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# Contributions of Some Yield Attributes to Seed Yield of Sesame (*Sesamum indicum* L.) in the Northern Guinea Savanna of Nigeria

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## ABSTRACT

Field trials were conducted during the rainy seasons of 2005, 2006 and 2007 to study the contributions of some yield attributes to the seed yield of sesame. The experiments consisted of four levels of poultry manure (0, 5.0, 10.0 and 15.0 t $ha^{-1}$), three levels of nitrogen in the form of urea (0, 60 and 120 kg N $ha^{-1}$ ) and three levels of phosphorus in the form of single super phosphate (0, 13.2 and 26.4 kg P $ha^{-1}$). The thirty six treatments were laid out in a split-plot design with three replications. The factorial combination of N and P were assigned to the main plot while poultry manure was assigned to the sub-plot. All yield attributes measured (number of capsules $plant^{-1}$, capsule yield $plant^{-1}$, seed yield $plant^{-1}$ and seed oil-content), correlated positively and significantly ($p = 0.01$) with the yield throughout the years of experimentation and the mean of the three years. Path coefficient analysis revealed that the highest contribution among the yield components was made by seed yield per plant (0.5866a) followed by number of capsule per plant, capsule yield plant and seed oil content. The combined effect of two factors on the yield was observed to be inconsistent when the individual year is being considered but when the three year data was combined, the combined contribution of number of capsules per plant and seed yield per plant was found to be the highest (0.3989). The highest percent contribution to seed yield was made by and via seed yield per plant (34.4042 and 21.2104%) when the data is combined. Seed yield $plant^{-1}$ should therefore, be considered as the most important traits in the determination of seed yield per unit area and selection of parents.

**Key words:** Correlation, path analysis, percent contribution, capsule yield, seed oil, number of capsule

## INTRODUCTION

Sesame (*Sesamum inducum* L.) also known as beniseed in West Africa, Sim-sim in East Africa is an oil crop belonging to the family *pedaliaceae* grown in both tropical and sub-tropical regions of Africa, Asia and Latin America. It is the most important crop from which semi-drying vegetable oils are obtained and perhaps the oldest crop cultivated for its oil (Onwueme and Sinha, 1991).

Asia and Africa are the major producers of sesame in the World, with Asia producing more than half of the world population figure. In 2007, Asia produces 2.4 million short tons of whole sesame seed while Africa produces 1.2 million short tons of sesame (UN/FAO, 2008).

The importance of sesame lies in its high quality oil which is often referred to as the "queen" of vegetable oil. The outstanding characteristics of sesame oil, is its stability and keeping quality as well as resistance to rancidity. Sesame oil is use in making paints, soaps, cosmetics, perfumes, insecticides canned sardine, canned beef as well as for pharmaceutical and ethno botanical uses (FAO, 2002; RMRDC, 2004; Biabani and Pakniat, 2008). The leaves are used as vegetables and are rich sources of vitamins (Auwalu and Babatunde, 2007).

As in cultivated crops the main objective of growing sesame is for high yield and high quality crops. The performance of the crop is affected by such factors as climatic, nutrients, water availability, inter and intra-specific competitions, pest and diseases, as well as socio-cultural and socio-economic factors among other things. The relationship that exists between different parts of the crop has a significant influence on the seed yield (Adeyemo and Ojo, 1991).

Correlation analysis is a handy technique which provides information about the degree of relationship between important plant traits and is also a good index to predict the yield response in relation to the change of a particular character (Malik *et al.*, 2007; Talebi *et al.*, 2007). Path coefficient is one of the effective technique to sought out inter-relationship of different yield characters and their direct and indirect effect on grain yield through correlation values (Khan *et al.*, 2003). Working on the correlation and path analysis in sesame, Gnanasekaran *et al.* (2008) and Kumar and Vivekanandan (2009) reported that positive and highly significant association between yield and yield attributes of sesame.

In sesame, seed yield, as in other crops, is a complex character which is dependent on a number of variables. To increase its yield, the study of direct and indirect effects of yield and its components provide the basis for its successful breeding program and thus increase of seed yield can be more effectively tackled on the basis of performance of yield components and selection for closely associated traits. Path co-efficient analysis measures the direct and indirect effect for one variable upon another and permits the separation of the correlation co-efficient into components of direct and indirect effect (Dewey and Lu, 1959). For efficient breeding and crop improvement, it is of utmost importance in any crop plant to ascertain the contribution of each yield related trait to yield and to select component maximizing yield (Ashkani *et al.*, 2007; Chowdhury *et al.*, 2010). The present study is one of such efforts to study the relationship between some yield attributes and the seed yield per unit area and also the contributions of some yield attributes to seed yield per unit area in sesame.

## MATERIALS AND METHODS

Field Experiments were conducted during the rainy seasons of 2005, 2006 and 2007 at the Institute for Agricultural Research (IAR) Farm, Ahmadu Bello University, Samaru, (11° 11/N; 07° 38/E, 686 m) above sea level, located in the northern Guinea savanna agro-ecological zone of Nigeria. The experiment consisted of factorial combinations of three levels of nitrogen (0, 60 and 120 kg N $ha^{-1}$) in the form of Urea, three levels of phosphorus (0, 13.2 and 26.4 kg P $ha^{-1}$) in the form single super phosphate and four levels of poultry manure (0, 5.0, 10.0 and 15.0 t $ha^{-1}$). The 36 treatment combinations were laid out in a split-plot design with nitrogen and phosphorus levels assigned to the main-plot, while poultry manure was assigned to the sub-plot. The gross plot size was 13.5 $m^2$ (4.53×3 m) while the net plot size was 9 $m^2$ (3×3 m).

The experimental area was disc-ploughed and harrowed twice to a fine tilt. This was then followed by ridging at 75 cm apart (between rows) and the field marked into plots and replications. The plots were separated by 1.0 m unplanted boarder while replications were separated by 2.0 m unplanted boarder. The three levels of phosphorus and the four levels of poultry manure were incorporated into the ridges according to field plan after land preparation and left for two weeks before sowing. Half of the nitrogen levels were applied at 3 Weeks After Sowing (WAS) while the remaining half was applied at 6 WAS. The planting material used was Ex-Sudan, it is white in colour, of medium in height (cm) and medium maturity (85 to 90 days) (RMRDC, 2004). Sesame was planted on the 16th, 19th and 20th July in 2005, 2006 and 2007, respectively. Six to ten seeds of sesame were sown at 15cm intra-row spacing on ridges spaced 75 cm apart and was later thinned to two plants per stand at 3 WAS. Manual hoe weeding was done at 3, 6 and 9 WAS to keep the experimental plots weed-free.

The crop was harvested on the 23rd, 27th and 28th of October 2005, 2006 and 2007 respectively, when the leaves and the stems changed colour from green to yellow with a reddish tint on them. Harvesting was manually done with the aid of a sickle by cutting the plants at the base close to the ground. Plants from each plot were put in a sack to dry so as to minimize seed loss when capsule dehisces. When the harvested plants were adequately dry, the sacks were gently beaten with sticks in order to release all the seeds from the capsules. The seeds were then separated from the chaff by winnowing. Ten randomly selected plant samples from each plot were used at harvest to determine the yield attributes such as number of capsule per plant, capsule yield per plant, seed yield per plant while the entire plant in the net plot were used to obtain the seed yield per hectare. The data collected were subjected to analysis of variance using the 'F' test to estimate the significance in the effects of the treatments as described by Snedecor and Cochran (1967). Comparisons of treatment means were done using the Duncan's Multiple Range Test (Duncan, 1955). The magnitude and type of association between the treatments measured were assessed through simple correlation analysis as described by Little and Hills (1978). The results of the correlation were used to develop simultaneous equations to work out the path coefficients as described by Dewey and Lu (1959) using MSTATC and SAS software.

The direct and indirect effects of individual and combined (two factors) contributions of yield components to total seed yield per hectare were determined using Path-coefficient analysis. The combined contribution was estimated as described by Ajala *et al.* (1996).

The residual factor (Rx) that is unaccounted for by the direct and combined contributions was estimated using the following formula:

$$Rx = 1 - \sqrt{(P_1 r_{15} + P_2 r_{25} + P_3 r_{35} + P_4 r_{45})}$$

## RESULTS

In 2005, all the yield characters considered, correlated positively and highly significantly with the yield except seed oil content which correlated negatively and not significantly with the yield (r = -0.05) (Table 1). All the yield characters considered correlated positively and significantly with themselves except between capsule yield per plant and seed oil content (r = 0.15), seed yield per plant and seed oil content (r = 0.04) which were not significant.

In 2006, all the yield characters considered, correlated positively and highly significantly with the yield and with themselves except between seed yield per plant and seed oil content (r = 0.07)

Table 1: Correlation matrix between some yield characters of sesame and grain yield in 2005

| | No. of capsule $plant^{-1}$ | Capsule yield $plant^{-1}$ (g) | Seed yield $plant^{-1}$ (g) | Seed oil content (%) | Grain yield $ha^{-1}$ (kg) |
|---|---|---|---|---|---|
| No. of capsule $plant^{-1}$ | 1.00 | | | | |
| Capsule yield $plant^{-1}$ (g) | 0.74** | 1.00 | | | |
| Seed yield $plant^{-1}$ (g) | 0.69** | 0.66** | 1.00 | | |
| Seed oil content (%) | 0.21* | 0.15 | 0.04 | 1.00 | |
| Grain yield $ha^{-1}$ (kg) | 0.52** | 0.53** | 0.74** | -0.05 | 1.00 |

*: Significant at 5% level of significance **: Significant at 1% level of significance

Table 2: Correlation matrix between some yield characters of sesame and grain yield in 2006

| | No. of capsule plant$^{-1}$ | Capsule yield plant$^{-1}$ (g) | Seed yield plant$^{-1}$ (g) | Seed oil content (%) | Grain yield ha$^{-1}$ (kg) |
|---|---|---|---|---|---|
| No. of capsule plant$^{-1}$ | 1.00 | | | | |
| Capsule yield plant$^{-1}$ (g) | 0.75** | 1.00 | | | |
| Seed yield plant$^{-1}$ (g) | 0.70** | 0.62** | 1.00 | | |
| Seed oil content (%) | 0.32** | 0.26** | 0.07 | 1.00 | |
| Grain yield ha$^{-1}$ (kg) | 0.78** | 0.72** | 0.79** | 0.26** | 1.00 |

**: Significant at 1% level of significance

Table 3: Correlation matrix between some yield characters of sesame and grain yield in 2007

| | No. of capsule plant$^{-1}$ | Capsule yield plant$^{-1}$ (g) | Seed yield plant$^{-1}$ (g) | Seed oil content (%) | Grain yield ha$^{-1}$ (kg) |
|---|---|---|---|---|---|
| No. of capsule plant$^{-1}$ | 1.00 | | | | |
| Capsule yield plant$^{-1}$(g) | 0.77** | 1.00 | | | |
| Seed yield plant$^{-1}$(g) | 0.68** | 0.64** | 1.00 | | |
| Seed oil content(%) | 0.36** | 0.26** | 0.15 | 1.00 | |
| Grain yield ha$^{-1}$ (kg) | 0.86** | 0.82** | 0.74** | 0.34** | 1.00 |

** Significant at 1% level of significance

Table 4: Correlation matrix between some yield characters of sesame and grain yield (2005 – 2007 combined)

| | No. of capsule plant$^{-1}$ | Capsule yield plant$^{-1}$ (g) | Seed yield plant$^{-1}$ (g) | Seed oil content (%) | Grain yield ha$^{-1}$ (kg) |
|---|---|---|---|---|---|
| No. of capsule plant$^{-1}$ | 1.00 | | | | |
| Capsule yield plant$^{-1}$(g) | 0.84** | 1.00 | | | |
| Seed yield plant$^{-1}$(g) | 0.73** | 0.68** | 1.00 | | |
| Seed oil content(%) | 0.37** | 0.31** | 0.14* | 1.00 | |
| Grain yield ha$^{-1}$(kg) | 0.70** | 0.63** | 0.78** | 0.22** | 1.00 |

*: Significant at 5% level of significance **: Significant at 1% level of significance

which was not significant (Table 2). In 2007, all the yield characters considered, correlated positively and highly significantly with the yield and with themselves except between seed yield per plant and seed oil content (r = 0.15) which was not significant (Table 3). The mean of the three years data showed that all the yield characters considered, correlated positively and significantly with the yield and with themselves (Table 4).

The direct and indirect contributions of some yield components to seed yield of sesame in 2005, 2006, 2007 and the combined data are shown in Table 5. The direct contribution of all the yield parameters was positive and large except for number of capsules per plant which was negative and small in 2005 (-0.0016), capsule yield per plant and seed oil content which were small but positive in 2005 (0.0945 and 0.0911, respectively), seed oil content in 2006 and 2007 (0.0872 and 0.0664, respectively), capsule yield per plant and seed oil content in the combine (0.0097 and 0.0432) which were all small but positive.

The indirect contributions through number of capsules per plant via all the yield components measured were all negative and small in 2005. The indirect contribution through capsule yield per plant via all the yield components were small but positive in 2005, 2006 and the mean of the three years. In 2007, it was only the indirect contribution through capsule yield per plant via seed oil content that was small (0.0528). The indirect contribution through seed oil content and the yield parameters measured were all small in the combined data.

When the individual percent contribution of yield components to sesame seed yield was carefully studied, it was observed that the highest percent contribution to seed yield was made by seed yield per plant in all the years and the combined data (46.5704, 21.7996 and 34.404%, respectively) except in 2007 where percent contribution from number of capsule per plant was highest (18.4602%) (Table 6). The least individual percent contribution of yield parameters to seed yield varied among the years. For example, in 2005 the least was number of capsule per plant (0.0003%) in 2006 and 2007 it was from seed oil content (0.7595 and 0.4410%, respectively) while

Table 5: The direct and indirect contributions of some yield components to grain yield from 2005 to 2007 and the mean

| Yield characteristics | No. of capsule plant$^{-1}$ | Capsule yield plant$^{-1}$ | Seed yield plant$^{-1}$ | Seed oil content |
|---|---|---|---|---|
| **2005** | | | | |
| No. of capsule plant$^{-1}$ | -0.0016a | 0.0699 | 0.4709 | 0.0191 |
| Capsule yield plant$^{-1}$ | -0.0013 | 0.0945a | 0.4504 | 0.0137 |
| Seed yield plant$^{-1}$ | -0.0012 | 0.0624 | 0.6824a | 0.0036 |
| Seed oil content | -0.0004 | 0.0142 | 0.0273 | 0.0911a |
| Total | -0.0045 | 0.241 | 1.631 | 0.1275 |
| **2006** | | | | |
| No. of capsule plant$^{-1}$ | 0.2729a | 0.1524 | 0.3268 | 0.0279 |
| Capsule yield plant$^{-1}$ | 0.2047 | 0.2032a | 0.2895 | 0.0227 |
| Seed yield plant$^{-1}$ | 0.1910 | 0.1260 | 0.4669a | 0.0061 |
| Seed oil content | 0.0873 | 0.0528 | 0.0327 | 0.0872a |
| Total | 0.7559 | 0.5344 | 1.1159 | 0.1439 |
| **2007** | | | | |
| No. of capsule plant$^{-1}$ | 0.4297a | 0.2499 | 0.1565 | 0.0239 |
| Capsule yield plant$^{-1}$ | 0.3309 | 0.3246a | 0.1473 | 0.0173 |
| Seed yield plant$^{-1}$ | 0.2922 | 0.2090 | 0.2301a | 0.0100 |
| Seed oil content | 0.1547 | 0.0844 | 0.0345 | 0.0664a |
| Total | 1.2075 | 0.8679 | 0.5684 | 0.1176 |
| **Mean** | | | | |
| No. of capsule plant$^{-1}$ | 0.2477a | 0.00820 | 0.2170 | 0.0160 |
| Capsule yield plant$^{-1}$ | 0.2081 | 0.0097a | 0.3989 | 0.0134 |
| Seed yield plant$^{-1}$ | 0.1808 | 0.0066 | 0.5866a | 0.0061 |
| Seed oil content | 0.0917 | 0.0030 | 0.0821 | 0.0432a |
| Total | 0.7283 | 0.0275 | 1.2846 | 0.0787 |

a: Direct contribution

Table 6: Percent contribution of some yield parameters to grain yield from 2005 to 2007 and the mean

| | Percentage contribution | | | |
|---|---|---|---|---|
| Yield characters | 2005 | 2006 | 2007 | Mean |
| **Individnal contribntion** | | | | |
| No. of capsule plant$^{-1}$ | 0.0003 | 7.4461 | 18.4602 | 6.1345 |
| Capsule yield plant$^{-1}$ | 0.8931 | 4.1291 | 10.5385 | 0.0094 |
| Seed yield plant$^{-1}$ | 46.5704 | 21.7996 | 5.2952 | 34.4042 |
| Seed oil content | 0.8303 | 0.7598 | 0.4410 | 0.1870 |
| **Combined contribntion** | | | | |
| No. of capsule plant$^{-1}$ vs. Capsule yield plant$^{-1}$ | -0.0234 | 8.3174 | 21.4797 | 0.4032 |
| No. of capsule plant$^{-1}$ vs. Seed yield plant$^{-1}$ | -0.1573 | 17.8368 | 13.4461 | 21.2104 |
| No. of capsule plant$^{-1}$ vs. Seed oil content | 0.0064 | 1.5222 | 2.0542 | 0.7925 |
| Capsule yield plant$^{-1}$ vs. Seed yield plant$^{-1}$ | 8.5129 | 11.7645 | 9.5617 | 0.7731 |
| Capsule yield plant$^{-1}$ vs. Seed oil content | -0.2583 | 0.9210 | 1.1209 | 0.0259 |
| Seed yield plant$^{-1}$ vs. Seed oil content | -0.4975 | 0.5697 | 0.4584 | 0.7101 |
| Residual | 44.1231 | 24.9338 | 17.1441 | 35.3497 |
| Total | 100.00 | 100.00 | 100.00 | 100.00 |

when averaged over three years, it was capsule yield per plant that contributed least percent to seed yield (0.0094).

The highest combined contribution of two yield components to seed yield $ha^{-1}$ was number of capsules per plant versus capsule yield per plant in 2007 but when pooled over three years, it was the number of capsule per plant versus seed yield per plant that contributed the highest percent combined contribution to seed yield $ha^{-1}$ (21.2104%). The least combined contribution (0.03%) to yield came from seed yield per plant plus seed oil content.

## DISCUSSION

The significant and positive correlation recorded between sesame seed yield per unit area and some yield components particularly number of capsules per plant, capsule yield per plant and seed yield per plant indicated an inter dependency between these characters. It also indicated that these parameters are important yield determinants because the capsules contain the seeds, the higher the number of capsules and the heavier the weight of the capsules signifies increased seed yield per plant there by leading to increased seed yield per unit area. This finding, corroborated those of Delgado and Yermanos (1975), Adeyemo and Ojo (1991), Subramanian and Subramanian (1994), Yingzhong and Yishou (2002), Gnanasekaran *et al.* (2008), Kumar and Vivekanandan (2009) and Chowdhury *et al.* (2010) who all reported positive and significant correlations between yield attributes of sesame and the final yield. Significant positive correlation estimated between seed oil content and seed yield per plant leads to the conclusion that simultaneous selection regarding oil content and seed yield per plant is possible to be done.

The path coefficient analysis revealed that the highest contribution among the yield components was made by seed yield per plant followed by number of capsule per plant, capsule yield plant and seed oil content, signifying the importance of these parameters as major contributors to yield.

The combined effect of two factors on the yield was observed to be inconsistent when the individual year is being considered but when the three year data was combined, the combined contribution of number of capsules per plant and seed yield per plant was found to be the highest. This is expected because, the higher number of capsules translated to higher seed yield per plant and hence the total seed yield per unit area. This finding is in harmony with those of Gnanasekaran *et al.* (2008), Kumar and Vivekanandan (2009) and Chowdhury *et al.* (2010).

## CONCLUSION

The strongest direct effect to seed yield per unit area was estimated for seed yield per plant followed by number of capsules per plant. Therefore, these traits could be used as selection criteria in sesame breeding programs.

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