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Effect of date of sowing and levels of sulphur on growth and yield of linseed (*Linum usitatissimum* L.)

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Abstract

A field study was undertaken to evaluate the response of the linseed crop to different sowing dates and varying sulphur levels during the rabi season of 2024 at the Crop Research Farm of Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences (SHUATS), Prayagraj, Uttar Pradesh, India. The experiment included sulphur along with three sulphur application rates (15, 30, and 45 kg S/ha). The treatments were arranged following a factorial design and replicated three times. The findings indicated that the treatment combinations significantly influenced growth and yield attributes. The highest values were observed for plant height (63.97 cm), plant dry weight (7.67 g), number of capsules per plant (30.88), seeds per capsule (8.11), test weight (9.15 g), grain yield (945.82 kg/ha), and stover yield (1560.67 kg/ha). In addition, economic analysis revealed that this treatment also recorded the highest gross return (INR 95,030.92/ha), net return (INR 64,952.92/ha), and benefit-cost ratio (2.16), which were significantly superior compared to other treatments.

Keywords: Sulphur, Date of Sowing, Linseed and Economics

Introduction

Linseed (*Linum usitatissimum* L.), commonly referred to as flax, is among the most important oilseed crops cultivated in India. It is a self-pollinated annual plant belonging to the family Linaceae and is widely known by different names such as tisi, linum, and linen. The crop is primarily grown for its versatile oil and fiber, making it highly valuable across the world. Linseed has been cultivated since ancient times and continues to hold significance due to its multiple uses.

One of the key nutritional benefits of linseed is its richness in omega-3 fatty acids, making it an excellent dietary source for individuals who do not consume fish. Apart from its nutritional value, linseed oil has substantial industrial importance and is widely used in the production of paints, varnishes, and printing inks. India holds the first position globally in terms of the area under linseed cultivation and ranks third in total production. The crop is grown on approximately 4.68 lakh hectares, with an annual production of around 1.63 lakh tonnes (Maurya *et al.*, 2017) ^[5].

Linseed is also recognized for its diverse chemical composition, which includes compounds with significant biological activity and functional properties such as solubility, thermal stability, emulsifying capacity, electrostatic charge density, water-holding capacity, and fat absorption ability. It is particularly rich in polyunsaturated fatty acids (PUFAs) of the omega-3 group, along with soluble dietary fiber, lignans, proteins, and carbohydrates. On average, flaxseed contains about 41% oil, 20% protein, 28% total dietary fiber, 7.7% moisture, and 3.4% ash, which represents the mineral residue after combustion. It has also been observed that protein content tends to decrease as oil content increases (Mahesh *et al.*, 2020) ^[6].

Considering the agronomic importance of linseed and the role of sulphur in crop nutrition, the present study entitled "Effect of Date of Sowing and Levels of Sulphur on Growth and Yield of Linseed" was conducted at the Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, SHUATS, Prayagraj, Uttar Pradesh, during the rabi season of 2024-25.

Materials and Method

Experimental Site and Soil

The experiment was carried out during the rabi season of 2024-25 at the Crop Research Farm of the Department of Agronomy, Naini Agricultural Institute, SHUATS, Prayagraj, Uttar Pradesh. Geographically, the experimental field is situated at 25°24'42" North latitude and 81°50'56" East longitude, with an elevation of 98 meters above mean sea level. The site is located on the right bank of the Yamuna River, opposite to Prayagraj city, and lies approximately 5 km away from the Prayagraj-Rewa road.

Formulations Used for the Experiment

Experimental Design and Treatments

The study was conducted using a Randomized Block Design (RBD) consisting of ten treatments with three replications. Each replication was divided into equal plots, and treatments were randomly assigned to ensure unbiased results. The experiment mainly focused on evaluating the effects of different sulphur sources and application levels. The treatment combinations were as follows:

- **T₁**: 6th November @ 15 kg/ha
- **T₂**: 6th November @ 30 kg/ha
- **T₃**: 6th November @ 45 kg/ha
- **T₄**: 13th November @ 15 kg/ha
- **T₅**: 13th November @ 30 kg/ha
- **T₆**: 13th November @ 45 kg/ha
- **T₇**: 20th November @ 15 kg/ha
- **T₈**: 20th November @ 30 kg/ha
- **T₉**: 20th November @ 45 kg/ha

Economic Analysis

An economic evaluation was performed to assess the profitability and feasibility of different treatment combinations in linseed cultivation. The following economic parameters were taken into consideration:

- **Cost of Cultivation:** This includes the total expenditure incurred during crop production, such as costs related to seeds, fertilizers, pesticides, labor, irrigation, machinery, and land rent. It reflects the overall investment required for cultivation.
- **Gross Return:** This represents the total income obtained from the sale of linseed produce without deducting any production costs.
- **Net Return:** This is calculated by subtracting the total cost of cultivation from the gross return, indicating the actual profit gained from the crop.
- **Benefit-Cost (B:C) Ratio:** This is determined by dividing the gross return by the cost of cultivation. A B:C ratio greater than one indicates a profitable enterprise, whereas a ratio less than one suggests a loss.

This economic assessment provided a comprehensive understanding of the financial viability and efficiency of

different treatment practices in linseed cultivation.

Result and Discussion

Plant height

At the time of harvest, the maximum and significantly greater plant height (63.97 cm) was observed under treatment T₃ [6th November sowing combined with sulphur application at 45 kg/ha]. This increase in plant height can be associated with the adequate availability of nutrients, which supports rapid vegetative development. Enhanced nutrient supply facilitates key physiological processes such as cell division, cell elongation, photosynthesis, and maintenance of cell turgidity, all of which contribute to increased plant height (Tripathi *et al.*, 2011)^[7].

Plant dry weight (g/plant)

At 80 days after sowing (DAS), the highest and statistically significant plant dry weight (4.67 g) was recorded in treatment T₃ [6th November + 45 kg S/ha]. This improvement may be attributed to the role of sulphur in accelerating metabolic and physiological activities within the plant system. Adequate sulphur nutrition enhances photosynthetic efficiency and promotes better development of plant components such as leaves, branches, and both above-ground and below-ground structures. These factors collectively contribute to increased accumulation of dry matter in plants (Mallick *et al.*, 2015)^[8].

Crop growth rate (g/m²/day)

During the period from 80 DAS to harvest, the highest and statistically significant crop growth rate (5.00 g/m²/day) was observed in treatment T₃ [6th November + 45 kg S/ha]. However, treatment T₆ [13th November + 45 kg S/ha] showed results that were statistically at par with T₃. The increased crop growth rate can be attributed to the beneficial effects of sulphur in enhancing metabolic processes, physiological activities, and photosynthetic performance. These improvements lead to better plant development, including increased plant height, branching, leaf area, and overall biomass production, which collectively contribute to a higher crop growth rate (Mallick *et al.*, 2015)^[8].

Relative growth rate (g/g/day)

No statistically significant differences were observed among the treatments for relative growth rate during the period from 80 DAS to harvest. However, the highest value (0.137 g/g/day) was recorded under treatment T₃ [6th November + 45 kg S/ha]. Crop Growth Rate (CGR) and Relative Growth Rate (RGR) are important growth indices that are derived from changes in dry matter accumulation over time and are used to evaluate plant growth within a specific interval. The results indicate that sulphur application influences plant growth dynamics by improving canopy development, which is essential for efficient light interception and enhanced biomass accumulation. These findings are in agreement with the observations reported by Soni and Singh (2023)^[9], highlighting the positive impact of sulphur on overall crop growth performance.

Table 1: Effect of sources and levels of Sulphur on Growth attributes of Linseed

Treatments	Plant height (cm) (At Harvest)	Dry Weight/plant(g) (At Harvest)	RGR (g/g/day) 80-At Harvest	CGR (g/g m ² /day) 80-At Harvest
T ₁	59.1	6.23	0.028	4.467
T ₂	57.2	6.58	0.026	4.467
T ₃	63.97	7.67	0.030	5.000
T ₄	58.37	5.82	0.025	4.383
T ₅	62.17	6.81	0.026	4.600
T ₆	56.9	6.47	0.027	4.483
T ₇	60.1	6.15	0.026	4.217
T ₈	59.37	6.68	0.024	4.300
T ₉	60.80	6.31	0.024	4.050
F-Test	S	S	S	S
SEm(±)	0.11	0.05	0.003	0.001
CD(p=0.05)	0.34	0.16	0.001	0.003

Economics

The economic evaluation revealed notable variations among the different treatments with respect to cost of cultivation, gross returns, net returns, and benefit-cost (B:C) ratio. Among all the treatments, the highest gross return (INR 95,030.92/ha) as well as the maximum net return (INR 64,952.92/ha) were recorded under Treatment T₃ (6th November sowing combined with sulphur application at 45 kg/ha).

Similarly, the benefit-cost ratio was also found to be highest (2.16) in the same treatment, indicating its superiority over the remaining treatments. The improved B:C ratio observed with early sowing on 6th November along with the application of sulphur at 45 kg/ha in linseed may be attributed to enhanced economic performance of the crop. This improvement is mainly due to higher seed yield and stover yield, which ultimately resulted in increased gross and net returns.

Table 2: Economics of different treatments in Linseed.

T ₁	29926.00	61231.70	31381.70	1.05
T ₂	30002.00	64641.89	34715.89	1.16
T ₃	30078.00	76806.11	46804.11	1.56
T ₄	29926.00	67843.79	37765.79	1.26
T ₅	30002.00	79993.30	50067.30	1.67
T ₆	30078.00	65618.91	35616.91	1.19
T ₇	29926.00	95030.92	64952.92	2.16
T ₈	30002.00	83423.55	53497.55	1.79
T ₉	30078.00	86132.48	56130.48	1.87

Conclusion

It can be concluded that with the application of Sulphur at 45kg/ha (Treatment-3), is found the most superior treatment combination for obtaining higher seed yield (945.82 kg/ha) and net returns INR (64952.92/ha) in Linseed.

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