The Pharma Innovation Journal 2023; 12(10): 1081-1084

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; 12(10): 1081-1084

www.thepharmajournal.com
Received: 03-07-2023
Accepted: 08-08-2023

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Effect of nitrogen and sulphur levels on growth attributes of mustard [*Brassica juncea* (L.)]

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Abstract
A research trial was conducted at Research Farm, Vivekananda Global University, Jaipur during *Rabi* season of 2018-19, to know the effect of nitrogen and sulphur on yield and economics of mustard [*Brassica juncea* (L.)]. The experiment was performed according to randomized block design with three replications. The treatments consisting of 9 treatment combinations *viz.*, 125% RDN + Sulphur 10 kg ha^{-1} (T_1), 125% RDN + Sulphur 20 kg ha^{-1} (T_2), 125% RDN + Sulphur 30 kg ha^{-1} (T_3), 100% RDN + Sulphur 10 kg ha^{-1} (T_4), 100% RDN + Sulphur 20 kg ha^{-1} (T_5), 100% RDN + Sulphur 20 kg ha^{-1} (T_5) 100% RDN + Sulphur 30 kg ha^{-1} (T_6), 75% RDN + Sulphur 10 kg ha^{-1} (T_7), 75% RDN + Sulphur 20 kg ha^{-1} (T_8) and 75% RDN + Sulphur 30 kg ha^{-1} (T_9) were applied to the mustard *var*. Laxmi (RH-8812). Results revealed that various nitrogen and sulphur treatments considerably boosted mustard's growth. With the application of 125% of the recommended nitrogen dose plus 30 kg of sulphur per hectare (T_3), the maximum Plant stand metre^{-1} row length, Plant height, Branches plant^{-1}, and Dry matter accumulation (g m^{-1} row length) of mustard were achieved. As a result, this treatment was advised for achieving maximum growth with increased financial returns.

Keywords: Economics, mustard, nitrogen, sulphur, growth and yield

1. Introduction

In 'Rape seed and Mustard' group of oil seeds, Indian mustard (*Brassica juncea*) occupies the prime position in India. Mustard is a Rabi season crop that needs relatively cool temperature, a fair supply of soil moisture during its growing season and a dry period during harvest. The mustard seeds contain 40 to 42% oil content and 30 to 45% protein content with a high nutrition value. Additionally, it is utilised in the production of hair oils, medications, soap, and grease by combining it with mineral oils for lubrication. Additionally, the seed is added to vegetables to flavour curries and is used as a condiment in the making of pickles. After the recovery of oil from rape and mustard seed, the residual meal is the rape or mustard cake. The oil cake contains 25 - 30% crude protein, 5% nitrogen, 1.8 - 2.0% phosphorus and 1.0 - 1.2% potassium content. The oil cakes is used as a cattle feed and manure. It is cultivated both under irrigated (79.2%) and rainfed (20.8%) conditions. India is the third largest rapeseed-mustard producer in the world after Canada and China. Mustard accounts for nearly one-third of the oil produced in India, making it the country's key edible oilseed crop. In India, it is grown on 9.12 million tonnes from an area of 6.78 mha with an average productivity of 1345 kg ha^{-1} [1]. Rajasthan is largest mustard producing states in the country, have first ranks both in area and production of rapeseed and mustard in the country with an annual production of 2.95 mha with production of 4.22 million tonnes. The average productivity of Rajasthan is 1659 kg ha^{-1} [1].

Crop production largely depends on cultivation of high yielding cultivars and requirement based application of nutrients thus for maximizing the yield, it is essential that mustard should not suffer due to inadequate moisture supply and mineral nutrition especially nitrogen. Nitrogen (N) is the most important nutrient, and being a constituent of protoplasm and protein, it is involved in several metabolic processes that strongly influence growth, productivity and quality of crops [2]. The deficiency of soil sulphur in the agriculture soils has been reported frequently over the past several years [3, 4]. One of the six macronutrients necessary for healthy plant development is sulphur (S). Reduced sulphur, which is integrated into the amino acids cysteine and methionine, is crucial for the catalytic centres and disulfide bridges of proteins. [5]. Additionally, thiol compounds and the so-called secondary sulphur compounds, which have a considerable impact on plant defence against stress and pests, are synthesised from sulphur, as are amino acids, protein, and a variety of other cellular components. Although mustard production in Rajasthan is higher than the country as a whole, it still falls short of global productivity. With all of the aforementioned information in mind, the current experiment was carried out to ascertain how nitrogen and sulphur affected the growth, yield, and quality of mustard (*Brassica juncea* (L.)).

2. Materials and Method

Experimental site: The field test was conducted at Vivekananda Global University's Research Farm in Jaipur during the Rabi season of 2018-19. The study area is situated in Rajasthan's agro-climatic zone III A (Semi-arid Eastern Plain Zone), at latitude 26o81'17" north and longitude 075o88'99" east. The climate of the area is categorised as semi-arid and is distinguished by the aridity of the atmosphere, extreme summer and winter temperatures (45.5 °C and 4 °C, respectively), and an annual rainfall range of 500–700 mm. The soil in the experimental field had a loamy sand texture and reacted somewhat alkalinely.

Experimentation and crop husbandry: The experiment was laid out in Randomized Block Design with three replications. The treatments consisting of nine treatment combinations *viz.*, 125% RDN + Sulphur 10 kg ha^{-1} (T_1), 125% RDN + Sulphur 20 kg ha^{-1} (T_2), 125% RDN + Sulphur 30 kg ha^{-1} (T_3), 100% RDN + Sulphur 10 kg ha^{-1} (T_4), 100% RDN + Sulphur 20 kg ha^{-1} (T_5), 100% RDN + Sulphur 20 kg ha^{-1} (T_5) 100% RDN + Sulphur 30 kg ha^{-1} (T_6), 75% RDN + Sulphur 10 kg ha^{-1} (T_7), 75% RDN + Sulphur 20 kg ha^{-1} (T_8) and 75% RDN + Sulphur 30 kg ha^{-1} (T_9) were applied to the mustard *var*. Laxmi (RH-8812). Weeding, fertiliser application, and crop protection management were all done according to standard crop production procedures.

Data collection: In order to measure the mustard's plant stand per metre of row length, plant height, number of branches per plant, and dry matter accumulation (g m-1 row length), five plants were chosen from the net plot and tagged. At 30 DAS and the time of crop harvest, five randomly chosen places within each plot were counted to determine the number of plants per metre row length. The average plant population was calculated and recorded as plants per metre of row length. From the base of the plant to the top of the main shoot, the height of five plants was measured at 60 DAS and at harvest. Their mean height was represented as plant height (cm). Five randomly chosen and tagged plants in each plot had their number of branches plant-1 at harvest counted, and the mean number of branches plant-1 was recorded. By removing five plants from each plot at 60, 90, and harvest stages, periodic changes in the buildup of dry matter were observed. The five plants from each plot had their roots dug up from the ground level for the periodic observations. In order to retain weight, the harvested plant was first dried by air before being baked at 600 °C. The total dry weight of the plants was averaged to determine the amount of dry matter in g m-1 row length. By accounting for the price of inputs and the revenue from output based on.

Statistical analysis: In order to determine the trend of the treatments used in accordance with Gomez and Gomez, statistical analysis of the experimental data was performed using the suitable method of analysis of variance assuming homogeneity [6]. The crucial difference (CD) values were generated for comparison between the treatment means wherever the F values were determined to be significant at the 5% level of probability.

3. Results and Discussion

Growth: Data revealed that all nitrogen and sulphur treatment exhibited significant impact on growth attributes of mustard. The application of 125% recommended dose of nitrogen + 30 kg sulphur ha^{-1} (T_3) significantly increased the Plant height 96.21 (At 60 DAS) 193.78 (At harvest) Branches plant-1 6.86 (At harvest) Dry matter accumulation 77.59 (At 60 DAS) 180.97 (At 90 DAS) and 226.3 (At harvest) of mustard which was closely followed by 125% RDN + Sulphur 10 kg ha^{-1} and 125% RDN + Sulphur 20 kg ha^{-1} and found significantly higher than 100% RDN + Sulphur 10 kg ha^{-1}, 100% RDN + Sulphur 20 kg ha^{-1}, 100% RDN + Sulphur 20 kg ha^{-1}, 100% RDN + Sulphur 30 kg ha^{-1}, 75% RDN + Sulphur 10 kg ha^{-1}, 75% RDN + Sulphur 20 kg ha^{-1} and 75% RDN + Sulphur 30 kg ha^{-1}. While, Plant stand per metre row length of mustard were not influenced by nitrogen and sulphur application and remained unchanged among all the treatments. With the application of higher levels of nitrogen and sulphur, the tissue differentiations (from the somatic to reproductive), meristematic activity and the development of floral primordial might have been enhanced the growth of mustard. This nutrition, which improves cell multiplication, elongation, and expansion and gives leaves a deep green colour due to better chlorophyll synthesis, may be the cause of the positive effects of nitrogen and sulphur application. This nutrition also results in a relatively greater amount of photosynthates accumulation in plants and their translocation, which reflects in terms of increased crop growth. A superior development of the plants in terms of plant height and dry biomass output, which results in improved bearing capacity due to optimum growth as a result of increased nitrogen and sulphur dose, may be responsible for the good influence of higher nitrogen and sulphur dose on sink component. Higher yield was recorded along with an increase in nitrogen rate [7, 14].

Economics: Summary of the data on net returns and B: C ratio of mustard revealed that all the treatments had significant impact on net returns and B: C ratio of mustard. The significantly maximum net return (₹ 67566 ha^{-1}) and B: C ratio (3.62) was obtained with the application of 125% recommended dose of nitrogen + sulphur 10 kg ha^{-1} which was closely followed by treatment 125% recommended dose of nitrogen + sulphur 20 kg ha^{-1} (₹ 66882 ha^{-1}) and 125% recommended dose of nitrogen + sulphur 30 kg ha^{-1} (₹ 66318 ha^{-1}) but superior to all other treatments. Application of 125% recommended dose of nitrogen + sulphur 10 kg ha^{-1} provided the additional net returns of ₹ 15717, ₹ 16537, ₹ 17769 and ₹ 32514 ha^{-1}, ₹ 31812 ha^{-1} and ₹ 32692 ha^{-1} in comparison to T_4, T_5, T_6, T_7, T_8 and T_9, respectively. In modern agriculture, crop production is taken as business. Therefore, based on the experimental results, the practices giving maximum net returns under particular set of condition can only be recommended to the farmers. Under present investigation large variations were noticed for gross returns and cost of cultivation under different nitrogen and sulphur levels. In terms of the economic analysis of applying nitrogen and sulphur to mustard, the variations in net returns at varied nitrogen and sulphur levels were mostly brought on by the variations in seed and Stover production. With higher doses of nitrogen and sulphur, the maximum gross return, net return, and benefit: cost ratio were also recorded by [12, 15, 16].

Table 1: Effect of nitrogen and sulphur on Growth attributes of Mustard

Treatment	Plant stand m^{-1} row length		Plant height		Branches plant^{-1}	Dry matter accumulation		
	At 30 DAS	At harvest	At 60 DAS	At harvest	At harvest	At 60 DAS	At 90 DAS	At harvest
T_1	9.74	9.38	93.79	189.12	6.70	74.67	176.76	221.6
T_2	10.00	9.58	94.75	191.78	6.83	76.14	178.50	223.8
T_3	9.96	9.52	96.21	193.78	6.86	77.59	180.97	226.3
T_4	10.05	9.68	76.63	162.44	5.46	60.56	151.05	187.2
T_5	9.95	9.59	78.00	163.60	5.53	61.82	152.61	190.9
T_6	10.27	9.85	79.21	166.02	5.60	63.53	153.70	193.8
T_7	10.35	9.94	59.80	134.46	4.29	46.28	122.73	155.3
T_8	10.55	10.11	60.57	136.12	4.37	47.98	124.12	157.3
T_9	10.46	10.02	61.96	138.23	4.43	49.07	127.13	159.9
SEM$\pm$	0.50	0.49	3.88	7.26	0.28	3.29	7.18	8.44
Cd	NS	NS	11.64	21.78	0.85	9.85	21.54	25.29

Table 2: Effect of nitrogen and sulphur on economics of mustard

Treatment	Gross return	Net return	B:C ratio
T_1	93392	67566	3.62
T_2	94423	66882	3.43
T_3	95573	66318	3.27
T_4	77382	51849	3.03
T_5	78276	51029	2.87
T_6	78758	49797	2.72
T_7	60290	35051	2.39
T_8	62024	35071	2.30
T_9	63541	34874	2.22
S.Em$\pm$	-	3586	0.13
Cd	-	10750	0.39

4. Conclusion

The impact of nitrogen and sulphur application on enhancing growth attributes and monetary returns was highly significant in mustard. The present study found consistent evidence that the application of nitrogen and sulphur offers substantial agronomic and economic advantages. Based on the results of one-year experimentation it may be concluded that for higher profitability and productivity, the mustard crop should be supplied 125% recommended dose of nitrogen + 30 kg sulphur ha^{-1} as it provides the maximum values of Plant stand per metre row length, Plant height, Branches plant-1, Dry matter accumulation (g m^{-1} row length) so 125% recommended dose of nitrogen + 30 kg sulphur ha^{-1} was found suitable for farmer practices on the basis of higher growth and monetary returns of this treatment.

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