

The Influence of Sowing Dates on the Growth and Yield of Two Maize (*Zea mays* L.) Varieties cultivated under Southern Guinea Savannah Agro-ecological Zone.

Abstract

Maize requires optimum growth conditions to express its genetic potential. Evaluating maize under different sowing dates provides a novel strategy of improving its productivity. To achieve this, a field study was conducted at the Teaching and Research Farm of the University of Agriculture, Makurdi during 2012 cropping season to determine the effect of different sowing dates on the growth and yield of maize. Makurdi is located under the Southern Guinea Savannah Agro-ecological Zone. Two maize varieties, TZESR-Y and QPM were obtained from the Department of Plant Breeding and Seed Science, University of Agriculture, Makurdi and evaluated under three different sowing dates (4th May, 18th May and 1st June, 2012). The factors were arranged in a 2x3 factorial style laid in a randomised complete block design with three replications. Data were collected on morphological parameters and subjected to analysis of variance. The result showed that sowing date had significant effect on number of leaves/plant, ear girth and grain yield. Early sowing had significant and positive effect on grain yield. The interaction effect of variety and sowing date was significant for plant height, number of leaves/plant and grain yield. Delayed sowing to 18 May and 1 June resulted in significant reduction of grain yield from 130.67 kg/plot to 127.18 kg/plot in QPM and 126.67 to 125 kg/plot in TZESR-Y. QPM when sown on 4 May gave the highest grain yield compared to when sowing was delayed to May 18 and June 1. This result implies that May 4 sowing date appears to provide the optimum conditions for maize cultivation under Southern Guinea Savannah agro-ecological Zone.

Key words: Sowing dates, maize, Guinea Savannah Agro-ecological Zone, morphological character.

INTRODUCTION

Maize (*Zea mays* L.) is one of the ancient cereal crops cultivated by man and its importance as a major staple food especially in sub-Saharan Africa is well known [1]. Maize is a member of the grass family, *Poaceae* and it is cultivated in various agro-ecological zones, including areas with temperate climates. In industrialised countries, maize is used largely as a feedstuff

35 and raw material for industries, however in developing countries such as Nigeria; it is a major
36 staple food item for over 50% of the population [1]. Apart from processing the grains into
37 flour, roasted or boiled fresh maize is fast gaining popularity as a delicacy for both rural and
38 urban dwellers because of its nutritive value.

39 Interest in Maize cultivation in Africa has increased considerably over the past few decades
40 due to the growing demand for the grains for livestock feeds and human nutrition. Presently,
41 its cultivation has shifted from subsistence to a commercial crop on which many agro-based
42 industries depend on for raw materials [2]. To satisfy this demand, some improved varieties
43 have been developed with great potentials to increase production if provided the optimum
44 planting conditions [1].

45 Maize like many other crops that are cultivated in the tropics is influenced by the
46 environmental changes (temperature, rainfall, sunshine, wind etc) associated with different
47 sowing dates. Each maize variety has an optimum sowing date, and the wider the deviation
48 from the optimum sowing date, the greater the yield loss. Considerable yield decline as a
49 result of sowing too early or too late have been reported in maize [3], [4]. [3] observed a
50 negative effect of delayed sowing on yield components of maize. They noted that delayed
51 sowing resulted in reduced number of grains per row, 100-grain weight and grain yield. The
52 study conducted on single hybrid maize by [4] also indicated the overwhelming effect of
53 sowing date on yield components. In all these studies, it is apparent that early sowing
54 performed better than late sowing. Studies have shown that planting too early leads to uneven
55 seedling emergence as a result of limited soil moisture content and high temperatures during
56 the dry season.

57 Due to loss of yield as a consequence of planting either lately or after the optimum sowing
58 date, [5] suggested that farmers could plant maize at different times in order to safeguard
59 against unfavourable conditions. This option may not be acceptable to farmers because it

60 would lead to waste of planting materials and efforts and may also results in inaccurate yield
61 predictions.

62 In order to overcome the challenges faced by maize farmers, [2] recommended last week in
63 April to third week in May for sowing Maize in the Southern Guinea Savannah agro-ecology.
64 However, the local farmers have suggested that the best guide is the onset and the time at
65 which the rains become established. In Makurdi, it has been observed that rainfall becomes
66 established in May. In addition, the Southern Guinea Savannah is a wide area; therefore there
67 is an urgent need to match specific maize varieties with optimum sowing dates for increased
68 yield. Although there are overwhelming reports in the literature that attributed significant
69 yield losses in maize to delay planting in most areas with tropical climates, no such report is
70 available for the maize farmers in Makurdi. To date, no study has reported on the most
71 appropriate sowing date for maize in Makurdi. This work was initiated to fill this gap by
72 providing information on the optimum date of sowing maize in Makurdi.

73

74 **MATERIALS AND METHODS**

75 Field experiment was conducted during the 2012 cropping season to determine the response
76 of two maize varieties to different sowing dates at the Teaching and Research Farm of the
77 University of Agriculture, Makurdi. Makurdi falls within the Southern Guinea Savannah
78 Agro-ecological zone of Nigeria and it is located on Latitude 7⁰43' N and Longitude 8⁰32' E.
79 The two varieties, TZESR-Y and Quality Protein Maize (QPM) were obtained from the
80 Maize Research Unit of the Department of Plant Breeding and Seed Science, University of
81 Agriculture, Makurdi. TZESR-Y and QPM are medium duration maize varieties that are
82 popularly cultivated in Makurdi because of their promising characteristics. TZESR-Y is a
83 yellow open-pollinated maize variety that is resistant to streak and/or downy mildew, while
84 QPM is cultivated for its high nutritional quality and dense grains.

85 The experimental area (216m²) which was left fallowed for two years was cleared and
86 divided in 18 plots. Plot size was 4m x 3m. Each plot consisted of six ridges maintained at
87 0.60 m apart and the intra row spacing was 0.30 m. The two maize varieties, TZESR-Y and
88 QPM and three different sowing dates (4th May, 18th May and 1 June, 2014) constituted the
89 treatments. The treatments were arranged in a 2x3 factorial style laid out in a randomised
90 complete block design with three replications resulting in 18 experimental plots. Three seeds
91 were sown per hill at a depth of 2-3 cm and after two weeks thinned down to one plant per
92 hill to give a plant density of 66,667 plants ha⁻¹. Manual weeding was carried out twice, at 2
93 and 6 weeks after planting to ensure farm sanitation. Split fertilizer application was done
94 using the band placement method at the rate of 200 kg/ha NPK (15:15:15) and top dressed
95 with 120 kg/ha of Urea before tasselling.

96 Data was collected on three plants from the middle of each row and the value obtained was
97 divided by three to obtain the average. Data were collected on plant height at 50% flowering,
98 number of leaves/plant 50% at flowering, leaf area at 50% flowering, ear length, ear girth,
99 number of seeds/ear, 100-kernel weight, and grain yield. Yield was calculated on plot size
100 basis using 10 plants randomly selected from each plot. Data analysis was subjected to
101 analysis of variance using a computer package GENSTAT (Edition 2011). Significant means
102 were separated using the Least Significant Difference as described by [6].

103

104 RESULTS AND DISCUSSION

105 Monthly meteorological data for Makurdi in 2012.

106 The meteorological data for Makurdi in 2012 is presented in Table 1. The amount of rainfall
107 received in April was 143.2 mm in six rainfall events, while 145.20 mm occurred in May and
108 was distributed in eleven rainy days. The highest amount of rainfall for 2012 was received in

July (351.1 mm), while the least occurred in February (0.5 mm). The temperature range (21.40-31.90 °C) recorded in May seems to be more favourable for maize cultivation.

Mean square estimates from the analysis of variance

The mean square estimates from the analysis of variance of growth and yield parameters of maize evaluated under different sowing dates are presented in Table 2. The results of the ANOVA showed that sowing date had significant ($P<0.05$) effect on number of leaves/plant, ear girth and grain yield, while plant height, leaf area, number of ears/plant, ear length, number of kernels/ear and 100-seed weight were not significantly affected by different sowing dates. [3] reported significant effect of sowing date on several maize yield characters in Pakistan.

Effect of variety and date of sowing on the yield and yield attributes of maize.

1. Plant height

Variety had significant effect ($p<0.05$) on plant height (Table 3). QPM had the maximum plant height (101.40 cm), while TZESR-Y gave the minimum (87.70 cm). Sowing date however did not significantly affect plant height, indicating the genetic stability of the traits under different sowing dates. Late sowing positively affected plant height as it increased when sowing was postponed to 18 May. The results confirmed the reports of other researchers [7, 8]. [4] reported a positive effect of sowing date on plant height when sowing was delayed from 5th to 20th June in single cross hybrid in Iran. The interaction effect of variety x sowing date on plant height was significant, indicating that both varieties differed under different sowing dates (Fig. 1). The highest plant height (98.90 cm) was obtained in QPM when sown on the 4 May.

2. Number of leaves/ plant

The varieties differed significantly in number of leaves/plant. QPM produced higher number of leaves/plant (20.19) compared to TZESR-Y which had lower number of leaves/plant

(18.50). Date of sowing had significant effect on number of leaves/plant and 18 May sowing gave the highest number of leaves/plant (20.04), while the least was obtained in 4 June sowing. Postponing sowing significantly increased the number of leaves/plant. The interaction effect of variety and sowing date on number of leaves/plant was significant (Fig. 2). QPM gave significantly higher number of leaves when sown on the 4 May compared to other sowing dates (Fig 2).

3. Leaf area

TZESR-Y produced higher leaf area (226.60 cm²) compared to QPM. 18 May and 1 June sowing produced higher leaf area although it was not statistically different from the leaf area obtained in 4 May sowing. The interaction of variety and sowing date on leaf area was non-significant. This result suggests that both varieties are genetically similar in respect of leaf area.

4. Number of ears/plant

Both varieties gave the same number of ears/plant (2.0). Sowing date had positive effect on ears/plant as the 4 and 18 May sowing produced the highest number of ears/plant compared to when sowing was delayed to 1 June (1.67). Delayed sowing considerably reduced the number of ears/plant by -0.66 per plot. The interaction effect of variety and sowing date on number of ears/plant was however not significant, indicating the genetic stability of this trait under different environmental conditions.

5. Ear length

Ear length was significantly higher in QPM (14.28) compared to TZESR-Y (10.20 cm). Late sowing had positive effect on ear length as it increased from 11.84 to 12.71 cm when sowing was postponed to 1 July. However, ear length did not significantly differ in the varieties

under different sowing dates contrary to the report of [9]. The interaction effect of variety and sowing date on ear length was also not significant.

6. Ear girth

Maximum ear girth was obtained in QPM (11.68 cm) while the minimum was recorded in TZESR-Y (11.63 cm), although such variation was not significant between the varieties. Early sowing (4 May) significantly gave highest ear girth (12.97 cm) but delayed sowing (18 May) significantly reduced ear girth from 12.97 cm to 10.79 cm. The interaction effect between variety and sowing date on ear girth was non-significant.

7. Number of kernels/ear

Kernels/ear differed significantly between the varieties, with QPM having higher kernels/ear (103.80) compared to TZESR-Y which had (81.00). Although sowing date had **no** significant effect on kernels/ear, early sowing (4 and 18 May) gave higher number of kernels/ear. This is contrary to the reports of [9] who reported a significant effect of sowing date on number of kernels/ear. Delayed sowing affected kernels/ear negatively as shown in the corresponding reduction of number of kernels/ear as sowing was delayed to 1 June. This result is expected because apart from having the least number of kernels/ear, plots sown on 1 June also had the least number of ears/plant, indicating the importance of the two yield components on yield.

8. 100-kernel weight

QPM recorded significantly higher 100-kernel weight (21.01 g) compared to TZESR-Y which had 17.68 g. Early (4 May) sowing gave the highest 100-kernel weight value which was not significantly different from the value obtained in plots sown on May 18 and June 1. Similar result was reported by [10] who established a non-significant effect of 1000-kernel weight in his study on planting date in Mashhad (Iran). Delaying sowing to 18 May reduced 100-seed weight by -1.09 g which is in line with the report of [11] who also found that delaying sowing date to mid December resulted in reduction in individual 1000-kernel

weight. The larger grain size associated with early sowing (4 May) might be due to prolonged vegetative and reproductive periods which enabled the plants to accumulate greater dry matter and efficiently utilised it for grain filling. The interaction effect of variety and sowing date was not significant on 100-seed weight, indicating the stability of the trait under varying environmental conditions.

9. Grain yield

The two varieties evaluated in the present study were significantly different in their yielding potentials as QPM recorded higher grain yield (128.80 kg/plot) compared to TZESR-Y (126.11 kg/plot). Early sowing (May 4) gave the highest yield of 128.67 kg/plot compared to when sowing was delayed to 1 July (126.42 kg/plot). This suggests that postponing sowing from 4 May to 1 June resulted in considerable yield reduction in the magnitude of 2.25 kg/plot. Our findings are in line with the reports of [12], [13] and [14] who had noted considerable reduction in yield and yield components when sowing was delayed. This is contrary to the report of the study conducted in South-eastern Iran which associated late sowing (5 August) with highest grain yield compared to the early sowing (5 and 20 July) [15]. Our result also partly agrees with the reports of [14] that delayed sowing resulted in progressive reduction of grain yield, but slightly differs in that their report also indicated that plots sown on April 7 produced higher grain yield which is contrary to our findings. The reason for the differences in our reports might be due to the variations in the locations under which the experiments were conducted. These results seem to suggest that the environmental changes associated with different sowing dates might have modifying effects on the growth and development of maize plants, hence the variation in the yield and yield components. It is likely that the reduction in yield when sowing was postponed to 1 June might be due to the compensatory effect of the yield components. The low yield observed in 1 June sowing might have been compensated for by having larger seeds. The optimum sowing dates resulted into

highest grain yield compared to late sowings (18 May and 1 June) because of higher number of ears/plant and higher number of kernels/ear. Similar observation had been made by [17].

Conclusion

The present study showed that 4th May was associated with favourable weather elements particularly rainfall, temperature, sunshine and radiation reception capacity of the maize plant for optimum growth and partitioning of the dry matter. Due to differences in the way crops respond to different sowing dates, it is necessary to match specific areas and crop varieties with the right sowing date in order to optimise yield. The present study provides farmers and agronomists with useful information for improving maize productivity in Makurdi and other locations with similar condition. It also showed that delaying the sowing to 18 and 1 June would result in significant reduction in growth and development of the yield components and consequently have a negative effect on grain yield in maize production.

234 Table 1. Monthly meteorological data at the Teaching and Research Farm of the University
 235 of Agriculture, Makurdi during 2012 cropping season.

Month	Total Rainfall (mm)	Number of rainy days	Average maximum temperature (⁰ C).	Average minimum temperature (⁰ C).	Relative humidity (%)
January	0.00	0	34.60	18.30	47
February	0.5	1	35.90	22.70	66
March	00	0	38.20	23.50	58
April	143.2	6	35.20	22.80	71
May	145.2	11	31.90	21.40	80
June	160.60	9	.0.60	21.10	83
July	351.9	15	29.80	20.60	85
August	174.3	16	29.40	20.60	85
September	290.7	13	30.20	20.50	84
October	199.1	16	31.00	20.40	83
November	27.3	1	33.40	20.70	79
December	0.0	0	35.50	15.50	53

236 **SOURCE:** Nigerian Air Force Base Meteorological Station, Makurdi.

237 Table 2. Mean squares estimates from analysis of variance of growth and yield parameters of Maize evaluated under different sowing dates at
238 Makurdi.

Source of variation	Df	Plant height (cm)	Number of leaves/plant	Leaf area (cm ²)	Number of ears/plant	Ear length (cm)	Ear girth (cm)	Number of kernels/ear	100-kernel weight (g)	Grain yield (Kg/plot)
Replication	2	135.40	41.933	2813.30	0.500	0.579	5.375	296.70	1.611	1.542
Variety	1	846.0*	12.869**	1669.0NS	0.00NS	74.827**	0.009NS	2329**	49.671**	34.722**
DOS	2	18.50NS	2.20*	973.0NS	0.667NS	1.150NS	7.996*	90.20NS	1774NS	7.6250**
Var x DOS	2	703.20*	1.996*	744.7NS	0.667	1.475NS	0.094NS	87.80NS	0.079NS	2.347**
Error	10	169.80	0.301	461.60	0.833	2.203	1.497	147.10	3.283	0.1250

239 *, **=Significant at 5 and 1% probability level, respectively. NS=Non-significant

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248 Table 3. Main effect of variety and date of sowing on the growth and yield parameters of maize evaluated under different sowing dates at
249 Makurdi.

Cultivar and Date of sowing	Plant height (cm)	Number of leaves/plant	Leaf area (cm ²)	Number of ears/plant	Ear length (cm)	Ear girth (cm)	Number of kernels/plant	100-kernel weight (g)	Yield (kg/plot)
Cultivar									
TZESR-Y	87.70	18.50	227.60	2.00	10.20	11.63	81.00	17.68	126.11
QPM	101.40	20.19	208.30	2.00	14.28	11.68	103.80	21.01	128.89
LSD _(0.05)	13.69	0.577	NS	NS	1.559	NS	12.74	1.903	0.371
Date of sowing									
4 th May	93.0	18.92	208.40	2.00	11.84	12.97	96.50	19.89	128.67
18 th May	96.40	20.04	232.40	2.33	12.17	10.79	91.70	18.80	127.42
1 st June	94.10	19.09	213.0	1.67	12.71	11.21	88.90	19.35	126.42
LSD _(0.05)	NS	0.706	NS	NS	NS	1.57	NS	NS	0.455

250 NS=not significant

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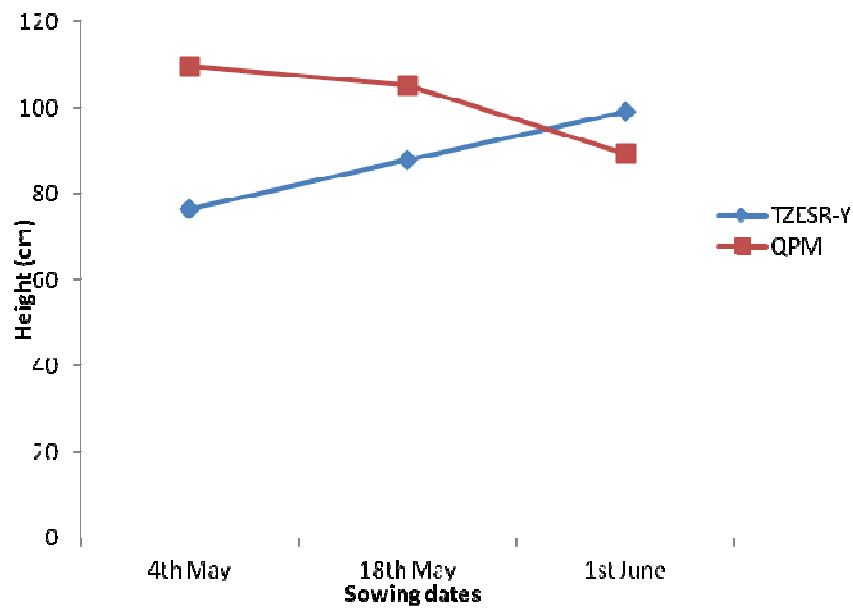
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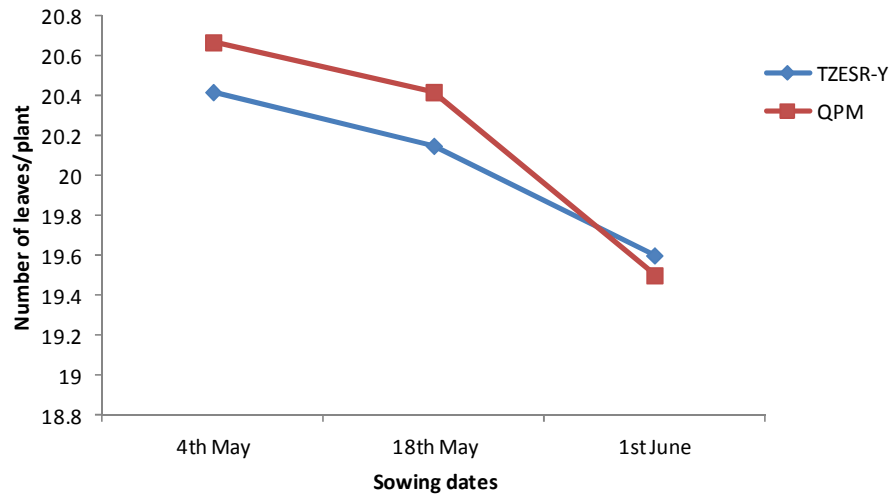
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259 Figure 1. Interaction effect of variety and date of sowing on plant height of two maize varieties

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262 Figure 2. Interaction effect of variety and sowing date on the number of leaves/plant of two maize
263 varieties

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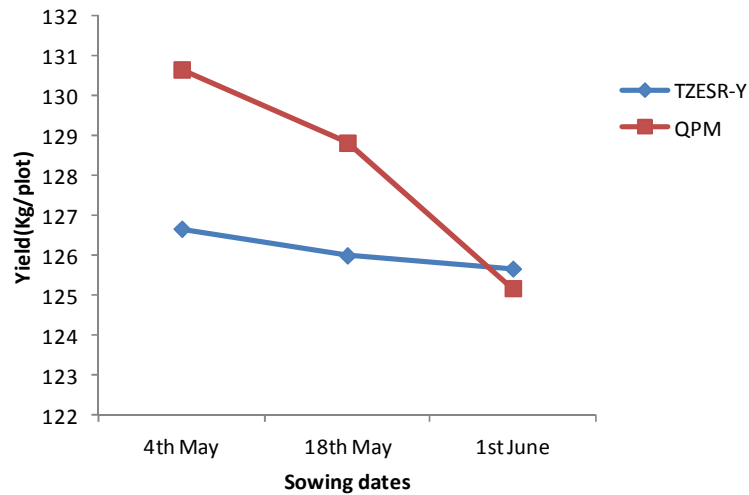


Figure 3. Interaction effect of variety and date of sowing on grain yield of two Maize varieties

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August	174.30	16	29.40	20.60	85
September	290.70	13	30.20	20.50	84
October	199.10	16	31.00	20.40	83
November	27.30	1	33.40	20.70	79
December	0.00	0	35.50	15.50	53

SOURCE: Nigerian Air Force Base Meteorological Station, Makurdi.