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Effect of Poultry Manure and Planting Arrangement on the Soil Physico-chemical Properties and Yield of Sesame/Groundnut Mixture

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ABSTRACT

In recent time, there is increasing interest in diversified agricultural production systems to obtain higher yields per unit area through better use of natural resources, minimizing the incidence of insect pests and diseases, greater stability and crop insurance offered by intercropping systems. Field experiment was conducted during the rainy seasons of 2011 and 2012 at the Teaching and Research Farm of the Faculty of Agriculture, Nasarawa State University, Keffi – Lafia Campus to study the effect of poultry manure and planting arrangement on the soil physico-chemical properties and yield of Sesame/groundnut mixture. The experiment consisted of four rates of poultry manure (0, 3.0, 6.0 and 9.0 t ha^{-1}) and two planting arrangement (single alternate row and double alternate row planting arrangement). The eight treatment combinations were laid out in randomized complete block design with four replications. The results obtained showed that the soil physical structure was slightly improved; total N, available P and organic carbon of the experimental soil were increased by 20, 62 and 6% respectively after the experiment. Yield and yield characters of the two crops were significantly increased by the application of 6 t ha^{-1} of poultry manure and double row planting arrangement. Land equivalent ratio was greater than unity indicating that the intercropping system was advantageous.

Introduction

In recent time, there is increasing interest in diversified agricultural production systems to obtain higher yields per unit area through better use of natural resources, minimizing the incidence of insect pests and diseases, greater stability and crop insurance in production under aberrant weather condition, the domestic need of farmers and animals and provide an equitable distribution of farm resources offered by intercropping systems.

Sesame (*Sesamum inducum* L.) 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). Groundnut (*Arachis hypogaea*) is an oil seed crop having high energy index. It is cultivated particularly for its edible oil and protein rich seeds borne in pods. It used as food and feed in the tropics (Obasi and Ezedinma, 1991). Groundnut (*Arachis hypogaea*) is an oil seed crop having high energy index. On the other hand, leguminous crops are highly nutritious and improve soil fertility by fixing atmospheric nitrogen.

Even though mixed cropping has become a dominant feature of the farming system adopted by small holder farmers in the savanna, the productivity of the mixed system is generally low probably because fertilizers are rarely used (particularly when the mixture involved a legume) or because specific fertilizer needs of crops components vary and also the plant population of component crops are low. In the process, soil nutrients reserves are being depleted because of continued nutrient mining without adequate replenishment. According to Chiezey *et al*. (2004), the issue is further aggravated by apparent lack of clearly defined cropping pattern especially with spatial arrangement for adequate solar energy interception for shorter components of the mixture. This study therefore assessed the effects of poultry manure and planting arrangement on the soil physico-chemical properties and yields of sesame/groundnut mixture.

Materials and Methods

The study was conducted during the rainy seasons of 2011 and 2012 at the Teaching and Research Farm of the Faculty of Agriculture, Nasarawa State University, Keffi Shabu-Lafia Campus in the southern Guinea savanna zone of Nigeria located between latitude 08^0 30/N and 08^0 30/E, 18m above sea level. The experiment consisted of four rates of poultry manure (0, 3, 6 and 9 t ha^{-1}) and two planting arrangement (single alternate row and double alternate row). The eight treatment combinations were laid out in a randomized complete block design and replicated three times. The gross plot size was $24m^2$ (6m x 4m) while the net plot size was $9m^2$ (3m x 3m). Samples of the experimental soils were randomly taken and analysed for its physico-chemical components as described by Black (1965).

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 four levels of poultry manure were incorporated into the ridges according to field plan after land preparation and left for two weeks before sowing. The seeds of the two crops were sown on the same day according to planting arrangement (single and double alternate row respectively). A sole crop each of sesame and groundnut were sown at the end of each

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replication to help determine the performance of the two crops in the mixture. Manual hoe-weeding were done at 3, 6 and 9 weeks after sowing to keep the experimental field weed free. All other agronomic practices were kept normal and uniform for all the treatments. The crops were harvested at physiological maturity. Ten plant samples from each plot of each crop were randomly selected to determine yield characters such as numbers of capsule per plant, capsule weight per plant, number of seeds per capsule and see yield per plant for sesame. For groundnut, the following yield characters were determined: number of pods per plant, pod weight per plant, number of seeds per pod, seed yield per plant, 100 seed weight and pod 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 (1990). Comparison of treatment means were done using Least significant difference (LSD).

Results and Discussion

The soil of the experimental field before the experiment in 2011 was sandy, moderately acidic, low cation exchange capacity, nitrogen and organic carbon (Table 1). The results obtained showed that the soil physical structure was slightly improved; total N, available P and organic carbon of the experimental soil were increased by 20, 62 and 13% respectively after the experiment (Table 1).

Each increase in the rate of applied poultry manure significantly increased number of capsules per plant, capsule yield per plant, number of seeds per capsule, seed yield per plant and seed yield per hectare up to 6 t ha^{-1} (Table 2). Increasing the rate of applied poultry manure from 6 to 9 t ha^{-1}, significantly decreased number of capsules per plant, capsule yield per plant, number of seeds per capsule, seed yield per plant and seed yield per hectare. 1000 seed weight was significantly increased by the application of highest rate of applied manure compared to any other rate of applied manure.

Planting arrangement had no significant effect on the number of capsules per plant and capsule yield per plant but, double row planting produced significantly higher number of seeds per capsule, seed yield per plant, seed yield per hectare and 1000 seed weight (Table 2).

Yield and yield characters of groundnut as influenced by poultry manure and planting arrangement is shown in Table 3. Number of pods per plant, pod yield per plant, number of seeds per pod, seed yield per plant and pod yield per hectare were significantly increased by the application of 6 t ha^{-1} of poultry manure compared with any other rate of applied poultry manure. Increasing the rate of applied manure from 6 to 9 t ha^{-1} significantly decreased number of pods per plant, pod yield per plant, number of seeds per pod, seed yield per plant and pod yield per hectare while, zero and 3 t ha^{-1} produced statistically similar and the number of pods per plant, pod yield per plant, number of seeds per pod, seed yield per plant and pod yield per hectare. Each increase in the rate of applied poultry manure significantly increased 100 seed weight of groundnut. The heaviest 100 seeds were produced by the application 9 t ha^{-1} while the control plots produced the least values for 100 seed weight.

Double row planting arrangement produced significantly higher number of pods per plant, pod yield per plant, number of seeds per pod, seed yield per plant, 100 seed weight and pod yield per hectare compared with single row planting arrangement (Table 3). In all the treatments tested, land equivalent ratio (LER) was greater than unity. Application of 9t/ha of poultry manure gave significantly higher LER (2.74) compared to any rate of applied manure while, double alternate row planting gave higher LER (2.08) compared to single alternate row planting.

Discussion

The improvement in the soil physico-chemical properties due to poultry manure application could be attributed to the ability of manure to greatly improve water holding capacity, soil aeration, soil structure, nutrient retention and microbial activity, from sparingly soluble P compounds in soil and enhances the utilization of P from P containing fertilizers (Anon., 2007a; Zeidan, 2007). The high increase in the soil available P could be attributed to the very high content of P in the experimental soil before the application of poultry manure.

The significant increase in virtually all the yield and yield characters of sesame and groundnut measured due to poultry manure application could be attributed to the fact that manure contained in them nutrients that are essential for growth and higher yield of crops. The yield and the yield characters measured were significantly increased by moderate amount (6 t ha^{-1}) of applied poultry manure and not the highest rate (9 t ha^{-1}) of applied poultry manure. This could be attributed to the fact that excess manure application has been reported to increase vegetative growth to the detriment of the reproductive yield (Haruna *et al*., 2011).

The significant increase in the yield and yield characters of sesame under double alternate row planting arrangement compared with single row planting arrangement could be attributed to the fact that inter-specific competition for light, space and nutrient is less under double row planting compared to single row planting arrangement. The significant increase in the yield and yield characters of groundnut under double alternate row planting arrangement compared with single row planting arrangement could be attributed to the fact that under single row planting arrangement, they were shielded by the taller and aggressive sesame (legumes are susceptible to shading) (Haruna *et al*., 2006). Land equivalent ratio in all treatments was greater than unity which implied that there was a greater advantage of intercropping groundnut with sesame.

Conclusion and recommendation

From the foregoing, it can be seen that the physico-chemical components of the experimental soil were significantly improved by the application of poultry manure; yield and yield characters of sesame and groundnut were significantly improved by the application of 6 t ha^{-1} of poultry manure and double row planting arrangement. Land equivalent ratio was greater than unity. Application of 6 t ha^{-1} of poultry manure and double row planting arrangement therefore, seems to be the ideal poultry manure rate and planting arrangement for sesame /groundnut mixture and is therefore recommended.

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Table 1: Physico-chemical properties of experimental site in 2011and 2012.

Soil Characteristics	Before the experiment in 2011	After the experiment in 2011	After the experiment in 2012
Particle size (%)			
Sand	95	90	80
Silt	2	3	5
Clay	5	6	8
Textural Class	sandy	Sandy	Sandy loam
Chemical Composition			
pH	5.40	5.70	6.40
Organic carbon (%)	0.310	0.330	0.350
Total N (%)	0.250	0.280	0.300
Available P (Cmol (+) kg^{-1})	18.342	19.250	29.750
Exch. Ca (Cmol (+) kg^{-1})	3.200	3.400	3.800
Exch. Mg (Cmol (+) kg^{-1})	0.430	0.440	0.360
Exch. K (Cmol (+) kg^{-1})	0.130	0.130	0.110
Exch. Na (Cmol (+) kg^{-1})	0.570	0.570	0.530
Exch. Acidity (Cmol (+) kg^{-1})	0.400	0.400	0.600
ECEC (Cmol (+) kg^{-1})	5.000	5.000	5.600

Table 2: Yield and yield characters of sesame as influenced by poultry manure and planting Arrangement (data pooled for 2011-2012)

Treatment	Number of capsules $plant^{-1}$	Capsule yield $plant^{-1}$ (g)	Number of seeds $capsule^{-1}$	Seed yield $plant^{-1}$ (g)	1000 seed weight (g)	Seed yield ha^{-1} (kg)
Poultry manure (t ha^{-1})						
0	37.97d	12.69c	50.01d	2.22d	3.72d	233.89d
3	61.66c	30.15b	54.94c	5.68c	3.89c	316.96c
6	106.85a	60.00a	63.28a	10.92a	4.26b	531.08a
9	66.23b	31.76b	58.97b	7.00b	4.32a	418.88b
LSD	2.961	2.750	2.264	0.633	0.011	2.903
Arrangement						
Single row	67.96	32.92	55.27b	5.73b	4.11b	371.56b
Double row	68.39	34.37	58.33a	7.17a	4.13a	378.84a
LSD			1.601	0.447	0.008	2.053
PM X A	NS	NS	NS	NS	NS	**

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

Table 3: Yield and yield characters of groundnut as influenced by poultry manure and planting Arrangement (Data pooled for 2011 - 2012).

Treatment	Number of pods $plant^{-1}$	Pod yield $plant^{-1}$ (g)	Number of seeds pod^{-1}	Seed yield $plant^{-1}$ (g)	100 seed weight (g)	Pod yield ha^{-1} (kg)
Poultry manure (t ha^{-1})						
0	36.46c	25.49c	2.57c	17.08c	37.32d	2813.50d
3	37.58c	25.70c	2.57c	17.22c	37.99c	3012.67c
6	46.82a	34.84a	2.95a	23.34a	41.09b	3963.17a
9	44.86b	30.90b	2.60b	20.70b	42.09a	3546.33b
LSD	1.306	0.728	0.017	0.741	0.419	7.312
Arrangement						
Single row	39.768b	27.82b	2.53b	18.64b	39.18b	2828.67b
Double row	43.01a	30.64a	2.80a	20.53a	40.06a	3839.17a
LSD	1.016	0.515	0.012	0.880	0.296	5.177
PM X A	NS	NS	NS	NS	NS	**

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

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