (Ulyatt *et al.*, 1980; Holmes *et al.*, 1985) and overseas (Moran, 1984). The reason for the superiority of CF1 over the commercial hybrids is not clear. ME was not correlated with yield or yield components in this trial. However, large hybrid differences in ME content can result from variation in digestibility of fibre (Allen, 1992). The high ME content of CF1 is potentially significant for animal production. Intakes and milk production in lactating cattle can respond to small changes in ME content of feed at these levels (Ulyatt *et al.*, 1980).

The results from this study contradict the generally accepted belief that good grain hybrids, associated with high grain:stover ratios, also produce high yields of high quality silage (Fairey, 1980; Anon., 1994). Among the commercial hybrids there was considerable variation in grain content (Table 3) which did not result in differences in ME. The experimental hybrid CF1 was in the highest yielding group of hybrids and produced the highest quality forage while having the lowest grain content. While it is true that many high grain yielding hybrids make good silage hybrids, grain yield is not a good predictor of forage yield and has no effect on the ME content of maize silage (Allen, 1992). The grain component contributed less than 50% of the yield for all hybrids in this trial. Several studies have found that stover digestibility has a strong influence on the ME content of maize silage (Allen, 1992; Argillier *et al.*, 1995).

The small positive correlation between ME and N content may be the result of a reduction in the neutral detergent fibre content. Cherney and Cox (1992) found that this fibre component decreased in response to increasing rates of N fertiliser and, presumably, N content in the forage.

Conclusion

There were significant differences among the hybrids in yield and forage quality. The best performing hybrid was CF1 which achieved high yield and quality. Although results are from only one trial they indicate the potential for improving the agronomic characteristics of maize hybrids for silage production in New Zealand through local breeding programmes. The results support the currently recommended population of 100,000 plants/ha for maize silage. The proportion of grain or any component of yield was not associated with forage quality.

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