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Influence of Nutrient Foliar Application on Linseed (*Linum usitatissimum* L.) under the Arid Condition of Western Rajasthan

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ABSTRACT

Linseed, one of the oldest and most valuable plants, is cultivated for both oilseeds and fiber. Despite its significant nutritional and industrial importance, there has been little research on the impact of foliar nutrition and the timing of its application throughout the day on the plant's morpho-physiological characteristics. Therefore, a two-year field experiment on linseed crop was conducted at Agricultural Research Station, Keshwana, Jalore (Rajasthan) to study the effect of foliar application of Nitrogen, Sulfur, Boron, Zinc and a growth promoter-triacontanol on growth and yield attributes of linseed. The experiment was laid out in randomized block design (RBD) with three replications and 12 treatments. These nutrients were applied individually (2% triacontanol, 2% urea, 0.2% boron , 0.5% zinc, 2% sulfur) as well as in combination with each other like 2% triacontanol + 0.2% boron + 0.5% zinc, 2% triacontanol + 0.5% zinc + 2% sulfur, 2% triacontanol + 2% urea + 0.5% zinc, 2% triacontanol + 2% urea + 0.2% boron, 2% triacontanol + 2% urea + 2% sulfur, 2% triacontanol + 2% urea + 0.2% boron + 0.5% zinc + 2% sulfur. The results revealed that the plant height (cm), Branches per plant, Dry matter accumulation, Capsules per plant and seed yield were reported maximum under foliar application of 2% triacontanol + 2% urea + 0.2% boron + 0.5% zinc + 2% sulfur over the control during the investigation. It has been concluded that foliar application of growth hormones and nutrients were enhance the growth parameters and yield attributes of linseed resulted higher seed yield.

Keywords Linseed, Urea, Triacontanol, Foliar application, Sulfur.

INTRODUCTION

Linseed (*Linum usitatissimum* L.) is a major *rabi* oilseed crop of the country and it is next in importance to rapeseed and mustard in terms of the area as well as production. India is the fourth largest linseed growing country in the world (10.8%) after Kazakhstan, Canada and Russia. Linseed is rich in protein (20%), oil (41%) and dietary fiber (28%). Linseed is primarily an industrial oilseed crop, with each part possessing

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significant commercial and medicinal value. (Muhammad *et al*. 2020). Major linseed producing states of India are Madhya Pradesh, Karnataka, Chhattisgarh, Jharkhand, Bihar, Maharashtra, Odisha, Uttar Pradesh, West Bengal and Assam. Madhya Pradesh and Uttar Pradesh collectively contribute approximately 70% to the national linseed production. In Bihar, it occupies a 9.65 thousand ha area with 8.19 metric tonnes of production and productivity of 849 kg ha^{-1} (Anonymous 2018).

It is grown mainly for seeds which are used for extracting oil as well as fiber which is used for manufacturing of linen. Linseed seeds contain approximately 33 to 47% oil, with 35-70% of this oil comprising linolenic acid (Omega-3 fatty acid), which helps reduce blood cholesterol levels. Linseed has many industrial and medicinal properties and is used for value-added products. The average yield of linseed is very low in India due to many constraints like poor soil fertility, inadequate application of macro and micronutrients, competition with other crops and traditional crop management practices (Alam *et al.* 2020).

Improper nutrient management has resulted in widespread sulfur (S) deficiency in soils (Kushwaha *et al.* 2019). Initially rare and sporadic, S deficiency has now become common. This deficiency adversely affects the growth and yield of oilseed crops, reducing yields by 10-30% due to inadequate nourishment (Basumatary *et al.* 2019). Different genotypes of oilseed crops show significant variation in their responses to sulphur application.

Micronutrients particularly zinc (Zn) and boron (B), play crucial roles in enhancing the yield, uptake, and quality of linseed. Deficiencies in these micronutrients negatively impact the growth and development of linseed. Zinc, an essential micronutrient, is required for optimal crop growth, and its deficiency leads to various adverse effects on linseed's growth and yield. Boron is vital for enzyme activation, protein synthesis, improved photosynthesis, and the uptake and utilization of calcium. Boron application has been shown to positively influence dry matter production, seed yield, and oil content. However, research on the effects of sulfur, zinc, and boron application on linseed growth and development is limited.

Triacontanol is a naturally occurring saturated primary alcohol, initially identified in alfalfa hay, which influences numerous physiological and biochemical processes in various crop plants (Karam and Keramat 2017). Recognized as a potent plant growth-promoting substance, it enhances growth when applied exogenously at relatively low concentrations to most crops. Chemically, triacontanol can be synthesized through the Kolbe coupling of stearic acid or by adding six-carbon units twice via enamine intermediates. It plays a significant role in promoting agricultural plant growth, yield, development, primary metabolic activities, and responses to abiotic stress factors in crop plants. Further, foliar application of nutrients is generally considered better than their soil application due to rapid absorption, requirement of small quantities and targeted delivery especially during critical growth stages (Meena *et al.* 2016).

Thus this study was aimed to determine the optimal nutrients and their combinations to enhance linseed crop growth and yield in the transitional plains of the Luni basin in Western Rajasthan.

MATERIALS AND METHODS

The field experiment was conducted during *rabi* season of 2018-19 and 2019-20 at Agricultural Research Station, Keshwana, Jalore part of Agriculture University, Jodhpur (Rajasthan). The experimental site is located in the transitional plain of the Luni Basin, within the agroclimatic zone IIB of Rajasthan (25° 25' N, 72° 29' E, at an elevation of 149.9 meters above sea level). Soil of the experiment site was sandy loam in texture being low in available carbon (0.25 %), low in available nitrogen (160 kg ha^{-1}), sulfur (12.10 kg ha^{-1}), Boron (0.21 mg kg^{-1}) and Zinc (0.19 mg kg^{-1}) with neutral in soil reaction (pH 7.6) Available Nitrogen was determined by micro Kjeldhal method, Subbiah and Asija (1956), available Sulfur was determined by 0.15 % calcium chloride extraction methods, Williams and Steinbergs, (1959), available Boron was determined by Hot Water methods of Berger *et al.* (1954) and Zinc was determined DTPA test as outlined by Lindsay and Norvell (1978). The experiment was conducted in randomized block design with three replications. There were twelve treatments viz; control, 2% triacontanol, 2% urea, 0.2% boron, 0.5% zinc, 2% sulfur, 2% triacontanol + 0.2% boron + 0.5% zinc, 2% triacontanol + 0.5% zinc + 2% sulfur, 2% triacontanol + 2% urea + 0.5% zinc, 2% triacontanol + 2% urea + 0.2% boron, 2% triacontanol + 2% urea + 2% sulfur, 2% triacontanol + 2% urea + 0.2% boron + 0.5% zinc + 2% sulfur. All the necessary plant protection and agronomic measures were practised as recommended. Experimental field was fertilized with recommended dose of fertilizers. Two foliar sprays were carried out at flowering and capsule development stages. Boron was applied from borax (11% B) whereas zinc sulphate monohydrate was used for the foliar application of zinc along with lime and Elemental sulfur was used as source of sulfur. The soil of this region has low content of nitrogen and availability of nitrogen is low therefore, the foliar application of nitrogen used as a treatment. Linseed variety JLS 27 was used for experiments. Sowing was done in row spacing of 30 x 10 cm apart. The data obtained on various parameters were subjected to analysis of variance (ANOVA). The level of significance used in 'F' test was at 5%. The critical difference (CD) values are given in the table at a 5% level of significance (Gomez and Gomez 1984).

RESULT AND DISCUSSION

Apical meristems are sites of cell division, made up of readily dividing cells, which are responsible for the increase in the height of the plant in both the shoot and root region. Plant height is the maximum stature, a typical mature individual of a species attains in a given habitat and its growth parameter is influenced by various biotic and biotic parameters (Kumari *et al.* 2021). Maximum plant height and highest dry matter accumulation were recorded under 0.2% Boron with 2% Sulfur along with 0.5% Zinc, 2% Urea and 2% Triacontanol which was significantly superior over the control however remain at par with 2% sulfur + 2% Urea + 2% Triacontanol (Table 1). The foliar application of nutrients improved the dry matter production because of the easy availability and translocation of nutrients which enhanced the overall growth of plants resulting the more vegetative growth and increased the dry matter production ultimately. However due to stress condition during the second year plant height was low as compared to first year. A similar trend was observed in the branching of linseed however branching in linseed remains at par with 0.2% Boron + 2% Urea + 2% Triacontanol during both the years (Table 1). Foliar application of

Table1. Growth parameters, yield attributes and yields of linseed as influenced by foliar application of nutrients.

Treatments Pl write detailed treatment	Plant height (cm)		Branches plant^{-1}		Dry matter accumulation (g m^2)		Capsules plant^{-1}		Seeds capsule^{-1}		Seed yield kg ha^{-1}	
	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019
T_1	41	37	5.4	5.8	203	232	26	35	4.5	4.7	580	717
T_2	45	43	6.0	6.2	244	230	28	37	5.9	6.2	627	770
T_3	48	46	6.7	6.9	240	243	38	45	6.2	6.4	655	792
T_4	44	42	6.3	6.8	227	237	45	40	5.8	5.4	727	781
T_5	45	44	6.5	6.7	209	236	43	39	5.7	5.9	766	717
T_6	46	45	6.4	6.8	264	257	46	43	6.0	5.7	833	880
T_7	54	60	6.9	7.0	270	260	50	63	6.3	6.8	955	951
T_8	59	62	7.3	7.2	283	271	60	65	6.5	7.0	1030	1056
T_9	63	62	7.4	7.4	278	282	58	69	6.7	7.3	1130	1156
T_{10}	65	66	7.6	7.7	322	299	64	71	7.0	7.4	1155	1236
T_{11}	68	67	7.7	7.9	307	314	64	73	7.3	7.6	1288	1325
T_{12}	72	70	7.9	8.1	339	350	71	75	7.7	7.9	1339	1356
SE(m)	1.8	1.2	0.2	0.2	17	16	3.3	0.9	0.2	0.2	23	20
CD (P=0.05)	5.4	3.5	0.5	0.5	70	47	9.8	2.8	0.6	0.5	92	60

various nutrients in these treatments improved the availability, absorption and uptake of nutrients which enhanced the meristematic activity and resulted in better growth and development making the plant taller in these treatments. The foliar application of micronutrients increased the cell division and elongation, meristematic activities, root activity, and the activity of enzymes which increased the number of braches per plant ultimately (Meena *et al.* 2016). Yield is the most significant and dynamic trait in crops. Yield is the measurement of the amount of a crop grown, or product such as seed, or stover produced per unit land area. It reflects the interaction of the environment with all growth and developmental process that occur throughout the life cycle. Yield attributing parameters viz: capsules per plant and seeds per capsule were reported maximum in 0.2% Boron with 2% Sulfur along with 0.5% Zinc, 2% Urea and 2% Triacontanol which was significantly superior over the control during both the years, however, remains on a par with 2% Sulfur + 2% Urea + 2% Triacontanol. However, seeds per capsule remain at par with 0.5% Zinc + 2% Urea + 2% Triacontanol and 0.2% Boron + 2% Urea + 2% Triacontanol treatments during 2019. Higher yield attributing characteristics lead to higher yield in the same treatment. The highest seed yield was observed in the treatment 0.2% Boron with 2% Sulfur along with 0.5% Zinc, 2% Urea and 2% Triacontanol which was significantly superior over the control during both years however it remains at par with T_{12} treatment (Table 1). Similar types of findings were confirmed by several workers (Kirnapure *et al.* 2020, Zaid *et al.* 2020). Triacontanol mediated improvements in growth, yield, photosynthesis, protein synthesis, water and nutrients intake, nitrogen fixation, and enzyme activity which enable plants to perform better and ultimately lead to higher yields. (Verma *et al.* 2022 and Meena *et al.* 2024).

CONCLUSION

Based on the results of study, it can be concluded that foliar application of growth hormones and nutrients (2% Triacontanol + 2% Urea + 0.2% Boron + 0.5% Zinc + 2% Sulfur) were enhance the growth parameters and yield attributes of linseed resulted higher seed yield. However, 2% Triacontanol + 2% Urea + 2% Sulfur, in on par with T_{12} so it can be concluded that these treatment can be used in the transitional plain of luni basin to enhance linseed production.

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