Effect of Organic and Inorganic Fertilizers on Growth, Yield and Quality of Radish (*Raphanus sativus* L.) cv. Pusa Himani

ABSTRACT

In this report, we compared the integrated effect of FYM, vermicompost, and poultry manure with inorganic fertilizers incorporated with PSB for yield in radish cv. Pusa Himani in response to morphological, yield as well as quality attributes. As per data analysis, T_6 [NPK (75%) + vermicompost (25% of N) + PSB] significantly enhanced the highest plant height, leaf length, number of leaves per plant, fresh weight of shoot and dry weight of shoot at 20 DAS, 40 DAS and at harvest, respectively. Similarly, at harvest maximum root length, maximum root diameter, maximum average weight of root, maximum yield per hectare, minimum days to harvest and quality parameters *i.e.* T.S.S., ascorbic acid, chlorophyll content of leaves, net return and B-C ratio in comparison to all concentration with all integrated nutrient combination. So, we may conclude that [NPK (75%) + vermicompost (25% of N) + PSB] increase yield by stimulating source activity as well improves utilization of PGR (plant growth regulators).

Keywords: Radish, FYM, vermicompost, poultry manure, PSB, inorganic fertilizers.

1. INTRODUCTION

Balanced use of fertilization is an essential requirement to improve the productivity of crop (Shukla *et al*., 2013). In recent years, the use of organic manure such as FYM, vermicompost, neem cake and poultry feed is required for supplementing the nutrients. Although, organic manures are slow in releasing nutrients, improve the soil texture binding with soil aggregates. It enhances CEC, water-holding capacity and phosphate availability (Talashilkar*et al.*, 1999). Moreover, nowadays poultry wasteis also recognized as a valuable source of plant nutrients for all crops. Its addition into the soil improves soil physical properties such as bulk density, water holding capacity and percent water stable aggregation (Weil and Kroontje, 1979). Further Shilpa *et al.,* 2023 reported that Phosphate solubilizing bacteria (PSB) are beneficialbacteria capable of solubilizing inorganic phosphorus from insoluble compounds. Several studies reported that the combined use of organic, biofertilizers along with inorganic for cauliflower significantly increases growth and yield (Choudhary *et al*., 2004); Similarly, the combined used of vermicompost (50%) along with poultry (50%), FYM (50%) was highly beneficial to increase growth and yield of radish cv. Pusa Desi.(Singh *et al*., 2016); Mishra *et al.* 2014 reported that NPK (150:38:63 kg ha^{-1}) along with 2.5 t ha^{-1} each of Azotobacter, Azospirillum and PSB significantly increased yield and quality of knol-knol. Further, integrated nutrient management applied as soil application has shown efficiency in increasing yield in many crops along with quality(Meena *et al.,* 2014 in tomato;Patel *et al.*, 2023 of radish; Kaur *et al.*, 2023 of radish; Kumar *et al.*, 2019 of radish; Yadav *et al.*, 2018 of radish; Sentiyangla*et al.*, 2010 of radish).

Keeping in view, the present study was conducted on radish (*Raphanus sativus* L.) cool season root crop. It is rich source of Ca, K and P. Radish roots are said to be useful in urinary complaints, piles

and in gastrodynia and also it is considered as an appetizer. The strong flavour of radish is due to volatile isothiocyanates (trans-4-methyl-thibutenyl-isothiocyanate). Radish is a good source of vitamin-C (ascorbic acid), containing 15-40 mg per 100 g of edible portion and supplying a variety of minerals. The leaves of radish are a good source for the extraction of protein on a commercial scale. (Kumar *et al.,* 2014). Therefore, keeping in the above facts, an experiment on the effect of organic and inorganic fertilizers on growth, yield and quality of radish cv. Pusa Himani under Udaipur condition.

2. MATERIAL AND METHODS

2.1. Materials

Seed of cv. Pusa Himani of radish was purchased from Sudharshan beej bhandar Udaipur. FYM (farm yard manure), vermicompost and poultry manure was purchase from Department of Animal Husbandry, RCA, MPUAT, Udaipur. Biofertilizer, PSB was procured from Department Soil Science, RCA, MPUAT, Udaipur. Reagents for quality analysis were procured from Hi Media and SiscoResearch Laboratory, Mumbai (India).

2.2. Experimental detail

The study was conducted at Horticulture farm, Department of Horticulture, Rajasthan College of Agriculture, MPUAT, Udaipur (at an altitude of 562.8 meters above mean sea level, at 24˚35' N latitude and 74˚42' E longitude) during December 2023 - May 2024. Before layout, the experiment Soil characteristics were studied*i.e.* texture of soil (clay), pH (7.34) and with organic carbon content (0.6%). Initial, available N, P and K level in the soil was 194.8, 17.1 and 255.3 kg ha^{-1}, respectively. The experiment was laid under a randomized block design having 10 treatments with three replications. The treatments details were**T_1**- RDF (100 kg N, 80 kg P_2O_5, 50 kg K_2O $ha^{-1)}$, **T_2**- 100% N through FYM, **T_3**- 100% N through Vermicompost, **T_4**- 100% N through Poultry manure, **T_5**- 75% NPK + 25% N through FYM + PSB, **T_6**- 75% NPK + 25% N through Vermicompost + PSB, T_7- 75% NPK + 25% N through Poultry manure + PSB, **T_8**- 50% NPK + 50% N through FYM + PSB, **T_9**- 50% NPK + 50% N through Vermicompost + PSB, **T_{10}**- 50% NPK + 50% N through Poultry manure + PSB.

The Radish (cv. Pusa Himani) seeds with a seed rate of 10 kg ha^{-1} were sown on 18th December 2023 in plot size of 2.4 m × 1.2 m. The distance between row to row and plant to plant was kept as 40 cm × 10 cm. Nitrogen was applied in the form of urea, phosphorus in the form of single super phosphate and potash in the form of muriate potash as per treatment. The entire quantity of phosphorus and potash and half dose of nitrogen were applied as basal dressing at the time of sowing, remaining half dose of nitrogen was applied after 30 days of sowing. PSB @ 4 kg ha^{-1} were applied in rows before sowing the seeds.

Standard package of practices was adopted, and sufficient irrigation was applied to maintain a continuous supply of moisture throughout the root zone. Observations were recorded on selected five tagged plants of each treatment and further analysed.

2.3 Evaluation of growth, yield and quality attributes

Growth parameters of radishwere recorded from five selected plant from each plot at 20 days after sowing, 40 days after sowing and at harvest. Plant height (cm), leaf length (cm) were measured by scale from the ground level to the top of the plant. Number of leaves plant^{-1}was counted visually. Fresh weight (g) of shoot was weighed with weighing balance. Dry weight (g) of shoot was recorded when after taking fresh weight, plants were dried in sun for 72 sunshine hrs and then in hot air oven at 65 ^{0}C temperature till constant weight. Yield parameters *viz.* root diameter (cm)was taken at the harvesting stage by using vernier caliper. Average weight of root (g plant^{-1}) was weighed with weighing at harvesting stage. Root yield per hectare (q) was recorded after cutting the leaves, roots were weighed on digital balance and root yield per net plot was recorded in kilogram which was converted into quintal hectare^{-1} as given below:

$$\text{Root yield (q ha}^{-1}\text{)} = \frac{\text{Root yield (kg plot}^{-1}\text{)} \times 10{,}000}{\text{Net area of plot (m}^2\text{)} \times 100}$$

Quality parameters *viz.* T.S.S. (^{0}B) was determined by using “Pocket Refractometer” of 0-53 per cent range at room temperature and values obtained were corrected at 20 °C (A.O.A.C, 1995). The Ascorbic acidwas estimated by the method described by Ranganna (1977). It was calculated using following formula:

$$\text{Ascorbic acid (mg 100 g}^{-1}\text{)} = \frac{\text{Titre (ml)} \times \text{Dye factor} \times \text{Volume made up (ml)}}{\text{Aliquat (ml) taken for estimation} \times \text{Volume of pulp (ml)}} \times 100$$

The chlorophyll content was estimated by the method described by (Arnon, 1949). The expression of total chlorophyll was measured at Spectronbic -20 (652 nm) and was calculated with the help of following formula:

$$\text{Total chlorophyll (mg g}^{-1}\text{ fresh weight)} = \frac{A\,(652) \times 29 \times \text{Total volume (ml)}}{\alpha \times 1000 \times \text{Weight of sample (g)}}$$

Where, α is the path length = 1 cm.

Net return was calculated after harvesting on the basis offollowing formula was used to estimate the net returns:

Net Return (₹ Plant^{-1}) = Gross return – Cost of cultivation

Benefit Cost ratiowas used to compute each treatment's B-C ratio in order to determine its economic feasibility.

$$\text{B-C ratio} = \frac{\text{Net return (₹ ha}^{-1})}{\text{Cost of cultivation (₹ ha}^{-1})}$$

2.4 Statistical analysis

Statistically analysis of the data was done throughthe method given byPanse and Sukhatme (1985)for drawing inferences. Wherever, the results were found significant, critical differences (CD) were computed at 5% level of significance.

3. RESULTS AND DISCUSSION

3.1. Influence of organic and inorganic fertilizer on growth parameters of radish cv. Pusa Himani

The results of the present investigation revealed that there was a significant difference on the vegetative growth parameters, *viz.*, plant height, leaf length, number of leaves per plant, fresh weight of shoot and dry weight of shoot (Table 1 and Table 2). The results showed that higher plant height (11.11cm, 27.64 cm and 35.79 cm), highest leaf length (10.30 cm, 25.06 cm and 30.95 cm), maximum number of leaves per plant (4.73, 10.27 and 13.53), maximum fresh weight of shoot (88.74 g, 157.20 g and 215.90 g) and maximum dry weight of shoot (8.22 g, 10.22 g and 17.46 g) at 20 DAS, 40 DAS and at harvest, respectively were reported for treatment T_6 [NPK (75%) + vermicompost (25% of N) + PSB] as compared to RDF. The probable reason for the increase in height of plant may be due to the combination of inorganic fertilizers with organic manures which increases the cation exchange capacity and water holding capacity. Vermicompost's nitrification inhibitory properties and improved soil structure in soil could also be associated with the increased plant height. The results corroborate the findings of Bhattari and Maharjan (2013). higher number of leaves and leaf length enhances the photosynthesis and accumulation of metabolites in plants. Thus, enriching the available nutrient pool of the soil due to the combined effect of slow release of nutrients through vermicompost and nitrogen availability through inorganic fertilizers, results in more number of leaves plant^{-1} and higher leaf length. The result obtained is in harmony with the results of Kumar *et al.* (2014) and Kushwah*et al.* (2020). Application of vermicompost enhanced the vegetative growth of radish and also stimulated the supply of plant nutrients during the course of microbial decomposition and enabled the crop to utilize nutrients and water more efficiently. It also releases macro and micronutrients during microbial decomposition which ultimately improves the vegetative growth. These observations were shown to be similar with that of an investigation conducted by Subedi *et al.* (2018), Meena *et al.* (2022), Kaur *et al*. (2023) and Balbande*et al*. (2023) on radish.

3.2. Influence of organic and inorganic fertilizer on yieldattributes of radish cv. Pusa Himani

It is evident from the data analysed in Table 3 that the application of vermicompost and PSB in combination with different levels of inorganic fertilizers significantly increased the yield parameters. At harvest, the maximum values of yield attributes *i.e*. root length (26.07 cm), root diameter (3.68 cm), minimum days to harvest (56.93), the average weight of root (118.07 g) and root yield (286.98 q ha^{-1}) were observed with the application of T_6[NPK (75%) + vermicompost (25% of N) + PSB]. The increase in all these yield attributes may be due to higher level of nitrogen from vermicompost and biofertilizers along with the reduced quantity of RDF. The feasible reason for the increase in root length, root weight and root diameter may be due to the decrease in bulk density and increase in porosity and water-holding capacity of the soil due to organic manures. It may be also due to the solubilization of plant nutrients by the addition of poultry manure and vermicompost leading to increased uptake of NPK. The results are also in agreement with the earlier findings by Randy (2016), Kushwah*et al.* (2020) and Kaur *et al*. (2023).

3.3. Influence of organic and inorganic fertilizer on quality attributes of radish cv. Pusa Himani

It is evident from the data analyzed in Table 4 that the application of vermicompost and PSB in combination with different levels of inorganic fertilizers significantly increased the following quality parameters *i.e*. ascorbic acid (13.9 mg 100 g^{-1}) and chlorophyll content of leaves (0.87 mg g^{-1} fresh weight) were observed with the application of T_6[NPK (75%) + vermicompost (25% of N) + PSB]. While, there was no significant increase in T.S.S. of radish cv. Pusa Himani. The improvement in physico-chemical properties of radish might be due to the fact that organic manures and bio-fertilizers are capable of supplying adequate macro and micro plant nutrients which plays a major role in quality improvement through desirable enzymatic changes taking place during growth. Bio-fertilizers enhanced the photosynthetic and metabolic activities resulting in the synthesis of higher amount of acids, metabolites and glucose. The produced reserves may contribute to the synthesis of chlorophyll content of leaves and ascorbic acid (Kumaran *et al.*, 1998).Barea *et al.* (1976) also had a similar opinion that the quality attributes improved due to higher photosynthetic rate with better source-sink relationship and nutrient uptake besides excellent physiological and biochemical activities. The results are in confirmation with the findings of Tripathi *et al*. (2017), Khede*et al.* (2019), Kushwah*et al.* (2019) and Kaur *et al.* (2023) in radish.

3.4. Influence of organic and inorganic fertilizer on the economic feasibility of radish cv. Pusa Himani

The regional adaptability of any agronomic practice in the cultivation of any crop is completely based on maximum economic value of treatments. Based on the cost analysis, highest net profit of Rs. 153479 ha^{-1} and maximum B-C ratio (3.24) was recorded with treatment T_6[NPK (75%) + vermicompost (25% of N) + PSB]. In the present investigation, supplementation of radish with organic fertilizers along with bio-fertilizer resulted in higher growth and yield parameters. Therefore, to produce a sustainable higher yield of radish it is recommended to make use of 25% N through Vermicompost and PSB @ 4 kg

ha^{-1} along with 75% NPK to enhance growth, yield and quality in addition to improving soil fertility in radish cultivation. The present findings are supported by Bairwa *et al.* (2009) in okra, Umrao *et al.* (2013) in garlic, Vithwel and Kanaujia (2013) in carrot and Jadhav *et al*. (2014) in radish.

4. CONCLUSION

On the basis of results obtained in the present investigation "Effect of Organic and Inorganic Fertilizers on Growth, Yield and Quality of Radish (*Raphanus sativus* L.) cv. Pusa Himani" it could be concluded that among the different treatments used, treatment T_6[NPK (75%) + vermicompost (25% of N) + PSB] proved the most beneficial for most of parameters studied *viz.,*plant height, leaf length, number of leaves per plant, fresh weight of shoot, dry weight of shoot (at 20 DAS, 40 DAS and at harvest), root length, root diameter, days to harvest, the average weight of root, root yield quintal per hectare, T.S.S., ascorbic acid, chlorophyll content of leaves, net return and B-C ratio.

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Table 1: Effect of organic and inorganic fertilizers with PSB on plant height (cm), leaf length and number of leaves per plant of radish cv. Pusa Himani

Treatments	Plantheight(cm)			Leaf length (cm)			Number of leaves plant^{-1}		
	20 DAS	40 DAS	at harvest	20 DAS	40 DAS	at harvest	20 DAS	40 DAS	at harvest
T_1	10.31	25.15	33.25	8.95	21.23	27.54	3.80	9.27	11.20
T_2	9.10	21.94	28.92	8.05	18.88	26.57	3.47	8.60	10.73
T_3	10.03	23.58	30.05	8.64	20.47	27.45	3.73	8.93	11.00
T_4	9.31	22.98	29.93	8.33	20.14	27.12	3.67	8.73	10.93
T_5	10.34	26.24	34.04	9.34	23.72	28.96	4.27	9.53	12.07
T_6	11.11	27.64	35.79	10.30	25.06	30.95	4.73	10.27	13.53
T_7	10.74	26.97	34.93	9.76	24.80	29.49	4.47	9.73	12.80
T_8	9.53	22.86	31.67	8.92	22.78	27.98	3.87	9.27	11.40
T_9	10.21	25.08	33.43	9.32	23.46	28.65	3.93	9.46	12.00
T_{10}	10.09	24.43	32.60	9.02	23.21	28.30	4.07	9.33	12.07
S.Em. ±	**0.36**	**0.60**	**0.85**	**0.35**	**0.44**	**0.82**	**0.15**	**0.28**	**0.17**
CDat5%	**1.05**	**1.76**	**2.50**	**1.04**	**1.30**	**2.39**	**0.45**	**0.83**	**0.50**

Table 2: Effect of organic and inorganic fertilizers with PSB on dry weight (g) and fresh weight (g) of shoot of radish cv. Pusa Himani

Treatments	Dry weight (g) of shoot			Fresh weight(g) of shoot		
	20 DAS	40 DAS	at harvest	20 DAS	40 DAS	at harvest
T_1	7.39	8.60	15.65	79.92	142.69	201.68
T_2	6.50	7.90	14.70	76.02	135.34	195.35
T_3	7.01	8.24	15.10	78.01	137.06	196.88
T_4	6.88	8.12	14.86	77.79	136.49	196.46
T_5	7.96	9.23	16.66	81.12	147.57	207.42
T_6	8.22	10.22	17.46	88.74	157.20	215.90
T_7	8.01	9.98	17.05	85.61	153.13	209.91
T_8	7.65	8.67	15.37	77.25	140.79	200.18
T_9	7.87	9.18	16.05	80.10	147.38	206.81
T_{10}	7.74	8.89	15.76	79.35	145.88	203.51
S.Em. ±	**0.29**	**0.38**	**0.54**	**2.36**	**3.73**	**3.22**
CDat5%	**0.86**	**1.12**	**1.59**	**6.92**	**10.95**	**9.44**

Table3: Effect of organic and inorganic fertilizers with PSB on yield parameters of radish cv. Pusa Himani

T. No.	Treatment details	Root length (cm)	Root diameter (cm)	Days to harvest	Average weight of root (g)	Root yield (q ha^{-1})
T_1	RDF (100 kg N, 80 kg P_2O_5, 50 kg K_2O $ha^{-1)}$	22.64	3.21	57.47	100.41	244.06
T_2	100% N through FYM	20.14	2.73	59.93	87.68	213.11
T_3	100% N through Vermicompost	21.56	2.85	59.20	96.80	235.27
T_4	100% N through Poultry manure	21.07	2.81	59.47	92.21	224.12
T_5	75% NPK + 25% N through FYM + PSB	25.12	3.21	57.27	110.23	267.91
T_6	75% NPK + 25% N through Vermicompost + PSB	26.07	3.68	56.93	118.07	286.98
T_7	75% NPK + 25% N through Poultry manure + PSB	25.78	3.42	57.07	115.12	279.80
T_8	50% NPK + 50% N through FYM + PSB	23.45	2.88	58.40	99.50	241.85
T_9	50% NPK + 50% N through Vermicompost + PSB	24.12	3.19	57.80	105.14	255.54
T_{10}	50% NPK + 50% N through Poultry manure + PSB	23.98	2.98	58.27	102.45	249.01
	SE(m) ±	**0.53**	**0.17**	**0.75**	**3.26**	**4.95**
	C.D. (P=0.05)	**1.54**	**0.51**	**2.20**	**9.57**	**14.53**

Table4 Effect of organic and inorganic fertilizers with PSB on quality attributes and B-C ratio of radish cv. Pusa Himani

T. No.	Treatment details	T.S.S. (^{0}Brix)	Ascorbic acid (mg 100g^{-1})	Chlorophyll content of leaves (mg g^{-1} fresh weight)	Net returns (Rs. ha^{-1})	B-C ratio
T_1	RDF (100 kg N, 80 kg P_2O_5, 50 kg K_2O ha$^{-1)}$	4.81	12.57	0.73	128003	2.99
T_2	100% N through FYM	4.71	11.93	0.66	75678	1.03
T_3	100% N through Vermicompost	4.75	12.10	0.68	101189	1.59
T_4	100% N through Poultry manure	4.73	12.00	0.69	88385	1.29
T_5	75% NPK + 25% N through FYM + PSB	4.98	13.60	0.78	137632	2.76
T_6	75% NPK + 25% N through Vermicompost + PSB	5.02	13.90	0.87	153479	3.24
T_7	75% NPK + 25% N through Poultry manure + PSB	4.99	13.80	0.85	147204	3.03
T_8	50% NPK + 50% N through FYM + PSB	4.82	12.53	0.70	111525	1.93
T_9	50% NPK + 50% N through Vermicompost + PSB	4.92	12.80	0.77	126108	2.39
T_{10}	50% NPK + 50% N through Poultry manure + PSB	4.87	12.63	0.73	119038	2.15
	SE(m) ±	**0.105**	**0.194**	**0.032**		
	C.D. (P=0.05)	**NS**	**0.569**	**0.095**		

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