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Research Article

Effect of Inter-Row Spacing on the Yield Attributes Of Sesame (*Sesamum Indicum L.*) Varieties in Northern Part of Sokoto, Nigeria

Mohammed Bukar[1*] Professor Abba Gambo[2] and Ibrahim Baba Shehu[3]
[1]Desert Research Monitoring and Control Center, Yobe State University Damaturu Nigeria
[2]Dean Faculty of Agriculture, Yobe State University, Damaturu Nigeria
[3]Department of Crop Production, University of Maiduguri Nigeria

***Corresponding Author**
Mohammed Bukar
Email: muhbukar565@gmai.com

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Abstract: Field trials were conducted at Dry Land Teaching and Research Farm Usmanu Danfodiyo University Sokoto during the 2015 and 2016 raining seasons to study the Effect of Inter-row spacing on the yield attribute of sesame (Sesamum indicum L.) varieties in Northern part of Sokoto, Nigeria. The treatments consisted of four levels of inter-row spacing (40, 50, 60 and 70cm) and three sesame varieties (Ex-sudan, Gulbarga Local White and Tumkur Local Black). The treatments were arranged in a randomized complete block design (R.C.B.D.) replicated three times with factorial combinations of inter-row spacing and varieties. Results of the study indicated that inter-row spacing level of 60cm consistently recorded the highest results for all the characters studied except capsule length and harvest index where 70 and 50cm inter-row spacing respectively recorded the highest result. Similarly, the use of Gulbarga Local White and Ex-sudan varieties of sesame showed superiority among the treatments in all the yield parameters investigated. From the finding of this research, it could be concluded that Gulbarga Local White variety of sesame planted at 70cm inter-row spacing gave the highest seed yield compared to Ex-sudan and Tumkur Local Black under the same conditions.

Keywords: Inter-row spacing, sesame, treatments, varieties, yield.

INTRODUCTION

Sesame belongs to the family Pedaliaceae and is one of the oldest cultivated oilseed crops in the world (Purseglove 1974). The genus consists of about 36 species of which 19 are indigenous to Africa (Weis 1983; Uzo 1998). But only three species have been reported to be grown for different purpose in Nigeria namely *Sesamum alatum, S. indicum* and *S radiatum* (Dabir 2000). The most popular specie is *S. indicum* which has hundreds of varieties and strains with considerable variations in size, form, growth pattern, colour of flowers, seed size, seed colour and composition. The crop is one of the most ancient oilseed crop known and used by humankind mainly due to its ease of extraction, high stability, and resistance to drought (Iwo *et al.,* 2002). It is believed to have originated from tropical Africa (Alegbejo *et al*., 2003). However, India is generally held as the subcontinent where sesame was first domesticated and then spread to other places in the world such as Africa, the Far East, China and America along trade routes (Bedigian, 2004). The top five Sesame seed producing countries includes; Myanmar, India, China, Sudan and Tanzania with seed production analysis of 890,000, 636,000, 623,492, 562,000 and 420,000 metric tonnes respectively. The total world production of sesame in 2013 was 4,756,752 tonnes, of which Africa contributed 2,117,585 and Nigeria contributed 165,000 tonnes. The total area cultivated in 2013 for World and Africa were 9,398,770 ha and 4,741,100 ha with Nigeria cultivating about 340,000 ha. The average yields obtained from these hectares were 506.1 kg, 446.6 kg and 485.3 kg respectively (FAOSTAT, 2013).

Sesame (*Sesamum indicum L.*) has been recognized as a crop with a high economic potential in Nigeria, both as a source of raw materials for industries and a reliable foreign exchange earner (Alegbejo 2003; NCRI 2008). In Nigeria, Sesame is widely grown in the Middle Belt, Northern and Central Nigeria as a minor crop. It became a major cash crop in many Northern States like Benue, Kogi, Gombe, Jigawa, Kano, Nasarawa, Katsina, Plateau, Yobe and Federal Capital Territory (NAERLS, 2010).

Sesame seed contains approximately 50% oil and 25% protein and is used in baking, candy making, and in other food industries. Oil from the seed, which contain about 47% oleic and 39% linoliec acid, is used in cooking, salad and in making margarine. Sesame oil and food fried in sesame oil have long shelf life because the oil contains an antioxidant called sesamol. The oil can be used in the manufacture of soap, paints, perfumes, pharmaceuticals and insecticides. Sesame meal left after oil extraction is an excellent high protein (35 to 50% crude protein) feed for poultry and livestock (Oplinger 1990).

Due to the fact that, high commercial potentials of sesame in the Nation's economy and its high nutritional values, research on the crop remains significantly scanty in the study area. However, lack of using appropriate inter-row spacing and high yielding varieties by farmers more often than not lead to low seed yield and productivity of the crop. Seed yield of 69.93kg/ha

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and 318.6kg/ha were obtained in the year 2006 and 2007 respectively with an inter-row spacing of 25cm (Adam *et al*., 2013). Owing to these reasons, it is, therefore, important to devote time and resources to study the best ways to improve the yield performance of sesame regarding variety and inter-row spacing in Northern part of Sokoto, Nigeria.

MATERIALS AND METHOD

The experiments were conducted during the 2015 and 2016 cropping seasons at the Usmanu Danfodiyo University Teaching and Research Dryland Farm, (Latitude 13º 8' 10" N and Longitude 5º 13' 06" E) Sokoto. The annual rainfall of the area ranges between 600mm and 700mm, the temperature ranges between 17^0C and 40^0C with an Altitude of 271m above the sea level (SERC, 2015). The climate of the area is semi-arid, characterized by a long dry season with cold dry air during harmattan from November to February and hot dry air from March to May followed by short rainy season (Davis, 1983 cited in Sampson 2010).

The treatments consist of four different inter-row spacing (40cm, 50cm, 60cm and 70cm) and three sesame (*Sesamum indicum* L.) varieties (Gulbarga Local White, Tumkur Local Black and Ex-Sudan) making up to 12 treatment combinations. The treatments were factorially combined and laid out in a Randomised Complete Block Design with three (Alegbejo, M. D.,*et al*., 2003) replications. The treatments were randomly allocated to the plots using randomization technique. All the plots received the same Agronomic practices.

The experimental site was ploughed, harrowed, leveled and worked to fine tilt. The prepared land was then marked and sub divided into the required plots and replications in accordance with the layout of the experiment The gross plot size was 3.0m x 2.0m ($6m^2$), consisting of rows each measuring 2.0m in length with 20cm intra-row spacing within each row. The inter-row spacing of 40, 50, 60 and 70cm was used. Net plot size of 4.4, 4.0, 3.6 and $3.2m^2$ for treatments with 40, 50, 60 and 70cm inter-row spacing was used with 6, 4, 3 and 2 inner rows for each. However, 2 border rows for each were used for destructive sampling. The seeds were sown on the 4th July 2015 and 27th June 2016 for first and second trial respectively when soil moisture was adequate. A mixture of one part of sesame seed and two parts of river sand was planted manually at a shallow depth of about 1cm, by the dibbling method.

Yield attributes such as capsule length per plant, number seeds per plant, seed yield and harvest index were measured and recorded. The data generated were subjected to analysis of variance (ANOVA) using SAS (version 8.0) computer package. Means found to be statistically significant were compared using Dunkan's New Multiple Range Test (DNMRT).

RESULTS AND DISCUSSION

Capsule Length per Plant

Results on the capsule length of sesame as affected by Inter-row spacing and Variety during the 2015, 2016 rainy seasons and in the two seasons combined are presented in Table 1. Capsule Length was not significantly (P>0.05) affected by Inter-row spacing in 2015, 2016 seasons and when combined. From this result, it was observed that there is a perfect relationship between inter-row spacing and capsule length of sesame. This finding is in line with that of Jakusko *et al.,* (2013) where capsules were observed to be significantly taller with the value of 2.9cm on the inter-row spacing of 60cm.

Capsule length per plant of sesame was significantly (P<0.05) affected by variety during 2015, 2016 rainy seasons and in the years combined. In 2015 season, ex-Sudan significantly (P<0.05) had the longest capsule length though statistically similar with *Gulbarga local white* whereas, *Tumkur local black* had the shortest number. The longest capsule length obtained by ex-Sudan might have help it to intercept and convert more solar radiation through photosynthesis, that resulted in the increased capsule length of this variety compared to others. According to Nandita *et al*., (2009) highest length (3.26 cm) was recorded with inter-row spacing (45 cm) for an improved variety (BINA Til) whereas lowest capsule length (1.82 cm) was obtained with the spacing of 15 cm for Batiaghata local Til variety of sesame due to difference in the accumulation of photosynthetic assimilates. The interaction effect of spacing and variety on capsule length per plant of sesame during 2015, 2016 seasons and when the two seasons were combined are all not significant (P>0.05).

NUMBER OF SEEDS PER CAPSULE

Results on the number of seeds per capsule as affected by Inter-row spacing and Variety during 2015, 2016 rainy seasons and when the two seasons were combined are presented in Table 2. The number of seeds per capsule was significantly (P<0.05) affected by Inter-row spacing during the 2015 season and when combined, but it was not significant during 2016 season. In 2015 season, inter-row spacing of 20x40 cm significantly (P<0.05) had the highest number of seeds per capsule followed by 20x50 cm spacing which was statistically similar with 20x60 cm while 20x70 cm spacing had the lowest number. When the two seasons were combined, 20x40 cm spacing significantly (P<0.05) had the highest number of seeds per capsule though statistically the same with 20x60 cm spacing while 20x70 cm spacing had the lowest number of seeds per capsule. The high number of seeds per capsule obtained at 40 cm inter-row spacing may be due to higher number of harvestable capsules per unit area observed with sesame planted at narrow inter-row spacing (high population density) as compared to those at wider inter-row spacing (low population density). This could be attributed to the less competition for assimilate during seed development according to Nandita *et al*., (2009).

Number of seeds per capsule of sesame was significantly (P<0.05) affected by Variety during 2015, 2016 rainy seasons and in the years combined. In 2015 season, *Gulbarga local white* significantly (P<0.05) had the highest number of seeds per capsule though statistically similar with ex-Sudan while *Tumkur local black* had the lowest number. The same trend was observed in 2016 season and when the two seasons were combined. The interaction effect of spacing and variety on number of seeds per capsule of sesame during 2016 and when combined are all not significant (P>0.05), but significant (P<0.05) at 2015 season.

The interaction effect of spacing and variety on number of seeds per capsule during 2015 season is presented in Table 3. Spacing of 20x40cm in combination with *Gulbarga local white* significantly (P<0.05) had the highest number of seeds per capsule though statistically the same with the combination of *Gulbarga local white* with 20x70, 20x60 and 20x50cm spacing respectively. Similar trend was observed in the combination of ex-Sudan variety and all the spacing levels while lowest number was recorded by 20x70cm spacing in combination with *Tumkur local black*.

SEED YIELD

Results on seed yield of sesame as influenced by Inter-row spacing and Variety during 2015, 2016 rainy season and in the two years combined are presented in Table 4. Seed yield was not significantly (P>0.05) influenced by inter-row spacing during 2015 and 2016 trials and when combined. According to Adam *et al*., (2013) wider row spacing resulting to increasing seed yield may be due to larger space and growth resources available per individual plant. Similarly, sowing sesame at wider inter-row spacing of 45cm gave the best distance for seed yield per hectare according to Ahmad *et al*., (2006).

Seed yield of sesame was significantly (P<0.05) influenced by variety during 2015, 2016 rainy seasons and when combined. In 2015 season, significantly (P<0.05) heaviest seed yield was recorded with *Gulbarga local white* followed by ex-

Sudan while least seed yield was recorded with *Tumkur local black*. The same trend was observed when both seasons were combined (Table 4). In 2016 season, significantly heaviest seed yield was recorded with *Gulbarga local white* though statistically the same with ex-Sudan while least seed yield was recorded with *Tumkur local black*. According to Iwo *et al*., (2002) seed yield is directly determined by yield-related traits and is significantly influenced by both genetic and environmental factors. Differences between the varieties for these characters could have been due to genetic factors and the ability of the different varieties to respond to environmental conditions (Ehsanipour *et al.*, 2012). Therefore, the high yield of *Gulbarga local white* variety might be as a result of increased number of capsules and capsules yield which in turn leads to reduced competition between individual plants due to low plant population density at 70 cm inter-row spacing. In addition, this explains the high ability of *Gulbarga local white* variety to allocate photosynthetic assimilate to economic yield. The interactions of spacing and variety on the seed yield of sesame during 2015, 2016 seasons and in the two seasons combined were all not significant.

HARVEST INDEX

Results on the effect of Inter-row spacing and Variety on harvest index of sesame during the 2015, 2016 trials and when combined are presented in Table 5. Harvest index was significantly ($P<0.05$) influenced by inter-row spacing only during the 2015 trial, but it was not significant ($P>0.05$) during 2016 trial and when the two seasons were combined. In 2015 trial, 20x70 cm spacing significantly ($P<0.05$) had the highest harvest index whereas 20x40 cm spacing had the lowest number.

Harvest index of sesame was significantly ($P<0.05$) influenced by variety during 2015, 2016 seasons and when combined. Ex-Sudan significantly ($P<0.05$) had the highest harvest index while *Tumkur local black* had the lowest number. The same trend was observed when the two seasons were combined. In 2016 season, ex-Sudan significantly ($P<0.05$) had the highest harvest index though statistically the same with *Gulbarga local white* while *Tumkur local black* had the lowest number. The interaction of spacing and varieties on harvest index of sesame was significant ($P<0.05$) only during the 2015 season, but it was not significant during 2016 season and when combined.

The interaction effect of spacing and variety on harvest index of sesame during the 2015 season is presented in Table 6. Ex-Sudan in combination with 20x50 cm spacing had the highest harvest index whereas *Tumkur Local Black* in combination with 20x50 cm spacing had the lowest harvest index.

CONCLUSION

From the finding of this research, it could be concluded that Gulbarga Local White variety of sesame planted at 60cm inter-row spacing gave the highest seed yield compared to Ex-sudan and Tumkur Local Black under the same conditions. It is therefore suggested as the best practice. However more research work needs to be conducted with other varieties of sesame having higher and or lower levels of Inter-row spacing to substantiate whether the increase and or decrease in levels of inter-row spacing could result in further increase in yield and yield attributes of sesame varieties in the study location or otherwise.

RECOMMENDATION

From the finding of this research, it therefore recommended that Gulbarga Local White variety of sesame planted at 60cm inter-row spacing gave the highest seed yield compared to Ex-sudan and Tumkur Local Black under the same conditions. It is therefore the best practice.

Table 1: Effect of inter-row spacing and variety on capsule length (cm) per plant of sesame during 2015 and 2016 rainy seasons and when combined at Dryland Teaching and Research Farm U.D.U.S.

Treatment	2015	2016	Combined
Spacing (cm)			
20 x 40	1.90	2.77	2.33
20 x 50	2.26	2.78	2.52
20 x 60	2.34	2.73	2.54
20 x 70	1.99	2.78	2.38
SE±	0.201	0.026	0.101
Significant	NS	NS	NS
Variety			
ex-Sudan	2.88[a]	2.88[a]	2.88[a]
Tumkur Local Black	0.78[b]	2.52[b]	1.65[b]
Gulbarga Local White	2.71[a]	2.89[a]	2.80[a]
SE±	0.174	0.023	0.087
Significant	*	*	*
Interaction			
S x V	NS	NS	NS

Means within a column followed by the same letter are statistically not significant at 5% level of probability using dmrt
* = significant only at 5%, ns = not significant at 5%,
s = spacing and v = variety

Table 2: Effect of inter-row spacing and variety on the number of seeds per capsule of sesame during the 2015 and 2016 rainy seasons at Dryland Teaching and Research Farm U.D.U.S.

Treatment	2015	2016	Combined
Spacing (cm)			
20 x 40	57.00[a]	60.00	58.00[a]
20 x 50	52.00[ab]	56.00	54.00[ab]
20 x 60	49.00[ab]	61.00	55.00[a]
20 x 70	44.00[b]	61.00	52.00[b]
SE±	3.225	1.825	1.989
Significant	*	NS	*
Variety			
ex-Sudan	63.00[a]	61.00[a]	62.00[a]
Tumkur Local Black	23.00[b]	54.00[b]	38.00[b]
Gulbarga Local White	64.00[a]	63.00[a]	64.00[a]
SE±	2.793	1.581	1.723
Significant	*	*	*
Interaction			
S x V	*	NS	NS

Means within a column followed by the same letters are statistically not significant at 5% level of probability using DMRT
***** = Significant only at 5%, NS = Not significant at 5%,
S = Spacing and V = Variety

Table 3: Interaction of spacing and variety on the number of seeds per capsule of sesame during 2015 rainy season at Dryland Teaching and Research Farm U.D.U.S

	ex- Sudan	Varieties *Tumkur local black*	*Gulbarga local white*
Spacing (cm)			
20 x 40	65.00[a]	38.00[b]	67.00[a]
20 x 50	62.00[a]	29.00[b]	63.00[a]
20 x 60	62.00[a]	26.00[b]	59.00[a]
20 x 70	65.00[a]	0.00[c]	66.00[a]
S.E ±		5.585	

Means within a column followed by the same letter are statistically not significant at 5%level of probability using Duncan New Multiple Range Test (DMRT)

Table 4: Effect of inter-row spacing and variety on the seed yield (t ha^{-1}) of sesame during the 2015 and 2016 rainy seasons and when combined at Dryland Teaching and Research Farm Usmanu Danfodiyo University, Sokoto

Treatment	2015	2016	Combined
Spacing (cm)			
20 x 40	0.338	0.388	0.363
20 x 50	0.319	0.342	0.330
20 x 60	0.367	0.398	0.383
20 x 70	0.341	0.407	0.374
SE±	0.0226	0.0464	0.0253
Significant	NS	NS	NS
Variety			
ex-Sudan	0.432^{b}	0.432^{a}	0.432^{b}
Tumkur local black	0.24^{c}	0.258^{b}	0.141^{c}
Gulbarga local white	0.568^{a}	0.462^{a}	0.515^{a}
SE±	0.0195	0.0402	0.0219
Significant	*	*	*
Interaction			
S x V	NS	NS	NS

Means within a column followed by the same letter are statistically not significant at 5% level of probability using Duncan's New Multiple Range Test (DMRT), * = Significant only at 5%,
NS = Not significant at 5%, S = Spacing and V = Variety

Table 5: Effect of inter-row spacing and variety on Harvest index of sesame during the 2015 and 2016 rainy seasons and when combined at Dryland Teaching and Research Farm U.D.U.S

Treatment	2015	2016	Combined
Spacing (cm)			
20 x 40	8.44^{b}	13.33	10.88
20 x 50	8.95^{b}	18.83	13.89
20 x 60	9.61^{ab}	13.53	11.57
20 x 70	11.19^{a}	14.06	12.62
SE±	0.701	3.218	1.655
Significant	*	NS	NS
Variety			
ex-Sudan	18.35^{a}	22.12^{a}	20.23^{a}
Tumkur Local Black	0.51^{c}	4.93^{b}	2.72^{c}
Gulbarga Local White	9.78^{b}	17.76^{a}	13.77^{b}
SE±	0.607	2.786	1.433
Significant	*	*	*
Interaction			
S x V	*	NS	NS

Means within a column followed by the same letter are statistically not significant at 5% level of probability using DMRT
* = Significant only at 5%, NS = Not significant at 5%,
S = Spacing and V = Variety

Table 6: Interaction of spacing and variety on the Harvest index of sesame during the 2015 rainy season at Dryland Teaching and Research Farm U.D.U.S

	ex- sudan	Varieties *Tumkur local black*	*Gulbarga local white*
Spacing (cm)			
20 x 40	14.28^{b}	0.84^{d}	10.20^{c}
20 x 50	18.88^{a}	0.11^{d}	7.85^{c}
20 x 60	18.43^{a}	0.74^{d}	9.66^{c}
20 x 70	21.82^{a}	0.34^{d}	11.40^{bc}
S.E ±		1.214	

Means within a column followed by the same letter(s) are statistically not significant at 5% level of probability using DMRT

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