Original Research Article

Effect of spacing and weed management practices on growth and yield of sesame

ABSTRACT

The field experiment titled "Effect of spacing and weed management practices on growth and yield of sesame" was conducted during*zaid*-2022 at the Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (U.P.) India. To study. The soil of experimental plot was sandy loamy in texture, nearly neutral in soil reaction (pH 7.8), low in organic carbon (0.35%). The treatments consist of three levels of spacing 20 x 10cm, 30 x 10cm, and 40 x 10cm.Three types of weed managements are Two hand weeding at 21 and 42DAS, Pendimethalin 0.75kg/ha at 1 DAS + one hand weeding at 21DAS, and + Quizalofop ethyl 0.05kg/ha on 25 DAS + one hand weeding at 42DAS.Theexperimentwaslaidout in randomized block design with nine treatments each replicated thrice. Results obtained that the higher plant height (129.99 cm), higher number of branches (3.77), higher plant dry weight (15.63 g/plant), higher crop growth rate (12.13 g/m^2/day) higher number of capsules/plant (31.91), higher number of seeds/ capsules (47.48), higher test weight (3.48 gm), higher seed yield(1177.07kg/ha) and higher stalk yield(1610.41kg/ha)were significantly influenced with spacing 40 x 10cm along with the application of Quizalofop ethyl @0.05kg/ha on 25 DAS + one hand weeding at 42DAS. Higher gross return (92,164.84 INR/ha), higher net return (65,840.84 INR/ha) and higher B:Cratio (2.50) were also recorded in treatment-9 spacing 40 x 10cm along with the application of Quizalofop ethyl @0.05kg/ha on 25 DAS + one hand weeding at 42DAS.

Keywords: *Sesame, spacing, weed management, growth parameters, yield attributes and economics.*

UNDER PEER REVIEW

INTRODUCTION

One of the most significant oilseed crop is sesame (*Sesamum indicum* L.). It is a member of the Pedaliaceae family. Due to its stable keeping qualities brought on by a high level of resistance to oxidation and rancidity, sesame is referred to as the "Queen of Oilseeds" and is more popularly known as “Til”. Sesame is a drought-resistant crop that may be produced in conditions of rainfed agriculture. Sesame is farmed on 15.62 million hectares in India, with a yield of 502 kg/ha and a production of 7.84 lakh tonnes. The principal sesame-growing states in India are Gujarat, Maharashtra and Tamil Nadu. Sesame oil is employed in the skin care, cosmetic, and soap sectors. It possesses antioxidant, antiviral, and antibacterial effects. Since sesame oil has no cholesterol, it is advised for people with heart disease.

In addition to the need for favorable climatic conditions for crop development, crop production in the field is also influenced by the distance between plant rows. One of the key elements examining the production potential of a certain variety of oilseed crop is planting geometry **(Mahan *et al*., 2008).** The production and quality of products in a community are impacted by the area available for each plant cultivation. More space might lead to reduced plant competition, but it also increases the likelihood of weed development. Because there is less room, agricultural plants may compete fiercely for growth factors such light, carbon dioxide, moisture, and nutrients **(Singh *et al*., 2004).** To produce a high seed output, a sufficient and uniform crop stand must be established. According to **Dungarwal *et al.* (2003),** uncontrolled weed growth can result in a 50% reduction in sesame output.The most popular weed management method used by farmers is hand weeding, but it is not only time-consuming, expensive, and physically demanding; in addition, it is difficult to find workers at the busiest times for agricultural activities, and high labour costs force farmers to look for alternatives. Herbicides provide opportunities for economical control of weeds starting with sowing, and chemical weed management continues to be the sole practical alternative. Considering the facts and to bridge the research gap highlighted above, the present experiment entitled, “Effect of spacing and weed management on growth and yield of sesame (*Sesamum indicum* L.)”, was conducted at Crop Research Farm, Department of Agronomy, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj during *zaid*-2023.

UNDER PEER REVIEW

MATERIALS AND METHODS

At the Crop Research Farm, Department of Agronomy, Naini Agriculture Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, the experiment was carried out during *zaid*-2022. which is situated 98m above mean sea level (SL) at 25.24' 42" N latitude, 81.50' 56" E longitude. Nine treatments, each replicated three times, were used in the experiment's Randomised Block Design. Each treatment's plot was 3m by 3m. The treatments consist of three levels of spacing 20 x 10cm, 30 x 10cm, and 40 x 10cm.Three types of weed managements are Two hand weeding at 21 and 42DAS, Pendimethalin 0.75kg/ha at 1 DAS + one hand weeding at 21DAS, and + Quizalofop ethyl 0.05kg/ha on 25 DAS + one hand weeding at 42DAS are contributing factors. At the time of sowing, N, P and K were supplied, and three are used as basal. On March-1st, 2023, the sesame variety was sowed. Each plot's 1 m^2 was used for harvesting. And five plants were randomly chosen from it for the purpose of observing the yield and growth metrics. Here are the specifics of the treatment: T_1: 20 x 10cm + two hand weeding at 21 and 42 DAS, T_2: 20 x 10cm + pendimethalin @0.75kg/ha at 1 DAS + one hand weeding at 21 DAS, T_3: 20 x 10cm + pendimethalin @0.75kg/ha at 1 DAS + one hand weeding at 21 DAS, T_4: 30 x 10cm + two hand weeding at 21 and 42 DAS, T_5: 20 x 10cm + pendimethalin @0.75kg/ha at 1 DAS + one hand weeding at 21 DAS, T_6: 20 x 10cm + pendimethalin @0.75kg/ha at 1 DAS + one hand weeding at 21 DAS, T_7: 40 x 10cm + two hand weeding at 21 and 42 DAS, T_8: 20 x 10cm + pendimethalin @0.75kg/ha at 1 DAS + one hand weeding at 21 DAS, T_9: 20 x 10cm + pendimethalin @0.75kg/ha at 1 DAS + one hand weeding at 21 DAS. Plant height, capsule per plant, dry weight, grain production, and stalk yield were all recorded. By using the analysis of variance approach, the data were statistically analysed **(Gomez and Gomez, 1976).**

RESULT AND DISCUSSION

Growth parameters

Plant height(cm)

At 100 DAS, the significantly higher plant height (129.99cm) was recorded in treatment-9 with the application of Quizalofop ethyl @0.05kg/ha at 25 DAS and one hand weeding at 42 DAS with 40 × 10cm spacing . However, treatment-8 with the application of pendimethalin @0.75kg/ha at 1 DAS and one hand weeding at 21 DAS with 40 × 10cm

UNDER PEER REVIEW

spacing was statistically at par with treatment-9 with application of Quizalofop ethyl @0.05kg/ha on 25 DAS and one hand weeding at 42 DAS with 40 × 10cm spacing.With a spacing of 40 x 10 cm, the plant height (129.99cm) was noticeably higher at 100 DAS. It may be caused by a plant's propensity to extend towards light when incoming solar radiation is not sufficiently blocked by the plant canopy, especially the lower one. **(Patel *et al*., 2018)**. The effective weed management may be the cause of the additional growth in plant height. may considerably reduce weed growth and crop nutrient and moisture uptake by manual weeding at the right time in the crop. **Singh *et al*. (2018)** findings supported this.

Number of branches/plant – At 100 DAS, the significantly higher number of branches (3.77) was recorded in treatment-9 with the application of Quizalofop ethyl @0.05kg/ha at 25 DAS and one hand weeding at 42 DAS with 40 × 10cm spacing . However, treatment-8 with the application of pendimethalin @0.75kg/ha at 1 DAS and one hand weeding at 21 DAS with 40 × 10cm spacing was statistically at par with treatment-9 with application of Quizalofop ethyl @0.05kg/ha on 25 DAS and one hand weeding at 42 DAS with 40 × 10cm spacing. Wider spacing and a noticeably greater number of branches (3.77) were seen during harvest. In comparison to narrow spacing, a wider geometry may allow for a greater number of branches/plants because there is more vertical and horizontal space available, which allows for better nutrient absorption and increased production of healthy primary and secondary branches. In addition, congenial micro environment predominated under wider spacing from the plant's early growth stage, which may have contributed to the plant's faster rate of growth and development **(Sivagamy and Rammohan, 2013).**Additional growth in the number of branches may be attributable to the sole or combined application of pendimethalin and butachlor, which kept broad spectrum weeds present from the start of crop growth and effectively used growth resources to produce more branches. The outcomes were consistent with **(Jha and Soni, 2013)**.

Plant dry weight(g) - At 100 DAS, the significantly higher plant dry weight (15.63g/plant) was recorded in treatment-9 with the application of Quizalofop ethyl @0.05kg/ha at 25 DAS and one hand weeding at 42 DAS with 40 × 10cm spacing . However, treatment-8 with the application of pendimethalin @0.75kg/ha at 1 DAS and one hand weeding at 21 DAS with 40 × 10cm spacing was statistically at par with

UNDER PEER REVIEW

treatment-9 with application of Quizalofop ethyl @0.05kg/ha on 25 DAS and one hand weeding at 42 DAS with 40 × 10cm spacing.

Wider spacing resulted in noticeably increased plant dry weight (15.63 gm/plant) at harvest. Sesame's dry weight greatly increased as a result of spacing. The increased dry weight may be the result of greater mineral, food, water, sun radiation, etc. consumption, according to spacing. Numerous physiological activities, including protein synthesis and enzyme activation, include nitrogen. Plant dryness may rise with reduced plant density at a 45 cm by 10 cm spacing. Plants might produce weight. If they could find enough food, drink, and space. These findings back up the findings from **(Patra and Mishra, 2000).**

Crop Growth Rate(g/m^2/day) – During 80-100 DAS, the significantly higher crop growth rate (12.13 g/m^2/day) was recorded in treatment-9 with the application of Quizalofop ethyl @0.05kg/ha at 25 DAS and one hand weeding at 42 DAS with 40 × 10cm spacing . However, treatment-8 with the application of pendimethalin @0.75kg/ha at 1 DAS and one hand weeding at 21 DAS with 40 × 10cm spacing was statistically at par with treatment-9 with application of Quizalofop ethyl @0.05kg/ha on 25 DAS and one hand weeding at 42 DAS with 40 × 10cm spacing.

With improved cropping geometry, a considerably greater crop growth rate (4.15 g/m^2/day) was seen. For a number of reasons, including enhanced mineral, nutrient, water, and solar radiation consumption as well as plants' propensity to stretch towards light when incoming solar radiation is insufficient, particularly the lower canopies of plants, solar radiation is absorbed by plants. The results agree with those revealed by **(Patel *et al*., 2017).**

YIELD ATTRIBUTES:

Number of capsules/plant- Treatment 9 with the application of Quizalofop ethyl @0.05kg/ha on 25 DAS and one hand weeding at 42 DAS with 40 × 10cm spacing had significantly higher number of capsules/plant (31.91). However treatment-8 with the application of pendimethalin @0.75kg/ha at 1 DAS and one hand weeding at 21 DAS with 40 × 10cm spacing was statistically at par with treatment-9 with application of Quizalofop ethyl @0.05kg/ha on 25 DAS and one hand weeding at 42 DAS with 40 × 10cm spacing.

UNDER PEER REVIEW

With correct control of plant spacing, a substantial and greater number of capsules/plant (31.91) were seen. These findings are consistent with those of **(Kathiresan, 2002)**, who reported that wider row spacing led to increased capsule length because it led to less intra specific competition and proper plant positioning in the field, which allowed for more air and light penetration. The application of herbicides combined with one hand weeding and two hand weeding recorded considerably larger numbers of capsules per plant than solitary application of the herbicides and one hand weeding, respectively. This additional increase in the number of capsules may be the result. Compared to butachlor and one hand weeding, quizalofop ethyl and one hand weeding recorded a considerably larger number of seeds per capsule. **Rajpurohit *et al*. (2017).**

Number of seeds/capsule - Treatment 9 with with the application of Quizalofop ethyl @0.05kg/ha on 25 DAS and one hand weeding at 42 DAS with 40 × 10cm spacing had significantly higher number of seeds/capsule (47.48), making it superior to the other treatments. However, treatment-8 with the application of pendimethalin @0.75kg/ha at 1 DAS and one hand weeding at 21 DAS with 40 × 10cm spacing was statistically at par with treatment-9 with application of Quizalofop ethyl @0.05kg/ha on 25 DAS and one hand weeding at 42 DAS with 40 × 10cm spacing.

With greater spacing, a considerable increase in the number of seeds per capsule (47.48) was noted. Similar lines of findings were made by **Sivagamy and Rammohan (2013),** who discovered that a lack of rivalry allowed crops to utilise growth-restraining resources effectively, which led to increased agricultural performance. Seeds/capsules showed a liner reaction (67.07).

Test Weight (g)- The highest test weight (3.48 g) was found in treatment 9 with the application of Quizalofop ethyl @0.05 kg/ha at 25 DAS and one hand weeding at 42 DAS with 40 × 10cm spacing, whereas the lowest test weight (2.51 g) was found in treatment-1 with 20 x 10cm spacing and two hand weeding at 21 and 42 DAS. The therapies did not, however, differ significantly from one another.

The lower values of the yield characteristics were caused by the tight spacing and dense plant population. The fierce battle for moisture, photosynthesis, and solar radiation may be to blame for the decline in yield with an increase in plant density. Wider spacing may result in reduced inter-plant competition since there is more room available for individual plants, which reduces inter-plant rivalry **Yadav *et al*. (2007)** noted the similar pattern. A

UNDER PEER REVIEW

decrease in weed competition for growth resources may lead to higher photosynthesis, which would improve crop partitioning and lead to further increases in the quantity of seeds/capsules. These findings agree with those of **Joshi *et al.* (2022).**

Seed yield and stalk yield(kg/ha) – Treatment 9 with the application of Quizalofop ethyl @0.05 kg/ha at 25 DAS and one hand weeding at 42 DAS with 40 × 10cm spacing had significantly higher seed production (1177.07 kg/ha) and stalk yield (1610.41 kg/ha). However, treatment-8 with the application of pendimethalin @0.75kg/ha at 1 DAS and one hand weeding at 21 DAS with 40 × 10cm spacing was statistically at par with treatment-9 with application of Quizalofop ethyl @0.05kg/ha on 25 DAS and one hand weeding at 42 DAS with 40 × 10cm spacing.

Treatment 9 with the application of Quizalofop ethyl @0.05kg/ha at 25 DAS and one hand weeding at 42 DAS with 40 × 10cm spacing had a significantly greater seed production (1177.07 kg/ha). It could be because there is less competition for nutrients, moisture, and light. A sufficient amount of sunlight absorption encourages effective photosynthesis processes, which leads to a bigger accumulation of photosynthates across a broader area. The lower values of the yield characteristics were caused by the tight spacing and dense plant population. The fierce battle for moisture, photosynthesis, and solar radiation may be to blame for the decline in yield with an increase in plant density. Wider spacing may result in reduced inter-plant competition since there is more room available for individual plants, which reduces inter-plant rivalry. **Shekh *et al.* (2014)** noted the similar pattern. Higher yields due to the use of herbicide and cultural practices that reduced crop weed competition and created a favourable environment for better plant growth resulted in increased yield components, such as the number of capsules per plant, the number of seeds per capsule, and the test weight, as a result of the efficient translocation of assimilates from the source to developing capsules or seeds. These outcomes concur with **Sheoran *et al.*(2012)** findings.

The significant and higher stalk yield (1610.41 kg/ha) was recorded in treatment-9 with the application of Quizalofop ethyl @0.05kg/ha on 25 DAS and one hand weeding at 42 DAS with 40 × 10cm spacing. 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.

UNDER PEER REVIEW

Potassium is involved in a variety of physiological processes, such as protein synthesis and enzyme activation. Similar findings were reported by **Nayek *et al.* (2014).**The effective weed control and lower dry weight of weeds may have contributed to the crop's ability to use more nutrients and water for better growth and development in terms of various growth-attributing characters like capsule length, number of capsules per plant, number of seeds per capsule, and seed yield per plant. This remarkable increase in seed and stover yield may also be attributable to these treatments. The effects of all the variables on the sesame seed and straw production were favourable and extremely significant. These results concur with those of **Mathukia *et al*. (2015).**

ECONOMIC ANALYSIS:

Economics- The result revealed that Maximum gross return (92,164.84INR/ha), Maximum net return (62,430.43INR/ha) and highest benefit-cost ratio (2.50) was recorded in treatment-9 (40 x 10cm + Quizalofop ethyl @0.05kg/ha on 25 DAS + one hand weeding at 42DAS)as compared to other treatments (Table-3). Higher gross Return, net return and benefit cost ratio was recorded with the application of Quizalofop ethyl @0.05kg/ha at 25 DAS and one hand weeding at 42 DAS with 40 × 10cm spacing, it might be due to the higher growth and yield attributes resulting in more seed and stalk yield with the recommended spacing and weed management practices.

CONCLUSION

It is concluded that with the spacing 40 × 10cm along with the application of Quizalofop ethyl @0.05kg/ha at 25 DAS and one hand weeding at 42 DAS (Treatment-9) has performed positively and improves growth and yield parameters.

UNDER PEER REVIEW

Table 1. Effect of spacing and weed management practices on growth and yield of Sesame.

S. No.	Treatments	Plant height (cm)	Number of branches	Plant Dry weight(g)	Crop growth rate ($g/m^2/day$)
1.	20 x 10cm + two hand weeding at 21 and 42 DAS	121.26	2.97	12.81	11.29
2.	20 x 10cm + pendimethalin @0.75kg/ha at 1 DAS + one hand weeding at 21 DAS	122.33	3.11	13.08	10.57
3.	20 x 10cm + Quizalofop ethyl @0.05kg/ha on 25 DAS + one hand weeding at 42 DAS	123.78	3.25	13.43	11.45
4.	30 x 10cm + two hand weeding at 21 and 42 DAS	125.03	3.33	13.91	10.29
5.	30 x 10cm + pendimethalin @0.75kg/ha at 1 DAS + one hand weeding at 21 DAS	126.37	3.34	14.41	11.72
6.	30 x 10cm + Quizalofop ethyl @0.05kg/ha on 25 DAS + one hand weeding at 42 DAS	127.78	3.47	14.66	11.68
7.	40 x 10cm + two hand weeding at 21 and 42 DAS	128.24	3.52	15.09	11.32
8.	40 x 10cm + pendimethalin @0.75kg/ha at 1 DAS + one hand weeding at 21 DAS	129.08	3.56	15.42	10.81
9.	40 x 10cm + Quizalofop ethyl @0.05kg/ha on 25 DAS + one hand weeding at 42 DAS	129.99	3.77	15.63	12.13
	F test	S	S	S	S
	S Em.(±)	0.46	0.09	0.13	0.21
	CD (p=0.05)	1.38	0.28	0.38	0.62

UNDER PEER REVIEW

Table 2. Effect of spacing and weed management practices on growth and yield of Sesame.

S. No	Treatments	No. capsules/ Plant	No. Seeds/ Capsule	Test weight (g)	Seed Yield (kg/ha)	Stalk Yield (kg/ha)	Harvest Index (%)
1.	20 x 10cm + two hand weeding at 21 and 42 DAS	27.92	39.81	2.59	886.23	1319.56	40.41
2.	20 x 10cm + pendimethalin @0.75kg/ha at 1 DAS + one hand weeding at 21 DAS	28.57	40.59	2.72	938.45	1371.78	40.82
3.	20 x 10cm + Quizalofop ethyl @0.05kg/ha on 25 DAS + one hand weeding at 42 DAS	28.87	41.24	3.05	971.64	1404.97	41.16
4.	30 x 10cm + two hand weeding at 21 and 42 DAS	29.02	42.33	3.17	991.58	1424.92	41.27
5.	30 x 10cm + pendimethalin @0.75kg/ha at 1 DAS + one hand weeding at 21 DAS	29.87	44.09	3.27	1021.15	1454.48	41.42
6.	30 x 10cm + Quizalofop ethyl @0.05kg/ha on 25 DAS + one hand weeding at 42 DAS	30.47	44.55	3.31	1043.91	1477.24	41.57
7.	40 x 10cm + two hand weeding at 21 and 42 DAS	30.92	45.37	3.21	1079.68	1513.02	41.86
8.	40 x 10cm + pendimethalin @0.75kg/ha at 1 DAS + one hand weeding at 21 DAS	31.38	46.70	3.43	1136.96	1570.30	42.26
9.	40 x 10cm + Quizalofop ethyl @0.05kg/ha on 25 DAS + one hand weeding at 42 DAS	31.91	47.48	3.48	1177.07	1610.41	42.37
	F test	S	S	NS	S	S	S
	SEm (±)	0.33	0.35	0.25	28.15	24.60	0.24
	CD (5%)	1.00	1.06	-	84.40	76.78	0.73

Table 3. Effect of spacing and weed management practices on Economics of Sesame.

S. No	Treatments	Cost of cultivation (INR/ha)	Gross return (INR/ha)	Net return (INR/ha)	B:C ratio
1.	20 x 10cm + two hand weeding at 21 and 42 DAS	26124.00	69391.55	43267.55	1.66
2.	20 x 10cm + pendimethalin @0.75kg/ha at 1 DAS + one hand weeding at 21 DAS	25524.00	73480.37	47956.37	1.88
3.	20 x 10cm + Quizalofop ethyl @0.05kg/ha on 25 DAS + one hand weeding at 42 DAS	25724.00	76079.41	50355.41	1.96
4.	30 x 10cm + two hand weeding at 21 and 42 DAS	26424.00	77640.98	51216.98	1.94
5.	30 x 10cm + pendimethalin @0.75kg/ha at 1 DAS + one hand weeding at 21 DAS	25824.00	79956.05	54132.05	2.10
6.	30 x 10cm + Quizalofop ethyl @0.05kg/ha on 25 DAS + one hand weeding at 42 DAS	26024.00	81738.15	55714.15	2.14
7.	40 x 10cm + two hand weeding at 21 and 42 DAS	26724.00	84539.21	57815.21	2.16
8.	40 x 10cm + pendimethalin @0.75kg/ha at 1 DAS + one hand weeding at 21 DAS	26124.00	88554.43	62430.43	2.39
9.	40 x 10cm + Quizalofop ethyl @0.05kg/ha on 25 DAS + one hand weeding at 42 DAS	26324.00	92164.84	65840.84	2.50

*** Data was not subjected to the statistical analysis**

UNDER PEER REVIEW

REFERENCES:

1. Aruna, E., KarunaSagar, G. and Reddy, A. P. K. (2020). Chemical weed control in broadcasted sesame. *Andhra Pradesh Journal of Agricultural Sciences*, **6**(2): 75-80.
2. Dawale, P.Y. Zalate, D.R. Padmani and D.R. Nikam (2009). Effect of weed population on yield, yield attributing characters and oil content of sesamum (*Sesamum indicum* L.). *Bioinfolet*. **6(**4): 331-333.
3. Dungarwal, H.S., Chaplot, P.C and Nagda, B.L. (2003). Integrated weed management in sesame (*Sesamum indicum* L.). *Indian Journal of Weed Science*. **35**: 236-238.
4. Gomez, K.A., Gomez, A. A., (1976). Three or more factor experiment. (In*:) Statistical Procedure for Agricultural Research 2nd ed*., 1976, pp.139 -141.
5. Joshi. N., Shourabh Joshi2, J.K. Sharma1 , H.S. Shekhawat1 and Uma Nath Shukla (2022). Efficacy of sequential application of pre- and post-emergence herbicides for weed management in sesame. *Indian Journal of Weed Science* **54**(3): 279–282.
6. Kathiresan, G., (2002). Response of sesame (*Sesamum indicum* L.) genotypes to levels of nutrients and spacing under different seasons. *Indian J. Agron*. **47**: 537-540.
7. Mahan, R.K.S., Singh, U.P. and Verma, N.K. (2008). Effect of Planting Geometries in Relation to Fertilizer Combinations on Growth and Yield of Mustard (*Brassica junceacoss*) var. "Varuna" under *Bundelkhand Region of Uttar Pradesh.*
8. Mathukia RK, Sagarka BK, Jadav CN. (2015). Integrated weed management in summer sesame. *India*n *Journal of Weed Science*, **47**(2):150-152.
9. Nayek SS, Brahmachari K, Choudhary MR. (2014). Integrated approach in nutrient management of sesame with special reference to its yield, quality and nutrient uptake. *The Bioscan*. **9**(1): 101-105.
10. Patel S G, Leva R L, Patel H R AndChaudhari N N (2018). Effect of spacing and nutrient management on summer sesame (*Sesamum indicum* L.) under south Gujarat conditions. *IndianJournal of Agricultural Sciences* **88**(4): 647–50.
11. Patil SG, Leva RL, Patil HR, Chaudhari NN. (2017). Effect of spacing and nutrient management on summer sesame (*sesamum indicum* L.) under south Gujarat conditions. *Indian J Agricultural sciences* . **88**(4):00-70867.
12. Patra AK, Mishra A. (2000). Effect of variety, nitrogen and spacing on yield attributes and yields of sesame (*Sesamum indicum* L.) during post-rainy season. *J. Oilseeds Res*. **17**(1):113-116.

UNDER PEER REVIEW

13. Rajpurohit DS, Arvadia LK, Jangir R (2017). Growth and yield of summer sesame (*Sesamum indicum* L.), dry weight of weeds and weed control efficiency influence by different row spacing and weed management under south Gujarat condition. *int j Curr Microbiol Appl Sci* **6**(8): 2493-2501.
14. Shekh M A, Mathukia R K and Sagarka B K. (2014). Sowing time and spacing for summer sesame (*Sesamum indicum* L.). Agriculture: *Towards a New Paradigm of Sustainability, pp*. 111–5.
15. Sheoran P, Shardana V, Singh S, Sharma P, Atwal AK. (2012). Evaluation of pre-emergence herbicides for weed management in sesame (*Sesamum indicum* L.) under semi arid subtropical conditions. *Journal of Oilseeds Research*. **29**(1):53-57.
16. Singh, K., Dhaka, R.S. and Fageria, M.S. (2004). Response of Cauliflower (Brassica oleracea var. botrytis L.) Cultivars to Row Spacing and Nitrogen Fertilization. *Progressive Horticulture,* **36**, 171-173.
17. Sivagamy, K. and Rammohan, J. (2013). Effect of sowing date and crop spacing on growth, yield attributes and quality of sesame. *IOSR Journal of Agriculture and Veterinary Science*, **5**(2): pp38-40.
18. Wysocki, D. and Sirovatka, N. (2010). Effect of Row Spacing and Seeding Rate on Winter Canola in Semiarid Oregon. *Journal of Science*, **85**, 444-446.
19. Yadav R A, Mishra A and Singh D. (2007). Response of sesame cultivars under various plant spacing and seed rates. *Plant Archives***7**(1): 287–8.

UNDER PEER REVIEW