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Contribution of plant spacing and N fertilizer application to growth and Yield of Sesame (Sesamum indicum L.)

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Abstract

Field trials on sesame were conducted at the Manga Agricultural Research Station during the 2009 and 2010 cropping seasons to determine the optimal rate of nitrogen fertilizer and intra-row spacing for sesame production. Consistently, intra-row spacing of 30 and 40cm produced the best results in both seasons in terms of grain yield. Sesame grain yield increased significantly with increase in the rate of nitrogen fertilization, implying that sesame yields could be boosted through an increase in nitrogen fertilizer application. Marginal insignificant yield response was observed with increased nitrogen level attaining the peak at 80kgN/ha. Main effects of nitrogen rates and intra-row spacing significantly ($P \leqslant 0.001$) affected most of the traits evaluated more than the interaction effects. Plant spacing of 75cm x 30cm at N application of 80kgN/ha recorded the highest grain yield (273kg/ha) in 2009 while 75cm x 30cm at 0kgN/ha (control) recorded the least grain yield (60kg/ha) in 2010. Even though there was no significant interaction effect on plant population, the interaction effects of 20 cm and 30cm at 80kg N/ha produced the highest plant populations of 6.9 and 7.1 respectively. Sesame plant height was significantly ($P \leqslant 0.001$) influenced by N application with plant height increasing with increase in N rate, attaining a maximum height of 142cm at 60kgN/ha. Even though there was no significant interaction effect on plant population, the interaction effects of 20 cm and 30cm at 80kg N/ha produced the highest plant populations of 6.9 and 7.1 respectively. Sesame plant height was significantly ($P \leqslant 0.001$) influenced by N application with plant height increasing with increase in N rate, attaining a maximum height of 142cm at 60kgN/ha in 2009.

INTRODUCTION

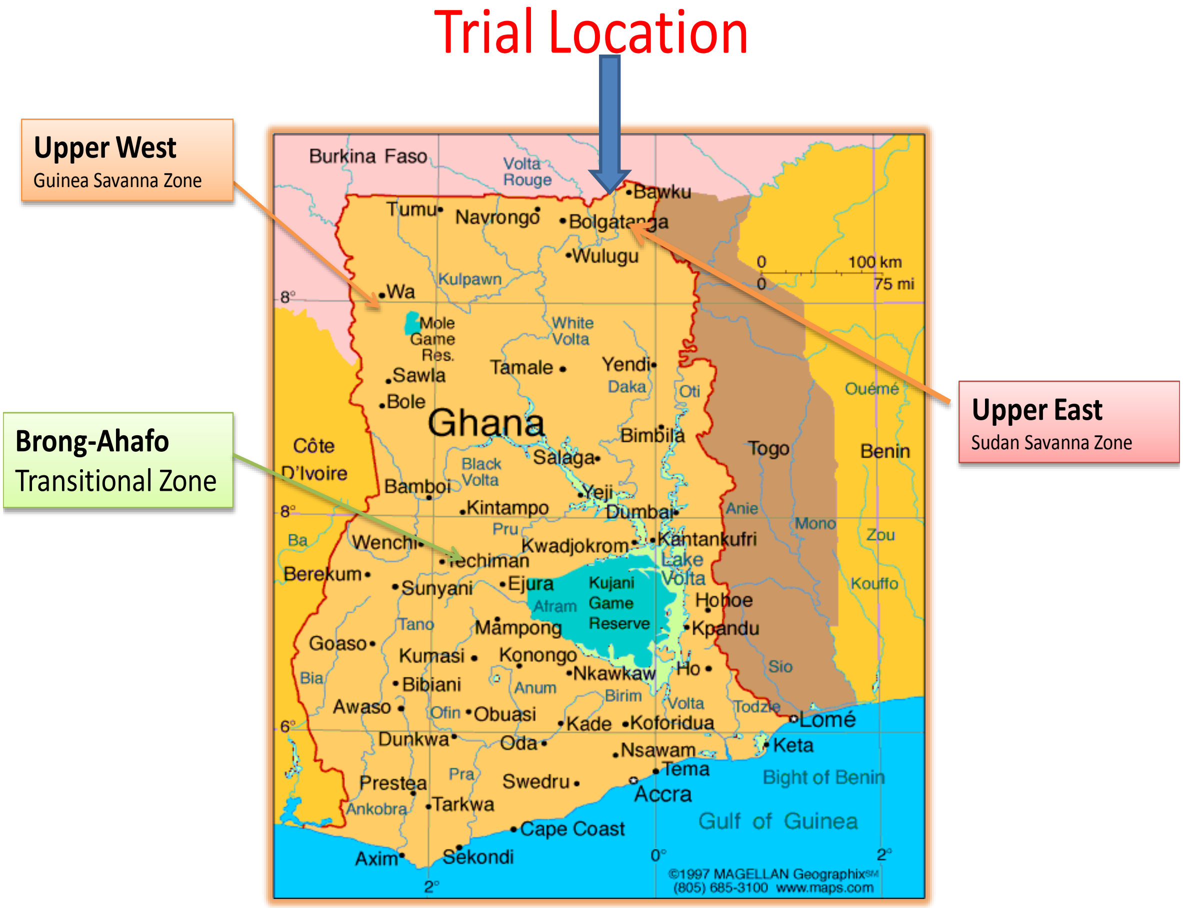
Sesame (*Sesamum indicum* L.) is one of the oldest spice and oilseed crop in the world. Its seeds contain approximately 50% oil and 25% protein (Burden, 2005). The presence of some antioxidants (sesamum, sesamolin and sesamol) makes the oil to be one of the most stable vegetable oils in the world. The oil contains mainly unsaturated fatty acids (oleic and linoleic of about 40% each) and 14% saturated acids. Sesame seed contains 17-19% protein and 16-18% carbohydrate (Ustimenko-Bakumovsky, 1983). It contains no linolenic acids and thus useful for industrial purposes such as medicinal drug and perfume production. The world production is estimated at 3.66 million tonnes with Africa producing only 0.95 million tons (Anon, 2008). Reasons cited for the low yields include inadequate agricultural inputs such as improved varieties, fertilizers and other agro-chemicals (Ashri, 1994, 1998; Weiss, 2000; Uzun and Cagirgam, 2006) as well as poor agronomic practices. Significant seed losses during threshing are also cited as factors for the low production and productivity of the crop.

Earlier research in Nigeria on the crop by Weiss (1983), Ogunremi and Ogunbodede (1986) reported that the growth performance of sesame in terms of shoot characteristics such as plant height and type of branching, height to first capsule, number of branches per plant, internode length and number of nodes are largely variety specific. In Ghana, however, limited information exists on the growth and yield response of sesame to agronomic practices. This study was therefore conducted to determine the optimal rate of nitrogen fertilizer and plant spacing for sesame production.

Materials and Methods

The experiment was conducted at the Manga Agricultural Research Station near Bawku, in the Upper East Region (11^{o} 01' N, 00^{o} 16' W, 249 m above sea level) (Figure 1). The climate is characterised by one rainy season from May/June to September/October. The mean annual rainfall during this period is between 800 mm and 1100 mm. The rainfall is erratic spatially and in duration. There is a long spell of dry season from November to mid-February, characterised by cold dry

Figure 1: A location map of study area



and dusty harmattan winds. Temperatures during this period can be as low as 14 degrees centigrade during the daytime.

The field was a flat land and the soil is Plinthic Lixisol (FAO-UNESCO, 1988) classification and developed from granite. The soil is deep to moderate deep and well drained. The mean physical and chemical properties of the surface soil taken at a depth of 0-15 cm before sowing are presented in Table 1.

Field trials were conducted at the Manga Agricultural Research Station during the 2009 and 2010 cropping seasons. Using the randomized complete block design (RCBD) with 4 replications, the 2 factors studied (rate of nitrogen and intra-row spacing) were factorially combined in a plot dimension of 6 ridges each measuring 0.75 m apart and 5 m long. Seeds of the sesame were brought from Burkina Faso by the Association of Church Development Projects (ACDEP) based in Tamale. The factors studied were different intra-row spacing (20cm, 30cm, 40cm, and 50cm each by a constant inter-row spacing of 75cm) and levels of nitrogen (0kg, 20kg, 40kg, 60kg, and 80kg) on the performance of Sesame. A fixed inter-row spacing of 75cm was maintained since that was the predominant practice of the farmers within the study area.

The trial fields were harrowed and ridged and sesame seeds sown manually using 3 to 4 seeds per hill. Two weeks after sowing, seedlings were thinned to 2 plants per hill followed by the basal application of fertilizer. At the various rates of nutrients under study, full rate of P-fertilizer as single superphosphate, K-fertilizer as muriate of potash and half rate of N-fertilizer as sulphate of ammonia were applied. The remaining half of N-fertilizer was applied as a top-dress in the form of Sulphate of ammonia at exactly 4 WAS. Each fertilizer application was preceded by weeding so as to reduce the effect of weed competition.

On plot basis, 5 plants were selected at random and tagged from the middle rows for the purpose of agronomic data collection. The parameters were stand count, plant height, number of capsules per plant, mean capsule weight, grain yield and biomass yield. The data were subjected to analysis of variance using the GenStat Statistical program (GenStat Discovery Edition 3, version 7.2.0.220), after which means resulting from significant treatment effects were separated using the least significance test by Steel and Torrie (1980). The co-efficient of variation (CV) was chosen as a stability

Table 1. Some physical and chemical properties of the surface (0-15 cm) soil at the experimental site at Manga Agricultural Research Station 2009.

Soil physical and chemical properties	Experimental site at Manga
Sand (%)	80.4
Silt (%)	16
Clay (%)	3.6
Soil texture	Loamy sand
Soil Ph	4.64
Organic Carbon (%)	0.35
Total nitrogen (%)	0.06
Available P (mg kg^{-1})	13.58
Exchangeable cations cmol (+) kg^{-1})	
Ca	0.07
Mg	0.05
K	65.70
CEC [cmol (+) kg^{-1}]	3.28

Table 2**:** Mean grain yield (kg/ha) of sesame as affected by N rate (kg/ha) and intra-row spacing (cm) during the 2009 and 2010 cropping seasons

N application rate (kg/ha)	Grain yield (kg/ha)	
	2009	2010
0	97	165
20	168	62
40	213	229
60	231	269
80	255	259
Lsd (5%)	42	50
CV %	40.8	41
Intra spacing (cm)		
20	185	179
30	195	218
40	205	196
50	187	195
Lsd (5%)	45	50.6
CV %	30	28

statistic that indicates the level of precision of the experiment.

Results

Main effects of nitrogen rates and intra-row spacing significantly (P≤0.001) affected most of the growth and yield parameters evaluated more than the interaction effects. Generally, mean grain yield in 2010 cropping season was higher than that of 2009. In 2009, grain yield increased with decreasing intra-row spacing possibly due to the crowding effect of plants grown under narrow to medium sized rows (intra-row spacing of 20-40cm). The yields in both seasons were significantly (P≤0.001) affected by N, with 60 kg N/ha accounting for the highest mean yield of 269kg/ha (in 2010) while the lowest yield of 60kg/ha was recorded under N rate of 0 kg N/ha in the same season (Table 2). In both cropping seasons grain yield increased with increase in N application with the highest mean yield occurring at N rate 60 kg N/ha and 30cm spacing. In 2009, the interaction effect of 75cm x 30cm spacing and 80kgN/ha N rate recorded the highest grain yield (273kg/ha) while 75cm x 50cm at 0kgN/ha (control) recorded the least grain yield of (80kg/ha).

The main effects of nitrogen rates and intra-row spacing significantly (P≤0.001) affected most of the traits evaluated more than the interaction effects (**Table 3)**. Mean plant population at harvest was significantly (P≤0.001) affected by intra-row spacing effect with the closer intra-row spacing treatments (20cm and 30cm) recording significantly higher plant population density compared to their wider intra-row (40cm and 50cm) counterparts. The interaction effects on the traits were not significant in most cases indicating that the effects of N and spacing on these traits were independent.

Generally, sesame plant height increased with increasing intra-row spacing in both cropping season. Mean plant height was significantly (P≤0.001) influenced by N application with the height increasing with increase in N rate, attaining a maximum height of 142cm at 60kgN/ha in 2009. In each cropping season, interaction of spacing and nitrogen level produced insignificant effect on the expression of plant height. However, Intra-row spacing of 20cm at 60kgN/ha accounted for the tallest plant (142cm) in 2009 whilst the shortest plant (87cm) was recorded by the control (0kgN/ha) at 20cm intra-row spacing in 2010 (**Table 4**).

Discussion

Sesame yields reported in 2010 cropping season were generally higher than those reported on in 2009. Nitrogen at the rate of 60 kg/ha produced the best yields in both seasons compared to the other rates, whereas 30 and 40 cm intra-row spacing consistently produced

Table 3. Mean plant population (10,000/ha) at harvest as affected by N rate (Kg/ha) and intra-row spacing (cm) during the 2009 and 2010 cropping seasons

N application rate (kg/ha)	Mean plant population(10,000/ha)	
	2009	2010
0	2.7	4.5
20	4.0	4.5
40	5.3	4.4
60	6.1	4.5
80	6.8	4.3
Lsd (5%)	0.6	0.8
CV %	18	25
Intra spacing (cm)		
20	4.9	6.0
30	5.1	4.6
40	4.4	3.8
50	4.7	3.5
Lsd (5%)	0.56	2.8
CV %	23	25

Table 4. Mean plant height (cm) of sesame as affected by N rate (Kg/ha) and intra-row spacing (cm) during the 2009 and 2010 cropping seasons

N application rate (kg/ha)	Mean plant population(10,000/ha)	
	2009	2010
0	108	94
20	129	126
40	129	122
60	131	123
80	136	122
Lsd (5%)	13.6	10.6
CV %	34	30
Intra spacing (cm)		
20	129	115
30	125	115
40	128	117
50	128	122
Lsd (5%)	11.4	8.6
CV %	25	20

the best results. Sesame yields in Africa are usually within the range of 200 to 300 kg/ha. Nitrogen fertilizer application significantly affected the performance of most of the parameters recorded in the present study. The low yields reported in the present study could be ascribed to the wider inter-row spacing (75cm) adopted compared to closer inter-row spacing as reported in the literature. Also sesame grain yield increased significantly with increase in the rate of nitrogen fertilization up to 40kg/ha, implying that sesame yields could be boosted through an increase in nitrogen fertilizer application. Marginal yield response was observed with increased nitrogen level attaining the peak at 80kgN/ha. This observation is consistent with reports by Olowe (2007) who suggested that sesame is a low N response crop. Earlier reports have shown that maximum grain yield of sesame was recorded on relatively low to medium levels of 30-60 kg /ha by Subramaniah *et al*. (1979) and Daulay and Singh (1982). Ashely (1993) reported optimum population for sesame to be at about 170 – 200, 000 plants /ha. However the findings of both 2009 and 2010 studies do not support the above assertion as there were no significant yield responses by sesame to the varied intra-row spacing used in these studies. The interaction effect of 75cm x 30cm spacing and 80kgN/ha N rate recording the highest grain yield (273kg/ha) and 75cm x 50cm at 0kgN/ha (control) recording the least grain yield of (80kg/ha) in 2009 is similar to study by Olowe and Busari (1994) in Nigeria, who reported that 60cm x 5cm and 60cm x 10cm were the appropriate plant spacing for sesame in southern Guinea savannah of Nigeria. In both cropping seasons, insignificant yield responses were observed with increasing levels of nitrogen attaining a peak at 80kgN/ha. This observation is consistent with reports by Olowe (2007) who suggested that sesame is a low N responsive crop. Earlier reports by Subramaniah et al. (1979) and Daulay and Singh (1982), on the contrary, have indicated that maximum grain yield of sesame was recorded on relatively low to medium levels of 30-60 kgN/ha.

Conclusion

In 2009, N rate of 40 kg/ha, 60 kg/ha and 80 kg/ha produced yields that were among the best whereas in 2010 N rate of 60 kg/ha gave superior results compared to the other rates. Similarly in 2009 intra row spacing of 40 cm gave the best yields whereas in 2010, 30 cm spacing recorded the best. Given the contrasting results regarding both N application and intra row spacing there is the need to carry out another trial in order to establish the optimal rate of nitrogen and Spacing. These results will therefore serve as very useful research information for further work on sesame improvement in the country which could leverage the current high levels of poverty in the country.

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