International Journal of Plant & Soil Science

Volume 35, Issue 11, Page 29-35, 2023; Article no.IJPSS.98781
ISSN: 2320-7035

Effect of Spacing and Nitrogen Management on Yield and Economics of Summer Sesame (*Sesamum indicum* L.)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJPSS/2023/v35i112942

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/98781

Original Research Article

Received: 11/02/2023
Accepted: 13/04/2023
Published: 01/05/2023

ABSTRACT

A field experiment was carried out in *Zaid* 2022 at the Department of Agronomy's Agricultural Research Farm in Prayagraj (Uttar Pradesh). There are three planting geometries used in the experiment 30 cm x 10 cm, 40 cm x 10 cm, and 50 cm x 10 cm. There are three nitrogen management treatments used in the experiment 50% of the Recommended Dose of Nitrogen (RDN) through inorganic fertilizer, 50% of the RDN th rough inorganic fertilizer in combination with 50% of Nitrogen provided through Farm yard manure with *Azotobacter* seed inoculation, and 50% of the RDN through inorganic fertilizer. Ten treatments were duplicated three times in the randomized block design of the experiment. Findings showed that with 30x10cm spacing ,50% RDN + 50% N through Farm yard manure + biofertilizer (*Azotobacter*) highest grain yield (552.38 kg/ha), net return (30221.00 INR/ha), gross return (71809.00 INR/ha), and benefit: cost ratio (1.73).

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Keywords: Spacing; Farm Yard Manure (FYM); Recommended Dose of Nitrogen (RDN); azotobacter; zaid.

1. INTRODUCTION

Sesame (*Sesamum indicum* L.) is being cultivated from 3000 years, this is the oldest oilseed crop with rich nutty flavor. In India we can seen sesame seed in many colors like black, red, brown, white. Oil content in sesame varies from 40 to 50%. Sesame is also known as Queen of oilseeds [1-3]. These seeds are used in candy making, baking and other religious rituals [4-7]. The sesame oil is used in making perfumes, soaps, paints etc. In India major sesame producing states are Gujarat, West Bengal, Tamil Nadu, Andhra Pradesh, Madhya Pradesh and Maharashtra [8-14]. Method of sowing determines plant population in the field. The most common method used for sowing summer sesame is broadcasting which results in uneven spacing in the field. Uneven plant spacing is responsible for low yield [15-18]. Caliskan et al. [19] reported positive effects of row planting.

Providing optimum nitrogen fertilizers to sesame crop also effect the intake of other nutrients, importantly P and K and some other micronutrients. Gebregergis [20] states that N P K fertilizers have been extensively researched and proven to significantly increase sesame yield. Particularly, growth and yield of sesame are greatly influenced by the application of N fertilizer.

Spacing and nitrogen are important factors in growth and yield of sesame [21-25]. Therefore this study "Effect of spacing and nitrogen management on yield and economics was carried out in Department of Agronomy, Agriculture Research Farm in Prayagraj (Uttar Pradesh).

2. MATERIALS AND METHODS

The experiment was conducted in the *Zaid* of 2022 at the Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agricultural, Technology and Sciences (SHUATS), Prayagraj (U.P.) This place is situated at 25° 57'12" N latitude and 87° 50'12" E longitude, 98 meters above mean sea level (MSL). This region is situated on the *Yamuna River's* right bank along the Prayagraj Rewa road, some 12 kilometers from the city. Ten treatments, each replicated three times and categorized as having three levels, were used in an experiment to see how spacing and nitrogen management affected the development and output of summer sesame (*Sesamum indicum* L.). The farm is situated at 25 degrees, 98 meters above mean sea level. 87° 50'12" East, 25° 57'12" North latitude; sea level (MSL). This region is situated on the *Yamuna River's* right bank along the Prayagraj, rewa path, about 12 kilom etres from the city.

2.1 Experimental Design

The experimental design was set up using a randomized block design with 10 treatments that are duplicated three times to examine the effects of spacing and nitrogen management on summer sesame (*Sesamum indicum* L.) growth and yield.

When employed in combinations the treatments was separated into 3 levels of plant geometry and 3 for nitrogen as follows : T_1: Spacing 30cm × 10cm + 50% RDN + 50% N through FYM,T_2: Spacing 30cm × 10cm + 50% RDN + Biofertilizer (*Azotobacter*) ,T_3: Spacing 30cm × 10cm + 50% RDN + 50% N through FYM + Biofertilizer (*Azotobacter*),T_4: Spacing 40cm × 10cm + 50% RDN + 50% N through FYM,T_5: Spacing 40cm × 10cm + 50% RDN + Biofertilizer (*Azotobacter*), T_6: Spacing 40cm × 10cm + 50% RDN + 50% N through FYM + Biofertilizer (*Azotobacter*), T_7: Spacing 50cm × 10cm + 50% RDN + 50% N through FYM, T_8: Spacing 50cm × 10cm + 50% RDN + Biofertilizer (*Azotobacter*), T_9: Spacing 50cm × 10cm + 50% RDN 50% N through FYM + Biofertilizer (*Azotobacter*), T_{10} : 10.Spacing 30cm × 10 cm + 50 : 40 : 30 NPK Kg/ha (Control).

When the oil harvest was ready, it was carefully handled. After harvesting, seeds were extracted from each net plot and dried for three days under the sun. Five randomly selected sample plants from each plot of each replication were manually measured for growth characteristics such plant height (cm), dry matter accumulation (g/plant), and more.

After cleaning and winnowing, grain yield per hectare was estimated and expressed in kilograms per hectare. Each net plot's leftover yield was measured and expressed, after full drying under the sun for 10-day s, in tons per acre.

2.2 Statistical Analysis

The data was computed and analyzed by following statistical method of Gomez and Gomez (1984). and benefit cost ratio was worked out after price value of seed with stover, and total cost included in crop cultivation.

3. RESULTS AND DISSCUSION

3.1 Effect of Spacing and Nitrogen Management on Yield and Yield Attributes

3.1.1 Number of capsules/plants

The statistical analysis of number of capsules produced by each plant found a significant influence. At a spacing of 30 cm × 10 cm + (50% RDN + 50% N via FYM + Biofertilizer (*Azotobacter*)), the plant produced largest number of capsules (78.69). Nonetheless, it was shown that the spacing of 30 cm × 10 cm + (50% RDN + Biofertilizer (*Azotobacter*)) and 40 cm × 10 cm + (50% RDN + 50% N via FYM + Biofertilizer (Azotobacter)), were statistically at par with spacing of 30 cm × 10 cm + (50% RDN + 50% N via FYM + Biofertilizer (Azotobacter)). A sufficient quantity of sunlight absorption promotes efficient photosynthesis. With restricted spacing and dense plant population lower yield attribute values were attained. Ample application of nitrogenous fertilizers will not only enhance the yield but also support soil N status encourage productivity. Several records show that in sesame, use of Nitrogenous fertilizers effect in remarkable rise in growth and yield variables and seed yield.

3.1.2 Number of seeds/capsules

Statistically, treatment T3 (spacing 30 cm× 10 cm + 50% RDN + 50% N via FYM + biofertilizer (*Azotobacte r*)) outperformed the other treatments and had the maximum number of capsules per plant (36.39). Both the T2 treatment (spacing 30 cm ×10 cm + 50% RDN + biofertilizer (*Azotobacter*)) and the T6 treatment (spacing 40 cm × 10 cm + 50% RDN + 50% N via FYM + biofertilizer (*Azotobacter)).* These results are in line with those of Yadav and similar (2007). Since it improves plant photosynthesis when handled appropriately, nitrogen is an essential part of chlorophyll. Higher nitrogen concentrations have been shown to increase dry matter because increased photosynthetic activity leads to the production of more photosynthate. In sesame, Shinde et al. [26] discovered that increasing the quantity of nitrogen led to the plant accumulation of dry matter.

3.1.3 Seed yield (kg/ha)

The grain yield showed that treatment T3 (spacing 30 cm ×10 cm + 50% RDN + 50% N via FYM + Biofertilizer (*Azotobacter*)) outperformed the other treatments and provided the maximum quantity of seed yield (552.38 kg/ha). While treatment T2 (Spacing 30 cm × 10 cm + 50% RDN + Biofertilizer (*Azotobacter*)) was observed to be statistically equivalent to treatment T3 (spacing 30 cm ×10 cm + 50% RDN + 50% N via FYM + Biofertilizer (*Azotobacter*)). Perhaps less competition exists for nutrients, moisture, and light. Adequate sunlight absorption promotes efficient photosynthesis, which causes more photosynthates to accumulate across a larger region. With restricted spacing and a dense plant population, lower yield attribute values were attained. Ogundare [27], Patra, and Mishra found findings that were comparable to th ese [28].

3.1.4 Stover yield (kg/ha)

The yield of sesame stover was also influenced by the usage of spacing and nitrogen management. The treatment T10 (Control with specified spacing and RDN) produced the greatest recorded stover yield (2602.6 kg/ha), whereas the treatment T1 (Spacing 30 cm 10 cm + 50% RDN + 50% N via FYM) produced the lowest reported yield (1920.6 kg/ha). Perhaps less competition exists for nutrients, moisture, and light. A sufficient quantity of sunlight absorption promotes efficient photosynthesis, which causes more photosynthesis to accumulate across a larger region. With restricted spacing and a dense plant population, lower yield attribute values were attained. Potassium is involved in a variety of physiological processes, such a s protein synthesis and enzyme activation. Similar findings were reported by Nayek et al. [29] and Preeti [30].

Table 1. Effect of spacing and nitrogen management on yield attributes ofsummer sesame (*Sesamum indicum*)

Treatment combinations	Yield and Yield Attributes					
	No.of capsules/ Plant	**No. of seeds/ capsule**	**Test Weight (g)**	**Seed Yield (kg/ha)**	**Stover Yield (kg/ha)**	**Harvest Index (%)**
T1. Spacing 30cm × 10cm + 50% RDN + 50% N through FYM	70.89	32.72	3.34	409.65	1920.6	15.03
T2. Spacing 30cm × 10cm + 50% RDN + Biofertilizer (*Azotobacter*)	75.61	35.28	3.38	451.64	1980	14.86
T3. Spacing 30cm × 10cm + (50% RDN + 50% N through FYM +Biofertilizer (*Azotobacter*)	78.69	36.39	3.38	552.38	2052.3	17.51
T4. Spacing 40cm × 10cm + 50% RDN + 50% N through FYM	68.93	29.68	3.31	401.82	2250.6	15.15
T5. Spacing 40cm × 10cm + 50% RDN + Biofertilizer (*Azotobacter*)	72.54	34.12	3.34	438.69	2271	14.92
T6. Spacing 40cm × 10cm + 50% RDN + 50% N through FYM + Biofertilizer (*Azotobacter*)	74.69	34.54	3.35	443.26	2501.9	14.76
T7. Spacing 50cm × 10cm + 50% RDN + 50% N through FYM	66.73	27.86	3.30	396.89	2560.8	16.70
T8. Spacing 50cm × 10cm + 50% RDN + Biofertilizer (*Azotobacter*)	68.61	28.73	3.30	399.51	2315.6	16.29
T9. Spacing 50cm × 10cm + 50% RDN + 50% N through FYM + Biofertilizer (*Azotobacter)*	69.76	31.33	3.32	419.36	2587.9	15.59
T10.Spacing 30cm ×10 cm + 50: 40: 30 NPK Kg/ha (Control)	65.35	25.56	3.29	387.69	2602.6	16.80
F test	S	S	NS	S	S	NS
SEm(±)	0.81	0.48	0.04	8.10	2.60	0.28
CD (P=0.05)	2.40	1.43	-	24.06	7.72	-

Table 2. Effect of spacing and nitrogen management on Economics of summersesame (*Sesamum indicum*)

S. No	Treatments	Cost of cultivation (INR/ha) Indian rupees	Gross returns (INR/ha)	Net returns (INR/ha)	B:C ratio (benefit cost ratio)
T1.	Spacing30cm×10cm+50%RDN+50%NthroughFYM	30878.00	53255.00	22376.00	1.72
T2.	Spacing 30×10cm+50%RDN+Biofertilizer(*Azotobacter)*	36273.00	58713.00	22440.00	1.62
T3.	Spacing30cm×10cm+50%RDN+50%NthroughFYM+Biofertilizer(*Azotobacter)*	41588.00	71809.00	30221.00	1.73
T4.	Spacing 40×10cm+50%RDN+50%NthroughFYM	30788.00	52237.00	21458.00	1.70
T5.	Spacing 40×10cm+50%RDN+Biofertilizer(*Azotobacter)*	36173.00	57030.00	20857.00	1.58
T6.	Spacing40cm×10cm+50%RDN+50%NthroughFYM+Biofertilizer(*Azotobacter)*	41488.00	57624.00	16136.00	1.39
T7.	Spacing 50×10cm+50%RDN+50%NthroughFYM	30678.00	51596.00	20917.00	1.68
T8.	Spacing 50×10cm+50%RDN+Biofertilizer(*Azotobacter)*	36073.00	51936.00	15863.00	1.44
T9.	Spacing50×10cm+50%RDN+50%NthroughFYM+Biofertilizer(*Azotobacter)*	41388.00	54517.00	13129.00	1.32
T10.	Spacing 30cm × 10cm + 50 : 40 : 30 NPK kg/ha	30227.00	50400.00	20713.00	1.67

4. CONCLUSION

It can be concluded that with spacing of 30 cm × 10 cm and 50% recommended dose of nitrogen along with 50% nitrogen through FYM and seeds treated with Biofertilizer (*Azotobacter*) was found more productive (552.38 kg/ha) seed yield, as well as economically viable with net return (30,221. 0 0 INR /ha), gross return (71809.00 INR/ha), and benefit : cost ratio (1.73). therefore it is profitable and can be suggested to farmers.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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