Ife Journal of Agriculture, Vol. 18, Nos 1 & 2 1996

Effects of Nitrogen and Stand Density on Grain Yield Performance of Hybrid Maize (*Zea Mays* L.) in a Southwest Location

C.O. Alofe, O.C. Adebooye and A.J. Isei
Department of Plant Science,
Obafemi Awolowo University,
Ile–Ife, Nigeria

Abstract

The study investigated the response of hybrid maize (Zea mays L.) to N and stand density during the late season of 1990 and early season of 1991. Six maize hybrids were tested at three stand densities and four levels of N fertilizer (Urea) in a randomized complete block design with split – split plot arrangement.

Results showed that all the hybrids produced significantly higher grain yields at 75cm x 50 cm at two plants/stand than at 75cm x 50cm at one plant/stand and 75cm x 50cm at three plants/stand. Significantly higher grain yield was also produced at each successive higher N level. Even at the highest level of N (240 kgN/ha) grain yield was still increasing. This suggests that the optimum N level may not have been reached. All the hybrids except that 8605–16 and 8239–15 significantly outyielded the open–pollinated checks. The highest yielding hybrids in late season were 8505–5, 8644–32 and 8605–16 while the highest yielding in early season were 8644–32 and 8644–31.

Introduction

Low grain yields of maize (*Zea mays* L.) are common in the Southwest zone of Nigeria. Several factors according to Agboola (1968) are responsible for the low yields, among which are, use of low yielding varieties, low soil fertility, low plant population per hectare, poor cultural management, inadequate weed control, and losses from diseases and pests. As much, there are always cases of shortages of maize grain either as food for human consumption or as food for livestock in the country. Most of the tonnage of maize produced in Nigeria is under the primitive subsistence system where fertilizer application is not often practised.

With the ever increasing demand for maize in Nigeria, great attention is now being put on scientific research in order to increase grain yield. As such, researches have centred on development of high yielding varieties, optimum plant population and stand density, and the optimum level of nitrogen fertilization that will ensure economically feasible grain yield at the given plant population.

The study was therefore designed to determine the grain yield of maize hybrids at different levels of Nitrogen fertilization and stand densities.

Materials and Methods

Two separate studies were conducted during the late season (August – November) 1990 and early season (April – July) 1991. The experiments were carried out at the Teaching and Research Farm of the Obafemi Awolowo University, Ile-Ife (07^0 28' N, 04^0 33'E, 224m above sea level). The soil of the site was classified as an alfisol, Oxic paleustalf (Harpstead, 1973). The site had been under cultivation for five consecutive years.

Eight maize varieties consisting of six hybrids (designated V_1 – V_6) and two open pollinated varieties (designated V_7 and V_8) as checks were used for the studies.

The varieties were:

V_1 =	8644	–	31	(Sx) Yellow
V_2 =	8505	–	5	(3x) White
V_3 =	8644	–	32	(Dx) Yellow
V_4 =	8605	–	16	(Dx) White
V_5 =	8321	–	18	(Sx) White (AGILORIN)
V_6 =	8329	–	15	(Sx) Yellow (AGLOKOJA)
V_7 =	TZSR	–	Y – I (O.P)	Yellow
V_8 =	TZSR	–	W – I (O.P)	White

N.B.

Sx = Single cross hybrid
Dx = Double cross hybrid
3x = Three – way cross hybrid
O.P. Open-pollinated variety

All the maize varieties used were resistant to major lowland diseases such as streak virus, rustand blight (Fajemisin, 1985). Four levels of Nitrogen (N) were used as follows:

No = OkgN/ha
Ni = 80kgN/ha
N2 = 160 kgN/ha
N3 = 240 kgN/ha

Three stand densities were also used as follows:

D1 = 1 plant/stand
D2 = 2 plants/stand
D3 = 3 plants/stand

The experiment was laid out in a randomized complete block design (RCBD) with a split-split plot arrangement. The experiment was replicated three times, each replicate mesuring 71.25m x 23m with a path of 2.0m in between replicates. Each replicate was further subdivided into four blocks for each N level with a 1.0m path in between blocks. Each block was further divided into three subplots for each density. Varieties formed the sub-sub plots. There were ninety six plots per replication.

Soil analysis of the experimental site was done at the Soil Analysis laboratory of the International Institute of Tropical Agriculture (IITA). Ibadan, The results of the analysis showed that the Nitrogen content of : soil was 0.087%. The experimental site was ploughed and harrowed for each study. Plantings were done at a spacing of 75cm x 50cm at one, two and three seeds per stand. Each plot measured 2.25m x 5m, having four rows, each containing eleven stands to give a total of forty four stands per plot. The corresponding plant populations resulting from D_1, D_2 and D_3 were 26,700; 53,300 and 80,000 plants/ha, respectively. All seeds were treated with Aldrex T and furadan before planting.

A mixture of Gramoxone (post-emergence herbicide) and lasso atrazine (Preemergence herbicide) were sprayed one day after planting. The source of N was urea ($CO(NH_2)_2$), 46%N. the control plot (No) received no Urea application, N1 received 80kgN/ha, N2 received 160kgN/ha and N3 received 240kg N/ha. The N was applied as single dose band application at planting. A basal application of 60kg P_20_5/ha and 90kg0/ha was made by broadcasting at planting. The sources of P_20_5 and K_20 were single super phosphate and muriate of potash, respectively. Manual weed control was carried out as the need arose during the course of the experiments.

Data were collected from the two middle rows while the first and fourth rows served as guard rows. Data were collected on grain yields at 15% moisture content. Harvesting was carried out when visual observation showed that maize ears had dried up. Data collected were subjected to analysis of variance (ANOVA) and means were separated using least significant difference at 5% level of probability (Lsd 5%). The coefficient of variation was also calculated to ascertain the reliability of the data.

Table 1: **Effect of density on overall grain yield performance (Kg/ha) by all varieties at all N–levels.**

Level	1990	1991	Mean
D1	974.3	1264.3	1119.3
D2	1538.0	1942.9	1740.5
D3	1249.7	1605.8	1427.8
Lsd(0.05)	79.8	188.5	—
CV	7.3%	5.3%	—

Table 2: **Effect of N on overall yield performance (Kg/ha by all varieties at all densities.**

Level	1990	1991	Mean
No	468.9	960.1	714.5
N1	1033.2	1410.3	1221.8
N2	1605.1	1874.2	1739.7
N3	1908.9	2275.1	2092.0
Lsd(0.05)	143.7	210.1	—
CV	5.7%	13.2%	

Table 3: **Effects of Variety X Density Interaction on grain yield performance (Kg/ha) at all N levels.**

	D1			D2			D3		
	1990	1991	MEAN	1990	1991	MEAN	1990	1991	MEAN
V_1	1080.6	1879.3	1480.0	1567.7	2321.1	1944.4	1302.0	2032.9	1667.5
V_2	1026.4	1105.6	1066.0	1676.2	1894.5	1785.4	1308.5	1835.5	1572.0
V_3	995.7	1458.3	1227.0	1724.7	2046.4	1885.6	1286.7	1867.5	1577.0
V_4	973.1	1248.8	1110.0	1546.1	1668.3	1607.2	1289.9	1206.5	1248.2
V_5	998.9	1338.3	1168.6	1588.9	2101.2	1845.1	1323.0	1641.6	1482.2
V_6	1020.0	1523.2	1271.6	1593.0	2025.2	1809.0	1277.8	1418.0	1347.9
V_7	843.8	1300.8	1072.3	1310.9	1382.9	1346.9	1157.4	1112.7	1135.1
V_8	855.9	1204.3	1030.0	1299.6	1236.2	1267.9	1052.3	1100.6	1076.5

Lsd (0.05) for 1990 = 104.9
Lsd (0.05) for 1991 = 319.5

Table 4: **Effects of varieties on overall grain yield performance (Kg/ha) at all N–Levels and all densities.**

	1990	1991	MEAN*
V_1	1315.8	2077.8	1696.8a
V_1	2337.0	1611.9	1474.5c
V_1	2335.7	2790.7	1563.2b
V_1	2269.7	1373.9	1321.8e
V_1	1303.6	1693.7	1498.7bc
V_1	1296.9	1006.3	1151.6f
V_1	1104.0	1712.0	1406.0d
V_1	1069.0	1568.5	1318.8e
CV	21.7%	18.4%	

Means followed by different letters are significantly different (Duncan's Multiple Range Test, $P < 0.05$).

Results and Discussion

The stand density significantly ($P < 0.05$) affected the grain yield of the maize varieties used for the studies (Table 1). The results showed that significantly higher grain yields were realized at D_2 than D_1 and D_3 both in the 1990 and 1991 trials. Also, D_3 plants significantly out yielded the D_1 plants. The early season trial (1991) numerically outyielded the late season (1990) study. The low yields recorded in D_1 plants may be due to inadequate utilization of available cropping space, while the low yields recorded in D_3 plants may be due to competition among the plants per stand. It is known that maize grain yields increased with increase in plant population up to a particular level beyond which yield decreased (Metcalfe and Elkins, 1980). Also, IITA (1986) reported significant increase in maize grain yield when plant population increased from 33,000 to 43,000 plants/ha while no significant difference was observed between 43,000 and 53,000 plants/ha, in Cameroun. The higher grain yields recorded during the early season (1991) trial may be due to rainfall stability that characterised the period of the study, as such moisture was not limiting, as compared with the late season (1990) study that was characterized by inadequate rainfall which adversely affected nutrient dissolution and uptake.

Table 2 shows that as the N level increased the grain yield of all the varieties at all densities increased significantly ($P < 0.05$) both in the 1990 and 1991 trials. Even at the highest N level, the grain yield was still increasing significantly. This suggests that the highest N requirement may not have been reached. These studies agree with the reports of Alofe *et al.* (1986), Lutz and Lillard (1981) and IITA (1988) that maize can tolerate as much as 200kg/ha, but contrary to Okeleye (1988) and Kang (1981) that 180kg/ha was optimum for maize. However, Chiwumba (1965) recommended split application of N fertilizer as best for early season because it resulted in higher grain yield than single dose application. This is contrary to the reports of Alofe and Okeleye (1988) that split N application did not have any significant yield advantage over single dose N application at planting. The contradiction in the two reports may be due to rainfall distribution during the course of the studies. It has been well documented that high rainfall encourages leaching and erosion; as such single dose application may be of little advantage when rainfall is excessive (IITA, 1986).

Table 3 shows that all the hybrids (V_1 – V_6) significantly outyielded the two open-pollinated varieties (V_7 – V_8) at D_1 in the 1990 trial but, there was no significant difference among the hybrids used ($P < 0.05$). The 1991 early season study showed that V_1 significantly outyielded all other hybrids and O.Ps but there was no significant difference between the other hybrids and the O.P.'s grain yields at D_1. However, at D_2 for 1990 late season study all the hybrids significantly outyielded the two O.P.'s. The two highest yielding hybrids were 8505–5(V_2) and 8644–32(V_3).

For 1991 early season study, all the hybrids except 8605–15 (V_4). Significantly out yielded the two O.P's at D_2 ($P < 0.5$). The highest yielding hybrids were 8644–31(V_1) and 8644–32(V_3).

At D_3 (Table 3) significantly higher grain yields were recorded in hybrids than the two O.P.'s in the 1990 late season trial, while for the 1991 early season study, all the hybrids except 8605–16(V_4) and 8329–15(V_6), significantly outyielded the two O.P.'s ($P < 0.05$). In general all the hybrids and O.P.'s at D_2 significantly outyielded plants under D_1 and D_3. This suggests that D_2 (2 plants/stand at 75cm x 50cm) is the optimum density per stand at 75cm x 50cm spacing in this locality. This agreed with the works of IITA (1984), Okeleye (1988) and Alofe *et al.* (1986).

Table 4 shows the grain yield performance of the maize varieties at all N levels and all densities. Hybrids 8505–5, 8644–32 and 8605–16 significantly outyielded other hybrids and O.P.'s ($P < 0.05$) during the late season of 1990. However, during the early season of 1991, hybrids 8644–31 and 8644–32 significantly outyielded other hybrids and O.P.'s ($P < 0.05$).

The results obtained in these studies suggested that hybrid 8644–32 is probably more adapted to this locality than the other hybrids. However, IITA (1986) had described 8644–32 as drought tolerant.

Conclusion

The need for proper agronomic practices to enhance increased maize production in Nigeria cannot be overemphasized. The late season that is often characterized by short rain period requires that varieties that are either early maturing or drought tolerant be developed. The results of this study showed that hybrid 8644–32 is more drought tolerant than other varieties for the late season.

Optimum plant population is a requirement for optimum grain yield, as such, the studies that showed a spacing of 75cm x 50cm at two plants/stand is the optimum spacing for maize in this locality. With respect to N application, grian yield was increasing even at the highest N level. Excessive vegetative growth was not observed on the plants even at the highest N level suggesting that the highest N level may not have been reached. Also, maturity was not delayed by N application, however, the degree of greenness increased as N levels increased.

In general, hybrids 8505–5, 8644–32 and 8505–16 are promising in the late season while 8644–32 and 8644–31 are best for early season.

References

Agboola, A.A. 1968. Increasing effeciency of applied fertilizer on maize (*Zea mays* L.) The *Nig. J. Agric.* (4): 45–48.

Alofe, C.O. S.K. Kim, Y. Efron, J.M. Fajemisin, J.A. Kahdr and B.T. Kang. 1986. Effects of N and plant density on grain yield performance of hybrid maize in forest and derived savanna zones of Nigeria. Paper Presented at National Coordinated Maize Research Programe meetings at Unife, Ile–Ife. March 7–21, 1986.

Alofe, C.O. and K.A. Okeleye. 1988: Effect of whole and split application on nitrate reductase activity, grain protein content and grain yields of improved open–pollinated maize varieties. *Niger J. Sci* 27:47 – 53.

Chiwumba, P.M. 1965. Time and method of N application. Annual Reports, Federal Department of Agriculture Research, Ibadan. 3–3pp.

Fajemisin, J.M. 1985: Status of maize production technology in Nigeria and prospects for sustained self-sufficiency. Nationally Accelerated Food Production Programme Workshop, Owerri, Nigeria. March 7 – 9, 1985.

Harpstead, M.I. 1973. The classification of some Nigerian soils. *Soil Sci.* 166: 437 – 443.

International Institute of Tropical Agriculture (1986). Maize Improvement Programme Annual Report, 102 – 108pp.

International Institute of Tropical Agriculture 1988. Maize Improvement Programme. Annual Reports, 87 – 88pp.

Lutz, J.A. and J.A. Lillard. 1973. Effect of fertility treatment on the growth, chemical composition and yield of non tillage corn on orchard grass sod. *Agron. J.* 65: 733–736.

Metcalfe, D.C. and D.M. Elkins. 1980. *Crop Production: Principles and Practices:* 333 – 365pp.

Okeleye, K.A. 1988. Effect of N and plant density on agronomic traits and grain yield payermance of open-pollinated maize (*Zea mays* L.) Unpublished Ph.D. thesis. Obafemi Awolowo University, Ile-Ife, Nigeria. 204pp.