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EFFECT OF SULPHUR AND BORON APPLICATION ON UPTAKE AND YIELD OF LINSEED UNDER RAINFED CONDITIONS

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ABSTRACT

Boron and Sulphur nutrition of soil and crops has assumed greater importance with the introduction of high yielding crop varieties under intensive cultivation with high use of chemical fertilizers there was significant increase in yield with the increase boron and sulphur at each stage. Use of boron doses 1.5 kg ha^{-1} and sulphur doses 30 kg ha^{-1} yield was highest. The highest sulphur uptake 5.68 kg ha^{-1} was recorded at 30 kg sulphur / ha^{-1}. The highest boron uptake (41.7 gm ha^{-1}) was recorded with 30 kg sulphur + 1.5 kg boron / ha^{-1}). The crop response was maximum 42.1 % with the use of 30 kg S / ha^{-1} and oil content of linseed grain was significantly influence of Sulphur 30 kg + 1.5 kg Boron/ha^{-1} respectively. The availability and transformation of Boron and Sulphur in soil, yield and quality of crops have a significantly relation to different doses respectively.

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INTRODUCTION

Linseed is important edible oil, kharif crop of rainfed area in Jharkhand. Linseed (*Linum usitatissimum* L.) (2n = 30) belongs to the family of Linaceae is next in importance to rapeseed and Mustard in area as well in production. The seeds contain lignans, a class of phytoestrogens considered to have antioxidant and cancer preventing properties (Gill, 1967). It is grown mostly under rainfed condition with little use of secondary and micronutrients, such as sulphur and boron. Very few work has been carried out on the study of determine the crop response of sulphur and boron and uptake of sulphur and boron by the crop under rainfed condition in situation of Jharkhand. The use of sulphur and boron is steadily increases in agriculture and offer on attractive way to promote the use of sulphur and boron in oil seed crops . Evidently, boron and sulphur has potential prospects in improved and sustainable use of chemical fertilizer including enhanced plant tolerance to stress, better plant nutrient uptake and reduce load of other chemical inputs (Glick *et al.,* 2007). The most important constraints to crop growth are those caused by shortage of plant nutrients. Sulphur is an essential macronutrient in plant growth and development. It is increasingly being recognized as the fourth major plant nutrient after nitrogen, phosphorus and potassium. Among the fertilizer elements sulphur requirement of oilseed crops is quite high as compared to other crops (Das and Das, 1994). The role of sulphur in the seed production of soybean has been reported by several investigators. (Bhuiyan *et al.,* 1998) found that application of sulphur at 20 kg per hectare produced the highest seed yield in soybean. The sulphur is also responsible for oil content and other nutrients like calcium, iron and glycine (Devi *et al.*, 2012). Srivastava *et al*. (2000) observed that among the fertilizer elements, sulphur requirement of oilseed crops is quite high as compared to other crops. Prasad and Prasad (2003) revealed that sulphur at 30 kg per hectare treated pea plants had higher number of grains per plant which was 24.18% higher than the control one. The use of PGPR as seed inoculation in linseed for their better improvement of their germination and performance in both acidic and alkaline condition. (Debbarma, 2015). Boron is essential micronutrients for plants, but at the same time, its range between deficiency and toxicity is narrower than that of any other element (Goldberg, 1997). Boron deficiency is often an unsuspected enemy of crop production. one of the first adverse effects is on flowering and fruiting and therefore, on the yield and quality of the crops. Depletion of B from soils is mainly through leaching to the lower layers and through the uptake by crops, which removes a significant amount. Boron deficiency has been realized as the second most important micronutrient constraint in crops after that of zinc (Zn) on global scale. Boron deficiency has been reported to result considerable yield reduction in fiber (cotton - *Gossypium hirsutum* L.), cereal (rice - *Oryza sativa* L., maize/corn *Zea mays* L.) , legume/pulse (soybean - *Glycine max* L.), oilseed (groundnut - *Arachis hypogaea* L., oilseed rape/canola - *Brassica napus or B. rapa* L.), (Arora *et al.,* 1985; Sakal *et al.*, 1988; Takkar *et al.*, 1989; Sinha *et al.,* 1991; Borkakati and Takkar, 2000) estimated a substantial potential net economic benefit from the use of Boron fertilizers in boron deficient crops. Keeping this in view an experiment was conducted to study the effect of sulphur and boron application on uptake and yield of linseed under rainfed conditions in North Chota Nagpur region of Jharkhand.

MATERIALS AND METHODS

The experiment was conducted in the sandy loam soil at the Zonal Research Station, Dumka (Birsa Agricultural University, Ranchi) during 2005-2006, 2006-2007, and 2007-2008 with linseed crop (Variety-Sweta). The initial soil properties were as follow: The pH 5.55, organic carbon 0.34% available sulphur and boron were 10.2 mg ha^{-1} and 0.48 mg ha^{-1} respectively. The treatments consisted of three level of sulphur (0, 15 and 30 kg ha^{-1}) in and four levels of boron (0, 1.0, 1.5, and 2.0 kg ha^{-1}), which were replicated three time in factorial Randomized Block Design. Full dose of phosphorus, potash and half dose of urea at the time of sowing and left amount urea were utilize by basal dose in two time respectively. Soil sample were collected before sowing and after harvest the crop. Plant samples were collect at the time of harvesting. At the time of crop maturity, seed yield was recorded. Seed samples were washed thoroughly, dried at 45 ^{0} c, timely pulverized and digested in a diacid mixture of HNO_3 and $HCLO_4$ in 9:1 ratio. Sulphur was analyzed by Turbid metric method (Chesnin and Yield 1951) and oil content were analyzed by Sexhiet method using petroleum ether. The boron in the extract was estimated by Azomethine method (John *et al.*, 1975)

RESULTS AND DISCUSSION

The grain yield of linseed increased from 8.21 to 11.67 q ha^{-1} progressively with the increase in level of Sulphur 0 to 30 kg ha^{-1} (Table1) . The yield was significantly higher at the B level 1.5 kg ha^{-1} and sulphur level 30 kg ha^{-1}. The finding was agreement with those of Das and Das (1995), Qingren *et al.* (1996) and Debbarma *et al.* (2015) reported similar effect of sulphur on yield of linseed.

The grain yield of linseed was significantly influenced by the levels of sulphur and boron, while considering their individual effects separately.

Increased in the level of boron from 0 to 2.0 kg ha^{-1} and sulphur 0 to 30 kg ha^{-1}, increase the oil content in seed from 31.47 to 36.70 and 33.32 to 34.09%, respectively (Table 2).

The results corroborate the findings of (Vrnyiova and Ducay, 2000., Chakraborty and Das, 2000) reported that the oil content in mustard seed were significantly influenced by the combined application of boron @ 3 kg ha^{-1} and sulphur @ 60 kg ha^{-1} in silty soil.

Nutrient uptake

Table 1: Effect of different levels of Sulphur and Boron on grain yield of Linseed (Figures in the table indicate mean grain yield in q ha^{-1})

Levels of S (kg ha^{-1})	Levels of B(kg ha^{-1}) 0	1.0	1.5	2.0	S- means
0	7.1	8.0	9.0	8.7	8.21
15	8.9	9.8	10.6	10.1	9.87
30	10.7	11.5	12.6	12.1	11.67
B-means	8.90	9.77	10.73	10.30	
	S	B		S x B	
SEM(+)	0.25	0.29		NS	
CD at 5%	0.73	0.84		NS	

Table 2: Oil content of Linseed grains as influenced by different levels of Sulphur and Boron (Figures in the table indicate mean oil content in percent)

Levels of Sulphur(kg ha^{-1})	Levels of Boron(kg ha^{-1}) 0	1.0	1.5	2.0	Sulphur-means
0	30.36	31.33	31.47	32.43	31.47
15	33.33	33.87	35.13	33.50	33.96
30	36.00	37.53	36.93	36.33	36.70
B-means	33.32	34.24	34.51	34.09	
CD at 5%	S	B		S x B	
	0.47	0.54		0.94	

Table 3(a). Sulphur -uptake by Linseed grains as influenced by different levels of sulphur and boron (Figures in the table indicate mean sulphur -uptake in kg ha^{-1})

Levels of Sulphur(kg ha^{-1})	Levels of Boron(kg ha^{-1}) 0	1.0	1.5	2.0	Sulphur-means
0	30.36	31.33	31.47	32.43	31.47
15	33.33	33.87	35.13	33.50	33.96
30	36.00	37.53	36.93	36.33	36.70
B-means	33.32	34.24	34.51	34.09	
CD at 5%	S	B		S x B	
	0.47	0.54		0.94	

Table 3(b): Boron-uptake by Linseed grains as influenced by different levels of Sulphur and Boron (Figures in the table indicate mean Boron-uptake in gm ha^{-1})

Levels of sulphur (kg ha^{-1})	Levels of B(kg ha^{-1})				sulphur - means
	0	1.0	1.5	2.0	
0	12.27	15.57	22.10	19.77	17.43
15	17.20	25.47	33.50	28.37	26.13
30	21.27	31.23	41.70	36.30	32.63
B-means	16.91	24.09	32.43	28.14	
	S	B		S x B	
CD at 5%	1.83	2.11		3.66	

Table 4: Crop response, sulphur -use efficiency (SUE), Boron-use efficiency (BUE) and Benefit:Cost ratios at different levels of sulphur and Boron

Level of S(kg ha^{-1})	Crop Response (%)	SUE(kg grains /kg S)	Apparent S-recovery from fertilizer source (%)	B:C ratio
0	-	-	-	-
15	20.2	11.1	9.5	6.58:1
30	42.1	11.5	11.3	7.14:1
0	-	-	-	-
1.0	10.2	87.0	0,.71	5.34:1
1.5	21.1	122.0	1.03	5.16:1
2.0	16.3	70.0	0.56	4.42:1

Table 5: Available sulphur and boron - status (post harvest) in soil as influenced by Different level of Sulphur and Boron applied to Linseed

Levels of S(kg ha^{-1})	Levels of B(kg ha^{-1})	Available S(mg kg^{-1})	Available B(mg kg^{-1})	Available P(mg kg^{-1})
0	0	9.1	0.41	12.6
	1.0	8.9	0.48	13.3
	1.5	9.6	0.52	13.3
	2.0	9.2	0.45	14.2
15	0	10.5	0.38	15.2
	1.0	9.8	0.47	16.5
	1.5	10.6	0.43	15.8
	2.0	11.3	0.49	17.1
30	0	12.1	0.46	14.7
	1.0	12.6	0.52	16.0
	1.5	11.8	0.52	17.4
	2.0	13.2	0.43	16..8

Nutrient uptake of sulphur and boron by grain was influenced by the levels of sulphur and boron, while considering their individual effect separately. The highest sulphur uptake (5.68 kg ha^{-1}) was recorded with 30 kg sulphur ha^{-1}, ignoring the level of boron on the other hand while ignoring the level of sulphur, it can be revealed that boron uptake increase significantly with the successive rise in boron -level up to 1.5 kg ha^{-1}, above which sulphur uptake decrease significantly (Table 2 and 3a).The response of sulphur is also depend on the availability of other fretlizer (Sarangthem *et al.*, 2008).The uptake of boron by linseed grain was significantly influence by the level of sulphur and boron, at any given level of sulphur, significantly increase in boron -uptake was recorded with successive rise in boron level of 1.5 kg ha^{-1}, above which there was significant decrease in boron -uptake (particularly at Sulphur 15.0 and 30.0 kg ha^{-1}). It was also concluded that application of S should be used for improvement of yield and quality linsed grain.

The highest boron uptake value (41.70 gm ha^{-1}) was recorded with 30 kg sulphur + 1.5 kg boron ha^{-1}. (Take 3b). At any given level of Boron uptake increase significantly with the rise in sulphur -level.

(Chakraborty and Das, 2000.), also found an increase in boron and sulphur by the mustard seed with increasing level of sulphur and boron as well as in combination 930 kg ha^{-1}+ 1.5 kg ha^{-1}) in silty loam soil. (Gangadhar *et al* 1990) reported that the application of Sulphur at higher dose increased the uptake of other elements including boron in sunflower stalk. Similar results have been reported by (Nad and Goswami 1985., Brajendra, 2003.,) also reported that in mustard and safflower plant sulphur uptake increase with increasing level of sulphur application in the soil of Plateau region of Jharkhand.

Crop response and use efficiency with cost: benefit ratio

The data on crop response, sulphur use efficiency (SUE), Boron use efficiency (BUE) and benefit cost ratio (B:C ratio) at different level of sulphur and Boron, the maximum crop response (42/.1%), SUE 11.5 kg grain/kg sulphur, apparently sulphur -recovery from fertilizer source (11.3%) and B.C ratio (7.14%) were obtained with 30 kg sulphur/ha(Table 4). The maximum crop response (21.1%), BUE (124.6 kg grain/kg Boron) and apparently boron-recovery from fertilizer source (1.03%) were obtained with 1.5 kg Boron/ha (Table 4).

(Tamak *et al.*, 1997) found that sulphur significantly improved the oil of sunflower over the control in sandy loam soils. This may be due to the fact that sulphur in an integral part of sulphur containing amino acid (cysteine, cystine and methionine) and 50-80% of total Sulphur in oil seed crops gives in making sulphur containing amino acid and rest is required for other sulphur containing compounds, hence improved protein as well as oil syntheses in oilseeds, Oil seed comments of mustard found to improve significantly by the application of sulphur and boron, either or in combination by (Shukla et al., 1983) in an alluvial sandy loam soil. The improvement in oil content in rape seed and mustard through sulphur application has been reported by (Agarwal and Gupta,1982., Golakiya and Dhuka, 1991., Karli and Babula, 1985.,) found an improvement in oil content of rapeseed and mustard with boron application a medium black soil deficient in Sulphur and Boron. It is also reported that high yield attributes are correlated with sulphur (Parakhia *et a l.,* 2016)

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