THE EFFECTS OF SOWING DATE ON MAIZE *(Zea mays* L.*)* DEVELOPMENT AND YIELDS OF SILAGE AND GRAIN

S.J. McCORMICK

RUAKURA SOIL RESEARCH STATION

RESEARCH DIVISION, NEW ZEALAND DEPARTMENT OF AGRICULTURE

SUMMARY

The data considered was obtained from three years of trials in one locality and covered a cold wet year and two hot dry years. Because of this and because the effect of sowing date has been averaged for varieties the quoting of actual production times and yields has been avoided in favour of describing the pattern of response of each relative to sowing date. The pattern of response was considered to have wider application in terms of locality and over years.

Delay in sowing maize for grain after 1st November led to a steady decline in grain yield because of -

(i) The lack of available soil moisture in some years

(ii) Grain formation periods of later sowings took place during periods of lower daily radiation.

Delay in sowing not only reduced yield but increasingly delayed the date of harvest.

The time required for the production of maize silage was affected very little by the date of sowing. The production period could be readily adjusted by delaying sowing up to mid December to allow for an increased production from spring pasture or to accommodate a winter crop. But as sowing was delayed after November 1st the yield of dry matter for silage fell steadily and the proportion of grain in the yield tended to decline.

INTRODUCTION

The main production uses of maize in New Zealand are:-

(i) As a silage crop.

(ii) As a grain cash crop.

Maize has the ability to produce a high yield of dry matter in a short time, especially over the summer period when the growth of pasture is restricted. As a silage crop with the full development of the grain, maize can, over a 5 month period, produce more dry matter per acre than pasture over a year. If maize is included in a sequence of annual cropping it should be possible to double the per acre yield of dry matter that is achieved from pasture. The efficiency of the sequence depends on the ability to fit each crop into the sequence to get the maximum combined yield. Both the yield and the production time required for each crop is involved in the overall efficiency of any system.

Yield of saleable grain is the most important consideration of a maize grain crop. But production time is important in relation to the optimum time for harvest and the subsequent use made of the area.

Studies in the U.S.A. on the phenology of maize have shown that -

(a) The length of the vegetative growth period, sowing to mid-silk is largely dependent on the variety used and the prevailing air temperature (Hanna, 1925; Shaw and Thom, 1951).

(b) The length of the grain formation period, mid-silk to maturity, is relatively independent of variety and environmental conditions, compared with the length of the vegetative period, and takes 50-55 days to complete (Shaw and Thom 1951).

(c) The length of the grain drying period, from maturity onwards, is dependent on the prevailing environmental conditions and to a lesser degree on the variety (Shibles 1962).

Date of sowing studies in the U.S.A. have shown that grain yield declines as sowing date is delayed after an optimum date in spring. The reasons for the grain yield decline are given as:-

(a) The time of occurrence of plant moisture stress in relation to the stage of crop development especially the grain formation period. (Denmead and Shaw, 1960; Rossman and Cook, 1966).

(b) The degree of coincidence of the grain formation period with the period of high daily radiation about mid Summer (Aldrich and Leng, 1965; Pendleton and Egli, 1969; Winter and Pendleton, 1970).

All of the responses mentioned will operate to some degree in New Zealand. The manner in which the responses affect the production time and the yield of maize will in turn affect the efficiency of the use made of the maize crop. The present paper deals with the average effect of sowing date on maize varieties of different relative maturities.

METHODS AND MATERIALS

Experimental work was carried out at Hamilton on Horotiu sandy loam soil over the three years 1968-71. In the 1968-69 and 1969-70 seasons, the four Wisconsin varieties, 304,434,537 and 575, of 90,95,105 and 110 days relative maturity respectively, were sown at five dates over the period 14th October to 22nd December. In the 1970-71 season, the Wisconsin varieties were sown at three dates only while a further sowing date trial was conducted. Varieties KC3 and PX610 of 75 and 115 days relative maturity respectively, were sown at four dates over the period 14th October to 2nd December. In each of the four trials, from a sequence of measurements taken for variety and sowing date, the data was determined when;

(a) 50% of plants had silked (Mid-silk)

(b) Dry weight accumulation in the grain had reached a maximum (Maturity).

(c) Moisture content of the grain had fallen to 26%.

Measurement was also made of the total plant dry weight yield and grain yield.

RESULTS AND DISCUSSION

1. The effect of sowing date on the time required for (i) vegetative development (ii) grain formation and (iii) grain drying.

Initially the number of days required for each of the three periods was plotted against sowing date for the individual years (Fig. 1). It was found that though the number of days required for each period at a given sowing date, varied from year to year with sowing date, the pattern of response to sowing date in each of the three years was similar. Consequently the recordings from the three years were combined to give single response lines for each of the three periods (Fig. II). A sowing date then represented the median date of a two week period within which sowings were made in the three years.

(i) Vegetative development (Sowing to mid-silk)

The time to Mid-silk decreased by 12 days as date was delayed from mid October to mid November. Sowing after mid November up to mid December brought about a further 5 day reduction in the length of the sowing to mid silk period. The reduction in the length of the sowing to mid silk period with delay of sowing date was interpreted as the direct response to the normal seasonal pattern of increasing daily temperature.

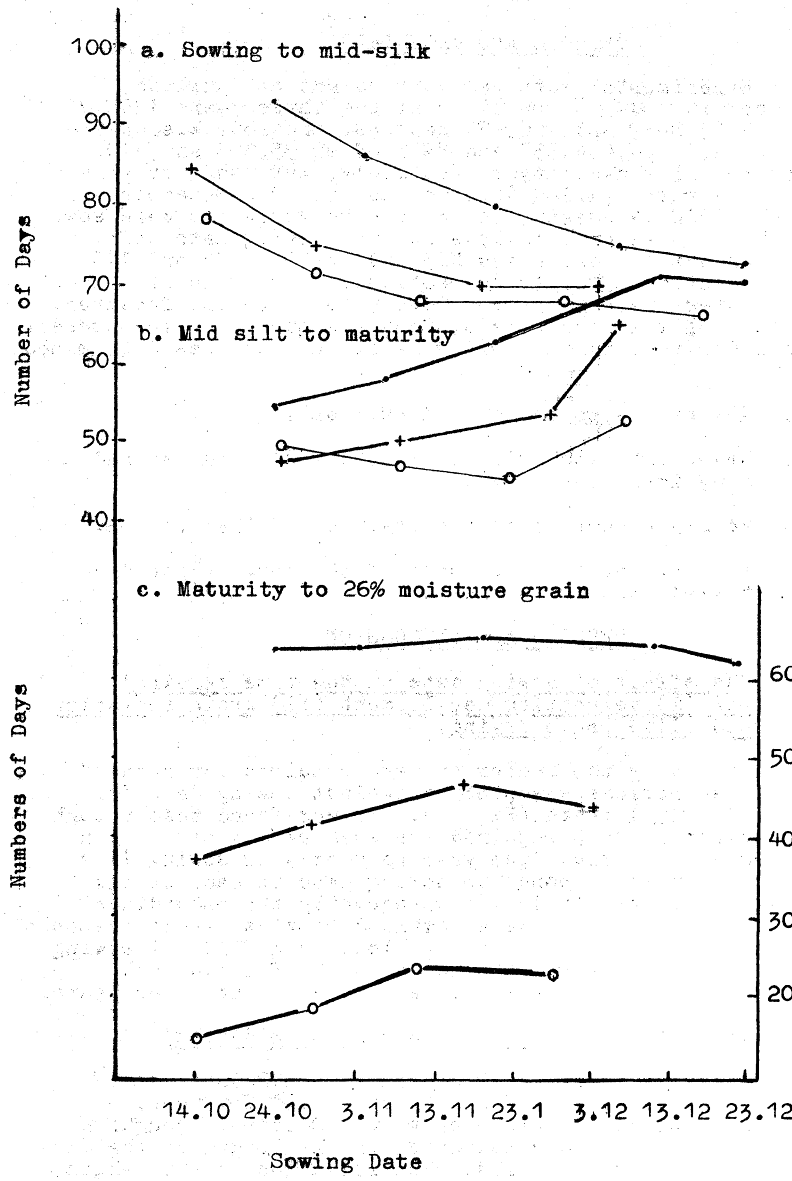

Fig 1. Numbers of days in relation to sowing date required by maize for growth (a) from sowing to mid-silk (b) from mid-silk to maturity and (c) from maturity to 26% moisture grain.
1965-69 .___.__, 1969-70 0-0-0 and 1970-71 +-+-+

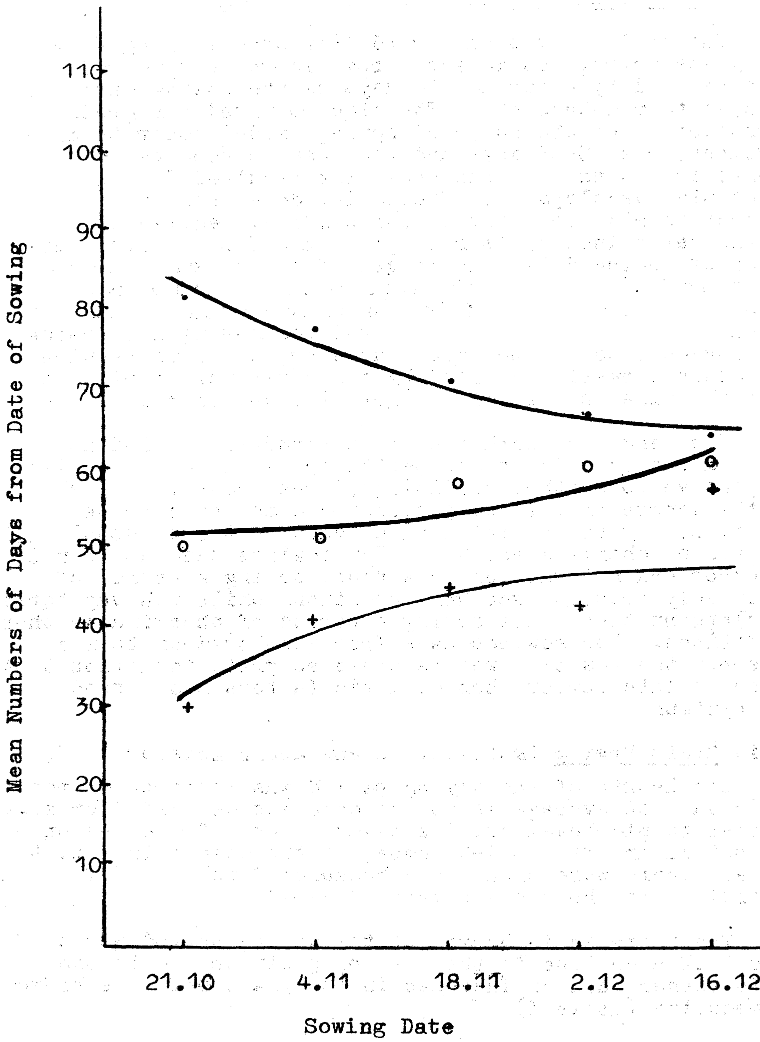

Fig. II Mean numbers of days in relation to sowing date for maize to develop (a) from sowing to mid-silk •___• (b) from mid-silk to maturity O-O and (c) from maturity to grain at 26% moisture content +___+

(ii) Grain Formation (Mid silk to Maturity)

The grain formation period increased in length by 6 days as sowing was delayed from mid-October to mid-November and by a further 14 days as the sowing date was delayed to mid-December. The time required for grain formation, over the range of sowings mid-October to mid-November, was 49-55 days and was less responsive to change in sowing date than the time required for the vegetative development. The sowing date range mid-October to mid- November is approximately equivalent to the determined optimum range in the U.S.A. Over this range of sowing dates the length of the period required for grain formation and the variability in its length relative to the length of the negative period agreed with U.S.A. data. Over the sowing date range, mid-November to mid-December, however, the time required for grain formation changed by a greater number of days than the time required for vegetative development.

The length of both the grain formation period and the vegetative development period appeared to be equally responsive to weather conditions. The relative variability in the length of the two periods was considered to be determined by the positioning of each on the seasonal pattern of changing weather. For sowings made up to mid-November grain formation took place during a period of relatively constant weather conditions while the vegetative development took place during a period of changing weather conditions. For sowings made from mid-November to mid-December the position was reversed as grain formation took place in late summer when climatic factors had passed the optimum.

(iii) Grain Drying (Maturity to 26% grain moisture)

The length of the drying period was found to increase by 15 days on average as sowing date was delayed from mid-October to mid-November. The exact nature of the response was not clear after mid-November as the mean points plotted for all years were unbalanced because of the loss of recordings in the drought year, 1969-70.

The increase in length of the drying period was a result of a decline in the rate of grain drying in the field rather than an increase in the grain moisture content at maturity (Table I).

TABLE I: Grain Moisture Content at Maturity and the Average Rate of Moisture Loss from Grain in Relation to Sowing Date.

Date Sown	Grain Moisture at maturity %	Average Moisture percent loss per day
21 October	39	0.72
4 November	39	0.49
18 November	41	0.42
2 December	40	0.39
16 December	46*	0.38

* Single recording.

2. The effect of sowing date on the production period required for (i) Silage (ii) Grain.

(i) Silage

The maximum dry weight yield of maize is reached at the time of grain maturity and subsequently declines with the loss of leaf and stalk. At maturity the maize can be readily ensiled with a dry matter content at 35% (Johnson et.al., 1966). In this paper the period sowing to maturity was taken as the silage production period being the minimum time required for the production of the maximum dry matter yield of maize for ensilage.

Change in sowing date between mid-October and mid-December altered the time required for silage production by only 6 days (Fig. III). The shortest time required for production was 127 days when sowing was made in mid-November. On delaying sowing, the reduction achieved in the length of the vegetative period was counteracted by the increased time taken for the formation of the grain.

Altering the sowing date from mid-October through to mid-December gave a range of ensiling dates from late February to late April. Any date in the range was acceptable for ensiling. Mid-December was considered to be the latest practical date of sowing for silage production to achieve full crop development before frost expected in early May. In the 1968-69 season maize sown in December was in fact cut back by frost before maturity. Change in sowing date, within the practical limits, resulted in only a small change in the time required for silage production. On the basis of time alone the period for silage production could be adjusted, by altering sowing date, to allow increased use of spring pasture growth or to accommodate a winter crop.

(ii) Grain

A 26% grain moisture content was taken as the optimum point of harvest in relation to combining losses during harvest (Corn Growers Guide 1968).

A delay in sowing date from mid-October to mid-November increased the time required to reach harvest by 3 days (Fig. III). A further delay in sowing date to mid December increased the production period for grain by another 16 days. Because of the pattern of the seasonal weather change, in relation to the period during which successive sowings of maize were developing, the production time required for grain was lengthened by delaying sowing. Both an increase in the length of the grain formation period and in the length of the grain drying period, as sowing was delayed, were responsible for the extension in the production time.

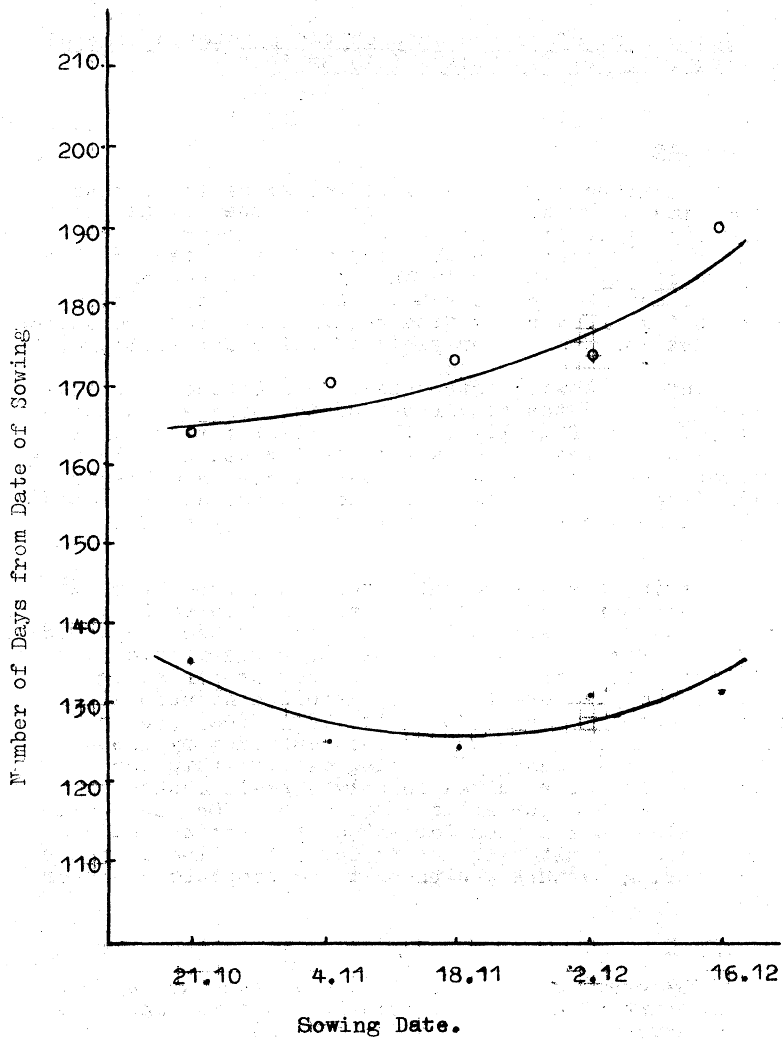

Fig. III Number of days from date of sowing to maturity •__• and from sowing to grain at 26% moisture 0-0-0 for silage and grain production in relation to sowing date.

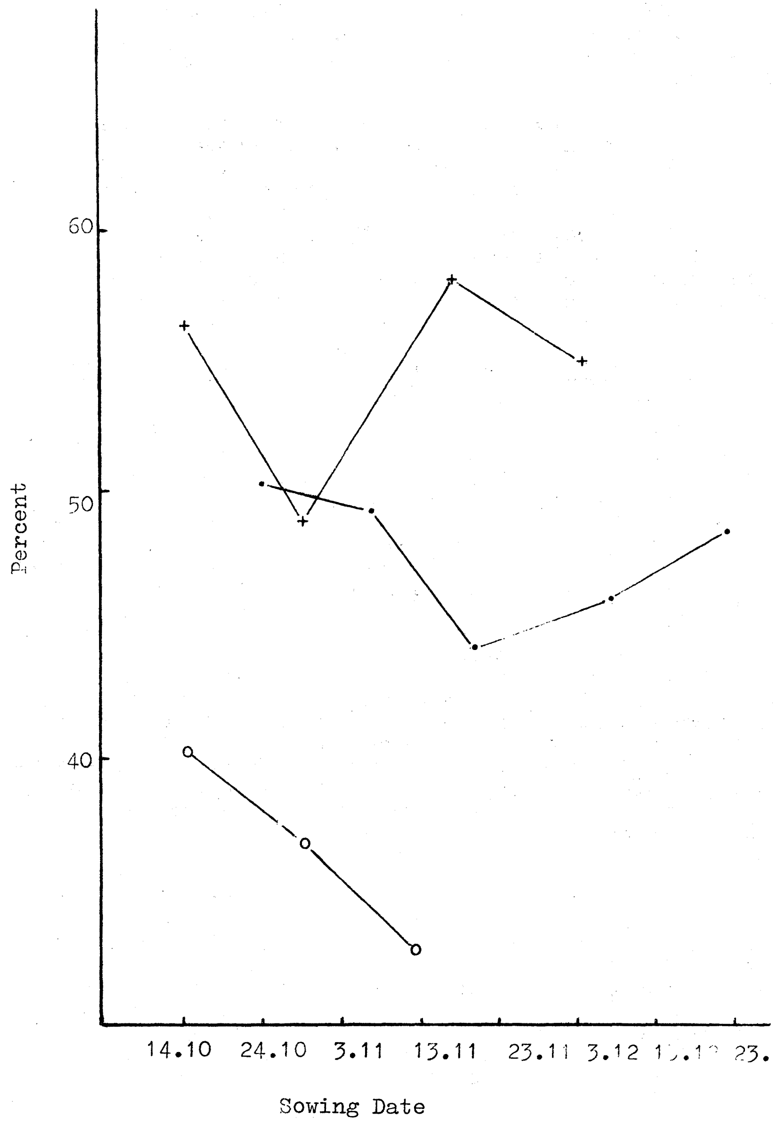

Fig. VI Grain dry matter yields expressed as percentage of total plant dry matter yields.

1968-69 .———., 1969-70 O——O and 1970-71 +——+ in relation to sowing dates.

Sowings made from mid-October through to late November reached harvest over the period early April to late May. Though sowing up to mid-December allowed the production of full grain yield in most years, there appeared to be little justification in delaying harvest until June.

The discussion on production times required for silage and grain referred to average responses for medium-short to full season varieties. Modification of the average responses shown might be required where only short or full season varieties are used. For full season varieties, the period of grain formation and grain drying would coincide to a greater extent with deteriorating weather conditions in the latter part of the season than for short season varieties sown on the same date.

3. The effect of sowing date on the yield of Maize for (i) Grain (ii) Silage

(i) Grain Yield (Fig. IV). In the 1969-70 season grain yield declined as sowing date was delayed after mid-October. In the 1970-71 season grain yield increased as sowing date was delayed to the end of October but showed no further change with later sowing. Both the overall lower yields obtained in the 1969-70 and 1970-71 seasons, compared to the 1968-69 season, and the pattern of the grain yield response in each of the two seasons demonstrated the effect of plant water stress on grain yield. In the 1969-70 season, an increasing lack of soil moisture was apparent from early October onwards. By mid-January, the beginning of the grain formation period of the late October sown maize, the plants of all five sowings showed visual symptoms of water stress. With delay in sowing, the vegetative growth period, and especially the grain formation period, of successive sowings coincided increasingly with periods of higher water stress. The result was a steady decline in grain yield with no grain at all harvested from the last two sowings made.

In the 1970-71 season, a similar pattern of increasingly low soil moisture was partially relieved by rainfall in late January. The fall of rain allowed a further development of the maize sown later than the end of October. The normal pattern of seasonal rainfall and evaporation tends to bring water stress from January to mid-March. Because of this, early sowings of maize for grain would be the least likely to suffer yield depression from water stress in a normal season.

In the 1968-69 season soil moisture was never considered to be a limiting factor to growth and development of the maize at any stage. The decline in yield with delay of sowing date in the 1968-69 season was considered to be the result of the effect on yield of the daily radiation received during the period of grain formation. The potential of radiation

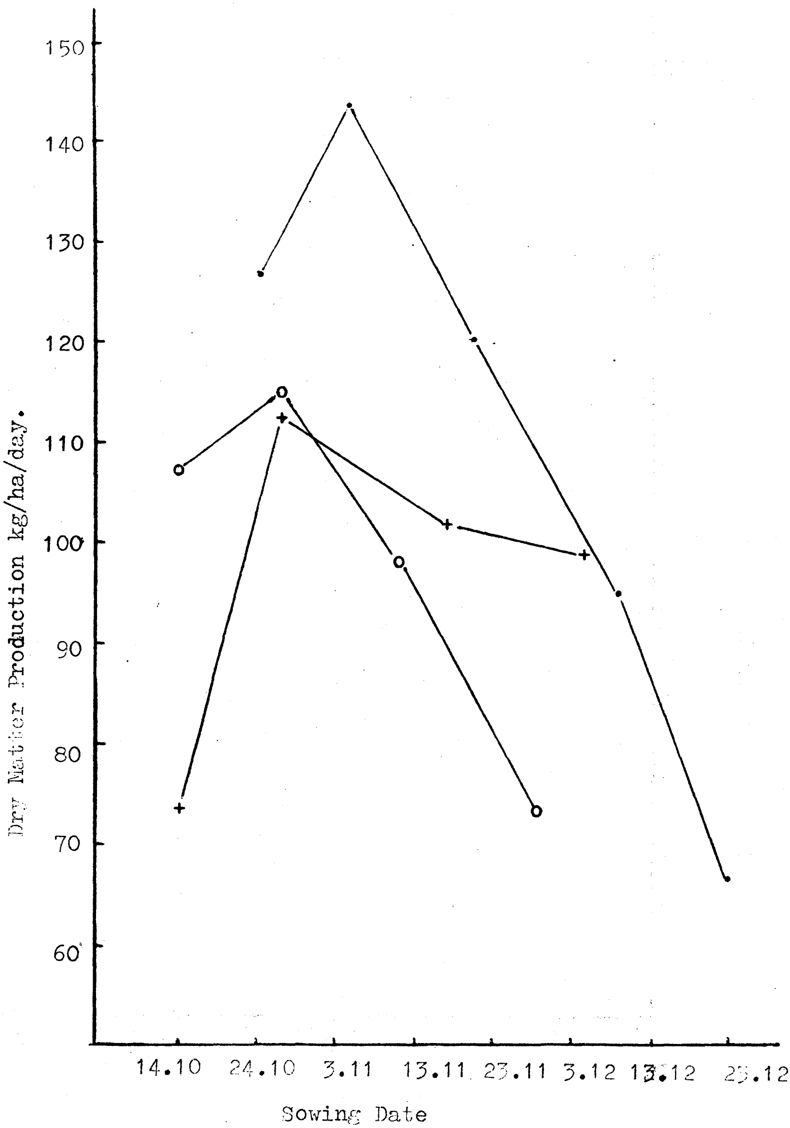

Fig. VII Mean daily rate of dry matter production for silage in relation to sowing date

1968-69 .____., 1969-70 O____O and 1970-71 +____+

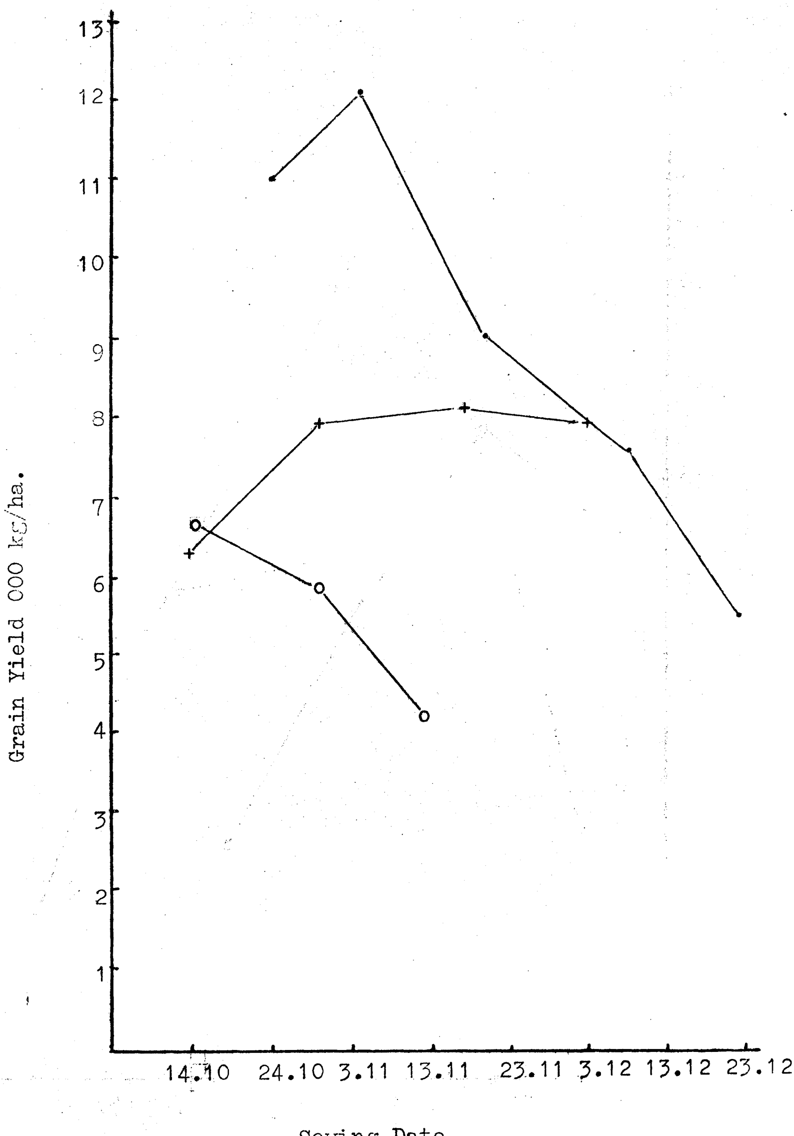

Fig. IV Yield of grain (15% moisture) kg/ha in relation to sowing date.

1968-69 .____. 1969-70 O________O and 1970-71 +_____+

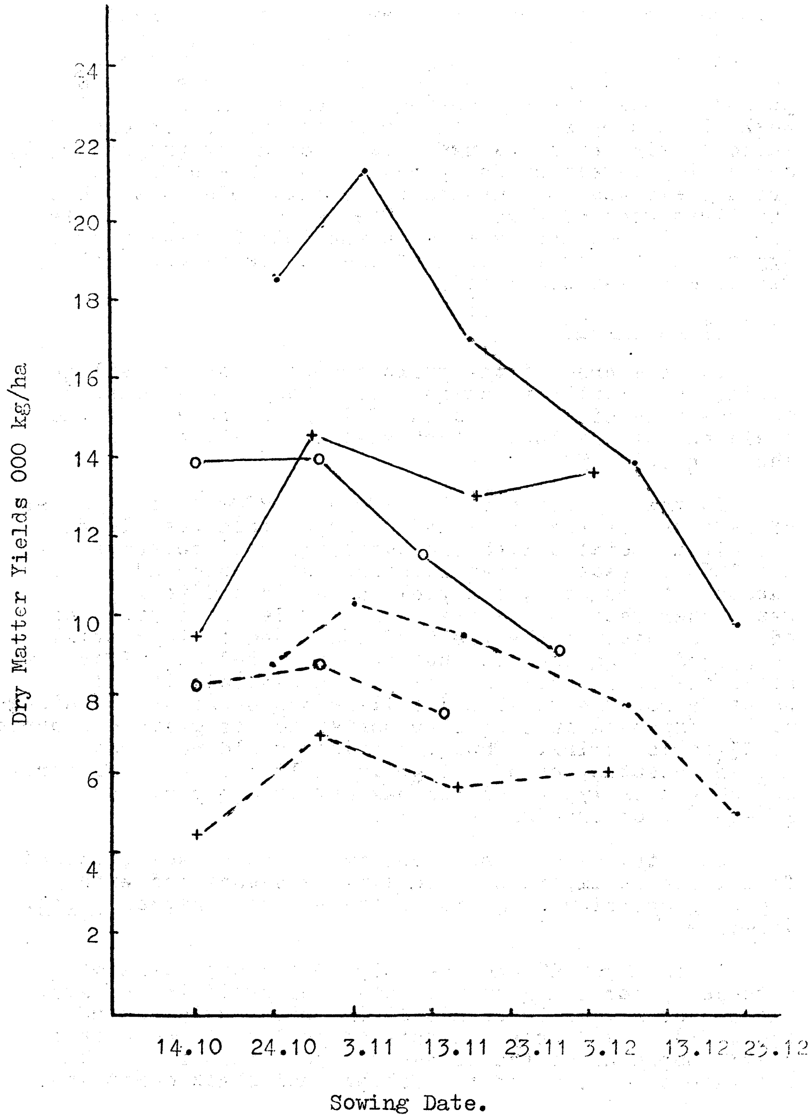

Fig. V. Total plant dry matter yield —— and stalks plus foliage dry matter yield - - - - in relation to sowing date in 1968-69 •——•, 1969-70 o——o o- - -o and 1970-71 +——+ +- - -+

received per unit leaf area per day reaches a maximum on the 21st December, with the longest length of day and with the sun at its highest angle, and subsequently decreases with the advancing season. The grain formation period of the earliest sowing commenced in the third week of January so that the grain formation periods of successively later sowings took place under progressively decreasing levels of daily radiation. The effect on grain yield was most marked on sowings made later than the first week of November. The decrease in grain yield for the mid-December sowing in the 1968-69 season, was aggravated by the frosting of the plants before grain development was completed.

(ii) Silage Yield

The response of the grain component of the silage yield, in relation to sowing date, has been discussed. The response of the stalk and foliage component of the yield and of the total plant yields for silage are shown in (Fig. V).

In the dry seasons, 1969-70 and 1970-71, the pattern of response of the stalk and foliage yield was clearly closely associated with the available soil moisture. In the 1968-69 season, when moisture was considered to be adequate throughout, the yield of stalk and foliage was higher than in the dry years. Under conditions of adequate moisture the yield of stalk and foliage still responded to sowing date but only declined significantly after the late November sowing. In general, in all three years, the stalk and foliage component of the silage yield responded in a similar manner to the grain component to delay in sowing. Thus the silage yield response was an accentuation of the grain yield response and early sowing was as important for maximum silage yield as it was for maximum grain yield.

Quality, as well as quantity of the silage produced from maize is important. Quality is associated with a high proportion of grain in the silage (Chapman et.al. 1964).

In the 1968-69 and the 1969-70 seasons there was a tendency for a higher percentage of grain in the dry matter for silage to be associated with early sowing (Fig. VI). Evidently the rate of decline in the grain yield component of the silage was more than rapid than the rate of decline of the foliage and stalk component.

To assess the efficiency of use of the land for silage production, in relation to sowing date, yield was combined with production time to give the average rate of dry matter production per day for each sowing date (Fig. VII). In all three years sowing within a week about the 1st November gave the highest rate of dry matter production.

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