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CORRELATIONS AMONG GRAIN YIELD AND YIELD ATTRIBUTES IN MAIZE VARIETIES AS INFLUENCED BY TIMING NITROGEN SECOND DOSE APPLICATION

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Abstract

Three maize varieties (SAMMAZ 14, SAMMAZ 15 and SAMMAZ 16) were compared for yield and yield components and correlation were worked out among the yield parameters against timing of second dose application of nitrogen fertilizer at 4, 5, 6, 7, 8 and 9 weeks after sowing (WAS) conducted at Institute for Agricultural Research Farm (Lat.11° 11' N, Long. 07^{0}38' E, 686m above sea level), Samaru-Zaria and Jaji Military Cantonment Farm located at 30 Km from Zaria along Kaduna – Zaria road (Lat. 10° 49' 25" N, Long. 07° 34' 10" E, 600m above sea level), both in Northern Guinea Savannah of Nigeria, during 2016 wet season. The treatments were factorially combined and laid out in a randomized complete block design (RCBD) with three replications. SAMMAZ 16 recorded significantly highest grain yield (3237.3kg/ha) over SAMMAZ 14 with (3002.5kgha^{-1}) and SAMMAZ 15 with (2513.8kgha^{-1}) and application of second dose of N fertilizer at 6 WAS recorded highest grain yield than other timings evaluated. Correlation coefficient in maize revealed at both locations that grain yield of maize was positively correlated with yield components. All the yield components are positively correlated with grain yield except crop growth rate (CGR) at Samaru and Leaf area index/Dry matter weight at Jaji. Among the varieties tested in this trial, SAMMAZ 16 and time of second dose of nitrogen fertilizer application at 6 WAS appeared to be the optimum for increased maize grain yield production in the Savannah region of Nigeria. Based upon correlation, harvested cob weight and 100 grain weight were found to be suitable for selecting a maize variety for higher grain yield along with other attributes i.e. plant height, dry matter production, number of leaves and crop growth rate.

Keywords: Maize Varieties, Correlation, Grain Yield, Fertilizer Second Dose Application

INTRODUCTION

Maize (*Zea mays L.*) originated in Mexico and belongs to the family poaceae (Garba, 2015). It is one of the oldest and most important cereal crops in the world with multiple uses for food, animal feed and industrial uses (Monlruzzaman, 2009). Maize is ranked third after wheat and rice in terms of grain production in the world (Asghar *et al.*, 2010), while in Nigeria it is the second most important cereal crop after Sorghum in the number of people it feeds (Osagie and Eka, 1998). Food and Agricultural Organisation statistical data (FAOSTAT,2013) reported that global average yield of maize was estimated at 1,016,740,000 metric tons (mt)/ha while average grain yield of 851,271,000(mt)ha^{-1} was realized in Nigeria. Maize grain yield in Nigeria varied from 0.8t ha^{-1} to 7.0t ha^{-1} depending on variety used, ecology, farming system adopted and management practices involved (Olakojo and Olaoye, 2007).

Maize crop is a heavy feeder requiring a lot of Nitrogen, Phosphorus, Potassium, Calcium and Magnesium for Maximum grain yield (Veen, 2007). Many Studies have shown that profitable maize production is only attainable under sufficiently fertile soils (Veen, 2007). This is particularly so in the Savannah region where soils are inherently of low fertility particularly Nitrogen (N) (Lombin, 1987). Earlier, the International Institute of Tropical Agriculture (IITA)has reported that limited use of nitrogenous fertilizers and declining soil fertility are among the major constrain for maize production in Nigeria (IITA, 2007).

The native soil N status in the Northern Guinea Savannah ecology of Nigeria is usually low therefore split fertilizer dose of 120:60:60kg N, P_2O5 and K_2Oha^{-1} was recommend for maize production (Ewenzor *et al.*, 1989). Even though farmers in the ecology recognize the need to fertilize their maize crop to achieve high maize yield on sustainable basis, timing of the application of fertilizer to their maize crop has been variable. Since nitrogen is subject to leaching and denitrification, multiple times of N application has been advocated (Tobert *et al.*, 2001). However, farmers in the savannah ecology of Nigeria are not consistent as to the timing of second doses of N to their crop, resulting in N deficiency when the nutrient is needed by the crop. Anonymous (2011) noted that N deficiency at any time of maize life would lead to yield reduction or none at all. Hence, present investigation was undertaken to study the correlation coefficient between maize grain yield and growth and yield parameters of maize varieties as influenced by timing of Nitrogen second dose application.

MATERIALS AND METHODS

Two field trials were conducted during the wet season of 2016 at Institute for Agricultural Research Farm (Lat $11^0$11'N, Long $07^0$38'E, 686m above sea level) Samaru – Zaria, Nigeria and Jaji Military Cantonment farm (lat 10°49 N, Long 07°34 E 600m above sea level) located at km 30 Kaduna – Zaria road both in the Northern Guinea Savannah ecological zone of Nigeria. The soil at Samaru was sandy loam soil with pH in water 6.05 while that of Jaji was loam soil with pH in Water 6.15.

The treatment combination comprising three maize varieties (SAMMAZ 14, SAMMAZ 15 and SAMMAZ 16) and six time of N fertilizer second dose application (4, 5, 6, 7, 8 and 9 weeks after sowing (WAS)). The trial was laid out in a randomized complete block design (RCBD) with three replications. Split fertilizer dose at the rate of 120kgN, 60kgP_20_5 and 60kgK_20 (NPK15-15-15) was applied at each location(Samaru and Jaji) as follows; basal fertilizer application at the rate of 74kg N, 60kg P_20_5 and 60kg k_20 (75% N, 100% P_20_5 and 100% K_20) was carried out one week after sowing.

The remaining 25% N as the second dose application with nitrogen (Urea 46% N) was applied in five split doses at 5 WAS, 6 WAS, 7 WAS, 8 WAS and 9 WAS while 4 WAS serves as the control (no or zero fertilizer application)for the trial. Sowing of maize was carried out on 11th June and 18th June for Samaru and Jaji respectively as a single year two location trial, the months of wet season ranges from late May to late September/early October. The yield attributes measured include ; Grain yield, 100 grain weight(g), Cob weight, cob length, Cob diameter, Plant height, number of leaves, Leaf area index, crop growth rate and dry matter weight, simple random sampling design was used. The data collected were subjected to analysis of variance (ANOVA) as described by Snedecor and Cochran (1967) using SAS statistical package. Where F-values were found to be significant, the treatment means were compared using Duncan's Multiple Range Test (DMRT) (Duncan, 1955). Then, correlation coefficient was worked out among the grain yield and growth/ yield parameters using excel worksheet according to Gomez and Gomez, 1984.

RESULTS AND DISCUSSION

Grain yield ($kgha^{-1}$) of maize for the combined at both locations was significantly influenced by varieties (table 1). SAMMAZ 16 (3237.3$kgha^{-1}$) recorded significantly higher grain yield over SAMMAZ 14 (3002.5$kgha^{-1}$) and SAMMAZ 15 (2513.8$kgha^{-1}$). The increase in grain yield of SAMMAZ 16 was 28.1% over SAMMAZ 15 and 7.81% over SAMMAZ 14 which is statistically at par with SAMMAZ 16. This might be due to genetic makeup and morphological characteristics of these recently released open pollinated varieties in exploiting agronomic and climatic optima at important growth stages (Jemal Abdulai, 2010) over other varieties.

Similar kinds of result have also been reported by Daikho (2013) and Singh *et al.*, (2014). Among different time of N fertilizer second dose application, significantly higher grain yield for the combined at both locations was recorded at time of second dose of application 6 WAS having a 7.9% over 5 WAS, 11.9% over 7 WAS, 19.6% over 8 WAS 36.5% over 9 WAS and 71.7% over the control at 4 WAS respectively.

The higher grain yield of maize was mainly due to better translocation of photosynthates from source to sink, also higher growth attributing characters like taller plants, higher number of leaves, higher leaf area index values with higher dry matter production and its accumulation into different parts of plant and yield attributing characters like harvested cob weight, 100 gram weight. The above result clearly indicates the importance of time of N fertilizer second dose application. This is in accordance with the report of Valero *et al.*, (2005) who states that application of fertilizer at 6 WAS coincide with the stage where roots, rootlet development of the plant is enhanced for anchorage and nutrient/water uptake for photosynthesis.

Hafiz *et al.*, (2011) further reported that application at 6WAS was for further development of roots and other photosynthetic apparatuses just prior to the commencement of reproductive growth stage leading to higher and longer accumulation of higher pre-anthesis assimilates stored within the plants which can then be shifted or translocated into higher grain yield during grain filling stage.

CONCLUSION

From the result of this trial, it was found out that SAMMAZ 16 performed better than SAMMAZ 14 and SAMMAZ 15 also time of second dose of nitrogen application 6WAS had the best performance relative to other timings observed. Based upon correlation, harvested cob weight, 100 grain weight, plant height and number of leaves were found to be suitable for selecting a maize variety for higher grain yield along with other attributes i.e. plant height, dry matter production, number of leaves and crop growth rate. SAMMAZ 16 and 6 WAS appeared to be the optimum for increased maize grain yield production in the Savannah region of Nigeria

Table 1: Effect of Maize Variety and time of Second dose of N fertilizer application on grain yield (kgha^{-1}) at Samaru and Jaji during 2016 wet season.

	Mean Yield of Maize kgh^{-1}		
Treatment	**Samaru**	**Jaji**	**Combined**
Variety (v)			
SAMMAZ 14	3730.9a	2274.1a	3002.5a
SAMMAZ 15	3243.2b	1784.3b	2513.8b
SAMMAZ 16	3887.4a	2587.2a	3237.3a
SE ±	97.960	84.110	91.035
Significance	*	*	*
Time of second fertilizer application (T)			
4 WAS	2647.3e	1518.5d	2082.5de
5 WAS	4198.3a	2427.8b	3313.1ab
6 WAS	4352.3a	2799.6a	3575.9a
7 WAS	4036.6ab	2351.8b	3194.2ab
8 WAS	3872.3bc	2105.6bc	2988.9bc
9 WAS	3333.4d	1907.4c	2620.4cd
SE ±	138.54	118.95	128.745
Significance	**	**	**
Interaction			
VXT	NS	NS	NS

Means followed by the same letter(s) within same treatment, group and location were statistically the same using DMRT at 5% level of significance

** Significant at 5% level of significance * Significant at 1% level of significant NS – not significant

Correlations between growth, yield and yield component of maize varieties

The correlation analysis was carried out per site as presented in Tables 2 and 3 because both locations are in Northern Guinea Savannah of Nigeria but differ in latitudes/elevation, topography, weather patterns and locality.

It was observed in table 2, at Samaru that grain yield showed a positive and highly significant (P≤0.01) correlation with 100 grain weight (r = 0.676**) harvested cob weight (r = 0.614**), plant height (r = 0.537**) and dry matter production (r = 0.588**). 100 grain weight showed a positive and highly significant (P≤0.01) correlation with harvested cob weight (r = 0.555**). It was also observed that plant height had a positive and highly significant (P≤0.01) correlation with dry matter production (r = 0.545**). Number of leaves also had a positive and highly significant (P≤0.01) with leaf area index (r = 0.670**) and dry matter production (r = 0.709**). Lead area index also showed a positive and highly significant (P≤0.01) correlation with dry matter production (r = 0.839**). Among all the growth attributes, all are positively correlated with grain yield except crop growth rate (CGR) at Samaru.

Table 3 at Jaji observed that all the growth attributes are positively correlated with grain yield except Leaf area index LAI and Dry matter weight at Jaji where grain yield showed a positive and highly significant (P≤0.01) correlation with harvested cob weight (r = 0.875**), plant height (r = 0.541**) number of leaves (r = 0.563**) and crop growth rate (r = 0.676**).

100 grain weight showed a positive and highly significant (P≤0.01) correlation with harvested cob weight (r = 0.575**), cob length (r = 0.508**), cob diameter (r = 0.688**), number of leaves (r = 0.651**) and dry matter production (r = 0.580**). Harvested cob weight showed a positive and highly significant (P≤0.01) correlation with cob length (r= 0.628**), plant height (r = 0.688**), number of leaves (r = 0.750**) and crop growth rate (r = 0.745**), cob length showed a positive and highly significant (P≤0.01) correlation with cob diameter (r – 0.600**), plant height (r = 0.622**), number of leaves (r = 0.674**), leaf area index (r = 0.523**), dry matter weight (r = 0.597**) and crop growth rates (r = 0.0570**).

Cob diameter showed a positive and highly significant (P≤0.01) correlation with plant height (r = 0.614**), number of leaves (r = 0.575**), leaf area index (r = 0.553**). Plant height also showed a positive and highly significant (P≤0.01) correlation with number of leaves (r = 0.748**) and crop growth rate (r = 0.588**). Number of leaves showed a positive and highly significant (P≤0.01) correlation with dry matter production (r = 0.735**) and crop growth rate (r = 0.617**). Leaf area index also showed a positive and highly significant (P≤0.01) correlation with dry matter production (r = 434**).

Results of this study showed that selection of maize varieties and suitable time of nitrogen second dose application had significant effects on yield and yield components. Other studies such as Saleem et al (2007), reported that significant differences in maize varieties exists on traits like plant height, cob lenght, flg leaf area, number of grain per cob, biological yield and grain yield. Time of nitrogen second dose application to maize crop was also found to be significant as well on the growth and yield parameters observed.

Application of n fertilizer at 6WAS was found to to be economically advantageous as well as enhancing better use of nitogen as compared to other time of nitrogen applied. The results also highlight the economic advantage/profitability of applying nitrogen second dose at 6WAS than other timings. This is in line with the report of Sitthaphanit et al,(2010). Chetan *et al.,* (2017) ; (2007); Rafique *et al.,* (2004); Vasic *et al.,* 2001); Jemal Abdulai (2010) reported positive (highly) correlation (P≤0.01) among yield, growth parameters and yield components.

Table 2: Correlation Coefficient (r) between grain yield (kgha-1) and growth parameter and yield components at Samaru for 2016 Wet season

	1	2	3	4	5	6	7	8	9	
Grain Yield	1.000									
100 gram wt	0.676**	1.000								
Harvested Cob wt	0.614**	0.555**	1.000							
Cob length	0.249*	0.239*	0.305*	1.000						
Cob diameter	0.297*	0.238*	0.222	-0.372*	1.000					
Plant height	0.537**	0.402*	0.359*	0.005	0.302*	1.000				
Number of leaves	0.476*	0.427*	0.579*	0.206	0.083	0.496*	1.000			
Leaf Area Index	0.516*	0.494*	0.666*	0.115	0.282*	0.419*	0.670**	1.000		
Dry Matter wt	0.588**	0.493*	0.677*	0.100	0.226	0.545**	0.709**	0.839**	1.000	
Crop growth rate	0.168	-0.049	0.163	0.154	0.213	0.005	0.273*	0.277*	0.169	1.

DF = 54 – 2 = 52 3 = harvested cob wt 6 = plant height 9(cm) 9 = crop growth rate 10 = dry matter wt

1 = Grain yield 4 = cob length (cm) 7 = number of leaves

2 = 100 grain weight 5 = cob diameter (cm) 8 = leaf area index

Table 3: Correlation Coefficient (r) between grain yield (kgha^{-1}) and growth parameters and yield components at Jaji for 2016 Wet season

	1	2	3	4	5	6	7	8	9
Grain Yield	1.000								
100 gram wt	0.351*	1.000							
Harvested Cob wt	0.875**	0.575**	1.000						
Cob length	0.462*	0.508**	0.628**	1.000					
Cob diameter	0.316*	0.668**	0.461*	0.600**	1.000				
Plant height	0.541**	0.485*	0.688**	0.622**	0.614**	1.000			
Number of leaves	0.563**	0.651**	0.750**	0.674**	0.575**	0.748**	1.000		
Leaf Area Index	0.265	0.417*	0.458*	0.523**	0.553**	0.379*	0.417*	1.000	
Dry Matter wt	0.222	0.580**	0.468*	0.597**	0.503*	0.470*	0.735**	0.434**	1.000

Crop growth rate	0.676**	0.274*	0.745**	0.570**	0.271	0.588**	0.617**	0.237	0.351*	1.

DF = 54 – 2 = 52 3 = harvested cob wt 6 = plant height 9(cm) 9 = crop growth rate 10 = dry matter wt

1 = Grain yield 4 = cob length (cm) 7 = number of leaves

2 = 100 grain weight 5 = cob diameter (cm) 8 = leaf area index

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