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Effect of sulphur and zinc on growth characterstics and yield of linseed under rainfed condition of Chitrakoot area

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Abstract
A field experiment was conducted at Rajaula Agriculture farm, of Mahatma Gandhi Chitrakoot Gramodaya Vishwavidyalaya Chitrakoot, Satna (M.P.) during Rabi season of 2017-18. To study the effect of sulphur and zinc on growth parameters, yield components and yield of linseed. The experiment comprised of 9 treatment combinations in randomized block design with three replications. Linseed variety Shekhar was grown with the recommended agronomic practices. On the basis of the results emanated from present investigation, it could be concluded that application of S @ 30 kg ha^{-1} + Zn @ 15 kg ha^{-1} significantly recorded maximum growth parameters such as viz. plant height at 30 days (10.77 cm), 60 days (32.70 cm) and 90 days (46.91 cm), number of branches at 30 days (1.67), 60 days (3.07) and 90 days (3.20). Similarly among the yield attributing characters such as number of capsule plant^{-1} (12.40), number of seed capsule^{-1} (8.20), root length (8.91) and test weight (4.07 gm). Similarly the maximum seed yield (503.47 kg ha^{-1}) was associated with the treatment fertilized with S @ 30 kg ha^{-1} + Zn @ 15 kg ha^{-1}.

Keywords: Growth, linseed, sulphur, yield and zinc

Introduction
The linseed (*Linum usitatissimum* L.) is an important *Rabi* oilseed crop next to rapeseed and mustard in India. It is grown for both seed and fibre in south - west Asia including Turkistan, Afghanistan and India. It is primarily grown for oil in Asia Minor and south Russia. It is traditionally cultivated for oil meant for edible as well as industrial purposes. Almost every part of this plant is commercially utilized either direct or after processing. On small scale, the seed and its oil are directly used for human consumption as flax seed breads, bagels and other baked and fired food stuffs. It is industrial oil and mostly 80 % of oil is used for paints, varnishes, a wide range of coating oils, linoleum, pad and printing inks, leather and soap industries. Linseed is highly nutritious. It is a source of complete protein (all 8 essential amino acids) high order linolenic acid (an essential polyunsaturated omega-3fatty acid), complex carbohydrates, vitamins and minerals. Recent advances in medical research have found linseed as best herbal source of omega - 3 and omega - 6 fatty acids, which have immense nutritional or medicinal effect on human body system. Linseed stem yields good quality fibre having strength and durability. The fibre is lustrous and blends very well with wool, cotton, silk, etc. (Rastogi *et al*. 2013) [11].

Oilseeds occupy an important position in the agricultural economy of India. The country is the largest producer of oilseeds in the world and oilseed sector occupies an important position in the agricultural industry as well as in trade and national economy of the country. Oilseeds are among the major crops that are grown in the country apart from cereals. In terms of acreage, production and economic value, these crops are second only to food grains. India is the fifth largest vegetable oil economy in the world next only to USA, China, Brazil and Argentina, and has an annual turnover of about ` 80000 crore. India accounts for 12-15 per cent of global oilseeds area, 7-8 per cent of oilseeds production, 6-7 per cent of vegetable oils production, 9-12 per cent of vegetable oils import and 9-10 per cent of the edible oils consumption (Jha *et al*., 2012) [7].

Among the different oilseeds crops grown in country, linseed (*Linum usitatissimum* L.) is considered the most important oilseed crop of India and stands next to rapeseed-mustard in *rabi* oilseed crop in area and production.

Linseed is an important industrial and edible oil and fiber producing crop. It is grown either for oil extracted from seed or for fiber from stem. Seed contain oil ranging from 37 to 43%.Flax seed is rich in oil (41%), protein (20%), dietary fiber (28%), contains 7.7% moisture and 3.3% ashes (Morris, 2005) [20]. It has a high percentage of essential fatty acids, 75% polyunsaturated fatty acids, 57% alpha- linoleic acid, which is an omega-3 fatty acid, and 16% linoleic acid, which is an omega-6 fatty acid.

There has been a continuous decline in linseed area in the country during the last four decades so to sustain linseed production mainly in irrigated area. The growth in the domestic production of oilseeds has not been able to keep pace with the growth in the demand in the country. Low and unstable yields of most oilseed crops, and uncertainty in returns to investment, which result from the continuing cultivation of oilseeds in rainfed, high risk production environments, are the factors leading to this situation of wide demand-supply gap. Therefore, it needs to develop appropriate agronomic practices to obtain higher crop yield. Among the different practices to obtain higher crop yield with suitable agro technique under different agro-climatic zone, application of suitable NPK levels, biofertilizers and selection of high yielding varieties are the major applied research thrust. The production potentiality of linseed has tremendous potential to increase productivity per unit area by using high yielding cultivars (Nagdy *et al.*, 2010) [4].

Method and Material

Experimental Site

The experiment was carried out at Rajaula Agriculture farm, Mahatma Gandhi Chitrakoot Gramoday Vishwavidyalaya Chitrakoot, Satna (M.P.) which lies in the semi- arid and sub-tropical region of Madhya Pradesh between 25°148' North latitude and 80°855' East longitude. The altitude of town is about 190-210 meter above mean sea level.

Edaphic Condition

The soil was moist, well drained with uniform plane topography. The soil of the experimental field was sandy loam in texture and slightly alkaline in reaction having pH 7.28 (1:2.5 soil: water suspension method given by Jackson, 1973) [6], Organic carbon percentage in soil is 0.24 percent (Walkley and Black's rapid titration method given by Walkley and Black, 1934) [19], with available nitrogen 98 kg ha^{-1} (Alkaline permanganate method given by Subbiah and Asija, 1956) [17], available phosphorus as sodium bicarbonate-extractable P was 17.32 kg ha^{-1} (Olsen's calorimetrically method, Olsen *et al.,* 1954) [10] available potassium was 305.99 kg ha^{-1} (Flame photometer method given by Hanwey and Heidel, 1952) [5]. Available sulphur was 8.5 kg ha^{-1} (Turbidimetric method, Chesnin and Yien, 1950) [3]. Available Zn was 0.549 ppm (DTPA extraction (AAS) Lindsay and Norvell, 1978) [8].

Detail of treatments and design

The 12 treatments combination of nutrient management practices having three each sulphur levels (10, 20 and 30 kg ha^{-1}) and zinc levels (5, 10, 15 kg ha^{-1}). Experiment was laid out in Factorial Randomized Block Design with three replications.

Table 1: Detail of the treatment combinations

Symbol	Details of Treatment
T_1	S @ 10 kg ha^{-1} + Zn @ 5 kg ha^{-1}
T_2	S @ 10 kg ha^{-1} + Zn @ 10 kg ha^{-1}
T_3	S @ 10 kg ha^{-1} + Zn @ 15 kg ha^{-1}
T_4	S @ 20 kg ha^{-1} + Zn @ 5 kg ha^{-1}
T_5	S @ 20 kg ha^{-1} + Zn @ 10 kg ha^{-1}
T_6	S @ 20 kg ha^{-1} + Zn @ 15 kg ha^{-1}
T_7	S @ 30 kg ha^{-1} + Zn @ 5 kg ha^{-1}
T_8	S @ 30 kg ha^{-1} + Zn @ 10 kg ha^{-1}
T_9	S @ 30 kg ha^{-1} + Zn @ 15 kg ha^{-1}

Preparation of experimental field

The field was prepared by ploughing with a tractor drawn disc plough by cross harrowing and planking. The field was levelled and weeds, grasses were removed with the help rake. There after field was laid out as per plan of layout manually.

Application of manures and fertilizers

FYM was applied @ 10q/ha as basal dose. A common dose of chemical fertilizers were applied @20kg. N in all the treatment Nitrogen and phosphorus where applied through Urea, DAP and Zinc chloride(50%) whereas sulphur was applied through W.P., out of total quantity of Nitrogen, phosphorus and sulphur fertilizers the full quantity of Nitrogen, Sulphur (@ 10,20 and 30 kg ha^{-1}) and zinc (5, 10 and 15 kg h^{-1}).

Harvesting and Threshing

The crop was harvested on 23th March 2018 when it reached to its physiological maturity i.e. when the leaves were turned yellow and more than 70% capsules were full matured to avoid shattering of the crop. Threshing of 29th March 2018 plot wise produce was done manually. The seed weight was recorded after sun drying the seed for three days. The straw weight was recorded after deducting the seed weight from the bundle weight. The seed and straw weight thus obtained were converted into quintals per hectare on the basis of net plot size.

Statistical analysis

The growth parameters and yields were recorded and analyzed as per Gomez and Gomez (1984) the tested at 5% level of significance to interpret the significant differences.

Result and Discussion

Growth Parameters

Plant Height: From the table-2, it can be observed that as the treatment number increases from T_1 to T_9, there is an increasing trend in plant height and the number of branches at all time points. For example, at 90 DAS, plant height ranges from 38.42 cm in T_1 to 46.91 cm in T_9, while the number of branches ranges from 2.50 in T_1 to 3.20 in T_9. Therefore, based on the results of this experiment, it can be concluded that the treatments have a positive effect on the growth of the plants, especially on plant height and the number of branches. Treatment T_9 appears to be the most effective in promoting plant growth. However, further studies are needed to determine the underlying mechanisms of the observed effects and to optimize the application of the treatments. Similar findings were reported by Agarwal et al., (1996) [1], Mankar *et al.,* (2003) [9] and Singh *et al.,* (2004) [15].

Table 2: Effect of different treatment combinations on growth parameters

Treatment	Plant height (cm)			Number of Branches		
	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS
T_1	9.49	26.40	38.42	1.20	2.40	2.50
T_2	9.53	26.65	39.48	1.27	2.40	2.53
T_3	9.61	27.59	39.56	1.33	2.47	2.60
T_4	9.75	28.37	40.99	1.53	2.53	2.67
T_5	9.93	28.44	42.01	1.53	2.60	2.73
T_6	10.70	31.49	44.20	1.60	2.73	2.80
T_7	10.15	30.48	42.96	1.60	2.60	2.73
T_8	10.71	32.47	44.26	1.67	2.87	3.13
T_9	10.77	32.70	46.91	1.67	3.07	3.20
S.Em±	0.66	1.74	2.64	0.13	0.28	0.29
CD 5%	1.99	5.23	7.39	0.40	0.85	0.88

Yield attributes

From the table-3, it can be observed that as the treatment number increases from T_1 to T_9, there is an increasing trend in all parameters measured. For example, the number of capsules per plant increases from 9.87 in T_1 to 12.40 in T_9, while the number of seeds per capsule increases from 6.67 in T_1 to 8.20 in T_9. The root length and test weight also show a similar increasing trend. Therefore, based on the results of this experiment, it can be concluded that the treatment has a positive effect on the growth of the plants, but further studies are needed to establish the significance of the observed differences. The consequences of the current investigation are additionally in concurrence with the investigation of Sharma *et al.*, (2001) [13], Singaravel *et al.*, (2002) [14] and Sangle *et al.*, (2004) [15].

Table 3: Effect of different treatment combinations on yield attributes

Treatment	Number of capsule plant^{-1}	Number of seed per capsule	Root length (cm)	Test weight (g)
T_1	9.87	6.67	7.85	4.1
T_2	9.93	6.67	8.08	4.2
T_3	10.60	7.00	8.19	4.3
T_4	10.60	7.33	8.39	4.4
T_5	11.07	7.80	8.41	4.4
T_6	11.54	8.00	8.49	4.6
T_7	11.53	7.93	8.45	4.5
T_8	12.27	8.07	8.50	4.7
T_9	12.40	8.20	8.91	4.7
S.Em±	0.81	0.54	0.47	0.13
CD 5%	2.44	1.62	1.41	0.40

Seed Yield

From the table-4, it can be observed that the seed yield increases as the treatment number increases from T_1 to T_9. For example, the seed yield ranges from 315.28 kg ha^{-1} in T_1 to 503.47 kg ha^{-1} in T_9. However, it is important to note that other factors, such as soil type, weather conditions, and crop management practices, can also influence seed yield. Therefore, further studies under different conditions and over multiple years are needed to validate the results of this experiment. These results also confirms the findings of Akbari *et al.*, (2003) [2], Vyas *et al.*, (2003) [18] and Singh *et al.*, (2000) [16].

Table 4: Effect of different treatment combinations on seed yield (kg ha^{-1})

Treatment	Seed yield (kg ha^{-1})
T_1	315.28
T_2	331.25
T_3	397.57
T_4	419.09
T_5	478.13
T_6	488.89
T_7	484.38
T_8	489.58
T_9	503.47
S.Em±	45.49
CD 5%	136.48

Conclusion

The study showed that the application of sulphur along with zinc resulted in higher growth parameters, yield components consequently seed yield of linseed. It will help in uplifting the socioeconomic status of the farmers. Application of sulphur along with zinc deserves a special attention for increasing yield of linseed.

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