SILAGE MAIZE PRODUCTION IN THE MANAWATU

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ABSTRACT

Sowing dates and hybrid relative maturity have a significant bearing on the maize crop development and will largely determine the time at which the crop is ready for green-chop or ensiling. These two factors were examined in a maize trial conducted at Palmerston North in 1972/73. Maize hybrids were sown on 26 October, 8 November, and 29 November. The three hybrids used were KC3 (80 days, R.M.), W415 (95 days R.M.), and Px 610 (115 days, R.M.).

Early maturing KC3 sown on 26 October was the only crop ready for ensiling in late February. All varieties sown on 26 October and the early and medium maturity varieities sown on 8 November were ready for ensiling on 20 March. All treatments except the late sown Px 610 were suitable for ensiling in mid-April.

INTRODUCTION

Maize is now established as a high-yielding grain crop with a considerable potential in much of the intensively farmed areas of the North Island. The crop is also used for green-feed and silage, and this practice could be significantly expanded. The ability of maize to produce good yields in regions where summer pasture is restricted, has undoubted value on intensively farmed units, particularly in the country's warmer and drier zones. The potential of maize as a forage crop for livestock feeding has been discussed by Mitchell (1966).

The nutritive value and silage yields of the maize changes as the crop matures. Decisions on the optimum time for harvest, both for silage and green-chop, must take account of these continuing changes in the crop itself. The farmer is able to exercise some control over timing of harvest through his selection of planting date and maize hybrid maturity. Maize planting and harvesting dates will have consequential effects on the yields of the cool season pasture or forage crop, which is usually grown before and after the crop.

This paper reports on a trial conducted in the Manawatu in which three maize hybrids of differing relative maturities were sown at three sowing dates. Total yield and its components were measured at the intermediate and final harvest.

METHODS

Three hybrids were used in this trial, viz. Px 610 (115 day R.M.), W415 (95 day R.M.), and KC3 (80 day R.M.), providing a range of relative maturities equivalent to that of the commercially available maize hybrids.

Plantings were spread over five weeks with sowings made on 26 October, 8 November, and 29 November, 1972. McCormick (1971) has shown that the optimum sowing date for the Waikato was within one week of 1 November. We estimated that 8 November would be close to the optimum sowing date for the Manawatu and chose this as the median date.

The trial was laid down on a recent alluvial soil (Manawatu fine sandy loam) on the Massey University Dairy Farm.

The maize varieties were sown in a randomised block lay-out with a separate block for each sowing date. Four replications were used. Individual plots were 6 x 30 m, which permitted 8 rows plot^{-1} with the outside two rows serving as guard rows. Samples for total dry matter estimates and final grain yield were obtained by cutting 1.5 m length from two adjacent rows selected at random within each plot. Two plants were randomly selected from each sample area for analysis into leaf, stem, grain and husk components.

The plants were sown in 75 cm rows with a commercial planter. The crops were sown with a starter fertiliser (N:P:K) applied at the rate of 33:14:38 kg/ha, and side-dressed with liquid urea at 90 kg N/ha when plants were approximately 40 cm high. Atrazine at 1.7 kg/ha was applied as a post-emergence weedspray. A post-emergence insecticide was required to combat Argentine stem weevil after the first sowing established and thereafter an insecticide was applied at planting with the second and third sowing. One mid-season spraying was required for army-worm control.

Edmeades (1973) showed that grain yields from maize hybrids of differing relative maturity were dependent on the population density at which the hybrids were planted. However, this variation could be minimised by planting at a population of 75,000 plants/ha. Mean plant population approximately 3 weeks after emergence was 76,000 plants/ha. Seedling losses averaged 27.5% for KC3, compared with 14.5% and 14.4% for W415 and Px610, respectivel Sowing rate was higher for KC3 because seed weights were lighter, despite comparable seed grading and this partially offset the greater seedling losses.

The growth and development of a maize crop is closely correlated with temperature, and consequently crop maturity is related more to heat units than to calendar days. The method of Gilmore and Rogers (1958) was used to compute heat units in degree-days.

Degree-days = 0.5 (Daily maximum temp. – Daily minimum temp – 10

The minimum temperature was set equal to 10^{0}C when recorded values fell below that level. The monthly data for the 1972-73 season and the 1928-60 years are presented in Table 1. The 1972-73 season was warmer than usual except for an unseasonally cool December.

TABLE 1: Monthly degree-day and rainfall data for Palmerston North.

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	Total
Degree-days (C)								
1972–73	109	186	158	251	234	223	123	1284
1928-60	102	126	174	222	207	188	122	1141
Rainfall (mm)								
1972-73	67	29	40	50	7	102	59	354
1921-50	97	84	84	76	76	61	84	562

The 1972/73 growing season was unusually dry in the Manawatu, as shown by the rainfall data given in Table 1. The total rainfall of 354 mm for the October-April months (inclusive) was below the estimated crop water requirements. The crop was irrigated with 45 mm water in early December and 75 mm in early January. Nevertheless water stress was apparent later in the season.

The first sowing was cut for silage on 28 March and the second and third sowing on the 17-18 April. The experiment was designed to fit into normal farm operations as far as practicable and consequently the crop was harvested according to real time and not according to the crop's physiological time scale, i.e. the phenological development of the crop. Observations were made on seedling and tasselling emergence of the crop. Yield and components of yield were measured by sampling the crop on 14-22 February, 20-22 March and 13 April.

RESULTS AND DISCUSSIONS

1. Early development of crop: Observations were made on the time from planting to seedling emergence and 50% tasselling.

The time from planting to seedling emergence reduced as sowing date was delayed. Initially 11 days for 26 October planting, it declined to 10 days for 8 November planting and 9 days for the final planting on 29 November. These changes were associated with mean 10 cm soil temperatures of 14^{0}C, 17^{0}C and 16^{0}C for the three respective germination periods.

The number of days from planting to 50% tassel emergence was recorded and the data are presented in Table 2. Means of 83, 77 and 66 days were recorded for Px 610, W415 and KC3, respectively. The pre-tasselling periods were shorter for the later sowings.

TABLE 2: Days from sowing to 50% tassel emergence (1) and degree-days accumulated during that period (2)

Sowing dates 1972	Px 610 (1)	Px 610 (2)	W415 (1)	W415 (2)	KC3 (1)	KC3 (2)
26 October	87	575	73	456	67	401
8 November	83	560	73	490	68	445
29 November	79	577	70	512	62	430
Mean	83	571	72	486	66	425

Edmeades (1972) recorded times of 56 and 70 days for KC3 and W575 respectively; grown in the same locality and sown in mid-November. McCormick (1971) found year-to-year variations of up to 15 days in time from planting to mid-silk. Similar variability in the length of the vegetative period was earlier reported by Shaw and Thom (1951). These workers found that warm temperatures and adequate soil water produced rapid growth and shortened the interval. Nutrition of the crop can also affect the length of the vegetative period as Peaslee *et al.* (1971) have shown that high levels of phosphorus and potassium can shorten time from emergence to silking.

The cooler December temperature may account for the apparent delay in tasselling found in this trial. The degree-days from planting to 50% tasselling were computed for each treatment and are presented in Table 2. These data suggest that a given number of degree-days must be accumulated before a particular hybrid will tassel. Mean degree-days of 425, 486 and 571 were accumulated for KC3, W415 and Px 610 respectively, before 50% tasselling occurred. The hybrids used by Edmeades (1972) accumulated 420 and 520 degree-days for KC3 and W575 (110 days R.M.), respectively, between planting and 50% tasselling. In climate room studies, McPherson and Boyer (per. comm.) have found that plants of XL45 (113 days R.M.) grown at 27^{0}C day temperature and 18^{0}C night temperature, tasselled after 550 degree-days elapsed, and this was achieved in only 44 calendar days. These data confirm observations of other workers that temperature plays an important role in determining the length of the vegetative period in the crop's development.

2. Silage yields: Maize may be required as a supplementary forage or early silage crop in February. Therefore the total dry matter and yield components were measured in February. The yield and grain component data are presented in Table 3.

TABLE 3: Silage yields (kg D.M./ha) and percent grain ( ) at February sampling.

Sowing dates 1972	Harvest dates 1973	Px 610	W415	KC3	Mean
26.10	14.2	11200 (3)	11100 (13)	10800 (25)	11030
8.11	19.2	12200 (0)	10500 (3)	10600 (10)	11100
29.11	22.2	6800 (0)	8300 (0)	6900 (0)	7300
Mean		10070	9970	9430	9810

S.E. Sowing date and varietal means ± 305 kg D.M./ha

The average crop dry matter yields were 11,000, 11,100 and 7,300 kg D.M./ha for the first , second and third sowings, respectively. The late sowing yielded significantly less ($P<0.01$) than the two earlier sowing dates. There were no significant varietal effects.

Date presented in Table 3 show that the grain component of the crop varied greatly according to sowing date and hybrid maturity. Grain, at the dough stage, accounted for 25% of the yield for variety KC3 sown on 26 October. The remaining sowing date x variety treatments had less than 13% grain. Therefore, it will be difficult to produce a February maize crop with a significant grain component in the Manawatu.

The March harvest for maize for silage enables the following forage crop to be sown while temperatures and soil conditions are still favourable for rapid establishment and early growth. On the other hand, harvesting the maize crop at this time may stop the crop from reaching its yield potential The total crop yields and grain component recorded in March are presented in Table 4.

TABLE 4: Silage yields (kg D.M./ha) and percent grain ( ) at March sampling.

Sowing dates 1972	Harvest dates 1973	Px 610	W415	KC3	Mean
26.10	20.3	16800 (34)	17700 (51)	15100 (57)	16530
8.11	22.3	15700 (23)	14700 (40)	13700 (44)	14700
29.11	22.3	14700 (7)	14100 (21)	11100 (23)	13300
Mean		15730	15500	13300	14840

S.E. Sowing date and varietal means ± 673 kg D.M./ha.

In March, the average crop dry matter yields were 16,530, 14,700 and 13,000 kg D.M./ha for the first, second and third sowing, respectively. The yield difference between the first and last sowing is significant ($P = 0.05$). Mean varietal yields recorded were 15,730, 15,500 and

13,300 for Px 610, W415 and KC3, respectively. The yield difference between Px 610 and KC3 is significant (P= 0.05).

Percent grain data are presented in Table 4. The early sown KC3 and W415 hybrids had reached 50% grain suggesting that grain filling was complete. This was confimed by the presence of the black-layer development on the KC3 and W415 kernels which is a good indicator of physiological maturity (Daynard and Duncan, 1969; Rench and Shaw, 1971). The late sown Px 610 had less than 20% grain. The remaining treatments had between 20% and 44% grain indicating that physiological maturity had not been reached.

The second and third sowing dates were finally sampled on 13 April before being cut for silage. The first sowing date was previously harvested for silage on 28 March. Dry matter yields are presented in Table 5.

TABLE 5: Silage yields (kg D.M./ha) and percent grain ( ) at final sampling.

Sowing dates 1972	Harvest dates 1973	Px 610	W415	KC3	Mean
26.10	20.3	16800 (34)	17700 (51)	15100 (57)	16530
8.11	13.4	20900 (32)	21500 (47)	13600 (55)	18670
29.11	13.4	16600 (21)	16000 (32)	13600 (37)	15400
Mean		18100	18400	14100	16870

S.E. Sowing date and varietal means ± 519 kg D.M./ha.

The final harvested dry matter yields were 16,500, 18,600 and 15,400 kg D.M./ha for the first, second and third sowing dates, respectively. The second sowing significantly (P = 0.01) outyielded the other two sowing dates. Variety KC3 produced a lower yield (P = 0.01) than the other two varieties, It should be noted, however, that the first sowing of Px 610 had not reached physiological maturity at time of harvest.

The grain component of the treatments are presented in Table 5. Black-layer development of the kernels showed that the second sowing of KC3 and W415 had reached physiological maturity by 13 April. Grain filling was continuing on the second sowing of Px 610 and the third sowing of all varieties.

3, Grain yields: The grain yields measured at the final harvest are presented in Table 6. The average yields were 7,600, 6,900 and 4,500 kg D.M./ha for the first, second and third sowing dates, respectively (9,000 kg D.M./ha = 170 bush/ac at 15.5% GMC). Grain yield was significantly reduced for the third sowing date (P = 0.01).

TABLE 6: Grain yield at final harvest (kg D.M./ha)

Sowing dates 1972	Harvest dates 1973	Px 610	W415	KC3	Mean
26.10	28.3	6700	9000	7100	7600
8.11	13.4	6100	7500	6900	6830
29.11	13.4	3300	4600	5500	4470
Mean		5379	7030	6500	

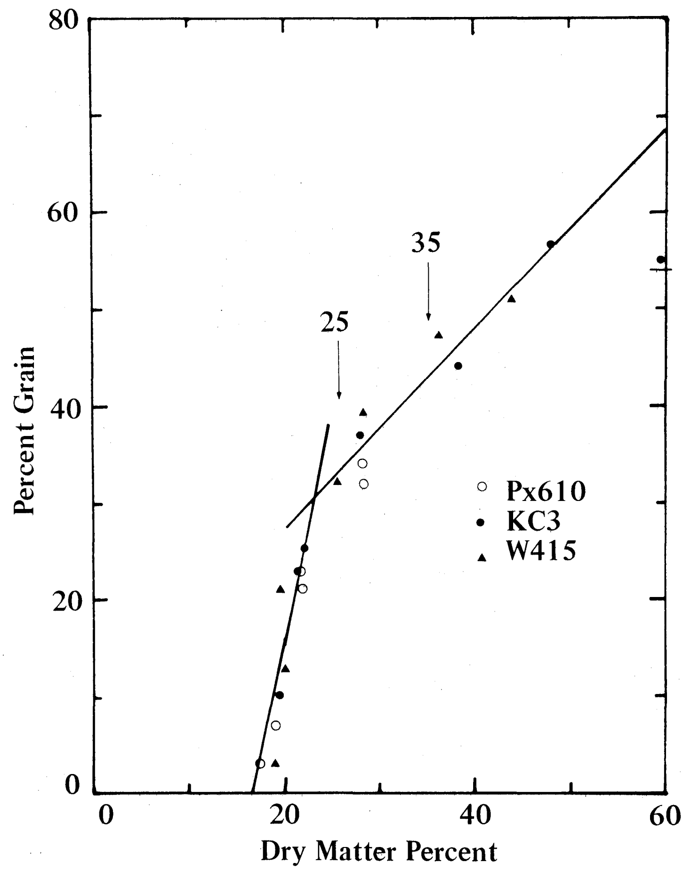
S.E. Sowing date and varietal means ± 428 kg D.M./ha.

Hybrid Px 610 did not reach physiological maturity under these trial conditions and consequently yielded less than the other two hybrids. Completion of grain filling would have added approximately 50% to Px 610 grain yields for the first and second sowings.

4. Components of yield: Maximum silage yields per hectare can only be obtained if harvesting is delayed until grain filling is complete. On the other hand, the crop must be harvested at a time which will provide a good quality silage suitable for high animal performance.

In reviewing the factors which affect the nutritive value of maize silage, Owen (1967) observed that cows fed the more mature or lower moisture silages voluntarily consumed more dry matter than those fed silage from immature corn. Johnson and McClure (1968) found that the D.M. digestibility of maize fed to sheep reached a maximum at the dough-dent stage (28% D.M.) and subsequently declined. Voluntary intake reached a maximum at 34% D.M. Colovos *et al.*(1970) found that the D.M. digestibility and voluntary intake for steers to be highest for silage made at the medium-hard dough stage (26% D.M.), Voluntary intake and D. M. digestibility of maize silage are maintained at reasonable levels as D.M. content is increased to 40%. Animal performance is relatively constant over a range of silage D.M. contents from 25 to 35%.

Figure 1: Relationship between dry matter percent and percent grain in silage.



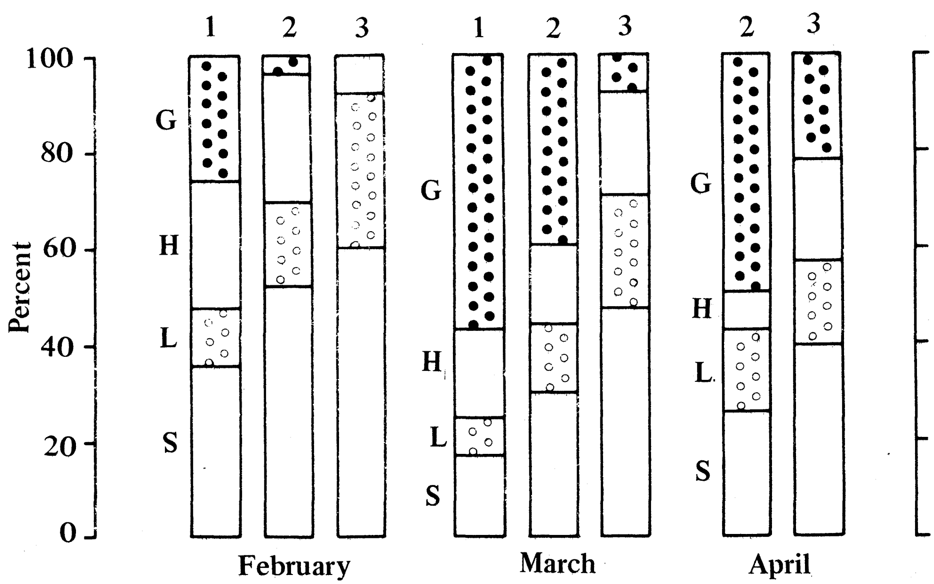
The relationship between crop D.M. % and percent grain was examined for all treatments for the three harvest dates and data are presented in Figure 1. The data were classed into three groups, viz. D.M.<25%, 25%<D.M.<50%, D.M.>50%. Figure 1 illustrates the close relationship between D.M. percent and percent grain. A change in D.M. percent from 25% to 35% is associated with a change in grain content from 30% to 45%. These figures indicate that if maize silage is to give best animal performance it should be harvested before grain filling is complete. The maize D.M. % at final harvest is given in Table 7.

TABLE 7: Dry matter percentage of silage at final harvest.

Sowing dates 1972	Harvest dates	Px 610	W415	KC3
25.10	28.3	31.8	43.3	54.8
3.11	13.4	29.5	40.3	57.1
29.11	13.4	23.7	26.9	30.2

Finally, the comparative changes in yield components which occurr over the February-April period are shown in Figure 2 for three different treatments, viz. the early maturing combination of KC3 sown on 26 October, the median treatment of W415 sown on 8 November and the late maturing combination of Px610 sown on 29 November.

Figure 2: The components of yield at three harvest dates for KC3 sown 26 October (1), W415 sown 8 November (2) and Px 610 sown 29 November (3).



The plants have been divided into four components, viz. stems (S), leaves (L), grain (G), and non-grain (H) components of the ear. Four general features are apparent:

1. The percent stalk falls from over 60% prior to silking to 18-23% when grain filling is complete.
2. The grain content changes from 0% to over 50% during the period from silking to approximately 10% at crop maturity.
3. The proportion of leaf drops from over 30% before silking to approximately 10% at crop maturity.
4. The non-grain component of the ear approaches 25% whole plant weight during early grain formation but declines to 10-20% at crop maturity.

These general characteristics will be influenced to some extent by variety, planting date and population, and by other environmental factors.

CONCLUSIONS

1. Temperature plays an important role in regulating the length of the vegetative period of a maize crop.
2. Early maturing KC3 sown on 6 October was the only treatment in this trial which produced a crop suitable for ensiling in late February. This crop would also have made valuable green-chop forage at this time. Yields of KC3 were equivalent to those of the later maturing varieties, but its forage quality was better.
3. All varieties sown on 26 October and the early and medium varieties sown on 8 November could have been satisfactorily ensiled on 20 March. These results suggest that as spring planting is delayed the farmer should sow early maturity hybrids in order to produce good quality silage for March harvesting.
4. All treatments except the late sown Px 610 were suitable for ensiling in mid-April, although several treatments had D.M. contents above 35%. Early sowing dates and late maturing varieties can be used for producing high-yielding crops of good quality silage for April harvesting.
5. Important changes occur in the proportions of leaves, stalks, grain and non-grain parts of the ear, and dry matter content as the crop matures. These must be considered in selecting the combination of planting date, hybrid maturity, and harvest date which the farmer will use. The reduced yields from the early maturing hybrids has to be considered in relation to the additional harvesting costs of the low dry matter silages produced by late-maturing varieties under certain conditions (Rutger, 1969).

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