Studies on performance of some open-pollinated maize cultivars in the Guinea savanna. I. Effects of plant density, nitrogen level, and their interactions on yield

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SUMMARY

Plant density and nitrogen (N) fertilizer responses of one local and three improved open-pollinated cultivars of maize (*Zea mays* L.) developed in different eras of maize breeding were studied on sandy-loam Alfisols in the Guinea savanna zone of Ghana in 1992 and 1993. A split-plot design was used in which plant densities (30 000, 50 000, 70 000 plants/ha) were the main-plots and 12 combinations of N fertilizer levels (0, 80, 160 kg N/ha) and cultivars (Local, Composite 4, Dobidi, Okomasa) were the sub-plots in four replicates. A cross location analysis for grain yield showed environment, plant density, nitrogen and cultivar effects were highly significant ($P<0.01$). The environment × cultivar, environment × nitrogen, density × nitrogen, and nitrogen × cultivar interactions were also significant ($P<0.05$). The density × cultivar interaction and all second- and third-order interactions involving the three factors were not significant. The mean yields were 3.08 and 4.51 t/ha for the local and the improved cultivars, respectively. For all cultivars, yields increased by 10 per cent after each 20 000 plants/ha increase in plant density. Similar N response patterns were observed for all the improved cultivars. Estimated biological optimum N rates were 154 kg N/ha for the local cultivar and 183 kg N/ha for the improved cultivars. Grain yields at the optimum N levels were 3.50 t/ha for the local and 5.53 t/ha for the improved cultivars. The greatest yield response to N was observed at 80 kg N/ha for all cultivars. The data showed that (1) improved cultivars out-yielded the local cultivar at low as well as at higher levels of soil fertility, (2) breeding did not result in varieties that required higher N rates to produce high yields, and (3) the data support the current N fertilizer recommendations for the Guinea savanna zone of Ghana.

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RÉSUMÉ

SALLAH, P. Y. K., TWUMASI-AFRIYIE, S. & FRIMPONG-MANSO, P. P.: *Des études sur la performance de quelques variétés de maïs pollinisées-ouvertément dans la Savane-guinéenne. I. Les effets de la densité de plante, le niveau d' azote et leurs intéractions sur le rendement.* La densité de plante et les réponses d'engrais d'azote (N) d'une variété locale et de trois variétés améliorées de maïs (*Zea mays* L.) pollinisées-ouvertement développées dans les ères différentes de la reproduction de maïs étaient étudiées sur les Alfisols terreau-sableux dans la zone Savano-guinéenne du Ghana en 1992 et 1993. Un dessin de lot-divisé était utilisé en quelque densités (30 000, 50 000, 70 000 plantes/ha) de plantes étaient les lots principaux et douze combinaisons des niveaux (0, 80, 160 kg N/ha) d' engrais d' N et les variétés (Local, Composite 4, Dobidi, Okomasa) étaient les sous-lots en quatre répliques. Une analyse à travers l' emplacement pour le rendement de grain montrait que les effets d' environment, de densité de plante, d'azote et de variété étaient hautement considérables ($P<0.01$). Les intéraction de l' environment × variété, environment × azote, densité × azote et azote × variété étaient également considérables ($P< 0.05$). L' intéraction de densité × variété et tous les intéractions de second - et troisiéme-ordre entraînant les trois facteurs n' étaient pas considérables. La moyenne des rendements étaient 3.08 et 4.51 t/ha pour les variétés locales et améliorées respectivement. Pour toutes variétés les rendements augmentaient par 10 pour cent suivant chaque 20 000 plantes/ha d' augmentation en densité de plante. Les modéles semblables de réponse d' N étaient observés pour toutes les variétés améliorées. Les proportions optima d' N biologique estimées étaient 154 kg N/ha pour la variété locale et 183 kg N/ha pour les variétés améliorées. Les rendements de grain aux niveaux d' N optimum étaient 3.50 t/ha pour la locale et 5.53 t/ha pour les variétés améliorées. La plus grande réponse de rendement à l'N était observée à 80 kg N/ha pour toutes les variétés. Les données montraient que (1) les variétés améliorées surpassaient en rendement la variété locale à faible ainsi qu' à plus fort niveau de fertilité de sol, (2) La reproduction ne résultait pas dans les variétés qui exigeaient des proportions plus élevées d' N pour produire des rendements élevées, et (3) les données soutiennent les récommendations courantes d' engrais N pour la zone Savano-guinéenne du Ghana.

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Introduction

Maize *(Zea mays* L.*)* is an important cereal under rain-fed agriculture in Ghana. Since the early 1970s, the Crops Research Institute (CRI) has released several high-yielding and disease-resistant maize varieties of different maturities to meet the needs of farmers in all the agro-ecologies (Agble, 1981; GGDP, 1988; Badu-Apraku *et al.*, 1990, 1992; Twumasi-Afriyie *et al.*, 1992; Sallah *et al.*, 1993). Prominent among these varieties are Composite 4, La Posta CRI, Dobidi, and Okomasa, all late-maturing varieties released between 1972 and 1988. In addition, improved crop management practices were developed for the varieties for extension to farmers (GGDP, 1993). Although about 50 per cent of the maize area is planted to improved varieties (GGDP, 1993), grain yields in the Guinea savanna are low, averaging about 1.7 t/ha ((PPMED, 1996).

Two important agronomic practices for maximizing yields are adoption of optimum plant densities and nitrogenous fertilizer rates. Maize growers in the Guinea savanna need, therefore, to adopt optimal N rates and plant populations if maize productivity per unit area is to be increased over the present low level. It is equally important that breeding programmes should aim at improving varietal response to plant density and nitrogen fertilization. To effectively do this, there is the need to determine the effects of past breeding efforts on response to these factors.

Several studies have reported plant density and N fertilizer responses in maize varieties adapted to temperate environments (Carlone & Russell, 1987; Fakorede & Mock, 1982; Lang, Pendleton & Dugan, 1956; Mooers, 1933). Carlone & Russel (1987) evaluated four composites and 24 hybrids representing cultivars of different eras from the US Corn Belt at three plant densities and four N levels. They observed that the effects of densities and N levels were not independent, and that a cultivar had a specific density × N level combination for maximum grain yield. Similarly, Mooers (1933) evaluated four composites under six densities and two N levels and concluded that individual cultivars produced optimum yields under unique density × N level combinations. Significant density × variety, N level × variety, density × N level, and density × N level × variety interactions were reported in all these studies. However, little information is available for maize varieties adapted to the lowland tropics.

Maize breeding research was initiated in the mid-1950s in Ghana (Agble, 1981). J. McEwen, working in Northern Ghana, released two improved early-maturing yellow varieties between 1954 and 1961. Dr W. K. Agble, leading a team of researchers, initiated the maize breeding programme at Kwadaso in 1956. The team developed the varieties named Ghana Synthetic 1, 2 and 3 (GS 1, GS 2, GS 3) from inbred lines. These varieties showed 30-100 per cent yield advantage over local cultivars. In 1972, Dr M. K. Akposoe of the Crops Research Institute released the late varieties, Composite 4 and La Posta CRI (Agble, 1981). More recently, a team of breeders at the Crops Research Institute released Dobidi (1984) and Okomasa (1988), both late-maturing varieties (Sallah *et al.*, 1993; GGDP, 1988). These late-maturing maize varieties have been widely adopted by farmers in Ghana (GGDP, 1993). Hence, the effects of breeding on the density and N responses in improved maize varieties in Ghana can be determined from evaluations of the varieties developed in the different years.

The objectives of this study were as follows: (1) determine the nature of grain yield responses to increasing plant density and N fertilization in four open-pollinated maize cultivars, representing local and improved cultivars grown in Ghana since 1972; (2) examine all main effects, primary and secondary interactions for yield; and (3) determine the effects of breeding on the density and N fertilizer responses of the improved cultivars in the Guinea savanna zone of Ghana.

Materials and methods

Three improved cultivars, namely Composite 4, Dobidi, and Okomasa, all late-maturing varieties, and a local cultivar collected from a farmer close to the test site were evaluated at three plant densities and three levels of N fertilizer. Composite 4, Dobidi and Okomasa were released for commercial production in 1972, 1984 and 1988, respectively (Agble, 1981; GGDP, 1988; Sallah *et al.*, 1993). The local cultivar represented the unimproved landrace variety grown by farmers in the area before improved varieties were introduced. Table 1 shows some characteristics of these varieties, including their genetic background.

The experiments were conducted in 1992 and 1993 on an Alfisol at Nyankpala and Damongo in the Guinea savanna zone of Ghana. The previous crop at the experimental fields in each year at both sites was cowpea (*Vigna unguiculata* L. Walp). In both years, the soils of the fields were characterized for some physical and chemical properties before land preparation (Table 2). The fields were disked-ploughed and harrowed once. Phosphorus and potassium were broadcast over all the plots at 60 kg P_2O_5/ha and 30 kg K_2O/ha as single superphosphate and muriate of potash, respectively. The plots were then ridged using a tractor before planting.

The experiment was a complete factorial in a split-plot design with four replications. Plant densities (30 000, 50 000, 70 000 plants/ha) were randomized in the main plots and the N level (0, 80, 160 kg N/ha) × cultivar combinations were randomized in the sub-plots. The sub-plots consisted of four 5-m rows of each cultivar. Rows were spaced at 0.75 m. Three seeds were planted within the row at 0.88, 0.53, and 0.38 m to ensure the target densities of 30 000, 50 000, and 70 000 plants/ha were obtained after thinning, respectively. Pre-emergence chemical weed control was practised, and consisted of an application of a combination of Pendimethalin [N - (1-ethylpropyl) - 3, 4 - dimethyl - 2, 6 - dinitrobenzenamine] and Gesaprim [2 - chloro - 4 - (ethylamino) - 6 - (isopropylamino) - s - triazine] at 3 and 2 l/ha, respectively, after planting. However, supplemental hoeing was also done when necessary to keep plots free of weeds. Seedlings were thinned at 2 weeks after planting to two plants per hill for the desired population densities. The source of N was urea and point-applications of the required N were made 10 days after planting to maize hills within the plot. The urea was buried immediately after application to avoid loss due to volatilization.

TABLE 1

Characteristics of Four Late-maturing Maize Varieties Evaluated at Nine Plant Density × N Level Treatments at Nyankpala and Damongo in 1992 and 1993

Variety name	*Origin*	*Parental source*	*Grain type+*	*Year released*	*Maize streak virus++*
Composite 4	CRI	CRI Pop.	W, D	1972	S
Dobidi	CRI	CIMMYT Pop. 43	W, D	1984	S
Okomasa	CRI	CIMMYT Pop. 43	W, D	1988	T
Local	Farmer	Landrace	Segre-gating W,Y,P/F	-	S

+ W = White, D = Dent, Y = Yellow, P = Purple, F = Flint.
++ S = Susceptible reaction to maize streak virus disease (MSV)
T = Tolerant reaction to MSV

Data were recorded on the two middle rows of a sub-plot for grain yield, stover dry yield, days to 50 per cent silking, plant and ear heights, per cent total lodging, percent grain moisture, ears/plant, ear acceptability rating, and one-thousand grain weight. Ears were rated for acceptability on 1-5 scale with 1= good ear and 5 = poor ear, based on size and uniformity of ears, kernel arrangement, and grain filling on the ear. Grain and stover yields were expressed in kg/ha at 15 per cent moisture. Five cobs were chosen at random from each sub-plot to estimate one-thousand grain weight at 15 per cent grain moisture. A combined analysis involving data across the two locations in the 2 years was carried out. A mixed model was used with environments

TABLE 2

Physical and Chemical Properties of the Soils of the Experimental Fields at the Two Sites in 2 Years

Soil properties	*Nyankpala*		*Damongo*	
	1992	*1993*	*1992*	*1993*
Particle size distribution (%)				
Sand	76.1	75.1	79.6	78.6
Silt	18.6	19.6	14.9	15.9
Clay	5.3	5.3	5.5	5.5
*p*H	5.3	5.5	5.5	5.6
Organic carbon (%)	0.43	0.45	0.45	0.47
Available N (%)	0.04	0.04	0.04	0.04
P (mg/kg)	5.29	3.29	10.78	18.88
K (mg/kg)	82.75	56.39	90.50	104.24
Mg (mg/kg)	50.33	35.57	60.00	56.10
Ca (mg/kg)	-	173.92	-	225.18

(year-locations) being random; varieties, densities, and N levels as fixed. Orthogonal polynomials were used to calculate linear and quadratic effects of densities, N levels and their interactions, as well as regression coefficients for plant densities and N levels (Little & Hills, 1977). The regression coefficients were used to determine the yield response of each variety to increasing plant density and N fertilizer application.

Results

Table 2 shows details of the physical and chemical properties of the soils at the experimental fields in 1992 and 1993. Particle size distributions showed predominance of sand over silt and clay in line with a sandy-loam soil type with *p*H of 5.3 to 5.6. Organic C and available N in the soils averaged 0.45 and 0.04 per cent, respectively. Phosphorus and K contents were in the range of 3.3 to 18.9 mg/kg and 56.3 to 104.2 mg/kg, respectively.

The growing seasons at the two sites in the 2 years had periods of severe moisture stress which affected general plant growth and development during the pre-flowering stage. Erratic rainfall during flowering and the post-pollination periods reduced yields in both years. An early drought after planting at Damongo in 1993 resulted in poor plant establishment which adversely affected the density treatments. Consequently, data from this environment (year-location) were highly variable and were not included in the analyses. The overall mean yields were 3.67 t/ha at Nyankpala in 1992, 4.82 t/ha at Damongo in 1992, and 3.96 t/ha at Nyankpala in 1993.

Table 3 shows the analysis of variance, combined over the three environments (E), for grain yield. Differences among plant densities (D) for grain yield, averaged over environments, N levels and varieties were significant ($P<0.05$). Yields increased by 9.8 per cent from 30 000 to 50 000 plants/ha and by 10.4 per cent from 50 000 to 70 000 plants/ha (Fig. 1). The linear response to density was highly significant ($P<0.01$) but the quadratic component was not significant (Table 3). The E × D interaction was also not significant.

Differences among N levels for grain yield were highly significant (Table 3). Yields increased by 35.2 per cent from zero fertilizer N (zero N) to 80 kg N/ha and by 10.6 per cent from 80 to 160 kg N/ha (Fig. 2). Consequently, both the linear and quadratic components of the response to N were highly significant (Table 3).

The E × N and D× N interactions were highly significant (Table 3). The linear × linear and the linear × quadratic components of the interaction between densities and N levels were highly significant ($P<0.01$), whereas the other components were not significant. The E × D × N interaction was not significant.

Fig. 1 illustrates the effects of varying plant populations and fertilizer N application rates on grain yields of the late-maturing maize cultivars. At zero N, no significant yield increase was observed when plant population was increased from 30 000 to 70 000 plants/ha. In contrast, the yield increase from 30 000 to 50 000 plants/ha was

TABLE 3

Combined Analysis of Variance for Grain Yield (kg/ha) for Four Maize Cultivars Evaluated at Three Densities and Three Nitrogen Levels in 1992 and 1993

Source of variation	*df*		*Mean square*
Replication	3		2803183
Reps. within environment (E)	8		15300573*
Density (D)	2		23080037*
Linear (l)		1	46067201**
Quadratic (q)		1	92873
E × Density	4		4110232
Error (a)	18		4201931
Nitrogen (N)	2		98101458**
N_l		1	185253980**
N_q		1	10948935**
E × N	4		3322411**
D × N	4		8095480**
$D_l \times N_l$		1	26406300**
$D_l \times Nq$		1	3565488**
$N_l \times Dq$		1	1762699
Dq × Nq		1	647514
E × D × N	8		593660
Cultivar (V)	3		55564958**
Local vs. improved cultivars		1	165263880**
Residual		2	1430994
E × V	6		7563814**
D × V	6		1206328
E × D × V	12		256827
N × V	6		1422490*
E × N × V	12		530119
D × N × V	12		633880
E × D × N × V	24		514254
Error (b)	297		587014

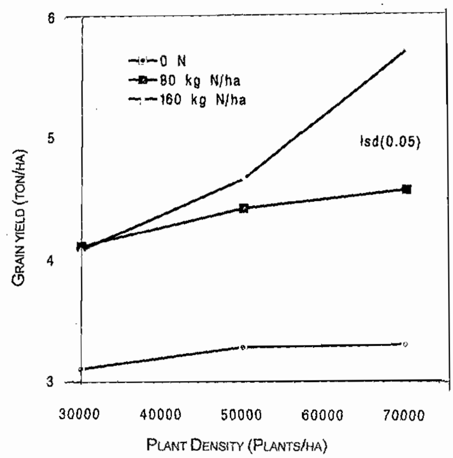

Fig. 1. Grain yield responses of late-maturing maize cultivars to plant population at three nitrogen levels.

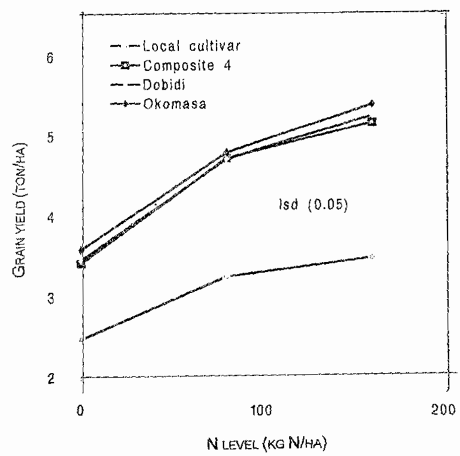

Fig. 2. Grain yield responses of four late-maturing maize cultivars to increasing rates of nitrogen fertilizer.

significant at 80 and 160 kg N/ha. However, further increase in plant population resulted in significant yield increase only at 160 kg N/ha.

Differences among the cultivars (V) for grain yield were highly significant (Table 3). However, these significant differences were mainly due to differences between the local cultivar, on one hand, and the improved cultivars (Composite 4, Dobidi, and Okomasa) on the other (Table 3). The improved cultivars, on the average, out-yielded the local cultivar by 46.4 per cent (Table 4). Yield differences among the improved cultivars were not significant.

The E × V interaction was highly significant ($P<0.01$), the N × V interaction was significant ($P<0.05$), but the D × V interaction was not significant for yield (Table 3). The D × N × V, E × D × V, and E × N × V interactions were all not significant (Table 3). The third-order interaction, E × D × N × V was also not significant.

The significant N × V interaction showed that neither the variety nor the N effect should be interpreted independently. All improved cultivars significantly out-yielded the local variety at all N-fertilizer levels (Fig. 2). The yield increases from 0 to 80 kg N/ha were 0.79, 1.30, 1.25, and 1.20 t/ha for the local cultivar, Composite 4, Dobidi, and Okomasa, respectively. Similarly, the yield increases from 80 to 160 kg N/ha for the four cultivars were 0.23, 0.45, 0.56, and 0.61 t/ha, respectively.

TABLE 4

Mean Variety Yields, Linear and Quadratic Regression Coefficients of Grain Yield on N Level for Each Variety and Across Varieties

Variety	*Grain yield*	*Regression coefficients+* b_l	b_q
	kg/ha		
Local	3080	13.2988**	-0.0432
Composite 4	4442	21.8380**	-0.0674*
Dobidi	4483	20.0025**	-0.0543*
Okomasa	4599	18.7544**	-0.0462
Mean	4152	18.4750**	-0.0528*
Standard error	74	-	-

+ b_l = linear regression coefficient
bq = quadratic regression coefficient
*, ** = significant at 5 and 1 per cent probability levels, respectively.

Table 4 shows the linear and quadratic regression coefficients of grain yield on N level for each variety. Linear responses to increasing N application were significant for all cultivars. The quadratic responses were negative for all cultivars, but were significant only for Composite 4 and Dobidi.

The significant N × V interaction indicated that a level of N fertilizer application is optimum for a cultivar's grain yield performance. However, this significant interaction was due to the magnitude of the differential response between the local and the improved cultivars at all levels of applied N (Fig. 2). Consequently, the following quadratic regression equations were used to estimate the optimum N level and grain yield for the local versus improved varieties:

$$\text{Yield}_{\text{(Local cultivar)}} = 2477.2 + 13.2988N - 0.0432N^2$$
$$\text{Yield}_{\text{(Improved cultivar)}} = 3489.7 + 20.1934N - 0.0560N^2$$

where Yield is grain yield in kg/ha and N is the nitrogen fertilizer rate in kg N/ha.

Fig. 3 illustrates the predicted yield response to applied N for each varietal type based on these equations. Predicted grain yields increased from 0 to 160 kg N/ha and declined thereafter for the local cultivar. Similarly, yields increased up to 180 kg N/ha before declining for the improved cultivars. The biological optimum N levels for maximum yields were 154 kg N/ha for the local cultivar and 183 kg N/ha for the improved cultivars. The yield at the optimum N level was 3.50 and 5.33 t/ha for the local and the improved cultivars, respectively. The plant populations at the optimum N levels required for these yields were 68 500 plants/ha for the local cultivar and 72 000 plants/ha for the improved cultivars.

Table 5 indicates mean values for the other agronomic traits for each cultivar averaged over densities and N levels. Differences among the cultivars were highly significant for all traits except number of ears per plant and stover dry weight.

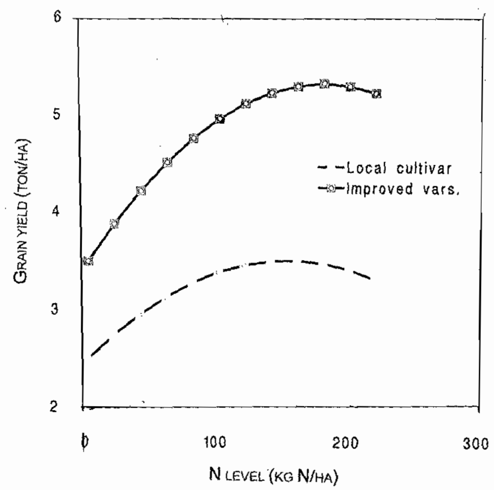

Fig. 3. Predicted grain yield responses of local and improved maize cultivars to applied nitrogen fertilizer.

Mean values for days to 50 per cent silk emergence and grain moisture content at harvest showed that all the four cultivars fit the late maturity group, although the local variety tended to silk earlier than the improved cultivars. Dobidi was similar to Okomasa in all traits except for its higher one-thousand grain weight. Composite 4 had the tallest plant-type and ear placement but was similar to the other improved cultivars in most other traits. In general, the local variety lodged more severely, had a lower grain weight and ear acceptability rating than the improved varieties.

Table 6 shows simple correlation coefficients between grain yield and nine other parameters. These correlations were calculated by using mean values of grain yield at each N × V combination as the dependent variable (Y) and means of the other parameters as the independent variable (X). Ear rating, grain weight, ears per plant, and total lodging had highly significant (P<0.01) correlations with yield. Although stover dry weight did not differ among the varieties, it had a significant (P<0.05) correlation with grain yield. Ear rating and total lodging were negatively correlated with yield whereas grain weight, ears per plant, and stover weight were positively correlated with yield. Ear height, plant height, and mid-silk showed the least relationship with grain yield.

TABLE 5

Means for Nine Plant and Ear Traits of Four Maize Varieties Averaged over Densities and N Levels

Traits	*Varieties* Local	*Comp. 4*	*Dobidi*	*Okomasa*	*SE*+
Mid-silk (days)	62	64	64	63	0.4
Plant height (cm)	187	206	185	183	2.5
Ear height (cm)	94	113	92	90	1.9
Grain moisture (%)	14.9	15.8	16.9	16.0	0.5
Ear rating ++	2.8	2.7	2.5	2.6	0.09
Ears per plant	0.93	0.95	0.92	0.94	ns
One-thousand grain weight (g)	291	308	321	304	5.6
Stover weight (kg/ha)	5399	5997	5779	5951	ns
Total lodging (%)	35.2	27.5	23.8	22.9	1.9

+ = standard error
++ = ear acceptability rating, 1 = good ear and 5 = poor ear
ns = not significant at 5 per cent probability level.

Discussion

The relatively high maize yields, averaging 3.24 t/ha, observed at zero fertilizer N was attributed to high initial soil fertility at the experimental sites. The organic matter content of the soils averaged 0.45 per cent with 0.04 per cent available N. Nitrogen contributions from the preceding legume crops through N fixation account for the high initial soil fertility and the resulting high yield without N application. The data support the beneficial consequences of legume-maize rotations on maize yields reported in the Guinea savanna zone of Ghana (Schmidt & Frey, 1988; 1992).

The density × cultivar interaction was not significant for yield, implying that the cultivars exhibited similar yield responses to increasing plant density. The significant density × nitrogen interaction showed that adoption of higher plant densities requires application of higher N rates for maximum yields. Hence, it would not be beneficial to increase the plant population beyond 30 000 plants/ha at zero N and 50 000 plants/ha at 80 kg N/ha. At higher N levels, however, the varieties would be expected to respond

TABLE 6

Phenotypic Correlations for Grain Yield with Nine Plant and Ear Traits of Four Maize Varieties Evaluated under Nine Plant Density× N Level Treatments

Traits	*Correlation coefficient*
Mid-silk (days)	0.15
Plant height (cm)	0.23
Ear height (cm)	0.14
Grain moisture (%)	0.39
Ear rating (1-5 score)	-0.88 **
One-thousand grain weight (g)	0.80 **
Ears per plant (number)	0.77 **
Stover weight (kg/ha)	0.58 *
Total lodging (%)	-0.89 **

to higher plant populations.

The estimated optimum N application rates for maximum grain yield were 154 kg N/ha for the local cultivar and 183 kg N/ha for the improved cultivars. The corresponding yields of 3.50 and 5.33 t/ha were indicative of the yield potentials of each cultivar under improved soil fertility. The local cultivar had the lowest yield response to N and was more susceptible to lodging. This confirms the common knowledge that very low yield benefits accrue from growing local maize cultivars in fertile environments. The common optimum N rate for the improved cultivars implied that breeding did not develop varieties which required higher levels of N application to produce high grain yields. Similarly, the response to increasing plant density did not differ among the improved cultivars, indicating breeding had no significant influence on the response to this factor in the cultivars.

The greatest response to N application was obtained from 0 to 80 kg N/ha for the three improved cultivars. For example, yield increases for Okomasa were 1.2 and 0.6 t/ha grain after applications of 80 and 160 kg N/ha, respectively. Yield increases beyond 90 kg N/ha rate were relatively small and rendered the additional fertilizer application uneconomical. Secondly, the potential danger of contaminating water resources through excessive application of fertilizers is a major concern. The present data, as well as these socioeconomic considerations, support the 90 kg N/ha recommended for maize production in the Guinea savanna zone of Ghana (GGDP, 1993).

The local cultivar in the study represented two unimproved cultivars grown by farmers at Nyankpala and Damongo. The local cultivars yielded significantly lower than the improved cultivars at all N levels. This observation probably indicates that the local cultivars were less efficient in uptake and utilization of available N. Thus, improved cultivars out-yielded the local cultivar at low and at higher levels of soil fertility. The results did not support the common notion that unimproved local cultivars are more productive than improved germplasm under low soil fertility.

Highly significant correlations were observed between grain yield and ear rating, grain weight, number of ears per plant, and total lodging. The high correlations support the practice of improving yield potential in maize via intense selection for these traits, which has been adopted by most breeding programmes. In contrast, the low correlations between yield and plant or ear height and days to 50 per cent silking showed that, within the same maturity group, height or days to flowering bear little relationship with grain yield.

It was concluded from the data that (1) all improved maize cultivars out-yielded the local cultivar at low as well as at high levels of soil fertility, (2) breeding evolved varieties with similar N response patterns, and (3) the current 90 kg N/ha be recommended for maize production in the Guinea savanna zone of Ghana.

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