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Sanjay Singh Bais
M.Sc. Student, Department of Agronomy, AKS University, Satna, Madhya Pradesh, India

T Singh
Professor and Head, Department of Agronomy, AKS University, Satna, Madhya Pradesh, India

Corresponding Author:
Sanjay Singh Bais
M.Sc. Student, Department of Agronomy, AKS University, Satna, Madhya Pradesh, India

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

Sanjay Singh Bais and T Singh

Abstract
A field experiment was conducted to study the effect of Sulphur and nitrogen level on growth, yield and quality of mustard (*Brassica juncea* L.) at the student instructional Farm, Department of Agronomy, AKS University, Satna, (M.P.) during the *kharif* season of 2021- 22. The soil of the experimental field was well drained, sandy loam in texture and slightly alkaline in nature. The treatment consisted of four Sulphur levels (0, 15, 30 and 45 kg/ha) and three nitrogen levels (0, 50 and 75 kg/ha) were tested in Factorial Randomized Block Design (FRBD) with three replications. The mustard variety Pusa Bold was grown and growth and yield, oil content as influenced by different treatments were assessed. Role of interaction effects enhances the growth & yield attributes, quality parameters with increasing trends of nitrogen from 0 to 75 kg N/ha and 0 to 45 kg S/ha caused significant results and found maximum at 45 kg S/ha and 75 kg N/ha.

Keywords: Mustard, sulphur, nitrogen, yield, variety, oil content

Introduction
Oilseeds crops are the second most important determinant of agricultural economy, next only to cereals. India has the 5th largest vegetable oil economy in the world next to USA, China, Brazil and Argentina accounting for 7.4% world oilseed output; 6.1% of oil meal production; 3.9% world oil meal export; 5.8% vegetable oil production; 11.2% of world oil import and 9.3% of the world edible oil consumption. In India, oilseeds contribute 3% and 10% to gross national products and value of all agricultural products, respectively, with 14 and 15 million people involved in oilseed cultivation and processing, respectively. India is one of the biggest importers of vegetable oils.

Under present soil fertility status in India, Sulphur is now recognized as the fourth nutrient element after nitrogen, phosphorus and potassium which are limiting the crop yield. Mustard a cruciferous crop, responds remarkably to Sulphur application. Adequate supply of Sulphur to rapeseed-mustard promotes the synthesis of Sulphur containing essential amino acids, proteins and oil.

Mustard crop responded favorably to nitrogen fertilization increases yield by influencing different growth parameters and by producing more vigorous growth and development as reflected via increasing plant height, number of flowering branches, total plant weight, leaf area index and number and weight of siliquae and seeds per plant. Nitrogen is a major nutrient element that provides lush green color in crop (due to increase in chlorophyll) and its deficiency in arid and semi-arid regions is considerable because the amount of organic matters, which are the main nitrogen reserves, is very low in these regions and even if they were found, they would be quickly decomposed.

Moreover, Sulphur and nitrogen are closely related with one another because both of these elements are required for protein synthesis and their amount in plant tissue always maintained at constant ratio. Application of fertilizers containing these two nutrient elements have been recognized to be the most important constraints and often inadequate application of Sulphur and nitrogen at farmer's field reduce the yield levels of mustard. Under Sulphur deficient soils, the full yield potential of mustard cannot be realized regardless of other nutrients applied or adoption of improved crop management practices.

Keeping all these points in view, field study was conducted to find out the effect of different levels of Sulphur and nitrogen on growth, yield attributes, yield and quality of mustard during *rabi* season of 2021.

Methodology

The experiment was conducted at the student instructional Farm, Department of Agronomy, AKS University, Satna, (M.P.). The treatments comprising of four graded levels of Sulphur and three graded levels of nitrogen were laid out in factorial randomized block design with three replications. The treatment consisted of four Sulphur levels (0, 15, 30 and 45 kg/ha) and three nitrogen levels (0, 50 and 75 kg/ha) thus there were twelve treatment combinations. The amount of fertilizers was computed for each plot and these were applied in the experiment as per treatment. The mustard variety Pusa Bold was grown and interaction effects, quality parameters as influenced by different treatments were assessed.

Results and Discussion

Sulphur and nitrogen levels show significant interaction effect on plant height and number of branches per plant at maximum crop growth stage. Significantly highest plant height (144.57 cm) and number of branches per plant (18.90) at harvest stage was found under the treatment combination consisting that the application of Sulphur @ 45 kg S/ha in combination with application of nitrogen @ 75 kg N/ha

Interaction effect between Sulphur and nitrogen on siliqua/ plant, length of siliqua, number of seeds/ siliqua, test weight was found significant and the highest number of siliqua/ plant (311.73), length of siliqua (9.72 cm), number of seeds/ siliqua (15.20), test weight (7.42 g) was observed with the application of 45 kg S/ha + 75 kg N/ha. The significantly higher seed yield (17.56 q/ha) and stover yield (59.78 q/ha) was registered with 45 kg S/ha + 75 kg N/ha.

The interaction effect in respect of plant height, branches, number siliquae/ plant, length of siliqua, seeds per siliqua, test weight, seed and stover yields were found significant. It therefore, appeared relevant to explain combined effects of Sulphur and nitrogen fertilization of mustard. The interaction between different levels of Sulphur and nitrogen fertilization on seed yield of mustard was found significant and maximum yield was obtained with the combined application of Sulphur and nitrogen at the rate of 45 kg S/ha + 75 kg N/ha. This indicates the synergistic effect of Sulphur and nitrogen application in improving the productivity of mustard. Similarly, number of branches, number of siliquae, seeds/ siliquae, seed and stover yield was found significantly higher with the application of 45 kg S/ha + 75 kg N/ha. The application of Sulphur and nitrogen improves the growth and development of crop resulted in higher values of yield attributes with the application of 45 kg S/ha + 75 kg N/ha which provides higher yield of mustard crop. Similar findings were also reported by Kumar *et al*. (2021) [3], Rajput *et al.* (2018a) [5], Chaurasiya *et al*. (2019) [1], and Nayak *et al*. (2022) [4].

Application of Sulphur and nitrogen caused significant increase in oil content in seeds. Increasing levels of nitrogen from 0 to 75 kg N/ha caused increase in oil content while further increase in nitrogen levels caused decrease in oil content. Application of 75 kg N/ha gave significantly more oil and protein yield. Similarly, application of 45 kg S/ha gave significantly higher values of oil content.

Increasing levels of nitrogen from 0 to 75 kg N/ha caused significant increase in oil content of mustard. The oil yield is the function of oil content in seed and seed yield. The oil content in seeds increased with the application of nitrogen up to 75 kg N/ha and decreased thereafter while seed yield was found maximum at 75 kg N/ha. Similar findings were also reported by Rajput *et al*. (2018a) [5].

Oil content of mustard seed and oil yield increased significantly due to Sulphur application and found maximum at 45 kg S/ha. Sulphur plays an important role in the formation of more glycosides and glucocinolate and activation of enzymes, which as in biochemical reaction with the plant and on hydrolysis produce higher amount of oil as well as alkyl isothiocyanate, which is responsible for pungency. The results are in close conformity with the findings of Verma and Dawson (2018) [6], Davut *et al*. (2020) [2] and Kumar *et al*. (2021) [3].

Table 1: Effect of different levels of sulphur and nitrogen on growth, yield and quality of mustard

Treatment	Plant height (cm)	Number of branches/plant	Number of siliquae/plant	Length of siliqua (cm)	Number of seeds per siliqua	Test weight (g)	Seed yield (q/ha)	Stover yield (q/ha)	Oil content (%)
	Effect of Sulphur levels								
S_0	133.54	14.47	228.60	6.45	9.64	4.96	12.10	48.38	37.67
S_1	136.55	16.22	255.24	7.16	11.80	5.32	14.16	53.22	38.71
S_2	138.34	16.73	265.78	7.58	12.44	5.76	14.89	54.25	39.36
S_3	139.41	17.26	275.18	8.21	12.84	6.03	15.37	55.04	39.67
S. Em±	0.64	0.62	2.08	0.40	0.38	0.37	0.29	1.19	0.56
CD	1.86	1.81	6.09	1.18	1.10	1.07	0.85	3.49	1.65
	Effect of nitrogen levels								
N_1	131.10	14.02	215.22	5.21	9.02	4.25	11.13	46.45	36.58
N_2	138.40	16.72	264.10	8.10	12.30	5.77	15.03	54.85	39.21
N_3	141.39	17.78	289.28	8.74	13.73	6.54	16.23	56.87	40.76
S. Em±	0.73	0.71	2.40	0.47	0.43	0.42	0.34	1.37	0.65
CD	2.15	2.09	7.04	1.37	1.28	1.24	0.99	4.03	1.91
Interaction effect between different levels of Sulphur and nitrogen									
S_0N_1	128.79	11.33	193.87	3.88	7.60	3.56	9.08	45.04	36.00
S_0N_2	135.53	15.80	240.60	7.58	10.33	5.61	13.44	49.89	38.10
S_0N_3	136.32	16.27	251.33	7.90	11.00	5.70	13.78	50.20	38.90
S_1N_1	129.98	14.27	213.00	4.84	9.27	3.93	10.97	46.23	36.59
S_1N_2	138.33	16.67	260.47	8.05	12.07	5.76	15.06	55.04	39.16
S_1N_3	141.36	17.73	292.27	8.58	14.07	6.28	16.44	58.40	40.38
S_2N_1	132.39	15.00	222.13	5.71	9.47	4.68	12.03	47.01	36.71
S_2N_2	139.31	17.00	273.40	8.23	13.20	5.85	15.50	56.64	39.55

S_2N_3	143.31	18.20	301.80	8.78	14.67	6.74	17.14	59.09	41.82
S_3N_1	133.24	15.47	231.87	6.41	9.73	4.81	12.42	47.51	37.03
S_3N_2	140.43	17.40	281.93	8.51	13.60	5.87	16.14	57.84	40.02
S_3N_3	144.57	18.90	311.73	9.72	15.20	7.42	17.56	59.78	41.95
S.Em±	0.37	0.36	1.20	0.23	0.22	0.21	0.17	0.69	0.32
CD	0.76	0.74	228.60	0.48	0.45	0.44	0.35	1.42	0.67

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