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Relationship between Some Growth Yield and Yield Components of Two Quality Protein Maize (*Zea mays L.*) Varieties at Samaru

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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 correlation between some parameters 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 show that a positive and highly significant correlation was recorded between grain yield and number of leaves/plant, plant height, leaf area index, total dry matter, cob weight/ha, number of grains/cob and 100-grain weight in all the three years and the mean over years except in 2008 when the correlation between plant height and leaf area index with grain yield was not significant. This concludes that grain yield of QPM is positively correlated with these parameters with implication that genetic improvement of any of these parameters will increase grain yield of QPM.

Keywords: Quality Protein Maize, Nitrogen, Sulfur, Fertilizer, Correlation and Yield

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Introduction

Maize ranks second to wheat in the world cereal production. Maize is the most important cereal in the Sub-Saharan Africa and one of the three most important cereal crops in the world with rice (*Oryza sativum L.)* and wheat (*Triticum aestivum L.) as the other two*. Maize is high yielding, easy to process, readily digested and costs less than the other cereals (Kumar, 1993). Maize is used as Human food, Chemicals, medicines, Biofuel, ornamental and other uses e.g. variegated and colored leaf forms as well as those with colorful ears are used (Wikipedia, 2011). Ghana has a long history of breeding for improved maize cultivars (Morris *et al*., 1999) and it is the dominant country for QPM production in Africa with approximately 70,000 hectares planted. The vast majority of QPM seed produced is 'Obatampa' (or improved versions thereof) which were developed in collaboration with International Institute for Tropical Agriculture (CIMMYT, 2005). The International Maize and Wheat Improvement Center (CIMMYT), in collaboration with the International Institute of Tropical Agriculture (IITA) and the National Agricultural Research Systems (NARS) in 17 countries of SSA, have developed a broad range of QPM cultivars responding to the needs of different countries and agro ecological zones. Commercial QPM seed is currently available in all collaborating countries and, based on average 2003-2005 seed production, approximately 200,000 hectares of land are being planted to QPM cultivars (Alan *et al*., 2007).

Nitrogen is the most limiting nutrient in the savanna soils where the soils are predominantly coarse textured and characteristically low in organic matter. Its deficiency is usually recognized first by pale green or yellowish green colour of the leaves, followed by premature necrosis of the older leaves. Where soils are rich in organic matter, such as where the land has just been cleared after a long fallow, a fair amount of nitrogen would be made available to crops through the decomposition of the organic matter (Anon., 1989). Based on the importance of nitrogen as mentioned above, it was chosen as one of the factors of the treatment. Likewise Sulfur is recognized as the fourth major nutrient after N, P and K. On the average maize crop absorbs as much S as it absorbs P, when S is deficient in soil, full yield potential of the crop cannot be realized regardless of other nutrients even under good crop husbandry practices (Tandon, 1989). Deficiency of S is likely to be widespread in Africa, especially in the savanna regions, where annual bush burning results in losses of sulfur to the atmosphere as Sulfur dioxide (SO_2) (Tandon, 1989).

The investigation aimed at evaluating the effects of nitrogen and sulfur on quality protein maize (QPM) with respect to growth and yield performance.

Materials and Methods

The experiment was conducted at the Institute for Agriculture Research (IAR) Farm, Samaru, Zaria (11^0 $11^/$ N; 07^0 $38^/$ E and 686 meters above sea level), located in the northern Guinea Savanna ecology. The experiments were 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 180kgN/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. Soils were randomly sampled from the experimental site before land preparation each year, at the depth of 0 – 30cm and analyzed for physical and chemical properties.

The land was double harrowed and then ridged 75cm apart. 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 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. This gave plant population of 53,333 plants per hectare. 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 treatment indicated (0, 60, 120 and 180 kg N ha^{-1} and 0, 5, 10 and 15 kg S ha^{-1}). 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 trials. Data collected was subjected to statistical analysis using excel analysis.

Results and Discussion

The relationship between grain yield, growth and yield components in 2006, 2007, 2008 and the mean over years is shown in Tables 1, 2, 3 and 4 respectively. A positive and highly significant correlation was recorded between grain yield and number of leaves/plant, plant height, leaf area index, total dry matter, cob weight/ha, number of grains/cob and 100-grain weight in all the three years and the mean over years except in 2008 when the correlation between plant height and leaf area index with grain yield was not significant. However, the correlation between grain yield and number of days to 50% tasselling and silking were highly significant but negative except in 2006 and the mean where the correlation was not significant with number of days to 50% tasselling.

Conclusion and Recommendations

From the findings of this study, the relationship (correlations) between growth, yield and yield parameters were positive and highly significant in all the three years and their mean. This implies that genetic improvement of any of these parameters will increase grain yield of QPM in northern Guinea Savanna ecological zone where the study was conducted.

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Tables

Table 1: Matrix of Correlation Coefficient between Grain Yield (kg/ha) and Growth and Yield parameters in 2006 Wet-Season

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
C1	1									
C2	0.4313**	1								
C3	0.2684**	0.2909**	1							
C4	0.2294*	0.1666	0.4748**	1						
C5	0.4835**	0.3455**	0.33622**	0.2367*	1					
C6	-0.1453	0.1083	0.0424	0.0478	-0.0695	1				
C7	-0.3839**	-0.0328	-0.0506	-0.0510	-0.2284*	0.9004**	1			
C8	0.9818**	0.4704**	0.2704**	0.2156*	0.5114**	-0.0783	-0.3250**	1		
C9	0.5817**	0.3338**	0.3142**	0.1509	0.3150**	0.0527	-0.1052	0.6014**	1	
C10	0.8393**	0.4228**	0.3345**	0.2171*	0.4525**	0.0399	-0.1683	0.8461**	0.5272**	1

C1	Grain Yield/ha	C6	Days to 50%Tasselling
C2	Number of leaves/plant 12 WAS	C7	Days to 50% Silking
C3	Plant Height 12 AS	C8	Cob Weight/ha (kg)
C4	Leaf Area Index (LAI) 12 WAS	C9	Number of Grains/cob
C5	Total Dry Matter (TDM) 12 WAS	C10	100 - Grain Weight (gm)

* = Significant at 5% level of Significance

** = Significant at 1% level of Significance

r = 1995 at 5% level of Significance

r = 2607 at 1% level of Significance

Table 2: Matrix of Correlation Coefficient between Grain Yield (kg/ha) and Growth and Yield parameters in 2007 Wet- Season

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
C1	1									
C2	0.2775**	1								
C3	0.4201**	0.2611**	1							
C4	0.4079**	0.4559**	0.6277**	1						
C5	0.5728**	0.0968	0.3428**	0.2677**	1					
C6	-0.2491**	0.3848**	-0.0721	0.1022	-0.2200*	1				
C7	-0.6568**	0.0774	-0.3392**	-0.2222*	-0.5398**	0.7426**	1			
C8	0.9879**	0.2966**	0.4168**	0.4059**	0.5583**	-0.2055*	-0.6401**	1		
C9	0.4739**	0.2419*	0.2601**	0.3140**	0.2615**	0.0284	-0.3086**	0.5079**	1	
C10	0.5436**	0.3430**	0.3623**	0.5362**	0.3526**	0.1348	-0.3171**	0.5727**	0.5272**	1

C1	Grain Yield/ha	C6	Days to 50%Tasselling
C2	Number of leaves/plant 12 WAS	C7	Days to 50% Silking
C3	Plant Height 12 WAS	C8	Cob Weight/ha (kg)
C4	Leaf Area Index (LAI) 12 WAS	C9	Number of Grains/cob
C5	Total Dry Matter (TDM) 12 WAS	C10	100 - Grain Weight (gm)

* = Significant at 5% level of Significance

** = Significant at 1% level of Significance

r = 1995 at 5% level of Significance

r = 2607 at 1% level of Significance

Table 3: Matrix of Correlation Coefficient between Grain Yield (kg/ha) and Growth and Yield parameters in 2008 Wet-Season

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
C1	1									
C2	0.3970**	1								
C3	-0.1210	0.2385*	1							
C4	0.0309	0.1081	0.1893	1						
C5	0.2907**	0.1694	-0.1694	0.3894**	1					
C6	-0.3517**	-0.1758	0.0923	-0.4177**	-0.4201**	1				
C7	-0.4525**	-0.0960	0.0917	-0.3520**	-0.3366**	0.6788**	1			
C8	0.9986**	0.3968**	-0.1212	0.0282	0.2908**	-0.3457**	-0.4493**	1		
C9	0.2832**	0.1874	0.4215**	0.1964	0.0092	-0.0812	-0.0854	0.2881**	1	
C10	0.5222**	0.3306**	0.0940	-0.0291	0.2132*	-0.2111*	-0.1751	0.5170**	0.1349	1

C1	Grain Yield/ha	C6	Days to 50%Tasselling
C2	Number of leaves/plant 12 WAS	C7	Days to 50% Silking
C3	Plant Height 12 WAS	C8	Cob Weight/ha (kg)
C4	Leaf Area Index (LAI) 12 WAS	C9	Number of Grains/cob
C5	Total Dry Matter (TDM) 12 WAS	C10	100 - Grain Weight (gm)

* = Significant at 5% level of Significance
** = Significant at 1% level of Significance
r = 1995 at 5% level of Significance
r = 2607 at 1% level of Significance

Table 4: Matrix of Correlation Coefficient between Grain Yield (kg/ha) and Growth and Yield parameters in 2006, 2007 and 2008 (Mean) Wet-Season

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
C1	1									
C2	0.7318**	1								
C3	0.4137**	0.5053**	1							
C4	0.4510**	0.4525**	0.5491**	1						
C5	0.2450*	0.0360	0.1855	0.3799**	1					
C6	-0.1129	0.0788	0.1088	0.0904	-0.0107	1				
C7	-0.4180**	-0.1631	-0.0933	-0.1404	-0.1748	0.7882**	1			
C8	0.9951**	0.7331**	0.4102**	0.4466**	0.2521**	-0.0881	-0.4047**	1		
C9	0.2641**	0.1139	0.2091*	0.1546	0.1394	0.0053	-0.1825	0.2847**	1	
C10	0.7087**	0.5341**	0.4585**	0.4962**	0.3868**	0.1209	-0.1773	0.7154**	0.3052**	1

C1	Grain Yield/ha	C6	Days to 50%Tasselling
C2	Number of leaves/plant 12 WAS	C7	Days to 50% Silking
C3	Plant Height 12 WAS	C8	Cob Weight/ha (kg)
C4	Leaf Area Index (LAI) 12 WAS	C9	Number of Grains/cob

* = Significant at 5% level of Significance
** = Significant at 1% level of Significance
r = 1995 at 5% level of Significance
r = 2607 at 1% level of Significance