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Response of different levels of potassium and sulphur on growth and yield attributes of Toria (*Brassica campestris* var. black toria)

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Abstract
A field experiment was conducted during Rabi 2019 at Crop Research Farm, Department of Agronomy, SHUATS, Pryagraj (U.P.). The soil of experimental plot was sandy loam in texture, neutral in soil reaction (pH 7.5), low in organic carbon (0.58%), available Potassium (239.2 kg ha^{-1}) and Sulphur (15.38 ppm).The experiment was laid out in Randomized Block Design and replicated thrice. The experiment was laid out with two levels of Potassium (30 and 40 kg ha^{-1}) and four levels of Sulphur (0, 20, 30 and 40 kg ha^{-1}) along with recommended dose of nitrogen at 80 kg ha^{-1} and phosphorus at 40 kg ha^{-1}. Application of 40 kg ha^{-1} Potassium along with 40 kg ha^{-1} Sulphur recorded highest plant height (93.29 cm), branches per plant (8.87), siliqua per plant (134.47), Seeds per siliqua (16.93), seed yield (1465.33 kg ha^{-1}), stover yield (2863.33 kg ha^{-1}) and test weight (3.59 g). However, plant dry weight was found to be highest with application of 20 kg ha^{-1} sulphur + 40 kg ha^{-1} potassium. The experiment shows treatment receiving 40 kg ha^{-1} Potassium + 40 kg ha^{-1} Sulphur was found more productive.

Keywords: Toria, potassium, sulphur, yield

Introduction

Toria is a herbaceous annual plant. The plant is shorter than Mustard (Rai). The height of the plant ranges between 45 and 150 cm. The stems are generally covered with a waxy deposit. In rape, leaves are borne sessile and hairy. India occupies 3rd position in Rapesseed-mustard production in world after china and Canada. About 35% area of the total cultivated area of world is in India with 16% of shares in production. Sulphur is also involved in various metabolic processes of plants. It is constituent of glutathione, a compound supposed to be associated with plant respiration and the synthesis of essential oils. Sulphur also plays a vital role in chlorophyll formation. Continuous removal of Sulphur from soils through plant uptake has led to widespread Sulphur deficiency and affected soil Sulphur budget (Aulakh *et al.*, 2003) [2]. The shortage in sulphur supply for crops decreases the N use efficiency of fertilizers (Ceccoti 1996) [3]. As the yield and yield components have increased significantly by an elevation in different levels of Potassium (Amanullah *et al*., 2011) [1]. K increases leaf area and leaf chlorophyll content, delays leaf senescence and thus contributes to a greater canopy photosynthesis and crop growth. Keeping in view the above fact, the experiment was laid out to assess the response of Potassium and Sulphur on growth and yield of Toria.

Materials and Methods

A field experiment was conducted at Crop Research Farm, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (U.P) located at 25° 39' 42" N latitude, 81° 67' 56" E longitude and 98 m altitude above the mean sea level, during *rabi* season of 2019-2020 on sandy loam soil, having moderate acidity (pH 7.5), organic carbon (0.58%), available nitrogen (219 kg/ha), phosphorus (19.6 kg/ha), potassium (239.2 kg/ha) and Sulphur (15.38 ppm). The climate of the region is semi-arid subtropical. The treatment comprised of 30 kg K/ha+ 0 kg S/ha, 40 kg K/ha+ 0 kg S/ha, 30 kg K/ha+ 20 kg S/ha, 40 kg K/ha+ 20 kg S/ha, 30 kg K/ha+ 30 kg S/ha, 40 kg K/ha+ 30 kg S/ha, 30 kg K/ha+ 40 kg S/ha, 40 kg K/ha+ 40 kg S/ha. These were replicated thrice in a Randomized Block Design. Recommended dose of fertilisers were applied at the time sowing in the form of Urea, DAP, MOP and Gypsum (for sulphur). Seeds were sown in Row to Row spacing 30 cm and plant to plant spacing 10 cm

Chemical analysis of soil

Collected soil samples were analyzed for organic carbon by rapid titration method (Sparks, 1996), Available nitrogen was estimated by alkaline permanganate method by Subbiah and Asija (1956) [18], available phosphorous by Olsen's method as outlined by Jackson (1967) [8], available potassium was determined by extracting with neutral normal ammonium acetate solution and estimating by using flame photometer (ELICO model) as outlined by Jackson (1973) and available sulphur was estimated by turbid metric method as described by Sparks (1996).

Statistical Analysis

Experimental data collected was subjected to statistical analysis by adapting Fishers method of analysis of variance (ANOVA) as outlined by (Gomez and Gomez, 1984) [7]. Critical Differences (CD) were calculated with F-test was found significant at 5% level.

Results and Discussion

Plant height

At 75 DAS highest plant height (93.29 cm) was recorded with application of 40 Kg/ha Potassium + 40 Kg/ha Sulphur, which was significantly superior over 30 Kg/ha Potassium + 0 Kg/ha Sulphur (84.1 cm), 40 Kg/ha Potassium + 0 Kg/ha Sulphur (86.05 cm), 30 Kg/ha Potassium + 20 Kg/ha Sulphur (85.58 cm). Sulphur generally tends to increase plant height. It enhances cell division, elongation and expansion. Almost similar trend was noticed with the plant height recorded by Kumar *et al*., (2018) [11].

Number of Branches/plant

At 75 DAS, highest no. of branches (8.87) was recorded with application of 40 Kg/ha Potassium + 40 Kg/ha Sulphur, which was significantly superior over all other treatments except with application of 30 Kg/ha Potassium + 40 Kg/ha Sulphur. It was attributed due to the more availability of sulphur and increases the plant height. Increased plant height ultimately increased the number of branches/plant of mustard, same findings also reported by Sardana (2011) [16], Kapur (2010) [9], Singh and Meena (2004) [17].

Plant dry weight (g/plant)

At 75 DAS, highest dry weight (15.11 g/plant) was recorded with application of 40 Kg/ha Potassium + 40 Kg/ha Sulphur, which was significantly superior over the treatment with application of 30 Kg/ha Potassium + 0 Kg/ha Sulphur (10.22 g/plant), 30 Kg/ha Potassium + 30 Kg/ha Sulphur (10.33 g/plant) and 30 Kg/ha Potassium + 40 Kg/ha Sulphur (11.22 g/plant). Whereas all other treatments were at par with 40 Kg/ha Potassium + 40 Kg/ha Sulphur. Availability of Sulphur in root zone of Mustard plant easily increased and the plant height appreciable increased. The dry weight accumulation per plant of mustard was increased due to plant height, number of leaves/plant, number of primary and secondary branches/plant increases. The same findings also reported by Dubey *et al*., (1993) [6] and Raut *et al*., (1999) [15].

Yield attributes and Yield

Application of 40 Kg/ha Potassium + 40 kg/ha Sulphur recorded significantly maximum Number of siliqua/plant (134.47), No. of seeds/siliqua (16.93), Test weight (3.59 g), Seed yield (1465.33 kg/ha), Stover yield (2863.33 kg/ha). The probable reason may be that adequate supply of all nutrient particularly potash which resulted in greater accumulation of carbohydrates, amino acids and their translocation to the production organs, which in turn improved all the growth and yield attributing characters. Increase in siliqua/plant and seeds/siliqua were higher under higher rates of Potash because of higher translocation of food material for the formulation of seeds. Similar results confirmed by these researchers Mozaffari *et al*. (2012) [14], Mir *et al*. (2010) [13], Laltanmawi *et al*. (2005) [12]. It was also observed that application of Potash in Mustard significantly increased seed yield and its attributes *viz*., siliqua/plant, seeds/siliqua and test weight. The number of siliqua/plant, seeds/siliqua and 1000 seed weight of mustard was significantly increased with application of Sulphur. The beneficial effect of Sulphur application probably induced the synthesis of growth promoting substances which would stimulate the root growth, cell elongation and protein synthesis resulting in better plant growth which in turn increases the stover yield. These results corroborated with findings of Chauhan and Tikoo (2002) [4]; Dayananda and Meena (2002) [5]; Kumar and Yadav (2007) [10].

Table 1: Response of different levels of Potassium and Sulphur on growth and yield attributes of Toria (*Brassica campestris* var. toria)

Treatments	Plant height (cm) 75 DAS	Branches/plant (No.) 75 DAS	Plant dry weight (g/plant) 75 DAS	Siliqua/Plant (No.)	Seeds/ Siliqua (No.)	Test weight (g)	Seed Yield (kg/ha)	Stover Yield (kg/ha)
30 kg/ha Potassium + 0 kg/ha Sulphur	84.1	6.47	10.22	106.73	14.13	2.74	1060.00	2123.33
40 kg/ha Potassium + 0 kg/ha Sulphur	86.05	7.13	11.89	111.00	15.47	3.06	1140.00	2513.33
30 kg/ha Potassium + 20 kg/ha Sulphur	85.58	7.27	12.11	114.80	15.40	2.62	1200.00	2586.67
40 kg/ha Potassium + 20 kg/ha Sulphur	87.67	7.27	16.89	100.73	15.93	2.74	1126.66	2706.67
30 kg/ha Potassium + 30 kg/ha Sulphur	88.06	7.33	10.33	114.47	14.87	3.21	1255.00	2420.00
40 kg/ha Potassium + 30 kg/ha Sulphur	91.46	7.47	11.78	123.13	14.80	2.75	1343.33	2303.33
30 kg/ha Potassium + 40 kg/ha Sulphur	92.24	8.2	11.22	127.93	15.73	3.49	1268.33	2576.67
40 kg/ha Potassium + 40 kg/ha Sulphur	93.29	8.87	15.11	134.47	16.93	3.59	1465.33	2863.33
SEm (±)	1.99	0.27	1.15	4.89	0.49	0.11	61.19	434.21
CD (5%)	6.05	0.83	3.50	14.84	1.50	0.35	185.62	NS

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Conclusion

On the basis of one year experimentation, it may be concluded that in Toria crop the application 40kg/ha Potassium + 40 kg/ha Sulphur after sowing is the suitable combination for obtaining better growth attributes like plant height, Dry weight and yield attributes like branches per plant, siliqua per plant, seeds per siliqua, test weight (g), grain yield (kg/ha), stover yield (kg/ha) and it can be recommended to the farmers of Prayagraj region for sustaining productivity and profitability of Toria.

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