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Effect of Plant Growth Regulators and Zinc Levels on Yield and Economics of Toria (*Brassica rapa* L.)

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ABSTRACT: At the Crop Research Farm, Department of Agronomy, SHUATS, Allahabad, a field experiment was undertaken during the Rabi season (2021-22). The soil texture of the experimental plot was sandy loam, with a pH of 7.1, low organic carbon (0.28 percent), available N (225 kg/ha), available P (19.50 kg/ha), and available K (213.7 kg/ha). PGR1 (GA3 30 ppm), PGR2 (GA3 60 ppm), and PGR3 (GA3 90 ppm) were used as plant growth regulators, and zinc (Zn1-5 kg/ha), Zn2-10 kg/ha), and Zn3-15 kg/ha) were used as fertilizers in 3 levels. The experiment used a Randomized Block Design with nine treatments and was repeated three times. The treatment of GA3 90 ppm + Zn 15 kg/ha resulted in the highest plant height (126.50cm) (Treatment-9) recorded in the study. Number of branches per plant (11.70), plant dry weight (14.50 g/plant), number of siliqua per plant (299.80), number of seeds per siliqua (23.20), test weight (3.23 g), seed yield (1.78 t/ha), straw yield (5.53 t/ha), and harvest index were all determined to be non-significant. The treatment (T9) with the application of GA3 90 ppm + Zn 15 Kg/ha produced the highest gross returns (95906.66 INR/ha), net returns (57686.66 INR/ha), and B:C ratio (1.50). Foliar sprayed of different concentrations of GA3 increased yield and growth parameters of Toria. Yield and quality contributing characters was showed highest with GA3 application with 90ppm compare to other treatments. Application of higher levels of zinc was also showed maximum in growth and yield during harvest, yield and growth parameters such as plant height, Number of branches, dry weight, Number of siliqua per plant and seeds per siliqua was showed superior with the application of zinc at 10kg/ha.

Keywords: Plant growth regulators, Growth, Yield, Zinc, Rabi, Gibberellic acid.

INTRODUCTION

Rapeseed-mustard covers 6.23 million hectares in India, with production and productivity of 9.34 million tonnes and 1499 kg per hectare, respectively (India starts 2019-20). It is a significant Rabi crop. Mustard is grown between October and November and February and March. Rajasthan, Uttar Pradesh, and Haryana are the most important growing regions. In India, mustard rapeseed is typically produced in seven kinds. Our country's primary mustard-producing states are Rajasthan and Uttar Pradesh. They account for around half of overall production. Gibberellic acid (GA_3) is a phytohormone required for plant growth and development in tiny quantities at low concentrations. So, in a given crop, advantageous conditions may be generated by exogenously injecting growth regulators like GA_3 in the right concentration at the right time. Gibberellic acid is a plant growth regulator that can control a wide range of growth and development processes in a number of crops. GA_3 improves plant development by stimulating stem elongation and increasing dry weight and yield. After harvest, produce a quintal ha^{-1}. Different dosages of GA_3 foliar applied on the mustard crop boosted yield and quality characteristics. Plant development requires micronutrients as well. Zinc affects the generation of growth hormones and aids in the reproduction of some plants. Many enzymes, such as Tryptophan synthetase, superoxide dismutase, and dehydrogenases, require zinc to function (Singh and Mann, 2007). Zinc shortage affects the synthesis of RNA and protein. As a result, the zinc-deficient plant has a low protein content (Singh and Mann, 2007). Zinc fertiliser treatment stimulates root and shoot development during the growing season, resulting in higher seed output, according to Rengel (2001). Zinc is also involved in photosynthesis and nitrogen metabolism, and it aids in the regulation of auxin levels in plants. It aids in the normal growth of fruits and stimulates flowering. It also aids in the transformation of carbohydrates and the metabolism of sulphur. Zinc spraying enhanced grain and straw yields by a substantial amount. The beneficial impact of zinc on various growth metrics, yield characteristics, and

yield can be attributed to zinc's catalytic or stimulatory action on most of the plant's physiological and metabolic processes. It also aids in the production of chlorophyll and plays a crucial function in nitrogen metabolism. As a result, adding zinc to a soil that was lacking in the mineral increased the plant's overall growth and development.

MATERIALS AND METHODS

During the Rabi season of 2021-22, the experiment was carried out. The experiment was set up in a Randomized Block Design with nine treatment combinations and three replications, with the different treatments being assigned to each replication at random. The experimental field's soil was sandy loam in texture, with a slightly alkaline response (pH 7.1), low organic carbon (0.28 percent), accessible N (225 kg/ha), P (19.50 kg/ha), and a greater quantity of K (92.00 kg/ha). T1: GA_3 30 ppm + Zn 5 kg/ha, T2: GA_3 30 ppm + Zn 10 kg/ha, T3: GA_3 30 ppm+ Zn 15 kg/ha, T4: GA3 60 ppm + Zn 5 kg/ha, T5: GA_3 60 ppm + Zn 10 kg/ha, T6: GA_3 60 ppm + Zn 15 kg/ha. T7: GA_3 90 ppm + Zn 5 kg/ha; T8: GA_3 90 ppm + Zn 10 kg/ha; T9: GA_3 90 ppm + Zn 15 kg/ha Plant height (cm), number of branches per plant, plant dry weight, number of siliqua per plant, number of seeds per siliqua, test weight, grain yield, and stover yield were all recorded as growth metrics at harvest.

RESULTS AND DISCUSSION

A. Yield

Siliqua per Plant. Treatment with application of $GA_3$90 ppm + Zn 15 Kg/ha was recorded maximum number of siliquae per plant (299.80) which was significantly superior over all other and treatment with application of GA_3 90 ppm + Zn 10 Kg/ha (251.90) which was statistically at par with the treatment with application of GA_3 90 ppm + Zn 15 Kg/ha. Application of zinc upto 7.5kg/ha was helped in obtaining the maximum number of siliqua per plant Hakim *et al.* (2014)

Seeds per Siliqua. Treatment with application of GA_3 90 ppm + Zn 15 Kg/ha was recorded maximum number of seeds per siliquae (23.20) which was significantly superior over all other and treatment with application of GA_3 90 ppm + Zn 10 Kg/ha (22.70) and GA_3 60 ppm + Zn 15 Kg/ha (22.30) which was statistically at par with the treatment with application of GA_3 90 ppm + Zn 15 Kg/ha. Application of zinc up to 5kg/ha was showed in the effect of increasing or obtained maximum number of seeds per siliqua Jat and Mehra (2007).

Test weight. Treatment with application of GA_3 90 ppm + Zn 15 Kg/ha was recorded maximum test weight (3.23g) which was significantly superior over all other and treatment with application of GA_3 60 ppm + Zn 10 Kg/ha (3.10) which was statistically at par with the treatment with application of GA_3 90 ppm + Zn 15 Kg/ha. Two application of GA_3 at 30ppm at flower initiation and at siliqua initiation stages has recorded significantly higher seed yield and test weight Akter *et al.* (2007).

Seed yield. Treatment with application of $GA_3$90 ppm + Zn 15 Kg/ha was recorded maximum seed yield (1.78 t/ha) which was significantly superior over all other and treatment with application of GA_3 90 ppm + Zn 10 Kg/ha. (1.63) which was statistically at par with the treatment with (T_9) with the application of GA_3 90 ppm + Zn 15 Kg/ha. Application of different levels of GA_3 had significant effect on seed yield per plant. The application of GA_3 at 125ppm produced the highest seed yield per plant Pradip *et al*. (2017)

Stover yield. Treatment with application of GA_3 90 ppm + Zn 15 Kg/ha was recorded maximum stover yield (5.53 t/ha) which was significantly superior over all other and treatment with application of GA_3 90 ppm + Zn 10 Kg/ha (5.10 t/ha) which was statistically at par with the treatment with application of GA_3 90 ppm + Zn 15 Kg/ha. Reported by Sarabdeep *et al.* (2017) that stover yield of mustard was recorded highest with the application of zinc at 10kg/ha.

Harvest index. Treatment with application of GA_3 30ppm + Zn 15 Kg/ha was recorded maximum harvest index (26.99%) and minimum with application of GA_3 60ppm + Zn 15 kg/ha (22.98%). There is no significant difference between treatments (Ijaz *et al.* 2019).

B. Economics

Cost of cultivation. Cost of cultivation (38220.00 INR/ha) was found to be highest in GA_3 90 ppm + Zn 15 Kg/ha (T_9) and the minimum cost of cultivation (36070.00 INR/ha) was found in GA_3 30 ppm + Zn 5 kg/ha (T_1) as compared to other treatments.

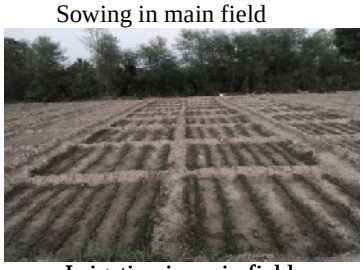
Gross returns. Gross returns (95906.66 INR/ha) was recoreded highest in GA_3 90 ppm + Zn 15 Kg/ha and the minimum gross returns (54596.66 INR/ha) was found inGA_3 30 ppm + Zn 5 Kg/ha as compared to other treatments.

Net returns. Net returns (57686.66 INR/ha) was recoreded highest in GA_3 90 ppm + Zn 15 Kg/ha and the minimum net returns (18526.66 INR/ha) was found in with the application of GA_3 30 ppm + Zn 5 kg/ha as compared to other treatments.

Benefit-cost ratio. Benefit Cost ratio (1.50) was found highest in GA_3 90 ppm + Zn 15 Kg/ha and the minimum benefit cost ratio (0.51) was found in with the application of GA_3 30 ppm + Zn 5 Kg/ha as compared to other treatments. The difference in Gross, Net returns and B:C ratio among treatments could be due to higher nutrient efficiency due to foliar application of plant growth regulators, which led to higher yields and helped in production of maximum economics Ganta *et al.* (2021).

Sowing in main field

Spraying of treatment in main field



Irrigation in main field

Treatment wise harvesting

Table 1: Effect of plant growth regulators and zinc levels on yield attributes and yield of Toria.

Treatments	No. of Siliqua per plant	No. of seeds per Siliqua	Test weight (g)	Seed yield (t/ha)	Stover yield (t/ha)	Harvest index (%)
GA_3 30 ppm + Zn 5 kg/ha	137.50	17.00	2.53	1.07	2.96	26.35
GA_3 30 ppm+ Zn 10 kg/ha	162.70	18.00	2.47	1.18	3.47	25.15
GA_3 30 ppm+ Zn 15 kg/ha	183.10	20.00	2.53	1.33	3.83	26.99
GA_3 60 ppm + Zn 5 kg/ha	167.40	19.00	2.73	1.23	3.72	24.68
GA_3 60 ppm + Zn 10 kg/ha	209.80	20.70	3.10	1.49	4.44	25.12
GA_3 60 ppm + Zn 15 kg /ha	230.00	22.30	2.73	1.39	4.64	22.98
GA_3 90 ppm + Zn 5 kg/ha	205.50	20.70	2.53	1.45	4.02	26.43
GA_3 90 ppm + Zn 10 kg/ha	251.90	22.70	2.60	1.63	5.10	24.23
GA_3 90 ppm + Zn 15 Kg/ha	299.80	23.20	3.23	1.78	5.53	24.34
SEm (±)	18.08	0.35	010	0.07	0.16	1.10
CD (5%)	54.21	1.05	0.31	0.20	0.48	—

Table 2: Effect of plant growth regulators and zinc levels on economics of Toria.

Sr. No.	Treatments	Total cost of cultivation (INR/ha)	Gross returns (INR/ha)	Net returns (INR/ha)	B:C ratio
1.	GA_3 30 ppm + Zn 5 kg/ha	36070.00	54596.66	18526.66	0.51
2.	GA_3 30 ppm+ Zn 10 kg/ha	37070.00	60536.66	23466.66	0.63
3.	GA_3 30 ppm+ Zn 15 kg/ha	38070.00	68000.00	29930.00	0.78
4.	GA_3 60 ppm + Zn 5 kg/ha	36130.00	64203.33	28073.33	0.77
5.	GA_3 60 ppm + Zn 10 kg/ha	37130.00	78520.00	41390.00	1.11
6.	GA_3 60 ppm + Zn 15 kg /ha	38130.00	77453.33	39323.33	1.03
7.	GA_3 90 ppm + Zn 5 kg/ha	36220.00	74160.00	37940.00	1.04
8.	GA_3 90 ppm + Zn 10 kg/ha	37220.00	86326.66	49106.66	1.31
9.	GA_3 90 ppm + Zn 15 Kg/ha	38220.00	95906.66	57686.66	1.50

CONCLUSION

On the basis of one season experimentation it can be concluded that with the application of GA_3 90 ppm + Zn 15 kg/ha was found more productive (1.78 t/ha) and economically viable (1.50).

The conclusions drawn are based on one season data only which requires further confirmation for recommendation.

FUTURE SCOPE

The conclusion drawn are based on one season data only which needs further confirmation for recommendations.

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Conflict of Interest. None.

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