Interrelationship and Path Coefficient Analysis of Some Growth and Yield Characterestics in Sesame (*Sesamum Indicum* L.)

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Abstract

Field experiments were conducted during 2005 and 2006 rainy seasons at the Teaching and Research Farm, Faculty of Agriculture, Adamawa State University, Mubi, Nigeria (Latitude 10^0 15'N and longitude 13^0 16' E at an altitude of 696 m above sea level) to study the effect of nitrogen (N) and phosphorous (P) rates on some growth and yield characteristics of sesame as well as to determine the interrelationship, path coefficient analysis and percentage contributions of these growth characters to seed yield. The treatments consisted of four N rates: 0, 30, 60 and 90 kg ha^{-1} and four P rates: 0, 15, 30 and 45 kg ha^{-1}. These treatments in factorial combinations were laid out in split plot design with N rates assigned to main plots and P rates assigned to sub plots and were replicated four times. The following data were collected; number of branches per plant, leaf area per plant, plant height and seed yield per hectare and were subjected to correlation and path coefficient analyses. Result obtained showed a positive relationship among the characters measured which also contributed meaningfully both directly and indirectly to total seed yield per plant with number of branches and plant height making the highest direct contributions, respectively. Hence these two may serve as a basis for selection in sesame crop improvement.

Keywords: Sesame, Interrelationship, Path coefficient Analysis

1. Introduction

The significance of sesame (*Sesamum indicum* L.) in Nigerian agriculture became apparent in the recent years following its importance as a cash crop in the world market. Sesame is now ranked as the second best to cocoa in terms of export volume and value (Anon., 2004). Nigeria's current annual export is valued at about \$20 million US and the country is the primary supplier of sesame seed to the world's largest importer, Japan (Anon., 2002). However, low yield of 300 kg ha $^{-1}$ obtained by poor resource farmers' as against 1295 kg ha^{-1}obtained under experimental station (Okpara *et al*., 2007) is discouraging. Efforts to improve sesame yield becomes pertinent to meet up with demands. Research activities on sesame have so far focus mainly in the areas of fertilizer trials, weed control, breeding for resistance to pest and diseases, seed rate, planting methods, etc. and little work was done on evaluating the interrelationship and contribution of different growth characters to seed yield of the crop. Yield is a quantitative character that is a function of many related characters and for effective yield improvement, a simultaneous improvement of most yield components alongside agronomic practices is imperative. Snedecor and Cochran (1967) described correlation as a measure of association between pairs of variables independent of other variables and path analysis decomposes correlation into pieces for easy interpretation of effects. In their studies with cowpea Yahaya *et al*. (2005) reported a highly significant correlation between plant height and total green pod yield. Also found to be significantly correlated to green pod yield were leaf area per plant. Direct percentage contribution of plant height was found to be higher to that of leaf area per plant; 20.98 % and 0.504%, respectively (Yahaya, *et al*., 2005).

This research therefore, aimed at assessing the interrelationship and contribution of some growth characters to seed yield with the view of enhancing their agronomic performance and as well as serve as a basis for selection in sesame improvement.

2. Materials and Methods

Field experiments were conducted at the Teaching and Research Farm, Faculty of Agriculture, Adamawa State University, Mubi (Latitude 10^0 15'N and longitude 13^0 16' E at an altitude of 696 m above sea level) during the 2005 and 2006 rainy seasons. Composite soil samples were collected during the two cropping seasons to determine physicochemical properties of the experimental site. The land was ploughed and harrowed in both seasons to obtain a fine tilt and marked into plots. Total land area used for the experiment was 1142.35m^2 (15.5m x 73.7m), with a gross plot size of 4.2m x 3m and net plot size of 1.2m x 1.95m.

The treatments consisted of four rates of N (0, 30, 60 and 90 kg) and four rates of P (0, 15, 30 and 45 kg) ha^{-1}. The treatments were laid out in factorial combinations in a split-plot design and were replicated four times. Nitrogen was assigned to main plots and phosphorous assigned to sub-plots. Sesame variety PB-Til no.1 obtained from Adamawa State Agricultural Development Programme (ADADP) was used for the study. Sowing was done on the 21st July, 2005 and 24th July, 2006 for the first and second experiments, respectively. Sowing was carried out by seed drilling in rows 60 cm spaced. The seedlings were later thinned out to 15 cm apart at two weeks after emergence as recommended (ADADP, 1996). The appropriate P rate and half of the total amount of N were incorporated into the soil during field leveling as a pre-plant application while the remaining half of N was applied as side dressing 3 weeks after sowing. Weeds were controlled manually using hoes at 3, 5 and 9 weeks after sowing. Data were collected on number of branches per plant, leaf area per plant, and seed yield per plant. Data collected were subjected to correlation analysis (Little and Hills, 1976). Path coefficient analysis was carried out as described by Dewey and Lu (1959) by solving the following equations:

$$P_1+r_{12}P_2+r_{13}P_3 = r_{14}$$

$$r_{12}P_2+P_2+r_{23}P_3 = r_{24}$$

$$r_{13}P_1+r_{23}P_2+P_3 = r_{34}$$

Where: $P_{1,}$ P_2 and P_3 are path coefficients measures direct contribution of growth

characters to fruit yield.

r_{12} …r_{34} are coefficients of correlations measures mutual association between two characters

3. Results and Discussion

The results of composite soil samples for the two rainy seasons used in determining the physico – chemical properties of the soils in the experimental sites as well as rainfall data for the two seasons are presented in Table 1. The soils were silty loam and acidic, organic carbon; an index of soil fertility was low. Total N and available P of the second experiment were slightly higher than those in the first experiment. These variations were apparent in most of the chemical properties. Also variation in rainfall might have affected the concentration of nutrients in the first experiment. While rainfall started in April in 2005, it commenced in March in 2006, and peaked in August and September, respectively.

Table 2 shows the matrix of correlation coefficient describing the relationships between growth characters and seed yield of sesame. Number of branches per plant and plant height had a highly significant ($P < 0.01$) and positive correlation coefficients of 0.41 and 0.40, respectively to seed yield per plant. This can be explained on the basis that the higher the plant the more fruit branches formed. Since auxiliary buds close to the shoot apex do not grow into branches due to the influence of apical meristem, where dominance declines with distance to the shoot apex (Forbes and Watson, 1992); hence the higher will be the yield. The highly significant and positive coefficient correlation conforms to the earlier report of Sunday and Ariyo (2008) who had a similar result in their studies with okra. Similarly, there is a significant ($P < 0.05$) and positive correlation between leaf area and seed yield ($r=0.21$). The significant correlation might not be unconnected with the fact that larger leaf areas achieved maximum photosynthesis and consequently maximum dry matter accumulation. The leaf being the source of assimilates are later partitioned to the storage sink (seed). In a similar study with okra Adenij and Aremu (2007) had earlier reported positive relationship between leaf area and fruit yield which suggest the number of fruits produced per plant.

The path coefficient analysis is presented in Fig. 1. it shows how the total contribution of number of branches to seed yield was divided into direct and indirect contributions (Table 3). It was observed that out of the total contribution of 0.41 by number of branches to seed yield; 0.3117 was contributed directly while 0.1052 indirectly via plant height. This followed the earlier explanation that the higher the plant the more the branches and consequently, more pods are produced, which resulted into higher seed yield. The indirect contribution via leaf area per plant is negative and negligible (-0.0069) showing that the taller the plant, more branches are formed and lower leaves are shaded by the upper leaves. Ultimately, affecting photosynthetic efficiency of the shaded lower leaves; leading to senescence and death. This trend is similar when the total contribution of plant height was partitioned into direct and indirect contributions. Indirect positive contribution via leaf area was smallest (0.0153) owing to the negative effect of the upper leaves on lower leaves which leads to senescence and death of the lower leaves. Out of the total contribution of plant height (direct and indirect), 0.3093 was directly contributed by plant height and 0.1059 indirectly via number of branches. The trend follows the same pattern with that of the total contribution of number of branches.

When the contribution of the growth characters were quantified on percentage basis (Table 4), number of branches, leaf area and plant height contributed 9.72%, 0.08% and 9.57%, respectively. The percentage contribution of leaf area per plant is lowest (0.08%), conforming to the reports of Oseni (1994) and Yahaya *et al.* (2005) who reported lowest contribution of leaf area to pod yield of cowpea. The contribution of number of branches in combination with plant height is the highest 6.55%, while the contribution of number of branches and leaf area is lowest and negative (-0.43). About 73.57% of the total contributions could not be explained in these studies likely due to variation in the amount of rainfall received in the two cropping seasons. Heavy rainfalls are not favourable for sesame production as it usually resulted to poor performance and low seed yield.

4. Conclusion

Significant and positive correlations were observed between growth characters and between growth characters and seed yield of sesame. When the correlation coefficients were partitioned into direct and indirect effects, number of branches per plant had the highest contribution followed by plant height. Leaf area per plant contributed the lowest. When the growth characters were quantified in terms of percentage, the percentage contribution of number of branches and plant height were higher. Implicit to this dictum, number of branches per plant and plant height should serve as basis for selection in sesame improvement.

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Table 1. Soil physicochemical properties and monthly rainfall of the experimental sites during the 2005 and 2006 rainy seasons

Soil properties	**2005**	**2006**
Soil pH (H_2O)	5.50	5.40
Organic carbon (g kg^{-1})	0.45	0.42
Organic matter (g kg^{-1})	0.74	0.76
Total N (g kg^{-1})	0.16	0.17
Available P (mg kg^{-1})	7.20	7.40
C.E.C (cmol kg^{-1})	3.43	3.40
Exchangeable K (cmol kg^{-1})	3.04	3.10
Exchangeable Na (cmol kg^{-1})	0.98	1.02
Exchangeable Ca (cmol kg^{-1})	7.54	6.87
Exchangeable Mg (cmol kg^{-1})	2.30	2.21
Textural class	Silty loam	Silty loam
Monthly rainfall (mm)		
March	0.00	48.50
April	47.20	2.50
May	75.30	92.70
June	154.70	95.60
July	207.00	229.60
August	329.00	216.00
September	254.70	244.00
October	41.90	52.50
Total	1110.3	981.6
Mean	158.61	122.7

Table 2. Matrix of correlation coefficient showing the relationships between growth characters and seed yield of sesame (*Sesamum indicum L.*)

	1 NB	2 LAP	3 PH	4 SY
1. Number of branches per plant (NB)	1.00			
2. Leaf area per plant (LAP)	0.24*	1.00		
3. Plant height (PH)	0.34**	0.53**	1.00	
4. Seed yield (SY)	0.41**	0.21*	0.40**	1.00

*, ** = significant and highly significant at 5% and 1% level of significance, respectively.

Table 3. Direct, indirect and total contribution of growth characters to Seed yield of sesame (*Sesamum indicum L.*)

Characters	Contributions
1. Number of branches (r_1) fruit yield (r_4)	
a. Direct contribution of number of branches (P_1)	0.3117
b. Indirect contribution via leaf area ($r_{12}P_2$)	- 0.0069
c. Indirect contribution via plant height ($r_{13}P_3$)	0.1052
Total contribution (direct and indirect)	0.41
2. Leaf area per plant (r_2) and fruit yield (r_4)	
a. Direct contribution of leaf area (P_2)	- 0.0288
b. Indirect contribution via number of branches ($r_{12}P_1$)	0.0748
c. Indirect contribution via plant height ($r_{23}P_3$)	0.1639
Total contribution (direct and indirect)	0.2099
3. Plant height (r_3) and fruit yield (r_4)	
a. Direct contribution of number of plant height (P_3)	0.3093
b. Indirect contribution via number of branches ($r_{13}P_1$)	0.1059
c. Indirect contribution via leaf area ($r_{23}P_2$)	0.0153
Total contribution (direct and indirect)	0.4309

Table 4. Direct and combine contribution (%) of growth characters to seed yield sesame (*Sesamum indicum L.*) and their residual effect

Growth characters	Percentage contribution (%)
Direct contribution $(P_i)^2$ x 100	
Number of branches $(P_1)^2$	9.72
Leaf area per plant $(P_2)^2$	0.08
Plant height $(P_3)^2$	9.57
Combined contributions ($2P_iP_jr_{ij}$) x 100	
Number of branches and leaf area ($2P_1P_2r_{12}$)	- 0.43
Number of branches and plant height ($2P_1P_3r_{13}$)	6.55
Leaf area and plant height ($2P_2P_3r_{23}$)	0.94
Residual effect ($1 – P_1 r_{14} – P_2r_{24} – P_3 r_{34}$)	73.57
Total	100

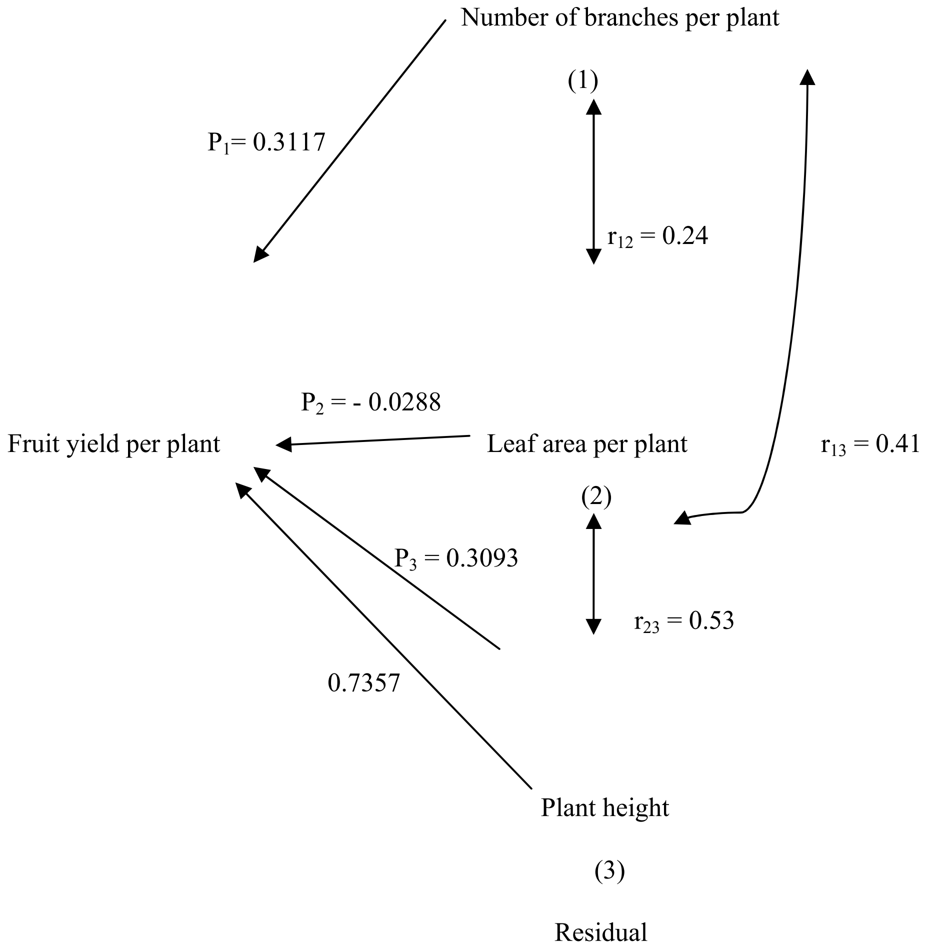

Figure 1. A path diagram and coefficient of factors affecting total seed yield of sesame (*Sesamum indicum L.*)