Optimum planting dates for four maturity groups of maize varieties grown in the Guinea savanna zone

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SUMMARY

Five maize varieties, comprising NAES EE W SR (extra-early, normal maize (NM)), Dorke SR (early, NM), Abeleehi (intermediate, NM), Obatanpa (intermediate, quality protein maize) and Okomasa (late, NM), were sown at 2-week intervals from mid-May to last week of July in 1993 and 1994 at Nyankpala in the Guinea savanna zone. The varieties were assigned to main-plots and planting dates to sub-plots in the randomized complete block with four replications per year. Effects due to variety and planting date were highly significant ($P < 0.01$) for grain yield. The variety × planting date interaction was not significant for yield. Grain yields averaged over planting dates were 3890, 5252, 5798, 5830, and 5883 kg/ha for the varieties NAES EE W SR, Dorke SR, Abeleehi, Obatanpa and Okomasa, respectively. Grain yields for the six sowing dates averaged over varieties were 5919, 5900, 6232, 4895, 4537 and 4502 kg/ha. Grain yields for the first three planting dates did not differ significantly from each other. Similar results were obtained for the last three planting dates. Yields on the average were 30 per cent higher for the first three planting dates than for the last three. Plant dry matter yield, number of ears per plant and thousand grain weight were the parameters which showed significant positive correlations with grain yield among planting dates. The data showed that (1) for all maturity groups, maize sown from mid-May to mid-June significantly out-yielded the later plantings, (2) the extra-early and early maize varieties were lower yielding than the later varieties, and (3) there was no yield advantage in the late varieties over the intermediate types in the Guinea savanna zone.

RÉSUMÉ

SALLAH, P. Y. K., TWUMASI-AFRIYIE, S. & KASEI, C. N.: *Les dates optima pour quatre groupes de maturité des variétés de maïs cultivées dans la zone savanno-guinéenne.* Les dates optima de plantation et les productivités relatives de groupes de maturité des variétés de maïs (*Zea mays* L.) developpées par l'Institut de Recherche des cultures étaient étudiées dans la zone savanno-guinéenne du Ghana. Cinq variétés de maïs y compris NAES, EE, W, SR [extra-précoce, maïs normal (MN)], Dorke SR (précoce MN), Abeleehi (intermédiaire MN), Obatanpa (intermédiaire, maïs protéique de qualité) et Okomasa (tardive, MN), étaient cultivées à l' intervalle de 2-semaines de la mi-mai à la demière semaine de juillet en 1993 et 1994 à Nyankpala dans la zone savanno-guinéenne. Des variétés étaient assignées aux lots principaux et des dates de plantations aux subdivisions dans un bloc complet choisi au hasard avec quatre reproductions par an. Les effets due à la variété et la date de plantation étaient hautement considérable ($P < 0.01$), pour le rendement de graine. La variété × l'intéraction de date de plantation n' était pas considérable pour le rendement. Les moyennes de rendements de graine sur les dates de plantation étaient 3890, 5252, 5798, 5830, 5883 kg/ha pour les variétés NAES EE W SR, Dorke SR, Abeleehi, Obatanpa et Okomasa respectivement. Les moyennes de rendements de graine pour les six dates de plantations sur les variétés étaient 5919, 5900, 6232, 4895, 4537 et 4502 kg/ha. Les rendements de graine pour les trois premières dates de plantations ne différaient pas considérablement les uns des autres. Des résultats semblables étaient obtenus pour les trois dernières dates de plantations. Les rendements étaient 30 pour cent plus élevés à la moyenne pour les trois premières dates de plantations que pour les trois dernières. Le rendement de matière sèche de plante, nombre d' épis par plante et le poids de mille graines étaient les paramètres qui montraient des corrélations considérablement positives avec le rendement de graine parmi les dates de plantations. Des données montraient que: (1) pour tous les groupes de maturité, les maïs cultivés de mi-mai à mi-juin surpassaient en rendement les plantations de plus tard; (2)

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l'extra-précoce et les variétés précoces de maïs étaient plus bas en rendement que les variétés de plus tard; et (3) il n'y avait aucun avantage en rendement dans les variétés tardives au-dessus des types intermédiaires dans la zone savanno-guinéenne.

Introduction

There has been a rapid expansion in production and utilization of maize in the Guinea savanna zone of Ghana over the past two decades. This increase is partly attributable to the high-yielding, disease-resistant maize varieties and the improved cultural practices extended to farmers.

Maize varieties currently recommended in the Guinea savanna zone are early, intermediate and late which mature in 90, 105 and 120 days after planting, respectively. The varieties include Dorke SR, an early white dent (Badu-Apraku *et al.*, 1992); Abeleehi, an intermediate white dent (Badu-Apraku *et al.*, 1990); Obatanpa, an intermediate, quality protein maize (Twumasi-Afriyie *et al.*, 1992); and Okomasa, a late white dent (GGDP, 1988). These varieties are tolerant to the maize streak virus disease which is endemic in all agro-ecologies in Ghana. In addition, an extra-early variety (NAES EE W SR) which matures in 75-80 days was included in the trials.

Availability of varieties of four different maturity groups would allow the farmer to grow the variety which best meets his needs. On the other hand, if maximum yield is the main consideration, then data on the relative potentials of these maturity groups would be essential in the choice of the appropriate variety. However, current information on the relative productivities of the four maturity groups is limited. Data from maize variety trials conducted in Ghana from 1982 to 1990 showed that the intermediate and late varieties out-yielded the early varieties by 27 to 40 per cent (Sallah, Badu-Apraku & Twumasi-Afriyie, 1995). No significant yield difference was detected between the intermediate and the late maturity groups.

Date of sowing has significant influence on the yield of maize under rain-fed conditions. The current recommended planting period for maize in the Guinea savanna is from the end of May through June (GGDP, 1993). This recommendation, however, needs to be re-examined due to the erratic rainfall in the sub-region over the past decade. The long-term annual rainfall for the Nyankpala-Tamale area averaged 1000 mm with significant negative deviations in the 1970s and 1980s (Kasei, 1990; Kasei & Sallah, 1993). Dry spells of 7-day durations occur once very year in June and twice in every 3 years in July and August (Kasei & Sallah, 1993). It may, therefore, be necessary to manipulate sowing varieties of different maturities to avoid drought during the critical periods of crop development.

The objectives of this study were to determine the relative productivities and optimum planting dates for the extra-early, early, intermediate and late-maturing varieties of maize in the Guinea savanna zone of Ghana.

Materials and methods

Four maturity groups of normal (NM) maize varieties comprising NAES EE W SR (extra-early), Dorke SR (early), Abeleehi (intermediate), Okomasa (late); and Obatanpa (intermediate) quality protein maize (QPM) were evaluated in the study (Table 1). The varieties were grown in 1993 and 1994 on an alfisol at the Nyankpala Agricultural Experiment Station (NAES) of the Crops Research Institute, located in the Guinea Savanna zone of Ghana. (NAES is now known as Savanna Agricultural Research Institute (SARI). The previous crop of the experimental field was soybean (*Glycine max* L.) in 1993 and cowpea (*Vigna unguiculata* L. Walp.) in 1994. The experimental design was a randomized complete block in split-plot arrangement with four replications. The varieties (NAES EE W SR, Dorke SR, Abeleehi, Obatanpa, Okomasa) were randomized in the main plots and the six planting dates were randomized in the sub-plots.

TABLE 1

Characteristics of Five Maize Varieties Evaluated at Six Planting Dates at Nyankpala in 1993 and 1994

Variety	*Maturity group*	*Days to maturity*	*Endosperm type**	*MSV reaction***	*Parental source*
NAES EE W SR	Extra-early	75-80	W,D/F	T	TZEE SR W
Dorke SR	Early	90-95	W,D	T	Pool 16-SR
Abeleehi	Intermediate	105-110	W,D	T	Pop 49-SR
Obatanpa	Intermediate	105-110	W,D/F QPM	T	Pop 63-SR
Okomasa	Late	115-120	W/D	T	Pop 43-SR

* W = White endosperm
D = Dent
F = Flint
QPM = Quality protein maize
** T = Tolerant to maize streak virus.

Planting was done at fortnightly intervals, beginning from the middle of May to the last week of July (Table 2).

The sub-plots consisted of four 5-m rows of each variety with rows spaced at 0.75 m. Hills within the rows were spaced at 35, 40, 45 and 50 cm for extra-early, early, intermediate and late varieties, respectively. Three seeds were hand-planted per hill and thinned at 2 weeks after planting to two plants per hill to obtain target populations of 76000, 66000, 59000 and 53000 plants/ha for NAES EE SR W, Dorke SR, Abeleehi or Obatanpa, and Okomasa, respectively. All plots were disked-ploughed, harrowed once and ridged before planting in 1993. In 1994, planting was on the flat but ridging was done at 4 weeks after planting.

TABLE 2

Planting Dates Used in the Evaluation of Four Maturity Groups of Maize Varieties at Nyankpala in 1993 and 1994

Planting number	*Date of planting*		
	Month	*1993*	*1994*
1	May	14	17
2	May	28	31
3	June	11	14
4	June	25	28
5	July	9	12
6	July	23	25

Pre-emergence herbicide weed control was practised but supplemental hoeing was also done when necessary to keep plots free from weeds. Compound fertilizer N-P-K (20-20-0) was hand-applied 10 days after planting at 45 kg N/ha and 45 kg P_2O_5/ha and top-dressed with urea at 45 kg N/ha at 3 to 4 weeks after planting.

Data were recorded on the two middle rows of a sub-plot for grain and stover yields, days to 50 per cent silk emergence, plant height, stem and root lodging, and ear traits. Grain yield was expressed in kg/ha at 15 per cent grain moisture. Five cobs were chosen at random from each plot to estimate 1000-seed weight at 15 per cent grain moisture. Statistical analyses were performed according to split-plot arrangement (Steel & Torie, 1980) across the 2 years. A mixed model was used with years and planting dates as random effects and varieties as fixed effects. Simple correlation coefficients between grain yield and other parameters were calculated over sowing dates by using mean grain yield as the y variable and the other parameters as the x variable.

Results and discussion

The growing seasons in 1993 and 1994 had periods of severe moisture stress in May, July and August. However, the total annual rainfall was 932 mm in

1993 and 1155 mm in 1994. Thus, rainfall was approximately 7 per cent below average in 1993 and 16 per cent above average in 1994. Rainfall distribution at Nyankpala from April to October during the experimental period is presented in Table 3. In 1994, 55 per cent of the total rain during the year fell from mid-August through to October, resulting in water-logging of the experimental plots for several hours after each rain. Crop growth and development in the different plantings were, therefore, adversely affected at one stage or another by moisture stress.

The analyses of variance are not presented but results showed that effects due to variety and planting date were highly significant ($P<0.01$) for grain yield. The variety × planting date interaction effect for yield was not significant. Consequently, the nature of the effects of time of planting on the yields of the varieties can be deduced from the main treatment effects.

Mean grain yields across years and planting dates for the five varieties are shown in Fig. 1. Yields ranged from 3890 kg/ha for the extra-early variety (NAES EE W SR) to 5883 kg/ha for the late variety (Okomasa). There was no significant difference between the yields of the intermediate normal maize (Abeleehi) and the intermediate quality protein maize (Obatanpa) varieties. Similarly, the yield difference between the intermediate varieties and the late variety was not significant. The intermediate and the late varieties significantly out-yielded the early variety by 11 per cent and the extra-early variety by 50 per cent.

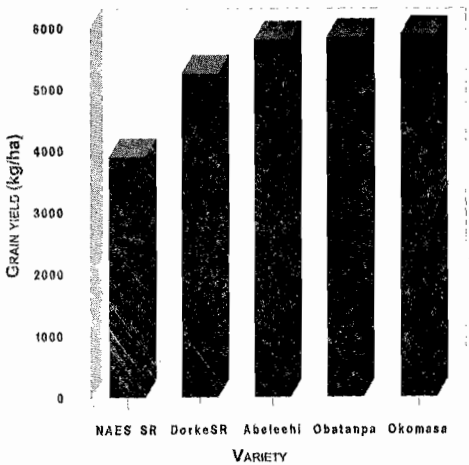

Fig. 1. Grain yield of five maize varieties evaluated at six planting dates at Nyankpala in 1993 and 1994

TABLE 3

Weekly Rainfall Distribution Between April and October at Nyankpala in 1993 and 1994

		Rainfall (mm)				
Month	*Year*	*Week 1*	*Week 2*	*Week 3*	*Week 4*	*Total*
Apr	1993	0.0	0.9	14.2	55.0	70.1
	1994	0.0	0.0	38.5	3.9	42.4
May	1993	49.3	0.0	60.9	17.8	128.0
	1994	31.3	44.7	0.0	102.1	178.1
Jun	1993	7.5	50.4	28.0	30.4	116.3
	1994	48.4	22.4	37.3	28.6	136.7
Jul	1993	31.7	22.4	31.0	46.3	131.4
	1994	5.8	32.0	63.8	8.8	110.4
Aug	1993	31.5	21.5	13.8	66.3	133.1
	1994	5.9	3.6	57.2	153.8	220.5
Sep	1993	67.6	22.0	66.8	75.1	231.5
	1994	1.0	61.8	37.9	49.9	150.6
Oct	1993	16.8	13.2	55.5	3.2	88.7
	1994	52.1	12.3	108.4	91.7	264.5

The length of the growing season in the Guinea savanna zone is estimated to be between 126 and 150 days (Kasei & Afuakwa, 1991) and this will support all maturity groups. However, the yield data for the five varieties showed that intermediate-to-late varieties have the highest yield potential and should be planted in the Guinea savanna zone for high grain yields. This observation is in close agreement with data from maize variety trials conducted in Ghana from 1982 to 1990 (Sallah, Badu-Apraku & Twumasi-Afriyie, 1995).

The two intermediate varieties included

in the study were different in terms of quality of protein in the grain. Both Abeleehi and Obatanpa have approximately 10 per cent grain protein but the levels of lysine and tryptophan in Obatanpa are twice those in Abeleehi (Ahenkora *et al.*, 1994). The data showed that yield was not sacrificed for improved protein quality in the development of the quality protein maize variety. This observation has an important implication for maize breeding programmes. That is, quality protein maize germplasm can be used to develop varieties that are as productive as those developed from normal maize germplasm.

The early variety yielded significantly lower than either the intermediate or the late variety and the extra-early variety produced the lowest grain yield. These yield differences are attributed to differences in the growth cycles of the varieties. The later maturing maize varieties have higher yield potentials and normally out-yield the earlier varieties (GGDP, 1993). This yield advantage of the later maturing varieties is attributed to more effective utilization of the long growing season for growth and dry matter accumulation, including grain filling.

Though the later maturing varieties had yield superiority, yield levels of 4-5 t/ha showed that the extra-early and early varieties are highly productive. The extra-early and early varieties are important in terms of food security to the farmer. Because of their earliness, these varieties can be harvested earlier as green maize or grain to fill the hunger gap.

The effect of time of planting on grain yields in the four maturity groups is illustrated in Fig. 2. The mean yield across years, varieties and planting dates was 5330 kg/ha. The yields for the planting dates, expressed as a percentage of the mean yield, were 11 for dates 1 and 2, 17 for date 3 above the mean; 8, 15 and 16 below the mean for dates 4, 5 and 6, respectively. There was no significant difference in yield among the first three planting dates (early plantings), suggesting that the growing conditions were similar for these plantings. Similarly, yield differences between the 4th, 5th and 6th planting dates (late plantings) were small and, in

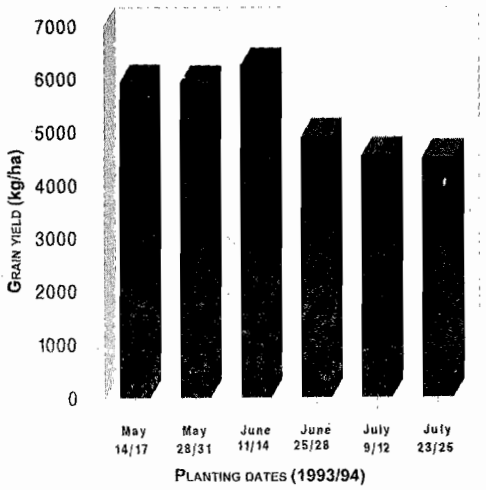

Fig. 2. Effects of time planting on grain yields of five maize varieties at Nyankpala in 1993 and 1994

general, not significant. Yields, on the average, were 30 per cent higher for the early plantings compared to the late plantings. The higher insolation and more favourable soil moisture regimes observed during the early part of the season probably enhanced crop productivity in the early plantings. In contrast, the frequent overcasts and heavy rains which resulted in water-logging later in the season might have reduced yields in the late plantings.

Data for the six planting dates clearly indicated that it was more advantageous to plant maize early than late in the season. Maize sowed from mid-May to mid-June yielded 30 per cent higher than later plantings irrespective of the maturity period. The current recommendation for planting maize in the Guinea savanna zone of Ghana is from the end of May to end of June (GGDP, 1993). The data suggest a need to modify this recommendation to promote early planting for higher yields in the Guinea savanna zone.

Phenotypic correlation coefficients between grain yield and eight parameters over the six sowing dates are presented in Table 4. Plant dry matter yield, 1000-grain weight and number of ears per

TABLE 4

Phenotypic Correlations for Grain Yield with Eight Parameters of Maize Varieties Evaluated at Six Planting Dates in the Guinea Savanna

Trait	*Correlation*
Plant dry yield	0.73*
Days to 50 per cent silk emergence	-0.01
Plant height	0.32
Ear rating	-0.59
Thousand grain weight	0.82*
Root lodging	0.49
Stalk lodging	-0.28
Ears per plant	0.99**

* Positive correlation

plant had significant positive correlations with grain yield. Ears per plant showed the highest correlation with grain yield. Correlation between yield and ear acceptability rating, though not significant, was negative.

Maize is produced for direct human consumption and for industrial use in Ghana. In both cases, grain quality is an important consideration. Harvesting and processing of grain during the rains might have serious consequencies on grain quality. It is suggested that future research should investigate the effect of time of sowing varieties of the different maturities on quality of the grain harvested.

Conclusion

Five open-pollinated maize varieties with varying maturity periods were sown at six different planting dates from mid-May to last week of July at Nyankpala in 1993 and 1994. The objectives were to determine the relative productivity and optimum planting dates for each maturity group in the Guinea savanna zone. Grain yields averaged over years and planting dates were 3890, 5252, 5798, 5830, 5883 kg/ha for NAES EE W SR (extra-early), Dorke SR (early), Abeleehi (intermediate), Obatanpa (intermediate, QPM) and Okomasa (late), respectively. Mean yields for the six sowing dates were 5919, 5900, 6232, 4895, 4537 and 4502 kg/ha. The data showed that: (1) maize sown from mid-May to mid-June produced more grain than later plantings regardless of the maturity period; (2) the extra-early and early varieties were lower in yield than the later varieties; and (3) there was no yield advantage in the late varieties over the intermediate types in the Guinea savanna zone.

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