Original Research Article

Influence of Sulphur and Spacing on Yield and Economics of Toria (*Brassica campestris* L.)

ABSTRACT

A field experiment was conducted during *Rabi* season of 2022 at the Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology And Sciences, Prayagraj (U.P.) India. To study the Response of Sulphur and Spacing on growth and yield of Toria. The treatments consist of Sulphur 15, 30, 45 kg/ha, and Spacing 20×15, 20×20, 25×20 cm. There were 10 treatments each replicated thrice. The soil of experimental plot was sandy loamy in texture, nearly neutral in soil reaction (pH 7.2) with EC-0.187 (dS/m), low in organic carbon (0.72%) available N (178.48 kg/ha), available P (27.80 kg/ha) and available K (233.24 kg/ha). Results revealed that the higher number of siliquae/plant (216.19), higher seeds/ siliquae (23.67), higher test weight (3.64 gm), higher seed yield (1756.67 kg/ha), higher stover yield (3206.67 kg/ha) and higher harvest index (35.39 %) were significantly influenced with application of Sulphur 45 kg/ha + Spacing 25×20 cm. Higher gross returns (INR 96,580.00/ha), higher net returns (INR 66,045.00/ha) and higher B:C ratio (2.16) were also recorded in treatment-9 (Sulphur 45 kg/ha + Spacing 25×20 cm)

Keywords: *Toria, Sulphur, Spacing, yield attributes and Economics.*

INTRODUCTION

Oil seed crops are crucial for human survival. food and are now the third most important crop behind grains and legumes. They are a crucial source of vegetable oil, which provides 2.5 times more energy than proteins and carbs. It contains specific vitamins E and D as well as necessary fatty acids for human physiology **(Downey, 1990).** One of the important products used by humans on a daily basis is edible oil **(Anonymous, 2017).** Rapeseed is a very important oilseed crop since it contains 40–46% excellent oil. Additionally, every meal contains 38–40% protein with a substantial amount of amino acids, including lysine, methionine, and cysteine **(Amjad, 2014).**

Toria is an 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 Rape seed-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 deficiency affects the yield and the quality of crop as it is involved in protein and enzyme synthesis as well as it is a constituent of amino acids like methionine (21% S), cystein (26% S) and cystine (21% S). Approximately 90% of plant Sulphur is present in these amino acids (**Tandon and Messick, 2002**). Sulphur is involved in the formation of chlorophyll, glucosides, glucosinolates, activation of enzyme and sulphydryl (-SH) linkages that are the source of pungency in oil. So, the oil seed crops require more amount of Sulphur, thus it absorbs more amount from the soil. It has been reported that the removal of Sulphur per ton of grain is 3 kg in cereals as against 12 kg in oilseeds (**Tandon 1995**). Rapeseed and mustard have the highest requirement of Sulphur among all the oilseed crops (**Hedge and Babu 2007**). Oil content can be increased by the application of Sulphur in rapeseed and mustard (*Brassica species*).

Proper row spacing of a particular crop is a significant agricultural factor and has a lot of impacts on the yield and its various components **(Diepen Brock, 2000)**. Many scientists reported that narrow row spacing resulted in maximum seed yield over board row spacing. Plants that grow in extensive wider rows may not effectively exploit the natural growth factors like light, water and nutrients, however, planting of crop in too much narrower rows may result in extreme inter and intra-row spacing competition **(Ali *et al.*, 1999)**. Thus, it is very imperative to deploy the proper spacing of row of the particular crop in order to increase plant productivity and for efficient use of natural recourses. Plant

population is the key factors signifying the quantity of radiation intercepted to per plant. In mustard, row spacing varies significantly across the world, subject to the cultivar, production system and prevailing environmental conditions of a particular region. Maintaining a proper row spacing is a vital factor to improve the growth of the crop and the time essential for canopy closure, alongside with the highest biomass and seed yield **(Svecnjak *et al*., 2006)**.

Keeping these points in view, the present study entitled "**Influence of Sulphur and spacing on growth and yield of Toria (*Brassica campestris* L.)",** was conducted at Crop Research Farm, Department of Agronomy, Naini Agriculture Institute, Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj, Uttar Pradesh during *Kharif* season of 2022.

Materials and Methods

The experiment was conducted during *Rabi* of 2022, Crop Research Farm, Department of Agronomy, Naini Agriculture Institute, Sam Higginbottom University of Agriculture Technology And Sciences, Prayagraj, Uttar Pradesh. Which is located at 25.24' 42'' N latitude, 81·50' 56" E longitude and 98m altitude above the mean sea level (SL). The experiment was conducted in Randomized Block Design with 10 treatments each replicated thrice. The plot size of each treatment was 3m x 3m. Factors are three levels of Sulphur (15,30,45 kg/ha) and the spacing 20×15 cm, 20×20 cm, 25×20 cm. The Toria crop was sown on 20 Sept 2022. Harvesting was done by taking $1m^2$ area from each plot. And from it five plants were randomly selected for recording growth and yield parameters. The treatment details are as follows, T_1 -(Sulphur – 15 kg/ha + Spacing 20×15 cm), T_2 -(Sulphur – 15 kg/ha + Spacing 20×15 cm), T_3 – (Sulphur – 15 kg/ha + Spacing 20×15 cm), T_4 -(Sulphur – 30 kg/ha + Spacing 20×20 cm), T_5 -(Sulphur – 30 kg/ha + Spacing 20×20 cm), T_6 -(Sulphur – 30 kg/ha + Spacing 20×20 cm), T_7 -(Sulphur – 45 kg/ha + Spacing 25×20 cm), T_8 -(Sulphur – 45 kg/ha + Spacing 25×15 cm), T_9 -(Sulphur – 45 kg/ha + Spacing 25×15 cm), and Control Plot. The observations were recorded for plant height, dry weight, Crop growth rate, number of siliqua/plant, number of seeds/siliqua, test weight, see yield and stover yield. The data was subjected to statistical analysis by analysis of variance method **(Gomez and Gomez, 1976).**

Results and Discussion

YIELD ATTRIBUTES:

Number of siliqua/plant

The significant higher number of siliquae/plant (216.19) were observed in treatment-9 (Sulphur 45 kg/ha + Spacing 25×20), which was significantly superior over rest of the treatments. However, treatment-8 (Sulphur 45 kg/ha + Spacing 20×20) was found to be statistically at par with treatment- 9 (Sulphur 45 kg/ha + Spacing 25×20). The significant higher number of siliquae/plant (216.19) were recorded with the application of Sulphur. That could be possibly due to synergistic effect of sulphur which encourages flower and seed formation in siliqua. One of the reasons might be due to increase in leaf area, plant height and increased photosynthesis rate lead to increase sink size. This is in accordance with the findings of **Saini *et al.*, (2020).** And also, with Wider plant spacing of 45 x 10cm markedly influenced the yield attributes over closer spacings owing to better geometric arrangement, resulted in better absorption of moisture and nutrients and more photosynthesis which consequently resulted in better manifestation of yield attributes. **Ramanathan and Chandrashekharan (1998).**

Number of seeds/siliqua

The significant higher number of seeds/siliqua (23.67) was observed in treatment-9 (Sulphur 45 kg/ha + Spacing 25×20), which was significantly superior over rest of the treatments. However, treatment-8 (Sulphur 45 kg/ha + Spacing 20×20) was found to be statistically at par with treatment- 9 (Sulphur 45 kg/ha + Spacing 25×20). The significant higher number of seeds/siliqua (23.67) was observed with the application of Sulphur. Increase in seeds/siliqua (No.) and test weight (g) were due to the positive effect of Sulphur at higher levels which is responsible for stimulating of flower, formation of siliqua and formation of seed in siliqua. Sulphur enhanced the translocation of photosynthates product toward seed and sink strength and production of assimilates was increased which may be the reason of increase seeds/siliqua (No.) and test weight (g). similar results were reported with **Nath *et al.*, (2018).**

Test weight (gm)

The significant higher number of test weight (23.67 gm) was observed in treatment-9 (Sulphur 45 kg/ha + Spacing 25×20), which was significantly superior over rest of the treatments. However, treatment-8 (Sulphur 45 kg/ha + Spacing 20×20) was found to be statistically at par with treatment- 9 (Sulphur 45 kg/ha + Spacing 25×20). Sulphur at higher levels which is responsible for stimulating of flower, formation of siliqua and formation of

seed in siliqua and also the maximum amount of phosphorus nutrient found in the seed and siliqua of yellow mustard plant which is responsible for formation seed and thickness of seed and the favorable effect of Sulphur enhanced the translocation of photosynthates product toward seed and sink strength and production of assimilates was increased which may be the reason of increase test weight (g). similar results are conformity with **Chauhan *et al*. (2020).**

Oil content (%)

The significant higher percentage of oil content (42.70 %) was observed in treatment-9 (Sulphur 45 kg/ha + Spacing 25×20), which was significantly superior over rest of the treatments. However, treatment-8 (Sulphur 45 kg/ha + Spacing 20×20) was found to be statistically at par with treatment- 9 (Sulphur 45 kg/ha + Spacing 25×20). Sulphur was found more efficient in increasing the oil content of the mustard seeds due to intensive participation of Sulphur in glucoside synthesis. These results are in close conformity with the findings of **Sahoo *et al*. (2018).**

Seed Yield (kg/ha)

The significant higher seed yield (1756.67 kg/ha) was observed in treatment-9 (Sulphur 45 kg/ha + Spacing 25×20), which was significantly superior over rest of the treatments. However, treatment-8 (Sulphur 45 kg/ha + Spacing 20×20) was found to be statistically at par with treatment- 9 (Sulphur 45 kg/ha + Spacing 25×20).

This reduced competition resulted more uniform root and leaf distribution. Which promotes more effective utilization of light by enhancing interception of PAR at flowering stage and radiation interception during seed filling stage. Equal distance plants orientation of leaves allowed more interception of sunlight by per leaf. That also might be due to more leaf area for interception of sun light and equidistant spacing between plants increase the ability of Toria crop to transform solar radiation into seed production **(Beenish *et al.,* 2019).** Further increase in seed yield might be due sulphur application. Mustard is a high sulphur demanding crop. Sulphur promotes oil synthesis and it is an important constituent of seed protein, amino acid, enzymes and glucosinolate **(Shekhawat et al. 2012).** Comparatively higher oil content in seed with increasing doses of sulphur as SSP might be due to higher solubility of SSP in such soils favouring higher uptake of sulphur. These results corroborated with the findings of the earlier researchers **Kumar and Trivedi (2012).**

Stover Yield (t/ha)

The significant higher stover yield (3206.67 kg/ha) was observed in treatment-9 (Sulphur 45 kg/ha + Spacing 25×20), which was significantly superior over rest of the treatments.

However, treatment-8 (Sulphur 45 kg/ha + Spacing 20×20) was found to be statistically at par with treatment- 9 (Sulphur 45 kg/ha + Spacing 25×20).

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 **Kumar and Yadav (2007).** And the greater number of plants per unit area contributed more stover yield. Final stover yield of Toria is expression of combined effects of various components. The results are in conformity with the findings of **Famda *et al.*, (2017).**

ECONOMIC ANALYSIS

Gross Returns

Observations regarding the economics of treatments are given in table.

Highest gross return (96580.00 INR/ha) was obtained in treatment-9 (Sulphur 45 kg/ha + Spacing 25×20) as compared to other treatments.

Net Returns

Net return (66045.00 INR /ha) was found to be highest in treatment-9 (Sulphur 45 kg/ha + Spacing 25×20) as compared to other treatments.

Benefit Cost Ration

Benefit Cost ratio (2.16) was found to be highest in treatment-9 with (Sulphur 45 kg/ha + Spacing 25×20) as compared to other treatments.

CONCLUSION

It was concluded that with the application of Sulphur 45kg/ha along with the spacing 20 x 25 cm (Treatment-9), has performed positively and improved growth and yield parameters. Higher grain yield, gross returns, net returns and benefit cost ratio were also recorded with application of with Sulphur 45kg/ha along with the spacing 20 x 25 cm (Treatment-9). These findings are based on one season therefore; further trials may be required for further confirmation.

Table 1. Influence of Sulphur and Spacing on yield attributes of Toria.

S. No.	Treatment combinations	No. of. Siliqua/plant	No. of. Seeds/Siliqua	Test weight (gm)	Oil Content(%)	Seed yield (kg/ha)	Stover yield (kg/ha)	Harvest Index (%)
1.	Sulphur 15 kg/ha + Spacing 20×15	162.36	19.19	2.80	37.24	1470.00	2366.67	30.61
2.	Sulphur 15 kg/ha + Spacing 20×20	167.47	18.77	2.88	38.97	1100.00	2563.33	30.02
3.	Sulphur 15 kg/ha + Spacing 25×20	169.98	19.91	3.05	39.81	1146.67	2680.33	30.04
4.	Sulphur 30 kg/ha + Spacing 20×15	175.03	21.19	3.21	38.87	1230.00	2803.33	30.54
5.	Sulphur 30 kg/ha + Spacing 20×20	182.47	22.32	3.32	40.32	1306.67	2893.33	31.11
6.	Sulphur 30 kg/ha + Spacing 25×20	189.65	22.69	3.41	41.29	1376.67	3053.33	31.08
7.	Sulphur 45 kg/ha + Spacing 20×15	201.83	21.35	3.47	40.80	1480.00	3103.33	32.24
8.	Sulphur 45 kg/ha + Spacing 20×20	209.75	23.17	3.58	41.94	1610.00	3180.00	34.52
9.	Sulphur 45 kg/ha + Spacing 25×20	216.19	23.67	3.64	42.70	1756.67	3206.67	35.39
10.	Control	180.17	19.18	3.12	37.56	1190.00	2723.33	30.41
	F test	S	S	S	S	S	S	S
	SEm(±)	1.87	0.23	0.06	0.27	133.39	98.35	0.71
	CD (P=0.05)	5.57	0.69	0.19	0.80	396.10	4.22	2.12

Table 2. Influence of Sulphur and Spacing on yield attributes of Toria.

S. No.	Treatment combinations	Cost of cultivation (INR/ha)	Gross return (INR/ha)	Net return (INR/ha)	B:C Ratio
1.	Sulphur 15 kg/ha + Spacing 20×15	28720.00	60213.00	31493.00	1.09
2.	Sulphur 15 kg/ha + Spacing 20×20	28420.00	60500.00	32080.00	1.13
3.	Sulphur 15 kg/ha + Spacing 25×20	28120.00	63030.00	34910.00	1.24
4.	Sulphur 30 kg/ha + Spacing 20×15	29935.00	67650.00	37715.00	1.26
5.	Sulphur 30 kg/ha + Spacing 20×20	29635.00	71830.00	42195.00	1.42
6.	Sulphur 30 kg/ha + Spacing 25×20	29335.00	75680.00	46345.00	1.58
7.	Sulphur 45 kg/ha + Spacing 20×15	31135.00	81400.00	50265.00	1.61
8.	Sulphur 45 kg/ha + Spacing 20×20	30835.00	92180.00	61345.00	1.99
9.	Sulphur 45 kg/ha + Spacing 25×20	30535.00	96580.00	66045.00	2.16
10.	Control	27220.00	65450.00	38230.00	1.40

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