Journal of Scientific Research and Reports

Volume 30, Issue 10, Page 842-853, 2024; Article no.JSRR.124275
ISSN: 2320-0227

Comparative Study of Irrigation and Nitrogen Management on *Summer* Sesame (*Sesamum indicum* L.)

Ankitha Suresh [a*], Monotosh Das Bairagya [a] and Apurba Mishra [a]

[a] Department of Agronomy, Siksha O Anusandhan Deemed to be University, Bhubaneswar- 751 003, Odisha, India.

Authors' contributions

This work was carried out in collaboration among all authors. Author AS performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Author MDB designed the study and managed the analyses of the study. Author AM managed the literature searches. All authors read and approved the final manuscript.

Article Information

DOI: https://doi.org/10.9734/jsrr/2024/v30i102508

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/124275

Original Research Article

Received: 05/08/2024
Accepted: 07/10/2024
Published: 16/10/2024

ABSTRACT

Aim: The aim of the experiment is to know the effect of irrigation and nitrogen management on growth, yield attributes, yield, economics and WUE of *summer* sesame.
Study Design: The experiment was laid out in split-plot design.
Place and Duration of Study: Research Farm of Agricultural Research Station, Brinjhagiri, Chhatabar of Faculty of Agricultural Sciences, Siksha O Anusandhan (Deemed to be University), Bhubaneswar (Odisha), during *summer* season of 2024.
Methodology: Three levels of irrigation (I_1 -3 irrigations at branching, flowering and capsule development stage, I_2 -2 irrigations at branching and flowering stage and I_3 -2 irrigations at

**Corresponding author: E-mail: ankithasuresh0902@gmail.com;*

***Cite as:** Suresh, Ankitha, Monotosh Das Bairagya, and Apurba Mishra. 2024. "Comparative Study of Irrigation and Nitrogen Management on Summer Sesame (Sesamum Indicum L.)". Journal of Scientific Research and Reports 30 (10):842-53. https://doi.org/10.9734/jsrr/2024/v30i102508.*

branching and capsule development stage) as main-plot treatments and four nutrient management levels (N_1 -STBR- 100% N through inorganic, N_2 -75% N through inorganic + 25% N through FYM, N_3 -75% N through inorganic + 25% N through vermicompost and N_4 -50% N through inorganic + 25% N through FYM+ 25% N through vermicompost) as sub-plot treatments replicated thrice. The net plot size was 4m × 3m.

Results: I_1 resulted the highest seed yield (795.1 kg ha^{-1}) and stover yield (2057.1 kg ha^{-1}). N_1 produced highest seed yield (818.9 kg ha^{-1}) and stover yield (2101.4 kg ha^{-1}). Highest net return (₹35894.00) and return per rupee investment (1.83) was obtained in I_1N_1. The highest WUE (4.14 kg ha^{-1} mm^{-1}) was calculated in I_2N_1.

Conclusion: Three irrigations at branching, flowering and capsule development stage and 50% N through inorganic + 25% N through FYM + 25% N through vermicompost can be recommended to achieve higher seed yield, higher oil content and oil yield.

Keywords: Sesame; irrigation; FYM; vermicompost; water use efficiency; yield and economics.

1. INTRODUCTION

Oilseeds play an important part in agricultural and industrial economy around the world. It is the main source of fats and protein, especially for vegetarians. Sesame (*Sesamum indicum* L., 2n = 26), an ancient oilseed crop that belongs to the *Pedaliaceae* family, is widely cultivated in Asia and Africa [1-3]. India ranks first in the world with 19.47 lakh ha area and 8.66 lakh tonnes production [4]. Tropical and subtropical regions typically host its growth. Because of its excellent stability, drought resilience and ease of extraction, it was a prominent oilseed crop in antiquity. Sesame is traditionally considered as a healthy food in Asian countries [5]. With its 32% crude protein and 8–10% oil content, sesame cake is a vital feed for cattle, poultry, and small ruminants [6]. It is susceptible to salinity and grows best on well-drained, relatively fertile soils that range in pH from 5.5 to 8.0. The sesame industry has certain challenges like yield instability and susceptibility to abiotic and biotic stresses and has limitations on technological advancements for cultivation. Lack of high-yielding and adapted varieties, vulnerability to capsule shattering, indeterminate growth habits, as well as abiotic and biotic stresses leads to lower the sesame yield [7,8]. It is mostly grown under rainfed conditions in arid and semi-arid regions where mild-to-severe moisture deficit stress is experienced. It is sensitive to drought mainly at the vegetative stages [9] in all of its growing regions and has low production potential in semiarid regions due to drought stress. Grain yield, as well as oil yield and quality, vary with genotypes and drought intensity. Sesame requires regular rainfall or proper irrigation. But extreme conditions like flooding, drought, and waterlogging can have a detrimental impact on growth and seed yield, emphasizing the need for well-managed water levels [10]. Positive effects on sesame yield have been documented by providing optimal irrigation practices during vegetative, flowering and fruiting stages [11]. Sesame is largely cultivated in the post-rainy or summer season with limited water availability and yield declines due to water deficit, particularly during moisture sensitive stages, highlighting the impact of irrigation on plant growth and development [12].

The major important factors for low yield of sesame are nutrient deficiency and imbalanced fertilizer. The main goal of integrated nutrient management is to minimize the massive use of chemical fertilizers, increase the balance between fertilizer inputs and crop nutrient requirements, optimizing yield, maximize profitability and decrease environmental pollution [13]. Balanced and efficient use of organic and inorganic sources of nutrients will lead to an increase in yield potential of the crop [14]. Efficient management of inorganic and organic sources helps in achieving continuous production of crops in an economically and sustainable manner. In order to balance the pH of the soil and provide macro and micronutrients, organic manures are added to sustain the levels of humic substances, especially fulvic and humic acid [15]. Thus, FYM and compost can't replace chemical fertilizers for maintaining soil fertility and productivity, but they can certainly reduce their inputs. Farmyard manure, vermicompost and chicken manure are examples of organic manures that are good sources of nutrients that plants require for producing high-quality produce. Appropriate and judicial use of proper nutrients through organic and inorganic sources can provide solutions to the ongoing problems such as an increase in the price of inorganic fertilizers and deterioration of soil fertility and productivity

[16]. In order to maintain high agricultural productivity over time, enhance soil health, and create a safer environment, integrated use of nutrient is an important approach.

Being a key structural component of cells, nitrogen is necessary for both vegetative and reproductive growth. At various growth phases, the application of N greatly boosted the dry matter accumulation of the crop's roots and shoots [17]. This manuscript on irrigation and nitrogen management in *summer* sesame (*Sesamum indicum* L.) is important for agriculture as it explores ways to improve crop yield, reduce water requirement and sustainability. By studying how different irrigation methods and nitrogen use affect sesame growth, the research offers useful guidelines for farmers. With the growing demand for oilseeds and the challenges of climate change, this study helps enhance resilience in sesame farming. Keeping these views in mind, an experiment was conducted with the objective to know the effect of irrigation and nitrogen management on growth, yield attributes, yield, economics and WUE of *summer* sesame.

2. MATERIALS AND METHODS

An experiment was conducted at Research Farm of Agricultural Research Station, Brinjhagiri, Chhatabar, Faculty of Agricultural Sciences, Siksha 'O' Anusandhan (Deemed to be University), Bhubaneswar (Odisha) during *summer* season of 2024. The location is situated in the South east coastal plain Zone of India. The field where the experiment was carried out is located at Latitude is 20.46°N and Longitude 85.67° E. The experimental field soil was sandy loam in texture, slightly acidic in reaction (pH 5.7), medium in organic carbon 0.42% (Walkley and Black, 1934 and Muhr et al.,1965), with medium available nitrogen 263.7 kg ha^{-1} (Alkaline permanganate method, Jackson, 1973), medium in available phosphorus 18.4 kg ha^{-1} (Bray's method, Bray and Krutz method*.,* 1945) and medium available potassium 136.7 kg ha^{-1} (Flame photometer Method, Muhr et al.1965) (Table 1). The experimental sesame variety "Prachi (ORM-17)" that was used in the study is a black-seeded variety with the duration of 85–95 days. The net plot size was 4.0 m × 3.0 m. The experiment was laid out in a split plot design with three levels of irrigation (I_1 -3 irrigations at branching, flowering and capsule development stage, I_2 -2 irrigations at branching and flowering stage and I_3 -2 irrigations at branching and capsule development stage) as main-plot treatments and four nutrient management levels (N_1 -STBR- 100% N through inorganic, N_2 -75% N through inorganic + 25% N through FYM, N_3 -75% N through inorganic + 25% N through vermicompost and N_4 -50% N through inorganic + 25% N through FYM+ 25% N through vermicompost) as sub-plot treatments with three replications. A considerable amount of rainfall (80.6 mm) occurred during cropping season (Fig. 1). A common pre-sowing irrigation was provided to all plots and later on irrigation was given as per treatments. Irrigation at branching, flowering and capsule development stage was given at a depth of 6cm using Area- Velocity method. The recommended dose of fertilizer was 40: 20: 20 (N, P_2O_5, K_2O) kg ha^{-1}. Organic sources of nitrogen were applied a day before sowing. Urea, single super phosphate and muriate of potash were used as sources of the N, P and K respectively. Fifty percent of N along with full dose of P and K were applied as basal and combined with the soil of the different plots. According to the treatment, the remaining N dose (half of the recommendation) was top dressed at branching stage. The plant growth attributes

Table 1. Soil physico-chemical properties of experimental soil

Sl. No	Properties	Value	Method used
1.	Mechanical composition		
	Sand (%)	71.4%	International pipette method (Jackson, 1973)
	Silt (%)	20.1%	
	Clay (%)	8.5%	
2.	Soil texture	Sandy loam soil	USDA system (Brady, 1974)
3.	pH	5.7	(Jackson, 1973)
4.	Electrical conductivity (dS m^{-1})	1.33	(Jackson, 1973)
5.	Organic carbon (%)	0.42	Walkley and Black method (Jackson, 1973)
6.	Available nitrogen (kg/ha)	263.7	Alkaline permanganate method (Jackson, 1973)
7.	Available phosphorus (kg/ha)	18.4	Bray's method (Bray and Krutz method*.,* 1945)
8.	Available potassium (kg/ha)	136.7	Flame photometric method (Jackson, 1973)

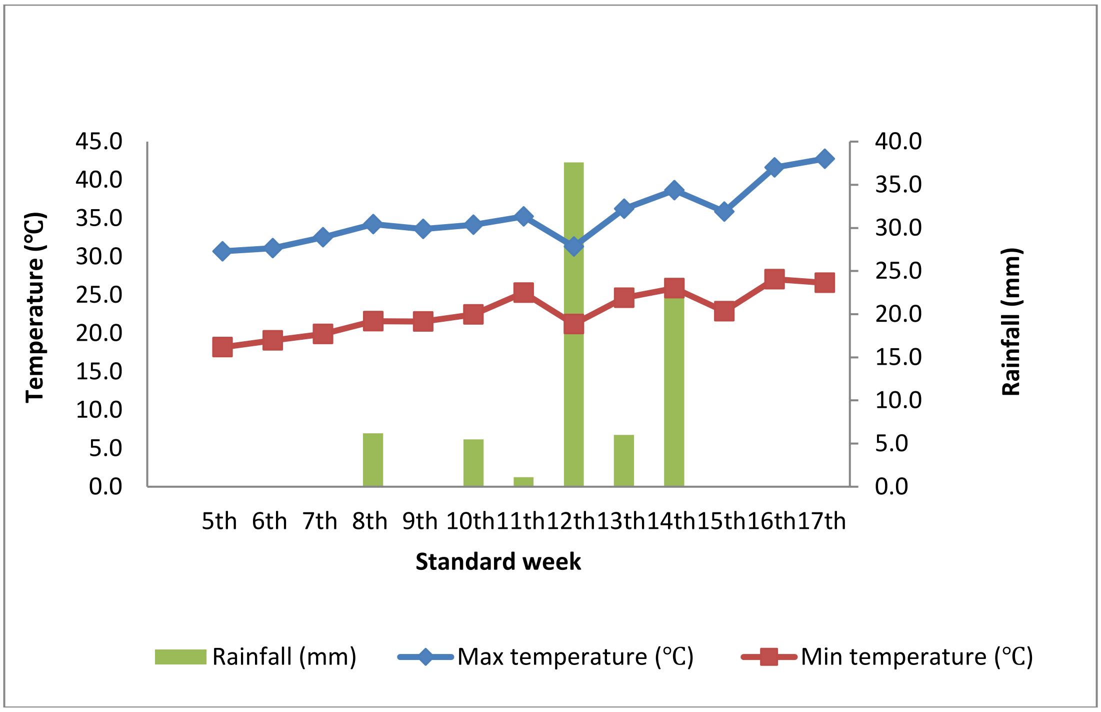

Fig. 1. Standard week, Maximum and Minimum temperature, Rainfall during experimental period

data like, plant height (cm), dry matter accumulation (g m^{-2}) and number of branches $plant^{-1}$ and yield attributing and yield characters like, number of capsules $plant^{-1}$, test weight (g), seed yield (kg ha^{-1}) and stover yield (kg ha^{-1}) was taken during maturity period. Harvest index, water use efficiency (kg ha^{-1} mm^{-1}) and economics of cultivation were estimated. The experimental data recorded were subjected to statistical analysis by the analysis of variance method (Gomex and Gomex, 1984). Fisher's 'F' test at probability level 0.05 tested the significance of different sources of variations. For the determination of critical difference at 5% level of significance, Fisher and Yate's tables were consulted. The value of standard error of mean [Sem (±)] and the least significant difference (CD) to compare the differences between the treatment means have been provided in tables, the coefficient of variation (CV %) was also given in each table.

3. RESULTS AND DISCUSSION

3.1 Effect on Growth Parameters

Observations from the entire study proved that, at maturity I_1 regime (3 irrigations at branching, flowering, and capsule development stages) produced the tallest plant (83.1 cm), maximum amount of dry matter accumulation (402.6 g m^{-2}) and highest number of branches $plant^{-1}$ (4.2) followed by I_2 regime (2 irrigations at branching and flowering stages) (82.4 cm, 387.8 g m^{-2} and 4.0 respectively). An increase in dry matter yield under I_1 may be due to the fact that the crop might have received the right quantity of irrigation at the right crop growth stage. These outcomes closely correspond with obtained by Chang et al. [18].

Irrespective of irrigation management, N_1 (STBR-100% N through inorganic) attained the tallest plant height (83.6 cm) followed by N_4 (50% N through inorganic + 25% N through FYM + 25% N through vermicompost) (82.6 cm). Whereas, at maturity, N_4 (50% N through inorganic + 25% N through FYM + 25% N through vermicompost) produced the highest amount of dry matter (403.1 g m^{-2}) and the maximum number of branches $plant^{-1}$ (4.3) followed by N_1 (STBR-100% N through inorganic) 394.8 g m^{-2} and 4.1 respectively. This could be due to the combination of inorganic and organic fertilizers which helped in increasing growth attributes and production of more dry matter [19]. Nitrogen application significantly affects the dry matter accumulation crop at different growth stages [17] (Table 2).

3.2 Effect on Yield Attributes and Yield

The highest number of capsules plant^{-1} (41.2), number of seeds capsule^{-1} (57.7) was observed in I_1 (3 irrigations at branching, flowering and capsule development stage) and is statistically at par with I_2 (2 irrigations at branching and flowering stage) 40.6 and 55.9 respectively. Test weight was counted to be highest in I_1 regime (2.66 g) and lowest in I_2 regime (2.41 g). Among different nitrogen management, the maximum number of capsules plant^{-1} (43.0), number of seeds capsule^{-1} (58.8) was observed in N_1 (STBR- 100% N through inorganic) and is at par with N_4 (50% N through inorganic + 25% N through FYM+ 25% N through vermicompost) 42.1 and 55.9 respectively. Maximum test weight (2.66 g) was obtained in N_4 (50% N through inorganic + 25% N through FYM+ 25% N through vermicompost) (Table 2). Statistically higher number of seed-bearing parts plants^{-1} recorded with the application of nitrogen fertilizer and vermicompost in an integrated pattern, which might have helped to supply sufficient nutrients timely throughout the growth period [20]. The application of organic sources resulted in a significant and maximum number of seeds plant^{-1}, potentially improving the overall growth of the crop at a lower cost. Thus, more availability of nutrients during growing periods and take part in metabolic activity for developing reproductive structures shows to have resulted in a higher number of seeds plant^{-1} [21,22].

Three irrigations at branching, flowering and capsule development stage (I_1) resulted the highest seed yield (795.1 kg ha^{-1}), stover yield (2057.1 kg ha^{-1}) and harvest index (0.28) followed by I_2 (2 irrigations at branching and flowering stage) 763.3 kg ha^{-1}, 2012.7 kg ha^{-1} and 0.28 respectively. The maximum amount of seed yield in 3 irrigations at branching, flowering and capsule development stage (I_1) may be due to producing maximum number of capsules per plant on account of increased availability of water. Optimum irrigation scheduling increased the seed yield of sesame [23]. Water deficiency during reproductive stage especially during capsule formation stage showed drastic reduction in seed yield [24]. Irrespective of irrigation levels, STBR- 100% N through inorganic (N_1) produced highest seed yield (818.9 kg ha^{-1}), stover yield (2101.4 kg ha^{-1}) and harvest index (0.28), followed by N_4 (50% N through inorganic + 25% N through FYM+ 25% N through vermicompost), 791.5 kg ha^{-1}, 2067.0 kg ha^{-1} and 0.28 respectively. The higher yield due to combined application of chemical fertilizer and organic manures could lead to more exploitation of crop genetic potential for vegetative and reproductive growth and sustained nutrient supply [25,16]. Combined application of organic manures and chemical fertilizers resulted in better consumption of applied nutrients through enhanced micro environmental conditions and the activities of soil microorganisms involved in nutrient transformation and fixation [26,27] (Table 3).

3.3 Oil Content and Oil Yield

Three irrigations at branching, flowering and capsule development stage (I_1) resulted in statistically highest oil content (47.2%) and oil yield (371.1 kg ha^{-1}). The lowest oil content was found in 2 irrigations at branching and capsule development stage (I_3) (44.4%) and oil yield (306.5 kg ha^{-1}). Among the different nitrogen management, it was found out that N_4 with 50% N through inorganic + 25% N through FYM+ 25% N through vermicompost, gave the highest oil content (48.1%) and oil yield (381.0 kg ha^{-1}). The application of FYM, vermicompost, and chemical fertilizers has enhanced the oil content because of the increased availability of sulphur, which is involved in the conversion of primary fatty acid metabolites to fatty acid end products [28,29] (Table 3).

3.4 Water Use Efficiency

The relationship of seed yield (Y) response to varying levels of water input is known as crop water production functions and can be beneficial for various water management applications. Improving agricultural water use efficiency (WUE) is essential because of the demand for increased grain production in India. The results showed that different water management treatments had an important effect on seed yield (Fig. 1). The highest WUE (4.14 kg ha^{-1} mm^{-1}) was calculated in I_2N_1 (2 irrigations at branching and flowering stage with STBR- 100% N through inorganic). The second highest WUE (3.99 kg ha^{-1} mm^{-1}) was calculated in I_2N_4 (2 irrigations at branching and flowering stage with 50% N through inorganic + 25% N through FYM+ 25% N through vermicompost). That may be due to a considerable less amount of water application without affecting crop yield. In case of I_1N_2 (3 irrigations at branching, flowering and capsule development stage with 75% N through inorganic + 25% N through FYM) produced the lowest WUE of 2.73 kg ha^{-1} mm^{-1}. as presented in Fig. 2. Because application

Table 2. Effect of irrigation and nitrogen management on plant height, number of branches plant^{-1}, number of capsules plant^{-1}, number of seeds capsule^{-1} and test weight (g) at maturity on *summer* sesame

Treatments	Plant height (cm)	Dry matter accumulation (g m^{-2})	Number of branches plant $^{-1}$	Number of capsules plant^{-1}	Number of seeds capsule^{-1}	Test weight (g)
I_1 (3 irrigations at branching, flowering and capsule development stage)	83.1	402.6	4.2	41.2	57.7	2.66
I_2 (2 irrigations at branching and flowering stage)	82.4	387.8	4.0	40.6	55.9	2.41
I_3 (2 irrigations at branching and capsule development stage)	78.5	363.3	3.8	38.9	50.9	2.57
SEm (±)	**0.4**	**4.3**	**0.1**	**0.44**	**1.3**	**0.05**
CD (0.05)	**1.6**	**16.9**	**0.5**	**1.8**	**5.1**	**0.20**
N_1 (STBR- 100% N through inorganic)	83.6	394.8	4.1	43.0	58.8	2.57
N_2 (75% N through inorganic + 25% N through FYM)	79.1	366.4	3.9	37.1	50.4	2.46
N_3 (75% N through inorganic + 25% N through vermicompost)	80.1	373.8	3.9	38.7	54.3	2.49
N_4 (50% N through inorganic + 25% N through FYM+ 25% N through vermicompost)	82.6	403.1	4.3	42.1	55.9	2.66
SEm (±)	**0.6**	**4.7**	**0.1**	**0.5**	**1.0**	**0.1**
CD (0.05)	**2.3**	**18.5**	**0.6**	**2.0**	**3.8**	**0.4**

Table 3. Effect of irrigation and nitrogen management on seed yield (kg ha^{-1}), stover yield (kg ha^{-1}), harvest index, oil content (%) and oil yield (kg ha^{-1}) on summer sesame

Treatments	Seed yield (kg ha^{-1})	Stover yield (kg ha^{-1})	Harvest index	Oil content (%)	Oil yield (kg ha^{-1})
I_1 (3 irrigations at branching, flowering and capsule development stage)	795.1	2057.1	0.28	47.2	371.1
I_2 (2 irrigations at branching and flowering stage)	763.3	2012.7	0.28	46.5	350.4
I_3 (2 irrigations at branching and capsule development stage)	698.8	1990.4	0.26	44.4	306.5
SEm (±)	**8.6**	**23.6**	**0.001**	**0.3**	**7.7**
CD (0.05)	**34.6**	**92.8**	**0.004**	**1.2**	**30.3**
N_1 (STBR- 100% N through inorganic)	818.9	2101.4	0.28	46.0	358.3
N_2 (75% N through inorganic + 25% N through FYM)	680.5	1921.3	0.26	44.6	304.2
N_3 (75% N through inorganic + 25% N through vermicompost)	718.8	1990.4	0.27	45.5	327.2
N_4 (50% N through inorganic + 25% N through FYM+ 25% N through vermicompost)	791.5	2067.0	0.28	48.1	381.0
SEm (±)	**8.8**	**10.8**	**0.001**	**0.5**	**9.5**
CD (0.05)	**34.2**	**42.5**	**0.003**	**2.1**	**37.2**

Table 4. Cost of cultivation of *summer* sesame influenced by irrigation and nitrogen management

Treatments	Cost of cultivation (₹)	Gross return (₹)	Net return (₹)	Return per rupee investment
I_1N_1 (3 irrigations at branching, flowering and capsule development stage with STBR- 100% N through inorganic)	43246	79140	35894	1.83
I_1N_2 (3 irrigations at branching, flowering and capsule development stage with 75% N through inorganic + 25% N through FYM**)**	44872	65940	21067	1.47
I_1N_3 (3 irrigations at branching, flowering and capsule development stage with 75% N through inorganic + 25% N through vermicompost**)**	51072	70903	19830	1.39
I_1N_4 (3 irrigations at branching, flowering and capsule development stage with 50% N through inorganic + 25% N through FYM+ 25% N through vermicompost**)**	52699	78749	26050	1.50
I_2N_1 (2 irrigations at branching and flowering stage with STBR- 100% N through inorganic**)**	42246	77050	34804	1.82
I_2N_2 (2 irrigations at branching and flowering stage with 75% N through inorganic + 25% N through FYM**)**	43872	65168	21295	1.48
I_2N_3 (2 irrigations at branching and flowering stage with 75% N through inorganic + 25% N through vermicompost**)**	50072	66491	16418	1.33
I_2N_4 (2 irrigations at branching and flowering stage with 50% N through inorganic + 25% N through FYM+ 25% N through vermicompost **)**	51699	74239	22540	1.44
I_3N_1 (2 irrigations at branching and capsule development stage with STBR- 100% N through inorganic**)**	42246	71459	29213	1.69
I_3N_2 (2 irrigations at branching and capsule development stage with 75% N through inorganic + 25% N through FYM**)**	43872	58089	14216	1.32
I_3N_3 (2 irrigations at branching and capsule development stage with 75% N through inorganic + 25% N through vermicompost**)**	50072	62434	12361	1.25
I_3N_4 (2 irrigations at branching and capsule development stage with 50% N through inorganic + 25% N through FYM+ 25% N through vermicompost**)**	51699	67047	15348	1.30
SEm (±)	**-**	**51.7**	**28.1**	**-**
CD (0.05)	**-**	**205.2**	**112.6**	**-**

(₹: Rupees, Indian currency)

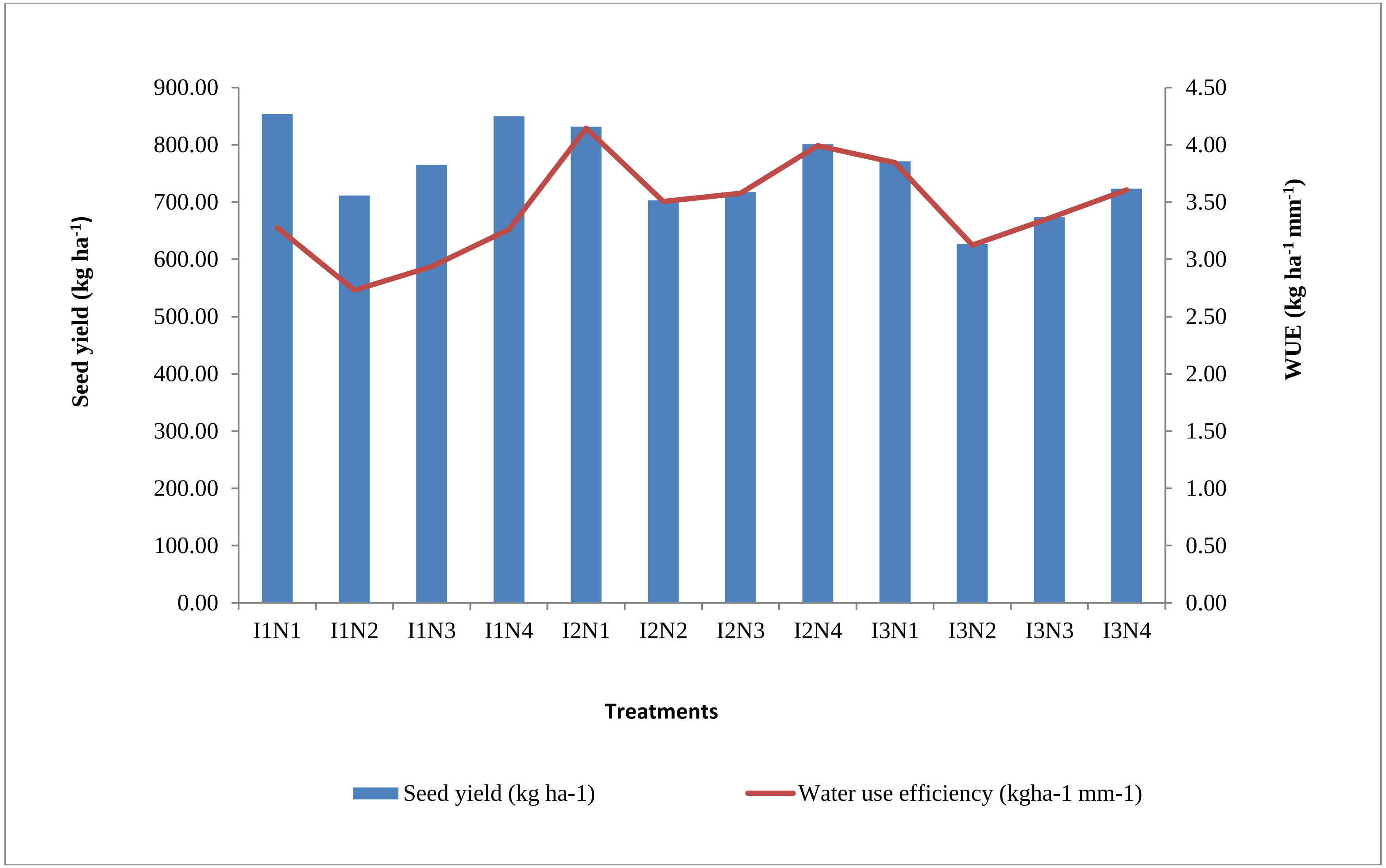

Fig. 2. Interaction effect of irrigation and nitrogen management on Water Use Efficiency (kg ha^{-1}mm^{-1}) of *summer* sesame

of irrigation water was more whereas, seed yield obtained was lesser among all I_1 regimes.

Studies revealed that limiting water applications to drought-sensitive growth stages aims at maximizing water productivity and stabilizing, rather than increasing yield [30]. WUE increases with irrigation amount and water-saving practices such as deficit level with minimum yield reduction [31].

3.5 Cost of Cultivation

Highest net return (₹35894.00/-) as well as return per rupee investment (1.83) was obtained in 3 irrigations at branching, flowering and capsule development stage with STBR- 100% N through inorganic (I_1N_1). The second highest net return (₹34804.00/-) was obtained in treatment with 2 irrigations at branching and flowering stage with STBR- 100% N through inorganic (I_2N_1). The lowest net return (₹12361.00/-) as well as return per rupee investment (1.25) calculated in treatment with 2 irrigations at branching and capsule development stage with 75% N through inorganic + 25% N through vermicompost (I_3N_3).

4. CONCLUSION

Three irrigations at branching, flowering and capsule development stage produced highest seed yield, oil content and oil yield. 50% N through inorganic + 25% N through FYM + 25% N through vermicompost can be recommended to achieve higher seed yield, highest oil content and oil yield. Application of 2 irrigations at branching and flowering stage with STBR- 100% N through inorganic treatment is economical as, it gives higher net return and return per rupee investment.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Stavridou E, Lagiotis G, Kalaitzidou P, Grigoriadis I, Bosmali I, Tsaliki E, Madesis P. Characterization of the genetic diversity present in a diverse sesame landrace collection based on phenotypic traits and EST-SSR markers coupled with an HRM analysis. Plants. 2021;10(4):656.
2. Wang L, Yu J, Zhang Y, You J, Zhang X, Wang L. Sinbase 2.0: an updated database to study multi-omics in Sesamum indicum. Plants. 2021;10(2):272.
3. Zhang H, Miao H, Wei L, Li C, Zhao R, Wang C. Genetic analysis and QTL mapping of seed coat colour in sesame (*Sesamum indicum* L.). PloS One. 2013; 8(5):e63898.
4. Ministry of Education and Information Technology (MeitY), Centre for Development of Advanced Computing, Hyderabad; 2024.
5. Miyake Y, Fukumoto S, Okada M, Sakaida K, Nakamura Y, Osawa T. Antioxidative catechol lignans converted from sesamin and sesaminol triglucoside by culturing with Aspergillus. Journal of Agricultural and Food Chemistry. 2005;53(1):22-27.
6. Kabinda J, Madzimure J, Murungweni C, Mpofu IDT. Significance of sesame (*Sesamum indicum* L.) as a feed resource towards small-ruminant animal production in Southern Africa: A review. Tropical Animal Health and Production. 2022;54(2): 106.
7. Kefale H, Wang L. Discovering favourable genes, QTLs, and genotypes as a genetic resource for sesame (*Sesamum indicum* L.) improvement. Frontiers in Genetics. 2022;13:1002182.
8. Qureshi M, Langham D, Lucas SJ, Uzun B, Yol E. Breeding history for shattering trait in sesame: classic to genomic approach. Mol. Biol. Rep. 2022;49(7): 7185–7194.
9. Boureima S, Oukarroum A, Diouf M, Cisse N, Van Damme P. Screening for drought tolerance in mutant germplasm of sesame (*Sesamum indicum* L.) probing by chlorophyll a fluorescence. Environmental and Experimental Botany. 2012;81:37-43.
10. Wei W, Li D, Wang L, Ding X, Zhang Y, Gao Y, Zhang X. Morphoanatomical and physiological responses to waterlogging of sesame (*Sesamum indicum* L.). Plant Sci. 2013;208:102–111.
11. Desoky ESM, Alharbi K, Rady MM, Elnahal ASM, Selem E, Arnaout SMAI, Mansour E. Physiological, biochemical, anatomical, and agronomic responses of sesame to exogenously applied polyamines under

different irrigation regimes. Agronomy. 2023;13(3):857.

12. Chauhan S, Rao VP, Reddy AP, Jayasree G, Reddy SN. Response of sesame (*Sesamum indicum* L.) to irrigation scheduling based on climatological approach and N fertigation levels. Journal of Oilseeds Research. 2016;33(1):38-44.
13. Selim MM. Introduction to the integrated nutrient management strategies and their contribution to yield and soil properties. International Journal of Agronomy. 2020; 2020(1):2821678.
14. Meena BP, Kumar A, Dhar S, Paul S, Kumar A. Productivity, nutrient uptake and quality of popcorn and potato in relation to organic nutrient management practices. Annals of Agricultural Research. 2016; 37(1):72-79.
15. Dipak GP, Jaganath M A, Takankhar VJ. Effect of integrated nutrient management on growth and yield of soybean (*Glycine max* L. Meril). International Journal of Chemical Studies. 2018. 6(4):264-266.
16. Singh AK, Kushwaha HS. Assessment of soybean (*Glycine max* Merill L.) based cropping systems through organic and inorganic inputs in Bundelkhand region. Journal of Krishi Vigyan. 2018;6(2): 7-12.
17. Men S, Chen H, Chen S, Zheng S, Shen X, Wang C, et.al, Liu D. Effects of supplemental nitrogen application on physiological characteristics, dry matter and nitrogen accumulation of winter rapeseed (*Brassica napus* L.) under waterlogging stress. Scientific Reports. 2020;10(1):10201.
18. Chang AH, Sheikh S A, Jamro GH, Jamro GM and Memon RB. Growth and yield response of sesame (*Sesamum indicum* L.) to different NP combinations. Indian Journal of Plant Science. 2005;4(1):32 -37.
19. Sharma JK, Jat G, Meena RH, Purohit HS, Choudhary. Effect of vermicompost and nutrients application on soil properties, yield, uptake and quality of Indian mustard (*Brassica juncea*). Annals of Plant and Soil Research. 2017;19(1):17-22.
20. Patel PM, Saini AK, Desai JS, Patel PD. Productivity and profitability of Indian mustard (*Brassica juncea* L.) under different nutrient management practices. The Pharma Innovation Journal. 2022; 11(3):1791-1794.
21. Ajnar P, Namdeo S. Effect of integrated nutrient management on Indian mustard yield attributes and yield. Journal of Pharmacognosy and Phytochemistry. 2021;10(2):545-548.
22. Singh R, Singh AK, Kumar P. Performance of Indian mustard (*Brassica juncea* L.) in response to integrated nutrient management. Journal of Agriculture Search. 2014;1(1):9- 12.
23. Abdelraouf RE, Anter AS. Response of new sesame lines (*Sesamum indicum* L.) to deficit irrigation under clay soils conditions. Plant Archieves. 2020;20(2): 2369-2377.
24. Ekom DT, Guidjinga KNA, Memena O, Nome AT. Performance of sesame seeds produced from plants subjected to water stress for early selection of tolerant genotypes. International Journal of Plant & Soil Science. 2019;1-10.
25. Dhaked GS, Tomer V, Panotra N. Effect of Indian mustard to various organic and inorganic sources of nutrient on yield, available soil P balance and P recycling through residues. The Pharma Innovation Journal. 2020;9(6):532-537.
26. Khambalkar PA, Singh N, Verma SK, Yadav SS. Influence of integrated nutrient management on soil fertility and properties of sandy clay loam and relationship with productivity of pearl millet (Pennisetum glaucum)-mustard (*Brassica juncea* L.) cropping sequence. Int. J. Chem. Stud. 2017;5(5):1237-1243.
27. Yadav KM, Chaudhry S, Kumar H, Singh R, Yadav R. Effect of integrated nutrient management on growth and yield of mustard [*Brassica juncea* L.). Czern & Cosson]. International Journal of Chemical Studies. 2018;6(2):3571-357.
28. Mhetre AG, Vaidya KP, Dademal AA, Kapse VD. Effect of integrated nutrient management on yield and quality of mustard (*Brassica juncea* L.) on Alfisols of Konkan (MS). The Pharma Innovation Journal. 2019;8(8):147-149.
29. Saha PK, Malik GC, Bhattacharyya P, Banerjee M. Integrated Nutrient Management on Growth and Productivity of Rapeseed-mustard Cultivation International Journal of Bio-resource and Stress Management. 2015;6 (2):192-197.
30. Geerts S, Raes D. Deficit irrigation as an on-farm strategy to maximize crop water productivity in dry areas. Agricultural water management. 2009;96(9):1275-1284.

31. Ucan K, Kıllı F, Gençoğlan C, Merdun H. Effect of irrigation frequency and amount on water use efficiency and yield of sesame (*Sesamum indicum* L.) under field conditions. Field Crops Research. 2007; 101(3):249-258.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/124275