

Original Research Article

Effect of Various levels of Phosphorus and Sulphur on Growth and Interaction of Toria (*Brassica campestris*) in Mid Hill Zone of Himachal Pradesh

Abstract

A field experiment was carried out at Research Farm Kakli, Eternal University, Baru Sahib (H.P.) during *Rabi* season of 2021-22 to study the “Different phosphorus and sulphur levels effects on growth of toria (*Brassica campestris*) in mid hill zone of Himachal Pradesh.” The trial comprised of two factors (phosphorus and sulphur) which prepared twelve treatment combinations and positioned out in factorial randomized block design and replicated thrice to attain the unvarying and unbiased results. The texture of soil was sandy loam with pH 7.12. The twelve treatment combinations comprising four phosphorus levels (15- 30- 45- 60 kg P₂O₅ /ha) and three levels of sulphur (20- 30- 40 kg S /ha). It was ascertained that significantly higher plant height, number of leaves /plant, number of branches /plant and dry weight /plant, were reported under treatment P₄ i.e. 60 kg P₂O₅ /ha. Amongst the several levels of sulphur, significantly higher growth attributes i.e. plant height, number of leaves /plant, number of branches /plant and dry weight /plant were reported under treatment S₃ i.e. 40 kg S /ha.

Key words: Toria, phosphorus, sulphur, growth attributes.

1. Introduction

Oilseeds inhabit a significant place in agriculturally built national economy, subsequent only to food grains (Ghosh *et al.*, 2002) India inhabits a leading position in global oilseeds position accounting for 19 per cent area and 9 per cent production (Hegde *et al.*, 2000). The major oil seed growing countries in world include United States, China, Canada, India, Iran and Afghanistan (Staff, 2019). India ranked fourth largest oil seed growing country due to its accountability of 25.60% share in global oil seed production. Present production of oilseeds in India is around 28.83 million tonnes from 26.54 million hectare with average productivity 1086 kg /ha. In India, Toria is cultivated on 6.86 million hectares in *Rabi* season. Rapeseed-Mustard is a crucial oil seed crop accounting around production 6.31(million tonnes) of total oilseed production in India (Annonymus, 2015).

Himachal Pradesh is a northern Indian state located in the “Heart of the Himalaya” with 55,673 km² geographical area, most of which is under forest, pasture and grazing while only 10% of state net area is used for cultivation of agriculture crops including oil seeds. Less than 10 % of state net area is utilized for cultivation of agriculture crops including wheat, paddy, maize, vegetables, ginger, oilseed, apple, fig etc. The vast majority of the cultivated area in Himachal Pradesh is found in the river valley and their tributaries. The larger part of the state populations is directly or indirectly relying upon agriculture, consequently agriculture sectors contribute over 45 % to the net state domestic products.

Phosphorus (rates and mode of application) determine plant reproductive efficiency and play a vital role in growth and development of toria crop. Phosphorus is the second essential nutrient element for crop growth and good quality yield. The most-clear impact of P is on the plant root system. The necessity of P in nodulating legumes is higher contrasted with non-nodulating crops as it plays an important role in nodule formation and fixation of atmospheric nitrogen (Brady and Weil, 2002). The role of phosphorus is critical in plant metabolism which plays an important role in energy transfer, respiration and photosynthesis. It is a key structural component of nucleic acids, co-enzymes, phosphoproteins and phospholipids. Phosphorus fertilization is a major input in crop production (Blackshaw *et al*, 2004).

Sulphur plays a vital role in quality, production and plays an important role in protein synthesis of essential amino acids like cysteine and methionine. Indian mustard markedly responded to sulphur application in oilseeds, sulphur plays a vital role in quality and development of seed. The importance of sulphur fertilization for increasing yield and quality of Indian mustard is being increasingly recognized. Application of sulphur was reported to increase yield attributes and yield of Indian mustard (Patel *et al*, 2009, Kumar *et al* (2022) and Kumar *et al*, 2011), which also has a significant effect on oil, fatty acid (Ahmad and Abdin, 2000) and glucosinolates content in mustard seed (Falk *et al*, 2007).

2. Materials and methods

A field experiment entitled “Effect of phosphorus and sulphur on growth and yield of toria (*Brassica campestris*) in mid hill zone of Himachal Pradesh” was conducted during *Rabi* season of the year 2021-22 at Kakli Research Farm of Dr. Khem Singh Gill Akal College of Agriculture, Eternal University, Baru Sahib which is situated in temperate zone of the Himachal Pradesh. The average annual rainfall ranges vary from 1250-1550 mm. The mean annual

maximum and minimum temperature are 31.95°C and 7.28°C respectively. The texture of the experimental soil was sandy loam with pH 7.12. The two factors (phosphorus and sulphur) were comprised of various levels i.e., P₁- 15 kg P₂O₅ /ha, P₂- 30 kg P₂O₅ /ha, P₃- 45 kg P₂O₅ /ha, P₄- 60 kg P₂O₅ /ha and S₁- 20 kg S /ha, S₂- 30 kg S /ha and S₃- 40 kg S /ha. The randomized block design was used with three replications to attain the unbiased results. Toria variety TL-17 produced at Punjab Agriculture University, Ludhiana was used. The crop was sown at a row distance of 30 cm with a seed rate of 5 kg /ha.

The soil sample was taken from field before the beginning of experiment. For the determination, the collected sample were carried to the laboratory and mixed thoroughly. After mixing, soil sample was sieved through 0.5mm sieve. The sieved 500 g sample was used for determination of initial status of soil like pH, electrical conductivity and OC.

Table1. Soil fertility status of experimental field

S. No.	Particular	Content	Method applied
I.	Physical characteristics		
	Particle size distribution		International Pipette (Piper, 1966)
1.	Sand (%)	68.9%	
2.	Silt (%)	25.6 %	
3.	Clay (%)	7.6 %	
	Texture Class	Sandy-loam	
II.	Chemical characteristics		
1.	Soil pH	7.12	Glass electrode pH meter (Edward et al, 1968)
2.	Electrical conductivity (dSm ⁻¹)	0.20	Solubridge method (Jackson, 1973)
3.	OC (%)	1.01	Walkley and Black's method (1934)

3. Results and discussion

3.1 Effect of phosphorus

The growth attributes of toria crop were significantly influenced by various levels of phosphorus at critical growth periods. Treatment P₄ i.e., 60 kg P₂O₅ /ha reported significantly higher growth attributes (plant height, number of leaves /plant, number of branches /plant, dry weight /plant). The significantly lower growth attributes were found under treatment P₁ i.e., 15 kg P₂O₅ /ha. The improved height of plant may be ascribed to better root proliferation and promoted winter hardiness due to enhanced phosphorus availability and the involvement of P in division and development of cell resulted in the maximum number of leaves/plant. The higher number of branches/plant might be because of the reason that, phosphorus has the synergetic effect with N uptake which is an essential nutrient needed for plant growth and the enhancement of dry weight might be ascribed to improvement of morphological attributes which are accountable for the photosynthetic aptitude of the plants. The results were corroborated with the previous findings of Yadav *et al* (2014) and Kumar and Saini (2022).

3.2 Effect of sulphur

The growth attributes of toria crop were significantly influenced by various levels of sulphur. The significantly higher growth parameters i.e., plant height, number of leaves /plant, number of branches /plant, dry weight /plant were recorded under treatment S₃ (40 kg S /ha). The significantly lowest growth attributes i.e., plant height, number of leaves /plant, number of branches /plant, dry weight /plant were obtained with the application of 20 kg S /ha (S₁). Sulphur which is an essential of succinyl Co-A, is participates in synthesis of chlorophyll in plant leaves and enhanced meristematic actions which results in apical growth and augmented plant height. The maximum leaves /plant are attributable to genetic characteristics. On the margin of meristem, slight protrusions rise in systematic manners which progress into leaves and leaf development; is governed by tissue distinction and enlargement. The enhancement in branches /plant might be attributable to stimulatory influence on cell division, elongation and cell structure setting in the plant due to which the shoot improved promptly causing in large number of branches and the enhanced weight production might be due to increased carbohydrate accretion in stem and leaves of plants. The results were corroborated with the previous findings of Yadav *et al* (2014), Kumar *et al* (2017), Kumar *et al* (2022) and Saini *et al* (2020).

3.3 Interaction effect

The interaction effect among various phosphorus and sulphur levels concerned to plant height (cm), leaves /plant and branches/plant was found to be non- significant and it was found significant with reference to dry weight/plant (g).

4. Conclusion

Based on the result of current examination it is ascertained that for the attainment of the maximum growth attributes of the toria variety TL-17, the phosphorus and sulphur should be applied at levels of 60 kg and 40 kg /ha.

Table2. Effect of various levels of phosphorus and sulphur on plant height (cm), number of leaves /plant, branches /plant and dry weight /plant (g) at 60 days after sowing

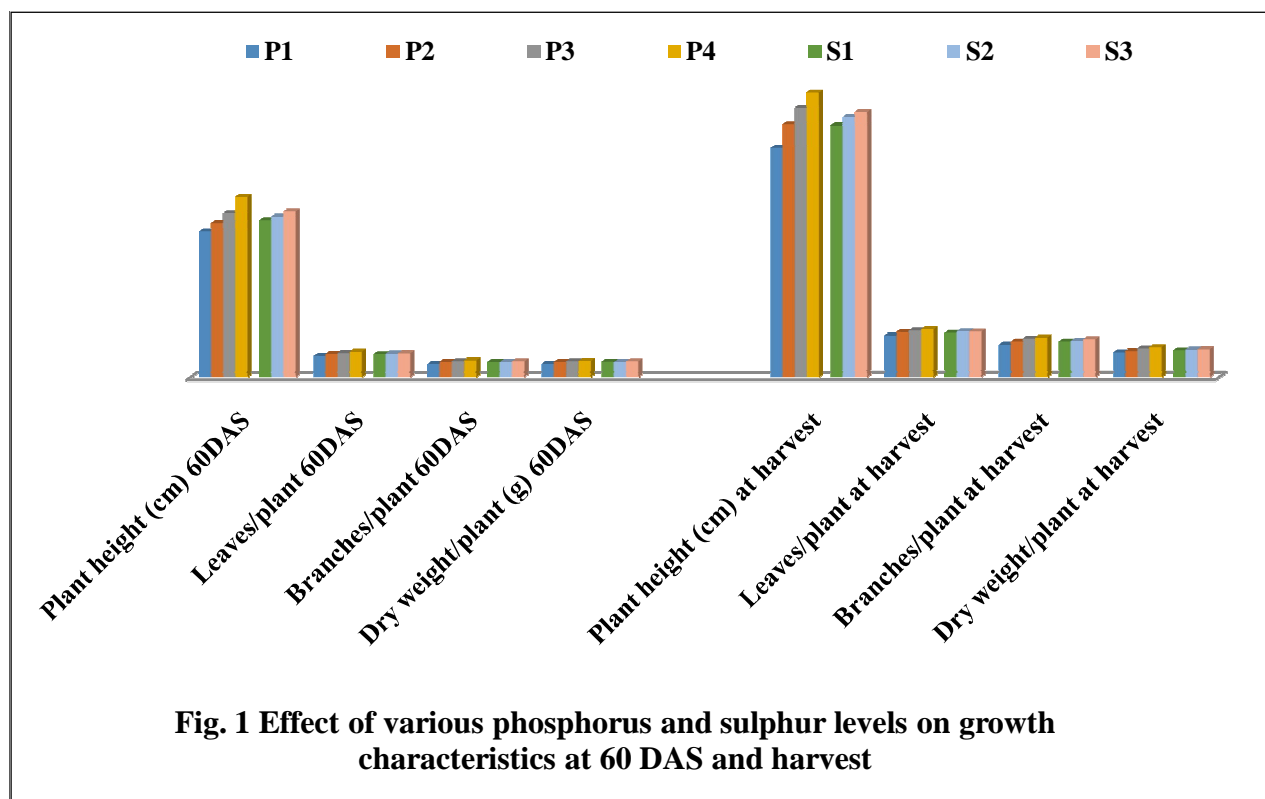
S. No.	Treatments	Plant height (cm)	Leaves/plant	Branches/plant	Dry weight/plant (g)
		60 DAS			
A	Phosphorus levels				
	P ₁ – 15 kg P ₂ O ₅ /ha	79.8	11.7	7.3	7.3
	P ₂ – 30 kg P ₂ O ₅ /ha	84.4	12.8	8.4	8.4
	P ₃ – 45 kg P ₂ O ₅ /ha	89.7	13.3	8.8	8.8
	P ₄ – 60 kg P ₂ O ₅ /ha	98.7	14	9.3	8.9
	S.Em. ±	1	0.08	0.1	0.1
	C.D. at 5%	3.1	0.2	0.4	0.3
B	Sulphur levels				
	S ₁ – 20 kg S/ha	85.8	12.7	8.4	8.6
	S ₂ – 30 kg S/ ha	87.9	13	8.3	8.3
	S ₃ – 40 kg S/ha	90.7	13.2	8.8	8.8
	S.Em. ±	0.9	0.07	0.1	0.1
	C.D. at 5%	2.7	0.2	0.4	0.4

Table3. Effect of various levels of phosphorus and sulphur on plant height (cm), number of leaves /plant, branches /plant and dry weight /plant (g) at harvest

S. No.	Treatments	Plant height (cm)	Leaves/plant	Branches/plant	Dry weight/plant (g)
		At harvest			
A	Phosphorus levels				
	P ₁ – 15 kg P ₂ O ₅ /ha	125.5	22.9	17.8	13.6
	P ₂ – 30 kg P ₂ O ₅ /ha	138.3	25	19.5	14.4
	P ₃ – 45 kg P ₂ O ₅ /ha	147.3	25.6	21.2	15.7
	P ₄ – 60 kg P ₂ O ₅ /ha	155.7	26.4	21.7	16.5
	S.E.m. ±	1.7	0.2	0.3	0.1
	C.D. at 5%	5.2	0.6	0.9	0.4
B	Sulphur levels				
	S ₁ – 20 kg S/ha	137.7	24.4	19.5	14.7
	S ₂ – 30 kg S/ ha	142.3	25.3	19.9	15.1
	S ₃ – 40 kg S/ha	145.1	25.2	20.7	15.3
	S.E.m. ±	1.5	0.1	0.2	0.1
	C.D. at 5%	4.5	0.5	0.2	0.3

Table4. Interaction effect of various phosphorus and sulphur levels on plant height (cm), number of leaves /plant, branches /plant and dry weight /plant at harvest

	Plant height(cm)			Leaves/plant			Branches/plant			Dry weight/plant (g)		
	S ₁	S ₂	S ₃	S ₁	S ₂	S ₃	S ₁	S ₂	S ₃	S ₁	S ₂	S ₃
P ₁	118	127.5	130.9	22	23	23.6	17.6	17.8	17.9	13.3	13.5	14.6
P ₂	136.7	137.5	140.7	24.3	25.2	25.6	18.9	19.6	19.9	13.9	14.4	14.9
P ₃	142.7	148.7	150.4	26.1	26.4	24.4	20.2	20.6	22.7	15.2	15.5	16.3
P ₄	153.2	155.5	158.3	25.4	26.7	27.2	21.1	21.7	22.2	16.6	15.9	17.6
S.E.m. ±	3			0.3			0.5			0.2		
C.D. at 5%	NS			NS			NS			0.6		



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