



Studies on Yield and Economics of Sesame (*Sesamum indicum* L.) as Influenced by Spacing and Foliar Application of Zinc

Gali Haritha ^{a≡*}, Rajesh Singh ^{a^o} and Thakur Indu ^{a[#]}

^a Department of Agronomy, NAI, SHUATS, Prayagraj-211007, Uttar Pradesh, India.

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/2022/v34i1430991

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/86213>

Original Research Article

Received 03 February 2022

Accepted 13 April 2022

Published 16 April 2022

ABSTRACT

Background: Sesame plants thrive in hot, dry weather. It is widely naturalized in tropical regions around the world and is cultivated for its edible seeds. The oil content of the seed is inversely proportional to its protein content. Most commercial cultivars of sesame are intolerant of water-logging.

The objective of the present experiment was to analyze the influence of spacing and application of zinc using foliar method on growth, yield and economics of Sesame (*Sesamum indicum* L.) during *kharif* season of 2021. The experiment was designed with varying combination of spacing and zinc using the Randomized Block Design which produced nine treatments with three replicates each. The treatment combinations are T₁ – 25 cm X 15 cm + 0.25% ZnSO₄, T₂ – 25 cm X 15 cm + 0.50% ZnSO₄, T₃ – 25 cm X 15 cm + 0.75% ZnSO₄, T₄ – 35 cm X 15 cm + 0.25% ZnSO₄, T₅ – 35 cm X 15 cm + 0.50% ZnSO₄, T₆ – 35 cm X 15 cm + 0.75% ZnSO₄, T₇ – 40 cm X 10 cm + 0.25% ZnSO₄, T₈ – 40 cm X 10 cm + 0.50% ZnSO₄, T₉ – 40 cm X 10 cm + 0.75% ZnSO₄. The combination, T₉ with spacing 40 X 10 cm and 0.75% ZnSO₄ recorded maximum number of capsules per plant (54.60), number of seeds per capsule (60.50), seed yield (1.20 t/ha), harvest index (31.89 %). The application of treatment T₉ 40 cm X 10 cm + 0.75% ZnSO₄ recorded higher net return (52,016.00 INR/ha), gross return (78,217.00 INR/ha) and benefit: cost ratio (1.99) as well.

[≡]M.Sc. Scholar;

^oAssistant Professor;

[#]Ph.D., Research Scholar;

*Corresponding author: E-mail: galiharitha9@gmail.com;

Conclusion: 40 cm X 10 cm + ZnSo₄ – 0.75 %, had the highest results for yield characteristics such as grain yield (1.20 t/ha), gross return (78,217.00 INR/ha), net return (52,016.00 INR/ha) and benefit: cost ratio (1.99).

Keywords: Economics; sesame; spacing; zinc; yield.

1. INTRODUCTION

Oilseed crops are a diverse group of plants grown in communities for the purpose of obtaining oil. As a result, oilseed production in India is extremely important to the country's economy, as they not only serve a vital part in the industrial sector and indirectly meet the needs of the people, but they also serve as a valuable source of foreign cash. These multipurpose commodities, such as oils and oilcakes, benefits humans, machines and animals, and the economy of our country in one way or another [1].

Sesame (*Sesamum indicum* L.) is an ancient oil seed crop known by different names such as til, gingelly, simsim, gergelim etc. This crop is a part of Pedaliaceae family and has its lineage from East Africa and India. India and China are the topmost producer followed by Myanmar, Uganda, Pakistan, Sudan, Ethiopia, Tanzania, Nigeria, Turkey, Guatemala. Sesame seeds are popular as “Seed of Immortality” and are resistance to rancidity as the percentage of stable unsaturated fatty acids including oleic and linoleic acid is greater than 80%. The by-product of oil milling industry, sesame cake, is an abundant source of protein, niacinamide and minerals (Ca and P). With 25% protein content, this oilseed crop has the maximum oil content (46.64%) [2]. It can be cultivated all year round being a photo-insensitive and a short-term crop with versatile adaptability.

Space plays a pivotal part in growth, development and ultimately the yield Increase in plant population per unit area leads to competition amongst plants for natural resources subsequently producing weak plants and acute lodging. Thus, in order for the crop to efficiently and maximally employ these resources and prevent overcrowding, it is crucial to manage row spacing during cultivation. A direct relationship has been established between crop yield and plant density until the resources turn limiting [3]. Contrary to overcrowding, low-density populace results in a greater number of branches carrying fertile pods and hence, delaying the

development phase for seed. Further, the plant productivity is influenced based on planting conformation as it changes the canopy geometry in turn impacting light interception and CO₂ assimilation [4]. For these reasons, spacing plays a paramount role as it affects the yield of sesame oilseed crop.

For crop feeding, the present-day method includes foliar mode of application where the liquid micronutrients are sprayed directly to the leaves [5]. This method is superior as opposed to soil application as it provides specific and quick response.

Zinc is an essential micronutrient that functions as a structural constituent or regulatory cofactor of a variety of enzymes and proteins in a variety of biochemical pathways, including carbohydrate metabolism, photosynthesis, sugar to starch conversion, protein metabolism, auxin (growth regulator) metabolism, pollen formation, biological membrane integrity, and pathogen resistance. Zinc (Zn) is an essential trace element that plays an important role in a wide range of enzymes, either as a metal component or as a functional, structural, or regulatory cofactor. Murthy [6] reported Zn deficiency results lower oil content. Murthy [7] stated that application of Zn can be implemented for higher yield and quality.

2. MATERIALS AND METHODS

The present field research was carried at Crop Research Farm of Department of Agronomy, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj at the beginning of *kharif* season (2021). The geographic coordinates were as follows: 25°24'42"N latitude and 81°50'56"E longitude being 98 m above the sea level. The objective included to study the influence of spacing and foliar application of zinc on growth, yield as well as economics of Sesame (*Sesamum indicum* L.) Var. G-1. The experiment was designed with varying combination of spacing and zinc using the Randomized Block Design which produced nine treatments with three replicates each. The

average plot size was 3m X 3m, a total of 9 treatments were established as follows:

- T₁ – 25 cm X 15 cm + 0.25% ZnSo₄,
- T₂ – 25 cm X 15 cm + 0.50% ZnSo₄,
- T₃ – 25 cm X 15 cm + 0.75% ZnSo₄,
- T₄ – 35 cm X 15 cm + 0.25% ZnSo₄,
- T₅ – 35 cm X 15 cm + 0.50% ZnSo₄,
- T₆ – 35 cm X 15 cm + 0.75% ZnSo₄,
- T₇ – 40 cm X 10 cm + 0.25% ZnSo₄,
- T₈ – 40 cm X 10 cm + 0.50% ZnSo₄,
- T₉ – 40 cm X 10 cm + 0.75% ZnSo₄.

The foliar application of zinc was applied as single spray at 40DAS. Upon reaching the maturity age, each treatment-wise crop was harvested. From each plot, five replicates were selected randomly to study and record the parameters of growth such as height of plant (cm) and dry matter accumulation (g/plant). The seeds were gathered from plots after the harvesting to be dried in sunlight for three days. After winnowing and cleaning, yield per hectare (t/ha) was computed. Stover yield (t/ha) was computed as well after drying the seeds for 10 days. For statistical analysis, Gomez and Gomez [8] method was adopted. The cost of seed with stover value and total cost was used to determine the benefit: cost ratio.

3. RESULTS AND DISCUSSION

3.1 Yield Attributes

3.1.1 Number of capsules/plants

Significant effect was observed by the statistical analysis of number of capsules/plant. Treatment T₉ 40 cm X 10 cm + ZnSo₄ – 0.75 % recorded significant and highest number of capsules/plant (54.60). However, treatment T₈ 40 cm X 10 cm + ZnSo₄ – 0.50 % was found to be statistically on par with 40 cm X 10 cm + ZnSo₄ – 0.75 %. The yield attributing characters such as number of capsules/plant was significantly higher with wider spacing. It may be due to less competition exerted for light, moisture and nutrients. Sufficient interception of sunlight promotes efficient photosynthesis activities and ultimately greater accumulation of photosynthates under wider spacing. Narrow spacing with dense plant population resulted in the lower values of yield attributes. The increase in number of capsules/plant due to zinc might be due to adequate supply of zinc during early growth is considered important in promoting vegetative growth by influencing cell division and

elongation in meristematic cell, thereby increasing the sink in terms in of number of capsules/plant. Similar results were also reported by Kumar et al. [9], Yadav et al. [10], Shekh et al. [11] and Patel [12].

3.1.2 Number of seeds/capsules

Significant effect was observed by the statistical analysis of number of seeds per capsule. Treatment 40 cm X 10 cm + ZnSo₄ – 0.75 % recorded significant and highest number of seeds/capsule (60.50). However, 40 cm X 10 cm + ZnSo₄ – 0.50 % recorded statistically on par with 40 cm X 10 cm + ZnSo₄ – 0.75 %. The yield attributing characters such as number of seeds/capsule were significantly higher with wider spacing. It may be due to less competition exerted for light, moisture and nutrients. Sufficient interception of sunlight promotes efficient photosynthesis activities and ultimately greater accumulation of photosynthates under wider spacing. Narrow spacing with dense plant population resulted in the lower values of yield attributes. The increase in number of seeds/capsule due to zinc might be due to adequate supply of zinc during early growth is considered important in promoting vegetative growth by influencing cell division and elongation in meristematic cell, thereby increasing the sink in terms in of number of seeds/capsule. Similar results were also reported by Kumar et al. [9], Yadav et al. [10], Shekh et al. [11] and Patel [12].

3.2 Grain Yield

Grain yield was significantly influenced with different combinations of Spacing and Foliar application of zinc along with nitrogen, phosphorus and potassium. The highest grain yield was obtained with the treatment 40 cm X 10 cm + ZnSo₄ – 0.75 % (1.20 t), However 35 cm X 15 cm+ ZnSo₄ – 0.75 % and 40 cm X 10 cm + ZnSo₄ – 0.50 % were found to be statistically on par with 40 cm X 10 cm + ZnSo₄ – 0.75 %. The grain yield of sesame increased significantly with increase in spacing and zinc. The grain yield of sesame increased significantly with increase in spacing and the level of applied foliar zinc up to 0.75%. Increase in spacing resulted due to better utilization of available resources viz. mineral, nutrients, water, solar radiation etc. and the optimum plant population due to higher yield of crop. The positive effect of zinc on seed yield might have been due to its requirement in carbohydrate synthesis, the

pronounced role in photosynthesis and cell elongation. The increase in yield attributes and yield due to the application of Zn. Similar results were also reported by Kumar et al. [9], Paraye et al. [13], Deosarkar et al. [14] in soybean. Higher seed yield and stover yield due to

spacing 40cm x 10cm spacing might be due to availability of larger feeding area for better utilisation of natural resources like space, sunlight, water, nutrients etc. This is in agreement with the findings of Shinde et al., [15].

Table 1. Effect of Spacing and Foliar application of Zinc on yield and yield attributing characters of Sesame

S. No	Treatment combinations	No. of capsules/plant	No. of seeds/capsule	Seed Yield (t/ha)	Stover Yield (t/ha)
T1	25 cm X 15 cm + ZnSo4 – 0.25 %	42.60	53.60	1.04	2.44
T2	25 cm X 15 cm + ZnSo4 – 0.50 %	44.40	54.53	1.06	2.47
T3	25 cm X 15 cm + ZnSo4 – 0.75 %	47.67	54.93	1.09	2.49
T4	35 cm X 15 cm + ZnSo4 – 0.25 %	45.60	56.43	1.11	2.50
T5	35 cm X 15 cm + ZnSo4 – 0.50 %	48.07	56.83	1.12	2.52
T6	35 cm X 15 cm + ZnSo4 – 0.75 %	51.47	57.30	1.17	2.54
T7	40 cm X 10 cm + ZnSo4 – 0.25 %	49.53	58.60	1.14	2.51
T8	40 cm X 10 cm + ZnSo4 – 0.50 %	53.87	59.37	1.19	2.56
T9	40 cm X 10 cm + ZnSo4 – 0.75 %	54.60	60.50	1.20	2.57
F test		S	S	S	S
S.Em (±)		0.60	0.55	0.01	0.01
CD (P<0.05)		1.77	1.64	0.03	0.04

Table 2. Effect of Spacing and Foliar application of Zinc on economics of Sesame

S. No	Treatment Combinations	Cost of cultivation (INR/ha)	Gross return (INR/ha)	Net return (INR/ha)	Benefit: Cost ratio
T1	25 cm X 15 cm + ZnSo4 – 0.25 %	25,856.00	67,817.00	41,961.00	1.62
T2	25 cm X 15 cm + ZnSo4 – 0.50 %	25,856.00	68,683.00	42,827.00	1.66
T3	25 cm X 15 cm + ZnSo4 – 0.75 %	25,856.00	70,850.00	44,994.00	1.74
T4	35 cm X 15 cm + ZnSo4 – 0.25 %	25,846.00	72,367.00	46,521.00	1.80
T5	35 cm X 15 cm + ZnSo4 – 0.50 %	25,846.00	72,583.00	46,737.00	1.81
T6	35 cm X 15 cm + ZnSo4 – 0.75 %	25,846.00	76,050.00	50,204.00	1.94
T7	40 cm X 10 cm + ZnSo4 – 0.25 %	26,201.00	73,883.00	47,682.00	1.82
T8	40 cm X 10 cm + ZnSo4 – 0.50 %	26,201.00	77,133.00	50,932.00	1.94
T9	40 cm X 10 cm + ZnSo4 – 0.75 %	26,201.00	78,217.00	52,016.00	1.99

#Data not subjected to statistical analysis

3.3 Stover Yield

Highest stover yield (2.57 t/ha) was recorded at treatment T₉ 40 cm X 10 cm + ZnSo₄ – 0.75 %, however, treatment T₆ 35 cm X 15 cm + ZnSo₄ – 0.75 % and T₈ 40 cm X 10 cm + ZnSo₄ – 0.50 % were found to be statistically onpar with T₉ 40 cm X 10 cm + ZnSo₄ – 0.75 %. The stover yield of sesame increased significantly with increase in spacing and the level of applied foliar zinc. The stover yield of sesame increased significantly with increase in spacing and the level of applied foliar zinc up to 0.75%. Increase in spacing resulted due to better utilization of available resources viz. mineral, nutrients, water, solar radiation etc. and the optimum plant population due to higher yield of crop. The positive effect of zinc on stover yield might have been due to its requirement in carbohydrate synthesis, the pronounced role in photosynthesis and cell elongation. The increase in yield attributes and yield due to the application of Zn might be due to fact that Zn influences on the water economy and crop growth through its effect on water uptake, root growth, maintenance of turgor, transpiration and stomatal behaviour, overcomes the adverse effect of water stress and improving the drought tolerance. Similar results were also reported by Kumar et al. [9], Paraye et al. [13], Deosarkar et al. [14] in soybean.

3.4 Economics

Out of all the different treatment combinations, T₉ 40 cm X 10 cm + ZnSo₄ – 0.75 %, was the most economically sound combination with highest net return (52,016.00 INR/ha), gross return (78,217.00 INR/ha) and benefit: cost ratio (1.99).

4. CONCLUSION

Different treatment combinations based on spacing and foliar application of Zinc were designed to analyze their effect on growth, yield as well as economics of Sesame. Amongst all the treatments, T₉ 40 cm X 10 cm + ZnSo₄ – 0.75 %, had the highest results for yield characteristics such as grain yield (1.20 t/ha), gross return (78,217.00 INR/ha), net return (52,016.00 INR/ha) and benefit: cost ratio (1.99). However, this research was based on experiments done for one season and could be repeated further for different seasons.

ACKNOWLEDGEMENTS

I express my gratitude to my advisor Dr. Rajesh Singh for constant support, guidance and for his valuable suggestions for improving the quality of this work. I am indebted to Dr. Umesha C. who has been a constant source of inspiration and all the faculty members of Department of Agronomy, SHUATS, Prayagraj, Uttar Pradesh (U.P), India for providing necessary facilities, for their cooperation, encouragement and support.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Weiss EA. Oil seed crops. Tropical Agriculture Series. Longman. London and New York; 1983.
2. Thanunathan K, Manickam G, Singharawal R. Studies on the influence of integrated nutrient management on growth, yield parameters and seed yield of sesamum. Crop Research. 2002;24(2): 309-313.
3. Norsworthy JK, Emerson RS. Effect of row spacing and soybean genotype on main stem and branch yield. Agronomy Journal. 2005;97:919-923.
4. Brar ZS, Bal DS, John AS. Influences of sowing dates, nitrogen and planting geometry on the performance of Gobhi Saron (*Brassica napus* spp. *olifera* var. *annua*). Indian Journal of Agronomy. 1998; 43(1):133-137.
5. Nasiri Y, Zehtab-Salmi S, Nasrullahzadeh S, Najafi N, Ghassemi Golezani K. Effect of foliar application of micronutrients (Fe and Zn) on flower yield and essential oil of chamomile (*Matricaria chamomilla* L.). Journal of Medicinal Plants Research. 2010;4(17):1733-1737.
6. Murthy IYLN, Muralidharudu YJ. Evaluation of castor genotypes under low zinc Alfisols. Journal of Oilseeds Research. 2003;20(1):156–157.
7. Murthy IYLN, Padmavathi P. Establishment of critical zinc, phosphorus: zinc ratio limits in safflower. Indian Journal of Agricultural Science. 2008;78(2):135–137.

8. Gomez KA, Gomez AA. Statistical Procedures for Agricultural Research. Edition 2. Wiley Inter Science Publications and John Wiley and Sons, New York; 1984.
9. Kumar S, Tewari SK, Singh SS. Effect of sources and levels of sulphur and spacing on the growth, yield and quality of spring sunflower (*Helianthus annuus*). Indian Journal of Agronomy. 2011;56(3):242–246.
10. Yadav RA, Mishra A, Singh D. Response of sesame cultivars under various plant spacing and seed rates. Plant Archives. 2007;7(1):287–288.
11. Shekh MA, Mathukia RK, Sagarka BK. Sowing Time and Spacing for summer Sesame (*Sesamum indicum* L.) Agriculture; Towards a New Paradigm of Sustainability. 2014;111-115.
12. Patel HK. Response of summer sesame to different spacing's and levels of nitrogen under north Gujarat condition. Thesis submitted to S.D.A.U., Gujarat; 2012.
13. Paraye PM, Kashyap TL, Chaubey AK. Effect of nutrient management practices and row spacing on growth yield attributes and yield of Indian mustard (*Brassica juncea* L.). Environment and Ecology. 2009;27(2):589–591.
14. Deosarkar DB, Patinge SP, Bhosale AM, Deshmukh SB. Effect of micronutrient on seed yield of soybean. Annals of Plant Physiology. 2001;15:163-166.
15. Shinde SD, Raskar BS, Tamboili BD. Effect of spacing and sulphur levels on productivity of sesame (*Sesamum indicum* L.) under summer condition. Journal of Maharashtra Agriculture University. 2011; 36(1):28-31.

© 2022 Haritha et al.; This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Peer-review history:

The peer review history for this paper can be accessed here:
<https://www.sdiarticle5.com/review-history/86213>