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Effect of nitrogen and sulphur level on growth, yield and quality of *Linum usitatissimum* L.

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Abstract
The present investigation entitled "Effect of different of nitrogen and sulphur level on growth, yield and quality of linseed (*Linum usitatissimum* L.)" was conducted during the Rabi season of 2022-2023 at Crop Research Centre, ITM University Gwalior (M.P.). The oilseed flax linseed (*Linum usitatissimum* L.) is predominantly the source of valuable oil, in which the most appreciated are omega-3 fatty acids. The experiment was laid out in the Randomized Block Design (RBD) with three replications. The experiment comprised with ten treatment combinations of one level absolute control and three level of nitrogen fertilizer (i.e. 40, 60 and 80 kg/ha) and three level of sulphur fertilizer (i.e. 20, 40 and 60 kg/ha) were applied in linseed (*Linum usitatissimum* L.). Result concluded that the N_2S_2 60 kg nitrogen and 40 kg Sulphur in linseed proved to better than crop production, yield and economic return a compare as compared to other treatments.

Keywords: Linseed, growth, yield, sulphur and nitrogen

Introduction
Linseed (*Linum usitatissimum* L.) also known as flaxseed in North America, in one of the earliest cultivated field crops, initially grown for its fiber. In North America, in the last two centuries linseed has been grown primarily for its oil. It is a spring annual adapted to a wide range of soil and climatic conditions in the cool temperate zones of the northern hemisphere. Linseed in North America is used primarily to produce industrial oil and animal feed meal. Linseed oil is a drying oil used in paints and varnishes and for the manufacture of linoleum flooring.

A trend toward bio-products has increased this market in the 2000s. Because linseed oil contains alpha-linolenic acid (ALA) an essential omega-3 fatty acid it has a variety of uses. Whole linseed is fed to poultry to produce omega-3 fatty acid-enriched eggs. Linseed meal is a component of rations fed to pets, poultry, and animal. Small quantities of linseed are also used in food products (bread and breakfast cereals) but a significant number of products are being developed using linseed in response to the variety of health benefits including reducing heart disease and cancer risk. Additional products have been created based on the health and nutrition claims of linseed oil lignans and antioxidant flavonoids. Small quantities of linseed are used for (re)planting seed. The oil content of the seed used for varies from 38-47%.

India is the third largest producer of oilseeds in the world. Among different oilseed crops linseed occupies an important place and India ranks third in world in linseed production. India's share in the world production of linseed is 20%. Linseed contributes a great importance among the oilseeds, owing to its various uses and special qualities. In India it is mainly cultivated for the seed which is used for the extraction of oil. The oil content of linseed varies from 33-47%. Linseed oil is also used in the manufacture of paints and varnishes.

Materials and Methods
Description of the Experimental Site
The experiment was conducted at crop research center poly-house in school of agriculture, ITM University Gwalior (M.P.) during Rabi season of (2022). The soil of experiment field is sandy loam in texture with (pH-7.8) and soil medium is low organic carbon (0.28%). ITM University is situated geographically at India $26^0 8' 51'' N$ latitude $78^0 11' 18'' E$ longitude. It falls under cliffs plateau and sub-tropical climate zone of Madhya Pradesh.

Treatment and Experimental design

The linseed variety used for the study was Jawahar Linseed Sagar 79 (JLS79) Released by CVRC, New Delhi in the year 2016 through AICRP for cultivation under irrigated situations of whole Madhya Pradesh. Urea was used as a source of N fertilizer and Single Super Phosphate (SSP) as S fertilizer. The treatments consisted of three level of nitrogen (40, 60, 80) and three level of sulphur (20, 40, 60) the experiment was laid out in randomized block design (RBD) in a factorial arrangement replicated three times. The field layout was prepared and the treatments ware assigned to each experimental plot randomly within a block plot spacing 30cm × 10cm.

Field activities, treatment application

Linseed seed was sown in rows at the recommended rate of 25kg ha $^{-1}$ on the prepared fine seedbed on October 17, 2022. Nitrogen fertilizer in the form of urea was applied at the specified rates in two equal parts, i.e. half was applied at sowing and the remaining half was top- dressed just at the start of flowering stage. Sulphur was applied in the form of Single Super Phosphate (SSP) at the specified rates at sowing. All broadleaved and grass weeds ware removed by hand weeding 30-35 days after emergence. Harvesting was start at February 27, 2022.

Result and Discussion

Effect of different nitrogen level on growth and yield of linseed: The data pertaining to the effect of different nutrient treatments on plant population, plant height, Dry matter accumulation per plant (g), Number of leave plant $^{-1}$, capsule per plant, Seed per capsule, test weight, Grain yield, Stover yield, biological yield, Harvest index**,** the maximum plant population at 15 DAS (34.97), plant population at harvest (34.61), plant height at harvest (54.59), Dry matter accumulation per plant (g) at harvest (7.27), Number of leave plant $^{-1}$ at harvest (337.25), capsule per plant (72.95), Seed per capsule (8.60), test weight (7.91), Grain yield (1497.89), Stover yield (2669.23), biological yield (4167.13), Harvest index (38.2), were recorded under T_{10} (N3+S3) nitrogen 80 + sulphur 60 kg ha^{-1} was applied, and it was significantly superior as compared to other treatments. These results of the present study agree with the findings of several other investigators: Pasricha, *et al*., (1987) [2], Patil *et al.* (2014) [4], Prasad and Bharat Prasad (2002) [3], Sarika *et al*. (2006) [7], Solo *et al*. (2021) [10].

Table 1: Effect of Nitrogen and Sulphur levels on growth and yield parameters of linseed

Treatment	Germination percent (%) at 10 DAS	Germination percent	Plant height (cm)				Number of leaves per plant			
		At harvest	30 DAS	60 DAS	90 DAS	At harvest	30 DAS	60 DAS	90 DAS	At harvest
	Varieties									
Absolute control	32	29	14	27	33	38	185.55	274.72	359.94	260.40
Nitrogen Levels (Kg/ha)										
N1	33.78	32.18	18.08	35.06	42.38	43.07	200.50	321.94	385.22	297.39
N2	34.00	33.32	22.19	41.45	48.35	50.16	227.56	339.44	404.89	329.77
N3	34.97	34.61	25.08	43.29	51.82	54.59	233.33	346.13	410.70	337.25
S.E.(m)	1.06	2.02	1.57	2.43	2.42	2.85	6.24	6.77	7.58	7.18
C.D.(at 5%)	NS	NS	3.33	5.15	5.14	6.05	13.23	14.35	16.08	15.22
Sulphur levels (Kg/ha)										
S1	33.58	32.51	18.03	34.82	42.32	43.00	200.28	321.57	384.84	297.22
S2	34.19	33.22	22.33	41.91	48.30	49.95	227.67	339.68	404.39	329.59
S3	34.97	34.38	24.98	43.08	51.94	54.87	233.44	346.28	411.58	337.61
S.E.(m)	1.06	2.02	1.57	2.43	2.42	2.85	6.24	6.77	7.58	7.18
C.D.(at 5%)	NS	NS	3.33	5.15	5.14	6.05	13.23	14.35	16.08	15.22
Interaction										
S.E.(m)	1.84	3.65	2.72	4.21	4.20	4.94	10.81	11.72	13.14	12.44
C.D.(at 5%)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Effect of different sulphur levels on growth and yield of linseed

The data pertaining to the effect of different nutrient treatments on plant population, plant height, Dry matter accumulation per plant (g), Number of leave plant $^{-1}$, capsule per plant, Seed per capsule, test weight, Grain yield, Stover yield, biological yield, Harvest index, the maximum plant population at 15 DAS (34.97), plant population at harvest(34.38), plant height at harvest (54.87), Dry matter accumulation per plant (g) at harvest (7.19), Number of leave plant $^{-1}$ (337.61), capsule per plant (72.42), Seed per capsule (8.60), test weight (7.99), Grain yield (1438.33), Stover yield (2563.11), biological yield (4001.44), Harvest index (37.4) were recorded under T_{10} (N3+S3) nitrogen 80 + sulphur 60 kg ha^{-1} was applied and it was significantly superior as compared to other treatments. These results of the present study agree with the findings of several other investigators, including Nandanwar *et al.* (2000) [1], Sandeep Singh and Vinay Singh (2007) [8], Tomar (2012) [11], Singh *et al.* (2013) [9], Patel *et al.* (2017) [5], Pawar *et al.* (2023) [6],

Table 2: Effect of Nitrogen and Sulphur levels on yield parameters of linseed

Dry matter accumulation per plant (g)								Yield			
Treatment	**at 30 DAS**	**at 60 DAS**	**at 90 DAS**	**at harvest**	**Capsule per plant**	**Seed per capsule**	**Test weight (g)**	**Grain yield (kg/ha)**	**Straw yield (kg/ha)**	**Biological yield (kg/ha)**	**Harvest index (%)**
Absolute control	0.27	1.42	3.2	3.87	39.25	7.15	7.02	758.00	1282.00	2040.00	34.5
Nitrogen Levels (Kg/ha)											
N1	0.46	1.90	4.14	5.37	58.61	7.75	7.43	1080.89	1926.144	3007.03	35.0
N2	0.57	2.97	6.02	6.85	67.92	8.13	7.54	1367.33	2436.588	3803.92	37.1
N3	0.58	3.43	6.53	7.27	72.95	8.60	7.91	1497.89	2669.238	4167.13	38.2
S.Em±	0.07	0.55	0.85	0.88	4.38	1.03	0.94	122.97	219.1413	342.12	2.10
CD (P=0.05)	NS	1.17	1.80	1.86	9.29	2.18	2.00	260.70	464.5587	725.25	NS
Sulphur levels (Kg/ha)											
S1	0.49	2.53	4.41	5.59	58.13	7.61	7.17	1168.89	2082.96	3251.85	35.7
S2	0.55	2.84	5.95	6.71	68.93	8.27	7.71	1338.89	2385.9	3724.79	37.1
S3	0.57	2.93	6.33	7.19	72.42	8.60	7.99	1438.33	2563.11	4001.44	37.4
S.Em±	0.07	0.55	0.85	0.88	4.38	1.03	0.94	122.97	219.1413	342.12	2.10
CD (P=0.05)	NS	1.17	1.80	1.86	9.29	2.18	2.00	260.70	464.5587	725.25	NS
Interaction (NXS)											
S.Em±	0.12	0.95	1.47	1.52	7.59	1.78	1.63	213.00	379.5638	592.56	3.6
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Conclusion

Based on field experiment it may be concluded that the application of N_2S_2 60 kg nitrogen and 40 kg Sulphur in linseed proved to be better than from crop production, yield and economic return as compare as compared to other treatments.

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