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MR Sawadadkar
Department of agronomy, College of Agriculture, Latur, Maharashtra, India

AS Karle
Chief Agronomist AICRP on IFS VNMKV, Parbhani, Maharashtra, India

SN Band
Department of horticulture, College of Agriculture, Latur, Maharashtra, India

AT Jadhav
Department of agronomy, College of Agriculture, Latur, Maharashtra, India

DK Davkar
Department of agronomy, College of Agriculture, Latur, Maharashtra, India

Corresponding Author:
MR Sawadadkar
Department of agronomy, College of Agriculture, Latur, Maharashtra, India

Effect of different spacing and varieties of *kharif* sesame (*Sesamum indicum* L.) on growth and yield

MR Sawadadkar, AS Karle, SN Band, AT Jadhav and DK Davkar

Abstract
A field experiment was conducted at the Agronomy Experimental Farm Department, College of agriculture, Latur (Maharashtra) during *kharif* season of 2022-23 to study the "Effect of different spacing and varieties of *kharif* sesame (*Sesamum indicum L.*) on growth and yield". The experiment was laid out in Factorial Randomized Block Design (FRBD) with nine treatment combinations, consisting of two factors i.e., different spacing and varieties. The factor-A consist of three spacing's *viz*. S_1- 30cm x 20cm, S_2- 45cm x 15cm, S_3- 60cm x 10cm and factor-B consist of three varieties practices *viz*. V_1-TLT-10, V_2-TKG-22 and V_3- JLT-408. The result of the experiment revealed that spacing S_3- 60cm × 10cm recorded significantly highest growth and seed yield over spacing S_2- 45cm × 15cm and S_3- 30cm × 20cm. The variety TLT-10 recorded highest seed yield and growth.

Keywords: Sesame, different spacing, variety, growth and yield

Introduction
The ancient crop sesame (*Sesamum indicum* L.), also known as Til, gingelly simsim, and gergelim, is one of the most significant oilseed crops farmed in India and is second only to groundnut in terms of importance. Sesame is a high-quality meal that combines nutrition, edible oil, biomedicine, and healthcare. Because lignin and tocopherol a represent, sesamum has exceptional antioxidant properties. Protein (18-20%) and oil (48-50%) are often abundant in sesame. Sesame seeds are incredibly rich in high-quality proteins and important amino acids, particularly methionine, which is thought to help the human body age more slowly. Linoleic, oleic, palmitic, and stearic acids, as well as vitamins E, A, B1, and B2, niacin, and minerals like calcium and phosphorus, are all abundant in sesamum seeds. The seeds are used to make infant foods and are thought of as a mother's milk substitute to offset breastfeeding. The crop's oil, which contains 85% unsaturated fatty acids and is very stable, lowers cholesterol and helps to avoid coronary heart disease.

Sesame is known as "the queen of oils" because of its extra ordinary abilities to improve the appearance of the skin. It is grown throughout the year and, being a crop with a short growing season, fits well into a variety of cropping sequences and systems. Sesame oil is distinguished for its stability and purity as well as its great resistance to oxidative rancidity. Sesame oil is also known as "the poor man's ghee alternative" due to its high quality characteristics. Sesame cake or meal, which is a by product of the oil milling business, is rich in protein, carbohydrates, vitamins (Niacin), and minerals (Ca and P). It is also sometimes added to bread to enhance the flavour and nutritional content. Because of its high methionine content, sesame cake is also a valuable nutritional feed for cattle, especially dairy animals, and is used as an element in poultry feed. The cake contains 6.0-6.2% nitrogen, 2.0-2.2% phosphorus, and 1.0-1.2% potassium and can be used as manure.

India ranks first in sesame production (36%) and exports (45%) by area. The total acreage of sesame in India in *kharif* 2019 was 13,71,700 hectares. Together, four states Gujarat (4,16,200 ha; 8%), Uttar Pradesh (4,17,435 ha; 30%), Rajasthan (2,70,191 ha; 20%), and Madhya Pradesh (3,4,300 ha; 23%) accounted for 85% of the country's land area. In comparison to *kharif*-2018, there was a 4% rise in acreage on a nation-wide scale. In Madhya Pradesh, there was a significant reduction (29%). However, there were not able increases in Gujarat (49%) and Uttar Pradesh (26%).

The state with highest yield, Gujarat, was expected to produced 565 kgha^{-1}, followed by Rajasthan with 289 kg ha^{-1}, Madhya Pradesh with 262 kg ha^{-1} and Uttar Pradesh with 239 kg ha^{-1}. A yield of 291 kg ha^{-1} was projected to be the national average. The estimated total production of these four states was 3,25,852 MT, or 82% of the estimated national production.

Rajasthan (78,085;20%), Gujarat (65,653;16%), Madhya Pradesh (82347;21%), and Uttar Pradesh (99,767;25%) all made significant contributions to the nation's production. While the combined contribution of the other states was calculated to be 73,313 MT, or 18%. The anticipated 3,99,165 MT total production for the 2019 *kharif* season in India.

The total area within the world under sesame during 2020-21 was 7784 thousand hectares Mha with the production of 3150 thousand metric tonnes MT with productivity of 405 kg per hectare. India is the world leader with the largest area (1.62 M ha), production (0.76 MT), and productivity (474 kg/ ha). India (2167 kg/ha) rank fourth in average productivity in world. India contributes largest area (24%). In Maharashtra, this crop covers 28.7 thousand hectares, yielding 6.51 thousand tonnes and an average productivity of 227 kg/ha. Gujarat, Rajasthan, Uttar Pradesh, Madhya Pradesh, Maharashtra, Andhra Pradesh, Orissa, Tamil Nadu, West Bengal and Karnataka are major sesame growing states of the country.

In Maharashtra, sesame is largely grown in district of Akola, Chandrapur, Jalgaon, Bhandara, Ahmadnagar, Dhule and Osmanabad. An area under sesame in Maharashtra is reduced due to low productivity of sesame variety, relatively high productivity and less risk in production of other crops. The present sesame varieties under cultivation have low yield potential. Most of the evolved and released varieties under cultivation are selected from local cultivar and closely related population under less management. This is major cause for low productivity potential of varieties grown in India. There is need to increase productivity of sesame varieties by developing new varieties, this depends on availability of genetic variability for yield and its attributing traits in the sesame populations. Sesame crop has wide range of variability present in their population.

Sesame was grown on 18 lakh ha of land in India, with an annual production of 7.5 lakh tonnes and an average productivity of 448 kg ha^{-1}, which is less than the global average productivity of 535 kg ha^{-1}. In contrast, Maharashtra produced 0.80 lakh tonnes of sesame from 0.33 lakh ha of land during 2019-20, with an average productivity of 233 kg ha^{-1}. Due to its cultivation on marginal oils with low soil fertility, the use of local varieties, and poor agronomic management practices such as inadequate plant stands, inadequate nutrient management, and lack of control against serious pests and diseases, Maharashtra's sesamum production is lower than that of India's.

The insufficient supply of N is one of the nutrient management strategies that contributes to the low productivity of sesame. In most Indian soils, particularly the light-textured ones where the majority of the sesame growing area is concentrated, nitrogen is a plant nutrient that is universally inadequate (Chhonkar and Rattan, 2000) [23]. Due to the improper and on-going application of only chemical fertilisers in intensive cropping systems, the soil becomes nutritionally imbalanced, which negatively impacts productivity by limiting one or more micronutrients (Nambiar and Abrol, 1989) [24]. Although the use of inorganic fertiliser increases productivity, its cost is rising daily (Shaikh *et al.* 2011) [25]. The requirement for integrated nutrient management, which combines organic manure with chemical fertilisers to give crop plants superior nutrition (Shaikh *et al.* 2010) [26]. In organic and sustainable soil management, FYM is a crucial fertiliser. Many of the components required for plant growth and development are present in it. Sesame seed output can be increased by using fertiliser in conjunction with FYM and Azospirillum. Crop left overs that have been properly and economically justified are recycled into FYM, compost, vermicompost, green manure, etc.

The population density, pods per plant, seeds per pod, and test weight all influence the oil seed crop's seed yield (Singh *et al.* 2022) [27]. In order to get a high sesame seed output, a sufficient, uniform crop stand must be established. The knowledge that the ideal plant spacing may be a factor in increased production. In order to maximise a crop's potential production from a particular variety, planting geometry is one of the key considerations (Nadeem *et al.* 2015) [28].

Therefore, the field experiment was carried out to study the effect different spacing and varieties of *kharif* sesame (*Sesamum indicum* L.) on growth and yield.

Materials and Methods

A field experiment was conducted at Farm of agronomy section, College of agriculture, Latur (Maharashtra) during *kharif* season of 2022 to study the "Effect of different spacing and varieties of *kharif* sesame (*Sesamum indicum* L.) on growth and yield". The experimental site was clayey in texture, slightly alkaline in reaction, soil was low in available nitrogen (125.3 kg ha^{-1}), medium in available phosphorous (18.20 kg ha^{-1}) and high in available potassium (498.58 kg ha^{-1}). Soil was well drained, with good moisture retention capacity. The experiment was laid out in Factorial Randomized Block Design (FRBD) with nine treatment combinations, consisting of two factors i.e., different spacing and nutrient management, which included three levels each of different spacing and nutrient management. The factor-A consist of three spacings *viz*. S_1-30cm x 20cm, S_2-45cm x 15cm, S_3-60cm x 10cm and factor-B consist of three varieties *viz*. V_1-TLT-10 V_2- TKG-22 and V_3-JLT-408. The gross plot size of each experimental unit was 5.4 m × 6.0 m and net plot size was 4.2 m × 5.0 m. Pure seed of soybean variety MAUS-158 was sown with drilling and dibbling method on 19th July, 2022 as per treatments. The crop was harvested on 16th Oct, 2022.

Results and Discussion

Yield Attributes

Effect of different spacing

The spacing of S_3-60cm x 10cm recorded highest seed yield (830.11 kg ha^{-1}), straw yield (2370.80 kg ha^{-1}), biological yield (3112 kg ha^{-1}) and harvest index (25.10%) which was significantly superior over the wider spacing S_1-30cm x 20cm and S_2- 45cm x 15cm. Similar results were concluded by Sivagamy K, and Rammohan J (2013) [29]. This might be due to higher plant population under closer spacing resulted in higher photosynthetic activity along with proper grain filling and thus contributing to higher seed yield. The significantly highest values of number of seed $plant^{-1}$ (140.89), capsule yield $plant^{-1}$ (38.50g) and seed yield $plant^{-1}$ (7.78 g) were recorded with the spacing S_3- 60cm x 10cm, which was at par with the spacing S_2-45cm x 15cm and found significantly superior over the spacing S_1- 30cm x 20cm.

Effect of varieties

Sowing of sesame variety V_1 - TLT-10 recorded higher number of capsule yield $plant^{-1}$ (37.29 g), seed yield $plant^{-1}$ (7.89 g), seed yield (840.11 kg ha^{-1}), straw yield (2375.45 kg

ha^{-1}), biological yield (3135.62 kg ha^{-1}) and harvest index (24.96%) than adoption of V_3- JLT-408 and found at par with adoption of V_2- TKG-22. Similar results were concluded by Gautam and Mishra *et al.* (2023) [30].

Interaction (S×V)

The interaction effect of different spacing and varieties on yield of sesame was found to be non-significant.

Growth Attributes

Effect of different spacing

Adoption of different spacing had a substantial impact on growth-related characteristics such as plant height (123.54 cm), number of branches plant^{-1} (5.40), number of functional leaves plant^{-1} (51.03), leaf area in dm^2 (16.40 dm^2), dry matter (26.82 g) at all phases of the crop's growth, the spacing S_3- 60cm x 10cm had considerably greater plant height, functional leaf count, leaf area, dry matter It was much better than the remaining spacing and at par with spacing S_2-45cm x 15cm. The good impact of the prescribed fertilizer dose and weeding practices on growth of sesame. These findings are supported by Ojikpong *et al.* (2007) [31].

Effect of varieties

Sowing of sesame variety V_1-TLT-10 recorded higher plant height (124.40 cm), Number of branches plant^{-1} (5.52), number of leaves plant^{-1} (51.57), Leaf area plant^{-1}(dm^2) (16.61 dm^2) than sowing of V_3-JLT-408 and found at par with the V_2-TKG-22. Similar results were concluded by Gautam and Mishra *et al.* (2023) [30].

Interaction (S×N)

The interaction effect of different spacing and nutrient management on economics of soybean was found to be non-significant.

Table 1: Effect of different spacing and varieties on yield of sesame crop

Treatments	Capsule yield plant^{-1} (g)	Seed yield plant^{-1} (g)	Seed yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Biological yield (kg ha^{-1})	Harvest index (%)
A : Spacing						
S1- 30cm x 20cm	33.37	5.75	667.28	2105.70	2674.28	22.94
S2- 45cm x 15cm	36.28	7.29	783.22	2289.66	3075.67	24.57
S3- 60cm x 10cm	37.50	7.77	830.11	2370.80	3112.00	25.10
SEm ±	1.15	0.16	22.20	72.50	72.54	-
CD @ 5%	3.15	0.50	66.55	221.60	221.72	-
B : Varieties						
V1 : TLT-10	37.29	7.88	840.11	2375.45	3135.62	24.96
V2 : TKG-22	34.36	6.74	773.70	2240.00	2940.86	24.59
V3 : JLT-408	31.50	5.52	669.40	2100.30	2774.45	23.06
SEm ±	1.15	0.16	22.20	72.50	72.54	-
CD @ 5%	3.15	0.50	66.55	221.60	221.72	-
Interaction (S x V)						
SEm ±	2.02	0.26	38.45	126.35	126.41	-
CD @ 5%	NS	NS	NS	NS	NS	
General mean	36.05	6.98	760.30	2154.30	2916.99	22.12

Table 2: Effect of different spacing and varieties on growth of sesame crop.

Treatment	Plant height (cm)	No. of branches plant^{-1}	No. of leaves plant^{-1}	Leaf area plant^{-1}
A: Spacing				
S1- 30cm x 20cm	108.41	4.75	43.12	13.27
S2- 45cm x 15cm	121.39	5.36	48.66	15.79
S3- 60cm x 10cm	123.54	5.40	51.03	16.40
SEm ±	3.50	0.16	1.32	0.43
CD @ 5%	10.49	0.47	3.97	1.29
B: Varieties				
V_1 : TLT-10	124.40	5.52	51.67	16.61
V2 : TKG-22	119.62	5.18	47.83	15.34
V3 : JLT-408	109.32	4.81	43.31	13.71
SEm ±	3.50	0.16	1.32	0.43
CD @ 5%	10.487	0.474	3.97	1.295
Interaction (S × V)				
SEm ±	6.06	0.27	2.29	0.75
CD @ 5%	NS	NS	NS	NS
General mean	117.78	5.17	47.60	15.15

Conclusion

Among different spacings, the spacing of S_3- 60cm x 10cm proved to be effective for getting higher seed yield and growth attributes of sesame. Whereas sowing of V_1-TLT-10 was found to be more remunerative for getting more seed yield and growth attributes of sesame.

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