Original Research Article

Growth Attributes and their Interaction in Toria (*Brassica campestris*) as influenced by Various levels of Phosphorus and Sulphur 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 (FRBD) 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 P_2O_5 /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 P_4 i.e. 60 kg P_2O_5 /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 S_3 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 [1]. India inhabits a leading position in global oilseeds position accounting for 19 per cent area and 9 per cent production [2]. The major oil seed growing countries in world include United States, China, Canada, India, Iran and Afghanistan [3]. "India ranked fourth largest oil seed growing country due to its accountability of 25.60% share in global oil seed production. In India, rapeseed and mustard are grown on an area of 6.36 million hectare which has a production of 8.03 million tonnes of seeds" [4].

"Phosphorus (P) is acknowledged as "KING PIN" in Indian agriculture" [5]. "Indian soil are low, medium and high in accessibility of P and the total concentration of P in soil surface differs

from 0.02 to 0.10%. It works as a power currency for living cell as it holds higher adenosine tri-phosphate (ATP). Phosphorus helps in dynamic root and shoots growth. Phosphorus deficiency in soil decreases the root and shoots growth of rapeseed plants. And in severe cases, it checks the flowering of plant. 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" [6]. "It is a key structural component of nucleic acids, co-enzymes, phosphoproteins and phospholipids. Phosphorus fertilization is a major input in crop production" [7].

"After phosphorus, the next most key element that enormously needed by the oilseed crops is Sulphur (S). These crops needed sulphur largely because these crops required sulphur containing amino acid i.e. cystine, cysteine and methionine which helps in the vegetative growth of plant and also in protein and oil synthesis. S is primarily accountable for formation of glucosinolates (in rapeseed oil), glucosides and green colour (chlorophyll).and also helps in the establishment of sulphydryl linkage which has the major function of adding up pungency to oil crops mainly rapeseed and mustard. S augments the oil content in oil seed" [8]. "*Brassica* family crops are more prone to sulphur deficiency by showing symptom like leaves cupping or curling inward with reddish colour on lower surface of leaves. Application of sulphur was reported to increase yield attributes and yield of Indian mustard [9-11], which also has a significant effect on oil, fatty acid [12] and glucosinolates content in mustard seed" [13].

2. Materials and methods

A field experiment entitled "Effect of phosphorus and sulpur 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□ 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., P_1- 15 kg P_2O_5 /ha, P_2- 30 kg P_2O_5 /ha, P_3- 45 kg P_2O_5 /ha, P_4- 60 kg P_2O_5 /ha and S_1- 20 kg S /ha, S_2- 30 kg S /ha and S_3- 40 kg S /ha. The Factorial Randomized Block Design (FRBD) was used with three replications to attain the unbiased results. Toria varietyTL-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.

Table 1 Soil fertility status of experimental field

S. No.	**Particular**	**Content**	**Method applied**
I.	**Physical characteristics**		
	Particle size distribution		International Pipette Method [14]
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 [15]
2.	Electrical conductivity (dSm^{-1})	0.20	Solubridge method [16]
3.	OC (%)	1.01	Walkley and Black's method [17]

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 P_4 i.e., 60 kg P_2O_5 /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 P_1 i.e., 15 kg P_2O_5 /ha. Increase in height of plant and number of branches/ plant might be due to the positive impact of phosphorus at high levels which offer a better nutritional environment for dynamic growth of plants at vegetative stages and also helps in multiplication, elongation and expansion of cell in

plant body due to which augmentation in height and branches/plant. The highest dry matter accumulations (g) were attained due to enhancement in the application of phosphorus which facilitates the promoting and increasing of metabolic activities, physiological processes and escalating the photosynthesis process in relation to growth as a result of increasing in height of plant, number of leaves and branches/ plant above ground and below ground structures of plant which were the apparent reason of improving the dry weight accumulations/ plant. The results were corroborated with the previous findings of [18] and [19].

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 S_3 (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 (S_1). 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 application of sulphur which helps in promoting physiological activities and increasing the photosynthesis process related to growth as a result of increasing in height of plant, number of branches and leaves/plant. The results were corroborated with the previous findings of [18], [20], [10] and [21].

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.

Table 2 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_2O_5 /ha	79.8	11.7	7.3	7.3
	P_2 – 30 kg P_2O_5 /ha	84.4	12.8	8.4	8.4
	P_3– 45 kg P_2O_5 /ha	89.7	13.3	8.8	8.8
	P_4– 60 kg P_2O_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
	S2 – 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

Table 3 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_2O_5 /ha	125.5	22.9	17.8	13.6
	P_2 – 30 kg P_2O_5 /ha	138.3	25	19.5	14.4
	P_3– 45 kg P_2O_5 /ha	147.3	25.6	21.2	15.7
	P_4– 60 kg P_2O_5 /ha	155.7	26.4	21.7	16.5
	S.Em. ±	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.Em. ±	1.5	0.1	0.2	0.1
	C.D. at 5%	4.5	0.5	0.2	0.3

Table 4 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.Em. ±	3			0.3			0.5			0.2		
C.D. at 5%	NS			NS			NS			0.6		

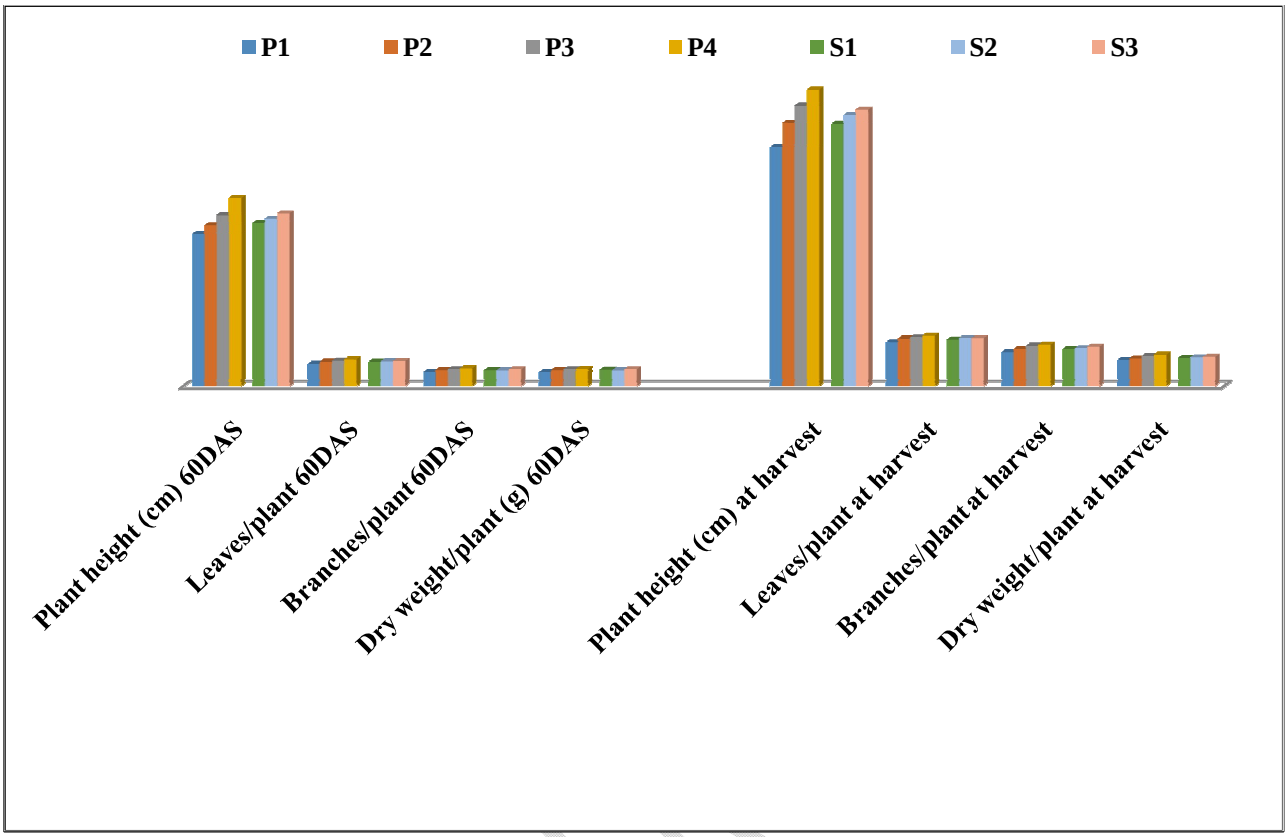

Fig. 1: Effect of various phosphorus and sulphur levels on growth characteristics at 60 DAS and harvest

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