RESEARCH ARTICLE

Effect of Phosphorus and Sulphur on Oil, Nutrient Uptake and Yield of Linseed

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ABSTRACT

A field experiment was conducted during rabi, 2011-12 to study the effect of phosphorus and sulphur on oil content, yield and nutrient uptake of linseed. Application of phosphorus @ 40 kg ha^{-1} and application of sulphur @30 kg ha^{-1} recorded the highest seed and straw yield, oil content, oil yield, P content in seed and straw, total P uptake, also S content in seed and straw, total S uptake, which were significantly superior over their respective lower levels. Similarly, Foliar spray of 2% DAP at flowering and capsule development recorded significantly higher seed and straw yield, oil content, oil yield, P content in seed and straw, total P uptake, also S content in seed and straw, total S uptake as compared to no foliar spray.

Keywords: Phosphorus, Sulphur, Linseed, Oil content, nutrient content

INTRODUCTION

Linseed (*Linum usitatissimum* L.) is an important oilseed crop of central India, locally known as *Jawas*. Linseed occupies 468.0 thousand ha area in India with productivity of 349 kg ha^{-1}, in Maharashtra it is grown on 68.0 thousand ha with productivity of 279 kg ha^{-1} which is well below national average (Anonymous, 2010). Phosphorus and sulphur plays an important role in improving the quality and quantity of linseed. (Yawalkar *et al*. 2002). Majority of cultivated area of the linseed needs fertilization for good yield as phosphorus and sulphur content in soil is low. Srivastava *et al.* (1994) reported that seed oil content of linseed increased with application of phosphorus up to 40 kg phosphorus ha^{-1}. Sune *et al.* (2006) stated that application of sulphur increased the oil and protein content over no application. Highest sulphur and phosphorus uptake was observed with 30 kg sulphur ha^{-1}. Phosphorus stimulates root development and growth in the seedling stage. It also stimulates fruit setting and seed formation (Yawalkar *et al*. 2002). Sulphur is involved in the chlorophyll formation and encourages vegetative growth. It is also essential for the synthesis of certain amino acid and oils. (Das, 1996). It can be called as master nutrient for oil seed production. In present crop management condition in India, intensive agriculture is necessary due to limited land resources. Therefore to meet the requirement of growing population, it is necessary to increase the productivity of the crop and nutrient management is one of the answers to this issue.

MATERIALS AND METHODS

A field experiment on was carried out during *rabi* 2011-2012 at Agronomy Farm, College of Agriculture, Nagpur to study the effect of phosphorus and sulphur on oil content, nutrient uptake of linseed and residual nutrient status in soil. Representative soil samples were taken randomly from 0-30 cm soil profile from the experimental site before sowing and after harvest of the crop for its nutrient status. Soil of the experimental site was clayey in texture (clay % - 54.43), low in available nitrogen (198.43 kg ha^{-1}), low in available phosphorus (11.20 kg ha^{-1}) and low in available sulphur (7.16 mg ha^{-1}) and very high in available potash (304.56 kg ha^{-1}). Organic carbon content was medium (0.55%) and soil reaction was slightly alkaline (pH- 7.6). The experiment was laid out in Factorial Randomized Block Design (FRBD) with 18 treatment combinations with net plot of 2.4 m x 3.0 m. Treatment combinations consisted of three levels of phosphorus (viz. P_1- 20 kg, P_2- 30 kg and P_3- 40 kg ha^{-1}), three levels of sulphur (viz. S_1- 10 kg, S_2- 20 kg and S_3- 30 kg ha^{-1}) and two levels of foliar spray (F_0 - No foliar spray and F_1 - foliar sprays of 2% DAP at flowering and capsule development). Seed was treated with thirum @ 3 g kg^{-1} seed to control seed born diseases. The sowing of linseed variety NL-260 was done by drilling method keeping 30 cm distance between the rows. Recommended dose of nitrogen *i.e.* 60 kg ha^{-1} was applied through urea to all treatments, in two equal splits first at sowing and second at flower initiation, while phosphorus was applied through DAP and sulphur was applied through elemental sulphur as per treatments at the time of sowing. Foliar sprays of 2% DAP were applied at flowering and capsule development stages of the crop. Grain, straw yield and oil yield as well as nutrient uptake by the crop were recorded.

RESULTS AND DISCUSSION

Seed and straw yield, oil content, oil yield as influenced by various treatments

Effect of phosphorus: Application of phosphorus @ 40 kg ha^{-1} recorded the highest seed (8.72 q ha^{-1}) and straw yield (28.84 q ha^{-1}), oil content (39.17%) and oil yield (2.89 q ha^{-1}) which were significantly superior over its lower levels. This might be because of vigorous growth of crop due to availability of phosphorus leading to increase number of capsule $plant^{-1}$ and improved seed formation which ultimately reflected as increase in seed yield. The above results were in confirmation with the findings of Sune *et al.* (2006).

Effect of sulphur: The highest seed (7.50 q ha^{-1}) and straw yield (25.86 q ha^{-1}), oil content (39.31%) and oil yield (2.93 q ha^{-1}) were recorded with application of 30 kg sulphur ha^{-1} which was significantly superior over 10 and 20 kg sulphur ha^{-1}. The increase in oil content might be due to higher oil synthesis due to increased dose of sulphur, however increased oil yield might be due to increased oil content and seed yield. Similar results were also reported by Jagtap *et al.* (2003) and Sune *et al.* (2006).

Effect of foliar spray: Foliar spray of 2% DAP at flowering and capsule development recorded significantly higher seed (7.12 q ha^{-1}) and straw yield (24.77 q ha^{-1}), oil content (38.96%) and oil yield (2.78q ha^{-1}) as compared to no foliar spray. These results were in close association with the findings of Kalpana *et al.* (2003).

Interaction: The effect of different interaction among the parameters tested were found to be non significant.

Nutrient uptake as influenced by various treatments

Effect of phosphorus: Application of phosphorus @ 40 kg ha^{-1} recorded the highest P content in seed (0.282%) and straw (0.205%), total P uptake (10.43 kg ha^{-1}), also S content in seed (0.121%) and straw (0.100%) and total S uptake (4.96mg ha^{-1}), which were significantly superior over its lower levels. These results are in confirmatory with the results reported by Sarode *et al.* (1997) and Sune *et al*. (2006). This might be due to the strong and positive correlation of phosphorus with its uptake.

Effect of sulphur: Application of 30 kg S ha^{-1} also recorded the highest P content in seed (0.241%) and straw (0.159%), total P uptake (7.75 kg ha^{-1}), also S content in seed (0.117%) and straw (0.096%) and total S uptake (4.29 mg ha^{-1}) which was significantly superior over 10 and 20 kg sulphur ha^{-1}. This might be due to increase in availability of phosphorus with increasing level of sulphur. Sarode *et al.* (1997) and Sune *et al.* (2006) also reported similar results.

Effect of foliar spray: Foliar spray of 2% DAP at flowering and capsule development recorded

Table 1: Seed and straw yield, oil content, oil yield, P content in seed and straw, total P uptake, S content in seed and straw and total S uptake as influenced by various treatments

Treatments	Seed yield q ha^{-1}	Straw yield q ha^{-1}	Oil Content (%)	Oil yield (q ha^{-1})	P content in seed (%)	P content in straw (%)	Total P uptake (kg ha^{-1})	S content in seed (%)	S content in straw (%)	Total S uptake (kg ha^{-1})
Phosphorus levels (P)										
P_1 (20 kg ha^{-1})	5.12	19.37	38.37	1.96	0.148	0.092	3.50	0.107	0.087	3.10
P_2 (30 kg ha^{-1})	6.93	23.99	38.87	2.70	0.216	0.147	6.47	0.115	0.096	3.99
P_3 (40 kg ha^{-1})	8.72	28.84	39.17	2.89	0.282	0.205	10.43	0.121	0.100	4.96
S.E. (m) ±	0.14	0.57	0.08	0.05	0.004	0.004	0.19	0.0004	0.0004	0.06
C.D. at 5%	0.40	1.64	0.23	0.16	0.012	0.011	0.55	0.0011	0.0011	0.18
Sulphur levels (S)										
S_1 (10 kg ha^{-1})	6.34	22.56	38.66	2.46	0.193	0.136	5.93	0.112	0.092	3.69
S_2 (20 kg ha^{-1})	6.94	24.08	38.94	2.71	0.212	0.149	6.73	0.114	0.095	4.04
S_3 (30 kg ha^{-1})	7.50	25.86	39.31	2.93	0.241	0.159	7.75	0.117	0.096	4.29
S.E. (m) ±	0.14	0.57	0.08	0.05	0.004	0.004	0.19	0.0004	0.0004	0.06
C.D. at 5%	0.40	1.64	0.23	0.16	0.012	0.011	0.55	0.0011	0.0011	0.18
Foliar spray of 2% DAP at flowering and capsule development (F)										
F_1 (Two foliar spray)	6.72	23.36	38.75	2.62	0.206	0.141	6.36	0.114	0.092	3.86
F_0 (No foliar spray)	7.12	24.77	38.96	2.78	0.225	0.155	7.24	0.115	0.096	4.16
S.E. (m) ±	0.11	0.46	0.06	0.04	0.003	0.003	0.15	0.0003	0.0003	0.05
C.D. at 5%	0.33	1.33	0.18	0.13	0.009	0.009	0.45	0.0009	0.0009	0.15
Interaction P x S										
S.E. (m) ±	0.24	0.98	0.14	0.09	0.007	0.007	0.32	0.0007	0.0006	0.11
C.D. at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Interaction P x F										
S.E. (m) ±	0.20	0.80	0.11	0.08	0.006	0.006	0.27	0.0005	0.0005	0.09
C.D. at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Interaction S x F										
S.E. (m) ±	0.20	0.80	0.11	0.08	0.006	0.006	0.27	0.0005	0.0005	0.09
C.D. at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Interaction P x S x F										
S.E. (m) ±	0.34	1.39	0.20	0.13	0.010	0.001	0.47	0.0009	0.0009	0.16
C.D. at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
G.M.	**6.92**	**24.07**	**38.90**	**2.70**	**0.215**	**0.148**	**6.80**	**0.114**	**0.094**	**4.04**

significantly higher P content in seed (0.225%) and straw (0.155%), total P uptake (7.24 kg ha^{-1}), also S content in seed (0.115%) and straw (0.096%) and total S uptake (4.16 mg ha^{-1}) as compared to no foliar spray. This might be due to foliar spray solution prepared in low concentration to supply any one plant nutrient or combination of nutrients. Similar findings were also reported by Kumar *et al.* (2008)

Interaction: The effect of different interaction among the parameters tested were found to be non significant.

CONCLUSION

Application of phosphorus @ 40 kg ha^{-1} and application of sulphur @ 30 kg ha^{-1} recorded the highest seed and straw yield, oil content, oil yield, P content in seed and straw, total P uptake, also S content in seed and straw, total S uptake, which were significantly superior over their respective lower levels. Similarly, Foliar spray of 2% DAP at flowering and capsule development recorded significantly higher seed and straw yield, oil content, oil yield, P content in seed and straw, total P uptake, also S content in seed and straw, total S uptake as compared to no foliar spray.

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