

Effect of Different Levels of Nitrogen Fertilizer on the Grain Yield of Maize

Awotundun, J.S

Ahmadu Bello University, College of Agriculture, Kabba Kogi State, Nigeria.

Abstract

A downy mildew resistant variety of maize (*Zea mays*) adapted to Kabba environmental condition was grown under rainfed condition in 1997 and 1998 seasons with five different levels of N fertilizer (0, 120, 150, 180 and 210/kg N/ha¹). Application of 120kg N/ha¹ fertilizers produced an average grain yield of 2329.97/kg/ha¹. This was an increase in yield of 63.52% over the control. An additional increase of 30kg N/ha¹ increased the grain yield by 38.39%. A further additional increase of another 30kg N/ha¹ increased the grain yield by 7.89% while the last 30kg N/ha¹ could only increase the grain yield by 2.97%. These increases in yield were associated with prolific factors, longer cobs and larger grains of the fertilizer treated plants. In short, this variety of maize responded very well to different levels of N fertilizer and thus the overall grain yield was significant.

Key words: N-fertilizer levels, maize, grain yield

Introduction:

Maize has high demand for nutrients and this can quickly exhaust the supply of soil nutrients to deficiency levels (Delorit *et al.* 1974; Awotundun *et al.*, 1994; Nyakanda *et al.*, 1996. Nutrient deficiencies, according to Hoffer and Krants (1949), also prolong the interval from emergence to tasselling or silking. The authors observed that the time of silking has been frequently hastened by 4 to 10 days by use of fertilizer and in extreme cases it has been hastened by 30 days.

In most instances, application of commercial fertilizer will result in increased yield, better filled grain and earlier maturity (Delorit *et al.*, 1974). Decieus (1970), Ifeanyi-chukwu (1983) and Awotundun (2000) reported that fertilizer (NPK) increased yields of both local variety and hybrid maize, but such responses varied with N application rates. Fergus *et al.* (1958),

Lister *et al.* (1975), Ologunle (1987), Arnon (1965), Okonkwo (1965) and Awotundun *et al.*

(2000) observed that N increased yield if applied together with phosphate and potassium fertilizers. Smith (1964) reported that a maize crop yield of 6.363kg/ha¹ including stover, required a nutrient uptake of 107 to 121/kg of N, 50 to 90/kg of P and 101 to 196/Kg of K/ha. Smith (1964) further indicated that in Philippine a maize average yield of 2. 217/kg of shelled maize per hectare would remove about 70, 19, and 39 kg/ha of N, P and K respectively. Corby (1957) and Cooke (1972) found N to be the dominant limiting factor in maize production and observed that it increased yield rapidly and more or less linearly up to a transition point beyond which yields changed little or decreased slightly and linearly. Folder (1969) obtained mean yields of 3, 887, 4, 105, 4, 271, 4, 401 and 4, 502/kg/ha at N fertilizer levels of 0, 45, 90, 135, and 180/kg/ha¹.

John *et al.* (1976) and Chiduzza *et al.* (1994) suggested split application of N to maize and recommended that the first application of N

*Corresponding author

should be made with mixed fertilizer during planting and that the second application should be applied 20 to 30 days after emergence of the seedlings.

Nitrogen is known to affect the number of days to attain 50% tasselling and silking. Rathore *et al.* (1976), Awotundun *et al.* (1994) Awotundun *et al.* (1997) and Sharma (1973) associated the reduction in the number of days to 50% tasselling with higher N levels. Krantz and Chandler (1954) reported that ear size was increased by 17% and the number of ears was increased by 41% when the rate of N fertilizer application increased from 22 to 199/kg/ha⁻¹. Berger (1962), Blako and Russell (1980) and Kamprath *et al.* (1982) observed that the development of two ears in semi prolific genotypes increased with higher rate of N. The authors reported that the number of plants with 2 ears was 35 to 45% greater at high N rate than at lower rates. The current practice at Kabba is four bags of N, P, K, fertilizer per hectare. This was based on the recommendation of (NARLS) National Agricultural Research Liason Service.

The present study was undertaken to provide more information on the effect of N fertilizer levels on the grain yield of an open-pollinated variety of maize. Kabba is within the sub-tropical region of the Southern Guinea Savannah ecological zone of Nigeria. It has an average rainfall of 110.5mm per annum, a mean annual temperature of 19.31°C and a mean annual relative humidity (RH) of 59.5%.

Materials and methods

Experiments on the effects of N fertilizer on the yield of maize were conducted under rainfed condition during the 1997/98 growing seasons. Seeds were sown at the rate of 45kg/ha⁻¹ with five N fertilizer levels, 0, 120, 150, 180 and 210/kg/N/ha⁻¹. The trial was sited on a soil containing 0.40%C and 0.035% total N. The textural class was sandy loam with 60% sand, 25% silt and 10% clay. Further soil analysis indicated that the soil had 36 P and 13 K. The soil pH was 6.6. Prior to 1987 when the plot was cultivated to cowpea and sunflower it has been under fallow for fifteen years.

The seeds were planted at the rate of three seeds per hole on 7th June and 13th July in respect

of 1997 and 1998 seasons, in a randomized complete block design with five treatments and five replicates. Seedlings were thinned to two plants per stand two weeks after-sowing. Each plot was 2.7m wide and 5.5m long and consisted of three ridges, which were separated by 60cm paths. The space between ridges was 90cm. There were 25 small plots in the entire trial. Nitrogen fertilizer rates per treatment was splits into two equal doses. The first doses of 0, 75, 90 and 105/kg/N/ha⁻¹ were applied by placement two weeks after sowing. P and K fertilizers at 60kg/ha were also added. Fertilizer placement was 2cm deep and 3cm from the plant. Six weeks after planting the second doses of N fertilizer were applied as top dressing at the same rates. The plots were treated with atrazine at 5l/ha⁻¹ immediately after sowing. Hand weeding was done three times at three week intervals.

Days to 50% heading and the number of tassels formed per treatment were recorded nine weeks after planting. At 10 and 13 weeks after sowing, plant heights were taken and ten ears were selected at random from the five outside ridges of each treatment for dry weight, ear diameter, average number of kernel per ear, and average ear weight per treatment. Harvesting for grain yields determination was done 19 weeks after planting.

Results

The results of the effect of different levels of N fertilizer on the grain yields of maize are presented in Table 1, 2 and 3. In both years, the effect of N fertilizer was significant. The parameters tested on the potential yield components of maize were number of barren plants, average length of cobs, cobs with and without viable seeds, cob diameter in centimeters, number of maize plants with double ears, average number of kernels per cob, and average ear weight in grammes. All these parameters were significant in accordance with Duncan's New Multiple Range Test (Table 1 and 2). Both the "cob + grain" weight as well as the weight of grain alone were also significantly different across treatments as shown in Table 3.

Discussion

The objective of this study was to determine the effect of different levels of N fertilizer on the grain yields of maize, ITA, yellow variety. The major finding is that this particular maize variety responded significantly to N fertilizer application in accordance with the different levels (Table 3). Mean grain weights were higher in 1998 than in 1997, perhaps a reflection of higher rainfall with better distribution in the former. Differences in the inherent soil fertility level contributed to these differential yields in the two years because the experiments were not conducted at the same soil in both years but on different points in the same field. Mean yield of 1998 over 1997 was 1242.83kg/ha⁻¹.

The findings that ITA yellow maize responded significantly to different levels of N fertilizer is in consonance with those of Corby (1965) and Cooke (1972) who found N as the determinant limiting factor in maize production. These workers observed that N increased yield rapidly and more or less linearly up to a transition point beyond which yield changed little or decreased linearly. The levels of N fertilizer were 0, 120, 150, 180 and 210/kg/N/ha⁻¹ which gave mean yields of 1815.15, 2329.97, 3224.58, 3479.12 and 3585.49/kg/ha⁻¹ respectively. This thus agrees with the observation by Folder (1969). The two split application regime of N fertilizer was in accordance with John *et al.* (1976). The larger cob diameter, ear weight and the number of kernels per cob were similar to those of Krantz and Chandler (1954). These authors observed that ear size was increased by 17% and the number of ears was increased by 41% when the rate of N fertilizer application was increased from 22 to 199/kg/N/ha⁻¹. The double ears of some maize plants which increased as the level of N fertilizer increased in the present study

was consistent with findings of Berger (1962), Blako and Russell (1980), and Kamprath *et al.* (1982) who independently observed that the development of two ears in semi-prolific genotypes increased with increasing rates of N. These authors reported that the number of plants with two ears per plant was 35 to 40% greater at higher N-rates than at lower rates. Similarly, the incidence of development of double ears in plants of the present research ranged from 10.42 to 18.08%

Conclusion

Although this downy mildew resistant variety of IITA yellow, open pollinated maize responded to every level of N fertilizer, treatment E produced the highest yield. The increase in yield continued steadily from control to the highest N fertilizer application. Therefore, based on the results of this study, 210/kg/N/ha⁻¹, 60kg/P₂O₅ and 60/kg/K₂O per hectare are recommended for open pollinated maize varieties, such as IITA yellow and downy mildew resistant variety used in this research.

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Table 1: Effect of different levels of nitrogen fertilizer on the potential yield components of maize in the 1997 trial

Treatment	Number of barren plants	Length of cobs (cm)	No. of cobs without viable seeds	No. of cobs with viable seeds	Ear diameter (cm)	No. of plants with double ears	No. of kernels per cob	Ear weight grammes
A-Control	1.8a	17.1a	9.0a	35.5b	5.1c	0.4c	235b	135.0b
B-120kgN/ha	1.4ab	16.3ab	4.2b	53.2a	5.1c	0.9c	389.2ab	153.5ab
C-150kgN/ha	1.4ab	15.2bc	3.1b	52.1a	6.1ab	5.8b	425.0ab	190.0ab
D-180kgN/ha	1.0b	14.9bc	2.3b	55.2a	6.5ab	9.7a	503.1a	204.1a
E-210kgN/ha	0.8c	14.7c	1.0c	58.0a	6.6a	10.2a	502.0a	215.0a

Means of the same column followed by the same letter are not significantly different ($P > 0.05$)

Table 2: Effect of different levels of nitrogen fertilizer on the potential yield components of maize in the 1998 trial

Treatment	No. of barren plants	Length of cobs (cm)	No. of cobs without viable seeds	No. of cobs with viable seeds	Ear diameter (cm)	No. of plants with double ears	No. of kernels per cob	Ear weight grammes
A- Control	5.8a	10.8a	9.0a	33.4b	6.148c	0.6c	245.0c	130.0b
B- 120kgN/ha	1.2b	13.7c	4.1b	58.1a	6.460c	1.6c	385.3b	165.3ab
C-150kgN/ha	0.0c	15.4ab	3.1b	62.5a	6.616ab	7.4b	450.6b	178.1ab
D- 180kgN/ha	0.0c	17.2ab	2.2b	65.3a	6.792ab	12.2a	530.4a	195.5a
E-210kgN/ha	0.0c	17.5a	0.8c	68.1a	6.904a	12.8a	550.1a	220.4a

Means of the same column followed by the same letter, are not significantly different ($P > 0.05$) according to the Duncan's New Multiple Range Test

Table 3: Effect of different levels of nitrogen on the yield of maize

Treatment	1997		1998	
	Cob - Grain Weight (Kg/treatment)	Grain Weight (kg/ha ⁻¹)	Cob - Grain Weight (Kg/treatment)	Grain Weight (kg/ha ⁻¹)
A -Control	2.7b	1630.9c	2.2c	1218.8c
B- 120kg N/ha	3.5b	1831.6c	5.1b	2835.0b
C - 150kg N/ha	4.5a	2354.8a	7.3a	4175.1a
D - 180kg N/ha	4.7a	2406.0a	8.0a	4410.7a
E- 210kg N/ha	5.2a	3497.6a	8.2a	4552.2a

Means on the same column followed by the same letter are not significantly different ($P > 0.05$) according to the Duncan's New Multiple Range Test.

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