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Effects of foliar fertilizer (boost-extra) and npk levels on vegetative growth of maize (*zea mays l.*) grown in Mubi, Northern Guinea Savannah Zone of Nigeria

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ABSTRACT

An experiment was conducted in 2012 at Teaching and Research Farm of Adamawa State University, Mubi, which lies within Northern Guinea Savanah Zone of Nigeria to study the effects of foliar fertilizer (Boost-Extra) and NPK levels on vegetative growth performance of maize. A split-plot design was adopted for the study with two maize varieties, Oba-98 and TZSR-W in the main-plots and seven fertilizer levels in the sub-plots (T_1 Control = 0:0:0 kg N,P_2O_5,K_2O ha^{-1} + 0 l ha^{-1} Boost-Extra; T_2 = 120:60:60 kg N,P_2O_5,K_2O ha^{-1} + 6 lha^{-1} Boost-Extra; T_3 = 90:45:45 kg N,P_2O_5,K_2O ha^{-1} + 6 lha^{-1} Boost-Extra; T_4 = 60:30:30 kg N,P_2O_5,K_2O ha^{-1} + 6 lha^{-1} Boost-Extra; T_5 = 30:15:15 kg N,P_2O_5,K_2O ha^{-1} + 6 lha^{-1} Boost-Extra; T_6 = 0:0:0 kg N,P_2O_5,K_2O ha^{-1} + 6 lha^{-1} Boost-Extra; T_7 = 120:60:60 kg N,P_2O_5,K_2O ha^{-1} + 0 l ha^{-1} Boost-Extra) replicated three times. Observed parameters were subjected to ANOVA using SAS package at $P \leq 0.05$. Means separated using DMRT. The results of the study revealed application of 6 lha^{-1} Boost-Extra foliar fertilizer had no significant effects on maize growth characters. Maize plant height, crop vigour, stem girth, leaf area index, shoot dry-matter and crop growth rate increased with increasing rates of NPK up to 90:45:45 kg^1 N,P_2O_5,K_2O ha^{-1} + 6 lha^{-1} Boost-Extra. Further increase dose of N,P_2O_5,K_2O ha^{-1} to 120:60:60 kg with or without 6 lha^{-1} Boost-Extra showed no significant effect on the maize growth parameters. The application of 6 lha^{-1} foliar Boost-Extra fertilizer produced vigorous plants against zero fertilized plants only at 3 weeks after sowing (WAS), when no fertilizer was applied. From the results of the study, application of foliar fertilizer (Boost-Extra) was found to be not economically viable. Soil applied NPK fertilizer was observed the best form to deliver fertilizer to maize, and application of 90:45:45 kg N,P_2O_5,K_2O ha^{-1} + 6 lha^{-1} Boost-Extra was found adequately to support vegetative growth parameters of maize at 6, 9 and 12 WAS.

Key Words: NPK soil applied fertilizer, Boost-Extra foliar fertilizer, weeks after sowing (WAS), maize (*Zea mays* L.).

INTRODUCTION

Maize, botanically known as *Zea mays* L. belongs to the family Poaceae. The crop was introduced into Nigeria probably in the 16^{th} century by the Portuguese (Osagie and Eka, 1998), and it is now grown and distributed in almost all parts of the country over an area, that none of the cereal crops occupies such a large hectarage (Ado *et al.*, 2004).

Maize plant takes up N, P and K from the soil as primary nutrients required for growth and development. However, the precise requirement of these minerals relies upon the fertility status of a soil, previous cropping history and duration of variety to be cultivated. However, a balanced application of 60-120 kg N ha^{-1}, 40-60 kg ha^{-1} P_2O_5 and 40 kg ha^{-1} K_2O are recommended for various ecosystems in Nigeria (Ado *et al.*, 2004).

Foliar fertilizer is a form of liquid fertilizer applied through the foliage of plants. This method tends to provide for rapid nutrient utilization and enables quick correction of deficiencies. However, the response from foliar fertilizer is often temporary due to minute amount of nutrient applied (Havlin *et al.*, 2005). Also, according to these authors, foliar feeding has been used as a means of supplying supplemental doses of nutrients, plant hormones, stimulants, and other beneficial substances. Observed effects of foliar fertilizer could dependent on species, fertilizer form, composition, concentration, and frequency of application, as well as the stage of plant growth.

MATERIALS AND METHODS

Experimental site

The experiment was conducted in 2012 rainy seasons at Teaching and Research Farm, of Adamawa State University, Mubi located between Latitude 9^0 30′ to $11^0$88′ N and Longitude $12^0$00 to 13^0 45′ E, which falls within northern Guinea Savannah zone of Nigeria. The total mean annual rainfall during the year 2012 was 1343.1 mm. The peak of the rainy season in this zone falls within August to September (ADSU Meteorological Unit, 2013).

Treatments and experimental Design

The experiment was laid out in a split-plot design. The main treatments consisted of maize varieties which were Oba-98 hybrid and TZSR-W. The sub-treatments comprised seven fertilizer levels, which were combinations of soil applied granular NPK fertilizer levels and foliar fertilizer (Boost-Extra):

T_1: (Control)	=	0:0:0 kg	N,P_2O_5,K_2O ha^{-1}	+	0 l ha^{-1} Boost-Extra
T_2:	=	120:60:60 kg	N,P_2O_5,K_2O ha^{-1}	+	6 lha^{-1} Boost-Extra
T_3:	=	90:45:45 kg	N,P_2O_5,K_2O ha^{-1}	+	6 lha^{-1} Boost-Extra
T_4:	=	60:30:30 kg	N,P_2O_5,K_2O ha^{-1}	+	6 lha^{-1} Boost-Extra
T_5:	=	30:15:15 kg	N,P_2O_5,K_2O ha^{-1}	+	6 lha^{-1} Boost-Extra
T_6:	=	0:0:0 kg	N,P_2O_5,K_2O ha^{-1}	+	6 lha^{-1} Boost-Extra
T_7:	=	120:60:60 kg	N,P_2O_5,K_2O ha^{-1}	+	0 l ha^{-1} Boost-Extra

These were replicated three times.

Sowing and spacing

The seeds were treated with Apron-plus 60D (10 g kg^{-1} of seeds) against fungal or insect attack and two seeds were sown per hill on a harrowed soil at a spacing of 25 cm x 75 cm. The plants were thinned to one plant per stand at 2 weeks after sowing (WAS).

Fertilizer application and weed control

Compound NPK fertilizer 15:15:15 grade was applied at 2 WAS according to the rate for each treatment. The remaining half dose of N was applied at 6 WAS in the form of urea (46% N). Boost-Extra foliar fertilizer was applied in the evening time at the rate of 3 l ha^{-1} at 2 and 6 WAS using a Knapsack sprayer. Atrazine, a pre-emergence herbicide was applied at 3 kg ha^{-1} immediately after sowing and that was followed by two hoe-weeding at 4 and 8 WAS.

Data Collection

The data collected include crop vigour, plant height, stem girth, leaf area index, shoot dry-matter, crop growth rate and days to 50% tasselling. All these parameters were subjected to statistical analysis of variance (ANOVA) using SAS package at probability 0.05 and the means separated using Duncan's Multiple Range Test.

RESULTS AND DISCUSSION

Results of this investigation showed that, growth parameters in maize were positively influenced by soil applied NPK fertilizer rates. Plant height, crop vigour, stem girth, leaf area index, shoot dry-matter and crop growth rate (CGR) increased significantly with increasing NPK rates to 90:45:45 kg N,P_2O_5,K_2O ha^{-1} + 6 lha folia (Boost-Extra) fertilizer at 9 and 12 WAS (Table 1, 2, 3, 4, 5 and 6 respectively). Further increase in NPK rate (120:60:60 kg N,P_2O_5,K_2O ha^{-1}) had no significant increase among the observed characters. This shows that the plateau level of the maize vegetative growth was attained at fertilizer application rate of 90:45:45 kg N,P_2O_5,K_2O ha^{-1} + 6 lha folia (Boost-Extra) fertilizer dose. However, at 6 WAS, application of 60:30:30 kg N,P_2O_5,K_2O ha^{-1} + 6 lha folia (Boost-Extra) fertilizer produced similar effects with 90:45:45 kg N,P_2O_5,K_2O ha^{-1} + 6 lha folia (Boost-Extra) fertilizer under plant height, leaf area index (LAI), shoot dry-matter and crop growth rate (CGR). Whereas plant height, stem girth, LAI and shoot dry-matter showed no significant difference at 3 WAS under all fertilizer treatments. (Table 1, 3, 4 and 5, respectively).

However, application of 6 lha^{-1} Boost-Extra foliar fertilizer was observe to increase crop vigour at 3 WAS when no fertilizer was applied (Table 1). This could be attributed to less nutrient demand by the maize plants at that tender stage and also, the fresh thin leaves of the maize plants, which were highly permeable to absorb foliar feeding efficiently. This result is in consonant with Renuka *et al* (2002), who reported premature lost of chlorophyll in leaves could be retarded by applying foliar N fertilizer. Moreover, Ling and Moshe (2007), reported increase in leaf area and leaf chlorophyll contents of maize in response to weekly application of different forms of foliar fertilizer. According to these authors, foliar fertilizer might partially compensate for insufficient uptake by the roots, but requires sufficient leaf area to become effective. This attribute could largely depend on the ability of leaf area index (LAI) to absorb foliar applied nutrients for assimilation.

Table 1: Effects of variety and fertilizer on plant height (cm) of maize at 3, 6, 9 and 12 WAS grown at Mubi in 2012 rainy season

TREATMENTS		3 WAS	6 WAS	9 WAS	12 WAS
Variety					
Oba 98		19.80	81.01	134.04a	156.08a
TZSR-W		18.72	79.16	129.90b	151.34b
S.E ±		1.391	1.984	0.159	0.200
Level of Significance		ns	Ns	*	*
Fertilizer					
NPK + (kg ha^{-1})	Boost-Extra (l ha^{-1})				
0:0:0 +	0	18.98	53.23c	115.61d	133.82d
120:60:60 +	6	19.39	96.35a	141.40a	165.83a
90:45:45 +	6	19.50	95.43a	141.14a	165.27a
60:30:30 +	6	19.36	93.65a	137.58b	161.42b
30:15:15 +	6	19.45	72.30b	130.99c	150.45c
0:0:0 +	6	19.02	53.32c	115.74d	133.50d
120:60:60 +	0	19.13	96.30a	141.35a	165.70a
S.E ±		0.942	0.405	0.402	0.704
Level of Significance		ns	*	*	*

Mean values with the same letter in each treatment group are not significantly different at P = 0.05 (DMRT).
** = Statistically significant difference at 5% level of probability.*
ns = Not significantly different at 5% level of probability.
WAS = Weeks after sowing.

Table 2: Effects of variety and fertilizer on vigour score of maize at 3, 6, 9 and 12 WAS grown at Mubi, in 2012 rainy season

TREATMENTS		3 WAS	6 WAS	9 WAS	12 WAS
Variety					
Oba 98		3.92	3.39	3.32	3.19
TZSR-W		3.91	3.34	3.26	3.14
S.E ±		0.024	0.020	0.012	0.034
Level of Significance		ns	Ns	ns	ns
Fertilizer					
NPK + (kg ha^{-1})	Boost-Extra (l ha^{-1})				
0:0:0 +	0	3.33d	2.27d	2.16d	2.00c
120:60:60 +	6	4.20a	4.00a	3.95a	4.00a
90:45:45 +	6	4.13a	4.00a	3.96a	4.00a
60:30:30 +	6	4.10a	3.76b	3.74b	3.16b
30:15:15 +	6	3.92b	3.20c	3.03c	3.00b
0:0:0 +	6	3.60c	2.35d	2.23d	2.00c
120:60:60 +	0	4.13a	4.00a	3.96a	4.00a
S.E ±		0.045	0.027	0.040	0.063
Level of Significance		*	*	*	*

Mean values with the same letter in each treatment group are not significantly different at $P \leq 0.05$ (DMRT).
** = Statistically significant difference at 5% level of probability.*
ns = Not significantly different at 5% level of probability.
WAS = Weeks after sowing.

In the current investigation, application of foliar fertilizer (6 lha^{-1} Boost-Extra) was found inadequate to support vegetative growth performance of maize at 6, 9 and 12 WAS for economic benefit. Moreover, according to Ling and Silberush (2002), foliar fertilizer containing NPK can only be used as a supplement to soil applied fertilizer but cannot replace soil fertilizer in the case of maize plant. This is because maize is a heavy feeder plant owing to its large nutrient demand.

This result of this investigation further revealed tasselling, which is a phonologic character was significantly delayed by application of soil NPK (N,P_2O_5,K_2O) fertilizer (Table 7). Maize plants deprived of soil applied NPK fertilizer came to tasselling three days earlier than those treated with soil-applied NPK fertilizer. This implies that, the soil

NPK fertilizer promoted vegetative growth to delay tasselling significantly. This indicates that, the primary nutrients for maize growth and yield are provided from NPK fertilizer. Where nitrogen (N) is essential element for building up protoplasm, amino acids and proteins, which induce cell division and initiate meristimatic activity. While phosphorus (P) is part of molecular structure of nucleic acid, the energy transfer compounds and also, proteins. Whereas, potassium (K) is a necessary element for overall metabolic and enzymatic activities, especially photosynthesis (Yuncai *et al*, 2008). All these factors translate to proper growth and development in maize plant.

Emerson (2008) reported nitrogen deficiency at early growth stage of maize resulted to smaller leaves. From the present investigation, non-fertilized and sole foliar Boost-Extra fertilizer treated plants produced narrow leaves that could not intercept adequate sunlight for photosynthesis and consequently, resulted into poor vegetative growth and development bearing the least shoot dry-matter (Table 6). This is in accordance with Mahmoodi *et al* (2011), who reported nitrogen availability in maize plant leads to increased leaf duration and promotes photosynthates concentration, which increases yield potential of a maize crop.

Table 3: Effects of variety and fertilizer on stem girth (cm) of maize at 3, 6, 9 and 12 WAS grown at Mubi, in 2012 rainy season

TREATMENTS		3 WAS	6 WAS	9 WAS	12 WAS
Variety					
Oba 98		0.92	2.20	2.44a	2.78a
TZSR-W		0.91	2.09	2.28b	2.64b
S.E ±		0.073	0.15	0.012	0.015
Level of Significance		ns	Ns	*	*
Fertilizer					
NPK + (kg ha^{-1})	Boost-Extra (l ha^{-1})				
0:0:0 +	0	0.90	2.06	2.05d	2.24d
120:60:60 +	6	0.92	2.21	2.59a	3.01a
90:45:45 +	6	0.92	2.21	2.57a	2.97a
60:30:30 +	6	0.92	2.17	2.50b	2.86b
30:15:15 +	6	0.91	2.13	2.17c	2.62c
0:0:0 +	6	0.90	2.04	2.05d	2.23d
120:60:60 +	0	0.92	2.20	2.62a	3.02a
S.E ±		0.032	0.176	0.030	0.018
Level of Significance		ns	Ns	*	*

Mean values with the same letter in each treatment group are not significantly different at P ≤ 0.05 (DMRT).
** = Statistically significant difference at 5% level of probability.*
ns = Not significantly different at 5% level of probability.
WAS = Weeks after sowing.

Table 4: Effects of variety and fertilizer on leaf area index (LAI) of maize plant at 3, 6, 9 and 12 WAS grown at Mubi, in 2012 rainy season

TREATMENTS		3 WAS	6 WAS	9 WAS	12 WAS
Variety					
Oba 98		0.18	1.62	2.61a	2.88a
TZSR-W		0.17	1.58	2.10b	2.32b
S.E ±		0.08	0.172	0.005	0.004
Level of Significance		ns	ns	*	*
Fertilizer					
NPK + (kg ha^{-1})	Boost-Extra (l ha^{-1})				
0:0:0 +	0	0.17	1.00c	1.98d	2.12d
120:60:60 +	6	0.18	1.92a	2.56a	2.90a
90:45:45 +	6	0.18	1.89a	2.56a	2.86a
60:30:30 +	6	0.18	1.90a	2.48b	2.73b
30:15:15 +	6	0.17	1.52b	2.31c	2.51c
0:0:0 +	6	0.17	1.02c	2.00d	2.12d
120:60:60 +	0	0.18	1.93a	2.59a	2.89a
S.E ±		0.134	0.015	0.022	0.015
Level of Significance		ns	*	*	*

Mean values with the same letter in each treatment group are not significantly different at P ≤ 0.05 (DMRT).
** = Statistically significant difference at 5% level of probability.*
ns = Not significantly different at 5% level of probability.
WAS = Weeks after sowing.

Table 5: Effects of variety and fertilizer on shoot dry-matter (g.plant^{-1}) of maize at 3, 6, 9 and 12 WAS grown at Mubi, in 2012 rainy season

TREATMENTS		3 WAS	6 WAS	9 WAS	12 WAS
Variety					
Oba 98		1.20	31.63a	110.14a	180.47a
TZSR-W		1.11	29.91b	106.02b	155.35b
S.E ±		0.310	0.249	0.177	0.586
Level of Significance		ns	*	*	*
Fertilizer					
NPK + (kg ha^{-1})	Boost-Extra (l ha^{-1})				
0:0:0 +	0	1.06	13.60c	60.00d	116.22d
120:60:60 +	6	1.11	40.31a	139.80a	202.08a
90:45:45 +	6	1.10	39.68a	138.65a	199.98a
60:30:30 +	6	1.09	38.86a	125.95b	186.13b
30:15:15 +	6	1.60	27.9b	92.28c	151.74c
0:0:0 +	6	1.04	13.58c	60.13d	117.23d
120:60:60 +	0	1.10	44.04a	138.79a	201.99a
S.E ±		0.575	0.572	0.494	0.638
Level of Significance		ns	*	*	*

Mean values with the same letter in each treatment group are not significantly different at P ≤ 0.05 (DMRT).
** = Statistically significant difference at 5% level of probability.*
ns = Not significantly different at 5% level of probability.
WAS = Weeks after sowing.

Table 6: Effects of variety and fertilizer on crop growth rate (g.plant^{-1}.day^{-1}) of maize at 6, 9 and 12 WAS grown at Mubi, in 2012 rainy season

TREATMENTS		6 WAS	9 WAS	12 WAS
Variety				
Oba 98		1.51a	3.78a	3.32
TZSR-W		1.45b	3.57b	2.36
S.E ±		0.026	0.051	0.013
Level of Significance		*	*	*
Fertilizer				
NPK + (kg ha^{-1})	Boost-Extra (l ha^{-1})			
0:0:0 +	0	0.77d	2.27d	2.68c
120:60:60 +	6	1.98a	4.53a	2.94a
90:45:45 +	6	1.96a	4.54a	2.95a
60:30:30 +	6	1.94a	4.20b	2.85b
30:15:15 +	6	0.93c	3.39c	2.82b
0:0:0 +	6	0.78d	2.27d	2.69c
120:60:60 +	0	1.99a	4.52a	2.96a
S.E ±		0.014	0.018	0.016
Level of Significance		*	*	*

Mean values with the same letter in each treatment group are not significantly different at P ≤ 0.05 (DMRT).
** = Statistically significant difference at 5% level of probability.*
ns = Not significantly different at 5% level of probability.
WAS = Weeks after sowing.

Table 7: Days to 50% tasseling of maize grown at Mubi, in 2012 rainy seasons

Fertilizer		
N,P_2O_5,K_2O + (kg ha^{-1})	Boost-Extra (l ha^{-1})	No. of days
0:0:0 +	0	55.50b
120:60:60 +	6	57.50a
90:45:45 +	6	57.50a
60:30:30 +	6	57.66a
30:15:15 +	6	57.33a
0:0:0 +	6	56.00b
120:60:60 +	0	58.00a
S.E ±		0.215
Level of Significance		*

Mean values with the same letter(s) in each treatment group are not significantly different at P ≤ 0.05 (DMRT).
** = Statistically significant different at 5% level of probability.*

CONCLUSION

The result of this investigation indicated the application of 120:60:60 kg N,P_2O_5,K_2O ha^{-1} + 6 lha^{-1} Boost-Extra foliar fertilizer, 90:45:45 kg N,P_2O_5,K_2O ha^{-1} + 6 lha^{-1} Boost-Extra foliar fertilizer and only 120:60:60 kg N,P_2O_5,K_2O ha^{-1} without Boost-Extra foliar fertilizer showed similar response which significantly recorded the highest effects on plant height, crop vigour, stem girth, leaf area index, shoot dry-matter and crop growth. Based on results of this study, application of 90:45:45 kg N,P_2O_5,K_2O ha^{-1} was found adequate to support vegetative growth of maize. Further fertilizer increase beyond 90:45:45 kg N,P_2O_5,K_2O ha^{-1} might have positive effects on yield or yield components of maize.

The application of Boost-Extra (6 lha^{-1}) produce vigourous plants against non-fertilized plants only at 3 WAS. the Boost-Extra (6 lha^{-1}) foliar fertilizer was not able to support vegetative growth of maize plant at later stage (6, 9 and 12 WAS). Thus, foliar fertilizer might be used to alleviate plant shock or recover drought stress for crops at tender age.

Tasselling, which is a phonologic character was significantly delayed by application of soil applied NPK (N,P_2O_5,K_2O) fertilizer. This reveals that, the soil NPK fertilizer promotes vegetative growth, which could translate into productive end yields.

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