EARLY SOWING OF MAIZE: EFFECT ON RATE OF DEVELOPMENT, GROWTH, YIELD AND OPTIMUM PLANT POPULATION

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ABSTRACT

Maize PX 610 was sown at approximately 2 week intervals from mid September to mid November in 1972 at 61.2, 73.8 and 91.8 thousand pl./ha in 0.76m rows at 91.8 thousand pl/ha in 0.38m rows.

Development to maturity and harvest (26% grain moisture) took longer, up to 24 days, with early sowing as soil and air temperatures were lower. Germination, vegetative development and grain drying took longer but grain was filled in 66 days at each sowing. Grain moisture at maturity was higher with early sowing but grain dried more rapidly. Maximum yields of dry matter, 22 t/ha and grain 13 t/ha were produced in the shortest times when sown on November 1 (148 days) and October 18 (173 days) respectively.

Plants sown early were characteristically shorter, had thicker stems and a smaller leaf area (up to October 18 sowing). Equal yields of dry matter and grain were obtained from sowings prior to November 15 but 91,200 pl/ha were required, as before October 18, compared to 61,200 pl/ha after, to give equal grain yields. More grain was produced per unit leaf area at early sowing possibly due to enhanced light interception at the lower L.A.I. and almost certainly because of increasing moisture stress affecting sowings made later than October 18.

Rows spaced 0.38 m compared to 0.76 m gave plants with thinner stems and less leaf area. However the leaf area of plants in 0.38 m rows was used more efficiently as yield of grain, from sowings made before October 18, tended to be higher.

INTRODUCTION

In a previous sowing date study with maize, (McCormick 1971) when sowings were made from mid October to mid December, it was observed that, with early sown maize, plants were often shorter, formed a less dense canopy and produced a higher grain to total plant dry matter ratio. Such observations agreed in principle were the findings of Pendleton and Egli (1969) who showed leaf area per plant to be less for early sown maize and the grain produced per unit leaf area to be higher. An explanation for the higher production of grain per unit leaf area with early sowing is that grain formation occurs closer to mid summer when days are longer and the angle of incidence of the sun is greater so that more radiant energy is available for photosynthesis.

The response of the maize plant to early sowing raises the question as to whether sowing in early October or late September, at a high plant population, might not increase grain yield as well as bring an earlier harvest. The limit to early sowing is determined by the incidence of killing frost. At Rukuhia, after October 1, the incidence is less than one in ten years. Maize, sown in late September, would because of the lower soil temperature, probably not emerge until the danger of frost had passed.

EXPERIMENTAL PROCEDURE

The study was conducted on the Rukuhia farm of the Ruakura Soil Research Station, Hamilton, on Horotiu sandy loam soil during 1972-73.

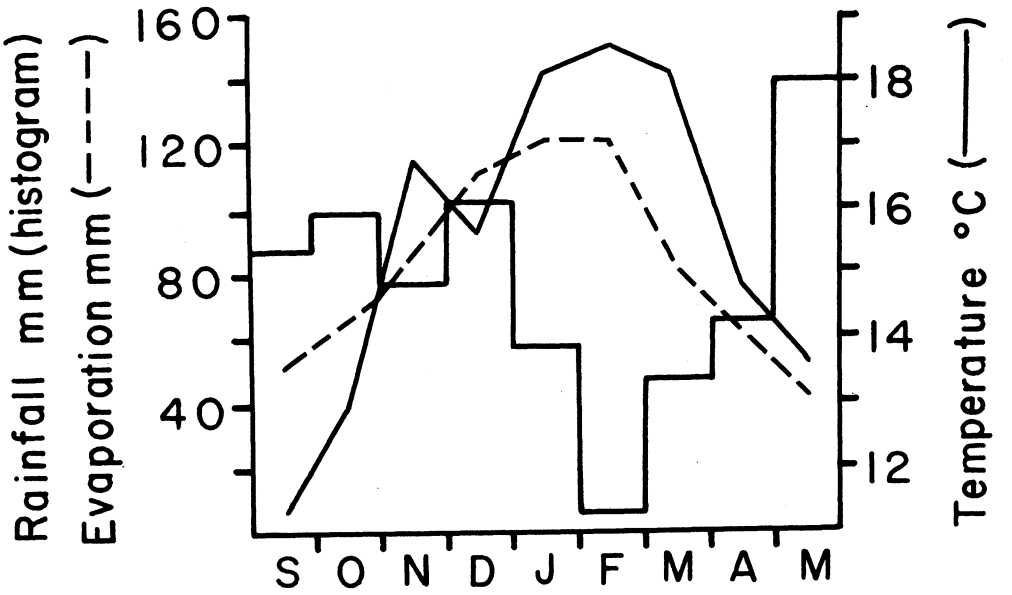
The commercial hybrid, PX610, was sown on September 14, October 2, October 18, November 1 and November 15 at high rates and thinned later to give populations of 61.2, 73.8 and 91.8 thousand pl./ha in 0.76 m rows and 91.8 thousand pl./ha in 0.38 m rows.

Days to emergence and percentage germination were determined from counts made of 100 kernels sown in each plot. Date of mid silk was determined from regular counts of the number of silks emerged in the two centre rows of a plot. Leaf area was calculated from measurements of the length and maximum width of all leaves on five plants per plot three weeks after mid silk. Leaf numbers of the plants were recorded at this time. Approximately four weeks after mid silk and until a constant value was reached the ratio grain dry weight to cob dry weight was measured weekly. Date of maturity was when the ratio reached 99% of its maximum value (Shaw and Thom, 1951). Total plant dry matter yield was measured at maturity. Date of harvest, at 26% grain moisture, was determined from weekly measurements of grain moisture. At harvest grain yield and other components of yield were measured. Grain yield was adjusted for a moisture content of 14%.

RESULTS AND DISCUSSION

Weather

The patterns of temperature, rainfall and evaporation during the season are given in Figure 1. Below average rainfall from January to April led to a reduction in the soil moisture available for growth from mid to late January onwards. Heat unit (mean daily temperature — 10 deg. C with temperatures below 10 deg. C read as 10 deg. C) accumulation followed an average pattern after November. Above average temperatures during November were balanced out with below average temperatures during December.



Rate of development

Maize development to maturity and harvest took increasingly longer for sowings made before and after November 1 and October 18 respectively (Figure 2). With early sowing germination took longer as soil temperatures were lower. Mean daily soil (10 cm) temperatures during emergence, from early to late sowing, were 11.4, 13.8, 14.2, 17.3 and 18.5 deg. C respectively. However the seed germinated equally as well (95-99%) at all sowings. Vegetative development also took longer with early sowing because of lower mean daily temperatures but grain filling took 66 days for all sowings except the earliest, when filling occupied only 61

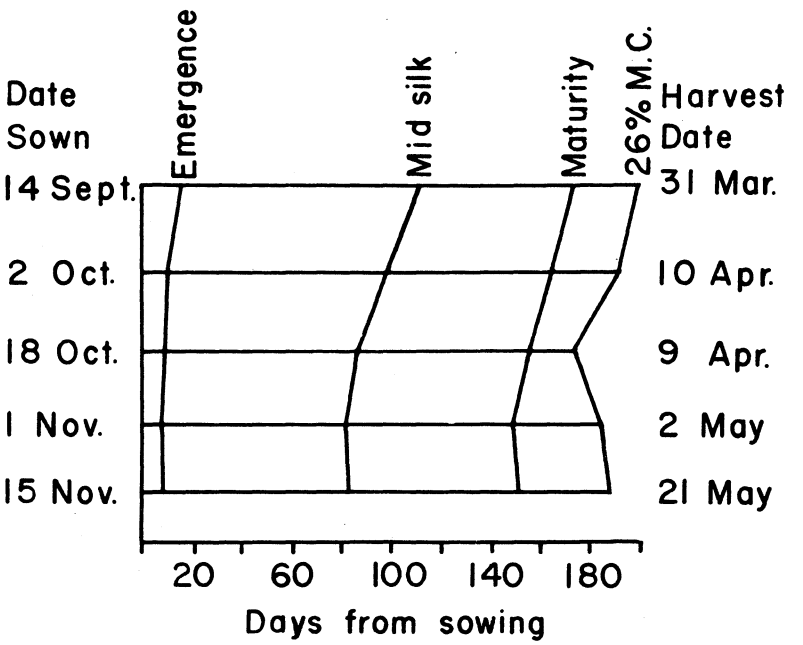


TABLE 1: Grain moisture at maturity and mean grain drying rate for five sowing dates.

Date sown	Estimated grain moisture at maturity %	Mean drying rate of grain %/day
14 Sept.	42.5	0.64
2 Oct.	39.0	0.54
18 Oct.	35.0	0.45
1 Nov.	36.5	0.30
15 Nov.	36.0	0.27

days. After maturity the grain of the early sown maize dried more rapidly as environmental conditions were favourable but still the grain took longer to reach 26% moisture because grain moisture at maturity was higher (Table 1). For sowings made later than October 18 the production time for grain increased because of the continued decline in the rate of grain drying.

Vegetative growth characteristics

Early sown maize had shorter plants with thicker stems (Table 2). The reduced stem thickness which accompanied later sowing did not result in an increased incidence of lodging at harvest (Table 2). The incidence of lodging was high for the latest sowing but arose primarily through excessive plant water stress and the high level of Northern Leaf Blight [**Helminthosporium turcium**] infection.

TABLE 2: Plant characteristics at five sowing dates

Date sown	Plant height m	Leaf number	Leaf* area cm^2	Stalk diameter cm	Lodging at harvest %
14 Sept.	2.80 bB	18.4	7586 bC	2.66 aA	3.3 bB
2 Oct.	2.68 cC	18.1	8187 aAB	2.58 abAB	4.6 bB
18 Oct.	2.80 bB	16.2	8279 aA	2.50 bB	9.5 bB
1 Nov.	2.91 aAB	16.3	8185 aAB	2.48 bB	3.4 bB
15 Nov.	2.99 aA	16.6	7753 bBC	2.28 cC	41.6 aA

* = Length x maximum width without correction

Plant leaf number (three weeks after mid silk) was greater for the two early sowings than for later sowings while plant leaf area, although only significantly less at the earliest and latest sowings, tended to increase and decline about the October 18 sowing date (Table 2). Plant leaf area decline, in this instance, was due either partly or wholly to the increase in plant water stress at the later sowings. However Pendleton and Egli (1969) reported a similar pattern of change in plant leaf area with delay in sowing when water was not limiting.

Yields of total plant and grain

Yields of total plant and grain from the first four sowings were not significantly different but the tendency was for yields, especially of grain, to decline with sowings made later than October 18 (Table 3). The decline in yield is most reasonably interpreted as the result of the decline in the level of water available for plant growth with advancing season. Thus the reduction in grain produced per unit leaf area and the rate of grain filling (Table 3) must be related also to the lack of adequate

TABLE 3: L.A.I. and yields of dry matter and grain at five sowing dates

Date sown	L.A.I.	Total DM yield t/ha	Grain yield t/ha	Grain/unit leaf area g/m	Grain fill, rate kg/ha day
14 Sept.	4.87	20.8 aA	12.6 aA	245	207
2 Oct.	6.57	21.5 A	13.0 aA	203	197
18 Oct.	6.67	21.4 aA	12.7 aA	203	192
1 Nov.	6.29	21.3	11.7 aA	189	177
15 Nov.	5.84	18.0 bA	8.6 bB	152	129

water. However, in the absence of plant water stress, the grain produced per unit leaf area was higher for the September 14 than for the October 2 sowing. The increased difficulty of grain production by leaves at the earlier sowing cannot be satisfactorily attributed to a higher mean daily radiation during the grain filling period. The higher rate of grain dry matter synthesis at the earlier sowing when leaf area was less would support an increased radiation effect. On the other hand with a lower leaf area at early sowing light interception per unit leaf area would be greater because of less mutual shading amongst leaves.

Plant population responses

A higher population of plants was required at the two early sowings compared with later sowings to produce similar yields of total dry matter and grain (Table 4). With the early sowings the smaller leaf area per plant was compensated for by the higher plant population to increase total leaf area. In neither of the two early sowings had grain reached maximum yield with the highest populations used (91,800 pl./ha). However, at the

TABLE 4: Leaf area index and yields of dry matter and grain for four populations at five sowing dates

	Leaf area index				Yield : D.M. t/ha				Yield : grain t/ha			
Pop 1000/ha	61	74	92	92*	61	74	92	92*	61	74	92	92*
Date sown												
Sept. 14	4.85	5.54	7.32	6.63	19.8a	20.2a	21.6a	21.7a	11.2cB	12.4bcAB	13.1abAB	13.8aA
Oct. 2	5.17	6.30	7.58	7.27	21.6abA	19.7bA	22.5aA	22.1abA	11.8cB	12.6bcAB	13.4abAB	14.2aA
Oct. 18	5.94	6.02	7.29	7.43	21.3a	22.5a	20.7a	20.8a	13.2a	12.5a	12.7a	12.2a
Nov. 1	5.32	5.80	7.07	6.95	20.1a	21.7a	21.0a	22.3a	11.2a	12.1a	11.6a	11.9a
Nov. 15	4.89	5.42	6.00	7.04	16.1bA	18.1abA	19.2aA	18.7abA	8.4a	9.4a	8.6a	8.2a

* 0.38 m rows compared to normal 0.76 m rows Duncan lettering apply across table only.

later sowings, maximum yield of grain was obtained with 61.2 to 73.0 thousand pl./ha even though the L.A.I. was less. It would appear that the response in grain yield to higher population at the later sowings was restricted by the lack of adequate water. Whether the potential for yield with early sowing, using a high plant population, is any greater than that for late sowing, given adequate water and optimum plant population, was unresolved. In practice though, where summer water stress is prevalent, early sowing using a high plant population would most likely produce the highest grain yield.

Row width

When 0.38 m rows rather than 0.76 m rows were used with a plant population of 91,800 pl./ha individual plants were reduced, significantly, in stalk thickness (2.44 to 2.35 cm) and leaf area (7960 to 7590 cm^2). The reaction to a practice which would appear to reduce competition between neighbouring plants was the reverse to that expected. Despite the reduction in per plant leaf area grain yield showed a tendency to be greater for the narrow row spacing in the two early sowings (Table 4). Presumably, through a better display of leaves, more sunlight was intercepted by the leaf canopy which led to higher yield.

Components of grain yield

The yield of cob per plant was less at early sowing than late sowing (Table 5). Size of cob was reduced rather than the number of cobs per plant. To maintain the same grain yield kernel weight at early sowing was greater.

TABLE 5: Components of grain yield at five sowing dates

Date sown	Cob wt/ plant g	Cob no./ plant	Shelling ratio %	Wt/ 100 kernels g
14 Sept.	183	1.03 aA	84 aA	35.3
2 Oct.	196	0.98 cB	83 aA	34.6
18 Oct.	202	1.01 abAB	82 aAB	32.9
1 Nov.	215	0.99 bcB	79 cC	32.3
15 Nov.	143	0.93 dC	81 bBC	28.9

Conclusions

Under average weather conditions the full season maize cultivar PX610 can be established readily in the Waikato as early as September 14. Early sown, maize has the advantage of an early grain harvest under more favourable weather conditions when grain is often in high demand.

Higher plant populations are required with early sowing to give grain yields equal to those obtained from sowings made October 18 and later as the area of leaf per plant is less. Whether early sown maize has, in fact, a higher potential for grain production **per se** requires further study. In general though, the early sown maize is more likely to give higher grain yields as it is less subject to plant water stress during the critical period of grain filling.

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