Original Research Article

Response of inorganic fertilizer and plant growth regulators on growth and seed yield of radish (*Raphanussativus* L.)

ABSTRACT

This study aimed to evaluate the influence ofdifferent levelsofinorganic fertilizerandplant growth regulatoronseed yield of radish (*Raphanussativus*L.) was formulated and conducted during the rabi season of 2022-23 at vegetable seed production plot, Department of Horticulture (Vegetable & Floriculture), BAC, Sabour Bhagalpur.The experiment was conducted to determine seed production ability at four levels of fertilizers *viz,* (F_0-control, F_1-N40:P30:K40, F_2-N60:P40:K50,& F_3-N8P50:K50) as well as seven levels of PGRs *viz,* P_0 (Control), P_1 (GA_3 @ 50ppm), P_2 (GA_3@100 ppm),P_3(GA_3@150ppm),P_4(NAA@50ppm),P_5(NAA@100ppm) andP_6(NAA@150ppm). Inorganic fertilizers were applied at 20 days and PGRs as foliar spray at 30 and 60 days after stecklings transplanting.The experiment was conducted in RBD (Factorial) and replicated thrice. the combinedeffect of inorganic fertilizersand Plant growth regulators F_2P_3significantly gave maximum diameter of pod (7.64 mm), length of pod (56.61mm), number of seeds/pod (6.18), 1000- seedweight (15.12g) and seedyield (18.23q/ha) and plant height is non-significant.The treatment combination F_3P_6 gave the maximum number of branches (8.06). Hence, F_2P_3 treatment combination is a best combination for seed yield of radish and enhancing seed yield is our ultimate goal. As we performed the study in a particular location, we recommend multilocation (multiplication)trials in different agro-climatic regions to study and final confirmation of the results.

Keyword: radish, seed, PGRs, inorganic fertilizer, steckling, transplanting

1. INTRODUCTION

Among the root vegetables, radish (*Raphanussativus* L.) is an ancient as well as popular vegetable of tropical and temperate regions and can be cultivated extensively in almost all seasons of the year. KashiShweta is a popular cultivated variety suitable for tropical conditions. It is considered to be the native of China and India. It is grown for its pungent taste and flavour and considered as an appetizer. The characteristic pungent flavour of radish is due to the volatile isothiocyanates (trans-4- methyl- thibutenyl -isothiocyanate). The tender leaves are also cooked and eaten as vegetable. It is a nutritious vegetable providing a good source of carbohydrates, protein and vitamins A, B &C(Bakhsh*et al*. 2006). The seed yield of radish depends on variety, cultivation methods, climatic conditions, soil, fertilizer, PGRs as well as edaphic factors etc. The seed quality of radish is also an important factor for higher yield of the crop and seed production of this crop is also considered a crucial problem for radish improvement and development. Amongst these, good quality seed is the most important and critical input. In most of the vegetable crops, the seed is an insignificant item in the total cost of production but the efficiency of other costlier inputs like fertilizer, irrigation, herbicides, insecticides, fungicides, harvesting and processing revolves around the use of good quality seed. The use of poor quality of seed is the major factor for low production of vegetable crops.Among the major essential nutrients were required by the plants for their normal growth and yield.Further it has been observed that farmers usually use urea only as chemical fertilizer without addition of phosphatic and potassic fertilizer, for sustainable cropping system balanced use of nutrients is essential (Mishra & Das, 2014). The role of nitrogen is acceptable as it is a necessary component of protein, nucleic acids, chlorophyll and certain important enzymes (Pervez et al. 2004).The excessive use of nitrogen negatively affects the quality as well yield of crops (Chen et al. 2004). Keeping this point in view, the present investigation was carried out during the rabi season 2022- 23 to study the effect of PGRs and levels of fertilizer on the seed yield of radish cv. KashiShweta at Bihar Agricultural University, Sabour, Bhagalpur.

2. MATERIAL AND METHODS

Field investigations were undertaken at vegetable seed production plot, department of Horticulture (Vegetable & Floriculture), BAC, Sabour Bhagalpur during the rabi season 2022-23. The variety KashiShweta was used for this study. Agronomic practices are followed as per the package of practices. The experiment consisted of four levels of fertilizers *viz,* (F_0-control, F_1-N40:P30:K40, F_2-N60:P40:K50,& F_3-N8P50:K50) as well as seven levels of PGRs *viz,* P_0 (Control), P_1 (GA_3 @ 50ppm), P_2 (GA_3@100 ppm),P_3(GA_3@150ppm),P_4(NAA@50ppm),P_5(NAA@100ppm) andP_6(NAA@150ppm). Total of 28 treatment combinations were tried in RBD (Factorial) and replicated thrice in a plot size of 2.50 x 1.80 m for each treatment. The treatments were required as per the plan. The observations on plant growth, seed yield and quality components were recorded for the net plot. After the harvest of the crop, recorded on seed yield components like diameter of pod (mm), length of pod (mm), number of seeds/pod, 1000- seed weight (g) and seed yield (q/ha) were recorded. Statistical analysis were performed by following the method of Panse and Sukhatme (1984).

3. RESULTS AND DISCUSSION

Plant height is closely related to growth and development of the plant. The maximum plant height (163.42cm) was recorded with the application of P_3 (GA_3@150 ppm). The increase in plant height might be due to cellelongation and make the plant taller. Similar results were also found by Haokip*et al.* (2016)and Shruthi*et al*. (2016) in carrot. Among different levels of nutrients at maturity stage, the maximum plant height (177.85 cm)) was recorded in F_3 (N80: P50: K60) which was found significantly superior to the rest of the nutrients levels. This could mightbe due to sufficient supply of NPK combined with maximum photosynthetic activity, resulting in rapid vegetative growth, physiologically healthier and strong plant morphology. This result was also supported by the earlier findings of Malek*et al*., (2010) in carrot and Panwar*et al*. (2001) in radish. Whereas (?) interaction effect was found non-significant over plant height.

Number of branches/plant was found significantly higher in plants sprayed with NAA as compared to GA_3 and maximum number of branches per plant (6.96) was recorded with the foliar application of P_6 (NAA @ 150 ppm). The increase in the number of branches due to auxin NAA treatment may be attributed to the activation of cell division and cell elongation in the auxiliary bud, which had a promoting effect on number of branches. The result of the present investigation in terms of number of branches are similar with the result of Meena and Malhotra (2006), Kurmi*et al.* (2019) and Yugandhar*et al.* (2016) in coriander. The highest number of branches (6.81) was found at fertility level F_3 (N80: P50: K60). This might be due to an adequate supply of NPK associated with high photosynthetic activity leading to vigorous vegetative growth, physiologically high stout and healthy plant morphology. Similar results were reported by Haokip*et al.* in carrot. (2016), Sharma and Lal (1994) in radish. The interaction effect of different levels of nutrients and plant growth regulators on number of branches was also found significant. The maximum number of branches (8.06) was recorded in F_3P_6 (N80: P50: K60+NAA @150 ppm). The number of branches increased due to proper supply of NPK as well as suppression of apical dominance due to spraying of NAA which diverts the polar transport of auxin towards the basal buds that leads to increase in the number of branches/plants.

The effect of different levels of fertilizers on diameter and length of pod was found significant. The maximum diameter (6.58mm) and length(45.24mm) of pod were recorded in F_2(N60: P40: K50). The reason for increase in pod length and pod diameter is that with high NPK doses plants got more nutrition and other favourable conditions like more water, more air etc. for growth, hence more vigorous plants. These results are in agreement with the findings of Sandhu*et al*. (1965), Mehla*et al*. (1987) in radish. The use of GA_3 could bring significant increment in length and diameter of pods. The maximum length (49.30 mm) and diameter (6.42 mm) of pod were associated with foliar application of GA_3 (P_3) which proved its superiority over other concentrations of GA_3. The increase in length and pod diameter may be attributed to increase in the number of cells as well as elongation of cells which is characteristic action of GA_3. These results are supported by Shruthiet. al. (2016) in radish and Alagukanna and Kumar (2003) in fenugreek (test?, trial?, experiment?).

Number of seeds per pod influenced significantly due to the different levels of fertilizer. Among the different levels of fertilizer, maximum number of seeds per pod (5.44) was found in F_2 (N60:P40:50). This could be due to an adequate supply of fertilizer to the root zone which increased the length and diameter of pods. Similar results were observed by Panwar*et. al* (2001). Among the different levels of PGRs, maximum number of seeds per pod (5.60) was recorded in P_3 (GA_3 @ 150 ppm). This might be due to spray of GA_3 results in improved photosynthesis, vegetative growth and mobilization of photosynthates(photosynthetic) towards reproductive site which finally increase the number of seed per plant. Similar results were observed by Haokip*et al*. (2016).

The different levels of fertilizer have a significant effect on 1000 seed weight. The maximum 1000 seed weight (13.32g). was observed F_2(N60:P40:K50). The increase in 1000 seed weight due to the application of NPK may be due to the fact that NPK helps in protein synthesis and ultimately increases the plumpness of the grain and hence, the greater supply of NPK must have resulted in bolder seeds having greater 1000seed weight. Similar findings were also found by Rastogi*et al.* (1987),Shukla*et al*. (2012) and Shukla*et al.* (2013) in radish.Maximum 1000 seed weight (13.84g) was observed in P_3 (GA_3 @ 150 ppm). This might be due to enhanced physiological activities like photosynthesis, translocation of fertilizer and photosynthates (Saxena, 1989). Similar results were observed by Malek*et al.* (2011) in carrotand Alagukanna& Kumar (2003) in fenugreek. The interaction effect between nutrients and PGRs was also found significant. The maximum (15.12g) 1000 seed weight was recorded in F_3P_3(N80: P50 : K60+ GA_3 @ 150 ppm). This might be due to enhanced physiological activities like photosynthesis, translocation of fertilizer and photosynthates (Saxena, 1989).

The maximum seed yield (14.01q/ha) was associated with foliar application of GA_3@150 ppm (P_3) which proved its superiority over other concentrations of GA_3 and NAA.Similar results were recorded by Malek*et al.* (2011) in carrot, Panwar et al. (2001),Mohanta et al. (2015). The highest seed yield (q/ha) was recorded at F_2 (N60:P40:K50) and found significantly superior to the rest of the levels. The increase in seed yield (q/ha) may be attributed to increased number of branches per plant along with an increased number of pods, more number of seeds per pod, and maximum weight of pods per plant which favourably resulted in maximum seed yield (q/ha). Similar results were obtained by Shukla et al. (2012), Shukla et al. (2013).

Table 1: Effect of different levels of chemical fertilizer (F) and PGRs (P) on plant height

Treatment	Control (P_0)	GA_3@50 ppm (P_1)	GA_3@100 ppm (P_2)	GA_3@150 ppm (P_3)	NAA@50 ppm (P_4)	NAA@100 ppm (P_5)	NAA@150 ppm (P_6)	Mean
Control	114.28	118.68	121.85	125.38	116.76	119.81	122.96	119.96
N40:P30:K40 Kg/ha (F_1)	148.24	153.65	157.78	160.92	150.82	155.36	158.70	155.07
N60:P40:K50 Kg/ha (F_2)	164.86	171.56	176.70	181.26	168.72	172.65	177.18	173.28
N80:P50:K60 Kg/ha (F_3)	168.56	175.65	179.48	186.12	173.21	179.08	182.86	177.85
Mean	148.99	154.89	158.95	163.42	152.38	156.73	160.43	
	F	P	FXP					
CD (*P* = .05)	5.05	6.69	NS					
CV %	5.22							

Table 2: Effect of different levels of chemical fertilizer (F) and PGRs (P) on number of branches/plant.

Treatment	Control (P_0)	GA_3@50 ppm (P_1)	GA_3@100 ppm (P_2)	GA_3@150 ppm (P_3)	NAA@50 ppm (P_4)	NAA@100 ppm (P_5)	NAA@150 ppm (P_6)	Mean
Control	2.52	3.84	4.20	4.68	4.81	5.08	5.48	4.37
N40:P30:K40 Kg/ha (F_1)	4.22	4.61	5.04	5.62	5.78	6.10	6.58	5.42
N60:P40:K50 Kg/ha (F_2)	4.93	5.38	5.88	6.56	6.74	7.45	7.68	6.37
N80:P50:K60 Kg/ha (F_3)	5.49	5.54	6.62	7.52	6.98	7.45	8.06	6.81
Mean	4.29	4.84	5.44	6.09	6.08	6.52	6.95	
	F	P	FXP					
CD (*P* = .05)	0.18	0.24	0.49					
CV %	5.21							

Table 3: Effect of different levels of chemical fertilizer (F) and PGRs (P) on diameter of pods (mm)

Treatment	Control (P_0)	GA_3@50 ppm (P_1)	GA_3@100 ppm (P_2)	GA_3@150 ppm (P_3)	NAA@50 ppm (P_4)	NAA@100 ppm (P_5)	NAA@150 ppm (P_6)	Mean
Control	4.10	4.32	4.48	4.81	4.08	4.32	4.72	4.40
N40:P30:K40 Kg/ha (F_1)	4.80	5.75	5.98	6.12	5.65	5.78	5.96	5.72
N60:P40:K50 Kg/ha (F_2)	5.82	6.28	6.75	7.64	5.96	6.46	7.12	6.58
N80:P50:K60 Kg/ha (F_3)	5.56	6.12	6.34	7.10	5.88	6.12	4.40	5.93
Mean	5.07	5.62	5.89	6.42	5.39	5.67	5.55	

	F	P	FXP	
CD (*P* = .05)	0.24	0.32	0.64	
CV %	7.00			

Table 4: Effect of different levels of chemical fertilizer (F) and PGRs (P) on length of pods (mm)

Treatment	Control (P_0)	GA_3@50 ppm (P_1)	GA_3@100 ppm (P_2)	GA_3@150 ppm (P_3)	NAA@50 ppm (P_4)	NAA@100 ppm (P_5)	NAA@150 ppm (P_6)	Mean
Control	25.40	26.38	35.17	42.56	25.42	30.19	38.32	31.92
N40:P30:K40 Kg/ha (F_1)	26.49	28.32	40.30	46.65	29.18	32.24	41.36	34.93
N60:P40:K50 Kg/ha (F_2)	35.26	42.31	46.55	56.61	40.78	44.50	50.64	45.24
N80:P50:K60 Kg/ha (F_3)	32.30	38.30	44.22	51.36	37.35	41.37	48.45	41.91
Mean	29.86	33.83	41.56	49.30	33.18	37.08	44.69	
	F	P	FXP					
CD (*P* = .05)	1.08	1.43	2.87					
CV %	4.55							

Table 5: Effect of different levels of chemical fertilizer (F) and PGRs (P) on number of seeds /pod

Treatment	Control (P_0)	GA_3@50 ppm (P_1)	GA_3@100 ppm (P_2)	GA_3@150 ppm (P_3)	NAA@50 ppm (P_4)	NAA@100 ppm (P_5)	NAA@150 ppm (P_6)	Mean
Control	3.49	3.96	4.02	4.58	3.86	4.08	4.48	4.07
N40:P30:K40 Kg/ha (F_1)	4.09	4.56	5.12	5.58	4.18	5.21	5.12	4.84
N60:P40:K50 Kg/ha (F_2)	4.70	5.01	6.02	6.18	5.07	5.32	5.78	5.44
N80:P50:K60 Kg/ha (F_3)	4.45	5.06	5.58	6.07	4.75	5.16	5.60	5.24
Mean	4.19	4.65	5.19	5.60	4.46	4.94	5.25	
	F	P	FXP					
CD (*P* = .05)	0.14	0.18	0.37					
CV %	4.72							

Table 6: Effect of different levels of chemical fertilizer (F) and PGRs (P) on 1000-seed weight

Treatment	Control (P_0)	GA_3@50 ppm (P_1)	GA_3@100 ppm (P_2)	GA_3@150 ppm (P_3)	NAA@50 ppm (P_4)	NAA@100 ppm (P_5)	NAA@150 ppm (P_6)	Mean
Control	10.46	10.84	11.15	11.73	10.75	11.04	11.50	11.07
N40:P30:K40 Kg/ha (F_1)	10.92	12.05	12.75	13.41	11.70	12.14	13.02	12.28
N60:P40:K50 Kg/ha (F_2)	11.60	12.49	13.94	15.12	12.38	13.17	14.56	13.32
N80:P50:K60 Kg/ha (F_3)	11.32	12.35	13.28	15.09	11.78	12.88	13.92	12.95
Mean	11.08	11.93	12.78	13.84	11.65	12.31	13.25	
	F	P	FXP					
CD (*P* = .05)	0.34	0.45	0.90					
CV %	4.45							

Table 7: Effect of different levels of chemical fertilizer (F) and PGRs (P) on seed yield (q/ha)

Treatment	Control (P_0)	GA_3@50 ppm (P_1)	GA_3@100 ppm (P_2)	GA_3@150 ppm (P_3)	NAA@50 ppm (P_4)	NAA@100 ppm (P_5)	NAA@150 ppm (P_6)	Mean
Control	5.12	6.06	7.07	7.68	5.89	6.91	7.44	6.60
N40:P30:K40 Kg/ha (F_1)	7.21	9.70	11.47	12.29	9.42	11.06	11.90	10.44
N60:P40:K50	10.48	14.62	17.20	18.23	14.13	16.59	17.85	15.59

Kg/ha (F_2)								
N80:P50:K60 Kg/ha (F_3)	9.92	14.07	16.63	17.82	13.66	16.07	17.25	15.06
Mean	8.18	11.11	13.09	14.01	10.78	12.66	13.61	
	F	P	FXP					
CD (*P* = .05)	0.59	0.78	1.57					
CV %	8.07							

4. Conclusion

Therefore, it may be concluded that the combined effect of PGRs and chemical fertilizer gave significant effect on vegetative growth and yield attributing traits for seed production of radish. The application of inorganic fertilizer @ 60:40:50 kg NPK/ha along with foliar spray of GA3 @ 150ppm at 30 & 60 days after stecklings transplanting was found most outstanding for getting higher seed yield, net return with higher benefit-cost ratio and seed yield of radish**.**

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