Response of different varieties of mustard (*Brassica juncea L.*) to sulphur application on growth and yield in Gird region of Madhya Pradesh, India

Abstract

In the rabi season of 2021–2022, a field experiment was set up at the Crop Research Centre–I, School of Agriculture, ITM University, Gwalior (M.P.) in a Randomised Block Design (factorial) with three replications. Twelve treatments were made up of three varieties HM Super 222, Bombay 76, and Lafar Kranti and four sulphur concentrations 0, 20, 40, and 60 kg S ha^{-1} to determine the ideal sulphur dosage and the ideal variety for increased output. On November 11, 2021, the experiment was planted in the CRC- I. At all of the periodic crop growth phases, with the exception of 30 DAS, there was a substantial increasein plant height, number of branches, total number of leaves, leaf area index, and dry matter accumulation from application of 0 to 60 kg S ha^{-1}. At 60, 90 DAS and harvest, the higher values of growth parameters were recorded at the maximum amount of sulphur, or 60 kg S ha^{-1} with the exception of 40 kg S ha^{-1} where it was comparable to each other. Number of siliqua per plant, siliqua length, seed per siliqua, and seed yield were all significantly influenced by sulphur levels. The highest values were 60 kg S ha^{-1}, which were comparable to 40 kg S ha^{-1}. Among varieties, plant height, number of branches, total number of leaves, leaf area index, and dry matter accumulation of variety HM Super 222 were recorded significantly superior to variety Lafar Kranti and comparable to Bombay 76 at all growth stages except 30 days after sowing. Number of siliqua per plant, seed per siliqua and siliqua length of variety HM Super 222 were recorded significantly maximum to Lafar Kranti while comparable to Bombay 76. 1000 grain weight and harvest index were non-significant. Seed yield and stover yield were highest in variety HM Super 222. Economically the application of 40 kg S ha^{-1} and HM Super 222 variety gave maximum net return and benefit cost (BC) ratio.

Keywords: *Brassica juncea, harvest index, mustard, Sulphur insufficiency*

Introduction

In north India, Indian mustard (*Brassica juncea (L.) Czern&Coss.*) is a major rabi season oilseed crop. It belongs to the family Cruciferae (Brassicaceae) and is also known as rai. Mustard is the country's second most important edible oil seed crop, after groundnut. mustard accounts for 28.79 % of India's total oilseed acreage and production (Anonymous, 2018-19).

Rajasthan, Haryana, Madhya Pradesh, and

Uttar Pradesh are the most important mustard-growing states in India. It accounts for more than 85percent of the country's total rapeseed-mustard production and is a key component of the oilseed sector. It contains between 38 and 42 percent oil and 24 percent protein.

In our country's agricultural economy, oilseed crops are quite important. Mustard seed production is expected to reach 109.5 lakh tonnes in 2021-22, according to COOIT data. The total area covered is estimated to be 87.44 lakh hectares, with an average yield of 1270 kg per hectare.

One of the most important oil seed crops in India is mustard (*Brassica juncea L.*). It occupies a prominent position in the sector of agriculture, particularly in the country's oil industry. The mustard seed is used to flavour curries and vegetables, as well as a condiment in pickles.

MP is the fourth-largest mustard producer in India. About 90 percent of the country's production is produced in Rajasthan, Uttar Pradesh, Haryana, Madhya Pradesh, and Gujarat. Rajasthan accounts for about half of the country's mustard production. After N, P, and K, sulphur is the fourth most important plant nutrient in Indian agriculture. It is necessary for the synthesis of amino acids, proteins, lipids, and main components of vitamin A in plants and activates the enzyme system. Sulphur also plays a role in the creation of chlorophyll, glucosides, and glucosinolate (mustard oil), as well as enzyme activation and the manufacture of sulfhydryl (SH-) links, which are the source of pungency oil seeds. Sulphur fertilization has also been proven to boost oil content in rapeseed and mustard seeds.

Sulphur insufficiency is common and pervasive in India. Sulphur deficiency is becoming more common in Indian soils as a result of increased intensification of agriculture with high-yielding varieties and multiple cropping, as well as the use of high-analysis sulphur-free fertilizers and limited or no use of organic manures, which has resulted in the depletion of the soil sulphur reserve.

For these reasons, mustard crops require a higher level of sulphur for optimum growth and development, as well as better yields. Sulphur levels had a major impact on mustard seed and stover output (Sharma et al., 2009).

Objectives:

1. Determine the proper sulphur dosage to gain a higher yield.

2. To choose an appropriate Indian mustard variety for higher production.

3. To investigate the interactions between different sulphur levels and mustard varieties.

4. To evaluate the economics of various treatments.

MATERIALS AND METHODS

The experimental site is located in Gwalior's district of Madhya Pradesh which is situated in subtropics at an elevation of 196 m above mean sea level with coordinates at 26º 21' N latitude and 78º 17' E longitude which represents Indo-Gangetic plains region.

Gwalior receives about 80 to 90% of the total rainfall in between the July to September from the southwest monsoon and some rare showers of cyclonic rains received in winter or late spring season. Also, the rainfall is restricted mainly among the months of July to September along with a some showers of cyclic rains during winter and spring season. During the summer and winter, the mean maximum and minimum temperatures show a wide range of variations. The region's regular climate ranges from a max of 48 °C in the summer with hot desiccating winds to a minimum of 0 °C or even lower in the winter with frost.

With three replications, the experiment was carried out using a Randomised Block Design(factorial). There were twelve treatment combinations made up of three varieties and four levels of sulphur (0, 20, 40, and 60 kg/ha). The numbers for HM Super 222, Bombay 76, and Lafar Kranti were chosen at randomly. Using a seed drill machine, mustard seeds were planted in a line 15 cm apart. The seeds were sown in the 2nd weeks of November 2021 at a rate of 4 kg/ha. The amount

of nitrogen, phosphorus, and potassium (120kg/ha, 40kg/ha, and 40kg/ha, respectively) was applied to the crop as fertilizer. The sources of nitrogen, phosphorus, and potassium applied in this experiment were urea, DAP, and murate of potash. The precise amount of fertilizer was determined using the gross plot area. By using elemental sulphur, sulphur was administered as needed for the treatment. Following 25 to 30 days after sowing, the remaining dose of nitrogen was added as a top dressing together with the full doses of phosphorus, potassium, and sulphur that were applied as basal dressing. The net plot area of each treatment had four randomly chosen plants that were tagged for the purpose of recording various biometric measurements. The data were then statistically evaluated using the method outlined by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Growth attributing characters: Sulphur levels had a substantial impact on growth characteristics, such as plant height, leaf area index, branches per plant, and dry matter accumulation per plant, at all phases, with the exception of the 30-day stage, where growth was somewhat accelerated. Growth characteristics gradually improved as sulphur levels rose significantly to 60 kg/ha. At the crop's growth stages at 60, 90 DAS and harvest, the maximum growth-contributing character was reported 60 kg S ha^{-1}, which was comparable to 40 kg S/ha and noticeably superior to 20 kg S/ha and the control (Table 1). The rise in plant height may be linked to better nutritional conditions for plant growth during active vegetative stages, which improved cell multiplications, cell elongation, and cell expression in the plant body, finally leading to an increase in plant height. The findings of the current study concur with those of Singh and Saran () and Khanpara et al. (1993) as well (1993) involved in cell division, elongation, and expansion, which ultimately resulted in the production of a greater

number of branches and plants. In comparison to sulphur-deficient plants, these processes required higher doses of sulphur. Additionally, the findings of Sharma *et al*. (1991) and Kumar et al. () were in line with these results.

Yield and yield contributing characters: Sulfur levels had a significant impact on yield and yield contributing characters at all stages, with the exception of the first 30 days (Table 2). These characters

included the number of siliquae per plant, length of the siliqua (cm), number of seeds per siliqua, test weight (g), seed yield (q/ha), stover yield (q/ha), and harvest index. The crop stages at 60, 90 DAS, and harvest, the maximum yield contributing character was reported at under 60 kg S/ha, which was comparable to 40 kg S/ha and noticeably superior to 20 Kg S/ha and the control (Fig 2). At all stages of crop growth, with the exception of the first 30 days, HM Super 222 outperformed the other types by a wide margin. Sulfur levels had a significant impact on yield and yield contributing characters at all stages, with the exception of the first 30 days.

Table 1: Effect of levels of sulphur and varieties on growth attributing characters:

Treatments	Plant height (cm) at harvest	Number of leaves at 90 DAS	Number of branches at 90 DAS	Leaf area index at 90 DAS	Dry matter (g /plant) at harvest
Varieties					
V_1-HM SUPER 222	158.46	27.42	17.80	6.33	73.55
V_2-BOMBAY 76	150.36	26.55	16.55	5.91	68.77
V_3-LAFAR KRANTI	136.17	22.72	15.03	5.24	60.47
SEm±	4.81	0.88	0.43	0.19	2.21
CD(P=0.05)	14.10	2.59	1.26	0.55	6.47
Levels of sulphur					
S_0-0 kg S ha^{-1}	126.11	21.01	14.31	4.90	56.82
S_1-20 kg S ha^{-1}	143.84	24.83	15.86	5.57	64.98
S_2-40 kg S ha^{-1}	160.23	27.89	17.76	6.34	73.38
S_3-60 kg S ha^{-1}	163.14	28.52	17.91	6.51	75.21
SEm±	5.55	1.02	0.50	0.22	2.55
CD(P=0.05)	16.29	2.99	1.46	0.63	7.47
V x S					
SEm±	9.62	1.77	0.86	0.37	4.41
CD(P=0.05)	NS	NS	NS	NS	NS

Sulfur levels had a significant impact on yield and yield contributing characters at all stages, with the exception of the first 30 days. These characters included the number of siliquae per plant, length of the siliqua (cm), number of seeds per siliqua, test weight (g), seed yield (q/ha), stover yield (q/ha), and harvest index. The crop stages at 60, 90 DAS, and harvest, the maximum yield contributing character was reported at under 60 kg S/ha, which was comparable to 40 kg S/ha and noticeably superior to 20 kg S/ha and the control. At all stages of crop growth, with the exception of the first 30 days, HM Super 222 outperformed the other types by a wide margin (Table 2). Sulphur improved mustard plant vegetative growth and development during the full period of crop growth, the value of these yield- contributing features with greater dosages of sulphur increased. Singh and Mukherjee (2004) have also reported on the advantages of sulphur on the various yield-contributing features.

The combination of larger siliquae/plant, more seeds/siliqua, and higher 1000-seed weight, which was the outcome of better translocation of photosynthates from source to sink, may have contributed significantly to the increase in seed yield under adequate sulphur supply. Additionally, sulphur promotes the development of the mustard seed's oil synthesis, pod setting, and seed and seed and stover yields. Rana *et al*. (2005) and Dongarkar *et al.* (2005) also reported the similar results. The highest value of the harvest index was 60 kg S/ha. This might be because larger sulphur doses encouraged improved photosynthate partitioning to reproductive regions, which raises the seed to stover ratio. Similar findings were reported by Kumar et al. (2000).

Table 2: Effect of levels of sulphur and varieties on yield and yield parameter.

Treatments	Siliqua per plant	Length of siliqua (cm)	Seeds per siliqua	1000 seed weight(g)	Seed yield (q /ha)	Stover yield (q/ha)	Biological yield(q/ha)	Harvest index (%)
Varieties								
V_1-HM SUPER 222	389.07	5.41	12.48	5.41	23.19	76.97	100.15	23.21
V_2-BOMBAY 76	370.71	5.15	11.97	4.96	21.54	71.79	93.33	22.97
V_3-LAFAR KRANTI	335.98	4.25	10.65	4.70	19.55	67.89	87.44	22.30
SEm±	9.32	0.12	0.39	0.20	0.55	1.67		
CD(P=0.05)	27.34	0.35	1.13	NS	1.62	4.90		
Levels of sulphur								
S_0-O kg S ha^{-1}	312.11	4.21	9.91	4.60	17.77	64.38	82.15	21.52
S_1-20 kg S ha^{-1}	350.23	4.77	11.32	4.86	20.80	70.24	91.04	22.83
S_2-40 kg S ha^{-1}	387.45	5.33	12.67	5.24	23.41	76.95	100.36	23.31
S_3-60 kg S ha^{-1}	411.23	5.44	12.92	5.40	23.73	77.29	101.02	23.63
SEm±	10.77	0.14	0.45	0.23	0.64	1.93		
CD(P=0.05)	31.57	0.40	1.31	NS	1.87	5.65		
V x S								
SEm±	18.65	0.24	0.77	0.41	1.10	3.34	3.69	1.19
CD(P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS

Fig 1: Effect of levels of sulphur and varieties on growth attributing characters:

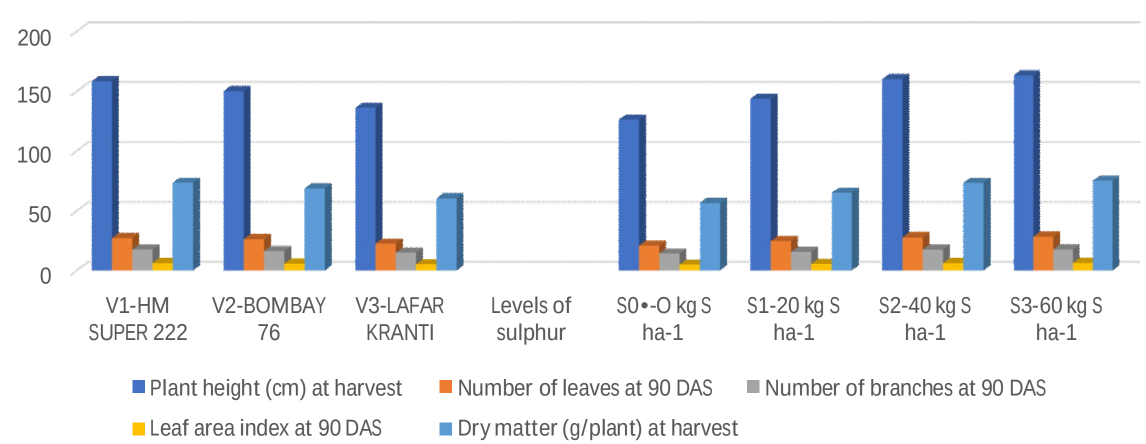
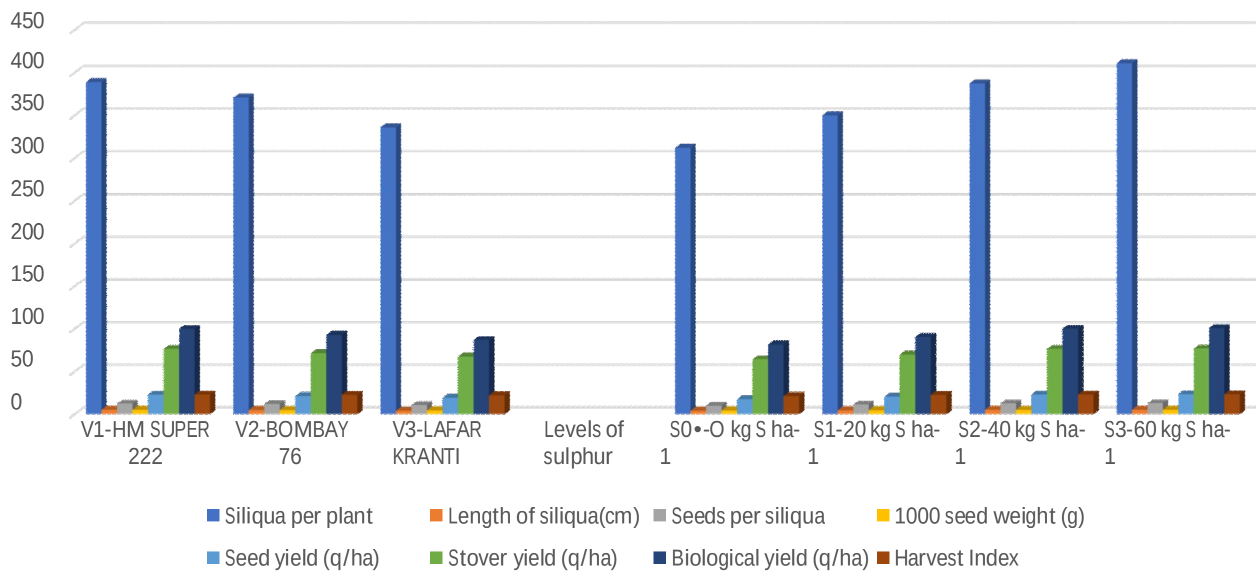


Fig 2: Effect of levels of sulphur and varieties on yield and yield parameter.



Conclusion

It is concluded that a number of siliqua per plant, seed per siliqua and siliqua length of variety HM Super 222 were recorded significantly maximum to Lafar Kranti while comparable to Bombay 76. 1000 grain weight and harvest index were non-significant. Seed yield and stover yield were highest in variety HM Super 222. Economically the application of 40 kg S ha-1 and HM Super 222 variety gave maximum net return and benefit cost (BC) ratio.

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