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Evaluating the Contributions of Some Growth and Yield Components of Sorghum (*Sorghum bicolo* L. *moench*) to Grain Yield at Samaru, Nigeria

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Abstract: *Studies were conducted during the rainy seasons of 2013 and 2014 at the Institute of Agricultural Research Farm, Samaru to investigate the response of sorghum varieties to the application of organic and inorganic fertilizers on Striga infested fields. The treatments consisted of four levels of organic manure Cassia obtusifolia green manure at 0, 7.5 and 15t ha^{-1} and cow dung 10 t ha^{-1} and three levels of nitrogen (0, 40 and 80 kg N ha^{-1}). The grain yield was strongly and positively correlated with plant height and number of leaves panicle weight, grain weight at combined and moderately so with all these growth and yield attributes in 2013,2014 respectively. Panicle weight gave the highest direct effect to yield compared to all other parameters. On the other hand, panicle weight via grain weight recorded the highest indirect effect to yield, while the least was by number of leaves via panicle weight. The highest individual contribution was recorded by plant height in 2013 while in 2014 panicle weight produced the highest contribution to yield. Panicle weight via grain weight recorded the highest combined contribution to yield.*

Key words: *Plant height, number of leaves, panicle and grain weight, Sorghum grain yield*

INTRODUCTION

Sorghum (*Sorghum bicolor* (L.) Moench) is the fifth most important cereal crop in the world being surpassed only by rice (*Oryza sativa* L.), wheat (*Triticum aestivum* L.), barley (*Hordeum vulgare* L.) and maize (*Zea mays* L.) (Abunyewa, 2008). It is unique in adapting to environmental extremes of abiotic and biotic stresses and being essential crop to diets of poor people in the semi-arid tropics where drought causes frequent failure of other crops (Godharle *et al*., 2010). Nigeria is the fourth largest producer of sorghum in the world, with an annual production in excess of 4 million metric tones. In the semi-arid tropics sorghum is used in various ways. Sorghum is primarily used for human

consumption as a staple food in the diets of many people in countries of the world, especially in sub – Saharan Africa. (Anon., 2015). The use of inorganic nitrogen (Mumera and Bello,1993; Pieterse,1996) and organic fertilizer (Ogborn, 1984; Bello,1987) has been reported to reduce *Striga* infestation. Depending on level of infestation, *Striga hermonthica* caused 20-80 % yield reduction in Sorghum yield (Altera and Itoh, 2011). Smaling *et al.* (1992) demonstrated the need for integrated nutrients management, especially in areas of low soil fertility where farmers cannot afford to rely on mineral fertilizer alone. Such integrated approach can reduce the inorganic fertilizer requirement, and at the same time increase the efficiency of the added input (Lee, 2007). Some weed plants have the potential to provide the nutrients. When we compare the available nutrients in synthetic fertilizers and their market values, the use of weeds to improve soil fertility would be cheaper. Exploiting available natural resources is a better way towards utilizing poor and marginal soils productively. The long-run effects of the combined application of organic and inorganic fertilizers in improving soil fertility and crop yield have been demonstrated (Bundy *et al*., 2005). The increase in yield of sorghum with organic and inorganic fertilizer applications was probably due to higher number of leaves per plant, plant height and leaf area per plant. Results were similar with findings of Lee *et al*. (2007) who also reported significant effect of N application on green fodder yield of sorghum. Application of organic and inorganic fertilizer in combination produced significantly taller plants when compared with application of organic matter alone but statistically lower than plant height treated with inorganic fertilizer Makinde *et al*. (2001) has earlier reported that, maize yield from sole organic application and a mixture of organic and inorganic fertilizers application were similar and were significantly higher than yields from organic fertilizer application alone. Murwira *et al.* (1993) observed that, nutrients use efficiency was increased through a combined application of organic and inorganic fertilizer. Similarly, Mahadi, (2011) reported that application of 8 and 12 t ha^{-1} of cow dung promoted plant height of maize.

The present work was aim at investigating the relationship between grain yield of sorghum and plant height, number of leaves, panicle weight and grain weight and more so to identify their contributions to yield under local condition of Samaru.

MATERIALS AND METHODS

The two Field trials were conducted during the wet seasons of 2013 and 2014 at Institute for Agricultural Research Farm, Samaru (11 11'N7 38 E; 686m above sea level) in the northern Guinea savanna of Nigeria to investigate the effects of nitrogen and Cassia green manuring on two varieties of sorghum grown on a *Striga*- infested field. The Experiment consisted of two sorghum varieties (SAMSORG-40 and SAMSORG-41) (Anon, 2015). Four levels of organic manure (*Cassia* green manure at 0, 7.5 and 15 t ha^{-1} and cow dung at 10 t ha^{-1}) and three nitrogen levels (0, 40 and 80 k g N ha^{-1}). The experiment was laid out in a split plot design, with nitrogen levels assigned to main plots and factorial combinations of organic manure levels and variety assigned to the sub-plots.

The strength of the relationship between plant height, number of leaves, panicle weight, grain weight and grain yield / ha was studied using correlation coefficient analysis (Little and Hills, 1978).

$$r = SP_{xy} / \sqrt{SS_x SS_y}$$

where, r = Coefficient of correlation

SP_{xy} = Sum of product x and y $\sum$ (x-x) (y-y)

SS_x = Sum of square of x $\sum$ $(x-x^2)$

SS_y = Sum of square of y $\sum$ $(y-y^2)$

The results of the above correlation were used to develop the following simultaneous equations to work out the path coefficient (P-P) (Dewey and Lu, 1959)

$r_{14} = P_1 + r_{12}P_2 + r_{13} P_3 + \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(1)$

$r_{24} = r_{12}P_1 + P_2 + r_{23} P_3 + \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(2)$

$r_{34} = r_{13}P_1 + r_{23} P_2 + P_3 + \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(3)$

where $P_{1--} P_3$ are path coefficients, While r_{12} r_{14} are the coefficients of correlation.

The direct and indirect effects of individual and combined (two factors) contributions of plant height, number of leaves, panicle weight, grain weight and grain yield / ha were determined using path- coefficient analysis. The combined contribution was estimated using the following formula (Ajala *et al.,* 1996): $C_{ij} = 2pp_{ij}$ where C = combined effect of i and j, r_{ij}=coefficient between i and j (i and j are the direct and indirect contributions). The residual factor Rx that is unaccounted for by the direct and combined contributions was estimated using the following formula (Ajala *et al.,* 1996).

$Rx = 1 \sqrt{} (P_1 r_{14} + P_2 r_{24} + P_3 r_{34})$

RESULTS AND DISCUSSION

The grain yield was strongly and positively correlated with plant height and number of leaves panicle weight, grain weight at combined and moderately so with all these growth and yield attributes in 2013,2014 respectively (**Table 1**). Plant height showed strong and positive relationship with number of leaves, panicle weight and grain weight (r=0.504**, r=0.418** and r=0.390**). Number of leaves was strongly correlated with panicle weight and grain weight (r=0.725**, r=0.714**). There was significant strong and positive correlation between panicle weight and grain weight (r=0.968**).

The moderate and positive significant correlation between the yield and all the observed parameters, stressed the dependence of yield on these parameters. It further shows the importance of producing taller plants and more leaves is required to intercept light for high assimilate production which transmitted into grain formation. Taller plants with more leaves and large assimilatory area stand the chance of intercepting more light and competing more effectively against weeds. This result corroborates the one earlier reported by Olabanji (2001), who observed significant and positive relationship between growth and yield characters.

Higher number and heavier panicles and grain weights were significantly positively correlated to grain yield. This is quite expected because panicle size and grain weight are yield attributing factors in cereal production. Olabanji (2001) has earlier observed a

positive and significant relationship between grain yield and yield parameters such as panicle weight and grain weight.

Table 2: The direct and indirect effects of some growth and yield attributes of sorghum on grain yield in 2013, 2014 and combined. The highest direct effect on yield was by panicle weight (0.634a), followed by plant height (0.281a), number of leaves (0.044a) and the lowest by grain weight (-0.197a). For the indirect effect, the highest was by grain weight via panicle weight (0.622), followed by plant height via panicle weight (0.369). Negative direct effect was recorded by all parameters via grain weight. In 2014, panicle weight gave the highest direct effect on yield (0.268a), followed by grain weight (0.232a), plant height (0.186a) and number of leaves (0.087a) in descending order. Panicle weight via grain weight (0.256) gave the highest indirect effect on grain yield, followed by plant height via panicle weight (0.125) and number of leaves via panicle weight (0.125). The least indirect effect was recorded by plant height via number of leaves (0.037). In the combined data of the two years under study, the highest direct effect on grain yield was recorded from grain weight (0.672a), followed by plant height (0.352a), number of leaves (0.118a) with the least recorded by panicle weight (-0.153a). For the indirect effect, panicle weight via grain weight (0.650) gave the highest effect followed by plant height via grain weight (0.262) and number of leaves via grain weight (0.239). The least indirect effect was by number of leaves via panicle weight, which was negative (-0.153). The indirect effects of each parameter via panicle weight were negative.

The greatest effect by panicle weight on yield showed that panicle weight greatly influenced yield. The heavier the panicle the more yield would be realized. The direct effects of some growth parameters to yield such as by plant height, number of leaves, as some of the primary determinants for yield may be attributed to the impact of complementary application of green manure, cow dung and the high rates of N-fertilizer which improved crop growth and eventually led to heavier panicles and grain weight that constituted the yield.

Table 1: Simple correlation between grain yield of Sorghum and plant height, number of leaves, panicle weight and grain weight at Samaru, Zaria during 2013,2014 rainy seasons.

Treatment	2013	2014	combined
Yield Vs plant height	0.679*	0.572*	0.651**
Yield Vs Number of leaves	0.433*	0.545*	0.819**
Yield Vs panicle weight	0.780*	0.740*	0.692**
Yield Vs grain weight	0.763*	0.733*	0.683**
Plant height Vs Number of leave	0.334*	0.426*	0.504**
Plant height Vs panicle weight	0.583*	0.468*	0.418**
Plant height Vs grain weight	0.555*	0.431*	0.390**
Number of leaves Vs panicle weight	0.289*	0.468*	0.725**
Number of leaves Vs grain weight	0.299*	0.519*	0.714**
panicle weight Vs grain weight	0.931*	0.956*	0.968**

*= Significant (p=0.05), **= Highly significant (p=0.01)

Table 2: Direct and indirect contributions of plant height, number of leaves, panicle weight and grain weight to Sorghum grain yield at Samaru, Zaria during 2013 and 2014 rainy seasons.

		2013		
Yield attributes	Plant height	Number of leaves	Panicle weight	Grain weight
Plant height	**0.281a**	0,015	0.369	-0.109
Number of leaves	0.094	**0.044a**	0.189	-0.059
Panicle weight	0.164	0.013	**0.634a**	-0.193
Grain weight	0.156	0.013	0.622	**-0.197a**
		2014		
Plant height	**0.186a**	0.037	0.125	0.100
Number of leaves	0.078	**0.087a**	0.125	0.121
Panicle weight	0.087	0.041	**0.268a**	0.222
Grain weight	0.080	0.045	0.256	**0.232**
		Combined		
Plant height	**0.352a**	0.060	-0.064	0.262
Number of leaves	0.179	**0.118a**	-0.052	0.239
Panicle weight	0.147	0.040	**-0.153a**	0.650
Grain weight	0.137	0.042	-0.148	**0.672a**

Table 3: Shows the percent contribution of Plant height, Number of leaves, Panicle weight and Grain weight to sorghum grain yield in 2013, 2014 and combined. In 2013 the highest individual contribution was recorded by plant height (6.92%) followed by panicle weight (4.16%), grain weight (3.88%) and number of leaves (0.25%) in descending order. The highest contribution in 2014 was by panicle weight (7.17%), followed by grain weight (5.40%), plant height (3.45%) and the lowest from number of leaves (0.76%). The highest combined contribution of plant height, number of leaves, panicle weight and grain weight to sorghum grain yield across the years of study and combined was by panicle weight via grain weight (11.90% in 2014 and 8.19% at combined) except in 2013 where plant height via grain weight had the highest contribution (6.15%). The percent residual effects were 25.8%, 27.8% and 26.8% for 2013, 2014 wet seasons and combined, respectively.

The individual and combined contributions of panicle weight to yield recorded over the years and the mean, showed that sorghum panicle weight has direct bearing on grain yield. The highest combined contributions of panicle weight via grain weight, is not surprising because all of them are major determinants of yield.

Table 3: Percentage contribution of Plant height, Number of leaves, Panicle weight and Grain weight to grain yield of Sorghum at Samaru, Zaria during 2013 and 2014 rainy seasons.

Treatments	2013	2014	Combined
Plant height	6.92	3.45	5.19
Number of leaves	0.25	0.76	0.51
Panicle weight	4.16	7.17	4.64
Grain weight	3.88	5.40	5.31
Combined contribution			
Plant height Vs Number of leaves	0.83	1.36	1.10
Plant height Vs Panicle weight	2.80	4.65	3.73
Plant height Vs	6.15	3.72	4.94

grain weight			
Number of leaves Vs Panicle weight	1.68	2.19	1.94
Number of leaves Vs grain weight	2.52	2.11	2.32
Panicle weight Vs grain weight	4.48	11.90	8.19
Residual	25.8	27.8	26.8
Total	100	100	100

CONCLUSION

Grain weight usually determines the weight of the panicle and panicle weight can be used to estimate yield per plant. Therefore, any factor that may directly or indirectly affect any of the two would equally affect the ultimate grain yield.

REFERENCES

Abunyenwa, A. A. (2008). Efficient utilization of water and nitrogen resources for Grain sorghum under rain fed conditions. University of Nebraska-Lincoln. http://www.digitalcommons.Un1.Edu/panhandleresext.

Altera, E. A., Itoh, K. and Onyango, J. C. (2011). Evaluation of ecologies and severity of *Striga* weed on rice in Sub-Saharan Africa. *Agricultural Biology Journal North America,* 2:752-760.

Anonymous (2015). Sorghum–based foods and recipes in northen Nigeria. IAR/ICRISAT Hope Project, Institute for Agricultural Research, Ahmadu Bello University, Zaria, Nigeria. 24pp.

Bundy, L. G. and Andrasky, T. W. (2005). Recovery of fertilizer nitrogen in crop residues and cover crops on an irrigated sandy soil. *Soil Science Society of America. J.,* 69:640-648.

Godbharle, A. R, More, A. W. and Ambekar, S. S. (2010). Genetic variability and correlation studies in elite 'B' and 'R' lines in kharif sorghum. *Electronic Journal of Plant Breeding*, 1(4): 14-23.

Little, T. M. and Hills, F. J. (1978). Agricultural Experimentation: Design and Analysis. John Wiley and Sons Inc., New York. 350pp.

Lee, L. S., Carmosini, N., Sassman, S. A., Dion, H. M. and Sepulveda, M. S. (2007). Agricultural contribution of antimicrobials and hormones on soil and water quality. *Advances in Agronomy,* 93: 1-48.

Mahadi, M. A. (2011). Effects of weed control methods and cow dung manure on the performance of quality protein maize (*Zea mays* L.). Unpublished M. Sc thesis submitted to the Department of Agronomy, Ahmadu Bello University, Zaria. Pp 162

Makinde, E. A., Akande, M. O. and Agboola, A. A. (2001). Effects of organic and inorganic fertilizers on the growth and yield of maize in a maize-melon intercrop. *Moor Journal of Agricultural Research,* 2:15-20.

Mumera, L. M., and Bello, F. E. (1993). Role of Nitrogen in resistance to *Striga* parasitism in maize. *Crop Science,* 33:758-763.

Murwira, K. H., Swift, M. J. and Frost, P. G. H. (1993). Manure as a key resource in sustainable Agriculture. In: Livestock and Sustainable National Cycling in mixed farming system of sub Saharan Africa. Vol. II. Technical papers in Proceedings of the Agricultural conference held in ILCA, Addis Ababa, Ethiopia from 22 to 26 Nov. 1993. Edited by Powell, J. M., Fermadez-Rivera, S. Williams, T. D. and Renard, C. P. 131-146.

Olabanji, O. G. (2001). Growth and productivity of pearl millet and cowpea in mixture as influenced by component crop proportion, cowpea variety and sowing date. Unpublished M. Sc. Dissertation, Ahmadu Bello University, Zaria, Nigeria. Pp. 115-117.

Smalling, E. M. A., Nandawa, S. M., Prestole, H., Rotter, R. and Muchera, F. N. (1992). Yield response of maize to fertilizer and manure under different agro-ecological conditions in Kenya. *Agriculture, Ecosystem and Environment,* 41: 241-252.

Appendix I: Meteorological data of monthly rainfall, temperature, relative humidity, sunshine hours at Samaru, Nigeria for 2013 and 2014 wet seasons.

Months	Rainfall (mm)	Temperature (^{0}C) Max.	Min	Relative humidity (%)	Sunshine (Hr)
		2013			
May	57.2	35.6	17.4	67.4	7.1
June	102.5	31.0	13.0	76.6	6.9
July	193.9	30.8	20.0	79.6	6.3
August	230.0	30.0	19.6	83.0	4.7
September	113.3	32.0	18.9	78.5	6.5
October	54.0	34.1	18.2	73.5	6.6
November	0.0	34.2	15.9	34.8	8.9
December	0.0	29.0	15.2	24.8	5.2
Total	946.3				
		2014			
May	35.0	35.1	22.2	48.3	6.3
June	98.3	32.1	21.2	55.5	6.4
July	205.0	31.4	20.1	66.2	6.3
August	303.0	30.1	20.1	75.2	6.1
September	206.7	31.1	21.2	66.2	6.3
October	151.7	33.9	19.1	62.1	6.2
November	0.0	30.1	14.0	38.0	6.9
December	0.0	26.2	13.2	23.1	5.9
Total	999.7				

Source : Meteorological Unit Institute for Agricultural Research (IAR), Samaru ABU, Zaria.