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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

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Key words: Boost-Extra foliar fertilizer, NPK soil applied fertilizer, Maize (*Zea mays* L.).

Abstract

Field trial was carried out in 2012 at Teaching and Research Farm of Adamawa State University, Mubi in the Northern Guinea Savanah zone of Nigeria, to determine the effects of Boost-extra foliar fertilizer and NPK levels on yield and yield components of maize. A split-plot design consisting 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}+0l ha^{-1} Boost-Extra; T_2 = 120:60:60kg N,P_2O_5,K_2O ha^{-1}+6lha^{-1} Boost-Extra; T_3 = 90:45:45 kg N,P_2O_5,K_2O ha^{-1}+6lha^{-1} Boost-Extra; T_4 = 60:30:30kg N,P_2O_5,K_2O ha^{-1}+6lha^{-1} Boost-Extra; T_5 = 30:15:15kg N,P_2O_5,K_2O ha^{-1}+6lha^{-1} Boost-Extra; T_6 = 0:0:0kg N,P_2O_5,K_2O ha^{-1}+6lha^{-1} Boost-Extra; T_7 = 120:60:60kg N:P_2O_5:K_2O ha^{-1}+0l ha^{-1} Boost-Extra) replicated three times was adopted. Grain yield and yield components were analyzed using analysis of variance (ANOVA) with SAS package at P = 0.05. The means were separated using Duncan's Multiple Range Test (DMRT). Results of the study showed application of Boost-Extra at 6l ha^{-1} rate had no significant effect on maize grain yield and yield components, while grain yield was further enhanced with increasing soil fertilizer dose up to 120:60:60kg N:P_2O_5:K_2O ha^{-1}, regardless of Boost-Extra. Application of soil fertilizer 120:60:60kg N:P_2O_5:K_2O ha^{-1} gave the highest grain yield. Thus, application of soil fertilizer 120:60:60kg N:P_2O_5:K_2O ha^{-1} is recommended for optimum maize production in Mubi area, Northern Guinea Savannah Zone of Nigeria.

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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. The scarcity of arable land has led to greater intensification of crop production using modern inputs such as machineries and fertilizers with the aim of boosting yield in staple crops such as maize.

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, hence a number of fertilizer recommendations have been made for optimum maize yield in Nigeria. For instance, a balanced application of 60-120 kg N ha^{-1}, 40-6 kg ha^{-1} P_2O_5 and 40 kg ha^{-1} K_2O is recommended for maize in various ecosystems in Nigeria (Ado *et al.*, 2004). In addition, Kogbe and Adediran (2003) recommended 100 kg/ha N and 40kg/ha P as well as 150 to 200kg/ha N for optimum maize yield in the Derived Savannah and Southern Guinea Savannah agro-ecologies of Nigeria. In terms of yield Fabumi (2009) showed that fertilizer NPK 20:10:10 at 300kg/ha significantly increased yield and yield components of maize, with the grain yield increasing by 200% in the savannah zone of Nigeria. On the other hand, reports by Adie (2009) noted that there were significant increases in grain yield and growth parameters in maize upon addition of NPK 15:15:15 fertilizer at the rates of 250, 500 and 750kg/ha over the control 0kg/ha in the southern part of Nigeria. With regards to the application of a mixture of soil based NPK fertilizer with foliar fertilizer, Boost Extra; 2.5 t ha^{-1} poultry manure, 30kg N ha^{-1} and some quantity of foliar fertilizer Boost Extra was reported to have increased yield and yield components in maize in Nigeria (Afe, *et al.*, 2015).

Thus, it can be deduced that considerable attention has been paid to application of soil based fertilizers to maize at various rates with an observed trend that shows increases in yield upon fertilizer application especially NPK. However, what is not well reported is the application of soil fertilizers in conjunction with foliar fertilizers. The application of foliar fertilizers in conjunction with soil based fertilizers is not a common practice in Nigeria. Although there is a lot of information on fertilizer requirements of maize and the various rates that can induce optimum yields of the crop in Nigeria, there is little knowledge of the modalities and advantages of application of foliar fertilizers in conjunction with soil based fertilizers. It is therefore important to explore this approach to fertilizer application especially to maize which is a major staple food in Nigeria so as to options in fertilizer application to crops for farmers. Understanding this mode of fertilizer application will be useful to maize farmers, farm technologists, policy makers and fertilizer manufacturers, and this could result into greater crop yield.

Foliar fertilizers are concentrated solutions containing desired elements to be applied in minute amount to the foliage of plants. This method provides for rapid nutrient utilization and enable correction of plant stress and nutrient deficiencies however, response from foliar fertilizers are often temporary and this could be due to the minute amount of nutrient incorporate (Havlin *et al.*, 2005).

However, given their roles in horticulture as a means of supplementing nutrient doses in horticultural plants, it is possible that foliar fertilizers in conjunction with soil based fertilizers could increase arable crop yields.

The aim of this study is to determine the effects of combined application of NPK (a soil based fertilizer) and foliar fertilizer (Boost Extra) on the yield and yield components of maize.

Materials and methods

Experimental site

The field trial was conducted in 2012 rainy seasons at Teaching and Research Farm, Adamawa State University, Mubi located between Latitude $9^{o}30^{1}$ to $11^{o}88^{1}$ N and Longitude $12^{o}00$ to $13^{o}45^{1}$E. This falls within northern Guinea Savannah zone of Nigeria with a 1343.1 mm total mean annual rainfall during the year 2012, andthe 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 with two maize varieties (Oba-98 hybrid and TZSR-W) as the main treatments and the sub-treatments comprised seven fertilizer levels, which were combinations of soil applied granular NPK fertilizer at various ratios and Boost-Extra foliar fertilizer at different doses as follows:

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} + 6l 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- + 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,

Sowing and spacing

The seeds were treated with Apron-plus 60D (10gkg^{-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 (10g 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 3kg 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. 100-grain weight, Maize cob diameter, cob yield, shelling percentage increased significantly with increasing NPK rates up to 90:45:40kg N,P_2O_5,K_2O ha^{-1} (Tables 1, 2, 3, 4 and 5 respectively). Whereas the grain yield increased remarkably with increasing NPK rates up to 120:60:60kg 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 the NPK fertilizer as the nitrogen component is the essential element for building up protoplasm, amino acids and proteins, which induce cell division and initiate meristimatic activity leading up to growth and development. While phosphorus is part of molecular structure of nucleic acid, and potassium is necessary for overall metabolic and enzymatic activities, especially in photosynthesis (Yuncai *et al.*, 2008). All these factors translate to sufficient dry matter synthesis, allocation, distribution and partitioning to result into high yields.

Table 1. 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		17.64a
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.

Table 2. 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		18.08
TZSR-W		17.63
S.E ±		0.076
Level of Significance		ns
Fertilizer		
NPK + (kg ha^{-1})	Boost-Extra (l ha^{-1})	
0:0:0 +	0	13.05d
120:60:60 +	6	20.81a
90:45:45 +	6	20.69a
60:30:30 +	6	19.55b
30:15:15 +	6	17.18c
0:0:0 +	6	12.92d
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 3. Effect of variety and fertilizer on cob diameter of maize grown at Mubi, in 2012 rainy seasons.

Treatments		Cob diameter
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	1091d
120:60:60 +	6	2625a
90:45:45 +	6	2572a
60:30:30 +	6	2167b
30:15:15 +	6	1637c
0:0:0 +	6	1030d
120:60:60 +	0	2621a
S.E ±		84.40
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 cob yield of maize grown at Mubi, in 2012 rainy seasons.

Treatments	Cob yield	
Variety		
Oba 98		2268a
TZSR-W		1798b
S.E ±		0.954
Level of Significance		*
Fertilizer		
NPK + (kg ha^{-1})	Boost-Extra (l ha^{-1})	
0:0:0 +	0	1128d
120:60:60 +	6	2663a
90:45:45 +	6	2630a
60:30:30 +	6	2169b
30:15:15 +	6	1642c
0:0:0 +	6	1097e
120:60:60 +	0	2659a
S.E ±		39.66
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.

Table 5. Effect of variety and fertilizer on shelling percentage (%) of maize grown at Mubi, in 2011 and 2012 rainy seasons.

Treatment		2011	2012	Combined
Variety				
Oba-98		76.12	76.53a	76.32a
TZSR-W		75.23	75.23b	75.23b
S.E ±		0.163	0.105	0.114
Level of Significance		ns	*	*
Fertilizer				
N,P_2O_5,K_2O + (kg ha^{-1})		Boost-Extra (l ha^{-1})		
0:0:0 +	0	64.52d	65.03d	64.78d
120:60:60 +	6	82.12a	82.45a	82.28a
90:45:45 +	6	81.82a	81.91a	81.87a
60:30:30 +	6	79.53b	79.65b	79.59b
30:15:15 +	6	75.13c	74.68c	74.90c
0:0:0 +	6	64.55d	65.11d	64.81d
120:60:60 +	0	82.04a	82.33a	82.19a
S.E	±	0.213	0.283	0.177
Level of Significance		*	*	*
Interaction, Var. x Fertilizer		*	*	*

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

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. Reports have indicated that, the rate of dry grain substance gathering is affected by nitrogen availability to plants during the grain filling period (Guldan and Brun, 1985; Munier-Julian *et al.*, 2004). Thus, nitrogen supply via NPK addition to crops in this experiment led to adequate grain filling resulting into heavier grains (Jones and Simons, 2003). From the present investigation, poor yield and yield components was observed from non-fertilized plants and sole Boost-Extra foliar fertilizer treated plants (Table 6). A similar result was obtained by Sawyer (2009), which 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. This implies that soil applied fertilizer cannot be substituted with the low nutrient content foliar fertilizerin maize, since maize is a heavy feeder crop, with high nutrient requirements.

Consequently, in the current investigation, application of 6 l ha^{-1} Boost-Extra was not able to meet the nutrient requirement of maize for any economic benefit.

Similar results were found by Asumada *et al,* (2012), which showed that application of NPK 90:38:38kg ha^{-1} in maize had significantly out-yielded even the combination of NPK 38:38:38kg ha^{-1}in conjunction with a high dose of Asontem foliar fertilizer. Accordingly, Ling and Silberush (2002) observed 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.

Table 6. Metrological data of Mubi, Nigeria during the 2012 growing season.

Month	Rainfall (mm)	Max. Temperature (°C)	Min. Temperature (°C)	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 (Table 6).

Cob Yield

The two varieties had similar cob yield in 2011, but in 2012 and the combined data, Oba 98 out yielded TZESR-W (15). The cob yield varies significantly in response to NPK levels (Table 4). From results of 2011 and the combined analyses, the cob yield obtained from treatment effects NPK 120:60:60 + Boost-Extra 6lha^{-1}, NPK 90:45:45 + Boost-Extra 6lha^{-1} and sole NPK 120:60:60 were statistically the same and yielded higher cobs than treatment NPK 60:30:30 + Boost-Extra 6lha^{-1}, which was followed by treatment NPK 30:15:15 + Boost-Extra 6lha^{-1}. Application of Boost-Extra (6lha^{-1}) was not significantly different from the cob yield obtained from the control treatment, and they both had the least cob yield throughout the experimental years. In 2012, highly significant variability was observed among the cob yields across the fertilizer treatments.

Treatments NPK 120:60:60 + Boost-Extra 6lha^{-1} and NPK 120:60:60 without Boost-Extra were at par and significantly produced the highest cob yield. However, sole NPK 120:60:60 was still similar to NPK 90:45:45 + Boost-Extra 6lha^{-1}, which yielded lower cobs than NPK 120:60:60 + Boost-Extra 6Lha^{-1}. The cob yield was observed to decrease significantly along application levels of NPK 60:30:30 + Boost-Extra 6lha^{-1} and NPK 30:15:15 + Boost-Extra 6lha^{-1}, respectively in contrast to the finding of Afe, *et al.*, (2015). The decrease in cob yield along application levels would require further investigations.

Cob Diameter

Cob diameter of oba 98 differed significantly over TZESR-W (Table 3). The cob diameter was positively influenced by NPK rates in 2011. The effect of treatments NPK 120:60:60 + Boost-Extra 6lha^{-1}, NPK 90:45:45 + Boost-Extra 6lha^{-1} and sole NPK 120:60:60 were comparable in cob diameter and produced significantly higher cob diameter than the other treatments. NPK 60:30:30 + Boost-Extra 6lha^{-1} and then NPK 30:15:15 + Boost-Extra 6lha^{-1}, respectively. Boost-Extra application alone and the control treatment showed no significant effect on cob diameter and recorded the least cob diameter throughout the study.

In 2012, as well as the combined season analysis, treatments NPK 120:60:60 + Boost-Extra 6Lha^{-1} and sole NPK 120:60:60 were statistically at par and exhibited greater cob diameter than the other treatments. These were followed by the cob diameter obtained from treatment NPK 90:45:45 + boost-Extra 6lha^{-1}, treatment NPK 60:30:30 + Boost-Extra 6lha^{-1} and then NPK 30:15:15 + Boost-Extra 6lha^{-1}, respectively. Sole Boost-Extra (6lha^{-1}) and zero fertilizer treatments gave comparable cob diameter which was the least. There was significant interaction between variety and fertilizer with respect to cob diameter in the two years combined.

Table 7. 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_2o)	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

Table 8. Composition of boost-extra foliar fertilizer according to its container label.

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

Conclusion and Recommendation

From result of these experiments, application of 120:60:60kg $N:P_2O_5:K_2O$ ha^{-1} + 6l ha^{-1} Boost-Extra foliar fertilizer and sole 120:60:60kg $N:P_2O_5:K_2O$ ha^{-1}significantly increased yield and yield components of maize over other treatment combinations. Therefore, application of 120:60:60kg $N:P_2O_5:K_2O$ ha^{-1} could be recommended for higher yield and yield components of the two maize varieties (Oba-98 and TZSR-W) in Mubi, Northern Guinea Savannah Zone of Nigeria. Whereas, application of 6 l ha^{-1} Boost-Extra solely did not give any significant increase in yield components and offers no economic gain in the cultivation of the maize varieties in this study, so could not be recommended for higher maize yield in the area.

References

Adamawa State University. Mubi, Weather Station Report (2012). Meteorological Data 2011 and 2012 Rainy Seasons.

Adeyemi A. 2009. Effects of cultivars and rates of NPK (15:15:15) on growth, development and yield of maize. Nigerian Journal of Soil Science, **19**, 123-135.

Ado SG, Adamu RS, Hussaini MA, Maigida DN, Zaraafi AB. 2004. Cereals in Nigeria. Principles of Production and Utility. 86-91. (Ed) N.U.A. Iden and F.A. Showemimo. Inst. For Agricultural Research, ABU Zaria, Nigeria.

Afe AI, Atanda S, Adedojo MO, Ogundare SK, Talabi AA. 2015. Response of Maize (*Zea mays* L.) to combined application of organic and inorganic (soil and foliar applied) fertilizers. African Journal of Biotechnology **14**, 3006-3010.

Asumadu H, Adu-Dapaah HK, Obosu-Ekyem S. 2012. Response of Maize to Organic Foliar Fertilizer and its Economic Implications to Farmers in Ghana. International Journal of Agric Reasearch. **7,9** :439-448. DOI: 10.3923/ijar.2012.439.448.

Bryceson DF. 2009. Sub-Saharan Africa's Vanishing Peasantries and the Specter of a Global Food Crisis. www.monthlyreview.org/090720bryceson

Fabunmi TO. 2009. Effect of different split application of NPK fertilizer on growth and yield of maize and economic returns. Nigeria Agricultural Journal. **40**, 1 -2. 450-462.

Guldan SJ. Brun WA. 1985. Relationship of cotyledon cell number and seed respiration to soybean seed growth. Crop Sci **25**, 815-819.

Havlin John L, James D, Beaton Samuel L, Tisdale and Werner-Nelson L. 2005. Soil Fertility and Fertilizers: An Introduction to Nutrient Management (7th Edition). New Delhi, 391.

Jones RR, Simmons SR. 2003. Effect of altered source-sink ratio on Nitrogen dynamics in soil crop system and grain production processes in rice: influence of nitrogen pattern as induced by its different application on the growth and yield formation processes. Journal of Agric. Sci **33**, 2: 171: 80.

Kogbe JOS, Adediran JA. 2003. Influence of nitrogen, phosphorus and potassium application on the yield of maize in the savanna zone of Nigeria. African Journal of Biotechnology **2**, 10, 345-349.

Ling F, Moshe Silberbrush. 2002. Response of maize to foliar, Soil application of nitrogen-phosphorus- potassium Fertilizers. Journal of Plant Nutrition **25**, 11: 2333-2342.

Ling Fan and Moshe Silberbush. 2007. Response of Maize to Foliar Vs. Soil Application of Nitrogen–Phosphorus–Potassium Fertilizers.Journal of Plant Nutrition10.1081/PLN-120014698: 2333-2342. First published: 14th Feb 2007.

Mahmoodi P, Yarnia M, Amirnia R, Khorshidi MB. 2011. Effect of nitrogen foliar application on grain filling rate and period in 3 cultivars of corn (*Zea mays* L.). African Journal of Agricultural Research. Vol. **6**, 29, 6226-6231, 5 December, 2011. ISSN 1991-637X.

Munier-Jolian NG, Munier-Jolian NM, Roch R, Duthion C. 2004. Seed growth in Legumes: I: Effect of photo-assimilates availability on seed growth rate. Journal of Experimental Botany **49**, 1963-1969.

Olakojo SA, Kogbe JO, Iken JE, Daramola AM. 2005. Yield and Disease Evaluation of Some Improved Maize (*Zea mays* L) varieties in South Western Nigeria. Trop. Subtrop. Agroecosyst **5,** 51-55.

Osagie AU, Eka OU. 1998. Nutritional Quality of Plant Foods. Post Harvest Research Unit, University of Benin, Benin 34-41.

Renuka R, Yoncong L, Herbert HB, Steward TR, Florence DA. 2002. Assessment of foliar Spray to alleviate flooding Injury in Corn (*Zea mays* L.). Proc. Fla. State Hort. Soc. **115,** 208-211.

Sawyer J. 2009. Foliar fertilization of corn and soybean. ICM News, Iowa State University, Extension and Outreach Integrated Crop Management. www.crops.extension.iastate.edu/cropnews/2009/07/foliar-fertilization-corn-nd soybean.

Yuncai Bur, Hucs Z, Schmidhalt U. 2008. Effect of foliar fertilization application on the growth and mineral nutrient content of maize seedling under drought and salinity. Soil Science and Plant Nutri