HP
Hummingbird Publications
Journal of Agriculture & Agricultural Technology
www.hummingpubng.com
JAAT 2019
© December, 2019
Vol. 19 No. 1

Analysis of the Factorial Effects of Variety and Spacing on the Yield of Sesame Seed (Sesamum Indicum) Using Split-Plot Design

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Keyword: *Split-Plot Design, ANOVA, Factor, Spacing, Variety.*

Abstract

Field trial was carried out in the rainy season of 2018 to study the effect of Variety and Spacing on the yield of Sesame Seed in the Federal Polytechnic Damaturu, Nigeria. A split-plot design was used with Variety as the main plot Factor and Spacing as the subplot Factor. The experiments consisted of four levels of Variety (NCRIBEN 01M, NCRIBEN 02M, NCRIBEN 04E, NCRIBEN 05E) and four levels of Spacing (10cm, 15cm, 20cm and 25cm). The Data obtained from this Experiment was analysed using the Analysis of Variance (ANOVA) Technique. The result of the analysis shows that Spacing had a significant effect on the yield of Sesame Seed (kilogram per hectare) with 10cm and 15cm intra row Spacing giving higher yield than 20cm and 25cm (with 65cm inter row spacing). However, the effect of spacing on 1000 grain weight, yield per plant, capsule length, number of capsules per plant, number of seeds per capsule was not significant; also Variety and interaction between Spacing and Variety had no significant effects on the yield of the Crop. Furthermore, this research had shown that the higher yield, in kilogram

per hectare, observed for low level of spacing was due to the relatively higher population of plant on the plots where the spacing was low.

Introduction

The name Sesame is used in literature worldwide. It is also known as "simsim" in East Africa, "Till" in India and "Gingely" in Sri-Lanka. The Hausa, Ibo, Yoruba, major tribes of Nigeria call it "Ridi", "Ekuku" and "Isasa", respectively. Other tribes in Nigeria also have names for it. (Abu,*et al* ,2012).

The plant is widely cultivated for its seeds. The oil extracted from sesame seeds is used in cooking, as salad oil, and in making margarine. The plants are highly tolerant to drought and grown as annuals from seed, reaching maturity in three to five months. The plants are cut and dried; as they dry, the seed capsules split open, and the seeds are easily extracted by shaking the plants upside down.

The increased sesame production in Nigeria was not witnessed by yield increase but by corresponding increase in the land area used for cultivation of sesame crop. (Umar, *et al.* 2014). The seeds serve as ingredients in soup and a source of oil (Biswas *et al.*, 2001) and the cake after oil extraction is used in livestock feed. It is also used in local preparation of weaning food (Lalude and Fashakin, 2006). Sesame is grown mainly for its seeds that contain approximately 50% oil and 25% protein (Burden, 2005). The presence of some antioxidants (sesamum, sesamolin, and sesamol) makes the oil one of the most stable vegetable oils in the world. The seeds are used as raw food as well as in confectioneries, sweets, bakery products and the oil is used in the industry for the preparation of soap, perfume, and carbon papers as well as in vegetable oil (Khan *et al*., 2001). The seed contains all the essential amino acids and fatty acids and it is a good source of vitamins (pantothenic acid and vitamin E) and minerals such as calcium (1450 mg/100g) and phosphorous (570 mg/100g) (Balasubramaniyan and Palaniappan, 2001),in Umar,et al (2014)

The crop is in high demand worldwide with Japan and China being the largest importers. A total of 4.8 million metric tonnes of Sesame seed is produced

yearly, the world over. Nigeria is one of the largest producers of the seed in Africa, producing over 300,000 metric tonnes annually (www.agronigeria.com.ng/sesame-seed/). The plant thrives well in the northern and western part of Nigeria due to its drought resistance. Presently, about 26 states in Nigeria produce Sesame. If one travels across the states where the seed is being produced, it is easy to notice that the Sesame plant is taking over parts of the fields that were being used for the production of millet, groundnuts and other crops that are produced in the area. This can be attributed to the good price and high demand for the seed. Within the last two seasons, the price of the commodity rose from N160,000/tonne to its present level of N300,000/tonne (www.agronigeria.com.ng/sesame-seed/).

For efficient breeding and crop improvement, it is of utmost importance in any crop plant to ascertain the contribution of each yield related trait to yield and to select components maximizing yield (Ashkani et al., 2007 ; Chowdhury et al., 2010). This study is one of such efforts to study the relationship between Factors like Variety/Spacing and the seed yield per unit area in Sesame Seed.

AIMS AND OBJECTIVES

The aims and objectives of this study are as follows:

I. To determine the effect of Variety on the yield of Sesame Seed;
II. To determine the effect of Spacing on the yield of Sesame Seed and
III. To determine the interaction effect between Variety and Spacing on the yield of the crop.

MATERIAL AND METHOD

The Data for this Study is from a Split-Plot Experiment conducted in the Federal Polytechnic Damaturu, Nigeria in the 2018 wet season with Variety as the main plot Factor and Spacing as the subplot Factor. The levels of the two Factors were:

Variety: four levels (NCRIBEN 01M, NCRIBEN 02M, NCRIBEN 04E (Ex-Sudan), NCRIBEN 05E (Kenana 4)).

Spacing: four levels (10cm, 15cm, 20cm and 25cm).

The seeds were obtained from the National Cereal Research Institute (NCRI) Badeggi, Niger State. The initial, NCRI, in the names of the Varieties is from

the name of the Research Institute; while BEN stands for Beniseed which is another name for Sesame seeds.

The sixteen treatment combinations were applied to the plots according to a split-plot design with the varieties assigned to the main plots and spacing to the subplots. The experimental area was sprayed with Dragon herbicide (Paraquat Dichloride 276Gm/Ltr) after which it was cleared and ploughed a few days later. The field was then marked in to plots and replicates. The size of each main plot was $56m^2$(7mx8m) and each subplot was $14m^2$ (7mx2m). Each subplot had 3 rows 65cm apart (between rows). The main plots were separated by 1m and the replicates by 2m.

Planting was done on 14th, July, 2018. The main plot factor (variety) was applied at random to the main plots of every replication and the subplot factor (spacing) was randomly allocated to the subplots of each main plot. About 10 seeds were planted in each hole, intra row in each subplot according to the spacing that was randomly allocated to that subplot. Hoe weeding and thinning (3 plants per hole) was done 4 weeks after sowing. The fertilizer, NPK (20:10:10) was applied seven weeks after sowing at the rate of 80Kg/Ha to all the plots.

Harvesting was done 13 weeks after sowing and allowed to dry in bags for two weeks before extracting the seeds from the pods by shaking the stem upside down. Seeds from each subplot were packaged separately and marked before taking it to the Laboratory for weighing. The yield attributes that were measured at harvest were: 1000 grain weight, grain weight per plant, capsule length, number of capsules per plant, number of seeds per capsule and grain yield per hectare.

RESULTS PRESENTATION AND DISCUSSION

The effect of variety on the yield of sesame seeds

Variety had no effect on the yield of sesame seeds at 5% level of significance (i.e. $P>0.05$). Any observable difference in yield among the different Varieties is attributable to random variation. This trend was consistent for 1000 grain weight, grain weight per plant, capsule length, number of capsules per plant, number of seeds per capsule and yield per hectare.

Table 1: Efffect of variety on 1000 grain weight, grain weight per plant, capsule length, number of capsules per plant, number of seeds per capsule and yield per hectare.

	VARIETY	1000 SEED WEIGHT (G)	YIELD PER PLANT (G)	YIELD (KG/HA)	CAPSULE LENGTH (CM)	NUMBER OF CAPSULES	NUMBER OF SEEDS PER CAPSULE
1	NCRIBEN 01M	2.77	6.92	624.47	2.48	92.3	54.5
2	NCRIBEN 02M	2.72	5.84	556.26	2.50	91.5	50.17
3	NCRIBEN 04E (EX-SUDAN)	2.74	6.73	625.86	2.57	82.8	53.58
4	NCRIBEN 05E (KENANA 4)	2.72	5.29	469.14	2.44	83.7	57.17
ANOVA (F-TEST AT A=0.05)		NS (P>0.05)	NS (P>0.05)	NS (P>0.05)	NS (P>0.05)	NS (P>0.05)	NS (P>0.05)

Source: Field Experiment 2018

NS = Not significant, α = Level of significance , F is the test statistic used in Analysis of Variance to test for the equality of more than two means.

The effect of Spacing on the yield of Sesame seeds

Spacing had a significant effect on the yield of sesame seeds, in kg/ha, at α=0.05. Spacing of 10cm and 15cm gave mean yield of 741.99 kg/ha and 684.08kg/ha respectively; the Least Significance Difference (LSD) shows that these were significantly higher than the yield observed from 20cm and 25cm spacing (467.88 kg/ha and 381.77 kg/ha respectively): this is similar to the findings of Asif Nadeem et al (2015) and Jakusko B.B. et al (2013). However, our research shows that spacing had no significant effect on 1000 grain weight, yield per plant, capsule length, number of capsules per plant, number of seeds per capsule. The higher yield in kg/ha observed for 10cm and 15cm spacing is due to the higher population of plants on the plots where those levels of spacing were used.

Table 1 The effect of Spacing on: 1000 grain weight, yield per plant, capsule length, number of capsules per plant, number of seeds per capsule and yield per hectare.

	SPACING (CM)	1000 SEED WEIGHT (G)	YIELD PER PLANT (G)	YIELD (KG/HA)	CAPSULE LENGTH (CM)	NUMBER OF CAPSULES PER PLANT	NUMBER OF SEEDS PER CAPSULE
1	10	2.73	5.09	741.99	2.49	88.1	53.92
2	15	2.72	6.93	684.08	2.57	88.4	56.08
3	20	2.76	6.42	467.88	2.43	86.3	51.08

4	**25**	2.74	6.35	381.77	2.50	87.4	54.33
ANOVA (F-TEST AT A=0.05)		NS (P>0.05)	NS (P>0.05)	S (P<0.05)	NS (P>0.05)	NS (P>0.05)	NS (P>0.05)
LSD (AT A=0.05)		NS	NS	S	NS	NS	NS

Source: Field Experiment 2018

NS = Not significant, S = Significant, α = Level of significance, F is the test statistic used in Analysis of Variance to test for the equality of more than two means. The least significant difference (LSD) is used to carry out a pairwise comparison of means, in the event that the F-test shows that the means are not equal. The LSD helps to identify the means that are not equal.

CONCLUSION

From the findings of this study, we can conclude that spacing has a significant effect on the yield of sesame seeds: spacing levels of 10cm and 15cm intra row have shown significantly higher yield (in kg/ha) than 20cm and 25cm (with 65cm inter row spacing).

RECOMMENDATION

Based on the findings of this study, we recommend a spacing of 10cm to 15cm (with 65cm inter row spacing) for farmers of sesame seeds in Damaturu area of Yobe State, Nigeria.

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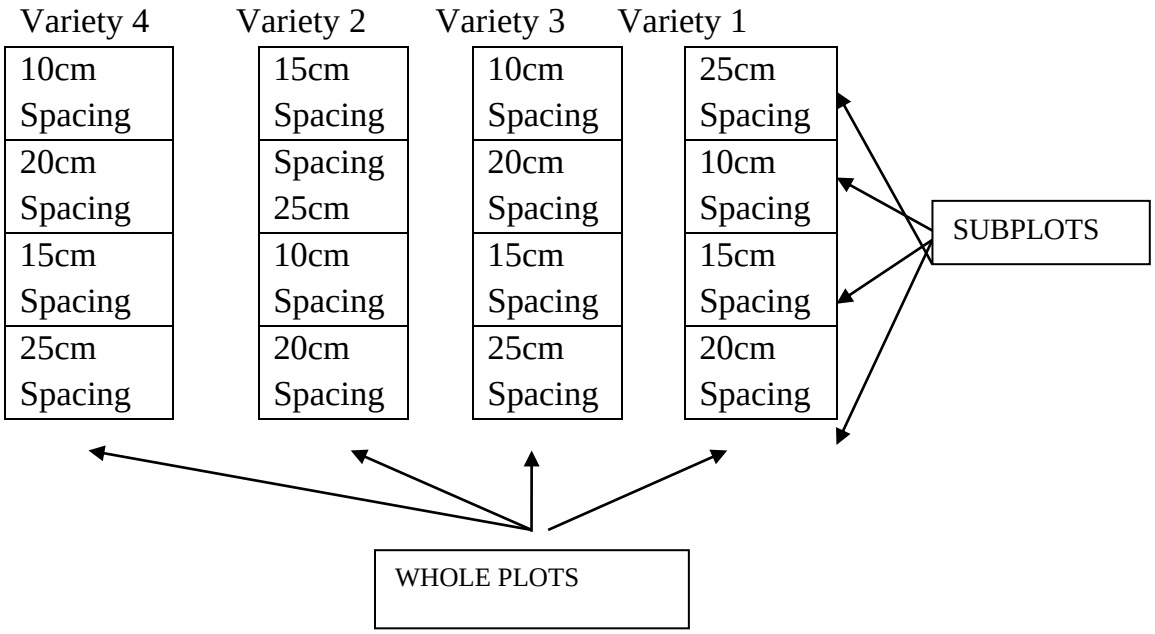
APPENDIX 1: LAYOUT

The Layout of the Experiment for one Replication is as follows:



APPENDIX 2: MODEL

The model used for this Split Plot Design is:

$Y_{ijk} = \mu + \gamma_i + \alpha_j + \varepsilon_{ij} + \beta_k + (\alpha\beta)_{jk} + \varepsilon_{ijk}$

Where

μ is the overall mean

γ_i is the i^{th} replicate effect

α_j is the fixed effect due to the j^{th} level of Variety

ε_{ij} main plot error term

β_k fixed effect due to the k^{th} level of Spacing

$(\alpha\beta)_{jk}$ is the interaction between the j^{th} level of Variety and the k^{th} level of Spacing

ε_{ijk} is the subplot error term.

HYPOTHESES:

1. Variety

H_0:Variety has no effect on the yield of Sesame Seed ($\alpha_1=\alpha_2=\alpha_3=....\alpha_5 = 0$)

H_1: Variety has effect on the yield of Sesame Seed (At least one α_i is not equal to 0)

2. Spacing

H_0: Spacing has no effect on the yield of Sesame Seed ($\beta_1= \beta_2 = \beta_3 = ...\beta_4 = 0$)

H_1: Spacing has effect on the yield of Sesame Seed (At least one β_j' is not equal to 0)

3. Interaction

H_0: There is no interaction effect between Variety and Spacing on the yield of Sesame Seed ($(\alpha\beta)_{ij} = 0$ ⊎ $i \neq j$

H_1: There is interaction effect between Variety and Spacing on the yield of Sesame Seed ($(\alpha\beta)_{ij}$ is not equal to 0 for some $i \neq j$)

ACKNOWLEDGEMENT: This is to acknowledge the contribution of TETFUND towards this Research by sponsoring the entire research budget.