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Effect of sulphur and zinc on growth, yield and quality of linseed (*Linum usitatissimum* L.)

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Abstract
The experiment was conducted during *Rabi* season of 2020-2021 at Experimental Farm, College of Agriculture, Latur. study of effect of sulphur and zinc on growth, yield and quality of linseed (*Linum usitatissimum* L.)" was laid out in Factorial Randomized Block Design with three replications. Among all treatments The (S2), 40 kg s ha^{-1} was observed to be most productive for getting higher growth & yield attributes, yield, net monetary returns and B:C ratio, which was closely followed by (S_1), 20 kg s ha^{-1}. (S_0), o kg s ha^{-1}.The (Z_3) 7.5 kg Zn ha^{-1} was found to be most productive for getting elevated growth & yield attributes, yield, net monetary returns and B:C ratio, which was be near to by (Z2), 5.0 kg Zn ha^{-1} Z1), 2.5 kg Zn ha^{-1}, by (Z_0), o kg Zn ha^{-1}.

Keywords: Sulphur, zinc, quality, linseed, *Linum usitatissimum* L.

Introduction
Linseed (*Linum usitatissimum* L.) is a *rabi* oilseed crop belongs to the family Linaceae. It is native to Mediterranean region and Southwest Africa. It is known as Jawas or Alashi (Marathi), Alsi in (Hindi). The genus *Linum* has over 200 species of which *Linum usitatissimum* L. is the only widely cultivated economically important species. It has somatic chromosome number 2n=30. Two morphologically distinct cultivated species of linseed are recognized, namely flax and linseed. Flax is growing for fibre purpose and linseed is growing for oil purpose. The linseed oil is used in industries medium for oil paint, etc. In India the paint and allied industries is the major consumer of linseed to 70 per cent of the total consumption. The thesis entitled "Study of effect of sulphur and zinc on growth, yield and quality of linseed (*Linum usitatissimum* L.)" is carried out with the following objective.
To study the effect of secondary micronutrients (Sulphur and Zinc) on growth and yield of Linseed, to study the effect of Sulphur and Zinc on quality and oil content in Linseed. and to study the economics of application of Sulphur and Zinc to Linseed

Materials and Methods
The experiment was conducted during *Rabi* season of 2020-2021 at Experimental Farm, College of Agriculture, Latur. The details of the experimental technique employed for the investigation are as under. " study of effect of sulphur and zinc on growth, yield and quality of linseed (*Linum usitatissimum* L.)" was laid out in Factorial Randomized Block Design with three replications. The experiment consisted of seven treatments.
The field experiment was laid out in Factorial Randomized Block Design with three replications. There are twelve treatments. The soil of experimental plot was medium to black in color with good drainage. The topography of experimental field was uniform and fairly levelled. The representative soil samples from 0 to 30 cm depth were taken from randomly selected plots all over the experimental field before laying out the experiment. A composite soil sample of about half kg was taken and analyzed for the determination of various physical and chemical properties of soil.
Data obtained on various variables were analyzed by "analysis of variance method". The total variance (S^2) and d. f. (n^{-1}) divided in to different possible sources. The variance due to main effect and interaction effects were calculated and compared with error variance for finding out "F" values and ultimately for testing the significance at P = 0.05.

Result and Discussion
The data presented in Table 1 recorded the mean seed yield (kg $ha^{-1)}$ were influenced significantly due to sulphur.

The application of sulphur @ 40 kg ha^{-1} (S_2) gave highest seed yield kg ha^{-1} which were found significantly superior over rest of the treatments. The lowest seed yield kg ha^{-1} was observed in treatment sulphur @ 0 kg ha^{-1} (S_0). The data presented in Table 4.11 observed the mean seed yield kg ha^{-1} influenced significantly due to zinc. The application of zinc @ 7.5 kg ha^{-1} (Z_3) gave highest seed yield. Which, were found significantly superior over rest of the treatments. The lowest seed yield were observed in treatment zinc @ 0 kg ha^{-1} (Z_0) Interaction effects of sulphur and zinc were indicated to be non-significant. The data presented in Table 1 observed the mean straw yield were influenced significantly due to sulphur. The application of sulphur @ 40 kg ha^{-1} (S_2) gave highest straw yield which were found significantly superior over rest of the treatments.

Table 1: Seed yield (kg ha^{-1}), straw yield (kg ha^{-1}), biological yield (kg ha^{-1}) and harvest index (%) as influenced by various treatments

Treatments	Seed yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Biological yield (kg ha^{-1})	Harvest index (%)
Sulphur				
S_0	1007	1632	2639	0.38
S_1	1183	1709	2892	0.40
S_2	1315	2449	3765	0.34
SE ±	29.83	59.87	89.77	0.33
CD at 5%	87.50	175.59	263.09	0.33
Zinc				
Z_0	1107	1682	2790	0.39
Z_1	1101	1914	3023	0.36
Z_2	1175	1990	1366	0.81
Z_3	1289	2135	2263	0.56
SE ±	34.45	69.13	103.58	0.33
CD at 5%	101.04	202.75	124.96	0.46
(C) Interaction (SxZ)				
SE ±	59.67	119.74	179.41	0.33
CD at 5%	NS	351.18	NS	NS
General mean	1168	1930	3099	0.33

The lowest straw yield was observed in treatment sulphur @ 0 kg ha^{-1} (S_0). Those result was recorded similar Choudhary *et al.* (2016), Minz *et al.* (2017) and Tiwari *et al.* (2018) The data presented in Table 1. Showed the mean straw yield were influenced significantly due to zinc. The application of zinc @ 7.5 kg ha^{-1} (Z_3) gave highest straw yield. Which, were found significantly superior over rest of the treatments. The lowest straw yield was observed in treatment zinc @ 0 kg ha^{-1} (Z_0). Interaction effects of sulphur and zinc were indicated to be non-significant.

Table 2: Mean seed yield (kg ha^{-1}), Gross monetary returns (`ha^{-1}), Cost of cultivation (ha^{-1}), Net monetary returns (ha^{-1}) and benefit cost ratio (B:C) as influenced by various treatments

Treatments	Seed yield (kg ha-1)	GMR (Rs / ha)	Cost of cultivation (Rs/ha)	NMR(Rs/ha)	BC ratio
Sulphur					
S_0	1007	50343	28401	21942	1.8
S_1	1183	59150	29601	29549	2.0
S_2	1316	65776	30801	34975	2.1
SE±	30	1492	-	1492	-
CDat5%	88	4375	-	4375	-
Zinc					
Z_0	1108	55386	29263	26123	1.9
Z_1	1101	55060	29488	25572	1.9
Z_2	1176	58781	29713	29068	2.0
Z_3	1289	64465	29938	34527	2.2
SE±	34	1723	-	1723	-
CDat5%	101	5052	-	5052	-
(C)Interaction (S x Z)					
SE±	60	2984	-	2984	-
CDat5%	NS	NS	-	NS	--
General mean	1168	58423	29601	28822	2.0

The data presented in Table 2 observed the mean gross monetary return were influenced significantly due to sulphur. The application of sulphur @ 40 kg ha^{-1} (S_2) gave highest gross monetary return which were found significantly superior over rest of the treatments. The lowest gross monetary return was observed in treatment sulphur @ 0 kg ha^{-1} (S_0). The data presented in Table 12 recorded the mean gross monetary return were influenced significantly due to zinc. The application of zinc @ 7.5 kg ha^{-1} (Z_3) gave highest gross monetary return. Which, were found significantly superior over rest of the treatments. The lowest gross monetary return was observed in treatment zinc @ 0 kg ha^{-1} (Z_0) Interaction effects of sulphur and zinc were indicated to be non-significant.

Conclusion

On the basis of field experiment carried out during the *rabi* season 2020, could be concluded that

1. The (S2), 40 kg s ha^{-1} was observed to be most productive for getting higher growth & yield attributes, yield, net monetary returns and B:C ratio, which was closely followed by (S_1), 20 kg s ha^{-1}. (S_0), o kg s ha^{-1}
2. The (Z_3) 7.5 kg Zn ha^{-1} was found to be most productive for getting elevated growth & yield attributes, yield, net monetary returns and B:C ratio, which was be near to by (Z2), 5.0 kg Zn ha^{-1} Z1), 2.5 kg Zn ha^{-1}, by (Z_0), o kg Zn ha^{-}

Above conclusions are based on single season research finding and its needs further confirmation by repeating the trial for at least one more season.

Simple correlation

The simple correlation studies showed that positive and significant correlation was found between grain yield $plant^{-1}$ and the characters plant height (cm), number of branches $plant^{-1}$, spread of $plant^{-1}$, total dry matter $plant^{-1}$ (g), number of capsule $plant^{-1}$, weight of capsule $plant^{-1}$ (g), number of seeds $capsule^{-1}$, test weight (g) and harvest index.

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