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Correlation Analysis of Growth and Yield Components of Maize (*Zea mays* L.) Under *Striga Hermonthica* Infestation

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Abstract

*A field trial was conducted in 2013 cropping season at Lapai and Mokwa in the Southern Guinea ecological zone of Nigeria. The objective was to assess the response of maize varieties to different rates of nitrogen and intra-row spacing as a means of suppressing Striga hermonthica infestation. The study was factorial arranged, conducted in a randomized complete block design with two maize varieties (local and improved SAMMAZ 16), four rates of nitrogen fertilizer (0, 60, 120 and 180 kg N ha^{-1}) and intra-row spacing (20, 25 and 30 cm) and replicated three times. The Results showed that in both locations there was a positive and highly significant correlation of grain yield with growth and yield parameters such as number of leaves 3(0.659** and 0.579**), dry cob weight 7(0.935**and 0.930**), 100 grain weight 8(0.774** and 0.829**) and stover yield 9(0.757** and 0.722**) with establishment count only at Mokwa 4(0.491**). All characters in the pooled data were positive and highly significant correlated with grain yield except stover yield 9(0.777) and days to first Striga emergence 10(0.057). Generally, Striga shoot count and Striga shoot dry matter were negative and highly significant correlated with all the characters in this study.*

Keywords: *Striga hermonthica, correlation, nitrogen fertilizer, intra-row spacing, maize varieties*

Introduction

Maize (*Zea mays* L.) is a monoecious plant belonging to the family Pooaceae with its origin centred in Mexico. It is one of the oldest and most important crops in the world with multiple 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). FAOSTAT (2013) reported that global average yield of maize was estimated at 1,016,740,000 metric tonnes while average grain yield of 851,271,000 metric tonnes per hectare was realized in Nigeria. Maize grain yields in Nigeria varied from 0.8 t/ha to 8.0 t/ha depending on variety used, ecology, farming system adopted and management practices involved (Olakojo and Olaoye, 2007). Maize is a source of energy, but its production has been decreasing over the years due to *Striga* infestation in farmers field which causes serious setback in terms of grain yield and this incidence of

Striga infestation was reported by Olakojo and Olaoye (2007) that farmers have been forced to abandon their farm lands for less susceptible crops. Yield losses of maize due to *Striga* in the sub-Sahara Africa has been estimated at 10.7 million tonnes per year (Gressel *et al*., 2004). Scientists all over the world have make several efforts to finding lasting solution to reducing Striga effect using such methods as nitrogenous fertilizer, host plant resistance, crop rotation (Dugje *et al*., 2010). The correlation on this study was carried out to identify maize characters that have been influenced by different nitrogen fertilizer rates and intra-row spacing on the yield of maize varieties under *Striga* infestation.

Materials and Methods

An experiment were carried out in two locations (Lapai and Mokwa) in the Southern Guinea ecological zone of Nigeria during the 2013 cropping season to evaluate the response of maize varieties to different rates of nitrogen fertilizer and intra-row spacing as it contribute to ameliorating the effect of *Striga hermonthica* infestation. Lapai lies between latitude 09^0 02'N and longitude 06^0 34'E, while Mokwa lies between latitude 09^0 18' N and longitude 5^0 04' E in the southern Guinea Savanna of Nigeria (Adetimirin *et al*., 2000 and Isah *et al*., 2011). The experimental field was tested to be sandy loam with pH of 5.46 and 5.44 in Lapai and Mokwa respectively (Garba, et al., 2014). The trial was laid out in a Randomized Complete Block Design with two maize varieties (Local (kabako) and improved SAMMAZ 16 *Striga* resistant maize variety), four levels of nitrogen fertilizer rates in the form of Urea (0, 60, 120 and 180 kg N ha^{-1}) and intra-row spacing (20, 25 and 30cm) which were combined in a factorial arrangement and replicated three times. A mixture of soil and *Striga hermonthica* seed was artificially inoculated uniformly in each sowing hole with the use of coca-cola bottle cap before sowing (Ezeaku and Gupta, 2004). Manual weeding was uniformly conducted using hand hoe at 3 weeks after sowing (WAS) and subsequently weeding was done by hand pulling with the exception of *Striga* plants. Half- dose of nitrogen fertilizer (0, 60, 120 and 180 kg N ha^{-1}) in the form of Urea (46 %) together with 60 kg N ha^{-1} each of P_2O_5 and K_2O were applied at 3 WAS and second-half dose at 6 WAS. A control (0 kg N ha^{-1}) was established to serve as a check. Five maize plant stands were sampled and records taken in each net plot on growth and *Striga* parameters such as plant height, number of leaves, days to 50 anthesis and silking, *Striga* shoot count and *Striga* shoots dry matter at 3, 6, 9 and 12 WAS, while yield and yield parameters such as dry cob weight, grain yield, 100 grain weight, stover yield were recorded after harvesting of the crop. Data collected were subjected to analysis of variance (ANOVA) using statistical analysis software (SAS, 2002). Correlation coefficients of the biometric observations were estimated following the method suggested by Steel and Torrie (1960).

Results

Result of correlation matrix between *Striga*, grain yield, growth and yield parameters of maize at 12 WAS in Lapai, Mokwa and pooled during 2013 rainy season is presented in Tables 1-3. The result in Table 1 showed that grain yield was positive and highly significantly correlated with 3 (0.659**), 7 (0.935**), 8 (0.774**) and 9 (0.757**). Other positive correlation was found between grain yield and 4 (0.279*) and 6 (0.391*). However, there was a negative highly significant correlation between the grain yield and *Striga* parameter 11 (-0.817**) and 12 (-0.825**). Number of leaves was highly significantly correlated with 6 (0.517**), 8 (0.639**) and 9 (0.635**), while it was only significant with 4 (0.385*). Correlation of number of leaves with *Striga* parameters was negative highly significant with 11 (-0.710**) and 12 (-0.788**). Days to 50% silking, dry cob weight, and 100 grain weight were highly correlated respectively with 7 (0.449**), 8 (0.811**) and 9 (0.650**). All Striga parameters with other characters were negative and highly correlated (Table 1).

Result of correlation matrix between *Striga*, grain yield, growth and yield parameters of maize at 12 WAS in Mokwa during 2013 rainy season is shown in Table 2. The result showed that grain yield exhibit a positive and highly significant correlation with 3 (0.579**), 4 (0.491**), 7 (0.930**), 8 (0.829**) and 9 (0.722**). Days to 50% anthesis were negatively highly significant. Number of leaves was positive and highly significant correlated with 4 (0.496**) 7 (0.646**), 8 (0.629**) and 9 (0.549**). Other positive correlation that was found between numbers of leave is 6 (0.307*). Percentage establishment counts, days to 50% silking, dry cob weight and 100 grain weight also exhibit a positive and highly significant correlation. All the *Striga* parameters measured with all characters showed negative and highly significant correlation.

Table 3 showed the correlation matrix between *Striga*, grain yield, growth and yield parameters of maize at 12 WAS in the pooled data during 2013 rainy season. The result showed that grain yield exhibit a positive and highly significant correlation with all characters in the pooled data during the 2013 rainy season, although no significant correlation on grain yield was observed with 9 (0.777) and 10 (0.057). The *Striga* parameters were negatively highly correlated with grain yield. Plant height, percentage establishment count, days to 50% anthesis and days to 50% silking were positively significant. Highly significant correlation was observed in number of leaves with 4 (0.395**), 6 (0.352**), 7 (0.693**), 8 (0.623**) and 9 (0.628**). All the characters with *Striga* parameters were negative and highly significant correlated except days to 50% anthesis with 11 (0.238*) and 12 (0.253*) (Table 3).

Discussion

The results of correlation analysis revealed that grain yield was positively and highly correlated with percentage establishment count, number of leaves, dry cob weight, 100 grain weight and stover yield. The positive and highly significant correlation exhibited with some characters of maize varieties might be due to influence of rates of nitrogen fertilizer application. This result is in line with the finding of Pearl (2012) who reported in his study a significant correlation between grain yield and 1000 seed weight, days to mid anthesis, days to mid silking, cob aspects and cob length, ears per plant, grain length, grain width, plant height and shelling percentage. Positive ($p<0.05$) correlation and highly significant ($p<0.01$) correlation between grain yield and yield components and harvest index of maize were also reported by Inamulah *et al*. (2011). However, *Striga* shoots count and *Striga* shoots dry matter showed negative not significant and negative highly significant correlation in Lapai and negative and highly correlation in Mokwa and the pooled data. The observed correlation results obtained with *Striga* parameters probably could be attributed to the genetic characteristic of maize varieties. This result is in consonant with the finding of Kim and Adetimirin (1997) who reported significant and negative correlation between grain yield of maize and *Striga* damage rating. Similar observation was made by Haron *et al*. (2012) who cited highly negative correlation between grain yields of maize and *Striga* damage rating. From this study, susceptible maize variety created an enabling environment for *Striga hermonthica* to compete favourably with the crop which depresses the crop growth and subsequent poor yield at harvest, but in contrast, the *Striga* resistant maize variety supported lower *Striga* incidence which lead to greater yield.

Conclusion

Correlation analysis showed a positive and highly correlation with growth and yield parameters of maize varieties, but the *Striga* parameters were negative and highly significant on correlation with all the characters measured in this study. From the results evaluated, one can suggest base on the objectives lined up in this study that: Effective control of *Striga hermonthica* under maize production can be best achieved with combination of 180 kg N ha^{-1} and intra-row spacing of 25 cm using improved *Striga* resistance SAMMAZ 16 variety and therefore, we recommended that, farmers in the study area should be encouraged to actualized the objective of this study such as obtaining optimum grain yield of maize under *Striga* infested field.

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Table 1: Matrix of Correlation Coefficient between Striga, grain yield, growth and yield parameters of Maize at 12 WAS in Lapai during 2013 rainy season.

	1	2	3	4	5	6	7	8	9	10	11	12
1	1.000											
2	0.036	1.000										
3	0.659**	0.309*	1.000									
4	0.279*	-0.019	0.385*	1.000								
5	-0.059	0.069	0.001	-0.174	1.000							
6	0.391*	0.092	0.517**	0.222	0.366*	1.000						
7	0.935**	0.021	0.707*	0.293*	-0.03	0.449**	1.000					
8	0.774**	0.214	0.639**	0.181	-0.024	0.334*	0.811**	1.000				
9	0.757**	0.129	0.635**	0.223	0.092	0.334*	0.800**	0.650**	1.000			
10	0.075	-0.014	0.139	0.168	0.032	0.139	0.096	0.151	0.093	1.000		
11	-817**	-0.124	-0.710**	-0.398	0.132	-0.369	-0.817**	-0.743**	-0.624**	-0.106	1.000	
12	-825**	-0.018	-0.788**	-0.363	0.183	-0.458	-0.817**	-0743**	-0.622**	-0.234*	0.841**	1.000

KEY: ** = Highly significant at 1%. * =significant at 5%

1. Grain yield
2. Plant height
3. Number of leaves
4. Establishment count
5. Days to 50% anthesis
6. Days to 50% silking
7. Dry cob weight
8. 100 grain weight
9. Stover yield
10. Days to first *Striga* emergence
11. *Striga* shoots count
12. *Striga* shoots dry matter

Table 2: Matrix of Correlation coefficient between *Striga*, grain yield, growth and yield parameters of maize at 12 WAS in Mokwa during 2013 rainy season.

	1	2	3	4	5	6	7	8	9	10	11	12
1	1.000											
2	0.091	1.000										
3	0.579**	0.321*	1.000									
4	0.491**	-0.208	0.496**	1.000								
5	-0.582**	0.066	-0.491**	-514**	1.000							
6	0.229	0.288*	0.307*	0.268*	-0.184	1.000						
7	0.930**	0.108	0.646**	0.462**	-0.575	0.268*	1.000					
8	0.829**	0.308*	0.629**	0.407*	-0.526	0.199	0.817**	1.000				
9	0.722**	0.140	0.549**	0.315*	-0.478	0.154	0.858**	0.644**	1.000			
10	0.042	-0.031	0.103	0.153	0.056	0.104	0.004	0.073	-0.138	1.000		
11	-744**	-0.289*	-0.642**	-0.501**	0.592**	-0.536**	-0.757**	-0.771**	-0.562**	-0.089	1.000	
12	-0.679	-0.438*	-0.675**	-0.510**	0.497**	-0.424*	-0.717**	-0.747**	-0.511**	-0.081	0.835**	1000

KEY: ** = Highly significant at 1%. * =significant at 5%

5. Grain yield — 5. Days to 50% anthesis — 9. Stover yield
6. Plant height — 6. Days to 50% silking — 10. Days to first *Striga* emergence
7. Number of leaves — 7. Dry cob weight — 11. *Striga* shoots count
8. Establishment count — 8. 100 grain weight — 12. *Striga* shoots dry matter

Table 3: Matrix of Correlation coefficient between *Striga*, grain yield, growth and yield parameters of Maize at 12 WAS in the pooled data during 2013 rainy season.

	1	2	3	4	5	6	7	8	9	10	11	12
1	1.000											
2	0.121	1.000										
3	0.652**	0.375**	1.000									
4	0.322**	-0.049	0.395**	1.000								
5	-0.283*	-0.038	-0.236*	-0.230*	1.000							
6	0.264*	0.123	0.352**	0.245*	0.231*	1.000						
7	0.938**	0.164*	0.693**	0.304*	-0.238*	0.301*	1.000					
8	0.768**	0.263*	0.623**	0.276*	-0.187*	0.261*	0.764**	1.000				
9	0.777	0.261*	0.628**	0.197*	-0.184*	0.179*	0.846**	0.591**	1.000			
10	0.057	-0.019	0.115	0.159	-0.034	0.120	0.054	0.111	-0.001	1.000		
11	-0.708**	-0.173	-0.625**	-0.441**	0.238*	-0.443**	-0.692**	-0.750**	-0.485**	-0.097	1.000	
12	-0.706**	-0.193*	-0.691**	-0.427**	0.253*	-0.412**	-0.690**	-0.784**	-0.518**	-0.179**	0.836**	1.000

KEY: ** = Highly significant at 1%. * =significant at 5%

1. Grain yield — 5. Days to 50% anthesis — 9. Stover yield
2. Plant height — 6. Days to 50% silking — 10. Days to first *Striga* emergence
3. Number of leaves — 7. Dry cob weight — 11. *Striga* shoots count
4. Establishment count — 8. 100 grain weight — 12. *Striga* shoots dry matter