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Effect of Biofertilizers and Sulphur Levels on Growth and Yield of Yellow Mustard (*Sinapis alba)*

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ABSTRACT: A field experiment was conducted in *Rabi* 2020 at Crop Research Farm (CRF), Department of Agronomy, SHUATS, Prayagraj (U.P.). The soil of experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH 7.1), low in organic carbon (0.36%) available N (171.48 kg/ha), available P (15.2 kg/ha) and available K (232.5 kg/ha). The trial was placed out in Randomized Block Design with nine treatments each replicated thrice. The treatments are T_1: *PSB* +15 kg/ha S, T_2: *PSB* + 30 kg/ha S, T_3: *PSB* + 45 kg/ha S, T_4: *Azotobacter* + 15 kg/ha S, T_5: *Azotobacter* +30 kg/ha S, T_6: *Azotobacter* + 45 kg/ha S, T_7: *VAM* + 15 kg/ha S, T_8: *VAM* + 30 kg/ha S, T_9: *VAM* + 45 kg/ha S used. The results showed that viz: plant height (94.46 cm), Branches (10.60), dry weight (23.71 g) number of siliquae per plant (133.92), seeds per siliquae (33.80) and test weight (3.63 g) were recorded significantly higher with application of *PSB* + 45 kg S/ha. Moreover, maximum seed yield (1.80 t/ha) and stover yield (3.36 t/ha) were noted significantly higher with application of *PSB* + 45 kg S/ha compared to all other treatments.

Keywords: Mustard, Biofertilizers, Sulphur, siliquae and seed yield.

INTRODUCTION

Yellow Mustard (*Sinapis alba*) is an important oilseed crop belongs to family *Cruciferae* (*Brassicaceae*). Oil seeds play an important role in Indian Agriculture and industries. Besides, immense value in our diet, oils and fats are used in cosmetics, soaps, lubricants, paints and varnish industries and their medicinal and therapeutic value. The requirement of vegetable oils and fats will be much higher in coming years in view of ever increasing population (Kumar *et al.*, 2016).

India mustard is predominantly cultivated in the states of Rajasthan, Uttar Pradesh, Haryana, Madhya Pradesh and Gujarat. Rajasthan ranks first in area and production of rapeseed and mustard with 2.50 million ha area and 3.71 million tonnes production. Mustard oil is used as condiment in pickles, flavouring curries and vegetables, and in the tanning industry for softening of leather. The mustard cake is used mostly for cattle feed and manure (Potdar *et al.*, 2019).

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 and Dawson 2019). Sulphur (S) is essential for the growth and development, plays a key role in plant metabolism, indispensable for the synthesis of essential oils, plays a vital role in chlorophyll formation required for development of cells.

Biofertilizers are well-known to play number of important roles in increasing soil fertility, Productivity of crop and their production in agriculture as they are eco-friendly but at any cost they can't replaces chemical fertilizers as they are crucial in getting higher crop yields (Solanki *et al.*, 2018). Phosphate solubilizing bacteria inoculants when applied to many crop plants, promote seed germination and initial vigour of plants by producing growth promoting substances. Application of biofertilizers results in increased mineral and water uptake, root development, vegetative growth and nitrogen-fixation (Solanki *et al.*, 2018). Azotobacter inoculants when applied to many non-leguminous crop plants, promote seed germination and initial vigour of plants by producing growth promoting substance (Yadav *et al*., 2010).

MATERIALS AND METHODS

A field experiment was conducted during Rabi season 2020 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P.) located at 25.28°N latitude, 81.54°E longitude and 98 m altitude above the mean sea level, during Rabi season 2020. 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 Biofertilizers and 3 levels of sulphur. The experiment laid out in Randomized Block Design

consisting of nine treatments which are T_1: *PSB* +15 kg/ha S, T_2: *PSB* + 30 kg/ha S, T_3: *PSB* + 45 kg/ha S, T_4: *Azotobacter* +15 kg/ha S, T_5: *Azotobacter* + 30 kg/ha S, T_6: *Azotobacter* + 45 kg/ha S, T_7: *VAM* +15 kg/ha S, T_8: *VAM* + 30 kg/ha S, T_9: *VAM* + 45 kg/ha S are replicated thrice. The sowing was done on 2nd December 2020 with the seed rate of 3-5 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 plant height, branches per plant and plant dry weight are recorded. The yield parameters like siliquae/plant, seeds/siliquae, grain yield, 1000 seed weight, stover yield and harvest index were recorded and statistically analyzed by analysis of variance (ANOVA) as relevant to Randomized Block Design (Gomez and Gomez 1984).

RESULTS AND DISCUSSION

Effect of Biofertilizers and Sulphur on plant height in yellow mustard

Data in Table 1 revealed that plant height (cm) of yellow mustard increasing with the advancement of experimentation. The plant height was significantly higher in all different growth intervals with Biofertilizers and Sulphur (S). At the time of harvest, highest plant height observed in treatment with *PSB*+ Sulphur at 45 kg/ha (94.46cm) which was significantly higher over rest of the treatments. However the treatment with *Azotobacter* + 45 kg/ha S and with *VAM* + 45 kg/ha S were found statistically on par with *PSB* + 45 kg/ha S. The increase in plant height might be due to presence of plant growth harmones *i.e*. IAA, cytokinin, gibberellins, similar results were found by Dutta and Singh (2002). The presence of Sulphur plays vital role in increased metabolic uses of sulphur in plants which seems to have endorsed meristematic activities ensuing in higher apical growth and increase of photosynthetic surface (Negi *et al.*, 2017).

Effect of Biofertilizers and Sulphur on dry weight (g) in yellow mustard: Data in Table 1 revealed that the plant dry weight (g) of yellow mustard increasing with the advancement of experimentation. The plant dry weight was significantly higher in all different growth intervals with Biofertilizers and Sulphur (S). Whereas, non-significant results were obtained at harvest in case of dry. Inoculation of *PSB* solubilization of inorganic insoluble phosphates by microorganisms helped in production of organic acids, chelating oxoacids from sugars, and exchange responses in growth environment, the results were found to similar with Kumar *et al.*, (2016).

Table 1: Effect of Biofertilizers and Sulphur on growth attributes of yellow mustard.

Treatments	Plant height (cm)					Number of Branches/plant			Dry weight (g)				
	20 DAS	40 DAS	60 DAS	80 DAS	At harvest	60 DAS	80 DAS	At harvest	20 DAS	40 DAS	60 DAS	80 DAS	At harvest
1. *PSB* + 15 kg/ha S	6.59	17.83	52.23	72.54	90.30	4.35	7.33	8.27	0.29	2.58	7.28	15.03	22.16
2. *PSB* + 30 kg/ha S	6.75	19.06	53.86	74.89	93.01	4.70	7.43	8.73	0.40	2.93	7.72	16.01	22.44
3. *PSB* + 45 kg/ha S	7.61	21.56	55.81	76.07	94.46	5.30	9.30	10.60	0.67	4.03	8.62	17.46	23.71
4. *Azotobacter* + 15 kg/ha S	7.05	18.41	52.41	73.41	90.73	4.93	7.47	8.30	0.34	2.87	7.87	15.74	22.42
5. *Azotobacter* + 30 kg/ha S	7.18	19.02	53.05	73.94	91.84	4.96	7.77	8.73	0.43	3.05	8.07	16.35	22.66
6. *Azotobacter* + 45 kg/ha S	7.23	19.90	54.07	75.28	93.43	4.97	8.30	8.80	0.61	3.69	8.13	17.19	23.34
7. *VAM* + 15 kg/ha S	6.91	18.59	52.69	73.74	91.00	4.77	7.96	8.53	0.38	2.90	7.98	15.82	22.25
8. *VAM* + 30 kg/ha S	6.86	20.30	53.81	74.38	92.45	5.07	8.03	9.17	0.46	3.73	8.07	16.08	22.91
9. *VAM* + 45 kg/ha S	7.17	20.53	54.37	75.73	93.99	5.10	8.76	9.96	0.64	3.95	8.34	17.34	23.56
S. em (±)	0.18	0.38	1.12	0.69	0.53	0.10	0.30	0.22	0.05	0.22	0.22	0.23	0.45
CD (5%)	0.54	1.15	3.35	2.08	1.58	0.29	0.90	0.65	0.15	0.66	0.65	0.69	-

Effect of Biofertilizers and Sulphur on No. of siliquae/plant, seeds/siliquae and test weight (g) in yellow mustard.

Number of Siliquae/plant: Data in Table 2 revealed that number of siliquae per plant of yellow mustard increasing with the advancement of experimentation. From the observations Siliquae per plant (133.92) was more and significant in treatment with T_3 with *PSB* + 45 kg S/ha was recorded significantly higher from treatments expect T_9 with *VAM* + 45 kg S/ha is statistically at par with *PSB* + 45 kg S/ha. Significant increase in number of grains/spikes is due to increase in the availability of Nitrogen through bio fertilizer inoculation by which more spikelets are produced due to increased rates of spikelets primordial production, similar results were found Hadiyal *et al*., (2017). The increment in number of siliquae/plant with increasing dose of sulphur application might be better for root growth, cell multiplication, elongation and cell expansion in plant body by higher dose of sulphur application, which ultimately increased the seed yield (Jaiswal *et al.*, 2014).

No. of Seeds/plant: Data in Table 2 revealed that number of seeds/siliquae of yellow mustard and there was increasing with the advancement of experimentation. From the observations Seeds per Siliquae (33.80) was more and significant in treatment with T_3 with PSB + 45 kg S/ha was recorded significantly higher from treatments expect T_6 with Azotobacter + 45 kg S/ha and T_9 with VAM + 45 kg S/ha is statistically at par with PSB + 45 kg S/ha. Significant increase in number of grains /spike is due to increase in the availability of Nitrogen through bio fertilizer inoculation by which more spikelet's are

produced due to increased rates of spikelet's primordial production, similar results were found (Hadiyal *et al*., 2017) increase in value of these yield contributing characters might be due do the higher doses of sulphur was due to the facts that the adequate sulphur was accessible during the whole period of crop growth for improved vegetative growth and development of mustard plants (Singh *et al.*, 2016).

Test weight (g): Data in Table 2 revealed that the test weight of yellow mustard and there was increased with the advancement of experimentation. From the observations Test weight (3.63 g) significantly higher in treatment with PSB + 45 kg/ha S. whereas treatment with *VAM* + 45 kg/ha S is statistically at par with PSB + 45 kg/ha S. Besides, an increased supply of Sulphur to siliquae would also provide a chance for seeds to grow to their complete potential with an apparent increase in 1000-seed weight as observed (Rana *et al*., 2005).

Table 2: Effect of Biofertilizers and Sulphur on yield attributes of yellow mustard.

Treatments	Siliquae/plant	Seeds/Siliquae	Test weight (g)
1. *PSB* + 15 kg/ha S	125.17	29.13	2.93
2. *PSB* + 30 kg/ha S	128.79	31.74	3.04
3. *PSB* + 45 kg/ha S	133.92	33.80	3.63
4. *Azotobacter* + 15 kg/ha S	125.30	30.21	3.03
5. *Azotobacter* + 30 kg/ha S	128.53	31.81	3.14
6. *Azotobacter* + 45 kg/ha S	133.23	32.89	3.34
7. *VAM* + 15 kg/ha S	125.90	30.33	3.10
8. *VAM* + 30 kg/ha S	128.78	32.36	3.29
9. *VAM* + 45 kg/ha S	133.27	32.98	3.45
S. EM (±)	0.78	0.41	0.08
C. D. (P = 0.05)	2.34	1.24	0.23

Effect of Biofertilizers and Sulphur on yield in yellow mustard. Data in Table 3 revealed that the yieldof yellow mustard was increasing in seed yield (1.80 t/ha) and stover yield (3.36 t/ha) which were recorded maximum with the application of T_3 with PSB + 45 kg S/ha was recorded significantly higher from treatments expect T_8 with VAM + 30 kg S/ha and T_9 with VAM + 45 kg S/ha is statistically at par with PSB + 45 kg S/ha. Increase in yield attributes and yield through bio-fertilizer might be attributed to supply of more plant hormones (auxin, cytokinin, gibberellin etc.) by the microorganisms inoculated or by the root resulting from reaction to microbial population similar results were obtained by Kalita *et al.,* (2019). Sulphur also stimulates the pod setting, seed formation and oil synthesis in the seed of mustard and it increases the biological, seed and stover yields of mustard (Sharma *et al.*, 2018).

Table 3: Effect of Biofertilizers and Sulphur on yield of yellow mustard.

Treatments	Seed yield (t/ha)	Stover yield (t/ha)	Harvest index (%)
1. *PSB* + 15 kg/ha S	1.16	2.47	44.07
2. *PSB* + 30 kg/ha S	1.36	2.84	32.38
3. *PSB* + 45 kg/ha S	1.80	3.36	34.88
4. *Azotobacter* + 15 kg/ha S	1.38	2.59	34.76
5. *Azotobacter* + 30 kg/ha S	1.43	2.85	33.41
6. *Azotobacter* + 45 kg/ha S	1.71	3.23	34.61
7. *VAM* + 15 kg/ha S	1.48	2.68	35.57
8. *VAM* + 30 kg/ha S	1.64	2.87	36.36
9. *VAM* + 45 kg/ha S	1.76	3.29	34.85
F- test	S	S	NS
S. EM (±)	0.06	0.13	0.30
C. D. (P = 0.05)	0.19	0.39	-

Fig. 1. Top dressing at 45DAS and Spraying of Insecticide at crop research farm.

Fig. 2. Field inspection at time of harvest by Advisor Sir.

CONCLUSION

On the basis of present study, suggests that the application of PSB + 45 kg/ha S resulted highest plant height (94.46 cm), number of branches per plant (10.60), siliquae/plant (133.92), seeds/siliquae (33.80), seed yield of (1.80 t/ha), stover yield (3.36 t/ha).

FUTURE SCOPE

The conclusions drawn are based on one year data only which requires further confirmation for recommend.

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Conflict of Interest: None.

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