The Pharma Innovation Journal 2021; 10(8): 1131-1134

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2021; 10(8): 1131-1134

www.thepharmajournal.com
Received: 18-06-2021
Accepted: 29-07-2021

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Effect of sulphur levels and spacing on yield, yield attributes and economics of yellow mustard (*Sinapis alba*)

Potluri Pavan Kumar, Rajesh Singh, Wasim Khan and Shazad Ahmed Khan

Abstract
A field experiment was conducted during *rabi* 2020 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P). The soil was sandy loam in texture, low in organic carbon and medium in available nitrogen, phosphorous and low in potassium. The experiment was laid out in Randomized Block Design with nine treatments each replicated thrice. The treatments comprises of three Sulphur levels (30 kg S/ha, 45 kg S/ha and 60 kg S/ha) and three spacing *viz*., (40×20 cm, 50×20 cm and 60×20 cm) was used. The results showed that *viz*: number of siliquae per plant (139.33), seeds per siliquae (43.09) and test weight (3.28 g) were significantly recorded with the application of Sulphur 60 kg/ha + 60×20 cm. Maximum seed yield (1.60 t/ha), stover yield (5.92 t/ha) and harvest index (22.38%) were significantly recorded with the application of Sulphur 60 kg/ha + 40×20 cm compared to all other treatments. However, the maximum gross returns (96180.00 INR/ha), net returns (63144.8 INR/ha) and B:C ratio (1.91) was significantly recorded significantly with the application of Sulphur 60 kg/ha + 40×20 cm as compared to all other treatments.

Keywords: Mustard, sulphur, spacing, yield and economics

Introduction
Mustard is an important Rabi oilseed crop. Mustard is a fast growing plant which produce a high biomass even in heavy metal polluted soils. It is generally cultivated on marginal and light texture soils having limited moisture. There was a considerable increase in productivity of mustard from 405kg/ha in 1966-67 to 1856kg/ha in 2018-19. In India Rapeseed- mustard occupy 5.99 million ha area with production of 6.31 million tonnes (Rathi *et al.*, 2016) [6]. Major mustard growing states in India Rajasthan (40.82%), Haryana (13.33%), Madhya Pradesh (11.76%), Uttar Pradesh (11.40%), West Bengal (8.64%) according to 2018-19 year. The oil content varies from 37-49%. The seeds are highly nutritive containing 38-57% erucic acid, 5-13% linoleic acid and 27% oleic acid. The seed and oil are used as condiment in the preparation of pickles and flavouring curries and vegetables.
Among the sources, application of gypsum increased the seed yield of mustard as compared with single super phosphate. Application of S in combination with balanced amounts of other nutrients significantly increased the oil content of mustard (5-6%). Sulphur application also has marked effect on soil properties and is used as soil amendment such as gypsum and pyrite to improve the availability of other nutrients in soil (Verma *et al.*, 2018). About 42.3%, Indian soils and 32.0% U.P. soils are deficient in sulphur. It is well accepted that sulphur deficiency in Indian soils is wide spread and major constraint in the way of decreasing crop productivity, produce quality and farm incomes (Abhilish *et al.*, 2016) [1]. Planting patterns play an important role in enhancing overall productivity of crops as it is likely to affect interception, absorption, penetration and utilization of incoming solar radiation. Plant density is another important character, which can be manipulated to attain the maximum production from per unit land area. The optimum plant density with proper geometry of planting is dependent on variety, its growth habit and agro-climatic conditions (Sondhiya *et al.*, 2019) [10].

Materials and Methods
A field experiment was conducted during Rabi season 2020 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P) which is located at 25 degree 39’ 42’’N latitude, 81 degree 67’56’’E longitude and 98 m altitude above the mean sea level, during

Kharif season 2020. The soil was sandy loam in texture, low in organic carbon and medium in available nitrogen, phosphorous and low in potassium. Nutrient sources were Urea, DAP, MOP to fulfill the requirement of Nitrogen, phosphorous and potassium. Gypsum used to fulfill the requirement of sulphur. Nitrogen applied as split dose half as basal dose remaining as top dressing. The treatment consisted 3 levels of Sulphur and 3 levels of spacing T1: 30 kg/ha Sulphur + 40×20 cm, T2: 30 kg/ha Sulphur + 50×20 cm, T3: 30 kg/ha Sulphur + 60×20 cm, T4: 45 kg/ha Sulphur + 40×20 cm, T5: 45 kg/ha Sulphur + 50×20 cm, T6: 45 kg/ha Sulphur + 60×20 cm, T7: 60 kg/ha Sulphur + 40×20 cm, T8: 60 kg/ha Sulphur + 50×20 cm, T9: 60 kg/ha Sulphur + 60×20 cm used. The Experiment was laid out in Randomized Block Design, with nine treatments which are replicated thrice. Date of sowing was on 27th November 2020 with the seed rate of 4-5 kg/ha. In the period from germination to harvest several plant growth parameters were recorded at frequent intervals along with it after harvest several yield parameters were recorded those parameters are growth parameters, plant height, branches per plant and plant dry weight are recorded. The yield parameters like siliquae per plant, seeds per siliquae, grain yield, test weight (1000 seeds), stover yield and harvest index were recorded and statistically analyzed using analysis of variance (ANOVA) as applicable to Randomized Block Design (Gomez K.A. and Gomez A.A. 1984).

Results

Yield attributes

Data in table 1 tabulated that Application of 60 kg/ha Sulphur + 60×20 cm resulted higher number of siliquae per plant (139.33), number of seeds per siliquae (43.09) and test weight 3.28 g) which was significantly higher. Sulphur (S) 60, 45 $kgha^{-1}$ + 60×20 cm, 50×20 cm recorded siliquae per plant (138.80, 137.90, 133.80 and 131.10), seeds per siliquae (42.47, 42.33 and 41.87) and test weight (3.09, 3.08 and 3.01) respectively which were statistically at par with (60 kg/ha Sulphur + 40×20 cm).

Table 1: Effect of Sulphur and spacing on yield attributes of Yellow Mustard

S. No	Treatments	Siliquae/plant	Seeds/Siliquae	Test weight (g)
1.	Sulphur 30 kg/ha + 40×20 cm	124.00	40.33	2.73
2.	Sulphur 30 kg/ha + 50×20 cm	126.33	40.37	2.84
3.	Sulphur 30 kg/ha + 60×20 cm	129.40	40.70	2.92
4.	Sulphur 45 kg/ha + 40×20 cm	128.43	40.53	2.86
5.	Sulphur 45 kg/ha + 50×20 cm	131.10	41.20	2.94
6.	Sulphur 45 kg/ha + 60×20 cm	137.90	42.33	3.01
7.	Sulphur 60 kg/ha + 40×20 cm	133.80	41.87	3.08
8.	Sulphur 60 kg/ha + 50×20 cm	138.80	42.47	3.09
9.	Sulphur 60 kg/ha + 60×20 cm	139.33	43.09	3.28
F- test		S	S	S
S. EM (±)		3.29	0.61	0.09
C. D. (P = 0.05)		9.85	1.83	0.28

Yield and Yield attributes

Data in table 2 tabulated that Application of 60 kg/ha Sulphur + 40×20 cm resulted maximum seed yield (1.60 t/ha), stover yield (5.92 t/ha) and harvest index (22.38%) which are recorded maximum with the application of T_7 which is (60 kg/ha Sulphur + 40×20 cm) which was significantly higher. Sulphur (S) 60, 45 $kgha^{-1}$ + 40×20 cm, 50×20 cm recorded seed yield (1.57, 1.54 t/ha) and stover yield (5.74, 5.64 t/ha) respectively which were statistically at par with (60 kg/ha Sulphur + 40×20 cm).

Table 2: Effect of sulphur levels and spacing Yield and Yield attributes Yellow Mustard

S. No	Treatments	Seed yield (t/ha)	Stover yield (t/ha)	Harvest index (%)
1.	Sulphur 30 kg/ha + 40×20 cm	1.46	5.10	22.29
2.	Sulphur 30 kg/ha + 50×20 cm	1.33	4.64	21.38
3.	Sulphur 30 kg/ha + 60×20 cm	1.29	4.55	22.17
4.	Sulphur 45 kg/ha + 40×20 cm	1.54	5.64	21.47
5.	Sulphur 45 kg/ha + 50×20 cm	1.47	5.31	21.77
6.	Sulphur 45 kg/ha + 60×20 cm	1.38	4.94	21.83
7.	Sulphur 60 kg/ha + 40×20 cm	1.60	5.92	22.38
8.	Sulphur 60 kg/ha + 50×20 cm	1.57	5.74	21.48
9.	Sulphur 60 kg/ha + 60×20 cm	1.49	5.50	21.30
F- test		S	S	NS
S. EM (±)		0.02	0.09	0.38
C. D. (P = 0.05)		0.07	0.26	-

Economics

Data in table 3 tabulated Experimental results revealed that application of Sulphur 60 kg/ha + 40×20 cm recorded higher gross returns (96,180.00 INR) net returns (63144.8 INR) and benefit: cost ratio (1.91) and minimum gross returns (77880.00 INR), minimum net returns (46157.6 INR) and minimum benefit: cost ratio (1.45) were recorded with the treatment of Sulphur 30 kg/ha + 60×20 cm.

Table 3: Effect of Sulphur levels and Spacing on economics of Yellow Mustard

S. No	Treatments	Cost of Cultivation (INR/ha)	Gross return (INR/ha)	Net Return (INR/ha)	B:C ratio
1.	Sulphur 30 kg/ha + 40×20 cm	31722.40	87960.00	56237.60	1.77
2.	Sulphur 30 kg/ha + 50×20 cm	31722.40	89220.00	57497.60	1.81
3.	Sulphur 30 kg/ha + 60×20 cm	31722.40	77880.00	46157.60	1.45
4.	Sulphur 45 kg/ha + 40×20 cm	32379.10	92640.00	60260.90	1.85
5.	Sulphur 45 kg/ha + 50×20 cm	32379.10	88740.00	56360.90	1.74
6.	Sulphur 45 kg/ha + 60×20 cm	32379.10	82980.00	50600.90	1.56
7.	Sulphur 60 kg/ha + 40×20 cm	33035.20	96180.00	63144.80	1.91
8.	Sulphur 60 kg/ha + 50×20 cm	33035.20	94320.00	61284.80	1.86
9.	Sulphur 60 kg/ha + 60×20 cm	33035.20	89460.00	56424.80	1.70

Discussion

The increase in no. of siliquae/plant, seeds/siliquae and test weight (g) was influenced by 45 kg S/ha (Kumar *et al.*, 2011) [5]. Under the 60×15 cm the highest number of silique/plant, seeds/silique, 1000 seed weight and seed yield/plant may be attributed to the reduced competition between plants for space, light, nutrients and soil moisture (Sondhiya *et al*., 2019) [10]. A significant increase in seed and stover yield was found with addition of Sulphur 40 kg/ha (Jaiswal *et al*., 2014) [4]. The increase in seed yield under adequate sulphur supply might be ascribed mainly due to the combined effect of higher number of siliquae/plant, more number of seeds/siliqua and higher 1000-seed weight, which was the result of better translocation of photosynthates from source to sink (Singh *et al.*, 2016). The application of S in different doses increased the seed yield of the crop over the control plot (Rakesh and banik 2016) [8]. The maximum seed yield (18.89 and 18.08 q/ha) and stover yield (58.38 and 55.16 q/ha) was recorded at 60 kg S/ha which was at par with 40 kg S/ha **(**Ravindra *et al.* 2018) [9]. higher yield parameters *viz* seed yield (2244 kg/ha) and stover yield (5989 kg/ha) was obtained when crop was sown on 30×20 cm. The net returns and B:C ratio increase with increasing levels of sulphur. The maximum net returns (13,173 and 13, 963) and B:C ratio (2.38 and 2.52) were recorded under application of 45kg S/ha, followed by 30 and 15 kg S/ha respectively (Kumar *et al*., 2011) [5]. observed that 74.86 Kg sulphur per hectare resulted net income and benefit cost ratio of Rs 15,799 and 2.69 respectively during the first year. In second year Rs 18,193 and 2.87 net income and benefit cost ratio (B:C) respectively in mustard (Singh and Meena 2005) [7]. The maximum net returns of (Rs 9,176 /ha) and benefit cost ratio of (1.49) with 60 Kg S per hectare, whereas the highest benefit cost ratio was obtained with 40Kg S ha-1 (Rana and Rana 2004) [12].

Acknowledgment

I express gratitude to my advisor Dr. Rajesh singh and all the faculty members of Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj, (U.P.) India for constant support and guidance to carry out the whole experiment research study.

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