EFFECT OF TIME OF NITROGEN APPLICATION ON THE PERFORMANCE OF MAIZE (*Zea mays* L.) VARITIIES AT MUBI, NORTHERN GUINEA SAVANNA OF NIGERIA

YOHANNA MAMMA KWAGA

Department of Crop Science,
Adamawa State University, Mubi, Nigeria
E-mail: kwagahanna@gmail.com

ABSTRACT

A field study was conducted in 2011 and 2012 rainy seasons at Mubi, in the northern Guinea Savanna ecology of Nigeria. The trial was conducted in a split-plot design with two maize (OBA – 98 and OBA – SUPER) varieties in the main plots. In the sub-plots, nine timings of nitrogen application and zero fertilization as a control were assessed. Throughout the study, the two varieties exhibited similar performance in all the parameters evaluated.. Application of basal dose (60:60: 60kgN,P_20_5,K_20 ha^{-1}) two weeks after sowing (WAS) plus 60kgN ha^{-1}4WAS tasseled earlier than zero fertilizer application and basal +30kgNha^{-1} 6WAS+30kgNha^{-1} 10WAS. Combined grain yield for two years showed that the highest grain yield was obtained from the application of basal dose +30kgNha^{-1} 4WAS+30kgNha^{-1} 8WAS. The treatment out-yielded zero fertilizer rate and basal dose+30kgNha^{-1}WAS+30kgNha $^{-1}$ 8WAS. In the combined analysis, all N fertilized treatments exhibited similar cob length, cob diameter, 100 grain weight and plant height at 9WAS, but were all significantly higher than zero fertilizer treatment.

Key words: timing, nitrogen, fertilization

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INTRODUCTION

Maize production is gaining ground in the northern Guinea Savanna ecology of Nigeria and is gradually replacing sorghum. In the past, many farmers in the ecology have been cultivating sorghum on the same piece of land for several years without fertilizer application and yet were able to obtain good yield except where *Striga hermonthica* posed threat. However such practice would lead to poor and sharp decline in maize yield. The high demand of maize for nitrogen and other major nutrients such as phosphorus and potassium makes it impossible to achieve high maize yield without fertilization (Kwaga, 1994, Havlin *et al*., 2010).The native soil N status in the northern Guinea Savanna ecology of Nigeria is usually low. Therefore fertilizer does of 120:60:60 kg N, P_2O_5 and K_2Oha^{-1} has been recommended for maize production in the ecology (Ewenzor *et al.,* 1989). Even though farmers in the ecology recognize the need to fertilize their maize crop to achieve high maize yield on sustainable basis, timing of the application of fertilizer to their maize crop has been variable.

Since nitrogen is subject to leaching and denitrification, multiple times of N application has been advocated (Tobert *et al.,* 2001). However, farmers in the Savanna ecology of Nigeria are not consistent as to the timing of second doses of N to their crops, resulting in N deficiency when the nutrient is needed by the crop. Anonymous (2011) noted that nitrogen deficiency at any time of maize life would lead to yield reduction.

Therefore this field trial has been undertaken with the objective of determining appropriate time for split nitrogen application to maize to obtain optimum yield.

MATERIALS AND METHOD

An investigation was carried out in the field at the Teaching and Research Farm of Adamawa State University, Mubi in 2011 and 2012 rainy seasons in the northern Guinea Savanna ecological zone of Nigeria. The soil of the area is broadly classified as alfisol (Brady and Weil, 1999) while the textural class of the trial site soil was clay loam, with pH of 6.25, total nitrogen 0.003gkg^{-1}, available P 0.007mgkg^{-1}, K2.56 Cmolkg^{-1} and CEC 2118.04 Cmolkg^{-1}.

The trial was conducted in a split-plot design with two maize varieties (OBA-SUPER and OBA- 98) in the main plots and time of nitrogen application in the sub-plots. The experiment was sown on July 9, 2011 and July 7, 2012. Two seeds were sown per hill at the spacing of 75cm by 25cm and thinned to one plant per stand 2 weeks after sowing (WAS). Each gross plot was comprised of four rows that were 75 cm apart and 5m in length (15m^2), while the two central rows (7.5m^2), constituted the net plot. Fertilizer was applied at the rate and time for each treatment. Compound fertilizer (NPK 15:15:15) was used to supply the basal application of

60:60:60; N, P_2O_5,K_2O kg ha $^{-1}$ at 2 WAS. Urea (46% N) was used to supply the later doses of nitrogen at 4, 6, 8 and 10 WAS as it applies to each treatment. All fertilizer applications were done by side placement. Each year the trial was hoe weeded at 3, 6, and 9 WAS. All data collected were subjected to statistical analysis and the means separated using Duncan Multiple Range Test (Duncan, 1955).

RESULTS

Varieties had no significant influence on plant height at 9WAS in the two years of the research and the combined data (Table 1) .All the fertilized treatments produced plants of similar heights at 9WAS during the period of the investigation irrespective of the time of N application. However, in 2011 and the combined analysis all fertilized treatments exhibited plants that were significantly taller than that of zero fertilizer treatment. However in 2012 , fertilizer application or its timing had no appreciable effect on plant height. . The two varieties did not differ significantly with respect to number of days to 50% tasseling. (Table1). In 2011, all the fertilized treatments had comparable number of days to 50% tasseling, and tasseled earlier than the zero fertilizer treatment. In 2012 Basal dose + 60kgNha $^{-1}$ 8WAS and Basal dose +30kgNha $^{-1}$4WAS+30kgN ha $^{-1}$8WAS had the shortest days to 50% tasseling but were comparable to the other treatments except Basal dose + 30kgNha^{-1} 6WAS+30kgN ha $^{-1}$8WAS, Basal dose + 30kgNha $^{-1}$ 6WAS +30kgNha $^{-1}$ 10WAS and zero fertilizer treatment . In the combined analysis Basal dose + 60kg Nha^{-1} 4WAS was the first treatment to reach 50% tasseling, but was at par, with other treatments except Basal dose + 30kgNha^{-1} 6WAS + 30kgN ha $^{-1}$ 10WAS and the zero fertilizer treatment which was the latest to reach 50% tasseling. Variety had no significant effect on cob length in the two years and the combined analysis (Table 2). In both years and the combined data the zero fertilizer treatment produced markedly shortest cobs compared to all the fertilized treatments. In 2012 and the combined analysis all fertilized treatments recorded similar pod length. However, in 2011 Basal dose + 60kgNha^{-1} which exhibited the longest pods was the only treatment that had appreciably longer pods than Basal dose + 30kgNha^{-1} 4WAS +30kgNha^{-1} 10WAS treatment which exhibited the shortest pods among the fertilized treatments. The two varieties had similar pod diameter in both years and the combined analysis (Table 2). However the zero fertilizer treatment produced cobs with least cob diameter in the two years and the combined analysis than all the fertilized treatments which also produced pods of comparable diameter.

Table 1 Effect of time of nitrogen application on plant height at 9WAS and days to 50% tasseling of maize varieties grown at Mubi in 2011 and 2012 rainy seasons

Treatment	Plant height at 9WAS (cm)			Days to 50% tasseling		
	2011	2012	Combined	2011	2012	Combined
Variety						
OBA-SUPER	179.40	221.50	200.45	63.70	62.71	63.20
OBA-98	190.84	223.00	210.42	62.57	61.73	62.15
SE ±	5.72	3.22	3.31	1.28	0.34	0.71
Level of Significance	ns	ns	ns	ns	ns	Ns
Time of N application (kgha^{-1})						
Control (No fertilizer)	119.03**b**	198.65	158.84**b**	66.33**a**	63.83**a**	65.08**a**
Basal application N::P_2O5::K_2O (60:60:60)	202.75**a**	238.00	220.38**a**	62.33**b**	62.00**abc**	62.17**bc**
Basal+60kgN 4WAS	192.87**a**	252.85	222.86**a**	62.00**b**	61.33**c**	61.67**c**
Basal+60kgN 6WAS	188.00**a**	208.70	198.35**a**	63.17**b**	63.00**abc**	63.08**bc**
Basal+60kgN 8WAS	190.52**a**	229.92	210.22**a**	63.17**b**	61.17**c**	62.17**bc**
Basal+30kgN 4WAS+30kgN6WAS	189.42**a**	222.52	205.97**a**	62.17**b**	62.00**abc**	62.08**bc**
Basal+30kgN 4WAS+30kgN8WAS	188.17**a**	236.20	212.41**a**	62.00**b**	61.83**bc**	61.92**c**
Basal+30kgN 4WAS+30kgN10WAS	191.28**a**	233.53	212.41**a**	63.66**b**	61.17**c**	62.42**bc**
Basal+30kgN 6WAS+30kgN8WAS	185.12**a**	221.32	203.22**a**	63.00**b**	62.33**ab**	62.67**bc**
Basal+30kgN 6WAS+30kgN10WAS	204.07**a**	215.80	209.93**a**	63.50**b**	63.50**ab**	63.50**ab**
SE ±	11.55	10.78	7.90	0.86	0.56	0.51
Level of Significance	*	ns	*	*	*	*

Means followed by common letter(s) in each treatment group are not significant at 5% level of productivity using Duncan Multiple Range Test.
* = Significant at 5% level of probability, ns = Not Significant at 5% level of probability,
WAS = Weeks after sowing

Table 2. Influence of time of nitrogen application on cob length and diameter of maize varieties grown at Mubi in 2011 and 2012 rainy seasons

Treatment	Cob length (cm)			Cob diameter (cm)		
	2011	2012	Combined	2011	2012	Combined
Variety						
OBA-SUPER	15.37	16.05	15.71	4.48	4.52	4.50
OBA- 98	15.31	16.19	15.75	4.37	4.55	4.46
SE ±	0.329	0.230	0.200	0.067	0.012	0.033
Level of Significance	ns	ns	ns	ns	ns	Ns
Time of N application ($kgha^{-1}$)						
Control application	12.78**c**	13.70**b**	13.24**b**	4.02**b**	4.15**b**	4.09**b**
Basal application $N:P_2O_5:K_2O$ (60:30:30)	15.63**ab**	16.06**a**	15.85**a**	4.45**a**	4.52**a**	4.49**a**
Basal+60kgN 4WAS	16.18**a**	16.69**a**	16.43**a**	4.56**a**	4.66**a**	4.61**a**
Basal+60kgN 6WAS	15.30**ab**	16.16**a**	15.73**a**	4.43**a**	4.64**a**	4.53**a**
Basal+60kgN 8WAS	15.62**ab**	16.29**a**	15.96**a**	4.41**a**	4.49**a**	4.45**a**
Basal+30kgN 4WAS+30kgN6WAS	15.88**ab**	16.36**a**	16.12**a**	4.46**a**	4.55**a**	4.49**a**
Basal+30kgN 4WAS+30kgN8WAS	15.70**ab**	16.79**a**	16.23**a**	4.49**a**	4.61**a**	4.55**a**
Basal+30kgN 4WAS+30kgN10WAS	14.96**b**	16.52**a**	15.74**a**	4.37**a**	4.60**a**	4.49**a**
Basal+30kgN 6WAS+30kgN8WAS	15.51**ab**	16.50**a**	16.00**a**	4.45**a**	4.64**a**	4.55**a**
Basal+30kgN 6WAS+30kgN10WAS	15.86**ab**	16.16**a**	16.01**a**	4.59**a**	4.50**a**	4.55**a**
SE ±	0.327	0.313	0.230	0.075	0.076	0.054
Level of Significance	*	ns	*	*	*	*

Means followed by common letter(s) in each treatment group are not significantly different at 5% level of probability using Duncan Multiple Range Test.
* = Significant at 5% level of probability, ns = Not Significant at 5% level of probability

Table 3 Influence of time of nitrogen application on 100 grain weight and grain yield of maize varieties grown at Mubi in 2011 and 2012 rainy seasons

	100 grain weight (g)				Grain yield (kgha^{-1})	
Treatment	2011	2012	Combined	2011	2012	Combined
Variety						
OBA-SUPER	25.80	25.84	25.82	3795	4866	4331
OBA- 98	24.61	26.37	25.49	3720	5021	4370
SE ±	0.874	0.437	0.489	148.3	639.26	271.31
Level of Significance	ns	ns	ns	ns	ns	Ns
Time of N application (kgha^{-1})						
Control (No fertilizer)	21.95**ab**	22.00**b**	21.98**b**	1910**b**	2622**c**	2266**c**
Basal application $N:P_2O_5:K_2O$ (60:30:30)	25.44**a**	25.44**a**	25.44**a**	4068**a**	4570**b**	4319**ab**
Basal+60kgN 4WAS	26.37**a**	27.49**a**	26.93**a**	4340**a**	5803**a**	5071**ab**
Basal+60kgN 6WAS	26.63**a**	26.34**a**	26.48**a**	3797**a**	4919**ab**	4358**ab**
Basal+60kgN 8WAS	25.14**a**	26.60**a**	25.87**a**	3950**a**	5351**ab**	4651**ab**
Basal+30kgN 4WAS+30kgN6WAS	25.97**a**	25.55**a**	26.42**a**	3887a	5094**ab**	4490**ab**
Basal+30kgN 4WAS+30kgN8WAS	25.33**a**	27.51**a**	26.42**a**	4298**a**	5931**a**	5114**a**
Basal+30kgN 4WAS+30kgN10WAS	24.34**a**	27.40**a**	25.88**a**	3194**a**	5295**ab**	4245**b**
Basal+30kgN 6WAS+30kgN8WAS	24.67**a**	26.57**a**	25.62**a**	3979**a**	5131**ab**	4555**ab**
Basal+30kgN 6WAS+30kgN10WAS	26.23**a**	26.16**a**	26.19**a**	4150**a**	4720**b**	4435**ab**
SE ±	0791	0.677	0.521	351.3	308.86	259.14
Level of Significance	*	*	*	*	*	*

Means followed by common letter(s) in each treatment group are not significantly different at 5% level of probability using Duncan Multiple Range Test.
* = Significant at 5% level of probability, ns = Not Significant at 5% level of probability

The two varieties produced grains of similar weight in the two seasons and the combined data (Table 3). In both years and the combined analysis treatments produced grains of comparable weight, which were all remarkably heavier than grains of zero fertilizer treatment. In both years and the combined analysis, variety had no marked effect on grain yield (Table 3). In the two seasons and the combined analysis all fertilized treatments out-yielded the zero fertilizer treatment. In 2011 all the fertilized treatments had similar grain yield. In 2012, Basal dose + 30kgNha^{-1} 4WAS+30kgN ha $^{-1}$8WAS produced the highest grain yield that was comparable to that of other fertilized treatments except that it gave appreciably higher yield than Basal dose +30kgNha^{-1} 6WAS + 30kgN ha $^{-1}$10WAS and the treatment with only basal dose. Similarly in the combined analysis Basal dose +30kgNha^{-1} 4WAS +30kgNha $^{-1}$ 8WAS produced the highest grain yield that was at par with grain yield of other fertilized treatment except that it out-yielded the treatment of Basal dose + 30kgNha^{-1} 4WAS+30kgN ha $^{-1}$10WAS.

DISCUSSION

During the period of the investigation the two varieties exhibited similar performance in all the parameters observed ... This signifies that the varieties (OBA – 98 and OBA -SUPER) are from the same genetic source, therefore not much difference should be expected in their performance.

Application of nitrogen irrespective of time of application produced taller plants, longer and thicker cobs, heavier seeds and higher yield than the zero fertilizer treatment. However, timing of nitrogen application only exhibited significant influence on maize performance in days to 50% tasseling and grain yield. The combined analysis has shown that basal fertilizer application (60:60:60 kg N, P_20_5, K_20) + 60 kg Nha-^{1} 4 WAS and basal fertilizer application +30kgNha^{-1} 4WAS+30kgNha $^{-1}$8WAS not only resulted in earlier tasseling than zero fertilizer treatment but also tasseled earlier than basal fertilizer application + 30kgNha^{-1} 6 WAS + 30kgNha^{-1} 10 WAS. There have been inconsistent reports from researchers on the influence of nitrogen on flowering in maize. Sharma(1973); Al-Rudha and Al-Younis, (1978); Gangwar and Kalra, (1988), Prasad and Singh, (1990), Kwaga, (1994) noted that nitrogen application to maize resulted in earlier silking. In contrast, Olugunde and Ogunlela,(1984);Ologunde and

Ogunlela(1985) observed that nitrogen application reduced number of days to 50% silking in maize. The conflicting reports may be attributed to the N status of different soils. Black (1968) remarked that when N is slightly deficient, nitrogen application had no effect on earliness to maturity. However, low nitrogen level could have adverse effect on the production of reproductive cells. According to Reddy and Reddy (2011), growth cannot be greater than allowed by nutrient in lowest availability. Therefore where nitrogen availability is very low as observed in the present study, growth including the production of reproductive cells can be seriously retarded. This concurs with the remarks of Thompson and Troeh (1978) who remarked that plants must have adequate nitrogen before it can synthesize cells and that shortage of nitrogen could halt the process of growth and reproduction. Also Ishizuka (1971) noted that shortage of nitrogen inhibits cell division resulting in slow silk emergence.

The delay in tasseling as observed under application of basal fertilizer + 30kg Nha^{-1} 6 WAS + 30kgNha^{-1} 10 WAS can be attributed to the late application of nitrogen. Therefore continuous application of nitrogen up to the later stage of growth in maize could foster vegetative growth and delay maturity. This is in consonance with the remarks of Reddy and Reddy (2011), who noted that late application of nitrogen increased leaf area and leaf area duration.

Although time of nitrogen application had no significant effect on maize yield attributes such as 100 grain weight, cob length and cob diameter, application of Basal fertilizer +30kgNha^{-1} 4 WAS + 30kgnha^{-1} 8 WAS produced the highest grain yield. Multiple application of nitrogen to maize has been advocated by Anonymous (2011). The multiple application should include the time the crop needs N most so as to reduce losses due to teaching and denitrification. ((Vetsch and Randal, 2004). Therefore unlike other major nutrients such as phosphorus and potassium, split application of N to spread its availability over time is desirable for achieving high maize. This is because N is liable to denitrification and leaching (Mengel and Kirby, 2006).

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