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Effects of Plant Spacing and Rate of Poultry Manure Application on Growth and Seed Yield of Sesame (*Sesamum indicum* L.)

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Abstract

Innovation of traditional system of crops constitutes an unavoidable solution to properly feed the rapidly growing populations in developing countries. Thus, a field trials were conducted during 2015 and 2016 at Gbokora (Daloa) to investigate the effect of plant spacing and rate of poultry manure application on growth, development and seed yield of sesame (*Sesamum indicum* L.). Treatments comprised two plants spacing (20 and 40 cm) and two rates of poultry manure (0 and 10 kg/m^2). The four treatment combinations were laid out in a randomized complete block design with three replications. Statistical analysis indicated that a wider spacing boosted significantly ($P < 0.05$) growth, seed yield and its components than a closer spacing. The fertilizing effect of poultry manure was superior to that of no fertilizer. However, interaction between plant spacing and rate of poultry manure indicates that the best value of seed yield and its components were produced on plot with 10 kg of poultry manure and wider space.

Key words: Sesame, plant spacing, poultry manure, food security

1. Introduction

To properly feed the rapidly growing populations in developing countries, the agricultural policy of governments should be directed towards innovation of the old agricultural practice. According to the work of Baudoin (2001) the maintenance of traditional farming systems is one of the causes of the decline in crop production in Sub-Saharan Africa. To this is added the priority given to cash crops to the detriment of food crops. This is the case of sesame. Sesame (*Sesamum indicum* L.) belongs to the family *pedaliaceae* and is one of the most ancient oil crops in the world (Nadeem et al., 2015). It is grown in both tropical and sub-tropical regions of Africa, Asia and Latin America. In Ivory Coast, its production is essential focused in the western area. The sesame plant is about 60 to 120 cm in height and the fruit is a dehiscent capsule held close to stem and when ripe, the capsule shatters to release a number of small seeds which are protected by a fibrous hull or skin, which may be whitish to brown (Agele et al., 2015). The average grain yield per hectare has been reported to be relatively low in most producing Africa countries between 300-350 kg/ha (Saha and Bhargava, 1980; Schilling and Cattan, 1991). This low productivity has discouraged growers thereby reducing the total area under sesame cultivation. Among factors responsible for the low yield are the poor fertility of soils and improper crop spacing. Proper inter row and intra row spacing is one of the important components in intensive farming system (Kanton et al., 2013). The space available for individual plant growing in a community affects the yield and quality of produce. Due to proper space plants can receive sufficient sun light, water and other necessary nutrients from the soil which enhance the yield of the sesame (Madisa et al., 2015). Ngala et al. (2013) 2013 reported that 75 cm row spacing produced the higher seed yield as compared with 25 cm and 50 cm row spacing. Wider row spacing showed more potential for high seed yield as compared to narrow row spacing. Very narrow row spacing increases the site-specific compactions between the plants resulting a lower grain yield.

Also nutrient management has constituted an important aspect of improved farm practices developed to attain high yields and quality in all crops to meet the demand of an ever-increasing human population (Haruna, 2011; Jakusko and Usman, 2013). 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. Poultry manure has long been recognized and used as manure in crop production. It improves soil fertility by adding both major and essential nutrients as well as soil organic matter which improve moisture and nutrient retention (Ogbonna and Umar-Shaba, 2012; Okonmah, 2012). Poultry manure application has been reported to promote sesame yield (Ogbonna and Umar-Shaba, 2012; Amanullah et al., 2014).

In Ivory Coast, work on the effects of crop spacing and organic manure on the growth and yield of sesame is not available. The objectives of this study, therefore, were to investigate the effects of plant spacing and poultry manure on seed yield and yield components of sesame.

2. Materials and methods

2.1. Study site

Field experiments were conducted in 2015 and 2016 at Gbokora (Daloa) (latitude: 06^{o} 53´ 58´´ N and longitude: 06^{o} 26´ 32´´W) (Ivory Coast). This site is characterized by two rainy seasons separated by a short dry period (from mid-July to mid-September) and a long dry season (December-March). Annual rainfall varies from 1000 to 1500 mm. The zone receives abundant sunshine with an annual maximum mean temperature ranging between 21–and 35^{o}C. Its vegetation is largely constituted by the dense forest. The soil in the experimental area is classified as ferallitic well drained sandy loam (Koffi et al., 2014; Morel, 2014).

2.2. Plant material and experimental design

The seed of sesame was obtained at the market of Gohitafla (Ivory Coast). The sowing was done according to two row spacing (40 x 40 cm (S1) and 20 x 20 cm (S2)). In order to improve the growth and seed yield of the crop a poultry manure (PM)] was applied. In that respect, two treatments (T0 and T1) were considered: T0 (Control): no fertilizer, T1: 10 kg of poultry manure (PM). Thus, the experimental design consisted of three complete randomized blocks. Each block was composed of four plots representing, each treatment. To ensure proper stand, five seeds per hole were sown directly and thinned to one plant per hole at the two-leaf stage. All plants per treatment including control were studied. No irrigation was applied during the trials. Weeds were manually controlled, but the insecticide (Cypercal EC 50) was used to protect the crop against insects identified in the locality.

2.3. Data collections and statistical analysis

Three growth parameters (plant height (PLG), stem girth (SG) and number of branches (NB)) and 6 yield parameters (number of branches with capsule (NBC), number of capsule per plant (NCP), weight of capsule per plant (WC), number of seed per plant (NS), weight of seed per plant (WS) and seed yield (SY)) were measured in 2015 and 2016, from sowing in 14 March to harvesting in 18 June. Significant effect of plant spacing and poultry manure were tested by MANOVA. When a significant effect is detected for a factor, each parameter was examined by using the SAS statistical package. In case of a significant difference the Least Significant Difference (LSD) multiple range-tests were used to identify the means which differed.

3. Results

3.1. Effect of plant spacing on growth and seed yield of sesame

Data in **table 1** shows that seven parameters tested were influenced by plant spacing. The highest values of plant height, number of branches with capsules, number of capsules, weight of capsule, weight of seeds, number of seeds and seed yield were obtained with wider spacing. Those of numbers of branches and plant girth were not boosted by plant spacing.

3.2. Effect of poultry manure on growth and seed yield of sesame

Seed yield and its eight components (plant height, number of branches, plant girth, number of branches with capsules, number of capsules per plant, weight of capsules per plant, number of seeds per plant, weight of seeds per plant) studied were significantly boosted by poultry manure at $P = 0.05$. The highest value of each of these parameters was recorded on plants having grown on soil supplemented with poultry manure (PM) (**Table 2**).

3.3. Effect of interaction between plant spacing and poultry manure growth and poultry manure of sesame

Interaction between plant spacing and poultry manure indicated that seed yield and its components tested were significantly affected at p= 0.05. The highest values of those parameters were recorded on plots containing poultry manure with a wider spacing (40 cm) (**Table 3**).

Table 1. Effect of plant spacing on growth and seed yield of sesame

Plant spacing	PLH (m)	GS (mm)	NB	NBC	NC	WC (g)	NS	WS (g)	SY (t/ha)
Wider	1,451±0,147a*	13,176±4,059a	4,119±1,902a	3,214±1,457a	38,309±25,371a	12,742±8,490a	2110,190±2069,893a	6,148±5,906a	1,803±3,789a
Narrow	1,376±0,214b	12,804±2,103a	4,222±1,475a	2,416±1,461b	20,166±18,089b	5,867±4,944b	1122,000 ±1321,401b	2,356±1,664b	0,524±0,915b
F	7.8	0,175	1,962	3,469	9,923	12,350	11,384	16,990	7,729
P	0.000	0,839	0,145	0,034	0,000	0,000	0,000	0,000	0,000

*For a given parameter, values followed by the same letter(s) were not significantly different at *P* = 0.05, on the basis of the Least Significant Difference (LSD) test , F = Fischer , PLH: Plant height, SG: stem girth NB: number of branches, NBC: number of branches with capsule, NC: number of capsule per plant, WC: weight of capsule per plant, NS: number of seed per plant, WS: weight of seed per plant (WS), SY: seed yield.

Table 2. Effect of poultry manure on growth and seed yield of sesame

Fertilizer	PLH (m)	GS (mm)	NB	NBC	NC	WC (g)	NS	WS (g)	SY (t/ha)
Poultry Manure	1,534±0,145a*	14,414±3,204a	4,360±1,751a	3,278±1,582a	42,836±26,064a	11,316±9,358a	2471,541±2181,820a	5,315±5,697a	2,068±3,753a
Control	1,335±0,172b	11,358±1,956b	3,527±1,385b	2,290±1,133b	17,527±11,145b	5,532±3,321b	1375,236±839,094b	2,416±1,313b	0,374±0,348b
F	60.41	36,126	6,974	15,126	52,602	53,839	54,138	53,793	32,740
P	0.000	0,000	0,009	0,000	0,000	0,000	0,000	0,000	0,000

*For a given parameter, values followed by the same letter(s) were not significantly different at *P* = 0.05, on the basis of the Least Significant Difference (LSD) test , F = Fischer , PLH: Plant height, SG: stem girth NB: number of branches, NBC: number of branches with capsule, NC: number of capsule per plant, WC: weight of capsule per plant, NS: number of seed per plant, WS: weight of seed per plant (WS), SY: seed yield.

Table 3. Effect of interaction between plant spacing and poultry manure growth and seed yield of sesame

Interaction	PLH (m)	GS (mm)	NB	NBC	NC	WC (g)	NS	WS (g)	SY (t/ha)
Poultry X Wider	1,497±0,131 a*	15,223±4,39 6a	4,954±2,10 3a	3,909±1,47 7a	53,909±25,832 a	17,857±8,74 5a	3384,455 ±2107,14 0a	8,854±6,016a	2,894±4,278a
Poultry X Narrow	1,527±0,100 a	13,512±2,03 1b	4,200±1,32 1ab	2,800±1,43 6b	30,900±17,773 b	8,652±4,976 b	2286,600 ±1315,21 2b	3,090±1,777b	0,871±1,118b
Control X Wider	1,400±0,151 b	10,925±2,00 1d	3,200±1,10 5b	2,450±0,99 8bc	21,150±7,734b c	7,117±2,722 b	1708,500 ±624,275 bc	3,071±1,367b	0,503±0,351c
Control X Narrow	1,188±0,162 c	11,919±1,89 5bc	4,250±1,69 3ab	1,937±1,38 8c	6,750±4,219c	2,386±1,555 c	566,250± 359,635c	1,440±0,921c	0,091±0,092cd
F	6.81	3,472	3,441	4,995	4,224	4,213	5,028	7,207	5,080
P	0.001	0,049	0,035	0,037	0,029	0,030	0,003	0,001	0,007

*For a given parameter, values followed by the same letter(s) were not significantly different at *P* = 0.05, on the basis of the Least Significant Difference (LSD) test , F = Fischer , PLH: Plant height, SG: stem girth NB: number of branches, NBC: number of branches with capsule, NC: number of capsule per plant, WC: weight of capsule per plant, NS: number of seed per plant, WS: weight of seed per plant (WS), SY: seed yield.

4. Discussion

The current study shows the plots supplemented with poultry manure recorded the best values of seed yield and its components. This result indicates the useful of fertilizer application mainly organic fertilizer to promote sesame production. According to Amanullah (2007) poultry manure contains all the essential plant nutrients that are used by plants. In this case, the applied poultry manure increased both major and minor nutrient elements as well as organic matter content in the soil could be explained increasing of sesame production. Manure apart from supplying plant nutrient elements to the soil also improves the soil physical and chemical properties and provides better environment for root development and aeration (Mbagwu and Ekwealor, 1990). The crop positive response to poultry manure application agrees with the earlier findings of Ogbonna (2012) and Shiyam (2013).

The result also showed that the widely spaced plants produced better value of seed yield and its components than those at closer spacing. These results are in agreement with (Ngala et al., 2013) who reported that wider row spacing showed more potential to realize high seed yield than the closest spacing. Increase in seed yield at wider row spacing may be due to larger space and growth resources available per individual plant, which enhanced growth and development. The decrease in seed yield at narrow spacing could have resulted from the higher inter and intra plant competition for growth resources.

The interaction between poultry manure and plant spacing indicates that the best values of seed yield and its components were produced on plot with poultry manure and wider space. This result could be attributed to available nutrients at vegetative and reproductive stages which lead to more branches per plants under widely space. Earlier study has shown that plant height and number of branches/plant have significant direct positive correlation with seed yield in sesame (Parameshwarappa, 2009).

5. Conclusion

The current study indicated the importance to improve the traditional system of crop in to feed properly the increasing population in developing countries. Thus to boost the production of sesame, farmers must sow this crop by respecting a wider spacing (40 cm) with an application of 10 kg per m^2 of poultry manure.

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