Sustainable Agriculture Research; Vol. 2, No. 3; 2013
ISSN 1927-050X E-ISSN 1927-0518
Published by Canadian Center of Science and Education

Competitive Behaviour of Groundnut in Sesame/Groundnut Intercropping System Under Varying Poultry Manure Rates and Planting Arrangement

Haruna I. M.[1], Aliyu L.[2] & Maunde S. M.[3]

[1] Department of Agronomy, Nasarawa State University, Keffi, Nigeria

[2] Department of Agronomy, Ahmadu Bello University, Zaria, Nigeria

[3] Adamawa State College of Agriculture, Ganye, Nigeria

Correspondence: Haruna I. M., Department of Agronomy, Nasarawa State University, Keffi, Nigeria. Tel: 234-803-968-3552. E-mail: ibrahimmharuna@yahoo.com

Received: February 14, 2013. Accepted: March 20, 2013 Online Published: March 22, 2013

doi:10.5539/sar.v2n3p22 URL: http://dx.doi.org/10.5539/sar.v2n3p22

Abstract

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 competitive behaviour of groundnut in Sesame-groundnut intercropping system. 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 a randomized complete block design with four replications. The results obtained in both the years showed that sesame when grown with groundnut under different rates of poultry manure and planting arrangement appeared to be a dominant crop as indicated by its higher values of Land equivalent ratio, competitive ratio, higher and positive values for aggressivity and area time equivalent ratio. Application of 6 t ha^{-1} of poultry manure and double alternate row planting arrangement produced the highest values for all the competition indices measured respectively.

1. 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. Intercropping is the practice of growing two or more crops simultaneously on the same piece of land.

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 & Sinha, 1991). 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 (Haruna et al., 2011). Sesame oil is used in making paints, soaps, cosmetics, perfumes, insecticides canned sardine, canned beef as well as for pharmaceutical and ethno botanical uses (FAO, 2002; RMRDC, 2004).

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 which develop below the soil surface. It used as food and feed in the tropics (Obasi & 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.

Farmers in Nigeria savanna grow crops in mixture but the yields obtained are generally low because fertilizers (organic or inorganic) are really applied and they do not practice spatial arrangement that will ensure better solar energy interception for higher yield (Chiezey et al., 2005; Haruna et al., 2006).

Work on the competitive behavior of components crops in different sesame-based intercropping systems as

affected by planting pattern have been reported by Sarkar and Chakraborty (2000), Sarkar and Sanyl (2000) and Sarkar et al. (2001). However, no systematic research work has been done so far to explore the competitive behaviour of a component crop in sesame-legume intercropping systems under varying poultry manure rates and planting pattern. This study therefore, seeks to achieve that.

2. 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 southern Guinea savanna zone of Nigeria located between latitude 08º30'N and 08º30'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 18 m^2 (4.5 m x 4 m) while the net plot size was 9 m^2 (3 m x 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 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 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 competitive behaviors of groundnut in sesame/groundnut association determined are: Land Equivalent Ratio (LER), Aggressivity (A), Competative ratio (CR) and Area Time Equivalent ratio (ATER) which were determined using the following formulae:

$$\text{Land Equivalent Ratio} = \frac{Yab}{Yaa} + \frac{Yba}{Ybb}$$

Where, Yaa and Ybb were sole yield of crops ‘a’ and ‘b’ respectively, Yab and Yba were mixture yield of crops ‘a’ and ‘b’ respectively (Willey, 1979).

$$\text{Aggressivity} = \frac{Yab}{Yaa \times Zab} - \frac{Yba}{Ybb \times Zba}$$

Where, Yab and Yba were the individual yields of crops ‘a’ and ‘b’ in mixture respectively, Yaa and Ybb were the sole yield of crops ‘a’ and ‘b’ respectively, Zab and Zba where the sown proportion of crop ‘a’ and ‘b’ respectively (McGilchrist, 1965).

Competitive ratio was determined as described by (Willey & Rao, 1980).

$$\text{Competitive Ratio for crop ‘a’} = \frac{LERa}{LERb} \times \frac{Zba}{Zab}$$

$$\text{Competitive Ratio for crop ‘b’} = \frac{LERb}{LERa} \times \frac{Zab}{Zba}$$

Where, LERa and LERb are land equivalent ratio for crop ‘a’ and ‘b’ respectively while, Zab and Zba are the sown proportions of crop ‘a’ and crop ‘b’ respectively.

Area Time Equivalent Ratio was determined as described by Hiebsch and McCollum (1987).

$$\text{Area time equivalent ratio } \frac{(Rya \times ta) + (Ryb \times tb)}{T}$$

Where, Rya and Ryb are relative yield of crop ‘a’ and ‘b’ respectively, ‘ta’ is the duration (days) for crop ‘a’ and ‘b’ respectively, T is the duration (days) of the intercropping system.

3. Results and Discussion

3.1 Land Equivalent Ratio

In 2011 and 2012, all treatment combinations had LER that is greater than unity (Table 1). This is an indication that there was a yield advantage of intercropping groundnut with sesame over growing either of the crops as a sole. This could be attributed to the fact that component crops differ in their use of growth resources in such a

way that when they are grown in combination, they are able to 'complement' each other and so make better overall use of resources better than when grown alone. Application of 6 t ha^{-1} of poultry manure and double row planting arrangement produced significantly the highest LER compared to other rates of applied manure and planting arrangement respectively. The lowest LER was produced by the control plots and single row planting arrangement in both years respectively. The higher LER obtain at 6 t ha^{-1} of poultry manure could be attributed to the fact that highest yield from the two crops were obtained at that rate while the lowest LER produced by the control plots could be attributed to the fact that the lowest yield from the two crops were obtained at that rate. Double alternate row planting arrangement out yielded single alternate row planting arrangement because there was little effect of shading of sesame on groundnut under double row planting arrangement compared to single alternate row planting arrangement hence the higher yield that translated to higher LER in double row.

Table 1. Effect of poultry manure and planting arrangement on the land equivalent ratio of sesame/Groundnut mixture

Treatment	2011			2012		
Poultry manure (t ha^{-1})	LER Sesame	LER Groundnut	Total LER	LER Sesame	LER Groundnut	Total LER
0	1.08d	0.28d	1.35d	1.06d	0.27d	1.33d
3	1.46c	0.30c	1.76c	1.43c	0.29c	1.72c
6	2.45a	0.39a	2.80a	2.40a	0.38a	2.78a
9	1.93b	0.35b	2.32b	1.89b	0.34b	2.23b
SE±	0.162	0.003	0.016	0.015	0.003	0.015
Planting Arrangement						
Single alternate row	1.71b	0.28b	1.99b	1.68b	0.27b	1.95b
Double alternate row	1.74a	0.38a	2.12a	1.71a	0.37a	2.08a
SE±	0.011	0.002	0.012	0.011	0.002	0.011

Means followed by the same letter(s) are not statistically different at 5% level of significance.

3.2 Aggressivity (A)

Seasame was more aggressive in the mixture than groundnut at all treatment combinations in both the years (Table 2). The aggressiveness of sesame significantly increased with poultry manure application up to 6 t ha^{-1} beyond which it significantly decreased in both the years. Similarly, double row planting arrangement significantly increased sesame aggressivity than when planted on single row in all the years. Irrespective of the applied treatments, positive sign of aggressivity for sesame indicated the dominant behavior of sesame over groundnut which had negative aggressivity values.

Table 2. Effect poultry manure and planting arrangement on the aggresivity of sesame/groundnut mixture

Treatment	2011			2012		
Poultry manure (t ha^{-1})	K Sesame	K Groundnut	Total K	K Sesame	K Groundnut	Total K
0	0.015d	-0.015a	0.030d	0.015d	-0.015a	0.030d
3	0.020c	-0.020b	0.040c	0.020c	-0.020b	0.040c
6	0.040a	-0.040d	0.080a	0.040a	-0.040d	0.080a
9	0.030b	-0.030c	0.060b	0.030b	-0.030c	0.040b
SE±	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Planting Arrangement						
Single alternate row	0.025b	-0.025a	0.055a	0.025b	-0.025a	0.050b
Double alternate row	0.028a	-0.028b	0.050b	0.028a	-0.028b	0.055a
SE±	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001

Means followed by the same letter(s) are not statistically different at 5% level of significance.

Table 3. Effect poultry manure and planting arrangement on the competative ratio of sesame/groundnut mixture

Treatment	2011		2012	
	CR Sesame	CR Groundnut	CR Sesame	CR Groundnut
0	4.65c	0.27a	4.56c	0.26a
3	5.15b	0.21b	5.02b	0.20b
6	5.11b	0.20b	5.01b	0.20b
9	7.19a	0.14c	7.04	0.14c
SE±	0.079	0.009	0.06	0.008
Planting Arrangement				
Single alternate row	6.25a	0.17b	6.13a	0.17b
Double alternate row	4.79b	0.25a	4.68b	0.24a
SE±	0.056	0.007	0.042	0.006

Means followed by the same letter(s) are not statistically different at 5% level of significance.

3.3 Competitive Ratio (CR)

The higher CR values for sesame in both the years under different poultry manure rates and planting arrangement compared to groundnut, is an indication that sesame was more competitive than groundnut (Table 4). The lower CR value for groundnut (0.14-0.27) is an indication that it is not a good competitor when grown with sesame.

Table 4. Effect poultry manure and planting arrangement on the area time equivalent ratio of sesame/groundnut mixture

Treatment	2011	2012
Poultry manure (t ha^{-1})		
0	0.71d	0.68d
3	0.92c	0.88c
6	1.47a	1.41a
9	1.21b	1.17b
SE±	0.01	0.009
Planting Arrangement		
Single alternate row	1.04b	1.00b
Double alternate row	1.11a	1.06a
SE±	0.007	0.006

Means followed by different letter(s) are statistically different at 5% level of significant.

3.4 Area Time Equivalent Ratio (ATER)

The highest ATER values in both the years (1.47 and 1.41 respectively) were recorded by the application of 6 t ha^{-1} of poultry manure (Table 4). The lowest values for ATER in the both the years was recorded by the control plots (0.71 and 0.68 respectively). Double alternate row planting arrangement produced significantly higher ATER in both the years compared with single alternate row planting arrangement.

The time (duration) the field was dedicated to production is not considered in the calculation of LER but ATER as proposed by Hiebsch and McCollum (1987) take into consideration the land occupancy period of the crops. The land occupancy period of sesame was 97 days while, that of groundnut was 80 days. Maximum utilization of space and time was observed in plots to which 6 t ha^{-1} were applied. The better ATER was due to better combined intercropped yield and temporal difference which existed between the crops.

4. Conclusion

From the foregoing, it can be seen that sesame/groundnut intercropping is more efficient than growing either of the crop alone. Sesame was more competitive than groundnut in the mixture because it had higher values for

LER, aggressivity, CR and ATER in all the years of the experiment. The performance of sesame/groundnut mixture was superior when 6 t ha^{-1} of poultry manure was applied and under double row planting arrangement.

References

Chiezey, U. F., Haruna, I. M., & Odion, E. C. (2005). Productivity of sorghum/soyabean mixture and influence of N, P and plant arrangement in the northern Guinea Savanna Zone of Nigeria. *Crop Research, 29*(1), 1-14.

FAO (Food and Agriculture Organization of the United Nations). (2002). *Sesame Production Information*. Retrieved from http://www.ecoport.org/EP.exeSEntFull?ID=1937

Haruna, I. M., Aliyu, L., Olufajo, O. O., & Odion, E. C. (2011). Contributions of some yield attributes to the seed of sesame (*Sesamum indicum* L.) in the Northern Guinea Savanna of Nigeria. *Asian Journal of Crop Science, 3*(2), 92-98. http://dx.doi.org/10.3923/ajcs.2011.92.98

Haruna, I. M., Rahman, S. A., & Alhassan, U. (2006). Performance of Sorghum/Soyabean Mixtures at varying planting arrangements, nitrogen and phosphorus fertilizer rates in the Northern Guinea Savanna of Nigeria. *Tropical Science, 46*(2), 116-119. http://dx.doi.org/10.1002/ts.62

Hiebsch, C. K., & Mc Collum, R. I. (1987). Reply to Chandra K. Reddy. *Agronomy Journal, 79*(5), 945-946. http://dx.doi.org/10.2134/agronj1987.00021962007900010004x

McGilchrist, C. A. (1965). Analysis of Competition Experiments. *Biometrics, 21*(4), 975-985. http://dx.doi.org/10.2307/2528258

Obasi, M. O., & Ezedinma, F. O. C. (1991). Evaluation of groundnut and chemical composition in kerstings groundnut. *Indian J. Agric. Sci., 61*, 811-814.

Onwueme, I. C., & Sinha, T. D. (1991). *Field crop production in Tropical Africa*. The Netherlands. p. 480.

RMRDC. (2004). Report on survey of Agro-Raw Materials in Nigeria Beniseed. Raw materials research and development council, Abuja. p. 99.

Sarkar, R. K., & Chakraborty, A. (2000). Biological feasibility and Economic Viability of Intercropping Pulse and oilseed crops with Sesame (*Sesamum indicum* L.) under different planting patterns in rice fallow gangetic alluvial land. *Indian Journal of Agricultural Science, 70*, 211-214.

Sarkar, R. K., & Sanyal, S. R. (2000). Production potential and economic feasibility of Sesame (*Sesamum indicum* L.) based intercropping system with Pulse and oilseed crops on rice fallow land. *Indian Journal of Agricultural Science, 45*, 545-550.

Sarkar, R. K., Kundu, S., & Kundu C. (2001). Sustainable intercropping system o of sesame (*Sesamum indicum* L.) with Pulse and oilseed crops on rice fallow land. *Indian Journal of Agricultural Science, 45*, 545-550.

Willey, R. W. (1979). *Field Crop Abstract,* 73-85.

Willey, R. W., & Rao, M. R. (1980). A competitive ratio for quantifying competition between intercrops. *Experimental Agriculture, 16*, 117-125. http://dx.doi.org/10.1017/S0014479700010802