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EFFECT OF FOLIAR APPLICATION OF FERTILIZER ON GROWTH AND SEED YIELD OF SESAME (*SESAMUM INDICUM* L.)

Podalakuru Kranthikumar[1*], A. K. Ghotmukale[2], P. Sireesha[1], V. A. Khedkar[1] and S.S. Sukne[1]
[1]Department of Agronomy, College of Agriculture, Latur-413512
(Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani) Maharashtra, India.
[2]Oilseeds Research Station, Latur, Maharashtra, India
*Corresponding author Email: podalakurukranthikumar3gmail.com
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ABSTRACT

A field experiment was carried out during *kharif* season of 2023 at Experimental farm of Agronomy Section, Oilseeds Research Station, Latur (MS) to study the effect of foliar application of fertilizer on growth and seed yield of sesame (*Sesamum indicum* L.). The experiment consists of nine treatments arranged in randomized block design and replicated three times. The treatments were T_1: Soil application of 100% RDF, T_2: T_1 + foliar application of 2% Urea at flowering stage, T_3: T_1 + foliar application of 2% DAP at flowering stage, T_4: T_1 + foliar application of 2% Urea at flowering & capsule formation stage, T_5: T_1 + foliar application of 2% DAP at flowering & capsule formation stage, T_6: 75% RDF + foliar application of 2% Urea at flowering stage, T_7: 75% RDF + foliar application of 2% DAP at flowering stage, T_8: 75% RDF + foliar application of 2% Urea at flowering & capsule formation stage, T_9: 75% RDF + foliar application of 2% DAP at flowering & capsule formation stage. The results showed that the soil application of 100% RDF + foliar application of 2% Urea at flowering & capsule formation stage (T_4) recorded significantly higher growth and yield attributes, yield, GMR and NMR followed by soil application of 100% RDF + foliar application of 2% DAP at flowering & capsule formation stage. Highest B:C ratio was also found with the soil application of 100% RDF + foliar application of 2% Urea at flowering & capsule formation stage
Keywords**:** Foliar application, growth and yield attributes, gross monetary returns, net monetary returns

Introduction

Sesame (*Sesamum indicum* L.) is indeed an ancient crop with a wide range of uses and benefits. It is known by various names in different parts of the world, including sesamum, til, gingelly, simsim, and gergelim. Sesame seeds are rich in oil (approximately 48-50%) and protein (around 18-20%). They are a valuable source of quality proteins and essential amino acids, particularly methionine, which is known for its potential anti-aging benefits for the human body. Sesame seeds also provide essential vitamins, such as vitamin E, A, B1, and B2. They contain niacin (a form of vitamin B3) and minerals like calcium and phosphorus, which are important for overall well-being. Sesame is often referred to as "the queen of oil seeds" due to its extraordinary cosmetic and skin care qualities. In some regions, sesame oil is referred to as a "poor man's substitute for ghee" because it offers a cost-effective and healthier alternative to clarified butter (ghee). The total area of sesame in India is 15.23 lakh hectares, production accounting to 8.02 lakh tonnes and productivity to 1855 kg ha^{-1}, whereas the area of sesame in Maharashtra is 0.11 lakh hectares, production accounting to 0.30 lakh tonnes and productivity to 783 kg ha^{-1}. (Indiastat 2022-23). Among the management practices, fertilization is the most important factors in determining yield of sesame (Subramanyan and Arulmozhi, 1999). Among the fertilizer particularly basal and split application of nitrogen has vital role for increasing production of sesame. Seed yield increased with an increased rate of N and K application (Mandal *et al.*, 1993) split application of N and K as 50% basal and 50% top dressing at 20 DAS significantly increased the growth, yield characters and yield of sesame (Kannan, 1992). Foliar fertilization is gaining importance, especially in rainfed or dryland farming areas where water availability can be limited. It allows for the direct application of nutrients to the plant, making efficient use of available moisture. Research reports have indicated positive effects of foliar fertilization on crop yield and the quality of oilseed crops. It can help address nutrient deficiencies quickly and effectively, leading to improved crop performance. Foliar fertilization brings nutrients in close proximity to the metabolizing areas of the plant. This direct delivery to the leaves allows for rapid absorption and utilization of nutrients in critical metabolic processes. foliage without the process of being first mineralized in soil, absorbed through the roots and then transported to leaf for assimilation (De and Chatterjee,1976).

Materials and Methods

The field experiment was carried out at the Oilseeds Research Station, Latur, Experimental Farm of the Agronomy Section during the *kharif* 2023–2024. The soil at the experimental location had black clayey in texture, moderately alkaline in reaction (pH 7.83), low in available nitrogen (87.80 kg ha^{-1}), medium levels of phosphorus (21.18 kg ha^{-1}) and high levels of potassium (413.31 kg ha^{-1}). The rainfall received during the experiment was 378.66 mm and spread over 17 rainy days and mean average maximum temperature was 29.35^{o}C and minimum temperature was 20.16^{o}C. The mean average relative humidity was at morning 77.54% and at evening 36.80%, respectively. The nine treatments in the experiment are arranged in a randomized block design and replicated three times. The treatments were T_1: Soil application of 100% RDF, T_2: T_1 + foliar application of 2% Urea at flowering stage, T_3: T_1 + foliar application of 2% DAP at flowering stage, T_4: T_1 + foliar application of 2% Urea at flowering & capsule formation stage, T_5: T_1 + foliar application of 2% DAP at flowering & capsule formation stage, T_6: 75% RDF + foliar application of 2% Urea at flowering stage, T_7: 75% RDF + foliar application of 2% DAP at flowering stage, T_8: 75% RDF + foliar application of 2% Urea at flowering & capsule formation stage, T_9: 75% RDF + foliar application of 2% DAP at flowering & capsule formation stage. The experimental unit's gross and net plot sizes were, respectively, 4.5 m x 5.4 m and 3.9 m x 4.5 m. Seeds are sown at a spacing of 45 cm x 15 cm using the dibbling method on July 9, 2023 with a seed rate of 3 kg ha^{-1}. The recommended fertilizer dose of 50:25:00 NPK kg ha^{-1} was applied. The 50% of N and full dose of P and K were applied as basal and remaining 50% of N is applied as top dressing on 30 days after sowing. The crop was harvested on 17th October 2023. The statistical technique of analysis of variance was employed to analyse the recorded data (Panse and Sukhatme, 1967).

Methodology

Plant height (cm)

Height of five randomly selected and labelled plants in each plot was measured from base of the plant to the tip of main shoot at 15, 30, 45, 60, 75 DAS and at harvest. The mean plant height (cm) at each growth stage was worked out and recorded as plant height (cm) at respective stage.

Number of branches $Plant^{-1}$

Primary branches arising from main shoot were counted.

Number of functional leaves $plant^{-1}$

Total number of functional leaves $plant^{-1}$ were counted and recorded at different growth stages of crop up to the harvest. All fully opened green leaves from each plant were recorded as functional leaves.

Leaf area $plant^{-1}$ (dm^2)

Leaf area was calculated by using the plant samples labelled for studies from each net plot. The leaves were graded into three categories *viz.*, small, medium and big and counted as per the category. The representative sample of each category was taken for its linear measurement maximum length and breadth in cm, it was measured and mean was worked out.

$$A = L \times B \times K \times N$$

Where,

A= Leaf area in (dm^2) particular group

L = Maximum length of leaf (cm)

B = Maximum breath of leaf (cm)

K = leaf area constant for sesame (0.7)

N= Number of Leaves

Number of capsules $plant^{-1}$

Number of capsules borne on sample plants were counted and recorded at different observation dates up to harvesting.

Dry matter accumulation plant^{-1}

Dry matter production was recorded at 15, 30, 45, 60, 75 DAS and at harvest. For this, one representative plant from each net plot was uprooted from each net plot. After removal of root portion, the plant parts leaves and stem stored in well labelled brown paper bag for drying. Initially plant samples were sundried for 3-4 days followed by oven drying at a constant 62± 2°C temperature. After air cooling the constant dry weight was recorded as total dry matter weight (g) plant^{-1} for each treatment.

Capsule yield plant^{-1} (g)

Capsule yield obtained from each plant were sun dried and weight was recorded in gram.

Seed yield plant^{-1} (g)

After harvesting seed yield obtained from observation plant were weighted and recorded in gram.

Seed yield (kg ha^{-1})

The plants from each net plot were harvested and threshed then seeds were cleaned by winnowing and weight of seed per net plot was recorded in kilograms.

Biological yield (kg ha^{-1})

The biological yield was recorded by the following formula in kg,

Biological yield = Seed yield + Straw yield.

Harvest Index (%)

Harvest index indicates the efficiency of plant material to convert the photosynthates into the economic yield and it is worked out as

$$HI = \frac{\text{Economic yield}}{\text{Biological yield}} \times 100$$

Where, Biological yield = Seed yield + Straw yield

Gross monetary returns (ha^{-1})

The gross monetary returns (ha^{-1}) occurred due to different treatments in the present study were worked out by considering market prices of economic product, by product and crop residues during the experimental year.

Net monetary returns (ha^{-1})

The net monetary returns (ha^{-1}) of each treatment were worked out by deducting the cost of cultivation (ha^{-1}) of each treatment from the gross monetary returns (ha^{-1}) gained from the respective treatments.

Benefit: Cost ratio (B:C)

The benefit: cost ratio of each treatment was calculated by dividing the gross monetary returns with the mean cost of cultivation.

Statistical analysis and interpretation of data

The experimental data were statistically analyzed by using a standard method of "analysis of variance" as reported by Panse and Sukhatme (1967). The total variance (S^2) and degree of freedom (N-1) were partition into different possible sources. The variance due to main effect and interaction effects calculated and compared with error variance for finding out of 'F' value and ultimately for testing the significance at P=0.05 wherever, the results were found significant critical differences was calculated for comparison of treatment mean at 5 percent level of significance.

Results and Discussion

Growth attributes

The data showed (Table 1) that, among various treatments, significantly higher plant height (124 cm), number of branches plant^{-1} (6.33), number of functional leaves plant^{-1} (66.33), leaf area plant^{-1} (16.90 dm^2) and dry matter accumulation plant^{-1} (28.97 g) were recorded with the soil application of 100% RDF + foliar application of 2% urea at flowering and capsule formation stage (T_4) which was at par with the soil application of 100% RDF + foliar application of 2% DAP at flowering and capsule formation stage (T_5) and found significantly superior than other treatments. The balanced application of nutrients through RDF, foliar application of Urea and DAP may have contributed to the increase in growth parameters by increasing plant height, branch count, and leaf area *i.e.*, the crop's overall growth and development, which in turn raised the crop's mean number of capsule plant^{-1}. It could be because of the beneficial effect of soil application of RDF along with foliar application of chemical fertilizers like urea, which enhances the uptake of nitrogen, other major elements and plays a vital role in cell division and helps to increase the height of the plant and helps to increase plant height, leaves, leaf area and branches. The findings are analogous to those obtained by Sujatha and Rao (2019), Kiruthika *et al.* (2019) and Dalei *et al.* (2014).

Soil application of RDF along with foliar application was essential for growth and development as well as increase the uptake of nutrients which resulted in higher accumulation of dry matter plant^{-1}. These outcomes were consistent with the findings of Alex *et al.* (2017) and Kumar *et al.* (2018).

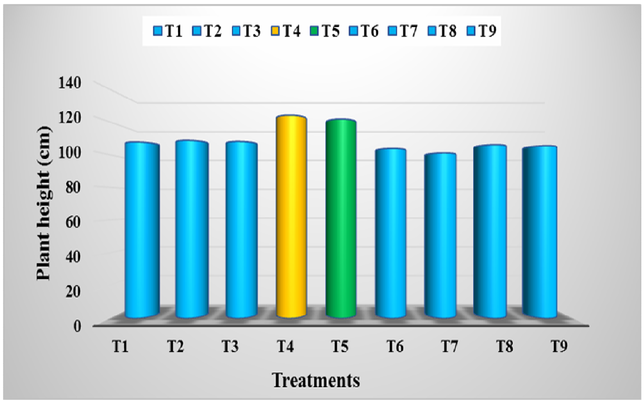

Fig. 1: Mean plant height of sesame as influenced by different treatments at harvest.

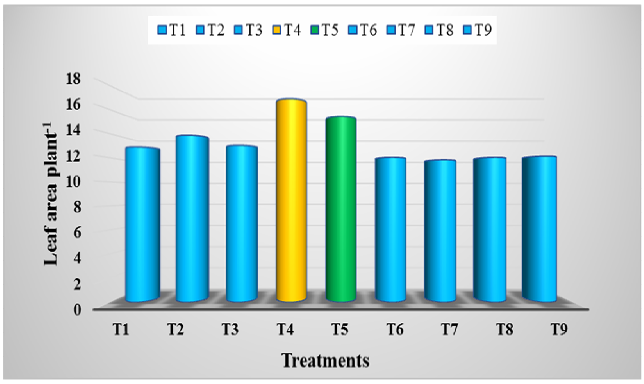

Fig. 2: Mean leaf area plant^{-1} (dm^2) of sesame as influenced by different treatments at various growth stages of crop.

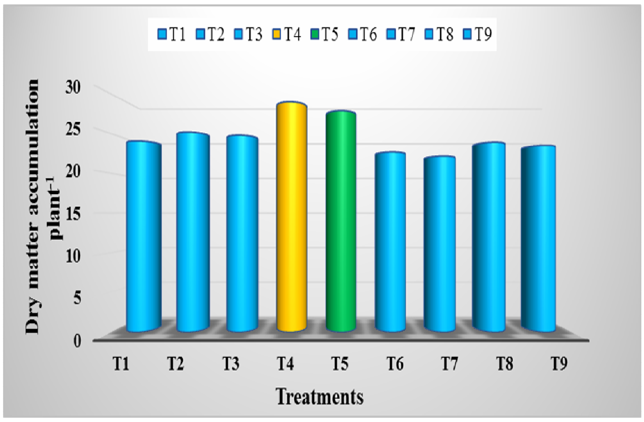

Fig. 3: Mean weight of dry matter plant^{-1} of sesame as influenced by different treatments at various growth stages of crop.

Yield attributes

The results of various treatments were found significant on yield contributing characters of sesame as showed in Table 2. The maximum number of capsule plant^{-1} (63.33), capsule yield plant^{-1} (40.00 g), seed yield plant^{-1} (8.17 g), were obtained with the soil application of 100% RDF + foliar application of 2% urea at flowering and capsule formation stage (T_4) which was followed by soil application of 100% RDF + foliar application of 2% DAP at flowering and capsule formation stage (T_5) and found to be significantly beneficial than other treatments. It might be due to the fact that available more water enhanced nutrient availability which improved nitrogen and other macro and micro elements absorption as well as enhancing the production and translocation of the dry matter content from source to sink and also foliar applications of fertilizers supplemented with 100% RDF will provide additional quantity of N and P fertilizers as per needs by the crop. Similar results are reported with the findings of Thanunathan *et al.* (2006), Deshmukh *et al.* (2009), Stanley and Basavarajappa (2014), Dalei *et al.* (2014), Mahajan *et al.* (2016), Alex *et al.* (2017), Jagadesh *et al.* (2019).

Yield and economics

Data shown in Table 2 reveals that seed yield (814.69 kg ha^{-1}), biological yield (3593.02 kg ha^{-1}), GMR (97763 ha^{-1}) and NMR (52638 ha^{-1}) of sesame were obtained with the soil application of 100% RDF + foliar application of 2% urea at flowering and capsule formation stage (T_4) which was at par with by soil application of 100% RDF + foliar application of 2% DAP at flowering and capsule formation stage (T_5) found to be significantly beneficial than other treatments. Highest HI and B:C ratio were also observed with the soil application of 100% RDF + foliar application of 2% urea at flowering and capsule formation stage. The superiority in seed yield due to foliar applications of fertilizers supplemented with 100% RDF mainly due to effect of additional quantity of N and P fertilizers as per needs by the crop which results in the higher GMR and NMR. The outcomes confirm the conclusions drawn by Thanunathan *et al.* (2006), Deshmukh *et al.* (2009), Stanley and Basavarajappa (2014), Mahajan *et al.* (2016) Wadile *et al.* (2019) and Harisudan and Sapre (2019).

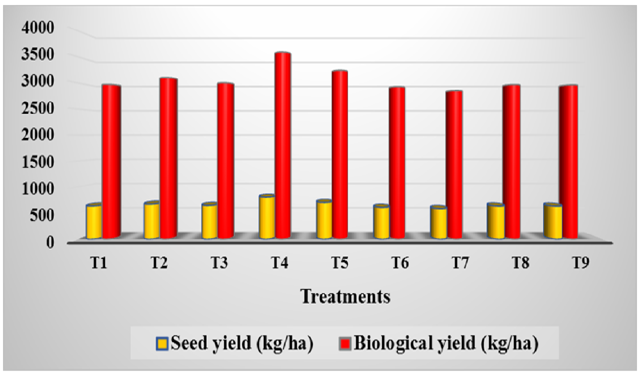

Fig. 4: Seed yield, biological yield of sesame as influenced by different treatments at harvest.

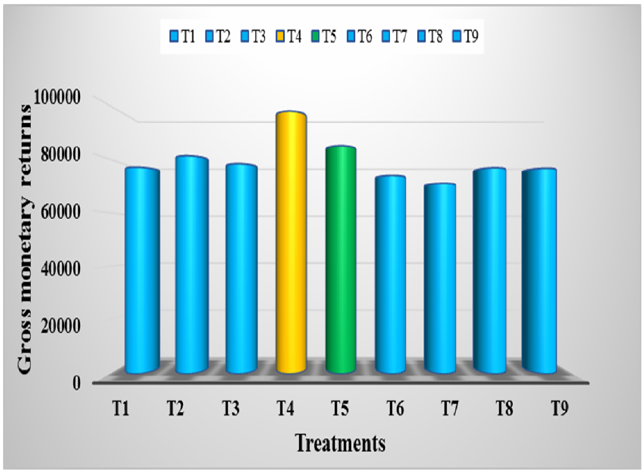

Fig. 5: Gross monetary return (kg ha^{-1}) as influenced by various treatments

Conclusion

It can be concluded that the soil application of 100% RDF + foliar application of 2% urea at flowering and capsule formation stage resulted in significantly higher growth and yield attributes of sesame followed by 100% RDF + foliar application of 2% DAP at flowering and capsule formation stage. Soil application of 100% RDF + foliar application of 2% urea at flowering and capsule formation stage was found to be more remunerative for getting higher yield, GMR and NMR of Sesame and it was followed by 100% RDF + foliar application of 2% DAP at flowering and capsule formation stage. Soil application of 100% RDF + foliar application of 2% urea at flowering and capsule formation stage also produces the highest B:C ratio.

Table 1: Effect of different treatments on growth attributes of sesame

Treatments	Plant height (cm) at harvest	Number of branches plant^{-1} at harvest	Number of leaves plant^{-1} at 60 DAS	Leaf area plant^{-1} (dm^2) at 60 DAS	Dry matter accumulation plant^{-1} (g) at harvest
T_1	107.67	5.10	57.00	12.90	24.07
T_2	108.67	5.37	59.15	13.87	25.17
T_3	108.00	5.17	58.33	13.03	24.77
T_4	124.00	6.33	66.33	16.90	28.97
T_5	121.67	5.36	63.13	15.43	27.83
T_6	103.67	4.93	55.17	12.03	22.67
T_7	101.00	4.83	54.17	11.83	22.17
T_8	106.00	5.05	56.50	12.03	23.90
T_9	105.33	5.00	55.67	12.13	23.50
SE±	4.53	0.27	2.36	0.64	1.05
CD @ 5%	15.80	0.82	7.10	1.93	3.16
General Mean	**109.56**	**5.27**	**58.38**	**13.39**	**24.78**

Table 2: Effect of different treatments on yield attributes, yield and economics of sesame

Treatments	Number of capsule plant^{-1}	Capsule yield plant^{-1} (g)	Seed yield (kg ha^{-1})	Biological Yield (kg ha^{-1})	Harvest index (%)	GMR (kg ha^{-1})	NMR (kg ha^{-1})	B:C ratio
T_1	54.67	34.33	641.20	2971.24	21.57	76943	37743	1.96
T_2	55.33	35.67	676.80	3101.80	21.81	81216	38616	1.91
T_3	55.00	35.00	651.57	3001.57	21.70	78188	38833	1.99
T_4	63.33	40.00	814.69	3593.02	22.67	97763	52638	2.17
T_5	58.67	38.00	707.32	3239.32	21.83	84878	43028	2.03
T_6	50.67	32.33	615.14	2926.81	21.01	73817	34242	1.86
T_7	50.00	32.00	590.84	2849.17	20.74	70901	31051	1.78
T_8	52.67	33.33	639.29	2967.29	21.54	76715	37115	1.92
T_9	51.33	33.00	637.93	2961.93	21.53	76552	36602	1.91
SE±	2.42	1.53	39.01	132.42	-	4395	4395	-
CD @ 5%	7.63	4.58	116.92	396.94	-	13175	13175	-
General Mean	**54.63**	**34.85**	**663.86**	**3068.02**	**21.59**	**79664**	**39097**	**1.95**

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