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Effect of different levels of nitrogen and sulphur on growth and yield of Indian mustard (*Brassica juncea* (L.) Czern and Coss.) in salt affected soil

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Abstract
Field experiment entitled "Effect of different levels of nitrogen and sulphur on growth and of Indian mustard [*Brassica juncea* (L.) Czern and Coss.] in salt affected soil" was carried out at Student instructional farm of N.D. University of Agriculture & Technology, Kumarganj, Faizabad. The experiment comprised of four nitrogen levels (0, 40, 80 and 120 kg ha^{-1}) and four sulphur levels (0, 20, 40 and 60 kg ha^{-1}) tested in Randomized Block Design and replication three times. The growth characters such as plant height, number of primary and secondary branches $plant^{-1}$, number of leaves $plant^{-1}$ and dry matter accumulation $plant^{-1}$ were maximum at 120 kg N ha^{-1} and 60 kg S ha^{-1}. The maximum seed yield (19.20 and 18.39 q ha^{-1}) and stover yield (59.49and 57.21 q ha^{-1}) was recorded at 120 kg N, which was at par with 80 kg N ha^{-1}. In case of sulphur application the maximum seed yield (18.89 and 18.08 q ha^{-1}) and stover yield (58.38 and 55.16kg ha^{-1}) was recorded at 60kg S ha^{-1}, which was at par with 40 kg S ha^{-1}

Keywords: different levels of nitrogen, sulphur, Indian mustard, *Brassica juncea* (L.) Czern and Coss., salt affected soil

Introduction
Indian mustard is an important winter season oil seed crop but its productivity in the eastern Uttar Pradesh is very low. One of the important factors responsible for its low yield is inadequate use of plant nutrient particularly nitrogen and sulphur. The importance of nitrogen fertilization to achieve the higher production potential in mustard is well recognized it is the basic constituent of plant life. It tends to encourage vegetative growth and governs a considerable degree the utilization of other nutrients. Sulphur is involved in various metabolic process on the plants. It is indispensable for synthesis of essential amino acids like–cysteine, cystine and methonine; the SH-Sulphydry linkages provide the source of pungency in oils; It involves in the formation of glycosides or glucosinolates, which on hydrolysis increase the oil content of mustard; and improve the quantity and quality of oilseeds. It is also constituent of glutathione, a compound supposed to be associated with plant respiration and in the synthesis of essential oils, flavored compound in crucifers and improved marketing quality of many crops. It play a vital role in chlorophyll formation. Keeping the above view a study was undertaken to "Effect of different levels of nitrogen and sulphur on growth and of Indian mustard [*Brassica juncea* (L.) Czern and Coss.] in salt affected soil''

Materials and Methods
A field experiment were carried out to "Study the effect of nitrogen and sulphur levels on yield attributes, yield and quality of Indian mustard [*Brassica juncea* (L.) Czern & Coss.]." during rabi season at instructional farm of N.D. University of Agriculture & Technology, Kumarganj, Faizabad. The soil of experimental field was silty loam in texture, and having pH (1:2.5) 8.69, EC 0.35 dS/m, organic carbon 0.33%, available nitrogen 197.25 kg/ha, available phosphorus 10.30 kg/ha., available potash 162.20 kg/ha and available sulphur 8.10 kg/ha The experiment comprised of four nitrogen levels (0, 40, 80 and 120 kg ha^{-1}) and four sulphur levels (0, 20, 40 and 60 kg ha^{-1}) tested in Randomized Block Design with three replications. Nitrogen and sulphur was supplied through urea and gypsum respectively. As per treatment half dose of nitrogen and full dose sulphur was applied as basal dressing. The remaining half dose of nitrogen was applied after first irrigation. Full dose of P and K was applied at the time of sowing. The crop was sown in row 45 cm apart. The growth attributes and yield were recorded at deferent crop growth stages and maturity.

Results and Discussion

Nitrogen and sulphur application induced significant increase in the growth and yield of Indian mustard nitrogen application up to 120 kg ha^{-1} recorded significant increase in plan height, number of primary, number of leaves and secondary branches, dry matter accumulation at all the growth stages and seed yield over the subsequent level of nitrogen, which was at par with 80 kg N ha^{-1} over the control and 40 kg N ha^{-1}. In case of sulphur significantly increase the growth and yield of Indian mustard with the application of 60 kg S ha^{-1}, which was at par with 40 kg over the control end 20 kg S ha^{-1}. It may be due to mineral nitrogen, sulphur, carbohydrate synthesized in the green part of the plant are metabolized into amino-acid and finally into protein, which was allowed the plant to grow faster. Thus, the plant height significantly increased (Bhari *et al*, 2000) [1] and (Sharma *et al.*, 2007) [10] for increased branching might be due to increasing plant height and increasing in nitrogen uptake, which ultimately resulted increasing branches $plant^{-1}$ (Dongarkar *et al.*, 2005) [2] and dry matter accumulation showed increasing trend with age of crop and highest growth rate noticed between 30-60 days stage. The dry matter accumulation $plant^{-1}$ significantly with increase in dose of nitrogen and sulphur (Samui *et al.*, 1986) [9]. The plant height was significantly influenced by varying levels of sulphur fertilization, plant height significantly increased up to 60 kg Sha^{-1}. Increase in plant height may be attributed mainly due to fact that sulphur application improved the nutritional environment and hence could result in more nutrient uptake and increase in dry matter production. This might be due to direct involvement of sulphur in cell division, cell enlargement and cell elongation. Similar results have also been obtained by Mohan and Sharma (1992) [7], Sharma (1994) [11] and Murya (1995).

Significant increase in plant height, number of leaves, number of branches at all the growth stages was recorded with sulphur application up to 60 kg S ha^{-1} as compared to control during both the years of investigation. This might be due to the fact that sulphur enhances cell multiplication, elongation and expansion imparts a deep green colour to leaves due to better chlorophyll synthesis in comparison to sulphur deficient plant. These result confirm the findings of Mahapatra and Chandrajee (1992) [5].

Dry matter accumulation and number of secondary branches was greatly affected by different level of sulphur upto 60 kg S ha^{-1}. All the treatments were significantly superior over control at all the stages of crop growth. Dry matter production successively increased with maturity due to favorable effect of sulphur probably because of involvement of deeper and intensive root system higher uptake, quick physiological process result in better growth and development, increase in plant height, number of leaves, which tern in greater dry matter production of plant. Similar results were also reported by Khanapare *et al.* (1993), Dubey and Khan (1993) [3].

Seed Yield

There was significant increase in seed yield with every increasing levels of nitrogen up to 80 kg N ha^{-1}. The highest yield of 19.20 q ha^{-1} was recorded with 120 kg N ha^{-1} which remained at par with 80 kg N ha^{-1} (18.63 q ha^{-1}). The increase in seed yield was associated with increase all the yield contributing characters *viz.*, siliqua $plant^{-1}$, length of siliqua, seeds $siliqua^{-1}$ and test weight. Adequate supply of nitrogen facilitated better growth and development of crop plant, enhanced nutrient uptake and resulted significant increase in yield attributes. Similar results have also been reported by Sharma (2008) [12] cumulative response of growth and yield attributes. To determine the seed yield obtained by sulphur assumed due to better response of growth and yield contributing characters. Seed and stover yield were increased with sulphur application up to 60 kg S ha^{-1} but beneficial yield was obtained up to 40 kg S ha^{-1}. Seed yield increased due to enhanced rate of photosynthesis and carbohydrate metabolism as influenced by sulphur application. Sulphur, augmented the translocation of photosynthate to sink site. The results are in close conformity with that of Singh and Meena (2004) [13], Rajput *et al.* (1993) [8].

Table 1: Plant height, Number of primary branches per plant and Number of secondary branches per plant of mustard as influenced by nitrogen and sulphur levels at different growth stages

Treatments	Plant height (cm)								Number of primary branches per plant						Number of secondary branches per plant					
	30 DAS		60 DAS		90 DAS		At harvest		60 DAS		90 DAS		At harvest		60 DAS		90 DAS		At harvest	
	2006-07	2007-08	2006-07	2007-08	2006-07	2007-08	2006-07	2006-07	2007-08	2006-07	2007-08	2006-07	2007-08	2007-08	2007-08	2006-07	2007-08	2006-07	2007-08	2007-08
Levels of nitrogen																				
N_0	8.88	8.83	54.90	54.15	141.48	140.10	150.50	147.85	5.98	5.90	8.98	8.84	9.40	9.38	7.88	7.78	10.21	10.15	10.34	10.26
N_{40}	10.24	10.21	61.33	60.80	161.80	160.76	172.79	170.68	7.10	7.00	10.30	10.21	10.43	10.41	9.30	9.23	12.23	12.13	12.34	12.26
N_{80}	11.18	11.14	67.65	67.23	167.53	166.45	193.10	190.83	8.63	8.35	11.26	11.15	11.44	11.44	10.44	10.35	13.59	13.55	13.61	13.54
N_{120}	11.85	11.80	70.25	69.85	172.85	172.05	199.75	196.34	9.11	9.04	12.48	12.34	12.53	12.46	11.49	11.38	14.93	14.83	14.89	14.85
SEm±	0.24	0.22	1.27	1.33	3.23	3.62	3.36	3.54	0.13	0.16	0.22	0.20	0.23	0.21	0.21	0.18	0.26	0.24	0.25	0.24
CD (P=0.05)	0.68	0.67	3.67	3.83	9.34	10.45	9.71	10.22	0.37	0.45	0.62	0.57	0.65	0.61	0.61	0.52	0.76	0.70	0.72	0.70
Levels of sulphur																				
S_0	9.13	9.10	57.00	56.05	148.15	147.01	169.40	167.19	5.80	5.73	9.19	9.10	9.43	9.38	8.28	8.23	10.99	10.90	10.03	11.00
S_{20}	10.20	10.16	61.75	61.45	157.40	156.28	176.26	173.45	7.53	7.45	10.13	10.06	10.41	10.40	9.31	9.18	12.24	12.18	12.29	12.21
S_{40}	11.16	11.13	66.33	65.98	165.85	165.05	182.33	180.28	8.31	8.21	11.28	11.15	11.43	11.43	10.31	10.23	13.43	13.33	13.50	13.43
S_{60}	11.65	11.59	69.05	68.55	172.25	171.03	188.13	184.78	9.18	8.90	12.48	12.23	12.53	12.49	11.20	11.10	14.30	14.25	14.36	14.28
SEm±	0.24	0.22	1.27	1.33	3.23	3.62	3.36	3.54	0.13	0.16	0.22	0.20	0.23	0.21	0.21	0.18	0.26	0.24	0.25	0.24
CD (P=0.05)	0.68	0.67	3.67	3.83	9.34	10.45	9.71	10.22	0.37	0.45	0.62	0.57	0.65	0.61	0.61	0.52	0.76	0.70	0.72	0.70

Table 2: Number of leaves per plant, Dry matter accumulation per plant (g) and Yield of mustard as influenced by nitrogen and sulphur levels at different growth stages

Treatments	Number of leaves per plant						Dry matter accumulation per plant (g)								Yield			
	30 DAS		60 DAS		90 DAS		30DAS		60 DAS		90 DAS		At harvest		Seed (q/ha)		Stover (q/ha)	
	2006-07	2007-08	2006-07	2007-08	2006-07	2007-08	2006-07	2006-07	2007-08	2006-07	2007-08	2006-07	2007-08	2007-08	2007-08	2006-07	2006-07	2006-07
Levels of nitrogen																		
N_0	5.28	5.20	24.08	23.43	46.48	45.03	1.39	1.36	19.69	19.63	66.28	65.85	123.01	122.40	13.85	13.05	44.72	39.94
N_{40}	5.79	5.65	27.78	27.16	50.80	49.78	1.67	1.64	21.23	21.10	72.58	72.48	125.46	125.17	16.85	15.65	50.62	48.48
N_{80}	6.39	6.28	31.58	31.23	56.00	55.40	2.05	2.03	23.10	22.72	81.38	81.30	123.58	131.38	18.63	17.84	58.75	55.91
N_{120}	6.83	6.70	33.23	32.93	59.90	59.73	2.26	2.21	24.43	24.33	86.30	86.25	142.93	142.43	19.20	18.39	59.49	57.21
SEm±	0.13	0.12	0.61	0.60	1.70	1.01	0.04	0.03	0.43	0.49	1.43	1.57	2.59	2.43	0.25	0.25	1.21	1.06
CD (P=0.05)	0.37	0.34	1.77	1.74	3.09	2.92	0.10	0.10	1.25	1.41	4.12	4.53	7.48	7.03	0.72	0.73	3.50	3.05
Levels of sulphur																		
S_0	5.49	5.40	25.68	25.08	48.10	47.00	1.62	1.60	19.95	19.84	66.43	66.23	123.23	122.80	14.58	13.78	45.64	44.08
S_{20}	5.95	5.88	27.70	27.28	52.58	51.75	1.75	1.71	21.51	21.20	72.40	72.20	128.54	128.33	16.40	15.60	52.06	48.45
S_{40}	6.23	6.10	30.48	29.90	55.33	54.70	1.97	1.94	22.94	22.81	81.30	81.18	133.28	132.88	18.26	17.48	57.50	53.85
S_{60}	6.61	6.45	32.80	32.49	57.18	56.48	2.03	2.00	24.04	23.92	86.40	86.28	137.94	137.37	18.89	18.08	58.38	55.16
SEm±	0.13	0.12	0.61	0.60	1.07	1.01	0.04	0.03	0.43	0.49	1.43	1.57	2.59	2.43	0.25	0.25	1.21	1.06
CD (P=0.05)	0.37	0.34	1.77	1.74	3.09	2.92	0.10	0.10	1.25	1.41	4.12	4.53	7.48	7.03	0.72	0.73	3.50	3.05

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