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Effect of levels of nitrogen & sulphur on growth, yield and quality of Indian mustard (*Brassica juncea L.*)

Aman Dixit, PK Singh, Anurag Verma and Deepak Pandey

Abstract
An experiment was conducted at Shradhay Bhagwati Singh Agriculture Research Farm (Hajipur), Chandra Bhanu Gupta krishi Mahavidyalaya, BKT, Lucknow (Uttar Pradesh) during the *Rabi* season of 2021-22. The 16 treatments comprised 4 levels of nitrogen (0, 30, 60, 90 kg N/ha) and 4 levels of sulphur (0, 20, 40, 60 kg s/ha) were tested. Application of nitrogen from 30 to 90 kg /ha increased the all growth, yield attributes and yield significantly over no nitrogen treatments. Application of 90 kg N/ha recorded significantly highest values of growth, yield attributes and yields over rest of the treatments. Crop fertilized with 60 kg/ha sulphur produced the maximum growth, yield attributes and yield followed by 40 kg S/ha, 20 kg S/ha and no sulphur treatment. Increasing levels of nitrogen and sulphur increased the gross income, net income and benefit: cost ratio, however the maximum gross income, net income and benefit: cost ratio was recorded at 90 kg N/ha and 60 kg S/ha.

Keywords: Nitrogen, sulphur, growth, yield, quality

Introduction
Mustard (*Brassica juncea*) is predominantly cultivated in the states of Rajasthan. Uttar Pradesh, Madhya Pradesh. Haryana, Gujarat, Punjab and Bihar (AICRP, 2020-2021) [1]. Rajasthan is the state having the largest area of 2550.92 hectare and highest production of 1466 kg/ha as compared to Uttar Pradesh having an area of 694.66 hectare and production of 1290 kg/ha, respectively (Government of India Ministry of Agriculture and Farmers Welfare Department of Agriculture, 2020-2021) [6] which is considered low.
The role of different nutrients in growth and yield of various oilseeds is well established. Nitrogen is an important component of many essential structural, genetic and metabolic compounds in plant cells. It is also an elementary constituent of numerous important organic compounds including amino acids, proteins, nucleic acids, enzymes, and the chlorophyll molecule. Nitrogen is the nutrient which normally produces the greatest yield response in crop plants, promoting rapid vegetative growth and giving the plant a healthy green color (Singh and Meena 2004) [12]. Sulphur is essential role of increasing oil content (%) and oil yield Sulphur application greatly influenced chlorophyll synthesis, carbohydrate as well as protein metabolism. Since last few decades, the growth, development and productivity of brassicas have been hampered due to a number of factors including the in balance and use of Sub-optimum dose of nutrients in soil. In fact, the extra pressure on the limited land resources and use of high yielding varieties to feed rapidly increasing production have lead to the present scenario of shortage of important plant mineral nutrient in major soils on the globe. The deficiency of soil S in the agriculture soils has been reported frequently in mustard crop (McGrath *et al*., 1996) [9] and Mansoori (2011) found significant interaction between N and S on height of plant, number of pods per plant, number of seeds per pod, 1000 seed weight, seed yield and oil percentage. Amanullahjan *et al.,* (2002) reported that grain yield was significantly higher at the highest levels of both the nutrients applied while oil contents decreased with increase in level of Sulphur to 90 kg ha^{-1} (43/19%) and nitrogen to level of 120 kg ha^{-1} (42%). However meagre information is available with regards to response of nitrogen and sulphur on mustard under central plain zone of U.P, there is therefore, an urgent need to find out the optimum dose of nitrogen and sulphur for obtaining higher grain yield as well as oil yield under central plain zone of U.P.

Material and Methods
The experiment was carried out during Rabi 2021-22 at Shradhay Bhagwati Singh Agriculture Research Farm, Hajipur, Chandra Bhanu Gupta Krishi Mahavidyalaya, BKT, Lucknow,

(U.P.). Geographically, Experimental site falls under subtropical zone and is situated at 26.50^0 North latitude, $80.50^{0'}$ East longitudes with an altitude of 123 meters above mean sea level. The experimental site is situated about 20 kms away from Lucknow city on Sitapur road. The soil of experimental site was silty loam in texture and slightly alkaline in reaction (p^H 8.00), EC dSm^{-1} (0.14), medium in organic carbon (0.70), available N (270 kg ha^{-1}), available P (27.47 kg ha^{-1}), available K (262.50 kg ha^{-1}), available S (8.68 mg/kg).

The experiment comprised of four nitrogen levels (0, 30, 60 and 900 kg ha^{-1}) and four sulphur levels (0, 20, 40 and 60 kg ha^{-1}) were tested in Factorial Randomized Block Design with three replications. Nitrogen and sulphur was supplied through urea and pure sulphur, 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 at 45 cm apart. The growth attributes and yield were recorded at deferent crop growth stages and maturity. The data obtained were statistically analyses as per standard statistical procedures.

Fig 1: The data obtained were statistically analyses as per standard statistical procedures

Results and Discussion

Growth characters

Significantly maximum plant height (173.87 cm), leaf area index (3.70), no. of branches (6.94) and dry matter accumulation (45.73) was recorded with 90 kg N/ha over rest levels of nitrogen. Application of nitrogen increased the availability of nitrogen to plants and enhanced the metabolic activity and meristematic tissues which in their higher cell division, and cell enlargement thus improved the all growth parameters like plant height, no. of branches, dry matter accumulation and leaf area index. These results are in conformity with the findings of Sharma (1986) [13], Singh *et*

al., (2002) [14], Zimik (2010) [22], Zandi *et al.,* (2012) [8]. All growth attributes were improved significantly due to sulphur application over no sulphur treatment. Crop received sulphur @ 60 kg/ha noticed the highest values of all growth attributes as compared to rest levels of sulphur. Application of Sulphur resulted in improvement in root growth, cell multiplication, elongation and cell expansion in the plant body which ultimately increased in growth character of mustard crop. Singh & Meena (2004) [12] Tripathi & Tripathi (2003) [20].

Yield attributes

Crop fertilized with 90 kg N/ha produced significantly maximum value of no. of siliquae/plant (275.31), length of siliquae(6.81cm), no. of seeds/ siliquae (11.40) and test weight (5.0g) over rest of the nitrogen levels. The higher availability of nitrogen to crop with N – application was mainly due to improved growth attributes and synthesis of higher photosynthates which were translocated to sink resulted in significant improvement in yield attributes the significantly higher values of yield attributes were recorded with 60kg S/ha over 30 kg/ha and without sulphur treatment. Significant response of sulphur application on yield attributes of mustard was due adequate Sulphur availability and uptake of Sulphur to crop resulted in better growth and development of mustard plants. Similar findings were also reported by Chatterjee *et al*., (1985) [4].

Yield studies

Grain and straw yield are the resultant of growth and yield attributes which were significantly highest with 90 kg N/ha as compared to its lower doses and consequently significant improvement in yield was recorded when crop fertilized with 90 kg N/ha. The percent increase in grain yield due to 90 kg N/ha was recorded to the tune of 9.59% 5.63, and 12.39 with 60 kg N/ha, 30 kg N/ha and no nitrogen treatment, respectively. Similar results were reported by Bhari *et al.,* (2000) [3], Cheema *et al.,* (2001) [5], Singh and Singh (2002) [14] and Dhake and Kumar (2003) [7]. Application of Sulphur increased the yields significantly with increased in levels of Sulphur. The maximum grain yield (19.83 q/ha), straw yield (77.13 q/ha), biological yield (96.96 q/ha) and harvest index (21.15%) was significantly recorded with highest Sulphur applied @ 60 kg/ha as compared to rest of the treatment. This increase in yields with increasing Sulphur application might be due to the fact that application of Sulphur along with nitrogen, favoured the better partitioning of the photosynthates to reproductive parts, thus improved the seed and straw yield. Similar increasing the levels of Sulphur improved the grain and straw yield reported by Singh and Nad (2000) [15], Singh and Singh (2003) [16], Thuan *et al.* (2010) [18] and Verma *et al.* (2011) [21].

Quality studies

Oil content

The content of oil in grain was reduced with increasing levels of nitrogen and being significantly highest with no nitrogen treatment. Contrary to this, application of sulphur improved the content (%) of oil and its production, however, being highest with 60 kg /ha sulphur and reduced with decreasing levels of sulphur. The oil yield was however, increased significantly with increasing levels of nitrogen and being highest with 90 kg N/ha. The content of oil was decreased with increasing nitrogen levels might be dur to increase in dry matter production with increasing levels of nitrogen was inversely proportionate with levels of nitrogen. Similar result, decreasing oil content (%) with with increasing the levels of Nitrogen are reported by Dhaka and Satish (2003) [7], Premi and Kumar (2004) [11], Tomar and Singh (2007) [19] and Sharma *et al*., (2020) [17].

The maximum oil content (%) and its production was recorded with the application of 60 kg S/ha (41.036%) as compared to rest of the treatment. The higher oil content (%) and its production with increasing levels of Sulphur might be due to formation of more glycosides and glucoinolate and activation of enzymes, with increasing Sulphur application resulted in biochemical reaction with the plant and on hydrolysis produce higher amount of oil as well as alkyl isothiocyanate, which is responsible for pungency.

Content in grain is inversely proportionate to yield of crop

The content of sulphur and its uptake in grain was increased with increasing levels of sulphur owing to higher availability of nitrogen enhanced the photosynthates and its translocation to sink resulted in significant improvement in content of sulphur in grain.

Content and uptake of N and sulphur in grain

The content of N in grain was decreased significantly with increase in level of Nitrogen. The maximum content (%) of N in grain was recorded with no nitrogen treatment. The decreasing N content in grain with increasing nitrogen levels was due to increase in grain yield with increasing nitrogen levels owing to inverse yield nitrogen low, hence the decrease in nitrogen.

Application of Sulphur increased the content (%) of N and Sulphur in grain significantly with successive increase in levels of Sulphur. However, maximum content (%) of N and Sulphur was recorded with the application of 60 kg S/ha (2.063, 0.898, 1.415, 0.562) followed by rest of the levels of Sulphur treatment. However, the lowest content (%) of N and Sulphur was recorded in control (1.722, 0.628, 1.185, 0.510). Increase in N and its uptake with increasing levels of sulphur might be due to higher availability of sulphur and its uptake by plant. Resulted in higher nutrient content of N and S by grain.

Economics

Net income and benefit: Cost ratio was increased with increasing supply of nitrogen and Sulphur to crop. Crop fertilized with 90 kg/ha achieved maximum net income (76633 Rs/ha) and Benefit cost ratio (3.12) which was followed by 60 kg N/ha 30 kg N/ha and no nitrogen treatment. The higher net income and benefit: cost ratio with increasing levels of nitrogen was due to higher grain and stalk. Application of 60 kg S/ha observed higher net income (79252 Rs/ha) and Benefit: cost ratio (3.20) which was followed by 40 kg/ha and no nitrogen treatments. This was because of higher grain and Stalk yield with these treatments resulted in higher net income and BCR with increasing levels of Sulphur.

Table 1: Grain and yield attributes as affected by nitrogen and sulphur

Treatment	Plant height (cm) at harvest	No. of branches at harvest	Dry matter accumulation (g/m^2)	LAI 90 DAS	No. of siliquae Per plant	Length of siliqua (cm)	No. of Seeds/siliqua	Test weight (gm)
Levels of Nitrogen (kg/ha)								
0	169.883	6.215	32.750	3.260	198.580	6.062	9.935	4.373
30	171.158	6.547	35.558	3.500	207.133	6.310	10.208	4.669
60	172.875	6.727	39.333	3.608	225.450	6.558	10.533	4.870
90	173.875	6.943	45.733	3.709	275.317	6.811	11.400	5.003
S Em±	0.047	0.013	0.108	0.007	0.161	0.010	0.028	0.041
CD at 5%	0.136	0.038	0.315	0.020	0.467	0.030	0.081	0.118
Levels of Sulphur (kg/ha)								
0	170.383	6.007	35.033	3.068	208.208	6.225	10.050	4.539
20	171.717	6.549	37.667	3.478	219.233	6.395	10.475	4.660
40	172.100	6.641	39.150	3.615	233.258	6.503	10.635	4.793
60	172.408	6.735	40.525	3.718	245.758	6.618	10.917	4.923
S Em±	0.047	0.013	0.108	0.007	0.161	0.010	0.028	0.041
CD at 5%	0.136	0.050	0.315	0.020	0.467	0.030	0.081	0.118

Table 2: Yield, nutrient uptake and economics as affected by levels of N and sulphur

Treatment	Grain yield (q/ha)	Stover yield (q/ha)	Content (%) in grain		Uptake (kg/ha)		Net income (Rs/ha)	Benefit Cost ratio (B: C)
			N	S	N	S		
Levels of Nitrogen (kg/ha)								
0	14.84	63.96	2.12	0.44	25.82	6.57	54820	2.34
30	16.68	65.55	1.93	0.50	29.69	8.37	63800	2.69
60	17.62	66.60	1.78	0.55	34.00	9.84	68209	2.83
90	19.31	72.21	1.77	0.64	40.93	12.33	76633	3.12
Levels of Sulphur (kg/ha)								
0	13.49	53.96	1.72	0.51	23.06	6.89	47756	2.07
20	16.35	64.74	1.84	0.53	30.08	8.60	62178	2.63
40	18.77	72.07	1.96	0.54	36.78	10.24	74206	3.06
60	19.83	77.13	2.06	0.56	40.65	11.12	79252	3.20

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