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Effect of Sulfur and Molybdenum on Nodulation, Growth, Yield and Quality of Soybean (*Glycine max* L. Merril.)

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ABSTRACT

The experiment was conducted to evaluate the effects of sulfur and molybdenum fertilization on nodulation, growth, yield and quality of soybean in an acidic soil of northeastern India. The field experiment was laid out in a Randomized Block Design (RBD) with the treatments comprising of 4 levels of sulfur @ 0, 20, 40 and 60 kg ha^{-1} and 4 levels of molybdenum @ 0, 0.5, 1.0 and 1.5 kg ha^{-1} making 16 treatment combinations altogether. Growth and yield parameters showed significant improvement with increasing levels of sulfur and molybdenum. The maximum number of leaves, nodules $plant^{-1}$, dry weight of nodules, number of pods, filled pods, seeds pod^{-1}, seed and stover yield were observed at 60 kg S ha^{-1}. In case of molybdenum, maximum number of leaves, number of nodules, filled pods, seeds pod^{-1}, seed and stover yield were recorded at 1.5 kg Mo ha^{-1}. Application of 60 kg sulfur and 1.5 kg Mo ha^{-1} produced the maximum plant dry weight, nodules, filled pods, seed and stover yield per plant. Maximum protein and oil content in seeds were also recorded from treatment comprised of 60 kg S and 1.5 kg Mo ha^{-1} as compared to control. These findings suggested that application of 60 kg S and 1.5 kg Mo ha^{-1} could be recommended to improve nodulation, growth, yield and quality of soybean in acidic soil of northeastern India.

Keywords: Acidic soil, Molybdenum, Northeastern India, Pulses, Sulfur

Introduction

Soybean (*Glycine max* L. Merril) is one of the most important oilseed crops of India. Soybean contains 40-42% protein and 20-22% of good quality edible oil. In India, it is cultivated in an area of 10.69 million ha with a total production and productivity of 12.67 million tones and 1185 kg ha^{-1} respectively Anonymous (2013). The average production of soybean per unit area in country is still low as compared to other developed and developing countries. Due to poor yield, oilseed production in the country does not meet the requirement of growing population. To bridge the gap between demand and supply, the country is forced to import edible oils and spends a lot of

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foreign exchange every year. The productivity of soybean can be increased by proper fertilizer management. The reduction in the yield of soybean and other pulses is generally ascribed to deficiency of secondary and micronutrients (Sentimenla *et al.*, 2012; Bhattacharjee *et al.*, 2013; Singh *et al.*, 2014; Kumar *et al.*, 2016; Longkumer *et al.*, 2017) particularly in oilseed crops. Sulfur application improves the grain yield and quality of crops which is mainly due to its associations with S-containing amino acids like cysteine, cystine and methionine (Singh, 2003). It is also an important constituent of many enzymes and is involved in the oxidation and synthesis of fatty acids. Sulfur is also an essential nutrient element for photosynthesis and nitrogen fixation (Becana *et al.*, 2018). Sulfur deficiency has been found to occur in soils, which are coarse textured, and low in organic matter. About 42.3% of Indian soils are deficient in sulfur which is a major constraint in increasing crop productivity, quality and farm income (Tandon, 2010).

Molybdenum is an important constituent of nitrogenase enzyme responsible for biological nitrogen fixation (BNF) through rhizobium which further helps to increase the plant growth and yield of soybean (Ishizuki, 1982). Molybdenum itself is not biologically active but is rather predominantly found to be an integral part of an organic protein complex called the molybdenum co-factor (Moco). Molybdenum deficiencies are found mainly on acidic and sandy soils in humid regions. Plant uptake of Molybdenum increases with increased in soil pH, which is opposite to that of other micronutrients. In view of the prevalent deficiency of sulfur and boron in acidic soils of north east India, and their perceived role in soybean growth and yield, we studied the effect of sulfur and molybdenum application on nodulation, growth, yield and quality of soybean in an acidic soil of northeastern India.

Materials and Methods

A field experiment was carried out in the Experimental Farm of School of Agricultural Sciences and Rural Development, Medziphema, Nagaland to study the effect of sulfur and molybdenum application on nodulation, growth, yield and quality of soybean. The soil texture of the experimental field was sandy loam and well drained. The topography of field was uniform having low available N (246.28 kg ha^{-1}), medium available P (13.36 kg ha^{-1}), low available K (160.7 kg ha^{-1}) and available S (12.31 kg ha^{-1}). Soil pH was 4.8. The temperature during the growing period ranged between 21°C - 32°C. The experiment was conducted in Randomized Block Design with 3 equal blocks consisting of 16 plots, 3 replications and net plot size was 2.0 m × 1.5 m. The row to row and plant to plant spacing was 45 and 10 cm, respectively. The soybean variety JS 97-52 was sown with a seed rate of @ 65 kg ha^{-1}. The observations were recorded on randomly selected 5 samples and their mean was taken for analysis at 15, 30, 45 and 60 days after sowing (DAS). Soil samples were analysed for available nitrogen, phosphorus, potassium and sulfur. Available nitrogen was determined by alkaline potassium permanganate method (Subbiah and Asija, 1956). Available phosphorus was determined by Bray and Kurtz method (1945). Available potassium was determined by flame photometer method (Hanway and Heidel, 1952). Available sulfur was determined by Turbidemetric method (Tabatabi and Bremer, 1970). Crop was harvested at physiological maturity, threshed and plot-wise yields were recorded. Grain and stover samples were taken for analysis of N, P, K, and S by standard procedures. Nitrogen content in seed and stover was estimated by Kjeldahl method (Black, 1965). Total phosphorus was estimated colorimetrically using Vanado-molybdo-phosphoric yellow colour method (Jackson, 1973). Total potassium was determined by flame photometry (Chapman and Pratt, 1961). Total sulfur content in plant was estimated by Turbidemetric method (Tabatabi and Bremer, 1970).

Experimental data were analyzed using standard statistical procedure of Cochran and Cox, (1957). Significance of treatments' effect was tested at 5% level of probability.

Results and Discussion

Sulfur and molybdenum play very important roles in enhancing the plant growth characters which results in improved crop yield. The improvement in plant height subsequent to S and Mo application might be due to the increase in metabolic activity, stimulation of root growth which resulted in increased uptake of N. The maximum plant height of 4.06, 19.25 and 40.50 cm were recorded at 1.5 kg Mo ha^{-1} at 15, 30 and 45 DAS, respectively, which was at par with 1.0 kg Mo ha^{-1} (Table 1). This finding is in conformity with that of Muhammad *et al.*, (2011) who observed that the foliar application of molybdenum had a significant effect on the vegetative growth of cauliflower. Combined application of sulfur and molybdenum @ 40 and 0.5 kg ha^{-1} significantly increased plant height up to 73.04 cm at 60 DAS. Positive results were also reported by Singh *et al.*, (2008) in black gram with the application of sulfur and molybdenum. Mo application @ 1.0 kg Mo ha^{-1} produced significant influence on number of leaves $plant^{-1}$ with maximum number of leaves (44.14) recorded at 60 DAS which was at par with 1.5 kg Mo ha^{-1}. Significant increased in the number of leaves with the application of molybdenum was also reported by Hossain *et al.*, (2018). The maximum number of leaves (48.03) was also observed at 60 kg S ha^{-1}. Salih *et al.*, (2016) also reported significant increased in the number of leaves $plant^{-1}$ with the application of sulfur in wheat. S in combination with Mo showed significant effect on the number of leaves $plant^{-1}$ at 15, 30, 45 and 60 DAS.

Application of sulfur significantly increased the number of nodules $plant^{-1}$. Application of 1.5 kg Mo ha^{-1} at 30, 45 and 60 DAS significantly increased nodule numbers. The maximum number of nodules (43.67) was recorded at 60 DAS with the application of 60 kg S and 1.5 kg Mo ha^{-1} which was found at par with the application of 60 kg S and 0.5 or 1.0 kg Mo ha^{-1}. Biswas *et al.*, (2006) also found significant increase in nodules with the application of sulfur and molybdenum in soybean. Increasing sulfur doses significantly influenced the fresh weight of nodules at 30, 45 and 60 DAS. The maximum fresh weight of nodules/plant was observed at 60 DAS at 40 kg S ha^{-1} *i.e.* 0.72 g which was found at par with 60 kg S ha^{-1}. Singh *et al.*, (1997) also found significant increase in nodule weight with sulfur application in summer mung bean.

Application of 1.5 kg Mo ha^{-1} increased nodule fresh weight significantly with a maximum of 0.31 and 0.41 g at 30 and 45 DAS. Pareek (2005) also reported significant increased in nodule fresh weight of cowpea with the application of molybdenum. Application of 60 kg S ha^{-1} gave maximum nodule dry weight of 0.48g at 60 DAS which was at par with 40 kg S ha^{-1}. Molybdenum application also significantly increased the dry weight of nodules and 0.10, 0.21 and 0.43 g of dry weight of nodules were recorded by application of 1.5 kg Mo ha^{-1} at 30, 45 and 60 DAS respectively, which was also found to be at par with the application of 1.0 kg Mo ha^{-1}. Application of Zn + Bo + Mo on an average increased nodule dry weight by 34% over control (Tripathy *et al.*, 1999). The improvement in nodulation might be due to increased nitrogenase activity by application of micronutrients. The different levels of S and Mo significantly influence the dry weight of nodules per plant at 30, 45 and 60 DAS. Maximum dry weight of nodules was recorded at 60 DAS with the level of sulfur and molybdenum @ 60 and 1.5 kg ha^{-1}, respectively.

Sulfur application significantly increased the number of pods $plant^{-1}$. Application of molybdenum also recorded significant increased in the number of pods $plant^{-1}$@ 1.0 kg Mo ha^{-1}which was at par with 0.5 kg Mo ha^{-1}. Increasing levels of sulfur @ 60 kg S ha^{-1} observed significant increased in the number of filled pods $plant^{-1}$. Molybdenum application also significantly increased the number of filled pods $plant^{-1}$. Application of 1.5 kg Mo ha^{-1} recorded maximum number of filled pods $plant^{-1}$ which was found to be at par with 1.0 kg Mo ha^{-1}. Laltlanmawia *et al.* (2004) also reported significant increase in number of filled pods $plant^{-1}$ in soybean under acidic soils of Nagaland. Interaction of S and Mo increased the number of filled pods $plant^{-1}$ at 60 kg S and 1.5 kg Mo ha^{-1} but failed to reach significant level (Table 3). Increasing levels of sulfur and molybdenum application significantly increased the stover yield. Similar result was also reported by Najar *et al.* (2011). The Maximum value of protein 42.60% was found at combined application of 60 kg S and 1.5 kg Mo ha^{-1}.

Seed nitrogen content was significantly influenced by increasing levels of sulfur. Maximum N content in seed and stover viz., 6.43 and 1.60% respectively were recorded @ 1.0 and 1.5 kg Mo ha^{-1} (Table 5). Application of 60 kg S ha^{-1} produced the highest amount of P content in soybean which was found at par with 40 kg S ha^{-1}. The maximum P content in seed and stover were 0.49 and 0.36%, respectively at 1.5 kg Mo ha^{-1}. Maximum K content of 0.61% in stover and 1.50% in seed were recorded at 60 kg S ha^{-1} which was found at par with 40 kg S ha^{-1}. The application of molybdenum also had a significant influence on the K content of seed and stover. The maximum K content in stover and seed viz., 0.56% and 1.38% respectively were recorded at 1.5 kg Mo ha^{-1} which was found at par with 0.5 and 1.0 kg Mo ha^{-1}. Application of molybdenum also significantly increased the level of sulfur content in seed. These observations were in accordance with the findings of Devi *et al.* (2012) who found higher content of sulfur in soybean seed at increasing levels of sulfur application. The highest S content in stover 0.38 % and seed 0.35 % were recorded with combined application of 60 kg S and 1.5 kg Mo ha^{-1} (Table 6).

Application of molybdenum significantly increased the N uptake by soybean and maximum of 192.09 kg ha^{-1} was recorded by the application of 1.5 kg Mo ha^{-1} (Table 7). Tripathy *et al.* (1999) reported significant increase in the uptake of N with the application of micronutrients. This increase was due to higher concentration of nutrients in plant parts and higher pod yield. Increasing levels of S and Mo increased the N uptake by the crop. The maximum P uptake of 22.72 kg ha^{-1} was recorded in soybean @ 5 kg Mo ha^{-1}. This finding is in accordance with the observations made by Devarajan and Palaniappan (1995) who observed that application of Mo enhanced uptake of P in soybean variety Co1. Combination of different levels of S and Mo did not show any significant result on P uptake by soybean. Molybdenum application produced significant influence on the K uptake at 1.5 kg Mo ha^{-1}. The combined application of S and Mo did not produce any significant influence on the K content in both stover and seed. The maximum S uptake 21.06 kg ha^{-1} was observed by application of 60 kg S ha^{-1}. Similarly molybdenum application had a significant influence on the sulfur uptake by the crop. Application of 1.5 kg Mo ha^{-1} produced the maximum S uptake by soybean (18.53 kg ha^{-1}). Maximum S uptake of 21.65 kg $ha^{-1}$was reported with combined application of 60 kg S and 1.5 kg Mo ha^{-1}.

Application of S significantly increased the available N in soil after harvest. Kulhare *et al.* (2007) also reported increase in available NPK with sulfur fertilization in soybean. Maximum N content 277.36 kg ha^{-1} was recorded at 1.0 kg Mo ha^{-1} which was found at par with 0.5 and 1.5 kg Mo ha^{-1}. Molybdenum application significantly increased the P content in soil which was found at par with 1.0 kg Mo ha^{-1}. Interaction of S and Mo did not show any significant influence on available P in soil after harvest. Molybdenum application significantly influenced the potassium content in soil after harvest of the crop with a maximum of 205.94 kg ha^{-1} recorded at 1.5 kg Mo ha^{-1} which was found at par with 1.0 kg Mo ha^{-1}. Molybdenum application significantly influenced the available S in soil after harvest and the highest available S was recorded at 1.5 kg Mo ha^{-1}.

Based on the results of this experiment, we conclude that application of 60 kg S and 1.5 kg Mo ha^{-1} could be recommended to improve nodulation, growth, yield and quality of soybean in acidic soil of northeastern India.

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Table 1. Effect of sulfur and molybdenum on number of nodules, fresh weight (g) and dry weight nodules (g), plant height (cm), number of leaves per plant, plant dry weight (g)

Treatments S level (kg ha^{-1})	Plant height (cm) at harvest	Number of leaves per plant at harvest	Plant dry wights (g) at harvest	Number of nodules at harvest	Fresh weight of nodules (g) at harvest	Dry weight of nodules (g)
0	59.33	36.75	12.13	24.08	0.57	0.31
20	67.75	37.20	17.83	26.00	0.64	0.37
40	68.67	43.17	21.50	34.00	0.72	0.41
60	67.75	48.03	23.42	41.58	0.70	0.48
SEm±	1.03	0.88	0.33	0.75	0.02	0.01
C.D. at 5%	2.97	2.53	0.96	2.16	0.05	0.02
Mo level (kg ha^{-1})						
0	59.75	38.94	15.58	30.00	0.60	0.33
0.5	66.50	40.44	18.75	28.67	0.71	0.40
0.1	69.33	41.61	20.13	33.08	0.66	0.41
1.5	67.92	44.14	20.42	33.92	0.67	0.43
SEm±	1.03	0.88	0.33	0.75	0.02	0.01
C.D. at 5%	2.97	2.97	0.96	2.16	0.05	0.02

Table 2. Interaction effect of different levels of sulfur and molybdenum on growth attributes of soybean at harvest.

Treatments	Height (cm)	No. of leaves	No. of nodules	Dry weight of nodules (g)	Plant dry Weight (g)	Fresh weight of nodules (g)
T_1	43.67	36.33	25.33	0.22	9.00	0.56
T_2	57.67	38.00	20.67	0.34	12.00	0.63
T_3	66.67	37.78	25.67	0.34	13.50	0.56
T_4	69.33	34.89	24.67	0.34	14.00	0.52
T_5	68.00	37.22	25.67	0.35	12.33	0.58
T_6	68.67	35.33	24.33	0.38	19.00	0.65
T_7	71.33	35.33	26.67	0.37	20.00	0.66
T_8	63.00	40.89	27.33	0.39	20.00	0.67
T_9	61.67	39.22	27.67	0.35	19.00	0.61
T_{10}	73.00	40.89	29.67	0.41	21.67	0.83
T_{11}	70.07	43.22	38.67	0.41	22.67	0.78
T_{12}	69.33	49.33	40.00	0.45	22.67	0.67
T_{13}	65.67	43.00	41.33	0.40	22.00	0.65
T_{14}	66.67	47.55	40.00	0.48	22.33	0.72
T_{15}	68.67	50.11	41.33	0.52	24.33	0.62
T_{16}	70.00	51.49	43.67	0.59	25.00	0.79
SEm±	2.05	1.75	1.50	0.02	0.67	0.03
C.D.at 5%	5.93	5.06	4.32	0.05	1.92	0.10

Table 3. Interaction effect of different levels of sulfur and molybdenum on yield attributes of soybean at harvest

Treatments	No. of seeds pod^{-1}	No. of Pods $plant^{-1}$	No. of filled pods $plant^{-1}$	Seed yield (q ha^{-1})	Stover yield (q ha^{-1})	Protein content (%)
S level (kg ha^{-1})						
0	2.25	69.92	53.32	19.43	27.75	35.42
20	2.35	73.88	58.25	20.79	29.88	38.02
40	2.53	80.60	65.65	22.33	30.91	38.98
60	2.67	84 .23	72.07	24.20	32.33	40.49
SEm±	0.04	1.22	1.08	0.10	0.13	0.40
C.D. at 5%	0.10	3.52	3.12	0.29	0.36	1.17
Mo level (kg ha^{-1})						
0	2.32	75.97	59.43	20.59	29.18	34.90
0.5	2.45	78.16	62.08	21.43	29.91	38.42
0.1	2.48	80.30	62.33	22.07	30.56	39.42
1.5	2.55	74.21	65.43	22.66	31.23	40.18
SEm±	0.04	1.22	1.08	0.10	0.13	0.40
C.D. at 5%	0.10	3.5	3.12	0.29	0.36	1.17

Table 4. Interaction effect of different levels of sulfur and molybdenum on yield attributes of soybean at harvest

Treatments	No. of seeds pod^{-1}	No. of Pods $plant^{-1}$	No. of filled pods $plant^{-1}$	Seed yield (q ha^{-1})	Stover yield (q ha^{-1})	Protein content (%)
T_1	2.13	69.10	52.80	18.37	26.80	34.58
T_2	2.33	66.41	54.20	18.97	27.10	33.75
T_3	2.27	73.63	53.20	20.12	28.23	36.15
T_4	2.27	70.54	53.07	20.27	28.87	37.19
T_5	2.27	74.87	55.60	19.88	29.13	34.38
T_6	2.33	74.67	60.60	20.62	29.87	38.48
T_7	2.40	74.23	54.67	21.33	30.10	39.23
T_8	2.40	71.77	62.13	21.32	30.43	40.00
T_9	2.40	77.17	61.87	21.00	30.00	34.58
T_{10}	2.47	83.87	64.53	22.13	30.93	40.00
T_{11}	2.53	84.17	66.80	22.60	31.13	40.42
T_{12}	2.73	77.20	69.40	23.60	31.57	40.94
T_{13}	2.47	82.73	67.47	23.12	30.77	36.04
T_{14}	2.67	87.70	69.00	24.00	31.73	41.46
T_{15}	2.73	89.17	74.67	24.23	32.77	41.88
T_{16}	2.80	77.33	77.13	25.45	34.07	42.60
SEm±	0.07	2.44	2.16	0.20	0.25	0.81
C.D.at 5%	NS	NS	NS	0.57	0.73	2.33

Table 5. Effect of different levels of sulfur and molybdenum on nutrient content of soybean (N, P, K and S) at harvest

Treatments	Nutrient content							
	Seed				Stover			
	N (%)	P (%)	K (%)	S (%)	N (%)	P (%)	K (%)	S (%)
S level (kg ha^{-1})								
0	5.67	0.40	1.25	0.27	1.47	0.27	0.43	0.30
20	6.08	0.44	1.28	0.30	1.52	0.31	0.50	0.32
40	6.24	0.48	1.40	0.33	1.63	0.38	0.52	0.34
60	6.48	0.56	1.50	0.34	1.66	0.41	0.61	0.37
SEm±	0.06	0.01	0.03	0.01	0.03	0.01	0.01	0.01
C.D. at 5%	0.19	0.03	0.10	0.02	0.09	0.02	0.02	0.02
Mo level (kg ha^{-1})								
0	5.58	0.46	1.35	0.31	1.55	0.32	0.46	0.32
0.5	6.15	0.46	1.31	0.31	1.56	0.34	0.50	0.33
0.1	6.31	0.47	1.38	0.31	1.57	0.34	0.53	0.33
1.5	6.43	0.49	1.38	0.32	1.60	0.36	0.56	0.34
SEm±	0.06	0.01	0.03	0.01	0.03	0.01	0.01	0.01
C.D. at 5%	0.19	0.03	0.10	0.02	0.09	0.02	0.02	NS

Table 6. Interaction effect of sulfur and molybdenum on nutrient content of soybean (N, P, K and S) at harvest

Treatments	Nutrient content							
	Seed				Stover			
	N (%)	P (%)	K (%)	S (%)	N (%)	P (%)	K (%)	S (%)
T_1	5.53	0.41	1.41	0.26	1.42	0.22	0.40	0.29
T_2	5.40	0.39	1.18	0.28	1.45	0.28	0.39	0.29
T_3	5.78	0.40	1.19	0.27	1.51	0.29	0.45	0.30
T_4	5.95	0.41	1.21	0.28	1.48	0.29	0.47	0.31
T_5	5.50	0.42	1.21	0.30	1.53	0.29	0.45	0.31
T_6	6.16	0.42	1.23	0.30	1.51	0.30	0.48	0.32
T_7	6.28	0.43	1.35	0.30	1.47	0.30	0.49	0.32
T_8	6.40	0.47	1.32	0.32	1.57	0.34	0.57	0.33
T_9	5.53	0.46	1.33	0.33	1.61	0.35	0.45	0.33
T_{10}	6.40	0.47	1.35	0.32	1.62	0.38	0.53	0.34
T_{11}	6.47	0.48	1.45	0.33	1.62	0.38	0.53	0.34
T_{12}	6.55	0.52	1.46	0.34	1.67	0.40	0.56	0.35
T_{13}	5.77	0.55	1.46	0.34	1.65	0.40	0.55	0.35
T_{14}	6.63	0.56	1.47	0.35	1.64	0.40	0.60	0.36
T_{15}	6.70	0.55	1.53	0.34	1.67	0.40	0.63	0.37
T_{16}	6.82	0.57	1.55	0.35	1.69	0.42	0.64	0.38
SEm±	0.19	0.02	0.07	0.01	0.06	0.01	0.02	0.02
C.D. at 5%	0.55	0.06	0.20	0.03	0.17	0.04	0.05	NS

Table 7. Effect of sulfur and molybdenum application on nutrient uptake of soybean after harvest

Treatments	Nutrient uptake (kg ha^{-1})			
	N	P	K	S
S level (kg ha^{-1})				
0	150.64	15.31	36.08	14.49
20	173.10	18.26	41.54	16.54
40	193.67	22.51	47.31	18.63
60	211.37	26.61	56.05	21.06
SEm±	2.50	0.29	0.68	0.26
C.D. at 5%	7.22	0.84	1.97	0.74
Mo level (kg ha^{-1})				
0	170.88	18.83	41.51	17.04
0.5	180.00	20.21	43.39	17.86
1.0	185.81	20.94	46.79	17.29
1.5	192.09	22.72	49.29	18.53
SEm±	2.50	0.27	0.68	0.26
C.D. at 5%	7.22	0.78	1.97	0.74

Table 8. Interaction effect of sulfur and molybdenum application on nutrient uptake of soybean at harvest

Treatments	Nutrient uptake (kg ha^{-1})			
	N	P	K	S
T_1	138.61	13.29	36.52	13.66
T_2	148.10	15.00	33.09	14.69
T_3	158.95	16.24	36.60	14.27
T_4	156.92	16.71	38.13	15.35
T_5	162.67	16.73	37.24	15.98
T_6	172.06	17.72	39.77	16.43
T_7	176.36	18.28	43.62	16.15
T_8	181.31	20.33	45.53	17.60
T_9	182.12	20.25	41.51	18.07
T_{10}	191.59	22.09	46.35	18.68
T_{11}	195.09	22.78	49.31	18.26
T_{12}	205.86	24.93	52.06	19.50
T_{13}	200.12	25.05	50.77	20.47
T_{14}	208.24	26.03	54.37	21.65
T_{15}	212.84	26.43	57.61	20.47
T_{16}	224.28	28.93	61.45	21.65
SEm±	5.00	0.54	1.36	0.52
C.D. at 5%	NS	NS	NS	1.49

Table 9. Effect of sulfur and molybdenum application on available nutrient (NPKS) in soil after harvest

Treatment	Available nutrient (kg ha^{-1})			
	N	P	K	S
S level (kg ha^{-1})				
0	241.04	9.50	179.71	15.59
20	264.31	14.28	189.03	16.15
40	281.28	17.83	199.46	17.03
60	283.33	21.04	212.80	17.45
SEm±	5.02	0.29	3.32	0.34
C.D. at 5%	14.50	0.84	9.58	0.98
Mo level (kg ha^{-1})				
0	254.40	13.74	185.12	16.37
0.5	266.15	15.50	193.39	16.55
1.0	277.36	16.34	196.55	16.78
1.5	272.05	17.06	205.94	16.94
SEm±	5.02	0.29	3.32	0.34
C.D.at 5%	14.50	0.84	9.58	0.98

Table 10. Interaction effect of sulfur and molybdenum application on available nutrient (NPKS) in soil after harvest

Treatments	Available nutrient (kg ha^{-1})			
	N	P	K	S
T_1	220.29	7.00	171.30	15.34
T_2	234.89	9.53	180.09	15.48
T_3	262.12	9.98	174.34	15.66
T_4	246.84	11.50	193.10	15.88
T_5	250.94	12.19	187.20	15.95
T_6	265.03	14.09	185.13	16.09
T_7	274.35	15.03	187.87	16.22
T_8	266.91	15.80	195.93	16.35
T_9	274.62	16.39	177.43	16.55
T_{10}	279.81	17.87	199.80	16.89
T_{11}	285.35	18.21	205.53	17.22
T_{12}	285.35	18.85	215.07	17.46
T_{13}	271.74	19.37	204.53	17.65
T_{14}	284.85	20.51	208.53	17.76
T_{15}	287.64	22.16	218.47	18.02
T_{16}	289.09	22.11	219.67	18.07
SEm±	10.04	0.58	6.63	0.68
C.D. at 5%	NS	NS	NS	NS