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Analyses of Growth, Yield and Fertilization of Vegetable Sesame (*Sesamum radiatum* Schum)

B.M. Auwalu and F.E. Babatunde
Crop Production Programme, School of Agriculture and Agricultural Technology,
PMB 0248, Abubakar Tafawa Balewa University, Bauchi, Nigeria

Abstract: Growth and yield data obtained from response of vegetable sesame to nitrogen and phosphorus fertilizer application were correlated and regressed. Total marketable yield of vegetable sesame was found to be strongly correlated with growth parameters such as plant height, number of leaves per plant and leaf area index. Within the yield parameters, there was a highly significant correlation ($p<0.01$) between total marketable yield and leaf fresh weight as well as shoot dry weight. Yield analysis indicated that the direct contribution of plant height were the main yield contributing factors in both 1996 and 1997. The total contributions (direct and combined) were found to be 42.79 and 64.45% in 1996 and 1997, respectively. However, 57.21 and 35.55% represented the residual factor contribution in 1996 and 1997, respectively. Regression analysis showed that yield and yield components in vegetable sesame cultivation were not mainly determined by nitrogen and phosphorus fertilizer application.

Key words: Correlation, direct and combined contribution, regression

Introduction

Vegetable sesame (*Sesamum radiatum* Schum), a member of the family *Pedaliaceae* is an important vegetable commonly consumed in Nigeria and many other parts of the tropics. The plant occurs throughout tropical Africa mainly as weed (Hutchinson and Dalziel, 1963) where it is gathered in the wild and is used as a potherb. It is one of the many neglected leafy vegetables of the tropics despite its nutritional contribution. It is sometimes cultivated to be used as an ingredient that increases the desirable viscosity of sauces. These sauces are mixed with mashed food prepared from cereals or root crop flours, where it adds to the protein, vitamin and mineral contents of the predominantly starchy diets of the people of area concerned (Oyenuga and Fetuga, 1975; Omidiji, 1978).

Vegetable sesame is propagated by seeds drilled in or broadcast on a well-prepared seedbed. Seeds are at times first raised in a nursery and the seedlings are transplanted to the well-prepared seed beds (Auwalu, 1995). The leaves are harvested 6-8 weeks from seedling emergence or establishment. The crop is harvested either by uprooting the entire plant or by repeated topping of plants that regrow to yield harvestable branches. Nutritional analysis showed that most tropical greens are much richer than temperate types in protein, vitamins and minerals (Tindall, 1977; Omidiji, 1978).

Increasing the productivity of a crop like vegetable sesame requires information on the status of the production techniques, relationship between growth and yield parameters as well as within yield components and the degree of environmental and fertilization influence on the expression of yield. Since yield is a quantitative character that is a function of many related characters for an effective yield improvement, a simultaneous improvement of most yield components is imperative. The correlation

Corresponding Author: F.E. Babatunde, Crop Production Programme,
School of Agriculture and Agricultural Technology,
PMB 0248, Abubakar Tafawa Balewa University, Bauchi, Nigeria

coefficient measures the mutual association between a pair of variables independent of other variables while regression analysis gives the relationship between one variable and one or more factors (Ajala *et al*., 1996; Babatunde and Auwalu, 2003).

The present study seeks to establish the relationship between growth parameters, yield and yield components and fertilizer application as they influence and/or determine productivity in vegetable sesame.

Materials and Methods

The experiments were conducted during the dry season of 1996 and the rainy season of 1997 at the horticultural garden of the School of Agriculture, Abubakar Tatari Ali Polytechnic Bauchi and the research farm of the School of Agriculture, Abubakar Tafawa Balewa University Bauchi, Nigeria, respectively. Both research field are approximately located at 10°17' N, 9°49' E and 609.3 m above sea level in the northern guinea savannah ecological zone of Nigeria as reported by Auwalu *et al*. (2004).

Three levels of N fertilizer (urea = 46% N) and three levels of P fertilizer (single super phosphate = 7.8% P_2O_5) were applied in factorial combination laid out in a randomized complete block design with three replications and are explicitly explained by Auwalu *et al*. (2004). All the standard agronomic and cultural practices undertaken (which included land preparation, sowing, thinning, weeds, pests and disease) with the exception of irrigation practice in 1996, were carried out uniformly in both years.

Growth parameters such as plant height, number of leaves per plant, leaf area index were correlated with total marketable yield t ha^{-1} in 1996 and 1997 using the Pearson correlation in MINITAB 10.2 version computer software package. The path coefficients were obtained using the correlation coefficients used to develop simultaneous equations as described by Dewey and Lu (1959) as follows:

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

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

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

In the above equations, P_1, P_2 and P_3 are path coefficients, while r_{12} .....r_{34} are the coefficients of correlation. The path coefficients measure the direct contribution between yield and the concerned growth parameters, whereas the correlation coefficients measures a mutual association between the growth parameters as explained by Babatunde and Auwalu (2003). The direct contribution was calculated as follows:

$$Di = (Pi)^2 \times 100$$

Where D = direct effect of i

The combined contributions of two growth parameters was estimated with the formula:

$$C\,ij = 2\,Pi\,Pj\,r\,ij$$

Table 1: Direct, indirect and total contributions of growth parameters to total marketable yield of vegetable sesame in two years

Parameters	Contributions	
	1996	1997
Plant height (X1) to total marketable yield (X4)		
Direct contribution of plant height (P_1)	0.732	0.585
Indirect contribution via number of leaves / plant ($r_{12}P_2$)	-0.180	0.064
Indirect contribution via Leaf area index ($r_{13}P_3$)	0.099	0.130
Total contributions (Direct+Indirect)	0.651	0.779
Number of leaves / plant (X2) to total marketable yield (X4)		
Direct contribution of number of leaves / plant (P_2)	-0.198	0.087
Indirect contribution via plant height ($r_{12}P_1$)	0.667	0.432
Indirect contribution via leaf area index ($r_{23}P_3$)	0.106	0.167
Total contributions (Direct+Indirect)	0.575	0.686
Leaf area index (X3) and total marketable yield (X4)		
Direct contribution of leaf area index (P_3)	0.120	0.198
Indirect contribution via plant height ($r_{12}P_1$)	0.667	0.432
Indirect contribution via number of leaves/plant($r_{23}P_2$)	-0.174	0.073
Total contributions (Direct+Indirect)	0.613	0.703

Where C ij = combined effect of i and j
r ij = coefficient of correlation between i and j
(i and j depict direct and indirect contributions,, respectively)

The residual factors Rx which is unaccounted for by the direct and combined contributions was estimated as follows:

$$Rx = 1 - (P_1 r_{14} + P_2 r_{24} + P_3 r_{34}) \times 100$$

Where Rx = Residual effect
Pi = Path coefficients
r ij = Total contribution of factors i and j represented by the coefficient of correlation in the above simultaneous equations. However, all these were obtained through the explicit calculations presented in Table 1. The three components of direct effect, combined contribution and residual effect should add-up to unity or 100%.

Combined analysis of variance for data on leaf fresh weight, shoot dry weight and total marketable yield was also done. These yield components were correlated among themselves. Similarly, regression analysis was carried out between these yield component and the fertilizer application with the use of MINITAB 10.2 version computer software package.

Results and Discussion

In both seasons, the correlations were positive and highly significant ($p<0.01$). This indicated that the growth as well as yield parameters are interrelated among themselves. It also implies that the growth parameters are the major determinants of vegetable sesame yield (Table 2) This result is in conformity with the result obtained by Babatunde and Auwalu (2003) who carried out correlation analysis between growth and yield of red variant Roselle. It was further ascertained in this result that the taller plants possessed higher number of leaves per plant and this eventually led to wider leaf area. This wider leaf area would invariably lead to greater photosynthetic activity hence, higher total marketable yield. The reason may however be attributed to the fact that vegetable sesame is an indeterminate plant with sympodial growth habit like pepper (Aliyu *et al*., undated) and Roselle (Babatunde and Auwalu, 2003).

Similarly, the correlation coefficients of combined analysis between yield and yield components was positive and highly significant ($p<0.01$) as presented in Table 3. However, the highest correlation coefficient (0.952**) was obtained when total marketable yield was correlated with leaf fresh weight.

Table 4 shows that there was differential contribution of some growth parameters on total marketable yield of vegetable sesame. Plant height made the largest direct contribution of 54.02 and 34.35% in 1996 and 1997, respectively to total marketable yield. In same vein, the residual effect which cannot be accounted for by direct and combined contributions were large in both seasons. It was above half of the entire contribution (57.21%) in 1996 and up to 35.55% in 1997. Thus, it was only about 42.79 and 64.45% variation in vegetable sesame total marketable yield that could be attributed to the direct effect from plant height, number of leaves per plant and leaf area index and their combined contributions in 1n 1996 and 1997, respectively.

The result of the regression analysis between yield components and fertilization showed that both nitrogen and phosphorus fertilizer application are not very important determinant of yield (Table 5).

Table 2: Correlation coefficients between yield, growth parameters and within growth as well as yield parameters of vegetable sesame in two years

Parameters	Plant height	No. of leaves/plant	Leaf area index	Leaf fresh weight	Shoot dry weight
1996					
Number of leaves/plant	0.911**				
Leaf area index	0.822**	0.884**			
Leaf fresh weight	0.664**	0.556**	0.633**		
Shoot dry weight	0.200**	0.100**	0.272**	0.499**	
Total marketable yield	0.650**	0.574**	0.547**	0.724**	0.354**
1997					
Number of leaves/plant	0.739**				
Leaf area index	0.657**	0.843**			
Leaf fresh weight	0.691**	0.396**	0.295**		
Shoot dry weight	0.894**	0.761**	0.604**	0.783**	
Total marketable yield	0.779**	0.685**	0.655**	0.479**	0.723**

** = $p<0.01$

Table 3: Correlation coefficients of combined analysis between total marketable yield and other yield parameters

Yield components	Total marketable yield	Leaf fresh weight
Leaf fresh weight	0.952**	
Shoot dry weight	0.940**	0.945**

**$p<0.01$

Table 4: Direct and combined contribution of some growth parameters on total marketable yield of vegetable sesame presented as percentage in two years

Parameters	1996	1997
Direct contribution (Pi) 2×100		
Plant height	54.02	34.35
Number of leaves per plant	4.23	0.71
Leaf area index	1.56	3.96
Total	59.83	39.02
Combined contributions (2 Pi Pj r ij)		
Plant height and number of leaves per plant	-27.59	7.28
Plant height and leaf area index	15.11	15.33
Number of leaves per plant and leaf area index	-4.56	2.82
Residual	57.21	35.55
Total	-17.04	25.43
Grand total	100.00	100.00

Table 5: Combined contribution of nitrogen and phosphorus fertilization on yield and yield components of vegetable sesame

Yield components	R^2	(%) Regression equation
Leaf fresh weight (LFWT)	1.7	LFWT = 2.36+0.227 N+0.151 P
Shoot dry weight (SDWT)	4.0	SDWT = 1.40+0.547 N+0.050 P
Total marketable yield (TMY)	0 2.0	TMY = 8.39+1.48 N–0.06 P

R^2 = Coefficient of determination, N = Nitrogen, P = Phosphorus

This is evident from the fact that the coefficients of determination were infinitesimal and not significant. In spite of non-significancy from the regression equation, the total marketable yield showed negative phosphorus regression sign. This can also be linked to the high level of residual contribution to total marketable yield as presented in Table 4. This finding is however contrary to that of Babatunde and Auwalu (2003) who reported that factors (agronomic practices) were very important determinants of yield in red variant roselle calyx.

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