Effect of sulphur, potassium and micronutrient complex on yield and free proline accumulation in mustard [*Brassica juncea* (L.) Czernj and Cosson] cv. 'VARUNA' under water stress condition

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SUMMARY

A field experiment was conducted during *rabi* season of year 1997-98 on laterite soil at Dapoli to study the effect of sulphur, potassium and micronutrient complex on yield and free proline accumulation in mustard [*Brassica juncea* (L.) Czernj and Cosson] cv. VARUNA. The application of sulphur @ 40 kg/ha, Potassium @ 60 kg/ha and micronutrient complex in the trade from of 'Bio green plus' increased yield per hectare. Among various treatments, sulphur is most promising which increased seed yield from 2.21 to 9.15 q/ha where as potassium and micronutrient complex elevated to 5.69 and 5.00 q/ha, respectively. The combination like sulphur + potassium + micronutrient complex significantly increased the yield of mustard compared with absolute stress control and even higher than irrigation control. The application of sulphur + potassium was another promising combination as it produced 10.37 q/ha seed yield. In current investigation, Potassium @ 60 kg/ha showed the maximum ability to generate the free proline content under water stress condition. Among the various treatment combinations sulphur + potassium + micronutrient complex generated maximum free proline content.

Key words : Mustard, Sulphur, Potassium, Micronutrient complex, Water stress.

Water is one of the major environmental factors affecting almost all aspect of plant growth and metabolism. It is well established that water stress reduces the growth and yield of crop plants. In Konkan region, oilseed cultivation is done during post monsoon season on very small area. The high infiltration rate and poor water holding capacity of soil (Dongale *et al.*, 1987) results in development of moisture stress and imposes limitation on cultivation of oilseeds crops on larger area. Further, practically there is no rainfall from October to May. Thus, crop requires frequent irrigation. Singh and Singh (1991) reported that moisture stress at siliqua initiation stage in mustard recorded highest reduction for seeds per siliqua (62.3%) followed by siliqua per plant (56.0%) and seed size (43.3%) when compared with irrigated control. The traditional rainfed cultivation of mustard warrants existence of native characteristics of stress tolerance in this crop. It is therefore, necessary to control the losses in seed yield due to water stress of this crop. Further, it is also required to formulate strategies and package for increasing the seed yield of this crop under water stress condition.

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Various metabolites are accumulated in the plant tissue upon reduction in leaf water content, free proline amino acid accumulates at very high concentration with a subsequent rapid decrease in water content. Proline is a protective substance which minimizes the damage of dehydrated cells due to water stress. This experiment was conducted to find out effect of sulphur, potassium, micronutrient complex on yield and free accumulation of proline in mustard [*Brassica juncea* (L.) Czernj and Cosson] cv. VARUNA under water stress condition.

MATERIALS AND METHODS

A Field experiment was conducted during *rabi* season of year 1997-98 at Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli on laterite soil in a randomized block design replicated 3 times. The field soil was found to be medium in available nitrogen (390.76 kg/ha), low in available phosphorus (13.60 kg/ha) and medium in available potassium (224.15kg.ha). The crop was subjected to various treatment *viz*. 40kg sulphur per hectare (S_{40}), 60 kg potassium per hectare (K_{60}), foliar spray of micronutrient complex in the trade form of 'Bio Green Plus' of Herba Agro Pvt.Ltd. Mumbai. The doses of sulphur and potassium were adjusted through single super phosphate and muriate of potash, respectively. The combination of treatments *viz*. sulphur @ 40kg/ha + potassium @ 60kg/ha, sulphur @40kg/ha. + micronutrient complex, potassium @ 60kg/ha + micronutirent complex and sulphur @ 40 kg/ha + potassium @ 0 kg/ha +

micronutrient complex were also taken for study. Further, where sulphur was not involved in the treatment the recommended dose of 90 kg nitrogen (N) and 50 kg phosphorus (P_2O_5) were adjusted through urea and diammonium phosphate, respectively. All the fertilizer treatments were given bund placement along with F.Y.M. @ 5 tonnes per hectare below the seed rows before sowing. Under control treatment only recommended dose of nitrogen and phosphorous (90 and 50 kg/ha, respectively) was given. The 8 treatment plots were subjected to terminal water stress after giving initial irrigation through line sprinkler system providing adequate moisture for seed germination. One additional plot receiving recommended dose of nitrogen and phosphorous and weekly flood irrigation was kept for comparison with the effects of various fertilizer treatment given under stress condition. The observations on plant height and yield contributing parameters were recorded on 5 selected plants from net plot area at maturity stage. The free proline content was estimated in leaves at 60 DAS according to the method of Bates *et al.* (1973).

RESULTS AND DISCUSSION

Results obtained are summarized in Table 1. Analysis of variance revealed that different level of sulphur, potassium and micronutrient complex had significant effect on growth attributes and yield attributes:

Growth attributes:

Plant height and total number of branches recorded at harvesting stage were significantly increased due to application of sulphur @ 40kg/ha, potassium @ 60 kg/ha and micronutrient complex in the trade form of 'Bio Green Plus' of Herba Agro India Pvt. Ltd. individually or in combunation over a stress control and irrigated control. Mean plant height at harvest was 182.9cm (Table 1). The combination like sulphur + potassium + micronutrient complex showed significant increase in plant height (199.3cm) followed by treatment sulphur + potassium (195.9cm) These results were not only significant over stress control but at par with irrigated control. However, the application of sulphur @ 40kg/ha increased plant height upto 187.9cm. This clearly suggested that the effect of water stress on plant height can be totally nullified by application of sulphur, potassium and micronutrient complex either individually or better way in combination. Under irrigated condition the mustard var. 'Varuna' had 8.41 branches. Due to terminal water stress, the number of primary branches was reduced upto 5.83. The treatments with mineral nutrition were played a significant role in enhancing the primary branches per plant even under stress condition. Application of sulphur @ 40 kg/ha and potassium @ 60 kg/ha produced more number of primary branches which were statistically equivalent to that of noticed under irrigated crop. It is important to note that the number of branches produced by sulphur + potassium, sulphur + micronutrient complex and sulphur + potassium + micronutrient complex were significantly higher than irrigated crop. Among them effect of sulphur + potassium + micronutrient complex was the most promising (10.25) followed by sulphur + potassium (10.00). This increase in plant height and number of branches might be attributed to better nutritional environment for plant growth at active vegetative stage.

Table 1: Effect of sulphur, potassium and micronutrient complex on growth, yield and free proline accumulation in mustard [*Brassica juniea* (L.) Czernj and Cosson] cv. VARUNA

Treatments	Plant height (cm)	Number of branches	No. of siliquae per plant	No. of seeds siliquae	Thousand seed weight (g)	Seed yield g/plant	Seed yield q/ha	Stover yield q/ha.	Free production µmoles/g. fresh weight of leaves
S_{40}	187.9	8.66	275.34	11.61	3.99	8.97	9.15	22.80	15.55
K_{60}	172.6	8.83	192.96	11.08	3.86	6.75	5.69	18.70	38.29
BG	170.2	7.58	177.26	10.03	3.85	6.42	5.00	18.37	14.88
S_{40}+K_{60}	195.9	10.00	318.56	11.44	4.13	9.68	10.37	26.66	24.55
S_{40}+BG	189.2	9.50	293.33	11.60	4.11	9.06	9.36	24.50	23.39
K_{60}+BG	181.9	9.16	206.46	11.17	4.00	7.77	9.45	20.66	23.19
S_{40}+K_{60}+BG	199.3	10.25	338.10	12.40	4.23	9.92	11.47	28.41	33.25
SF Control	193.8	8.41	278.10	12.64	4.05	9.92	11.42	26.55	8.30
S. Control	155.7	5.83	132.16	9.95	3.64	4.10	2.21	13.92	13.38
Mean	182.9	8.62	245.81	11.32	3.98	8.069	7.90	22.29	21.52
S.E.±	2.246	0.331	11.40	0.383	0.089	0.151	0.527	0.586	1.98
C.D. (P=0.05)	6.73	0.992	18.06	1.146	0.268	0.453	1.583	1.756	5.936

Yield attributes:

The yield component like number of siliqua per plant, seed per siliqua, seed yield per plant (g), 1000-seed weight and seed yield (q/ha) were significantly increased by sulphur @ 40kg/ha, potassium @ 60 kg/ha and Micronutrient complex under water stress condition over absolute stress control. The irrigated crop had an average 278.10 siliqua per plant and the terminal water stress reduced the number of siliqua to 132.16. The application of sulphur, potassium and micronutrient complex had significantly increased the number of siliqua per plant 275.35, 192.96 and 177.26, respectively. The treatments *viz*. S_{40}+K_{60}, S_{40}+BG, K_{60}+BG, S_{40}+K_{60}+BG resulted in production of average siliqua yield was 318.56. 293.33, 206.46 and 338.10, respectively. The treatment of sulphur + potassium + micronutrient complex resulted in spectacular enhancement in number of siliqua (338.10) followed by sulphur + potassium (318.56). This clearly suggested that use of sulphur, potassium and micronutrient complex can develop adequately strong reproductive sink in terms of number of siliqua per plant. Data on effect of mineral nutrient treatments on seed yield (g/plant) under water stress condition are presented in Table 1. Under irrigated condition, the seed yield was 9.92 g/plant under stress condition it was 4.10 g/plant. The mineral nutrient treatment showed significant effect on seed yield due to increase in number of siliqua per plant and number of seeds per siliqua. Application of sulphur @ 40kg/ha, sulphur + potassium, sulphur + micronutrient complex and sulphur + potassium + micronutrient complex resulted significant increase in seed yield over a stress control. These results were also highly comparable with irrigated crop.

The seed yield under absolute stress control was 2.21 q/ha where as irrigated control it was 11.42 q/ha. Application of sulphur, potassium and micronutrient complex either singly or in combination resulted in significant increase in seed yield in mustard. Sulphur, potassium and micronutrient complex increased the seed yield to 9.15, 5.69 and 5.00 q/ha, respectively under stress condition. Combine application of sulphur, potassium and micronutrient complex was noticed to be effective as it resulted in higher production of seed yield (11.47 q/ha) equivalent to that of irrigated crop even under water stress condition. The increase in seed yield was due to the improvement of yield attributes mainly increase in siliguae/ plant, number of seeds/siliqua and test weight of seeds. Increase in seed yield of mustard with micronutrient and sulphur was reported by Singh (1963) and Aulakh *et al.* (1980). Chatterjee *et al.* (1985) obtained 42% increased yield with sulphur in conjunction with boron through improvement of number of siliqua/plant and test weight of grains.

Free proline accumulation:

Mean free proline content was higher in water stress condition than in no stress condition. Among the treatments, potassium @ 60 kg/ha application showed higher free proline accumulation (38.29 ìmoles/g fresh weight of leaves). Treatment of sulphur @ 40 kg/ha and micronutrient complex showed lower magnitude of free proline content (15.55 and 14.88 ìmoles/g fresh wt.of leaves, respectively) which were closer to absolute stress control (13.38 μmoles/g). This suggested that the mechanism of drought resistance induced due to potassium application as largely through the generation of free proline content. Among various treatment combinations, sulphur + potassium + micronutrient complex generated maximum free proline content (33.25 μmoles/g fresh wt. of leaves) which again suggested that use of all three kinds of nutrients in combunation lead to induce the drought tolerance through generation of large quantity of free proline.

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