

## INFLUENCE OF SULPHUR ON YIELD AND YIELD CONTRIBUTING PARAMETERS AND ECONOMICS OF LINSEED

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### ABSTRACT

The experiment was carried out to identify suitable sulphur dose of linseed during *rabi* season of year 2017-18 with linseed variety PKV-NL-260 on field No. 11 of Agronomy farm, college of Agriculture, Nagpur. The experiment was laid out in randomized block design with three replications. The treatments included T<sub>1</sub>- RDF (60:30:00 NPK kg ha<sup>-1</sup>), T<sub>2</sub>- RDF + 15 kg S ha<sup>-1</sup> through gypsum, T<sub>3</sub>- RDF + 20 kg S ha<sup>-1</sup> through gypsum, T<sub>4</sub>- RDF + 25 kg S ha<sup>-1</sup> through gypsum, T<sub>5</sub>- RDF + 15 kg S ha<sup>-1</sup> through bentsulf, T<sub>6</sub>- RDF + 20 kg S ha<sup>-1</sup> through bentsulf, T<sub>7</sub>- RDF + 25 kg S ha<sup>-1</sup> through bentsulf and T<sub>8</sub>- No fertilizer (control). The results of the study indicated that application of RDF + 25 kg S ha<sup>-1</sup> through bentsulf recorded higher yield, yield attributing characters and economics viz., number of capsules plant<sup>-1</sup>, seed and straw yield plant<sup>-1</sup>, biological yield, harvest index, GMR, NMR and B: C ratio.

(Key words: Linseed, sulphur, yield and economics)

### INTRODUCTION

Linseed is grown both for its seed as well as fibre which is used for the manufacture of linen cloth. Its seed contains a good percentage of oil which varies from 33 to 47 per cent in different varieties. The oil is edible and also due to its quick drying property it is used for the preparation of paints, varnishes, printing ink, oil cloth, soap, patent leather, and waterproof fabrics.

The oilcake left after the oil extraction is a most valuable feeding cake, which contains 36 per cent protein. It is fed to both milch and fattening animals. It is also used as organic manure because it contains about 5 per cent nitrogen, 1.4 per cent phosphorus and 1.8 per cent potash.

India contributes about 10.81 per cent and 5.3 per cent to world area and production respectively. The major linseed growing states of country are Madhya Pradesh, Chhattisgarh, Uttar Pradesh, Maharashtra, Bihar, Orissa, Jharkhand, West Bengal, Nagaland and Assam, accounting for about 97% of total area of nation. In Maharashtra it is cultivated on an area of 14.2 thousand ha with production of 3.4 thousand tones and having productivity of 239 kg ha<sup>-1</sup> and in Vidarbha region, it is grown on area of 9.3 thousand ha with the production of 1.7 thousand tones and having productivity of 180 kg ha<sup>-1</sup>. (Anonymous, 2016).

The use of sulphur is one of the most important factors in increasing yield. Sulphur plays an important role in the formation of aminoacids, synthesis of proteins, chlorophyll and oil. Balanced use of sulphur commensurate with crop needs and soil nutrient status is indispensable

for sustained production of high yield level. Experimental evidences indicate that sulphur is most essential plant nutrient which is generally lacking in Indian soils. It is necessary to supply these to the hungry soil in concentrated and readily available form i.e. fertilizers. It is also essential to know the optimum level of sulphur.

### MATERIALS AND METHODS

The present investigation entitled "Effect of sulphur on growth, yield and quality of linseed (*Linum usitatissimum* L.)" was conducted at Department of Agronomy farm, College of Agriculture, Nagpur during *rabi* season of year 2017-18. The soil was clayey in nature with pH 7.9 indicating slightly alkaline in reaction, low in available nitrogen; medium in available phosphorus and very high in available potassium.

The Experiment was laid out in Randomised Block Design with T<sub>1</sub>- RDF (60:30:00 NPK kg ha<sup>-1</sup>), T<sub>2</sub>- RDF + 15 Kg S ha<sup>-1</sup> through gypsum, T<sub>3</sub>- RDF + 20 kg S ha<sup>-1</sup> through gypsum, T<sub>4</sub>- RDF + 25 kg S ha<sup>-1</sup> through gypsum, T<sub>5</sub>- RDF + 15 kg S ha<sup>-1</sup> through bentsulf, T<sub>6</sub>- RDF + 20 kg S ha<sup>-1</sup> through bentsulf, T<sub>7</sub>- RDF + 25 kg S ha<sup>-1</sup> through bentsulf, T<sub>8</sub>- No fertilizer (control). There were eight treatment combinations replicated thrice.

The crop variety PKV- NL- 260 was used with gross plot size of 3.6 m × 5.0 m and net plot size of 2.4 m × 3.0 m. As per the treatment, the quantity of sulphur and fertilizer required plot<sup>-1</sup> was calculated. Nitrogen was applied as per treatments in two splits i.e. 1/2 at sowing, 1/2 at 30 DAS. Full dose of phosphorus, potassium were applied at sowing. In

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order to represent the plot, five plants of linseed from each net plot were selected randomly, labeled properly. The biometric observations were recorded at harvest viz., number of capsules plant<sup>-1</sup>, grain and straw yield plant<sup>-1</sup>, grain and straw yield kg ha<sup>-1</sup>, biological yield and harvest index. Economics was also calculated.

## RESULTS AND DISCUSSION

### Effect of sulphur on number of capsules plant<sup>-1</sup>

Data pertaining to number of capsules plant<sup>-1</sup> as influenced by different treatments are presented in table 1.

At harvest number of capsules plant<sup>-1</sup> was significantly influenced with different treatments. RDF + 25 kg S ha<sup>-1</sup> through bensulf (T<sub>7</sub>) recorded significantly higher number of capsules plant<sup>-1</sup> over application of RDF (60:30:00 NPK kg ha<sup>-1</sup>)(T<sub>1</sub>), RDF + 15 kg S ha<sup>-1</sup> through gypsum(T<sub>2</sub>), RDF + 20 kg S ha<sup>-1</sup> through gypsum(T<sub>3</sub>), RDF + 15 kg S ha<sup>-1</sup> through bensulf (T<sub>5</sub>), no fertilizer (control) (T<sub>8</sub>) treatments. However, it was found at par with treatment RDF + 25 kg S ha<sup>-1</sup> through gypsum (T<sub>4</sub>), and RDF + 20 kg S ha<sup>-1</sup> through bensulf (T<sub>6</sub>). Maximum number of capsules plant<sup>-1</sup>(73.90) was recorded in treatment - RDF + 25 kg S ha<sup>-1</sup> through bensulf (T<sub>7</sub>) while minimum number of capsules plant<sup>-1</sup>(50.10) was recorded in treatment T<sub>8</sub> with no fertilizer (control).

Similarly Banerjee *et al.* (2001) reported that application of sulphur with increasing level up to 30 kg ha<sup>-1</sup> increased number of capsules plant<sup>-1</sup> over control in linseed.

### Effect of sulphur on yield

#### Seed yield plant<sup>-1</sup> (g)

The data presented in table 1 revealed that seed yield g plant<sup>-1</sup> of linseed was influenced significantly due to different integrated nutrient and sulphur management treatments. The seed yield plant<sup>-1</sup> was significantly higher with RDF + 25 kg S ha<sup>-1</sup> through bensulf (T<sub>7</sub>) and was found at par with RDF + 25 kg S ha<sup>-1</sup> through gypsum (T<sub>4</sub>), and RDF + 20 kg S ha<sup>-1</sup> through bensulf (T<sub>6</sub>), RDF + 25 kg S ha<sup>-1</sup> through bensulf (T<sub>7</sub>) recorded significantly higher seed yield over application of RDF (60:30:00 NPK kg ha<sup>-1</sup>)(T<sub>1</sub>), RDF + 15 Kg S ha<sup>-1</sup> through gypsum(T<sub>2</sub>), RDF + 20 kg S ha<sup>-1</sup> through gypsum(T<sub>3</sub>), RDF + 15 kg S ha<sup>-1</sup> through bensulf(T<sub>5</sub>), no fertilizer (control) (T<sub>8</sub>) treatments.

Maximum seed yield plant<sup>-1</sup>(4.76 g) was recorded in RDF + 25 kg S ha<sup>-1</sup> through bensulf (T<sub>7</sub>), while minimum grain yield plant<sup>-1</sup>(1.81 g) recorded in treatment having no fertilizer (control) (T<sub>8</sub>).

Upadhyay *et al.* (2012) reported that application of sulphur with increasing level up to 40 kg ha<sup>-1</sup> increased seed yield over control in linseed. Similarly Prasad and Prasad *et al.*(2002) reported that application of sulphur with increasing level up to 30 kg ha<sup>-1</sup> increased seed yield over control in linseed.

#### Straw yield plant<sup>-1</sup>(g)

The data presented in table 1 revealed that straw yield g plant<sup>-1</sup> of linseed was influenced significantly due to different integrated nutrient management treatments. The straw yield plant<sup>-1</sup> was significantly higher with RDF + 25 kg S ha<sup>-1</sup> through bensulf (T<sub>7</sub>) and was found at par with RDF + 25 kg S ha<sup>-1</sup> through gypsum (T<sub>4</sub>) and RDF + 20 kg S ha<sup>-1</sup> through bensulf (T<sub>6</sub>) but it was significantly superior over RDF (60:30:00 NPK kg ha<sup>-1</sup>)(T<sub>1</sub>), RDF + 15 Kg S ha<sup>-1</sup> through gypsum(T<sub>2</sub>), RDF + 20 kg S ha<sup>-1</sup> through gypsum(T<sub>3</sub>), RDF + 15 kg S ha<sup>-1</sup> through bensulf(T<sub>5</sub>) and no fertilizer (control) (T<sub>8</sub>) treatments.

Maximum straw yield plant<sup>-1</sup>(6.42 g) was recorded in treatment RDF + 25 kg S ha<sup>-1</sup> through bensulf (T<sub>7</sub>), while minimum straw yield plant<sup>-1</sup>(3.75 g) was recorded in treatment T<sub>8</sub> with no fertilizer (control). The highest straw yield might be because sulphur encourages above ground vegetative growth due to increased synthesis of amino acids, fatty acids, and meristematic activity that enhanced higher dry matter accumulation.

Pandey and Ali (2012) reported that seed and stover yield of linseed increased significantly when sulphur was applied through ammonium sulphate when compared to the other sources of sulphur up to 40 kg ha<sup>-1</sup>.

#### Seed yield (kg ha<sup>-1</sup>)

The data presented in table 1 revealed that grain yield kg ha<sup>-1</sup> of linseed was influenced significantly due to different integrated nutrient management treatments. RDF + 25 kg S ha<sup>-1</sup> through bensulf (T<sub>7</sub>) found statistically higher in grain yield over application of RDF (60:30:00 NPK kg ha<sup>-1</sup>)(T<sub>1</sub>), RDF + 15 Kg S ha<sup>-1</sup> through gypsum(T<sub>2</sub>), RDF + 20 kg S ha<sup>-1</sup> through gypsum(T<sub>3</sub>), RDF + 15 kg S ha<sup>-1</sup> through bensulf(T<sub>5</sub>) and no fertilizer (control) (T<sub>8</sub>) treatments and was found at par with with RDF + 25 kg S ha<sup>-1</sup> through gypsum (T<sub>4</sub>), and RDF + 20 kg S ha<sup>-1</sup> through bensulf (T<sub>6</sub>).

Maximum grain yield ha<sup>-1</sup>(1038 kg) was recorded in RDF + 25 kg S ha<sup>-1</sup> through bensulf (T<sub>7</sub>) while, minimum grain yield ha<sup>-1</sup>(498 kg ha<sup>-1</sup>) recorded in treatment T<sub>8</sub> with no fertilizer (control). Higher grain yield might be due to greater availability of nutrients and plant metabolism which in turn produced higher seed yield.

Lawaniya *et al.*(2015) reported that application of sulphur with increasing level up to 40 kg ha<sup>-1</sup> increased seed yield kg ha<sup>-1</sup> over control in linseed. Similarly Ghosh *et al.*(2000) reported that application of sulphur 30 kg ha<sup>-1</sup> increased grain yield kg ha<sup>-1</sup> over control in linseed.

#### Straw yield (kg ha<sup>-1</sup>)

The data presented in table 1 revealed that straw yield (kg ha<sup>-1</sup>) of linseed was influenced significantly due to different integrated fertilizer and sulphur management treatments. The straw yield ha<sup>-1</sup> was significantly higher with RDF + 25 kg S ha<sup>-1</sup> through bensulf (T<sub>7</sub>) over application of RDF (60:30:00 NPK kg ha<sup>-1</sup>)(T<sub>1</sub>), RDF + 15 Kg S ha<sup>-1</sup> through gypsum(T<sub>2</sub>), RDF + 20 kg S ha<sup>-1</sup> through gypsum(T<sub>3</sub>), RDF + 15 kg S ha<sup>-1</sup> through bensulf(T<sub>5</sub>), no

**Table 1. Effect of sulphur on yield attributes, yield and economics of linseed**

Treatments	Number of capsules plant <sup>-1</sup> at harvest	Grain Yield (kg ha <sup>-1</sup> ) (g plant <sup>-1</sup> )	Straw yield (kg ha <sup>-1</sup> ) (g plant <sup>-1</sup> )	Biological yield (kg ha <sup>-1</sup> )	Harvest index (%)	Economics (Rs. ha <sup>-1</sup> )	GMR (Rs. ha <sup>-1</sup> )	NMR (Rs. ha <sup>-1</sup> )	B:C ratio	
T <sub>1</sub> - RDF (60:30:00 NPK kg ha <sup>-1</sup> )	59.70	731	2.54	1404	4.20	2273	32.15	34739	20773	2.48
T <sub>2</sub> - RDF + 15 kg S ha <sup>-1</sup> through gypsum	61.60	800	2.83	1569	4.49	2502	32.00	38023	23083	2.54
T <sub>3</sub> - RDF + 20 kg S ha <sup>-1</sup> through gypsum	62.10	825	3.01	1677	4.68	2582	32.02	39288	24024	2.57
T <sub>4</sub> - RDF + 25 kg S ha <sup>-1</sup> through gypsum	72.70	987	4.27	2259	5.89	3091	31.69	47157	31568	3.02
T <sub>5</sub> - RDF + 15 kg S ha <sup>-1</sup> through bensulf	63.80	867	3.33	1926	5.00	2735	31.80	41254	26712	2.83
T <sub>6</sub> - RDF + 20 kg S ha <sup>-1</sup> through bensulf	68.90	985	4.23	2289	5.72	3019	31.17	47021	32280	3.10
T <sub>7</sub> - RDF + 25 kg S ha <sup>-1</sup> through bensulf	73.90	1038	4.76	2358	6.42	3180	32.63	49370	34434	3.30
T <sub>8</sub> - No Fertilizer (control)	50.10	498	1.81	892	3.75	1600	32.41	23644	11738	1.98
S E (m)	2.66	16.90	0.22	37.84	0.231	61.60	0.93	836.4	836.4	-
C D at 5%	7.9	50.46	0.66	112.00	0.690	183.00	-	2508.0	2508.0	-

fertilizer (control) ( $T_8$ ) treatments and was found at par with RDF + 25 kg S ha<sup>-1</sup> through gypsum ( $T_4$ ), and RDF + 20 kg S ha<sup>-1</sup> through bentsulf ( $T_6$ ). Maximum straw yield (2358 kg ha<sup>-1</sup>) was recorded in treatment with RDF + 25 kg S ha<sup>-1</sup> through bentsulf ( $T_7$ ), while minimum straw yield (892 kg ha<sup>-1</sup>) was recorded in treatment  $T_8$  with no fertilizer (control).

Chaudhary *et al.* (2016) reported that application of sulphur with increasing level up to 30 kg ha<sup>-1</sup> increased straw yield kg ha<sup>-1</sup> over control in linseed. Similarly Pandey and Ali (2012) reported that seed and stover yield of linseed increased significantly when sulphur was applied through ammonium sulphate compared to the other sources of sulphur up to 40 kg ha<sup>-1</sup>.

### Effect of sulphur on biological yield (kg ha<sup>-1</sup>) and harvest index (%)

#### Biological yield

The data presented in table 1 revealed that biological yield (kg ha<sup>-1</sup>) of linseed was influenced significantly due to different integrated fertilizer and sulphur management treatments. The biological yield was significantly higher with RDF + 25 kg S ha<sup>-1</sup> through bentsulf ( $T_7$ ) and found superior over application of RDF (60:30:00 NPK kg ha<sup>-1</sup>) ( $T_1$ ), RDF + 15 kg S ha<sup>-1</sup> through gypsum ( $T_2$ ), RDF + 20 kg S ha<sup>-1</sup> through gypsum ( $T_3$ ), RDF + 15 kg S ha<sup>-1</sup> through bentsulf ( $T_5$ ), no fertilizer (control) ( $T_8$ ) treatments and was found at par with RDF + 25 kg S ha<sup>-1</sup> through gypsum ( $T_4$ ), and RDF + 20 kg S ha<sup>-1</sup> through bentsulf ( $T_6$ ).

Maximum biological yield (3181 kg ha<sup>-1</sup>) was recorded in treatment with RDF + 25 kg S ha<sup>-1</sup> through bentsulf ( $T_7$ ), while minimum biological yield (1601 kg ha<sup>-1</sup>) was recorded in treatment  $T_8$  with no fertilizer (control).

Banerjee *et al.* (2001) reported that application of sulphur with increasing level up to 30 kg ha<sup>-1</sup> increased biological yield kg ha<sup>-1</sup> over control in linseed.

#### Harvest index (%)

The data presented in table 1 revealed that harvest index of linseed was influenced significantly due to different integrated nutrient management treatments. Numerically, maximum harvest index of 32.63 % was recorded in treatment with RDF + 25 kg S ha<sup>-1</sup> through bentsulf ( $T_7$ ), while minimum harvest index (31.18%) was recorded in treatment with RDF + 20 kg S ha<sup>-1</sup> through bentsulf ( $T_6$ ).

Prasad and Prasad (2002) reported that application of sulphur with increasing level up to 30 kg ha<sup>-1</sup> increased harvest index.

#### Economic studies

Data on gross monetary return, net monetary return and B: C ratio as affected by various sulphur treatments are presented in table 1.

Perusal of the data indicated that GMR (Rs. 49371 ha<sup>-1</sup>), and NMR (Rs. 34434 ha<sup>-1</sup>) were significantly higher in RDF + 25 kg S ha<sup>-1</sup> through bentsulf ( $T_7$ ). Among various treatments highest GMR (Rs. 49371 ha<sup>-1</sup>), NMR (Rs. 34434 ha<sup>-1</sup>) and B:C ratio (3.30) were recorded by the application of RDF + 25 kg S ha<sup>-1</sup> through bentsulf ( $T_7$ ) followed by the application of RDF + 25 kg S ha<sup>-1</sup> through gypsum ( $T_4$ ), and RDF + 20 kg S ha<sup>-1</sup> through bentsulf ( $T_6$ ).

Patil *et al.* (2013) noticed that highest gross monetary return of Rs. 33557 ha<sup>-1</sup> and net monetary return of Rs. 17489 ha<sup>-1</sup> were recorded with the application of 30 kg S ha<sup>-1</sup> which was significantly more than application of 20 and 10 kg S ha<sup>-1</sup>. Each increasing level of sulphur increased the economic yield significantly which ultimately resulted in increased gross and net monetary return ha<sup>-1</sup>. The highest B: C ratio of (2.09) was observed with the application of 30 kg S ha<sup>-1</sup>.

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