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# Dry matter partitioning and grain yield potential in sesame *Sesamum indicum* L.) as influenced by poultry manure, nitrogen and phosphorus at Samaru, Nigeria

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Field trials were conducted during the rainy seasons of 2005, 2006 and 2007 at the teaching and research farm of Institute for Agricultural Research (IAR), Ahmadu Bello University, Samaru, (11$^o$ 11$^/$ N; 07$^o$ 38$^/$E, 686m) above sea level, located in the northern Guinea savanna agro-ecological zone of Nigeria to study the effects of poultry manure, nitrogen and phosphorus on dry matter partitioning and grain yield potential of sesame. The experiments consisted of four levels of poultry manure (0, 5, 10, and 15 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 treatment combinations 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. The results obtained showed that applications of 15 t ha$^{-1}$ of poultry manure, 120 kg N ha$^{-1}$ and 26.4 kg P ha$^{-1}$ partitioned more dry matter to the leaf and stem compared with other levels of applied nutrients while, the dry matter partitioned to the capsule was optimized with the applications of 5 t ha$^{-1}$ of poultry manure, 60 kg N ha$^{-1}$ and 13.2 kg P ha$^{-1}$. The highest contribution to the total dry weight per plant was made by the capsule dry weight (60%) followed by stem dry weight (27%) and leaf dry weight made the least contribution (13%). Grain yield per plant was optimized at 5 t ha$^{-1}$ of poultry manure, 60 kg N ha$^{-1}$ and 13.2 kg P ha$^{-1}$. Applications of 5 t ha$^{-1}$ of poultry manure, 60 kg N ha$^{-1}$ and 13.2 kg P ha$^{-1}$ is therefore recommended for sesame farmers in this area for higher capsule and seed yield.

**Key words:** Poultry manure, Nitrogen and Phosphorus

## Introduction

Fertilizer application to sesame either in organic or inorganic form, is a key component to good growth, high yield, high seed quality, oil and protein content as well as optimum economic return. The fertilizer most frequently

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applied to sesame by smallholders is organic either animal manure of some kind, waste products from the homestead or previous crop residues. Duhoon *et al.* (2004) working on the optimization of sesame production through bio/natural inputs found that application of 3.75t $ha^{-1}$ of farmyard manure plus other organic amendments gave significantly higher seed yield compared with the control. Vaiyapuri *et al.* (2004) evaluating the effect of sulphur levels and different organic amendments on the growth and yield of sesame reported that application of 45 kg $ha^{-1}$ of sulphur and 10t $ha^{-1}$ of poultry manure gave the maximum plant height, leaf area index, number of branches per plant, total dry matter, number of capsules per plant, capsule weight per plant, number of seeds per capsules, 1000-seed weight and seed yield per hectare.

Growth characters such as plant height, number of branches per plant, total dry matter and leaf area index have also been reported to be significantly increased with fertilizer application, for instance, Gnanamurthy *et al.* (1992), Osman, (1993), Ishawar *et al.* (1994) and Mankar and Satao, (1995) reported that nitrogen application significantly increased the growth and yield of sesame. Hossein *et al.* (1995) working on the stages of development, growth and yield of sesame as influenced by nitrogen application observed that maximum dry matter accumulation, crop growth rate and leaf area index were recorded at higher nitrogen levels while the highest seed yield was obtained from 60 kg N $ha^{-1}$ application.

In Nigeria, Olowe and Busari, (2000) observed that in the southern Guinea savanna, application of 13.2 kg P $ha^{-1}$ significantly increased growth, yield and yield attributes. Okpara *et al.* (2007) also found that application of 26.4 kg P $ha^{-1}$ significantly increased the number of leaves per plant, number of seeds per capsule and seed yield per hectare. Excessive application of organic manure or inorganic nitrogenous fertilizers to sesame, results in the promotion of vegetative growth to the detriment of reproductive growth and as such, assimilates rather than being translocated to the sink (capsule) at maturity, is being moved to the vegetative parts of the plant, thereby limiting yield. Works on the partitioning of dry matter into the various parts of the plant (leaf, stem and capsules) as influenced by fertilizer application in this agro-ecology is not documented. This work, therefore seeks to evaluate the partitioning of dry matter and grain yield potential in sesame as influenced by poultry manure, nitrogen and phosphorus.

## 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, ($11^{o}$ $11^{/}$ N; $07^{o}$ $38^{/}$E, 686m) above sea level, located in the northern Guinea savanna agro-ecological zone of Nigeria. The experiment consisted of factorial combinations of four levels of poultry manure (0, 5, 10 and 15 t $ha^{-1}$), three levels of nitrogen (0, 60 and 120 kg N $ha^{-1}$) in the form of Urea and three levels of phosphorus (0, 13.2 and 26.4 kg P $ha^{-1}$) in the form single super phosphate. The thirty six (36) treatment combinations were laid out in a split-plot design with nitrogen and phosphorus levels being assigned to the main-plot, while poultry manure was assigned to the sub-plot. The gross plot size was 13.5$m^2$ (4.5m x 3m) while the net plot size was 9$m^2$ (3m x 3m).

The experimental area was disc-ploughed and harrowed twice to a fine tilt. This was then followed by ridging at 75cm apart (between rows) and the field marked into plots and replications. The plots were separated by 1.0m 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 16$^{th}$, 19$^{th}$ and 20$^{th}$ July in 2005, 2006 and 2007 respectively. Seeds of sesame were sown at 15cm intra-row spacing on ridges spaced 75cm apart. Manual hoe weeding was done at 3, 6, and 9 WAS to keep the experimental plots weed-free.

The crop was harvested on the 23$^{rd}$, 27$^{th}$ and 28$^{th}$ of October 2005, 2006 and 2007 respectively, when the leaves and the stems changed colour from green to yellow with reddish spots on them. Ten randomly selected plant samples from each plot were harvested at physiological maturity, separated into stem, leaves and capsules. They were then dried and weighed to record data on dry weight of leaf, stem and capsule. Dry weight per plant was calculated as sum of the dry weights of the plant components. The capsules were threshed, grains weighed and the grain yield per plant was worked out. Data was statistically analyzed and means were compared using LSD test (Steel and Torrie, 1984) while, the contribution of the leaf, stem and capsule dry weight to the total dry weight was computed using percentage.

## Results and discussion

### *Leaf weight per plant*

Statistical analysis of data showed that each increase in the rate of applied poultry manure, nitrogen and phosphorus significantly increased leaf dry weight per plant at harvest (Table 1). The heaviest leaves (10.00 g, 8.70 g and

8.55 g) were produced with the applications of the highest rates of applied poultry manure, nitrogen and phosphorus (15 t $ha^{-1}$, 120 kg N $ha^{-1}$ and 26.4 P $ha^{-1}$ respectively). The control plots that received no treatments recorded the lowest leaf dry weight. At all levels of applied poultry manure, nitrogen and phosphorus, leaf dry weight that constitute the smallest portion of the total dry weight. For example, at 15 t $ha^{-1}$ of poultry manure, leaf dry weight contributed 21.74% to the total dry weight while stem and capsule dry weight contributed 36.27 and 41.99% respectively to the total dry weight. The least contribution of leaf dry weight to the total dry weight could be attributed to the fact that, in sesame, at physiological maturity, senescence have set in, most of the leaves have fallen off leaving behind small quantities that are generally yellowish in colour. Leaf dry weight increased with increase in applied poultry manure, nitrogen and phosphorus because fertilizer application particularly manure and nitrogen have been reported to increase leaf size and chlorophyll content, delayed maturity time and increased vegetative growth period as stated by Haruna *et al*. (2011).

### *Stem dry weight per plant*

Application of poultry manure, nitrogen and phosphorus significantly affected stem dry weight (Table 1). Each increase in the rate of applied poultry manure, nitrogen and phosphorus significantly increased stem dry weight per plant at harvest. The heaviest stems (16.68 g, 13.72 g and 13.2 g) were produced with the applications of the highest rates of applied poultry manure, nitrogen and phosphorus (15 t $ha^{-1}$, 120 kg N $ha^{-1}$ and 26.4 P $ha^{-1}$ respectively). The least stem weights were recorded in the control plots that received no treatments. At all levels of applied poultry manure, nitrogen and phosphorus, the contribution of stem dry weight to the total dry weight was higher than that from leaf dry weight. For instance, at 120 kg N $ha^{-1}$, stem contributed 30.13% to the total dry weight while, leaf dry weight contributed 19.11%. This could be attributed to the fact that greater assimilates were partitioned to the stem when there is higher nutrient in the root zone.

### *Capsule dry weight per plant*

Capsule dry weight was optimized at 5 t $ha^{-1}$ of poultry manure (Table 1). Increasing the rate of applied manure from 5 to 10 and from 10 to 15 t $ha^{-1}$, decreased capsule dry weight per plant significantly. Application of 15 t $ha^{-1}$ produced statistically similar capsule dry weight with the control. Application of 60 kg $ha^{-1}$ of nitrogen produced significantly higher capsule dry weight per plant compared with other levels of applied nitrogen. Plots without nitrogen produced the least capsule dry weight per plant. Phosphorous application at the rate of 13.2 kg P $ha^{-1}$ produced significantly higher capsule yield compared with other levels of applied P. Application of 13.2 kg P $ha^{-1}$ produced significantly higher capsule yield compared with the control but when P rate was increased from 13.2 to 26.4 kg P $ha^{-1}$, no further increase in capsule yield per plant was recorded. The highest contribution to total dry weight per plant was made by capsule dry weight per plant. At all levels of applied poultry manure, nitrogen and phosphorus, capsule dry weight was higher than leaf and stem dry weight. The highest contribution of capsule to the total dry weight could be attributed to fact that at flowering, most of the assimilation were partitioned to the sink (capsule). This continued until physiological maturity is attained. The response of capsule yield to moderate amount of poultry manure, nitrogen and phosphorus and not the highest applied rates as in the case of leaf, stem and total dry weights per plant could be attributed to the fact that excessive amount of manure and nitrogen has been reported to increase vegetative growth to the detriment of reproductive growth as reported by Aliyu *et al*. (1996) and Haruna *et al*. (2011).

### *Total dry weight per plant*

Application of 5 and 10 t $ha^{-1}$ of poultry manure produced similar dry weight but was significantly higher than the control (Table 1). Increasing the rate of applied manure to 15 t $ha^{-1}$ produced the heaviest plant while, the control plots produced the lightest plant. Application of 60 kg N $ha^{-1}$ produced heavier plants compared with the control but no further increase in dry weight was recorded when N rate was increased to 120 kg $ha^{-1}$. Similarly, application of 13.2 kg $ha^{-1}$ produced significantly heavier plants compared with the control but no further increase in dry weight was recorded when P rate was increased to 26.4 kg $ha^{-1}$.

### *Seed yield per plant*

Application of 5 t $ha^{-1}$ of poultry manure significantly increased the seed yield per plant of sesame compared with other levels of applied poultry manure in all the years (Table 1). Application of 60 kg N $ha^{-1}$ produced higher seed yield per plant compared with other levels of applied nitrogen. Application of 13.2 kg $ha^{-1}$ of phosphorous fertilizer significantly increased the seed yield per plant of sesame compared with other levels of applied phosphorus. From the foregoing, seed yield per plant was optimized by moderate rates of applied poultry manure (5 t $ha^{-1}$), nitrogen (60 kg N $ha^{-1}$) and phosphorus (13.2 kg $ha^{-1}$) but not the highest applied rates of the fertilizers as in the case of leaf and stem dry weights. This could be attributed to the fact that excessive nitrogen and manure application was reported to reduce fruit number and yield but enhances plant growth by Aliyu *et al*. (1996) and Haruna *et al*. (2011). This finding corroborated those of Gnanamurthy *et al*. (1992), Osman, (1993); Olowe and Busari, (2000); Okpara *et al*., (2007) and Fathy and Mohammed, (2009).

**Table 1.** Effects of poultry manure, nitrogen and phosphorus on the partitioning of dry matter in sesame at harvest (Data pooled from 2005 to 2007).

| Treatments | Leaf wt (g) | % | Stem wt (g) | % | Capsule wt (g) | % | Total dry matter (g) | Seed yield per plant (g) |
|---|---|---|---|---|---|---|---|---|
| **Manure (t ha$^{-1}$)** | | | | | | | | |
| 0 | 3.00d | 11.38 | 7.56d | 24.59 | 19.68c | 64.02 | 30.24c | 5.17d |
| 5.0 | 4.75c | 7.19 | 7.16c | 18.72 | 28.33a | 74.09 | 40.24b | 10.04a |
| 10.0 | 5.67b | 13.94 | 10.92b | 26.86 | 24.07b | 59.20 | 40.66b | 7.05b |
| 15.0 | 10.00a | 21.74 | 16.68a | 36.27 | 19.31c | 41.99 | 45.99a | 5.96c |
| SE± | 0.119 | | 0.157 | | 0.395 | | 0.435 | 0.179 |
| **Nitrogen (kg ha$^{-1}$)** | | | | | | | | |
| 0 | 2.83c[1] | 10.03 | 6.82c | 24.16 | 18.56c | 65.82 | 28.23b | 5.53b |
| 60 | 4.90b | 11.41 | 11.19b | 26.06 | 26.85a | 62.53 | 42.94a | 9.12a |
| 120 | 8.70a | 19.11 | 13.72a | 30.13 | 23.11b | 50.76 | 45.53a | 6.17b |
| SE± | 0.154 | | 1.94 | | 0.897 | | 1.068 | 0.297 |
| **Phosphorus (kg ha$^{-1}$)** | | | | | | | | |
| 0 | 3.15c | 9.76 | 7.56c | 23.44 | 21.55b | 66.80 | 32.26b | 5.77b |
| 13.2 | 4.75b | 11.82 | 10.99b | 27.35 | 24.45a | 60.84 | 40.19a | 8.51a |
| 26.4 | 8.55a | 19.30 | 13.20a | 29.80 | 22.54b | 50.89 | 44.29a | 6.53b |
| SE± | 0.154 | | 0.030 | | 0.897 | | 1.068 | 0.297 |
| **Interactions** | | | | | | | | |
| N X P | NS | | NS | | NS | | NS | NS |
| N X M | NS | | NS | | NS | | NS | NS |
| P X M | NS | | NS | | NS | | NS | NS |
| N X P XM | NS | | NS | | NS | | NS | NS |

[1]Means followed by the same letter (s) within the same treatment group and columns are not statistically different at 5 % level of significance. NS= Not significant at 5% level of significance * = Significant at 5% level of significance

## Conclusion

It is concluded that partitioning of the highest dry matter to the leaves and stem that was achieved by the highest rates of applied poultry manure, nitrogen and phosphorus (15 t ha$^{-1}$, 60 kg N ha$^{-1}$ and 13.2 kg P ha$^{-1}$ respectively) while, partitioning of the highest dry matter to the capsule was obtained with the applications of 5 t ha$^{-1}$ of poultry manure, 60 kg ha$^{-1}$ of nitrogen and 13.2 kg ha$^{-1}$ of phosphorus. At all levels of applied poultry manure, nitrogen and phosphorus, the highest contribution to the total dry weight per plant was made by capsule dry weight per plant, followed by stem dry weight. The leaf dry weight made the lowest contribution to total dry weight per plant.

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