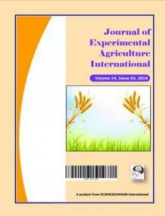

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Growth and Yield of Sesame (*Sesamum indicum* L.) as Influenced by Population Density of Component Cowpea in a Sesame-cowpea Mixture

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Author's contribution

The sole author designed, analyzed and interpreted and prepared the manuscript.

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ABSTRACT

Aim: To study the effects of population density on the growth and yield of sesame (*Sesamum indicum* L.) intercropped with cowpea (*Vigna unquiculata* L. Walp).
Materials and Methods: A field trial was carried out at the Teaching and Research Farm of kwara State University, Malete (08° 42″ 48.5N and 004° 26 17.9″ E) in the southern Guinea savannah agro-ecological zone of Nigeria in 2014 cropping season. The treatments consisted of full population of sesame intercropped with 100%, 75%, 50%, and 25% full population of cowpea. Sole sesame and cowpea were also included as control. Cowpea populations were introduced into sesame at two weeks after planting. The treatments were arranged in a randomized complete block design and replicated three times. Efficiency of intercropping was evaluated using land equivalent ratio (LER) and percentage yield difference indices (PYD).
Results: Intercropping significantly influenced growth and yield of cowpea, meanwhile, growth and yield of sesame were not affected by intercropping. The highest height of cowpea, 22.30 cm, was recorded when full populations of both crops were mixed. Combinations of full population of both crops produced lowest number of branches (1.03) and pods (1.87) per plants in cowpea and also recorded highest LER (1.30) and PYD (31%). Sole cowpea significantly out-yielded other treatment combinations in the intercrop.

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Conclusion: The study demonstrated the suitability of intercropping sesame with cowpea in all the component population ratios tested with the best ratios when full populations of both crops were mixed.

Keywords: Efficiency; competition; intercropping; land equivalent ratio; percentage yield difference.

1. INTRODUCTION

Beniseed (*Sesamum indium* L.) belongs to the double-cotyledon pedaliaceae family. It is an annual plant which grows either bush-like or upright, depending on the variety to a height of 1-2.0 m. The blossoming of ripening phases takes place over several weeks, starting at bottom of the plant and progresses upward [1]. Sesame seed is one of the oldest oilseed crops known and has been domesticated for over 5000 years [2]. The seed is considered as one of the most important oil crop in the world due to the superior oil and protein, in view of these attributes, the crop is often referred to as, the queen of the oil seed crops. It rich in calcium and potassium with high quality and stable oil with high index of sesamin and sesamolin antioxidant as well as monounsaturated and poly unsaturated fatty acid and widely used by some pharmaceutical and cosmetic industries [3].

Cowpea (*Vigna unguiculata* L. Walp), one of the several species in the widely cultivated genus vigna, is an important crop in many countries of tropical Africa, Asia and South America. The grains and the leaves consumed are sources of high-quality protein to man. According to [4], careful and positive attention to cowpea production would support 850 million People in the world with high incidence of undernourishment, particularly, in sub-Saharan Africa.

In most African countries, cowpea is either grown alone or intercropped with other arable crops. This simultaneous growing of two or more crops on the same field is widely practiced among traditional farmers in the tropics. In addition to increased production per unit area, through optimizing the use of natural resources [5,6] the system was reported to increase income, as well as, reduced quantity of nitrogen required per unit area [7,8]. In the recent time, sesame cultivation has increased among the resource poor farmers in the study area. Intercropping sesame with other arable crops has not gain popularity, in spite numerous benefits of intercropping.

In crop mixture, population density is an important agronomic consideration for optimum yield. According to [9], good soil management, plant density and planting configuration can enhance the benefits of the system. The significant role of cowpea as a component crop in crop mixture is well known. It is tolerant to shade and also enriches the soil through nitrogen fixation. Despite these, information on sesame intercropping with cowpea particularly at different component population is inconsistent. In a study involving sesame and maize system, [10], observed that interplant competition from sesame significantly reduced the yield of maize and suggested that sesame should be planted two weeks after maize. Similarly, [11], observed a reduction of 22.64% in cowpea bean grain yield in a cowpea-sesame mixture, when the two crops were sown at the same time. In contrast, [7], reported a more aggressive competitive behavior characteristic of cowpea over sesame resulting in about 26.0% yield reduction of sesame in a cowpea/sesame intercropping.

While considerable informations are available in cowpea intercropping with other crops, reported work on sesame-cowpea mixture is scanty and inconsistent, particularly with component population ratio. However, with the current growing interest of farmers in the study area suggest the need to provide information that is research base for guidance for the interest of the farmers. This research was therefore, initiated to study the effects of population density on the growth and yield of sesame in sesame/ cowpea mixture with a view of determining the suitability of intercropping sesame with cowpea and the population density of cowpea for optimum yield.

2. MATERIALS AND METHODS

The experiment was carried out at the Teaching and Research Farm of Kwara State University, Malete, in the southern guinea savannah ecological zone of Nigeria in 2014 late cropping season (late august to middle November). The mean annual rainfall of the study area during the year was 1,076 mm in 55 rainy days. The maximum temperature was 37.7℃ while minimum was 21.4℃ with relative humidity of

92.6% [12]. The land was ploughed, and doubled harrowed for good seed germination. Four to five seeds of sesame were planted per stand at a spacing of 60.0 cm x 10.0 cm and were thinned to two plants per stand at two weeks after planting (WAP). The treatments consisted of full population of sesame intercropped with full, 75%, 50%, and 25% full population of cowpea in a randomized complete block design in three replicates. Cowpea populations were introduced into sesame after two weeks of planting. Sole crop of sesame and cowpea at full population were also included in the treatment as a check.

Pendimethalin [N-(1-ethylpropyl)-3, 4-dimethyl-2, 6-dinitrobenzenamine] was applied as a pre-emergence herbicide immediately after planting of sesame at the rate of three litres per hectare using knapsack sprayer. This was followed by hand weeding at 6 weeks after planting (WAP). The two crops were protected from insect by spraying with cyalothrin at the rate of 1.5kg active ingredient /hectare. Inorganic N.P.K (15:15:15) fertilizer was applied to sesame at the rate of 150 kg/hectare at 4 WAP using the side placement method.

2.1 Data Collection

Growth parameters: Plant height, stem girth, number of branches and pods per plant were taken from five tagged plants at the two inner rows for both sesame and cowpea. The numbers of days at which 50% population of both crops flowered and pod were also recorded. The dry matter was determined by the difference in the initial and final weight from randomly selected five plants that were oven dried to a constant weight. The yield obtained from the nested plot (4.66 m^2) from each plot was converted to kilograms per hectare and 1000 seeds from harvested plots were weighed on a sensitive balance in the laboratory. The efficiency of intercropping was determined using land equivalent ratio [13] and percentage yield difference [14] indices. Percentage yield difference, gives the numerical value of intercropping advantage when the percentage intercrop is deducted from the sole crop.

$$LER = Yij/Yii + .Yji/Yjj$$

Where:

Y = yield per unit area
Yii and Yjj = sole crop yield of component crop i and j
Yij and Yji = intercrop yield

$$PYD = 100- \{Ysa-Yja/Ysa + Ysb- Yjb/Ysb \} x 100/1$$

Where:

Ysa= sole crop yield of crop A
Ysb =sole crop yield of crop B
Yja = intercrop yield of crop A
Yjb = intercrop yield of crop B

All the data were subjected to statistical analysis with [15] version and treatment means compared at 5% level of probability using Duncans Multiple Range Test.

3. RESULTS

The soil of the experimental site is sandy loam with 86.4% sand, 60% clay, 94% silt, slightly acidic, low in inorganic carbon, total nitrogen and available phosphorous (Table 1). Plant height, stem girth, days to 50% flowering and podding of sesame were not influenced by intercropping, but these parameters in cowpea were affected (Table 2). The height of cowpea (22.33 cm) was significantly taller than all other population ratios including the sole stand. Notwithstanding, superior thicker plant of cowpea were observed at the sole stand compared to other treatments. Intercropped cowpea at full population with full population of sesame significantly took longer days to flower and pod compared to other treatments.

Table 1. Physio-chemical properties of the soil of the experimental site

Properties	
Particle size (%)	
Sand	86.4
Clay	60
Silt	94
Soil textural class	Sandy loam
pH (H_20)	5.96
Bulk density (g/cm^3)	1.65
Total porosity (%)	38.0
Organic carbon (%)	1.48
Total N (%)	0.15
Available P (mg/kg)	2.55
Exchangeable cation (cmol/kg)	4.77
K^+	0.29
Ca^{2+}	3.03
Mg^{2+}	0.89
Na^+	0.31

The effect of intercropping on number of branches and pods per plant and dry matter weight in sesame/cowpea mixture is presented in

Table 3. Number of branches and pods per plant and dry matter weight of cowpea increased as the population pressure decreased. Compared to other population ratios, more number of branches and pods of cowpea were recorded at the sole stand. Although more branches of sesame were observed at the sole stand, it was not statistically different.

The significant effect of intercropping on the weight of 1000 grains, grain yield of cowpea and sesame, land equivalent ratios and percentage yield difference is presented in Table 4. Irrespective of the population ratios at the intercrop, cowpea planted as sole crop, significantly had more seed weight and grain yield. The highest grain yield of cowpea (1,739.04 kg/hectare) at the intercrop was recorded when full populations of both crops were mixed. Although, higher seed yield was obtained at the treatment where sesame was planted as a sole crop, it was not significantly different from the intercrop population ratios. Based on LER and PYD indices, all the population ratios tested demonstrated intercropping advantages over their respective sole crops stand, that is, efficient utilization of natural resources.

4. DISCUSSION

The overall result of the study indicated that sesame could be intercropped with cowpea in all the population ratios considered. This implies that planting sesame and cowpea in the mixture is better than planting any of the crops as a sole. The intercropping advantage as observed in this study is consistent with the works of earlier researchers on intercropping involving cowpea and sesame such as: cowpea/ maize [6], cowpea/sesame [7,16,17], and maize/sesame [10].

Although, the height and other parameters of sesame were not statistically affected by intercropping in all the observed population ratios tested, growth and yield of cowpea in the mixture were influenced. Cowpea height decreased as the population of components crops decreased. The observed tall plants of cowpea at high population ratio particularly at full population of both crops, could be due to competition for natural resources, especially light, between the two component crops. Cowpea being an under storey crops had to compete for light at the initial growth stages. As expected, when plant competes for light they tend to grow taller

Table 2. Effects of intercropping on plant height stem girth days to 50% flowering and podding in a sesame/cowpea mixture in 2014

Component population ratios			Plant height (cm)		Stem girth (cm)		Days to 50% flowering		Days to 50% podding	
S	:	C	S	C	S	C	S	C	S	C
100	:	100	101.89a	22.33a	1.10a	0.76b	63.67a	31.03a	74.67a	59.00a
100	:	75	101.10a	19.97b	1.18a	0.77b	60.99b	30.67a	77.00a	57.33b
100	:	50	98.20a	19.30b	1.26a	0.78b	61.33b	30.09b	73.33a	55.67d
100	:	25	96.40a	19.67b	1.15a	0.81b	61.97b	29.00c	77.67a	56.67c
Sole			99.42a	19.50b	1.22a	0.89a	60.33b	28.80c	76.00a	46.67c

Values with the same letter(s) in the same column are not significantly different at 5% level of probability by Duncan's Multiple Range Test. S = sesame, C =cowpea

Table 3. Effects of intercropping on number of branches and pods/plant and dry matter weight in a sesame/cowpea intercropping in 2014

Component population ratios			Number of branches/plant		Number of pods /plant		Dry matter weight (g)	
S	:	C	S	C	S	C	S	C
100	:	100	10.00a	1.03c	43.50a	15.87c	58.89b	38.37c
100	:	75	10.03a	1.05c	43.92a	16.13c	58.97b	41.33d
100	:	50	10.00a	2.04b	43.75a	16.53b	59.98b	43.02c
100	:	25	10.03a	2.06b	43.50a	16.60b	60.00b	56.97b
Sole			10.04a	7.53a	43.98a	19.13a	62.09a	114.07a

Values with the same letter(s) in the same column are not significantly different at 5% level of probability by Duncan's Multiple Range Test. S = Sesame, C =cowpea

Table 4. Effects of intercropping on the weight of 1000 grains, yield LER and PYD in a sesame/cowpea intercropping in 2014

Component population ratios			Weight of 1000 grains (g)		Yield (kg/ha)		LER	PYD (%)
S		C	S	C	S	C	S	C
100	:	100	3.05a	117.67b	888.37a	1,739.04b	1.30a	31a
100	:	75	3.01a	128.67b	887.53a	1,661.28b	1.28ab	29b
100	:	50	3.03a	128.70b	888.36a	1,481.76c	1.25b	25c
100	:	25	3.00a	127.67b	890.37a	1,426.28bc	1.23bc	23cd
Sole			3.08a	129.33a	990.39a	4,278.24a	1.00d	100d

Values with the same letter(s) in the same column are not significantly different at 5% level of probability by Duncan's Multiple Range Test. S = Sesame, C=cowpea, LER= Land equivalent ratio, PYD = Percentage yield difference

by producing more nodes/stem so as to capture more light, hence the recorded tall cowpea at high population pressure.

Another reason for the non significant effect of intercropping on the growth and yield of sesame could be due to early planting of sesame before cowpea. Although, cowpea flowered before the components sesame did, the time of podding coincided with the period of flowering in sesame. Sesame, been naturally taller than cowpea in addition with the vigorous growth habit and early establishment, was able to utilize the natural resources better than cowpea at this critical growth stage of cowpea. [10], reported a decreased of 19-55% in maize yield due to inter-plant competition from associated sesame.

The yield parameters of sesame viz; number of branches and pods per plant were not statistically affected by intercropping, these traits in cowpea were however influenced. Poor number of branches and pods per plant of cowpea at high population pressure of component crops has been reported [6]. Fewer number of pod/plant of cowpea at the intercrop as observed in this study was a reflection of poor number of branches/plant. Although, at reduced population of cowpea in the intercrop, production of branches and consequently number of pods per plant were appeared to be favored probably due to wider spacing of cowpea that encouraged more branching as a result of reduction in competition. However, despite this, the fewer number of plants could not compensate for the yield. The observed non significant effects of intercropping on the growth and yield of sesame did not conform to the findings of [7] who recorded 26% reduction in the yield of sesame due competition from associated cowpea. The contrast could be ascribed to time of introduction of cowpea in the mixture. In the earlier experiment, the two crops were planted at the same time whereas in the foregoing, cowpea was introduced to sesame at two weeks after planting. This early planting gives sesame the advantage of utilizing natural resources better than the component cowpea, consequently, the growth and yield were not influenced.

Based on LER and PYD indices, all the component ratios tested demonstrated the suitability of intercropping cowpea with sesame. That is, mixing the two crops is more preferred than planting either of the crops alone. In an earlier study, on sesame/cowpea mixture [18], intercropping advantages due to efficient utilization of natural resources were recorded, especially in a 2:2 and 2:1 spatial row arrangements.

5. CONCLUSION

The growth and yield of sesame were not affected by intercropping in a sesame/ cowpea mixture especially when sesame is planted two weeks before cowpea. Meanwhile, growth and yield of cowpea were influenced. All the population ratios tested demonstrated the suitability of intercropping cowpea with sesame. A combination of full population of both crops was found to be most suitable.

COMPETING INTERESTS

Author has declared that no competing interests exist.

REFERENCES

1. Ogbonna PE, Umar-Shaaba YG. Yield responses of sesame (*Sesamum indicum.* L.). to rates of poultry manure application and time of planting in a derived savannah ecology of south eastern Nigeria. African

Journal of Biotechnology. 2011; 10(65):14881-14887.
2. Albue FA, et al. Ecofiologia do gergerlim (*Sesamum indicum*. L.). In. Bethrao, N.E. de M. Oliveira, M.I.P. de (editors technicos). Ecofiological das culturas de algodao, amendoim, gergelim, mamona, pinhao-mansoe sisal 2nd ed. Brasillia: Embrapa. 2012;122-143.
3. Suddhiyam et al. Fertilizer for organic sesame. Asian Journal of Food and Agro-industry, Bangkok. 2009;2(Special issue):197-204.
4. FAO. The state of food and agriculture. Document prepared for the international conference on worlds state of food. FAO, Rome, Italy; 2005. Available:ftp://fao.org/docrep
5. Calson JD. Intercropping with maize in sub-arid Regions In: Community Planning and Analysis, Technical Brief. 2008;25.
6. Afe AI, Olofintoye JA. Response of cowpea cultivars of contrasting maturity dates to varying component population ratios of early maturing maize. Journals of Agriculture and Biodiversity Research. 2013;2(7):137143. Available:http:/www.onlineresearchjournals.org/JARB16
7. Bathi IH, Ahmad OR, Nasir MS. Agronomic traits of sesame as affected by grain legume intercropping and planting pattern. Pakistan Journal of Agricultural Sciences. 2013;42(1-2):56-60.
8. Bedousa CI, Justes EA. Commonly used indices for evaluating species interaction and intercrop efficiency. Application to durum wheat-winter pea intercrops. Field Crops Research. 2011;124:25-366.
9. Vanasten PJ. Agronomic and economic benefits of coffee-banana intercropping in Uganda's small holders farming systems. Agricultural Systems. 2011;104:326-334.
10. Mkamilo GS. Maize-sesame intercropping in Southeast Tanzania: Farmers' practices and perceptions and intercrop performance. PhD Thesis, Wageningen University, Netherlands; 2004.
11. Guede SRE, et al. Consórcios de caupi e milho emcutivo organic producao de graos e espigas verdes. Horticultural Brassilera, Brasilia. 2010;28(2):174-177.
12. PME. Project Monitoring and Evaluation Eepartment, Kwara State Agricultural Development, Weather Survey; 2014.
13. Mead R, Willey RW. The concept of land equivalent ratio and advantages in yield from intercropping. Experimental Agriculture. 1980;16:217-228.
14. Afe A, S. Atanda S. Percentage yield difference, an index for evaluating intercropping efficiency. American Journal of Experimental Agriculture. 2015;5(5): 459-465.
15. ASSISTAT. Silva F, Azevedo C. Principal components Analysistat in the Soft Ware Assistat Attendance in World Congress on Computers in Agriculture, 7, Reno-Nv-USA; American Society of Agricultural and Biological Engineers; 2009.
16. Udom GN, Fagam AS, Ekwere E. Effects of intra-row spacing and weeing frequency on the yield performance of sesame/cowpea intercropping. Emirates journals of food and agricultural sciences, Abu Dhabi. 2000;18(2):52-6010.
17. Araujo AC, Magali AIA, Apolino JN S, Walter EP, Jalade O. Relative planting times on the production components in sesame/ cowpea bean intercropping in organic system. Genetic Agrotec. 2013; 7(6):531-537.
18. Osman AK, Idris EM, Abdullah AK. Agronoic and economic evaluation of sesame and two cowpea varieties intercropped at different spatial arrangements. Food and Agriculture Organization of the United Nations. Sesame and Safflower Newsletter. 2006; 21-2006.

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