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Short Communication

EFFECTS OF NITROGEN AND SULFUR FERTILIZERS ON MAIZE GRAIN PROTEIN CONTENT OF QPM MAIZE VARIETIES AT SAMARU ZARIA

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ABSTRACT
Field trials were conducted in 2006, 2007 and 2008 wet seasons, at the Institute for Agricultural Research Farm, Samaru in the Northern Guinea savanna of Nigeria to determine the effect the treatment factors on maize grain protein content of quality protein maize (QPM) varieties. Treatments consisted of four (4) rates each of nitrogen (0, 60,120 and 180 kg N/ha) and sulfur fertilizer (0, 5, 10 and 15 kg S/ha) and two QPM varieties (Obatampa and EV – 99), laid out in a split plot design with variety and nitrogen in the main plots and sulfur in the sub plots and replicated three times. The results showed the treatment factors namely variety, nitrogen and sulfur fertilizers did not affect maize grain protein content in all the three years except nitrogen application in 2007 and sulfur application in 2006..

KEY WORDS: Quality Protein Maize, Protein Content, and Maize Grain.

INTRODUCTION

During the 1st millennium AD, maize (Zea mays L.) cultivation spread from Mexico into the United States and a millennium later into north east and south eastern Canada, transforming the landscape as Native Americans cleared large forest and grassland areas for the new crop (Evan *et.al*. 2005). It is unknown what precipitated its domestication because the edible portion of the wild variety is too small and hard to obtain to be eaten directly, as each kernel is enclosed in a very hard bi-valve shell. However, it was demonstrated that the kernels of teosinte are readily "popped" for human consumption like modern popcorn. Some have argued that it would have taken too many generations of selective breeding in order to produce large compressed ears for efficient cultivation. However, studies of the hybrids readily made by intercrossing teosinte and modern maize suggest that this objection is not well founded (Evan *et.al*., 2005). Maize belongs to the family graminae, and probably originated from Mexico in Central America (Anon., 1994). The cultivation of maize spread from Mexico, northward to Canada and southward to Argentina (Anon., 1992). Maize is widely cultivated throughout the world, and a greater weight of maize is produced each year than any other grain. The United States produces 40% of the world's harvest; other top producing countries include China, Brazil, Mexico, Indonesia, India, France and Argentina (FAO, 2009). Worldwide production was 817 million tonnes in 2009—more than rice (678 million tonnes) or wheat (682 million tonnes) (FAO, 2009). In 2009, over 159 million hectares of maize were planted worldwide, with a yield of over 5 tonnes/hectare. Production can be significantly higher in certain regions of the world. There is conflicting evidence to support a report by food and agriculture organization (FAO) that maize yield potential has increased over the past few decades (FAO, 2009).

United States of America was the highest producer accounting for about half the world's total (43.1%) followed by Asia (32%), Latin America and Caribbean (16.3%). Africa produced 4.1% of the world's total with Nigeria producing 7.53 million tones or 1.1% of the world's figure (FAO, 2009). The world average yield was 4255kg per hectare. Average yield in USA was 8600 kg per hectare, while in Sub-Saharan Africa it was 1316 kg per hectare (Anon., 1992). Maize is one of the most important food crops worldwide and grown between latitude 58^o N and 49^o S of the equator. Varying latitudes have an effect on number of days to flowering and maturity. This is as a result of higher temperatures at lower altitudes, which accelerate growth while the lower prevailing temperatures at higher altitudes retard growth and extend time to mature (Seed Co., 1999). Maize is the most important cereal in the United States occupying double the area of all others crops. Some parts of Africa particularly South Africa, Malawi, Zimbabwe, Kenya, Tanzania, Ghana, Nigeria and Egypt are suitable for growing maize and it is fast replacing traditional staple foodstuffs.

MATERIALS AND METHODS

The study was conducted at the Institute for Agriculture Research (IAR) Farm, Samaru, Zaria (11^o 11$^/$ N; 07^o 38$^/$ E and 686 meters above sea level), located in the northern Guinea Savanna ecology. The experiment was carried out for three wet seasons, 2006, 2007 and 2008.

The treatments consisted of two (2) open pollinated QPM varieties (Obatampa and EV – 99), four rates each of nitrogen (0, 60, 120 and 180 kg N/ha) using urea and sulfur (0, 5, 10, and 15 kg S/ha) using potassium sulfate. The experiment was laid out in split plot design with nitrogen and variety in the main plot and sulfur in the subplot. The experiment was replicated three times, each replication comprised of thirty-two plots. Borders between plots within a replication were separated by one meter spacing and between replications by spacing of 1.5m. Gross plot size was 6 ridges i.e. 4.5m by 2.5m, giving an area of 11.25m^2, while net plot size was 4 ridges i.e. 3.0m by 1.5m with an area of 4.5m^2. Plots were demarcated after ridging with well-formed borders between plots and replications to minimize nutrient seepage. Sowing was done by hand in the month of June after rainfall has been established to provide moisture for better germination. Two seeds were planted per hole at the spacing of 25cm between holes, and then the seedlings were later thinned to one plant per stand at two weeks after sowing. The nutrients applied were N, P, K and S. However, P and K were equally applied to all the plots while N and S were as the treatment indicated. N was applied in two equal doses, at 3 and 6 weeks after sowing when the whole of P, K, S and half of N were applied.

Weeding was done by hoe to control weeds at 3 and 6 weeks after sowing. This was followed by remolding immediately after the second weeding and at the time of second dose of N fertilizer application. Stem borer infestation was observed, which was controlled by spraying with a broad spectrum insecticide called best Action at the rate of 1 litre per hectare. No disease was observed throughout the period of the trial. Grains from each plot were collected, oven dried and ground into powder using grinder. The powder was then sieved using 1mm-mesh sieve and one gram was used for laboratory analysis for N and S. One gram of the sieved sample was digested using sulfuric acid and perchloric acid with copper and sodium sulfate acting as catalysts. The digest was then used to determine N and S content of the grain. Part of the digest was distilled into boric acid and the distillate was then titrated against a standard hydrochloric acid (HCl) and the percent N and S contents were determined from the titre using Macro – Kjedhal (Bremmer, 1965, IITA 1975). The protein content for grains obtained from each plot was determined from the grains N content by multiplying the value with a factor 6.25 (AOAC 1980). The values of the grain protein content were then subjected to statistical analysis of variance and means of treatments were compared using Duncan Multiple Range Test (DMRT) (Duncan, 1955).

RESULTS AND DISCUSSION

QPM grain protein as influenced by varietal differences, N and S is presented in Table 1. Differences between varieties did not affect grain protein content in all the three years and when averaged over years. Application of nitrogen only influenced grain protein content in 2007, where 0 kg N/ha produced significantly lower grain protein than the other nitrogen rates which were statistically similar. When sulfur fertilizer was applied, grain protein content was only affected significantly in 2006. Application of 5 kg S/ha produced significantly higher grain protein than the other sulfur rates which were statistically similar. Both nitrogen and sulfur significantly influenced some growth, yield and yield components as well as grain protein content.

TABLE 1: Effects of Nitrogen and Sulfur fertilizers on QPM Maize Varieties' Grain Protein Content in 2006, 2007 and 2008 Wet Seasons.

	Maize Grain Protein Content (%)		
Treatment	2006	2007	2008
QPM Variety			
Obatampa V1	7.77	8.26	8.72
EV-99 V2	7.56	8.36	8.81
S.E. ±	0.078	0.065	0.057
Significance	NS	NS	NS
Nitrogen Fertilizer (kg N/ha)			
0	7.45	8.05 b	8.91
60	7.65	8.44 a	8.72
120	7.92	8.33 a	8.57
180	7.64	8.41 a	8.84
S.E. ±	0.110	0.092	0.081
Significance	NS	*	NS
Sulfur Fertilizer (kg S/ha)			
0	7.48 b	8.33	8.91
5	7.99 a	8.41	8.70
10	7.55 b	8.15	8.46
15	7.63 b	8.35	8.97
S.E. ±	0.112	0.147	0.198
Significance	*	NS	NS

Means followed by the same letter(s) within a treatment group are not significantly different at 5 percent level of significance using DMRT
NS = Not Significant
* = Significant at 5% level of Significance

This was probably because both nitrogen and sulfur are important nutrients for growth and development which led to higher photosynthetic activities that resulted in the production of enough assimilate for subsequent translocation for higher yield and yield components such as grain protein content. Parameters that were not significantly affected by the differences between varieties include leaf area index, cob yield/ha, grain weight per plant, net assimilation rate and grain protein content. This response could be due to the fact that the two varieties were similar in terms of leaf area index and net assimilation rate which are two important factors in the production of assimilate for subsequent translocation to the yield and yield components.

A report by Haque *et al*. 2001 revealed that nitrogen is a component of protein and nucleic acids and when N is sub-optimal, growth is reduced. Ndayako (1997), also reported significant increase in plant height and number of leaves from nitrogen rates ranging from 50 – 150 kg N/ha. Since nitrogen is involved in the synthesis of chlorophyll molecules, its application increases the crop's ability to intercept more solar energy for increased CO_2 assimilation. This finding coincides with that of Aliyu *et.al*. (1996) who reported that excessive nitrogen reduces yield and yield components but enhances plant growth.

SUMMARY AND CONCLUSION

Field trials were conducted during 2006, 2007 and 2008 wet season at the Institute for Agricultural Research (IAR) farm, Samaru to assess the effect of Nitrogen and Sulfur fertilizer rates on quality protein maize (QPM) varieties. Treatments consisted of four Nitrogen rates (0, 60, 120 and 180 kg N/ha) and four Sulfur fertilizer levels (0, 5, 10 and 15 kg S/ha), laid out in a split plot design and replicated three times. The results showed that, grain protein content of the QPM varieties was not significantly affected by application of nitrogen and sulfur in all the three years of the study except in 2007 and 2006 respectively. All the three rates of nitrogen applied produced similar and significantly higher grain protein content than the control, whereas on the other hand 5 kg S/ha produced significantly higher grain protein than the other rates including the control which were statistically similar. It can therefore be concluded that application of nitrogen and sulfur significantly increased grain protein content.

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