CONSEQUENCE OF SULPHUR AND BORON ON GROWTH AND YIELD OF MUSTARD UNDER RAINFED CONDITIONS

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ABSTRACT

The experiment was conducted at the Rajola Farm of the Faculty of Agricultural Sciences, Mahatma Gandhi Chitrakoot Gramodaya Vishwavidyalaya, Chitrakoot, Satna, during the rabi season of 2010–11. The observation on various traits was recorded in, pre-harvest studies [Plant height (cm) and Number of branches per plant]; and post harvest studies [Number of siliquae per plant, Number of seeds per siliqua, 1000 seeds weight, Seed yield (kg/ha), Stalk yield (kg/ha)] with twelve treatment combination. It is concluded from the present study that integrated use of organic and inorganic sources are useful for wheat and it also contribute significant amount of nutrients to preceding mustard crop. On the basis of experimental trail, thus it may be concluded that the combination of 40 kg Sulphur per hectare and one spray of boron (1 ppm) along with recommended doses of N, P and K under rainfed condition should be applied in mustard crop for obtaining higher seed yield.

Key words: Brassica juncea, MOP, Sulphur, Number of branches

I. INTRODUCTION

Mustard (Brassica juncea L.) is one of the important oilseed crops grown in India (Behera et al., 2003). Due to poor yield, oil seed production in the country does not meet the requirement of growing population. To bridge the gap between demand and supply, the country is forced to import edible oils and spends a lot of foreign exchange every year (Mishra et al., 2002). The productivity of mustard can be increased by proper fertilizer management and putting more area under irrigation. Knowledge of the concentration of plant nutrients in a crop and the amount of nutrients removed by a particular crop from the soil may be a helpful guide for the formulation of a sound fertilizer management programme (Gokhale et al., 2005). Nitrogen, phosphorus and potassium as major, sulphur among the secondary, zinc and boron as the micro nutrients play an important role in the yield and quality of mustard (Bhagat and Soni, 2000; Mishra, 2001). The ability of the "Plants" to produce more yields depend on the availability of adequate plant nutrients in appropriate proportion, because cultivation of high yielding varieties of crop coupled with intensive cropping system has depleted the soil fertility, resulting in multi-nutrient deficiencies in soil-plant system. Under such situation, use of only one or two primary nutrients will not be sufficient for maintaining the long term sustainability of crop production (Bhat et al., 2007; Kumar et al., 2001). Moreover use of balanced fertilization in optimum quantity is a key component of the crop production technology (Dwivedi et al., 2001).

Sulphur deficiency has been found to occur in soils which are coarse textured and low in organic matter. Sulphur requirements of crop plants are quite high and high yielding varieties require higher amounts of sulphur as compared to low yielding varieties of the crops. 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 creasing crop productivity, produce quality and farm incomes (Tandon 2010). Shakhela and Vyas (1995) reported that individual effects of S were significantly increased seed and stover yields of mustard. The increase in seed yield due to 60 kg S ha^{-1} was 17.6 percent over 30 kg/ha^{-1} application rates. Bhagat and Soni (2000) found that the significant improvements in growth as well as yield attributes parameters were observed due to S application over control. The crop responded up to 50 kg S ha^{-1} in terms of siliquae /plant, length of siliqua, seeds per siliqua and seed yield (Kumar et al., 2001).

Boron (B) is one of the seven essential micronutrients required for normal growth and development of plants. It's neither an enzyme constituent nor is there convincing evidence that it directly affects enzyme activities. Most of the plant available B comes from the decomposition of soil organic matter and from boron adsorbed and precipitated on the surface of soil particles. Generally humid region soils have less available boron due to its leaching loss.

In the present investigation, to study the effect of sulphur and boron on growth, yield and quality of mustard under rainfed condition, the interaction effect of sulphur and boron.

II. MATERIALS AND METHODS

Experimental site:

The experiment was conducted at the Rajola Farm of the Faculty of Agricultural Sciences, Mahatma Gandhi Chitrakoot Gramodaya Vishwavidyalaya, Chitrakoot – Satna (Madhya Pradesh), during the rabi season of 2010 – 11. The experimental field is situated in the north eastern part of Madhya Pradesh.Chitrakoot is situated at an altitude of 306 m above mean sea level at 24° 31' N latitude and 81° 15' E latitude. The climate of the region is semi-arid and sub-tropical having extreme winter and summer. During the winter months, the temperature drops down to as low as 2°C while in the summer the temperature reaches above 47°C. The average rainfall in this area is approximately 90 – 100 cm.

Field preparation and fertilizer application

A pre sowing irrigation was given to the experimental field and when it came in the condition, two cross ploughing followed by planking were done to maintain a good tilt of the soil. The plots were delineated by forming channels and plot bunds and each plot were levelled, to avoid water stagnation. The nutrient management was done as per treatments, the nitrogen was applied through Urea and DAP. Nitrogen was given in two splits, half at the time of sowing as basal dressing through urea and DAP and half as top dressing after the first irrigation through urea. The total amount of phosphorus was supplied through DAP as basal at the time of sowing. A basal application of total amount of potash was also given through murate of potash (MOP) at the time of sowing. Sulphur also applied as per treatments through elemental sulphur. Spray of boron was done as boric acid as per treatments. The level of sulphur and boron is i.e. S_0, 00 kgha^1; S_1, 20 kgha^1, S_2, 40 kgha^1; S_3, 60 kgha^1, B_0, Control; B_1, One spray (1ppm) and B_2, Two sprays (1ppm), while treatment combinations (T_1 to T_{12}) are- T_1: S_0B_0, T_2: S_0B_1, T_3: S_0B_2, T_4: S_1B_0, T_5: S_1B_1, T_6: S_1B_2, T_7: S_2B_0, T_8: S_2B_1, T_9:S_2B_2, T_{10}: S_3B_0, T_{11}: S_3B_1 and T_{12}: S_3B_2.

III. OBSERVATIONS RECORDED

The observation on various traits was recorded in A. Pre-harvest studies [Plant height (cm) and Number of branches per plant]; B. Post harvest studies [Number of siliquae per plant, Number of seeds per siliqua, 1000 seeds weight, Seed yield (kg/ha), Stalk yield (kg/ha)] and chemical composition of soil signify in Table 1. The representative soil samples from each plot were collected before sowing at 0-15 cm below soil surface and take it with the help of soil auger. Each sample was air-dried and sieved through 2 mm sieve. The prepared samples were used for the following determinations by standard methods. pH, electrical conductivity (dSm^{-1}), organic carbon (%), available-N (kgha^{-1}), available-P (kgha^{-1}), available-K (kgha^{-1}) and available-S (kgha^{-1})

IV. RESULT AND DISCUSSION

Effect of sulphur and boron on plant height

Plant height a measure of growth was recorded periodically at an interval of 30 days starting from 30th day after sowing up to harvest stage. The mean data on plant height (Table- 2) indicates that it was enhanced by multi-fold with the advancement of plant growth till 90 DAS; thereafter such an increase was slow up to the harvest stage. The plant height was found to be influenced significantly due to different levels of sulphur and boron at all the growth stages. It is revealed from the Table 2 under reference that the variations in plant height due to sulphur level were found to be significant at 30, 60, 90 DAS and harvest stages of crop growth. Mean plant height was observed in the range of 28.93 to 35.19 , 122.60 to 138.83, 140.09 to 158.02 and 144.87 to 162.64 cm under different level of sulphur at 30, 60, 90 DAS and harvest stage respectively. It is clear from Table.2, that the increasing level of sulphur up to 60 kg ha^{-1} increased the plant height significantly at 30, 60,90 DAS and harvest stage. Maximum height was observed with application of sulphur 60 kgha^{-1} (S_3) which was significantly higher to 0 and 20 kg ha^{-1} (S_0 & S_1) and statistically at par with 40 kg ha^{-1} levels (S_2). Plant height was recorded in the range of 31.10 to 32.58, 127.94 to 136.48, 143.68 to 156.40 and 150.05 to 160.07 cm under different level of boron at 30, 60, 90 DAS and harvest stage respectively. It is inferred from that application of two spray of boron (1ppm each) resulted significantly higher taller plant as compared to control and one spray at 90 DAS and harvest stage, whereas 30 DAS different levels of boron did not show any significant effect on plant height. The interaction effect due to sulphur and boron on plant height was found statistically non significant at all the observation stages.

Effect of sulphur and boron on number of leaves per plant

The number of leaves per plant was observed at 30, and 60 DAS and found significantly influenced due to different treatments are presented in Table 3. Number of leaves / plant ranged from 6.53 to 8.80, and 18.38 to 30.96 under different level of sulphur at 30 and 60 DAS respectively. At 30 DAS, maximum number of leaves / plant observed with the application of sulphur 60 kgha^{-1} (S_3) which was significantly higher to 0 and 20 kgha^{-1} (S_0 & S_1) and statistically at par with 40 kgha^{-1} levels (S_2).At 60 DAS, maximum number of leaves / plant observed with the application of sulphur 60 kgha^{-1} (S_3) which was significantly higher over rest all the other levels of sulphur. Number of leaves / plant ranged from 7.52 to 8.15, and 22.32 to 27.62 under different level of boron at 30 and 60 DAS respectively. It is inferred from Table 4.3, at 60 DAS, application of two spray of boron (1ppm each) resulted significantly higher number of leaves / plant as compared to control and one spray treatments, whereas 30 DAS two spray of boron produced maximum number of leaves / plant which was significantly higher over control but statistically at par with one spray treatment. The interaction effect due to sulphur and boron on number of leaves / plant was found statistically non significant at all the observation stages

Effect of sulphur and boron on number of branches per plant

Number of branches per plant a measure of growth was recorded periodically at an interval of 30 days starting from 30th day after sowing up to harvest stage. The mean data on number of branches/ plant in Table. 4, that it was enhanced by multi-fold with the advancement of plant growth till 90 DAS; thereafter such an increase was slow up to the harvest stage. The number of branches/ plant was found to be influenced significantly due to different levels of sulphur and boron at all the growth stages. Number of branches/ plant observed in the range of 1.89 to2.47, 9.13 to11.84, 12.73 to 18.13 and 13.02 to 18.58 under different level of sulphur at 30, 60, 90 DAS and harvest stage respectively. that the increasing level of sulphur up to 60 kg ha^{-1} increased the number of branches / plant significantly at 30, 60,90 DAS and harvest stage. Maximum number of branches / plant was observed with the application of sulphur 60 kgha^{-1} (S_3) which was significantly higher to 0, 20 and 40 kgha^{-1}

(S_0, S_1 & S_2). Number of branches / plant ranged from 2.07 to16.95 under different level of boron at different observation stage of present study. It is inferred from Table 4, at 90 DAS and harvest stage, application of two spray of boron (1ppm each) resulted significantly higher number of branches / plant as compared to control and one spray treatments, whereas 60 DAS two spray of boron produced maximum number of branches / plant which was significantly higher over control but statistically at par with one spray treatment. At 30 DAS, number of branches / plant did not show any significant difference in different levels of boron. The interaction effect due to sulphur and boron on number of branches / plant was found statistically non significant at all the observation stages except harvest stage where interaction was found significant.

Effect of sulphur and boron on yield attributing characters

The number of siliquae per plant was significantly influenced by different levels of sulphur and boron is presented in Table 2 Number of siliquae / plant observed in the range of 111.31 to 163.56 under different level of sulphur at harvest stage. It is clear from Table 4.5, that the increasing level of sulphur up to 60 kg ha^{-1} increased the number of siliquae / plant significantly over control. Maximum number of siliquae / plant was observed with application of 60 kg Sha^{-1} (S_3) which was significantly higher to 0 and 20 kg Sha^{-1} but statistically at par with 40 kg S ha^{-1}. Number of siliquae / plant observed in the range of 115.15 to 163.33 under different level of boron at harvest stage. that application of two spray of boron (1ppm each) resulted significantly higher number of siliquae / plant as compared to control and one spray treatments. Application of two spray of boron recorded 41.80 and 14.77 percent significantly higher number of siliquae / plant as compared to control and one spray treatments. The interaction effect due to sulphur and boron on number of siliquae / plant was found statistically significant. Number of siliquae / plant noted 72.27 to 197.53 under different treatments combination of sulphur and boron. Maximum number of siliquae / plant (197.53) was observed with S_3B_2 which was significantly higher over rest all the treatment combination.

Length of siliquae / plant observed in the range of 2.71 to 3.21 cm under different level of sulphur. It is clear from Table 4.5, that the increasing level of sulphur up to 60 kg ha^{-1} increased the length of siliquae / plant significantly over control. Maximum length of siliquae / plant (3.21 cm) was observed with application of 60 kg S ha^{-1} (S_3) which was significantly higher to 0 and 20 kg Sha^{-1} but statistically at par with 40 kg S ha^{-1}. Length of siliquae / plant observed in the range of 2.80 to 3.18 cmunder different level of boron at harvest stage. that application of two spray of boron (1ppm each) resulted significantly higher length of siliquae / plant as compared to control and one spray treatments. The interaction effect due to sulphur and boron on length of siliquae / plant was found statistically non significant at harvest stage.

Number of seeds per siliqua noted in the range of 10.73 to 12.56 under different level of sulphur, that the increasing level of sulphur up to 40 kg ha^{-1} increased the number of seeds per siliqua significantly. Maximum number of seeds per siliqua (12.56) was observed with application of 60 kg S ha^{-1} (S_3) which was significantly higher to 0 and 20 kg Sha^{-1} but statistically at par with 40 kg S ha^{-1}. Number of seeds per siliqua observed in the range of 11.38 to 12.18 under different level of boron at harvest stage. that application of two spray of boron (1ppm each) resulted significantly higher length of siliquae / plant as compared to control and one spray treatments. The interaction effect due to sulphur and boron on number of seeds per siliqua was found statistically non significant at harvest stage.

Test weight is an important yield attributing character which determines the seed size and quality of seed produced. A significant increase was noted in 1000 seed weight under different levels of sulphur as compared to the control. It is observed in the range of 3.86-4.43 g under different treatments, that the increasing level of sulphur up to 60 kg ha^{-1} increased the 1000 seeds weight significantly. Maximum test weight (4.43 g) was observed with the application of 60 kg S ha^{-1} (S_3) which was significantly higher to 0 20 and 40 kg Sha^{-1}. Test weight of seeds observed in the range of 4.01 to 4.25 g under different level of boron at harvest stage. The interaction effect due to sulphur and boron on test weight of seeds was found statistically significant. Test weight of seeds noted 3.65 to 4.49 g under different treatments combination of sulphur and boron. Maximum test weight of seeds (4.49 g) was observed with S_3B_2 which was significantly higher over rest all the treatment combination except S3B1 , S_2B_2 and S_3B_0 which show non significant difference from each other.

Effect of different levels of sulphur and boron on Seed and Stover yield

Seed and Stover yield indicated in Table 2, there was a significant response in seed yield due to different levels of sulphur and boron as compared to respective control. Seed yield varied from 996.67 -1399.33 kg/ha under different levels of sulphur and the magnitude of increase in yield due to various levels was 14.21 to 40.40 % over control. It's increasing level of sulphur, the seed yield significantly up to 60 kg ha^{-1}. Maximum yield (1399.33 kg/ha) was observed with the application of 60 kg S ha^{-1} (S_3) which was 40.40, 22.93 and 8.79 percent significantly higher to 0, 20 and 40 kg Sha^{-1} treatments respectively. Seed yield observed in the range of 1058.17 to 1335.67 kg/ha under different level of boron. Maximum yield (1335.67 kg/ha) was observed with two sprays of boron which was 26.22, and 9.33 percent significantly higher over to control and one spray of boron treatments respectively. The interaction effect due to sulphur and boron on seed yield was found statistically significant and seed yield noted 879.67 to 1508.33 kg/ha under different treatments combination of sulphur and boron. Maximum seed yield (1508.33 kg/ha) observed with S_3B_2 which was significantly higher over rest all the treatment combinations except S_3B_1 and S_2B_2 which show non-significant difference from each other, whether as minimum seed yield was noted with S_0B_0 treatment combination. Stover yield due to different levels of sulphur and boron, increasing level of sulphur increases the stover yield significantly up to 60 kg ha^{-1}. Stover yield varied from 1255.33 to 1531.78 kg/ha under different levels of sulphur. Maximum yield (1531.78 kg/ha) was observed with the application of 60 kg S ha^{-1} (S_3) which was significantly higher to 0 and 20 kg S ha^{-1} but statistically at par with 40 kg S ha^{-1} treatments respectively. Stover yield observed in the range of 1396.08 to 1487.08 kg/ha under different level of boron, that the maximum yield (1487.08 kg/ha) was observed with two sprays of boron which was significantly higher over to control but statistically at par with one spray of boron respectively. The interaction effect due to sulphur and boron on stover yield was found statistically non significant. The findings confirm the results of Shakhela and Vyas (1995), Mishra (2001), Kumar et al. (2006) and Sarangthem et al. (2008).

V. CONCLUSION

It is concluded from the present study that integrated use of organic and inorganic sources are useful for wheat and it also contribute significant amount of nutrients to preceding mustard crop. On the basis of experimental trail, thus it may be concluded that the combination of 40 kg Sulphur per hectare and one spray of boron (1 ppm) along with recommended doses of N, P and K under rainfed condition should be applied in mustard crop for obtaining higher seed yield.

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Table 1: Chemical composition of soil

Ingredients	Quantity	Method
Soil pH (1:2)	7.78	Digital pH Meter
Organic carbon (%)	0.432	Walkley and Black (1934) method
EC (dSm^{-1})	0.26	EC Meter
Available nitrogen (kg ha^{-1})	222.36	Alkaline Permanganate method (Subbiah and Asija, 1956)
Available phosphorus (kg ha^{-1})	11.36	Olsen's Colorimetric method (Olsen et al., 1954)
Available potassium (kg ha^{-1})	342.22	Flame photometric method (Jackson, 1958)
Available sulphur (kg ha^{-1})	10.88	Turbid metric method

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Table no.2 - Growth, yield and yield attributes of mustard as influenced by sulphur and Boron levels.

Levels (kg/ha)	Plant height (cm)			No. of leaf/ plant	No. of leaf/ plant	No. of Branches /plant	No. of siliquae /plant	No. of seeds/ siliqua	1000seed weight (g)	Seed yield (q/ha)	Straw yield (q/ha)
S-level	30DAS	60 DAS	90DAS	30DAS	60DAS	90 DAS					
S_0: 0 kgha^{-1}	28.93	122.60	140.09	6.53	18.38	12.73	111.31	10.73	3.86	996.67	1255.33
S_1: 20 kgha^{-1}	30.40	131.22	149.53	7.73	22.73	14.09	124.60	11.58	4.02	1138.33	1448.56
S_2: 40 kgha^{-1}	33.53	136.24	155.47	8.36	26.71	16.82	161.62	12.34	4.28	1286.22	1526.33
S_3: 60 kgha^{-1}	35.19	138.83	158.02	8.80	30.96	18.13	163.56	12.56	4.43	1399.33	1531.78
S.E. (m)±	**0.66**	**2.34**	**2.08**	**0.23**	**0.98**	**0.44**	**3.08**	**0.11**	**0.04**	**18.62**	**23.64**
C.D. (5%)	**1.93**	**6.86**	**6.10**	**0.67**	**2.87**	**1.29**	**9.02**	**0.33**	**0.12**	**54.60**	**69.35**
B-level											
B_0: Control	31.10	127.94	143.68	7.52	22.32	14.60	115.18	11.38	4.01	1058.17	1396.08
B_1 : 1 Spray (1ppm)	32.58	132.26	152.25	7.90	24.15	15.08	142.30	11.85	4.18	1221.58	1438.33
B_2 : 2 Spray (1ppm)	32.58	136.48	156.40	8.15	27.62	16.65	163.33	12.18	4.25	1335.67	1487.08
S.E. (m) ±	**0.57**	**2.03**	**1.80**	**0.20**	**0.85**	**0.38**	**2.66**	**0.10**	**0.04**	**16.12**	**20.48**
C.D. (5%)	**NS**	**5.95**	**5.28**	**0.58**	**2.49**	**1.11**	**7.82**	**0.29**	**0.11**	**47.29**	**60.06**
S X B (Interactions)	**NS**	**NS**	**NS**	NS	NS	**NS**	**S***	**NS**	**S***	**NS**	**NS**