Influence of organic manure and inorganic fertilizers on growth and yield of Radish (*Raphanus sativus* L.) in Gird region of Madhya Pradesh, India

ABSTRACT

A field experiment was conducted to study the effect of organic manure and inorganic fertilizers on growth and yield of Radish (*Raphanus sativus* L.) in Grid region of Madhya Pradesh as factorial based on the randomized block design(RBD) with three replication and Ten treatments viz., T_1-(100% NPK through inorganic sources), T_2-(100% NPK through Farm Yard manure (16t/ha)), T_3-(100% NPK through Vermicompost (12t/ha)), T_4-(100% NPK through Poultry Manure (9.48t/ha)), T_5-(75% NPK+25%N through FYM), T_6-(75% NPK+25% N through Vermicompost), T_7-(75% NPK+25% N through Poultry manure), T_8-(50% NPK+50% N through FYM), T_9-(50% NPK+50% N through Vermicompost), T_{10}-(50% NPK+50% N through Poultry manure) were made up of single variety Ivory white the experiment was planted in the CRC-II, School of agriculture, ITM University Gwalior. At all of the periodic crop growth phases except at 15 DAS, T_6 showed significant plant height and leaf count increases across crop phases. T_5, T_6 had maximum heights; T_3, T_{10} had minimum. T_5, T_6, T_8 displayed the highest leaf counts; T_1 the least. Leaf lengths followed a similar trend, with T_8, T_6 having the longest; T_1 the shortest. Overall, T_6 exhibited prominent growth in both height and leaf attributes, while T_1 consistently showed the lowest values throughout all stages and measurements. The conventional practices T_6 had significant positive influence on yield and yield attributing parameters, viz; root length (35.05cm), weight of whole plant (418.91g), initial fresh weight of roots (355.54g) but initial fresh weight of leaves (72.52g) in recorded in treatment T_2, root diameter (50.61mm), girth of root (12.3cm), dry weight of leaves (13.49g) measured in T_2, dry weight of root (102.19g), root yield per plot (21.33kg), root yield per hectare (319.98qha^{-1}). Conclusion-: Economically the application of 75% NPK+25% N through vermicompost gave maximum net return (Rs. 262553.80) and BC ratio (3.94).

Keywords: Economics, FYM, NPK, Poultry Manure, Vermicompost,

INTRODUCTION

Vegetables are the most important crops which are grown and consumed worldwide. India is second largest producer of vegetable after china; the share of the

total vegetable production is almost 13.82 percent **(APEDA).** Radish (*Raphanus sativus* L.) 2n=18 is an important root vegetable crop belongs to the family Brassicaceae and originated from Europe. It is called '*Mooli*'.

Radish is grown in almost all the states of India with an area of **206** thousand hectare and production **3304** thousand MT **(2nd Advance estimates for 2021-22 as per PIB data base, 2022**). However, as per the final estimated data for 2020-21, the area was **207** thousand hectares with production of **3263** thousand MT **(NHB data base, 2022)**.Haryana is leading producer of Radish. The production of Radish is 550.07 thousand tonnes in Haryana **(Agriexchange Apeda, 2021-22)**. Large scale production of radish in the field is a prevalent practice in several states across India, including Haryana, West Bengal, Punjab, Bihar, Assam and Madhya Pradesh. In Madhya Pradesh specifically, radish cultivation is noteworthy, with approximately 11381.25 hectares of land dedicated to its cultivation, resulting in a substantial production output of 174821.14 tonnes (**MPH data base, 2019-20).**

Radish holds significant medicinal importance, offering various therapeutic uses. It can be employed to alleviate neurological headaches, address sleeplessness issues, and manage chronic diarrhea. The roots of the radish are particularly beneficial for urinary complaints and piles. Moreover, radish leaves are valuable resources for large scale protein extraction, while radish seeds have the potential to yield non-drying fatty oil suitable for soap production, illumination and edible purposes as documented study in **(Politud, 2016).** Radish is predominantly a cool season vegetable crop, it sown during winter from September to January in northern plains of India; Asiatic types can tolerate higher temperatures than European varieties, so in the mild climate of peninsular India, radish can be grown almost all the year round expect for few months of summer. It is an annual or biennial crop depending upon the type for the purpose it is grown **(PCARRD, 2009).**

Organic manure like farm yard manure (FYM), poultry manure and Vermicompost should also be used as they also make the soil fertile and give nutrition to plant. FYM helps to improving the physical, chemical and biological properties of soil **(Mengistu & Mekonnen, 2012).** In comparison to chemical fertilizers, vermicompost stands out as a superior option for improving soil quality and productivity. Similarly, poultry manure, another organic fertilizer, contains elevated levels of essential nutrients like nitrogen, phosphorus, and potassium when compared to manure from other animals. Moreover, poultry manure contributes to

enhanced soil fertility, improved soil aeration, and increased water-holding capacity. These findings emphasize the advantages of using organic alternatives like vermicompost and poultry manure over chemical fertilizers for sustainable and fruitful agriculture as demonstrated by **(Khatri *et al*., 2019).** Chemical fertilizer deteriorates the quality of produce and are expensive too, leading to reduction in the net profit and returns to the farmers. The integrated nutrient management system approach utilizes a judicious combination of inorganic fertilizer and organic manure in building soil fertility and to the increase the production potential of the crop **(Kumar *et al*., 2013).**

MATERIALS AND METHODS

The experimental site is located in Gwalior's district of Madhya Pradesh which is situated in subtropics at an elevation of 196 m above sea level with coordinates at 26° 21'N latitude and 78° 17' E longitude which represents Indo-gangetic plains region.

Gwalior experiences a distinct pattern of rainfall and temperature throughout the year. The majority of its annual rainfall, approximately 80-90%, occurs during the southwest monsoon season, which typically spans from July to September. Occasional showers from cyclonic rains can also be observed during the winter or late spring months. This means that rainfall is concentrated mainly between July and September, with limited precipitation during the winter and spring seasons. The climate in Gwalior exhibits significant temperature fluctuations during both summer and winter. Summers are characterized by scorching heat, with mean maximum temperatures reaching as high as 48°C. Hot and desiccating winds are common during this period. In contrast, winters are quite cold, with mean minimum temperatures dropping to 0°C or even lower. Frost is a regular occurrence during the winter months.

The experiment was carried out using a randomised block design (RBD Factorial). Ten treatments viz., T_1-(100 % NPK through inorganic sources), T_2-(100% NPK through Farm Yard manure (16t/ha)), T_3-(100% NPK through Vermicompost (12t/ha)), T_4-(100% NPK through Poultry Manure (9.48t/ha)), T_5-(75% NPK+25%N through FYM), T_6-(75% NPK+25% N through Vermicompost), T_7-(75% NPK+25% N through Poultry manure), T_8-(50% NPK+50% N through FYM), T_9-(50% NPK+50% N through Vermicompost), T_{10}-(50% NPK+50% N through Poultry manure) with three (3) replications, were made up of single variety

Ivory white to determine the influence of organic manure and inorganic fertilizers on growth and yield attributes for increased output of radish. On November 28, 2022, the experiment was planted in the CRC-II. In the experiment, NPK (nitrogen, phosphorous, and potash) was applied using urea, DAP, and MOP in accordance with specific treatment protocols. The basal dressing involved the application of the entire phosphorous and potash quantity, along with one-third of the total nitrogen, as per the respective treatment specifications. The remaining nitrogen was administered as top dressing at two different stages: 15 days after sowing (DAS) and 30 DAS. Each treatment was allocated a specific plot area, and within each plot, five randomly selected plants were identified and tagged. These tagged plants were used for the purpose of collecting various measurements and data throughout the course of the experiment. The data was analyzed using the statistically method outlined by Panse and Sukhatme, (1989).

RESULTS AND DISCUSSION

Growth components:

The results summarized in Table 1 reveal treatment T_6-(75% NPK+25% N through vermicompost) as the consistent leader in promoting plant height growth across all stages, showcasing its efficacy with a remarkable 28.6 cm height at harvest. However, the growth journey is far from monotonous, with treatments like T_4-(100% NPK through Poultry Manure (9.48t/ha)) and T_5-(75% NPK +25%N through FYM) demonstrating competitive potential at specific stages. The variability in growth patterns underlines the diverse interactions between treatments and growth factors**.** The close findings are supported by Kumar *et al.,* (2014) in radish, Basir kutawa *et al*., (2020) in okra, Kushwah *et al.,* (2019) in carrot and Aswathi P *et al*., (2021). Application of different sources of nutrients resulted in significant variation for number of leaves per plant at all growth stages. Highest number of leaves was recorded with T_6-(75% NPK+25% N through vermicompost) at 30 and 45 days while T8 at harvest followed by T_3-(100 % NPK through Vermicompost (12t/ha)), T_8-(50% NPK+50% N through FYM), T_6-(75% NPK+25% N through Vermicompost at 30, 45 DAS and at harvest) while lowest number of leaves was noted with T_1-(100% NPK through inorganic sources). Treatment T_6-(75% NPK+25% N through vermicompost) excels with the highest leaf count due to gradual nutrient release from vermicompost. This enriches soil nutrients, yielding more leaves per plant. The study highlights vermicompost's role in sustained nutrient supply, enhancing leaf growth under T_6-

(75% NPK+25% N through Vermicompost) at 30 and 45 DAS while T_8-(50% NPK+50% N through FYM) at 15 DAS and at harvest. Similar findings have been reported by Bhattarai and Maharjan, (2013), Kumar *et al*., (2014) and Khalid *et al.*, (2015) in radish. Among treatments, highest length of leaves was recorded with T_8-(50% NPK+50% N through FYM) 15 DAS and at harvest followed by T_6-(75% NPK+25% N through Vermicompost) at 45 DAS and at harvest, while minimum length of leaves was recorded with T_1-(100 % NPK through inorganic sources). Similar findings have been reported by Kumar *et al*., (2014) in radish and Rao *et al.,* (2010) in onion.

Yield and yield components:

The data presented clearly in Table 3. Maximum length of root (35.05 cm) was recorded under the treatment T_6-(75% NPK+25% N through Vermicompost) and it was followed by (33.55 cm) T_9-(50% NPK+50% N through Vermicompost) and minimum length of root (28.61 cm) recorded in T_7-(75% NPK+25% N through Poultry manure). Treatments recorded significant effect on diameter of root. Maximum diameter of root (50.61 mm) recorded under the treatment T_6-(75% NPK+25% N through Vermicompost), it was (46.05 mm) followed by T_9-(50% NPK+50% N through Vermicompost) and minimum (35.47mm) in T_{10}-(50% NPK+50% N through Poultry manure). These findings are in agreement with reported by Uddain *et al.* (2010), Kumar *et al.* (2014) in radish and Kumar *et al.* (2014) carrot.

The Table 2 presented that treatments indicated significant effect on fresh weight of root. Maximum Initial fresh weight of root (402.21 g) was observed with treatment T_6-(75% NPK+25% N through Vermicompost) followed by (285.78g) in T_8-(50% NPK+50% N through FYM) and minimum root weight (180.36g) observed in T_{10}-(50% NPK+50% N through Poultry manure). The treatments recorded significant effect on Initial fresh weight of leaves (73.52g) in T_2 followed by (63.37g) in T_6 (75% NPK+25% N through Vermicompost) and minimum fresh weight of leaves (44.52g) was recorded in T_{10} (50% NPK + 50% N through Poultry manure). Similar findings related to Kushwah *et al*. (2016) in radish, Kumar *et al*. (2014) in radish. The data summarized in Table 3 the treatment T_6-(75% NPK +25% N through Vermicompost (50.61 mm)) exhibit the widest root diameter among all treatments. Treatments T_9-(46.05 mm), T_4-(43.59 mm), and T_2-(42.74 mm) also show relatively wider root diameters while (35.47 mm) recorded lowest in T_{10}-(50%

NPK+50% N through Poultry manure). The variation in root diameters across treatments emphasizes the role of various factors in shaping the root development patterns of radish crops. Maximum Root girth (12.3 cm) was observed in T_6-(75% NPK+25% N through Vermicompost) followed by T_9-(11.69 cm) and minimum Girth of root (8.33 cm) was found in T_{10}-(50% NPK+50% N through Poultry manure). Similar findings are agreement with Kumar *et al.* (2009), Uddain *et al*., (2010), Kumar *et al.,* (2014) and Kushwah *et al.,* (2016) in radish.

The treatment indicated significant effect on dry weight of root and leaves. The data in Table 4 represents that the treatment T_6-(75% NPK+25% N through Vermicompost) 102.19g exhibits the highest dry weight of roots among all treatments. Treatments T_8-(99.24g), T_2-(96.91g), and (95.99g) in T_9-(50% NPK + 50% N through Vermicompost) also show relatively higher root dry weight while treatment T_{10}-(47.29 g) has the lowest and Treatments T_6-(12.25g), T8-(12.04g), and T_7-(11.29g) also show relatively higher leaf dry weights while treatments T8-(7.00 g) and T_5-(7.87g) have relatively lower dry weight. The close findings are supported by Kumar *et al.,* (2009), Uddain *et al.,* (2010) and Kumar *et al.,* (2014). The outcome of the investigation presented in (Table 5). Root yield per plot and per hectare was significantly increased due to use of different nutrient management in radish crop. The highest root yield of radish per plot (21.33kg) and per hectare (319.98q/ha) was obtained in T6-(75% NPK+25% N through Vermicompost), while lowest root yield (10.82 kg, 162.3q/ha) in T_{10}-(50% NPK+50% N through Poultry manure).

ECONOMICS

The suitability of any agricultural practice for cultivating a crop is determined by its ability to maximize economic returns. In a cost analysis, the most economically favorable treatment, T6, which involved 75% NPK fertilizer and 25% nitrogen through vermicompost, yielded the highest net profit of Rs. 262,553.8 per hectare. Additionally, this treatment achieved the maximum benefit-to-cost ratio B: C of 3.9 (Table 6).

CONCLUSION

Based on the current research findings, it can be concluded that treatment T6, which consisted of 75% NPK fertilizer and 25% nitrogen supplied through vermicompost, emerged as the most effective treatment combination for enhancing plant growth, root yield, and achieving the highest benefit-to-cost ratio (B: C) for

Radish (*Raphanus sativus* L.) of the Ivory White variety grown in the Gird region of Madhya Pradesh.

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Table 1: Effect of organic manure and inorganic fertilizers on growth parameters

Plant Height(cm)					Number of leaves per plant				Length of Leaves per plant(cm)			
Treatment	**15 DAS**	**30 DAS**	**45 DAS**	**At harvest**	**15 DAS**	**30 DAS**	**45 DAS**	**At harvest**	**15 DAS**	**30 DAS**	**45 DAS**	**At harvest**
T1	10.87	18.54	20.83	23.21	3.07	5.07	10.47	15.00	7.45	12.46	17.33	20.79
T2	11.58	17.83	22.61	23.07	4.00	6.87	15.60	19.33	11.18	17.42	21.53	22.66
T3	9.94	18.97	23.23	23.84	4.67	7.73	16.33	18.67	10.21	18.57	22.15	23.44
T4	12.09	19.39	23.91	25.01	4.53	6.93	14.97	15.67	10.35	18.98	22.49	23.61
T5	13.59	19.51	24.23	27.39	5.20	7.53	15.20	17.73	10.51	19.11	22.83	23.98
T6	11.10	20.57	27.13	28.67	4.87	7.87	17.60	19.73	11.23	20.17	24.06	26.27
T7	11.45	18.24	22.82	23.26	4.20	7.47	15.73	18.53	11.35	17.84	21.55	22.86
T8	11.43	20.03	22.43	24.58	4.97	6.80	16.73	20.47	11.75	19.63	23.70	26.93
T9	10.82	19.67	24.17	24.63	4.40	7.47	14.80	15.80	10.55	20.61	23.10	24.89
T10	11.11	16.71	22.39	22.26	3.60	6.33	15.60	17.80	10.70	16.29	20.65	21.86
SE(m)±	**0.55**	**1.44**	**0.77**	**0.93**	**0.42**	**0.48**	**1.21**	**1.15**	**0.60**	**1.34**	**1.22**	**1.17**
C.D. at 5%	**1.66**	**NS**	**2.29**	**2.78**	**1.25**	**1.43**	**3.61**	**3.45**	**1.81**	**4.00**	**3.65**	**3.49**

Table 2: Effect of organic manure and inorganic fertilizers on fresh weight of plant of Radish

Treatment	Weight of whole plant(g)	Initial fresh weight of roots(g)	Initial fresh weight of leaves(g)
T1	254.81	204.54	50.27
T2	348.43	274.91	73.52
T3	285.86	234.98	50.88
T4	321.95	259.81	62.13
T5	291.83	241.72	50.11
T6	418.91	355.54	63.37
T7	256.95	210.27	46.68
T8	346.51	285.78	60.73
T9	317.43	264.67	52.76
T10	224.88	180.36	44.52
SE(m)±	**13.27**	**10.24**	**3.23**
C.D. at 5%	**39.72**	**30.67**	**9.66**

Table 3: Effect of organic manure and inorganic fertilizers on root of Radish

Treatment	Root length(cm)	Root diameter(mm)	Girth of Root(cm)
T1	32.53	41.907	10.47
T2	31.94	42.74	10.27
T3	31.03	41.14	10.07
T4	33.41	43.587	10.25
T5	29.92	42.52	9.9
T6	35.05	50.607	12.3
T7	28.61	39.833	9.56
T8	32.63	40.833	11.38
T9	33.55	46.047	11.69
T10	30.29	35.467	8.33
SE(m)±	**1.06**	**1.62**	**0.41**
C.D. at 5%	**3.19**	**4.87**	**1.24**

Table 4: Effect of organic manure and inorganic fertilizers on dry weight of root and leaves of Radish

Treatment	Dry Weight of Root(g)	Dry weight of leaf(g)
T1	90.89	9.91
T2	96.91	13.49
T3	79.93	7.00
T4	93.43	9.85
T5	83.67	7.87
T6	102.19	12.25
T7	76.73	11.29
T8	99.24	12.04
T9	95.99	9.19
T10	47.29	9.26
SE(m)±	**3.25**	**0.46**
C.D. at 5%	**9.73**	**1.38**

Table 5: Effect of organic manure and inorganic fertilizers on yield of Radish

Treatment	Root Yield per plot(kg)	Root yield (q/ha)
T1	12.273	184.087
T2	16.497	247.417
T3	14.1	211.483
T4	15.59	233.83
T5	14.5	217.547
T6	21.333	319.983
T7	12.62	189.24
T8	17.147	257.203
T9	15.88	238.2
T10	10.82	162.327
SE(m)±	0.615	9.218
C.D. at 5%	1.841	27.601

Table 6: Effect of organic manure and inorganic fertilizers on economics of Radish

Treatment	Treatment Details	Radish yield	Gross return (a)	Cost of cultivation (b)	Net return (a-b)	Benefit: cost ratio [(a/b]
		q ha-1	Rs. ha-1	Rs. ha-1	Rs. ha-1	
T1	T1-100 % NPK through inorganic sources	184.09	202495.70	54690.00	147805.70	3.70
T2	T2-100 % NPK through Farm Yard manure (16t/ha)	247.42	272158.70	97640.00	174518.70	2.79
T3	T3-100 % NPK through Vermicompost (12t/ha)	211.48	232631.30	97640.00	134991.30	2.38
T4	T4-100 % NPK through Poultry Manure (9.48t/ha)	233.83	257213.00	79640.00	177573.00	3.23
T5	T5-75% NPK + 25%N through FYM	217.55	239301.70	65427.50	173874.20	3.66
T6	T6-75% NPK +25% N through Vermicompost	319.98	351981.30	89427.50	262553.80	3.94
T7	T7-75% NPK + 25% N through Poultry manure	189.24	208164.00	75927.50	132236.50	2.74
T8	T8-50% NPK + 50% N through FYM	257.20	282923.30	76165.00	206758.30	3.71
T9	T9-50% NPK + 50% N through Vermicompost	238.20	262020.00	76090.00	185930.00	3.44
T10	T10-50% NPK + 50% N through Poultry manure	162.33	178559.70	67090.00	111469.70	2.66