Ife J. of Agric. 21 (2005) (209-215)

SOWING-DATE STUDIES ON MAIZE (*ZEA MAYS* L.) UNDER RAINFOREST CONDITIONS: EFFECTS OF SOWING DATE ON THE VEGETATIVE AND FLOWERING STAGES.

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Abstract

This study was carried out to evaluate the effect of sowing date on the vegetative and flowering components of maize phenology. Three maize cultivars were grown at five sowing dates over a two-year period. Time of 50% tasseling was chosen to mark the end of the vegetative phase. This phase was highly affected by cultivar. However, the flowering stage, time of 25% pollen shedding and the subsequent flowering stages were highly affected by sowing date and cultivar. Date x cultivar interaction was not significant. Test of significance for the mean number of days to the various flowering stages at each sowing date showed that Date 3 had the lowest number of days to the various flowering stages in comparison with the other dates. Cultivar differences in days to the flowering stages were also observed. The early maturing TZE4 recorded a significantly lower number of days to 50% tasseling and to the other flowering stages than FARZ7 and FARZ34. Some flowering stages appeared to have been nearly coincident in time. These were 50% pollen shedding and 25% silking; and 75% pollen shedding and 50% silking, which occurred within one day of each other.

INTRODUCTION

The vegetative and flowering phases are important phenological stages in the growth and development of maize(Zea mays L.). Environmental conditions greatly influence these phenological stages. Allison and Daynard (1979) found that a decrease in photoperiod hastened flowering and decreased the number of leaves in maize, while high temperature hastened flowering but generally increased the number of leaves. Shaw and Thom (1951) divided the development of corn into two phases: vegetative growth and ear development. They further divided the vegetative phase into three periods. These were planting to emergence, emergence to tasseling and tasseling to silking. They found that the plant tasseled earlier with increase in temperature. They noted about three days shortening of the period for each rise in average temperature for the 60-day period following planting.

Hunter *et al.* (1974) reported photoperiod and temperature as accounting for a large portion of the variability for number of days to tassel initiation. They further noted that maize would require more time to initiate tassel at the coolest temperatures. They found that an increase in temperature resulted in a decrease at a decreasing rate in the number of days from planting to tasseling. It was also established that a delay in planting of five days resulted in a shortening of the period to tasseling by one day. It has been reported that there was little photosynthesis in maize leaves below 10^{0}C while the rate approached maximum at approximately 33^{0}C and decreased at higher temperatures (Duncan *et al.*, 1973). Also, Quinby *et al.* (1973) in their study on the influence of photoperiod and temperature on floral initiation and leaf number in sorghum(sorghum bicolor Moench) observed that there was an interaction between temperature and photoperiod. In night periods longer than 12 hours, variation in time of floral initiation among genotypes were due to differences in temperature response to allelle at the maturity loci.

Tollenaar *et al.* (1979) established that temperature and photoperiod exert an influence on the duration from planting to silking through their effect on number of leaves per plant. Pauli *et al.* (1964) found that location and planting date which led to different environmental conditions (particularly moisture and temperature) affected different growth stages of sorghum. They noted that earlier planting dates seemed to lengthen the time from planting to transition of growing point from vegetative to floral stages. It has been shown in a study on sorghum that 10-hour days hastened floral initiation and anthesis in two varieties used, at all temperature combinations (Caddel and Weibel, 1971).

Brever *et al.* (1976) reported that long photoperiod and low temperature independently increased the number of stunted plants and delayed silking in a maize hybrid. Moisture deficit also delayed tasseling and silking on dry plots by about four or five days. Vegetative growth was found to be only slightly affected by stress imposed early in the growing season (Deamead and Shaw, 1960). Lal (1974) reported that the interval between tassel initiation and silking was not affected by photoperiod but increased significantly with low temperature treatment. The objective of this study was to determine the influence of the environmental conditions provided at different sowing dates on the vegetative and the flowering phases in maize.

MATERIALS AND METHODS

The field experiment was conducted at the Teaching and Research Farm, Obafemi Awolowo University, Ile-Ife, Nigeria, which is located on latitude 7° 28'N, longitude 4° 33'E with an altitude of 244m. The dates of sowing were 27 April, 23 May, 1983; 15 and 30 May and 11 July, 1984. Three maize cultivars FARZ 7, FARZ 34 and TZE 4 were used in the study. Each plot consisted of four rows which were 10 m long. There were two replications of the experiment.

Plant spacing was 1.0 m between rows and 0.5 m within rows. Two seeds were planted per hole. Thining was done at three weeks to have one plant per stand. Fertilizer application was carried out at four weeks. A compound fertilizer 15:15:15 of NPK was applied at the rate of 60 kg per hectare.

Data were collected on the following traits: days to 50% tassel, days to first pollen shed, days to 25, 50 and 75% pollen shed; days to 25, 50 and 75% silk. Analysis of variance was carried out to determine the influence of sowing date on the various flowering stages. Statistically significant differences were determined using the Least Significant Difference (LSD) at 5% level of probability.

RESULTS AND DISCUSSION

The results of the analysis of variance for the various flowering stages are presented in Table 1. Days to 50% tassel was chosen as the end of the vegetative phase and the beginning of the flowering period. Shaw and Thom (1951) divided the vegetative period into planting to emergence, emergence to tasseling and tasseling to silking. Shaw and Loomis (1960) also divided corn growth stages into early vegetative growth from planting to flower differentiation, rapid vegetative growth from a plant height of 50 cm to silking, and others. Thus, the time of 50% tassel was taken as marking the end of the vegetative phase and the beginning of flowering in this study.

Results in Table 1 show a highly significant effect of cultivar on all flowering traits.. Sowing date had no significant effect on 50% tassel and 1st pollen shed. The interaction effect of date x cultivar was also not significant on all flowering traits. At 25% pollen shed, sowing date had a highly significant effect. Effect of cultivar was also significant but there was no significant effect of date x cultivar interaction. In the case of days to 50 and 75% pollen shed, the results were similar. The effects of sowing date and cultivar were highly significant, while the interaction effect was not.

Results obtained for the silking stages followed a similar trend. Cultivar and sowing date had highly significant effects on days to 25, 50 and 75% silk. In this study, days to 75% silk was taken as the time when most of the plants were in silk. Plant-to-plant variation might affect days to 100% silk such that the latest plant to silk might extend the time of silking in a way that it might not be representative of the general situation of plants in the plot. Hence, days to 75% silking was taken as the end of the flowering period and the beginning of the grain filling phase.

Sowing date had no significant effect on days to tasseling. However, the period was expected to be most variable. Shaw and Thom (1951) reported that warm temperatures combined with plentiful supply of moisture gave rapid growth and shortened the interval while

Table 1. Mean square values of calendar days to the various flowering stages for three maize cultivars at five sowing dates.

Source	Df	50% Tassel	1st Shed	25% Shed	50% Shed	75% Shed	25% Silk	50% Silk	75% Silk
Date	4	8.88	2.38	15.72**	19.25**	20.33**	16.13**	21.03**	34.14**
Replication	1	0.81	2.13	1.19	0.50	1.63	3.31	6.5	2.75
Cultivar	2	290.22**	256.63**	286.03**	294.22**	288.63**	214.53**	238.28**	270.91**
Date x Cultivar	8	7.12	2.27	6.74	6.91	7.14	6.24	5.14	8.48
Error	14	3.55	4.35	2.56	2.96	3.63	3.19	3.04	5.55

*Significant at 5% level, ** Significant at 1% level.

Table 2. Mean number of days of three maize cultivars to the different flowering stages as related to sowing dates.

Sowing date	50% Tassel	1st Shed	25% Shed	50% Shed	75% Shed	25% Silk	50% Silk	75% Silk
1	57.7	50.5	57.2	59.5	62.5	59.7	62.8	66.7
2	56.7	50.3	56.5	59.3	62.0	59.3	62.2	65.2
3	54.5	51.7	53.3	55.3	58.0	56.2	58.5	60.7
4	56.2	51.2	56.0	58.0	60.0	57.5	60.0	62.3
5	57.2	51.7	57.3	59.5	61.7	60.0	62.5	64.7
$LSD_{(0.05)}$	1.2	0.6	1.6	1.4	1.7	1.6	1.8	2.3

Table 3. Mean number of days to the various flowering stages for three maize cultivars across five sowing dates.

Cultivar	50% Tassel	1st Shed	25% Shed	50% Shed	75% Shed	25% Silk	50% Silk	75% Silk
FARZ 7	60.4	54.8	60.1	62.5	65.1	62.4	65.3	68.4
FARZ 34	58.6	53.1	58.1	60.3	62.6	59.8	62.5	65.1
TZE 4	50.3	45.3	50.0	52.2	54.8	53.4	55.8	58.2
$LSD_{(0.05)}$	6.6	6.2	6.6	6.7	6.6	5.7	6.0	6.4

Table 4. Time interval (in days) between some anthesis and silking stages

Sowing date	50% Shed to 25% Silk	75% Shed to 50% Silk
1	+0.2	+0.3
2	0.0	+0.2
3	+0.9	+0.5
4	-0.5	0.0
5	+0.5	+0.8

cooler temperatures lengthened the period. It would be noted that the five dates used in this study fell in the early growing season for maize. Th..s, temperature and moisture conditions might have been similar for the sowing dates. Days to first pollen shed were earlier than days to 50% tasseling. Hence, it was likely to have been affected in a similar way. However, highly significant effects of sowing date were recorded for the other flowering dates from 25% pollen shedding to 75% silking.

Shaw and Thom (1951) further reported that hot, dry weather caused more rapid rate of tasseling than cool weather with a plentiful supply of moisture, while the same hot dry weather would also cause a slower rate of silking than would cooler weather. Such situation might have been responsible for the significant effect which sowing date had on the other flowering stages. Furthermore, moisture stress might delay tasseling and silking (Classen and Shaw, 1970). When stress occurred after first silk, the percentage of plants that silked remained constant until the restoration of moisture supply. Thus, differences in environmental conditions a[illegible] arious sowing dates might have explained for the results obtained with the various flowering stages.

Table 2 shows the mean number of days to the various flowering stages in each date. In the case of 25% pollen shedding where the effect of sowing date was significant, Date 3 had a significantly low value. Differences in days to 25% pollen shedding on the other dates were not significant. Similarly, days to 50% pollen shedding were significantly lower in Date 3 than in the other dates. At 75% pollen shed, in addition to Date 3 having the lowest value, Date 4 was significantly different from Dates 1 and 2. For days to 25 and 50% silking, Date 3 differed significantly from the other dates, except Date 4. Date 3 also had the lowest number of days to 75% silking, although this was not statistically different from that of Date 4. But the values for Dates 1 and 2 were significantly higher than that of Date 4.

Analysis of variance showed that there was a highly significant effect of cultivar on flowering stages. Table 3 shows the mean number of days of the three cultivars to the various flowering stages. Maize cultivar TZE 4, which was the earliest maturing, had the lowest number of days to 50% tasseling. Although FARZ 7 attained 50% tasseling later than FARZ 34, there were no significant differences in their tasseling dates. A similar trend was observed for the other flowering stages. In each case, it was found that TZE 4 had a significantly lower number of days to any of the flowering stages than FARZ 7and FARZ 34. Also, in all cases, differences in the number of days of FARZ 7 and FARZ 34 to the various flowering stages were not significant, although FARZ 7 attained such flowering stages later than FARZ 34.

Siemer *et al.* (1969) reported that anthesis and silking were nearly coincident in time. Table 4 shows the interval between some anthesis and silking stages. It appeared that 50% pollen shedding and 25% silking occurred within a day of each other. Furthermore, 75% pollen shedding and 50% silking appeared to have been nearly coincident in time. In addition, Hawkins and Cooper (1979) found that tassel initiation occurred 9 days later in small than large seeds of maize. In this study, it was found that for the three cultivars used. TZE 4 tasseled on the average, about 9.2 days after the later maturing two cultivars which apparently had the larger seeds.

The results in this study seem to generally agree with the past work in the literature. For instance, Shaw and Thom (1951) found that silking occurred 6 to 8 days after tasseling. Tasseling to silking averaged 6.3, 6.1 and 8.2 days respectively for the early, medium and late maturing varieties used in their study. In the present study, t[illegible] number of days from 50% tasseling to 75% silking was found to be 6.5, 7.9 and 8.0 days for FARZ 34, TZE 4 and FARZ 7, respectively. Furthermore, Shaw and Thom (1951) found the period from emergence to tasseling as most variable. In the present study, although differences in number of days to the various flowering stages were not so large, perhaps because all plantings were done in the early season of the two years, significant differences were still observed in the number of days to the various flowering stages in the different dates. Cultivar differences were also high with the early maturing TZE 4 taking 50.3 days to tassel, while the later maturing FARZ 7 took an average of 60.4 days across the five sowing dates.

In addition, Pauli *et al.* (1964) established that location and planting dates which lead to different environmental conditions affect different growing stages. They found that medium to late planting dates generally resulted in a shortened total growth period than early planting. In this study, significant differences were noted among sowing dates, even though sowing was done in the early season of the two years. Furthermore, the earliest of the sowing dates was on 27 April, 1983. Plantings on that date generally took longer days to attain vegetative maturity and flowering stages. However, Date 3 in which sowing was carried out on 15 May, 1984 attained vegetative maturity earlier and performed better than the later plantings that year. The reason for this was believed to be that environmental conditions which were, perhaps, optimum for that sowing date.

Abundant solar radiation and adequate supply of moisture might have favoured the rapid growth of the crop, making plants to reach vegetative maturity and attain flowering earlier. The later plantings that year which were done on May 30 and July 11, could have been more affected by the relatively cool temperatures recorded in July, August and, perhaps in September. This might have affected the rate of dry matter production, and also lengthened the time of attachment of vegetative maturity and flowering. These observations are further in agreement with the work of Allison and Daynard (1979) who reported that increase in temperature would shorten the interval from sowing to start of ear initiation and from ear initiation to silking.

Otegui *et al.* (1995) reported in their study that as sowing date was delayed , growth occurred under greater temperatures with concomitant reductions in duration of growing cycles. Bollero *et al.* (1996) also reported that lower temperatures delayed corn development in terms of calendar days.

Furthermore developmental stages were found to be attained later in the year for the cool treatments than for the ambient or warm treatments. In addition, Fortin and Pierce (1990) concluded that a corn apical meristem exposed to 21.3°C had a developmental delay of 7.7 calendar days at tasseling, relative to corn exposed to 24.8°C. Thus, differences in these environmental factors might have accounted for the duration of the phenological stages at the different sowing dates.

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