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Full Length Research Paper

Yield responses of sesame (*Sesamium indicum* L) to rates of poultry manure application and time of planting in a derived savannah ecology of south eastern Nigeria

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A study was conducted in the year 2009 and repeated in 2010 to determine the response of sesame (*Sesamum indicum* L.) to date of planting and rates of poultry manure application in derived savannah ecology of south eastern Nigeria. The experiment was laid out in a 3 x 3 factorial experiment in randomized complete block design in three replications. The factors considered are time of planting and manure rates. Three planting seasons (July, August and September) and three poultry manure rates (0.0, 5.0 and 10.0 tons/ha) were chosen. In the second year, times of planting were June, July and August, while manure application rates remained the same. The results show that early planting and poultry manure application in both years promoted the yield attributes measured. Seed yield/ha decreased by 41.6 and 91.1% as planting was delayed from July to August and to September in 2009, while in 2010, it decreased by 16.4 and 31.8% as planting was delayed from June to July and to August. Application of 5.0 and 10.0 tons/ha of poultry manure increased seed yield by 33.55 and 76.9%, respectively in 2009 season, while in 2010, it increased by 156.6 and197.4%, with the application of 5.0 and 10.0 tons/ha of poultry manure. The interaction of time of planting and manure rates showed a trend of increased seed yield as planting was done early with high manure rate, hence, the highest seed yield was obtained from July planting with 10.0 tons/ha manure in 2009 and from June with 10.0 tons/ha manure in 2010.

Key words: Sesame, poultry manure, time of planting, interaction.

INTRODUCTION

Sesame (*Sesamum indicum* L) also known as beniseed is an important oil seed crop grown in tropical and sub-tropical regions of the world (Ashri, 1998). The sesame seed is a rich source of calcium and potassium (Suddhiyan et al., 2009) and the oil contain high amount of sesamin and sesamolin, natural antioxidants which prevent the oil from going rancid (Brar and Ahuja, 1979). It is used in cake and bread making, manufacture of soap, margarine, cosmetics, insecticides and pharmaceutical products. The seed cake is use for livestock feed and fertilizers. India is the world largest producer of sesame followed by China, Myanmar, Sudan, Ethiopia, Uganda and Nigeria (Wikipedia, 2009). In Nigeria, it was first grown in 1940s following the mandate given to West African Oilseeds Mission to investigate the possibility for the production of groundnut and other oilseeds (Idowu, 2002). Presently, its production is concentrated in the North and Middle Belt areas. In these areas, cultivation is mostly on small holdings by poor resource farmers (Olowe, 2007). The situation is the same in other developing countries (El-Greedly and Mekki, 2005).

Sesame is traditionally grown in areas located between latitude 6° and 10° N with annual rainfall below 1000 mm, ranging between 500 and 800 mm (Schilling and Catan, 1991; Olowe, 2007; Bennett and Wood, 1995; Beech, 1996; Bennett and Imire, 1997). It is a crop of the hot tropics and can withstand some degree of drought after establishment but very sensitive to water-logging (Uguru, 1996; Bedigan and Harlan,1983; Thomas, 2007). Adequate moisture is necessary for germination and early growth stages. It however prolongs growth if it continues late in the season (Oplinger, 1990). Due to the economic

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importance of sesame oil in the international market and the present quest for alternative to fossil fuel, there is need to increase the production of this crop. This can be achieved by expanding the area of production. El-Greedly and Mekki (2005) noted an increase in sesame production mainly due to increase in its growing areas. The derived savannah agro-ecology is a vegetation zone lying between the savanna and the forest zone. Many crops are grown in this zone in Nigeria; however, sesame cultivation is not common among farmers in this area. This study is part of a programme mounted to arouse research interest in the crop as well as to promote its cultivation in this zone. One of the steps is to identify the time of the year to grow sesame for optimum yield. Ajali et al. (2008) reported significant planting date effect on capsule numbers, percentage protein, biomass and grain yield in sesame. Mulkey, (1997) also recorded significant influence of planting date on flowering, day to maturity and seed yield.

The scarcity and expensive nature of inorganic fertilizers coupled with the negative effects on the environment has led to increased use of organic manure in crop production. Consequentially, organic farming has been advocated and farmers are being advised to reduce the use of chemicals to reduce the hazards to the environment. Organic manure apart from releasing nutrient to the crop also improves the soil structure (Mbagwu and Ekwealor, 1990). Poultry manure has long been recognized and used as manure in crop production and its analysis has shown that it is high in nitrogen, phosphorus, potassium and some other nutrient elements (Kroodsma, 1986). It should however be noted that excessive application of poultry manure can lead to water pollution and soil toxicity due to the high content of certain micronutrients. The study determined the effect of poultry manure application and its interaction with date of planting to growth and yield of the crop in this area.

MATERIALS AND METHODS

This study was conducted in the teaching and research farm of the Department of Crop Science, University of Nigeria, Nsukka located at latitude 06° 52[1] N, longitude 07° 24[1]E and altitude 447 m above sea level.

The sesame accession was obtained from National Cereal Research Institute (NCRI) Badeggi, Niger State, Nigeria. Poultry manure was purchased from a deep litter poultry farm for raising broilers.The field experiment was carried out in 2009 and repeated in 2010. The experiment was laid out in a 3 x 3 factorial in randomized complete block design (RCBD). The factors considered are dates of planting (July 22, August 22 and September 22) and poultry manure rates (0, 5.0 and 10 tons/ha). These gave nine treatment combinations and were replicated in four blocks. Each block was divided into nine plots each measuring 2 x 2 m with 0.5 m spacing between plots and 1.0 m between blocks. The land was ploughed and harrowed and planting was made on flat ground. The poultry manure was in dry condition and was applied four days before planting and was put into the soil. The seeds were placed in shallow grooves and covered lightly with soil. Two weeks after sowing, they were thinned to a spacing of 75 x 30 cm inter and intra row spacing. Soil samples were collected from the experimental site at the depth of 0 to 15 cm. The samples were bulked together to form a composite sample from which a sub sample was taken for laboratory analysis, to determine the physical and chemical properties of the soil. Samples of the poultry manure were also analyzed to determine the nutrient composition. Weather information were obtained from the University of Nigeria, Nsukka Meteorological station located at about 200 m away from the experimental site. Records were taken on number of days to 50 and 100% flowering, number of flowers/plant, number of aborted flowers/plant, days to maturity, number of capsules/plant, weight of capsules/plant, average capsule length, number of seeds/capsule, 1000 seed weight and seed yield/ha. The data were subjected to analysis of variance (ANOVA) according to the procedure outlined by Steel and Torrie (1980). The LSD method for comparing treatment means described by Obi (2005) was used. In the 2010 experiment, planting was started earlier; hence the planting dates were June 22, August 22 and September 22.

RESULTS

The results of the soil analysis before planting in 2009 and 2010 shown in Table 1 indicated that the soil of the experimental site is sandy loam. The soil was also acidic. There was however little differences in the soil properties between the planting dates in both years. Between the two years, the soil was higher in most of the chemical properties in 2010 than in 2009. Analysis of the poultry manure used in both years also indicated high organic carbon, organic matter and N, however the poultry manure used in 2010 was slightly higher in these attributes than in 2009 (Table 2). Weather information showed little variation in total rainfall, temperature and relative humidity between the two years (Table 3).

The result of the effect of poultry manure rates on attributes of sesame in 2009 experiment presented in Table 4 showed that application of poultry manure caused highly significant effect on all the yield attributes measured with the exception of capsule length. The result indicates that increasing the rate of manure significantly decreased number of days to flowering and maturity, while the other parameters increased significantly as manure rate was increased.

There was also significant difference between the effect of 5 and 10 tons/ha rates of poultry manure on these attributes. In the second year (2010) experiment, a similar trend was observed, however, there was no significant difference between the effect of 5 and 10 tons/ha rates of poultry manure on number of seeds/capsule and seed yield/ha (Table 5).The effect of time of planting was significant on all the attributes. In 2009, early planting significantly delayed flowering and maturity (Table 6). On the other hand, early planting in the season significantly promoted number of flowers/plant, number of capsules/plant, weight of capsules/plant, capsule length, 1000 seed weight and seed yield/ha. Planting in July produced the best performance in these attributes. Number of seeds/capsule was however highest from August planting when compared with

Table 1. Physical and chemical properties of the soil of the experimental sites

Parameter	Time of planting					
	July 2009	August 2009	September 2009	June 2010	July 2010	August 2010
Clay (%)	21.00	19.00	23.00	24.00	24.00	20.00
Silt (%)	13.00	12.00	10.00	11.00	11.00	9.00
Fine sand (%)	24.00	26.00	24.00	27.00	28.00	30.00
Course sand (%)	42.00	40.00	43.00	38.00	37.00	41.00
pH (H_2O)	4.90	3.50	5.50	4.90	4.60	4.70
pH (KCl)	3.80	4.00	4.60	4.20	3.40	3.90
Carbon	1.05	1.02	0.84	1.86	1.44	1.26
Organic matter	1.80	1.20	1.04	3.20	2.48	2.18
Nitrogen	0.07	0.09	0.06	0.08	0.07	0.06
Na^+ (me/100 g)	0.27	0.36	0.35	0.90	0.58	0.63
Ca^{2+} (me/100 g)	0.60	1.02	1.40	2.40	1.80	2.20
Mg^{2+} (me/100)	1.80	1.80	0.60	0.40	0.20	0.20
CEC (me/100 g)	15.20	13.40	9.60	19.60	15.60	12.00
Base salt	20.61	19.60	14.18	20.59	20.40	12.00
H^+ (me/100 g)	2.60	1.30	0.40	2.00	1.60	0.80
P (ppm)	15.02	17.04	13.04	31.71	28.91	30.78

Table 2. Chemical properties of the poultry manure used in the two planting seasons.

Year	2009	2010
pH (H_20)	6.90	7.50
pH (KCL)	6.60	7.50
Organic carbon	19.95	19.95
Organic matter	34.39	34.39
N (%)	1.68	2.38
Na^+ (%)	0.06	0.09
K^+ (%)	0.07	0.08
Ca^{2+} (%)	4.75	4.48
Mg^{2+} (%)	1.29	2.45
P (%)	1.34	1.37

early planting in July and late planting in September. In 2010 experiment, early planting also significantly delayed flowering and maturity. There was however no significant difference between planting in June and July on these attributes. Number of capsules/plant, capsule length, 1000 seed weight and number of seeds/capsule were highest in July planting followed by June planting. Planting in June produced the best performance in weight of capsules/plant and seed yield/ha (Table 7).

Significant manure x time of planting interaction was observed on all the yield attributes with exception of capsule length and 1000 seed weight in both years. In 2009, a trend of delayed flowering and maturity at low manure rate and at early planting was noted. On the other parameters, the reverse was the case. Early planting with high manure rate produced the highest performance in these attributes (Table 8). In the second year (2010), the interaction effect on flowering and maturity followed the same trend as in 2009 experiment, however, the highest values of number of flowers/plant, number of capsules/plant, number of seed/capsule were recorded at 5 tons/ha manure when planting was done in July, while weight of capsule/plant and seed yield/ha were highest at 5 tons/ha when planted in June (Table 9).

DISCUSSION

The soil of the experimental site was low in most of the plant nutrient element, implying that the soil is low in fertility. In 2010, however there was an improvement which may be attributed to the residual effect of the manure applied in the previous year. Most of the yield attributes responded positively to time of planting. Early

Table 3. Meteorological data for year 2009 and 2010.

Month	2009						2010					
	Rain days	Rainfall (mm)	Temperature (℃)		Relative humidity (%)		Rain days	Rainfall (mm)	Temperature (℃)		Relative humidity (%)	
			Maximum	Minimum	09:00 h	16:00 h			Maximum	Minimum	09:00 h	16:00 h
January	3	53.59	31.90	21.45	71.39	58.63	0	0.00	32.90	20.26	66.63	50.87
February	1	2.19	32.46	22.79	74.61	59.43	0	0.00	33.89	23.32	71.68	57.18
March	0	0.00	33.61	23.32	72.81	57.03	3	43.88	34.03	23.26	69.97	53.81
April	11	180.6	31.37	21.60	76.2	66.20	7	161.80	32.83	23.07	73.10	63.87
May	10	283.69	30.23	21.42	74.16	70.32	10	212.34	30.39	22.23	73.48	68.81
June	18	152.51	29.13	20.83	74.67	72.67	18	247.39	29.13	21.47	75.90	70.77
July	16	248.17	28.65	20.58	74.84	74.58	17	158.48	27.94	21.00	76.52	71.29
August	18	260.33	27.48	20.84	75.00	75.00	18	404.15	27.55	21.16	77.16	72.68
September	17	175.76	27.87	20.10	74.67	74.50	18	203.95	28.13	20.73	77.13	71.80
October	17	387.10	28.39	20.26	74.94	74.74	18	183.63	28.97	20.84	76.00	68.45
November	5	103.18	29.85	19.30	63.80	61.73	2	19.31	30.03	21.23	73.70	64.03
December	0	0.00	32.71	18.84	65.35	48.68	0	0.00	32.10	18.32	61.23	48.16

Source: University of Nigeria, Nsukka, Meteorological Station.

Table 4. Effect of manure application rates on some yield attributes of sesame in 2009 experiment.

Manure rate (tons/ha)	50% FL	100% FL	NFP	NCP	DM	WCP (g)	CL (cm)	NSC	1000 SW (g)	Seed yield (kg/ha)
0.0	48.86	59.92	77.6	52.1	109.5	13.27	1.85	29.8	55.51	459.0
5.0	43.17	56.53	106.8	65.1	107.00	15.58	1.91	32.8	58.74	613.0
10.0	44.78	54.86	125.6	75.1	106.6	18.28	1.93	34.5	60.71	812.0
LSD	1.25**	0.89**	17.85**	11.72**	0.56*	2.68**	0.099**	3.65*	ns	129.0**

FL= Days to flowering, NFP = number of flower/plant, NCP = number of capsules/plant, DM = days to maturity, WCP = weight of capsules/plant, CL = capsule length, NSC = number of seeds/capsule, SW = seed weight, ** = significant at 5% probability level, * = significant at 1% probability level.

Table 5. Effect of manure application rates on some yield attributes of sesame in 2010 experiment.

Manure rate (tons/ha)	50% FL	100% FL	NFP	NCP	DM	WCP (g)	CL (cm)	NSC	1000 SW (g)	Seed Yield (kg/ha)
0.0	57.33	66.56	37.4	28.7	110.89	6.13	1.945	30.03	57.06	228.0
5.0	46.44	57.72	93.9	77.4	103.42	15.69	1.964	33.84	57.86	585.0
10.0	43.67	53.97	128.9	104.3	100.72	18.70	2.006	34.60	60.05	678.0
LSD	0.50**	0.89**	14.99**	14.02**	0.766*	2.697**	NS	1.40*	NS	112.8**

FL= Days to flowering, NFP = number of flower/plant, NCP = number of capsules/plant, DM= days to maturity, WCP = weight of capsules/plant, CL = capsule length, NSC = number of seeds/capsule, SW = seed weight, ** = significant at 5% probability level, * = significant at 1% probability level.

Table 6. Effect of time of planting on some seed yield attributes of sesame in 2009 experiment.

Planting dates in 2009	50% FL	100% FL	NFP	NCP	DM	WCP (g)	CL (cm)	NSC	1000 SW (g)	Seed yield (kg/ha)
July 22	48.86	62.11	131.9	112.2	110.78	27.25	1.967	33.2	57.06	1126.0
August 22	43.17	55.19	110.2	56.6	104.89	15.67	1.964	37.1	57.86	658.0
September 22	44.78	54.00	68.1	23.4	103.76	4.21	1.752	26.8	60.05	100.0
LSD	1.247**	0.89**	17.85**	11.72**	4.494*	2.683**	0.099**	5.65*	ns	129.0**

FL = Days to flowering, NFP = number of flower/plant, NCP = number of capsules/plant, DM = days to maturity, WCP = weight of capsules/plant, CL = capsule length, NSC = number of seeds/capsule, SW = seed weight, ** = significant at 5% probability level, * = significant at 1% probability level.

Table 7. Effect of time of planting on some seed yield attributes of sesame in 2010 experiment.

Planting dates in 2010	50% FL	100% FL	NFP	NCP	DM	WCP (g)	CL (cm)	NSC	1000 SW (g)	Seed yield (kg/ha)
July 22	52.92	65.53	105.8	82.4	110.61	15.23	1.974	32.59	46.90	592.0
Aug. 22	52.72	61.39	109.3	94.0	105.17	14.26	1.998	34.23	47.00	495.0
Sept. 22	41.81	51.33	45.1	33.9	99.25	11.03	2.006	31.64	47.8	404.0
LSD	0.50**	0.891**	14.99**	14.02**	0.766**	2.697*	NS	1.40*	NS	112.8*

FL = Days to flowering, NFP = number of flower/plant, NCP = number of capsules/plant, DM = days to maturity, WCP = weight of capsules/plant, CL = capsule length, NSC = number of seeds/capsule, SW = seed weight, ** = significant at 5% probability level, * = significant at 1% probability level.

Table 8. Effect of manure x time of planting interaction on some seed yield attributes of sesame in 2009 experiment.

Planting dates in 2009	Manure rates (t/ha)	50% FL	100% FL	NFP	NCP	DM	WCP (g)	CL (cm)	NSC	1000 SW (g)	Seed yield (kg/ha)
	0.0	51.33	64.75	89.7	97.2	112.25	25.15	1.93	32.0	54.67	841.0
June 22	5.0	47.75	61.75	136.9	105.0	109.50	25.18	1.96	31.9	57.75	1041.0
	10.0	47.5	59.83	169.2	134.5	110.58	31.41	2.02	35.8	58.75	1495.0
	0.0	48.25	58.42	91.6	43.5	107.25	11.09	1.90	35.0	57.48	454.0
August 22	5.0	41.08	54.50	114.0	68.1	105.33	17.46	1.96	35.5	57.17	704.0
	10.0	40.17	52.67	125.0	58.2	102.08	18.47	2.03	40.6	58.92	816.0
	0.0	46.33	56.58	52.3	15.6	98.62	3.58	1.72	22.3	54.39	60.0
September 22	5.0	45.08	53.33	69.2	22.1	106.58	4.09	1.79	31.0	61.30	94.0
	10.0	42.92	52.08	82.7	32.6	106.08	4.97	1.75	27.0	64.46	125.0
LSD		5.60*	3.6*	10.2**	20.8**	6.5*	7.4**	NS	4.5*	NS	223.5*

FL= Days to flowering, NFP = £umber of flower/plant, NCP = number of capsules/plant, DM = days to maturity, WCP = weight of capsules/plant, CL = capsule length, NSC = number of seeds/capsule, SW = seed weight, ** = significant at 5% probability level, * = significant at 1% probability level.

planting in the season increased yield in the crop which agrees with earlier reports (Alamsarker et al., 2009; Bill, 2009; Fazlul et al., 2009). This is attributed to higher nutrient content in the soil during the early period of the season which declines with time as a result of leaching away of nutrient from the soil by more frequent rainfall (Jones, 1976). In addition, Bennett (2003) had reported that the crop is extremely sensitive to water-logged condition and will cause lost in plant stand and low yield. It was also noted that crops planted in September experienced drastic decreased in rainfall which might have negatively affected growth and seed development. This appears to agree with the findings of Mulkey, (1987) that adequate soil moisture is necessary during the vegetative stage. Reduction in rainfall becomes important at maturity stage to prevent spoilage of capsules and seeds by excessive moisture. Flowering and maturity were delayed in the early planted crops when compared with those planted in the later dates. This may be attributed to prolonged vegetative growth enhanced

Table 9. Effect of manure x time of planting interaction on some seed yield attributes of sesame in 2010 experiment.

Planting dates in 2009	Manure rates (t/ha)	50% FL	100% FL	NFP	NCP	DM	WCP (g)	CL (cm)	NSC	1000 SW (g)	Seed yield (kg/ha)
	0.0	63.25	73.08	59.6	47.8	118.58	7.26	1.99	31.19	45.67	247.0
June 22	5.0	49.00	63.92	123.4	99.1	107.50	20.56	1.97	33.50	46.33	772.0
	10.0	46.50	59.58	134.4	100.5	105.75	17.67	1.97	33.07	48.67	756.0
	0.0	62.92	70.33	37.2	29.9	111.00	7.44	2.01	30.97	44.33	270.0
August 22	5.0	49.17	57.42	110.9	98.3	105.00	15.39	2.02	34.86	46.33	528.0
	10.0	46.08	56.42	179.7	153.7	99.50	19.95	1.97	36.88	50.33	688.0
	0.0	45.83	56.25	15.4	8.5	103.08	3.69	2.02	27.94	48.00	167.0
September 22	5.0	41.17	51.83	47.5	34.7	97.75	11.14	1.98	33.15	49.83	455.0
	10.0	38.42	45.92	72.5	58.6	96.92	18.27	2.01	33.84	45.50	589.0
LSD		0.87*	1.54*	25.97**	24.28**	1.33*	4.67**	NS	3.2*	1.02*	108.0*

FL= Days to flowering, NFP= number of flower/plant, NCP= number of capsules/plant, DM= days to maturity, WCP= WEIGHT of capsules/plant, CL= capsule length, NSC= number of seeds/capsule, SW= seed weight.
** = Significant at 5% probability level, *= significant at 1% probability level.

by favourable condition for growth which probably delayed reproductive develop-ment. In the second year when planting started earlier in June, some of the yield attributes were better in the July planting. The response to time may also be attributed to changes in other factors of the environment. For instance, Fakorede (1985) reported that planting later in the season in this area characterized by heavy rainfall is subject to high cloud cover which reduces solar radiation resulting to low rate of photosynthesis. The weather data indicated that the 2009 recorded high temperature and better rainfall distribution than 2010. This may be responsible for the better performance of the crop in 2009. Changes in other climatic, biotic and adaphic factors of the environment may also be implicated.

The crop positive response to manure application agrees with the earlier findings of Ogbonna and Obi (2000) and Ayoola and Adeniyan (2006). Apart from supplying plant nutrient elements to the soil, manure also improves the soil physical properties which enhance crop growth and development (Mbagwu and Ekwealor, 1990; Salter and Hanworth, 1962; Stevenson and Ardakani, 1972). Tisdale and Nelson (1975) had earlier noted that crops respond to manure application in soil with low fertility status. This applies to the present study since the soil analysis revealed that the soil is low in fertility. There is presently the advocacy for organic farming which provides quality and safe products as an alternative to conventional practices involving use of inorganic fertile-zers and other agrochemicals implicated for a number of environmental degradation problems. Experiments have shown that inorganic fertilizers do not produce higher seed yield than organic fertilizers (Suddhiyan et al., 2009).

This study has shown that sesame can be produced in the derived savanna agro-ecology of south eastern Nigeria. It also revealed that early planting in the season and application of poultry manure increased seed yield in sesame.

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