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Effects of Combined Application of NPK and Foliar Fertilizer (Boost-Extra) On Yield and Yield Components of Maize (*Zea mays L.*) In Mubi, Northern Guinea Savannah Zone of Nigeria

***TOUNGOS Mohammed Dahiru (Ph.D) [1]; Nedamanya BAMAI [2] & Kwaga M. YAMMA (Ph.D) [3]**

Faculty of Agriculture, Department of Crop Science
Adamawa State University, P.M.B 25, Mubi
Adamawa State, Nigeria

***Corresponding Author: Toungos Mohammed Dahiru**
Email: *dahiru.toungos@gmail.com ; toungosm@adsu.edu.ng*

ABSTRACT

A field trial was carried out in 2012 at Teaching and Research Farm of Adamawa State University, Mubi, which falls within northern Guinea Savanah zone of Nigeria. The study was to determine the effect of combined application of Boost-extra foliar fertilizer and NPK levels on yield and yield components of maize. A split-plot design was adopted for the trial 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 l ha^{-1} Boost-Extra; T_3 = 90:45:45 kg N,P_2O_5,K_2O ha^{-1} + 6 l ha^{-1} Boost-Extra; T_4 = 60:30:30 kg N,P_2O_5,K_2O ha^{-1} + 6 l ha^{-1} Boost-Extra; T_5 = 30:15:15 kg N,P_2O_5,K_2O ha^{-1} + 6 l ha^{-1} Boost-Extra; T_6 = 0:0:0 kg N,P_2O_5,K_2O ha^{-1} + 6 l ha^{-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. The maize yield components and grain yield were subjected to statistical analysis of variance (ANOVA) using SAS package at probability 0.05. The means were separated using Doncan's Multiple Range Test (DMRT). Results of the study showed application of foliar fertilizer (Boost-Extra at 6 l ha^{-1} rate) had shown no significant effect on maize grain yield and yield components, even when in combination with soil applied NPK. Maize cob diameter increased with increasing application of NPK to 60:30:30 kg^1 N,P_2O_5,K_2O ha^{-1}, while cob diameter, shelling percentage and 100-grain weight increased with increasing NPK rate up to 90:45:45 kg^1 N,P_2O_5,K_2O ha^{-1}. However, grain yield was further enhanced with increasing soil NPK fertilizer dose up to 120:60:60 kg N,P_2O_5,K_2O ha^{-1}, regardless of Boost-Extra. Application of soil fertilizer 120:60:60 kg N,P_2O_5,K_2O ha^{-1} recorded the highest grain yield, thus, recommended for optimum maize production in Mubi Area, Northern Guinea Savannah Zone of Nigeria.

Keywords: Boost-Extra foliar fertilizer, NPK soil applied fertilizer, maize (*Zea mays* L.)

INTRODUCTION

Maize *(Zea mays)* is a member of Poaceae family. The crop originated from South and Central America. Maize is a versatile crop that grows across a wide range of agro-ecological zones of Nigeria and this is due to its high adaptability. The crop is one of the important cereal crops in Nigeria, not only on the basis of its cultivation, but also its economic value (Iken and Amusa, 2004). Reports have shown that, maize is an important staple food crop not only in Nigeria, but even in Africa (Olakojo *et al.*, 2005; Bryceson, 2009). In Nigeria, virtually all tribes consume maize; the fresh maize cobs are boiled or roasted and consumed locally, while the dry grains are ground into flour to prepare various food items such as solid food called '*tuwo'* or semi-solid food *'pap'*. corn-oil, a high quality oil (cholesterol-free) is also extracted from the grain and the grain can be processed into industrial starch.

Nigerian farmers have for long relied on shifting cultivation as a means of restoring soil fertility. But with the geometric increase in human population and scarcity of arable land, long fallow periods are no longer practicable. Therefore, to obtain optimum maize crop yield, fertilizer application is one input that plays a vital role. However, the precise requirement of fertilizer by maize relies majorly upon the fertility status of the soil, previous cropping history and the variety in question to be grown. 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 fertilizers are concentrated solutions containing desired elements to be applied in minute amount to the foliage of plants. This method seems to provide for rapid nutrient utilization and to enable correction plant stress and deficiencies (Havlin *et al.*, 2005). According to these authors, responses from foliar fertilizers are often temporary and this could be due to the minute amount of nutrient incorporated. Foliar fertilizers have been used by horticulturists, as a means of supplying supplemental doses of nutrients, plant hormones, phyto-stimulants, and other beneficial substances.

From the work of Sawyer (2009), no yield response was recorded from application of foliar fertilizer (low-biuret and mono-potassium phosphate) at four growth stages of maize, starting from sixth leaf to tasselling stage. Moreover, Asumada *et al* (2002), reported that, the application of inorganic fertilizer alone was more economical than sole Asontem foliar fertilizer or in combination with lower dosage of inorganic fertilizer. The result of these investigators showed application of NPK 90:38:38 kg ha^{-1} had significantly out-yielded even the combination of NPK 38:38:38 kg ha^{-1} plus high dose of Asontem foliar fertilizer. However, Ling and Silberush (2002), reported that foliar fertilizer containing NPK could be used as a supplement to soil applied fertilizer but cannot replace soil fertilizer in the case of maize. The observed effects of foliar fertilizers could depend on plant species, the form and composition of the fertilizer, concentration, and frequency of application, as well as a plant growth stage.

MATERIALS AND METHOD

Experimental site

A field trial was conducted in 2012 rainy seasons at Teaching and Research Farm, Adamawa State University, Mubi located between Latitude $9^0\ 30^1$ to $11^0 88^1$ N and Longitude $12^0 00$ to $13^0\ 45^1$ E. This falls within northern Guinea Savannah zone of Nigeria. The total mean annual rainfall during the year 2012 was 1343.1 mm with the peak of the rainy season within August to September (ADSU Meteorological Unit, 2013).

Treatments and experimental Design

Split-plot design was adopted for the experiment. Two maize varieties (Oba-98 hybrid and TZSR-W) were the main treatments and the sub-treatments comprised seven fertilizer levels, which were combinations of soil applied granular NPK fertilizer levels and Boost-Extra foliar fertilizer:

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 l ha^{-1} Boost-Extra
T_3:	=	90:45:45 kg	$N,P_2O_5,K_2O\ ha^{-1}$	+	6 l ha^{-1} Boost-Extra
T_4:	=	60:30:30 kg	$N,P_2O_5,K_2O\ ha^{-1}$	+	6 l ha^{-1} Boost-Extra
T_5:	=	30:15:15 kg	$N,P_2O_5,K_2O\ ha^{-1}$	+	6 l ha^{-1} Boost-Extra
T_6:	=	0:0:0 kg	$N,P_2O_5,K_2O\ ha^{-1}$	+	6 l ha^{-1} Boost-Extra
T_7:	=	120:60:60 kg	$N,P_2O_5,K_2O\ ha^{-1}$	+	0 l ha^{-1} Boost-Extra

These treatments 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. Two seeds were sown at a spacing of 25 cm x 75 cm on a harrowed soil, after seed treatment with Apron-plus 60D (10 g kg^{-1} of seeds). The emerged seedlings were thinned to one plant per stand at 2 weeks after sowing (WAS).

Fertilizer application and weed control

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. A split dose fertilizer application was adopted. Compound NPK fertilizer 15:15:15 grade was applied at 2 WAS according to the rate for each treatment, while the remaining half dose of N was applied at 6 WAS in the form of urea (46% N). Boost-Extra foliar fertilizer was applied at the rate of 3 l ha^{-1} at 2 and 6 WAS using a Knapsack sprayer.

Data Collection

The data collected include cob diameter, cob yield, shelling percentage, 100-grain weight and grain yield. The parameters were subjected to statistical analysis of variance at $P \leq 0.05$ and the means separated using Duncan's Multiple Range Test.

RESULTS AND DISCUSSION

From results of this trial, maize yield and yield components are positively influenced by soil applied NPK rates. Maize cob diameter increased with increasing NPK application to 60:30:30 kg N,P_2O_5,K_2O ha^{-1} dose (Table 1). Cob yield, shelling percentage and 100-grain weight increased significantly with increasing NPK rates up to 90:45:45 kg N,P_2O_5,K_2O ha^{-1} (Table 2, 3, and 4 respectively). Whereas grain yield further increased remarkably with increasing NPK rates up to 120:60:60 kg N,P_2O_5,K_2O ha^{-1} dose, regardless of Boost-Extra (Table 5). This shows that, the primary nutrients for grain yield and yield components were provided from NPK fertilizer. The stimulative effect of nitrogen is that, it is the essential element for building up protoplasm, amino acids and proteins, which induce cell division and initiate meristimatic activity. While phosphorus is part of molecular structure of nucleic acid, the energy transfer compounds and also, proteins. Whereas, potassium is necessary for overall metabolic and enzymatic activities, especially in photosynthesis (Yuncai *et al*, 2008). All these factors translate to proper dry matter synthesis, allocation, distribution and partitioning to result into high yields.

According to Mahmoodi *et al* (2011), nitrogen availability in maize plant leads to increased leaf duration and consequently photosynthates concentration, which causes increase in grain filling rate. Jones and Simons (2003) remark that, heavier grains result from proper grain filling, while, Guldan and Brun (1985); Munier-Julian *et al* (2004) indicated that, the rate of dry grain substance gathering is affected by nitrogen rate available for plant during the grain filling period. Emerson (2008) reported nitrogen deficiency at the early growth stage of maize could result to smaller leaves, which could not intercept adequate light.

From the present investigation, poor yield and yield components was observed from non-fertilized plants and sole Boost-Extra foliar fertilizer treated plants (Table 5). This is in cognizance with the work of Sawyer (2009), who reported no yield response from application of foliar fertilizer (low-biuret and mono-potassium phosphate) at four growth stages of maize, starting from sixth leaf to tasselling stage. Soil applied fertilizer to maize cannot be substituted with the low nutrient content of foliar fertilizer, since maize is a heavy feeder crop, owing to its large nutrient requirement. This is in conformity with the current investigation, which indicated application of 6 l ha^{-1} Boost-Extra was not able to meet nutrient requirement of maize for any economic benefit. This is in consonance with an observation made by Asumada *et al* (2012), who remarked that application of inorganic fertilizer alone was more economical than sole Asontem foliar fertilizer or in combination with lower dosage of inorganic fertilizer. The result of these investigators showed application of NPK 90:38:38 kg ha^{-1} had significantly out-yielded even the combination of NPK 38:38:38 kg ha^{-1} plus high dose of Asontem foliar fertilizer. This is also in accordance with Ling and Silberush (2002), who reported that, 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.

CONCLUSION

From result of this findings, application of 120:60:60 kg N,P_2O_5,K_2O ha^{-1} + 6 l ha^{-1} Boost-Extra foliar fertilizer, 90:45:45 kg N,P_2O_5,K_2O ha^{-1} + 6 l ha^{-1} Boost-Extra foliar fertilizer and 120:60:60 kg N,P_2O_5,K_2O ha^{-1} without Boost-Extra foliar fertilizer had similar effects and recorded the highest effects on crop vigour, stem girth, shoot dry matter as well as grain yield. However, the application of 120:60:60 kg N,P_2O_5,K_2O ha^{-1} with or without Boost-Extra foliar fertilizer out-yielded all other treatments in grain yield. Based on this result, application of 120:60:60 kg N,P_2O_5,K_2O ha^{-1} is recommended for cultivation of Oba-98 and TZSR-W in Mubi, Northern Guinea Savannah Zone of Nigeria, while the addition of 6 l ha^{-1} Boost-Extra foliar fertilizer for grain yield and yield components was unnecessary.

Table 1: Effect of variety and fertilizer on cob diameter of maize grown at Mubi, in 2012 rainy seasons.

TREATMENTS			Cob diameter (cm)
Variety			
Oba 98			4.27a
TZSR-W			3.67b
S.E ±			0.014
Level of Significance			*
Fertilizer			
NPK (kg ha^{-1})	+	Boost-Extra (l ha^{-1})	
0:0:0	+	0	3.67c
120:60:60	+	6	4.17a
90:45:45	+	6	4.15a
60:30:30	+	6	4.10a
30:15:15	+	6	3.85b
0:0:0	+	6	3.71c
120:60:60	+	0	4.14a
S.E ±			0.123
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.

Table 2: Effect of variety and fertilizer on cob yield of maize grown at Mubi, in 2012 rainy seasons.

TREATMENTS			**Cob yield** (kg ha^{-1})
Variety			
Oba 98			2185a
TZSR-W			1801b
S.E ±			0.854
Level of Significance			*
Fertilizer			
NPK (kg ha^{-1})	+	Boost-Extra (l ha^{-1})	
0:0:0	+	0	1108d
120:60:60	+	6	2663a
90:45:45	+	6	2630a
60:30:30	+	6	2169b
30:15:15	+	6	1642c
0:0:0	+	6	1097d
120:60:60	+	0	2659a
S.E ±			29.66
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.

Table 3: Effect of variety and fertilizer on shelling percentage (%) of maize grown in 2012 rainy seasons.

Treatments			**Shelling %**
Variety			
Oba 98			76.12
TZSR-W			75.64
S.E ±			1.874
Level of Significance			Ns
Fertilizer			
NPK (kg ha^{-1})	+	Boost-Extra (l ha^{-1})	
0:0:0	+	0	65.03d
120:60:60	+	6	82.45a
90:45:45	+	6	81.91a
60:30:30	+	6	79.65b
30:15:15	+	6	74.68c
0:0:0	+	6	65.11d
120:60:60	+	0	82.33a
S.E ±			29.66
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.

Table 4: Effect of variety and fertilizer on 100-grain weight of maize grown at Mubi, in 2012 rainy seasons.

TREATMENTS			**100-grain weight (g)**
Variety			
Oba 98			18.06
TZSR-W			17.65
S.E ±			0.496
Level of Significance			ns
Fertilizer			
NPK (kg ha^{-1})	+	Boost-Extra (l ha^{-1})	
0:0:0	+	0	13.05c
120:60:60	+	6	20.81a
90:45:45	+	6	20.69a
60:30:30	+	6	19.55ab
30:15:15	+	6	17.18b
0:0:0	+	6	12.92c
120:60:60	+	0	20.80a
S.E ±			0.139
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.

Table 5: Effect of variety and fertilizer on grain yield of maize Grown at Mubi, in 2012 rainy seasons.

TREATMENTS			Grain yield (kg ha^{-1})
Variety			
Oba 98			1764a
TZSR-W			1299b
S.E ±			3.85
Level of Significance			*
Fertilizer			
NPK (kg ha^{-1})	+	Boost-Extra (l ha^{-1})	
0:0:0	+	0	597e
120:60:60	+	6	2242a
90:45:45	+	6	2215b
60:30:30	+	6	1717c
30:15:15	+	6	1112d
0:0:0	+	6	598e
120:60:60	+	0	2241a
S.E ±			6.56
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.

Metrological Data, 2012

Month	*Rainfall (mm)*	*Max. Temperature (^0C)*	*Min. Temperature (^0C)*	*Relative Humidity (%)*
April	65.4	30.6	12.9	21.2
May	133.0	31.7	23.8	46.8
June	187.2	30.8	21.8	58.9
July	201.8	31.0	20.8	41.6
August	331.5	27.4	20.6	42.8
Sept	314.5	29.4	20.5	42.4
Oct	109.7	30.3	20.7	44.9
Total	**1343.1**	**211.2**	**141.1**	**298.5**
Mean	**191.9**	**30.2**	**20.2**	**42.6**

Source: Adamawa State University (ADSU, 2013) Mubi, Weather Meteorological Station

A composite soil sample (0 – 30cm depth) was collected before and after the experiment from twelve different points of the experimental field and some of its physical and chemical properties were determined. The soil was classified as sandy-loam with low cation exchange capacity. As presented in Table 4.1.

Table 4.1: Physical and chemical soil properties of the experimental site(0 – 30cm depth)

Chemical Properties	2011	2012
Particle size analysis (%)		
Sand	53.4	54.1
Silt	33.2	31.9
Clay	13.4	14.0
Texture	Sandy loam	Sandy loam
Chemical Properties		
Soil pH 1:2 (H_20)	6.20	5.90
Organic carbon(g kg^{-1})	3.6	3.8
Available P(mg kg^{-1})	6.48	6.88
Total N (g kg^{-1})	0.16	0.17
CEC[C mol (+)kg^{-1}]	3.20	3.44
Exchangeable bases[C mol (+) kg^{-1}]		
Ca	1.88	1.92
Mg	0.42	0.40
K	0.43	0.47
Na	0.36	0.34

Composition of boost-extra foliar fertilizer according to its container label.

Element	Quantity	(%)
Nitrogen	N	20%
Phosphate	P	20%
Potassium	K	20%
Magnesium	MgO	1.5%
Iron EDTA	Fe	0.15%
Manganese EDTA	Mn	0.075%
Copper EDTA	Cu	0.075%
Zinc EDTA	Zn	0.075%
Boron	B	0.0315%
Cobalt EDTA	Co	0.0012%
Molybdenum	Mo	0.0012%

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