INFLUENCE OF APPLICATION OF POULTRY MANURE ON PRODUCTIVITY OF SOYBEAN/SESAME MIXTURE AND PLANT ARRANGEMENT IN THE SOUTHERN GUINEA SAVANNA ECOLOGICAL ZONE OF NIGERIA.

[1]Ndagana M. K., [2]Omonomo P. and [3]Saidu A
[1]Department of Crop and Forestry,
NAERLS/ABU Zaria, Kaduna State
[2]Out station, Badeggi
National Centre for Genetic Resources and Biotechnology.
[3]Department of Crop Production
Federal University of Technology (FUT), Minna.
Corresponding author: *kolomuhammad3@gmail.com*
Phone.08060971423

ABSTRACT

The experiment was conducted at the National Cereal Research Institute, Research Farm, Badeggi, Niger State in the Southern Guinea Savanna agro-ecological zone of Nigeria to study the productivity of Soybean/Sesame mixture as influenced by poultry manure (PM,) and plant arrangement (PAR,) in the 2019 and 2020 wet seasons. The treatment consisted of three levels of poultry manure (0, 5 and 10 t/ha^{-1} and two plant arrangement (Single alternate row SAR and double alternate row DAR arrangements). The factorial combination of PM and PAR were laid out in a randomized block design with four replications. Application of 5t PM/ha increased number of Soybean pods and sesame capsules per plant and seed yields of both crops but reduced 1000-seed weight of sesame compared to plots which did not receive manure treatments. The application of both rates of PM (5t/ha^{-1}and 10t/ha^{-1}) to soybean/sesame mixture increased both the partial and total LERs of the crop compared to those which received no PM treatments. Sowing in DARs resulted in significantly higher number of soybean pods/plant, 1000 seed weight of sesame and seed yields of both crops than SARs. The effect of PAR on 100-seed weight, number of capsules (plant and LERs of soybeans were not significant. The results of LERs show that the efficiency and benefits of soybean/sesame mixture over pure stands of each crop were enhanced by the application of 5t/PM ha and sowing in DARs.

Keywords: Capsule/plant Land Equivalent Ratio, Organic manure, Plant arrangement, Pod/plant.

INTRODUCTION

Sesame (*Sesamum indicum L.)* from which semi-drying vegetable oils are obtained (Onwueme and Sinha, 1991) is produced mainly in the savanna agro-ecological zone of Nigeria with annual production of 350,000 metric tons (UN/FAO, 2018). Soybean is a recent introduction in this zone and some farmers have since integrated it into their farming system (Chiezey *et al.*, 2014). According to Andrew (2012), sole cropping is a rare practice among the farmers of the savanna and virtually all crops are grown in combination with other crops. The advantages or other wise of mixed cropping system has been studied by Norman (1994) and Okigbo (1979). When legumes are grown in association with legumes, there are often advantages to the non-legumes from nitrogen fixed by the legumes. In view of these advantages, mixed cropping involving different combinations of two or more crops have become a common features of the farming systems adopted by smaller holder farmers in the savanna, the productivity mixed cropping system is generally low probably because

fertilizer are rarely used or because specific needs of crop components vary and also the plant population of component crops are equally low. According to Chiezey *et al.* (2014), reveals that lack of clearly defines cropping pattern especially with spatial arrangement for adequate solar energy interception for shorter components of the mixture.

However, studies by Khan *et al.* (2008) and Chiezey *et al.* (2014) gave evidence that large yield advantages could be obtained from the mixture of cereals and Legumes. Planting of sorghum/Soybean in double rows with increasing rates of nitrogen up to 90kg ha increased sorghum yield, while soybean yield was highest with 90kg N ha. Investigation by Khan and Khata (2008) also suggest that substantial advantages of legume intercrop could be achieved not by means of costly inputs but by the simple expedient of growing crops together in an appropriate geometry. Planting crops in the same row or ridge-or closer depresses legume yield more than when the two were mixed in different rows (Agboola and Fayemi, 2011, Putman and Herbert, 2013) probably due to shading effects on the associated legumes (Beets, 2005). Work by Iftikhar *et al.* (2006) also indicated that intercropping sesame with legumes appear to be a dominant crop as indicated by its higher values of relative crowding coefficient, competitive ratio and positive significance of aggressively.

Although mixed cropping is a popular feature in the farming system in the Nigeria Savanna, information on the effect of poultry manure and the best plant arrangement to be adopted for good performance of soybean/sesame mixture is still scanty. This study was therefore, carried out to study the effect of poultry manure rate and plant row arrangement on the productivity of soybean sesame mixture in the Southern Guinea Savanna of Nigeria.

MATERIAL AND METHODS

Field experiments were conducted for two years during raining seasons of 2019 and 2020 at the experimental farm of the National Cereal Research Institute, Badeggi (9° 43 N, 6° 37 E and 420m in above sea level) Niger State, Southern Guinea Savanna agro-ecological zone of Nigeria to study the productivity of soybean/sesame mixture under varying levels of poultry manure and planting arrangement. Soil samples were collected at the depth of 0 - 30cm at the Research farm before sowing and the soil samples were analyzed for physical and chemical properties following the procedure outlined by Agbim (1995). The poultry manure was also analyzed before application. The experimental site was cleared, ploughed and harrowed twice to obtain fine tilth, ridged at 75cm apart and marked out into four replicate. The plots were separated by an unplanted border of 75cm while replicates were separated by 1.5m unplanted border. The treatments consisted of factorial combination of three Levels of poultry manure (0, 5 and 10t ha^{-1} and two plant row arrangements (Single alternate row (SAR) and double alternate row (DAR) arrangement). At the end of each replicate, there was a sole crop of soybean and sesame. In all, there were six treatments. The experiment was laid out in a randomized complete block design (RCBD) with four replications. The gross plot size was $18m^2$ and the net plot is 3m x 3m. The variety of soybean used for the study was TGX- 1448-2E while the variety of sesame used was NCRI BEN - 2M all obtained from National Cereal Research Institute (NCRI), Badeggi. The Poultry manure (PM) treatments were incorporated two (2) weeks before the crops were sown. Both crops were sown simultaneously on 7th and 15th of August in 2019 and 2020 respectively according to the experimental design. Soybean was sown at 5cm apart on 75cm ridges while sesame was sown at intra-row spacing of 15cm. Three-five seeds of soybean, and about ten seeds of sesame were sown per hole and

both crops were later thinned down to 2 plant/stand at (2WAS) two week after sowing for both plant row arrangements.

The net plots of each crop were harvested when they attained full physiological maturity (i.e. when the leaves turned yellow and began to fall off, and the pods and capsules of soybean and sesames, respectively, also turned yellow and fully ripe). Plants harvested from the net plots were then tied into bundles air derived and later threshed. Ten plants of each crop were randomly selected to determined number of pods or capsules per plant by counting number of pods/capsules per pants, while ten pods/capsules were randomly selected from each net plot before threshing for the determination of number of seeds per pod or capsule (counting number of seeds per pod or capsule. The 100-seed weight of soybean and 1000-seeds weighed of sesame were also determined (was weighed using weighing balance) from the net plot seed yields The seed yields per hectare of each crop were obtained by converting net plot yields to per hectare basis. The land equivalent ratio (LER) was calculated using the method of Mead and Willey (1980). The yields of the two crops in the mixture were divided by the appropriate sole crop yields.

Land equivalent ratio (LER) $= \frac{y1}{s1} + \frac{y2}{s2}$ .....equation 1

Where Y_1 = Yield of crop 1 in the mixture

Y_2 = Yield of crop 2 in the mixture

S_1 = Yield of crop 1 in Pure stand.

S_2 = Yield of crop 2 in Pure stand.

The data collected for each season were analyzed for the individual and combined years. The treatment means were compared using Duncan Multiple Range Test (Duncan 1995)

RESULTS AND DISCUSSION

Physical and chemical properties of the soil before sowing

Table 1 Presented results of physical and chemical properties of the soil prior to sowing. The result revealed that the soil texture of the experimental site was sandy loam for the two cropping seasons, slightly acidic in water which makes it suitable for plant growth because of the availability of plant nutrient for plant uptake at pH 5.5 to 6.5 (Brandy and Weil, 2002). The result showed that the soil was low in inorganic carbon, available phosphorus and low in nitrogen.

Table 1: Physical and chemical properties of the soils before sowing

Parameter	Value	
Parameter	2019	2020
Sand (g kg^{-1})	652	610
Silt (g kg^{-1})	102	140
Clay (g kg^{-1})	246	250
Texture Classes	Sandy Loam	Sandy Loam
pH in H_2O (1:2.5)	5.32	6.55
Total Nitrogen (g kg^{-1})	0.20	0.31
Available P (mg kg^{-1})	8.00	8.57
Organic Carbon (coml. Kg^{-1})		
Mg^{2+}	1.02	1.12
Ca^{2+}	2.14	2.77
K^{+}	0.41	0.53
Na^{+}	0.27	0.38
Exchangeable Cation (Cmol kg^{-1}	0.01	0.03
ECEC (Cmol kg^{-1})	3.90	4.13

Source: Soil sample as analyzed by Soil Dept, Federal University of Technology, Minna

Chemical Properties of Poultry Manure Used for the Experiment

Table 2 shown the nutrient content of organic manure (Poultry manure) used in the study. The poultry manure was slightly acidic. The organic matters, total nitrogen and available phosphorus contents were sufficient for the two cropping seasons. The Value of Ca, K, clearly showed that poultry manure dropping was rich in nutrient for the two wet season. The Na Zn Mn Concentration was low (Table 2). This is just presentation of your results; you have not discussed your results by comparing it with other studies

Table 2: Chemical Properties of the poultry manure used for the experiment trials

Parameter	Value	
Parameter	2019	2020
pH? In H_2O?	5.8	5.9
Organic Carbon (g/kg)	17.8	18.22
Total N (g/kg)	3.6	4.2
Available P. (mg/kg)	1.5	1.9
K^-	14.7	16.8
Ca^{2-}	21.1	23.4
Mg^{2-}	3.8	4.3
Na^+	2.5	2.8
Fe	12.0	13.5
Ca	21.1	22.3
Mn	0.6	0.7

Source: Poultry manure as analyzed by Soil Dept, Federal University of Technology Minna.

Number of Pods or Capsules/Plant

Table 3 indicates that application of both rates of PM (5t and 10t) to either soybean or sesame produced comparable but significantly higher number of soybean pods or sesame capsules/plant over the control. Sowing soybean in DARs was superior to SARs in number of soybean pods/plant, while in the case of sesame, sowing the crop in SARs or DARs did not result in significant difference in number of capsule/plant. This result may be attributed to the as the varieties. This result is in agreement with Legard and Steel, (2012) who reported that yield advantage of SARs over DARs could be attributed to mutual complementary effects of component crops in the use of available resources.

Table 3: Numbers of pods or capsules/plant of soybean sesame respectively as influenced by poultry manure and plant arrangement during 2019 and 2020 seasons at Badengi

Treatment	Number of soybean/pod			Number of capsules of sesame		
Manure M (t/ha)	2019	2020	Mean	2019	2020	Mean
0	65.1b	72.5b	68.8b	29.4b	22.1b	25.6b
5	80.6a	89.2a	84.4a	45.9a	63.3a	54.6a
10	77.0a	87.7a	82.4a	45.9a	63.3a	54.6a
SE+	3.29	4.09	3.69	4.57	6.08	3.33
Single Alternative						
SAR	67.2b	68.2b	57.7b	39.7	48.8	44.3
DAR	81.3a	89.1a	85.2a	43.2	57.7	50.5
SE+	2.19	3.22	2.71	3.05	4.98	4.02
Interaction						
M x AR	ns	ns	ns	ns	ns	ns

Means followed by unlike letter (s) within a treatment group and column differ significantly suing DMRT p = 0.05

100 seed weight of soybean and 1000 seed weight of sesame

Table 4 shown the 100-seed weight of soybean and 1000-seed weight of sesame responded to the application of Poultry manure (PM). The application of 5t PM ha^{-1} increased 100-seed weight of soybean, similar rate of manure significantly reduced 1000-seed weight of sesame. Plant arrangement did not have significant effect on the 100-seed weight. The increase in 100-seed weight of soybean with PM application could be because manure is believed to positively enhance the chlorophyll content in plants resulting in improved photosynthetic activities that promotes assimilate production, the result of which is increment in the final seed weight. These result conform to the finding of Jose (2009) who reported increased number of capsule/plant and seed yield of sesame following application of 10t PM/ha.

Table 4: 100-seed weight of soybean and 1000 – seed weight of sesame influenced by poultry manure and plant arrangement during 2019 and 2020 seasons at Badeggi.

Treatment	Number of soybean/pod			Number of capsules of sesame		
Manure M (t/ha)	2019	2020	Mean	2019	2020	Mean
0	13.8b	14.1b	14.0b	3.80a	3.70a	3.75a
5	15.2a	15.6a	15.4a	3.40b	3.40b	3.40b
10	16.3a	15.3a	15.8a	3.50b	3.60a	3.55b
SE+	0.63	0.39	0.51	0.049	0.082	0.006
Single Alternative						
SAR	13.7	13.2	13.5	3.40b	351b	3.46b
DAR						
SE+	0.44	0.51	14.4	3.73a	3.86a	3.80a
Interaction						
M x AR	ns	ns	ns	ns	ns	ns

Means followed by unlike letter (s) within a treatment group and column differ significantly using DMRT p = 0.05

Seed yields of soybeans and sesame

Table 5 shows application of Poultry manure PM and row arrangement significantly influenced the yields of both crops. The application of 5t and 10t PM ha^{-1} to both crops recorded statistically at par but significantly higher yields over the control. Sowing the crops in double alternate rows produced significantly higher seed yields compared to those shown in single alternate rows. It was also observed in the present study that the highest poultry manure rate of 5t and 10t PM ha^{-1} gave the highest performance among the rates suggesting that more nutrient is supplied to the soil at that rate. It will be necessary to test the effect of higher rates of poultry manure on sesame in this area to be able to determine the optimum rate. It has however been reported by Haruna (2011), that 10 tons/ha poultry manure application produced the highest grain yield as further increase to 15 tons/ha resulted to a decline in grain yield in sesame.

Table 5: Soybean and sesame yields (kg/ha) as influenced by poultry manure and plant arrangement during 2019 and 2020 seasons at Badeggi

Treatment	Number of seed/pod of soybean			Number of capsules of sesame		
Manure M (t/ha)	2019	2020	Mean	2019	2020	Mean
0	965.6.	752.5b	859.1b	219.3b	261.5b	240.4b
5						
10	1192.9a	1184.0a	1188.5a	332.3b	496.1a	414.2a
SE+	48.54	56.67	52.62	34.88	38.27	36.58
Single Alternative						
SAR	994.8b	1073.0b	1033.4b	301.5b	301.5b	309.3b
DAR	1204.4a	1221.0a	1212.5a	466.1a	466.1a	417.9a
SE+	32.36	37.44	23.24	33.67	33.67	28.46
Interaction						
M x AR	ns	ns	ns	ns	ns	ns

Means followed by unlike letter (s) within a treatment group and column differ significantly using DMRT p = 0.05

Land Equivalent Ratio

Table 6 Application of Poultry manure (PM) positively improved the land equivalent ratio (LERs) in both seasons. The application 5t PM ha^{-1} increased the LERs of each crop as well as the total LERs of both crop in both season and their combined data. However, in 2019, an increase in Poultry manure rate to 10t/ha^{-1} led to further increases in the Partial LERs of sesame and the total LERs of both crops. Although sowing in single and double alternate rows did not caused significant differences in LERs in 2019, sowing in DARs had significantly higher LERs of sesame as well as total sowing in DARs had significantly higher LERs of sesame as well as total LERs of both crops in 2020 and combined result. The increase in number of soybean pods or sesame capsules per plant, and seed yields of both crops with the application of poultry manure could be attributed to the low initial soil organic matter, N and P contents of the experimental soil (Table 1) and the ability of manure to supply essential nutrients such as N and P contained in it through of gradual process of mineralization (Eghball, 2002; Bationo *et al.*, 2007) to support crop growth and assimilate production which later translated to high yields. These result conform to the finding of Jose (2009) who reported increased number of capsule/plant and seed yield of sesame following application of 10t PM/ha. The increase in 100-seed weight

of soybean with PM application could be because manure is believed to positively enhance the chlorophyll content in plants resulting in improved photosynthetic activities that promotes assimilate production, the result of which is increment in the final seed weight. The results were in conformity with the findings of Nimje and Jagadishseth (2007) and Jain *et al.* (2015) who reported increased number of soybean pods/plant, 100-seed weighing seed yields of soybean with the application of 5t PM/ha. Double alternate rows produced higher number of soybean pods/plant, 1000-seed weight of sesame and yields of both crops probably because of low inter-specific competition for environmental and available resources in DARs than in SARs. Similar results were reported by Zaman and Malik (2000) which showed significant increases in the yields of maize/rice, beans inter crop when sown in double row strips.

Since application of PM increased the LERs of each crop component and the total LERs of both crops, application of PM enhanced the efficiency and benefits of soybean/sesame mixture over sole cropped soybean or sesame. The increases in LERs could be attributed to improved soil physical conditions which increased water and nutrient retention within the root zone for plant growth and development (Eghball, 2002; Bationo *et al.* 2007). Similarly, sowing the crops in double alternate rows recorded significantly higher individual and total LERs compared to those in single alternate rows.

Table 6: Land equivalent ratios of soybean/sesame mixture as influenced by poultry manure and plant arrangement at Badeggi during 2019 and 2020 wet seasons.

Treatment	Land equivalent ration								
	2019			2020			Combined		
	Soybean	Sesame	LER	Soybean	Sesame	LER	Soybean	Sesame	LER
Manure (Mt ha^{-1})									
0	0.43b	0.26c	0.69c	0.37b	0.30b	0.67b	0.43b	0.29b	0.72b
5	0.59a	0.40b	0.99b	0.57a	0.56a	1.13a	0.59a	0.49a	1.08a
10	0.60a	0.57a	1.17a	0.58a	0.57a	1.15a	0.60a	0.58a	1.18a
SE±	0.04	0.04	0.05	0.04	0.04	0.06	0.03	0.03	0.06
PAR									
SAR	0.51	0.38	0.89	0.52	0.34b	0.86b	0.51	0.37b	0.88b
DAR	0.60	0.44	1.04	0.59	0.53a	1.12a	0.60	0.50a	1.10a
SE±	0.03	0.03	0.05	0.03	0.03	0.05	0.03	0.03	0.04
Interaction MxPAR	ns	ns	ns	ns	ns	ns	ns	ns	ns

Means followed by unlike letter(s) within a treatment group and column differ significantly using DMRT P = 0.05

CONCLUSION

Application of 5t PM ha^{-1} increased number of soybean pods and sesame capsules per plant, 100-seed weight of soybean but reduced 1000-seed weight of sesame compared to the control. Sowing in double alternate rows resulted in significantly higher number of soybean pods per plant, 1000-seed weight of sesame and seed yields of both crops. The result of LERs showed that the efficiency and benefits of soybean/sesame mixture over pure stand of each crop were enhanced by the application of 5t PM ha^{-1} and sowing in DAR. Based on the study, application of 5t PM ha^{-1}and sowing double alternate rows of soybean and sesame is recommended in the study area.

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