International Journal of Research in Agronomy

E-ISSN: 2618-0618
P-ISSN: 2618-060X

www.agronomyjournals.com
2024; 7(3): 509-514
Received: 13-01-2024
Accepted: 17-02-2024

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Effect of integrated nutrient management on yield and soil nutrient status in radish

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DOI: https://doi.org/10.33545/2618060X.2024.v7.i3g.462

Abstract
A field experiment was conducted at the Experimental Farm of the College of Horticulture and Forestry, Neri, Hamirpur (HP) during the Rabi season of 2021 to investigate the effect of integrated nutrient management on yield and soil nutrient status in radish. Ten different treatments were employed for this investigation. The results indicated that the highest values for root weight, fresh weight of plant and root yield per plot were observed in treatment T9 (50% RDF of NPK + 25% N through Vermicompost (10.75 q/ha) + application of Jeevamrut @ 5% at weekly intervals). Treatment T_1 (Recommended dose of FYM (100 q/ha) and NPK (100 kg N, 48 kg P, 36 kg K/ha) exhibited the maximum soil pH (7.02) and electrical conductivity (0.212 dS/m), along with the highest organic carbon content (0.88%). Additionally, treatment T_9 showed the maximum available nitrogen (260.12 kg/ha) and phosphorus (25.60 kg/ha), while treatment T_1 recorded the highest potassium content (171.15 kg/ha). The treatment T_7 (50% RDF of NPK + 25% N through Sheep Manure (19 q/ha) + application of Jeevamrut @ 5% at weekly intervals) achieved the maximum benefit-cost ratio. In conclusion, it can be inferred that treatment T_9 (50% RDF of NPK + 25% N through Vermicompost (10.75 q/ha) + application of Jeevamrut @ 5% at weekly interval), followed by treatment T_7 (50% RDF of NPK + 25% N through Sheep manure (19 q/ha) + application of Jeevamrut @ 5% at weekly interval) performed better for the yield and quality of the produce of radish.

Keywords: Radish, Inorganic fertilizers, organic manures and yield

Introduction
Radish (*Raphanus sativus* L.) is a common root vegetable grown worldwide in both tropical and temperate climates. It belongs to the family Brassicaceae with the chromosomal number 2n=18 and it is commonly known as Mooli. It is originated from Central and Western China as well as from India. It is grown for its tender tuberous young roots and leaves, which can be eaten raw or cooked as a vegetable (Thamburaj and Singh, 2016) [23]. It is low in calories and high in vitamin C, protein, fat, fiber and other nutrients. Radish has a strong flavour because to the presence of volatile isothiocyanates. It has a high nutritional value to be quite beneficial in the treatment of piles, hepatic problems, enlarged spleen, and jaundice (Brar and Nandpuri, 1972) [3]. It is vital for good crop cultivation to give the appropriate amount of nutrients to the soil in a timely and effective manner. Chemical fertilizers are commonly used by farmers to achieve this as they also boost crop yields in current agricultural methods. But, chemical fertilizers are more expensive and using them over an extended period of time has resulted in contamination of food, pollution of the environment, decrease of soil fertility and so on. They also degrade the quality of produce resulting in lower net profit and returns to farmers. It is necessary to turn to alternate and less expensive sources such as organic manures (Kumar *et al.*, 2014) [9]. In agriculture, organic farming focuses mostly on the utilisation of plant wastes and manures. In addition to chemical fertilizers, plant nutrients found in organic manures like FYM, sheep manure, and vermicompost enhance the physical and chemical characteristics of soil that plants need (Synman *et al.*, 1998) [22]. They have been used for increasing agricultural output, preserving soil fertility. In order to improve soil fertility as well as to boost crop yield potential, a mixture of inorganic fertilizer and organic manure is applied. The integrated nutrient management method makes use of a careful balance of nutrients.

For the production of high-quality radish that is sustainable, optimal nutrition through organic manures and inorganic fertilizers is required. The use of organic fertilizer, compost, vermicompost and low-dose chemical fertilizer improves radish production (Kiran *et al*., 2016) [8]. Jeevamrut and Panchagavya are environmental friendly and cost-effective organic recipes derived from various cow products. In addition to essential amino acids and growth-promoting compounds like gibberellic acid (GA) and indole acetic acid (IAA), the organic liquid formulations also include beneficial microbes that enhance the growth, yield, and quality of vegetable crops while enriching the soil with microorganisms that aid in soil mineralization (Gore and Sreenivasa, 2011) [4]. Keeping the foregoing in mind, a field experiment was conducted to investigate the influence of integrated nutrient management on the growth, yield, and quality of Radish (*Raphanus sativus* L.).

Materials and Methods

The field experiment was carried out in the Rabi season of 2021-22 at the Experimental Farm of the Department of Vegetable Science, College of Horticulture and Forestry, Neri, Hamirpur, H.P. The experiment was carried out using Randomized Block Design and three replications. The investigation included ten different treatments. The seeds of the variety Japanese White was sown on 22nd October, 2021 with a spacing of 30 cm x 10 cm in a plot size of 1.5 m x 1.5 m accommodating 75 plants. Calculated quantities of inorganic fertilizers nitrogen, phosphorous and potassium (100:48:36 kg/ha) were applied in the form of urea (217 kg/ha), single super phosphate (300 kg/ha) and murate of potash (60 kg/ha) in respective treatments before sowing of seed. As the basal dose, a half-dose of N was applied together with the full doses of P and K and remaining half dose of N was split into two equal doses. The first dose was applied during the first earthing up, and the second dose was applied one month later.

Organic manures such as FYM (100 q/ha), Vermicompost (43 q/ha) and Sheep manure (76 q/ha) were applied during field preparation in the respective treatments. Jeevamrut was applied as drenching @ 5% at weekly interval while Panchagavya was applied as drenching @ 3% at weekly interval. Five plants were chosen at random to collect data on radish growth, yield, and quality parameters. The data collected on these observations was statistically analysed using standard procedures.

Table 1: Details of different Integrated Nutrient Management treatments

S. No	Treatments Details
T_1	Recommended dose of FYM (100 q/ha) and NPK (100 kg N, 48 kg P, 36 kg K/ha) (Control).
T_2	50% RDF of NPK + 50% N through FYM (50 q/ha)
T_3	50% RDF of NPK + 50% N through Sheep manure (38 q/ha)
T_4	50% RDF of NPK + 50% N through Vermicompost (21.5 q/ha)
T_5	50% RDF of NPK + 25% N through FYM (25 q/ha) + application of Jeevamrut @ 5% at weekly interval
T_6	50% RDF of NPK + 25% N through FYM (25 q/ha) + application of Panchagavya @ 3% at weekly interval
T_7	50% RDF of NPK + 25% N through Sheep manure (19 q/ha) + application of Jeevamrut @ 5% at weekly interval
T_8	50% RDF of NPK + 25% N through Sheep manure (19 q/ha) + application of Panchagavya @ 3% at weekly interval
T_9	50% RDF of NPK + 25% N through Vermicompost (10.75 q/ha) + application of Jeevamrut @ 5% at weekly interval
T_{10}	50% RDF of NPK + 25% N through Vermicompost (10.75 q/ha) + application of Panchagavya @ 3% at weekly interval

Results and Discussion

Effect of Integrated Nutrient Management on yield parameters

Analysis of data demonstrated that different mixes of organic manures and inorganic fertilizers had a substantial impact on radish growth and quality parameters. Days to marketable maturity is an essential agricultural feature for any crop because it determines when the crop will reach maturity. Among the treatments, T_9 had the minimum number of days to marketable maturity (60.67), which was statistically equivalent to T_7 and T_1. The maximum number of days to marketable maturity (73.67) were recorded in T_2. The early maturity observed in treatment T_9 could be attributed to the combination application of organic manures and inorganic fertilizers, which induced plant nutrients to solubilize, resulting in increased NPK absorption. Vemicompost and jeevamrut have a direct impact on plant growth by providing all needed macro and micronutrients in accessible forms during mineralization, enhancing soil physical and physiological qualities, and thereby increasing soil fertility levels (Shesharao, 2014) [17]. This led to the quick uptake of nutrients by the plant that resulted in its early maturity. Similar findings were also reported by (Kushwah *et al*., 2020) [10] and (Rawat and Pant, 2021) [15].

Number of leaves per plant is an important parameter in radish as more number of leaves produce more amounts of photosynthates that increase root yield. In the present study, highest number of leaves (15.27) were found in T_9 which was statistically equal to T_7 and T_1 whereas the lowest number of leaves (10.97) were recorded in T_3. The maximum number of leaves per plant observed by increased dosage and the beneficial effect of integrated nutrient management could be attributed to the influence of nutrient, the main constituent of protein, which is required for the formation of protoplasm, which leads to meristamatic activity, cell division, and plant development. These findings are consistent with the findings of (Subramani *et al*., 2011) [21], Kumar *et al*., 2014) [9] and (Kushwah *et al*., 2020) [10] respectively.

The yield parameters were shown to be considerably influenced by several combinations of inorganic fertilizers and organic manures. Root length is an important character as it represents the quality of produce. Root length is directly correlated with yield. Treatment T_9 had the highest root length (24.96 cm), which was statistically comparable to treatments T_7 and T_1, while treatment T_2 had the shortest root length (18.53 cm). According to (Kumar *et al*., 2014) [9], the longest roots observed in treatment T_9 might be the result of applying organic manure and inorganic fertilizer together. This would increase the inorganic fertilizer's efficacy and supply all the necessary nutrients in a balanced amount because the release of the fertilizer's control would correspond with the stage of root growth. An increase in root length indicates effective water absorption, followed by transport and conduction. Vermicompost would have improved the soil's cation and anion exchange capacities, which would have increased soil organic matter and reduced nitrogen loss while promoting root development. The addition of vermicompost results in the solubilization of plant nutrients, which results in higher uptake of NPK, may be the cause of the increase in root length. In a study conducted by (Gore and Sreenivasa, 2011) [3] it was found that jeevamrut contain important macro and micronutrients, essential amino acids, and substances that promote growth including Indole Acetic Acid (IAA) and Gibberellic Acid (GA), as well as helpful microbes, which help to improve vegetative growth thus increasing root length. These findings were also supported by (Mali *et al*., 2018) [11].

Root diameter is an important yield parameter of radish. The data analysis revealed that different treatments had significant influence on root diameter. The highest value for root diameter (3.35 cm) was found in treatment T_7 followed by T_9 whereas the lowest root diameter (2.09 cm) was recorded in treatment T_2. Similar findings were also reported by the studies of (Mali *et al*., 2018) [11] using integrated nutrient management practices. The application of organic manures and NPK aided plant metabolism, resulting in increased root diameter. The increased vegetative growth of the plant has a direct influence on the size of the root. This may have resulted in an increase in root diameter due to the accumulation of additional carbohydrates. Similar findings were also reported by (Kumar *et al*., 2014) [9], (Singh *et al*., 2019) [20], and (Kaluram *et al*., 2019) [6].

Root weight and fresh weight of the plant are important horticultural characters as they directly influence the yield. Treatment T_9 was found superior in both root weight (149.56 g) and fresh weight of plant (185.56 g) and they were statistically at par with T_7 and T_1. The conjoint application of organic manures and inorganic fertilizers that provided significant amounts of nitrogen may have contributed to the rise in root weight and fresh weight of plant in treatment T_9. This nitrogen is converted into amino acids which form complex proteins enhancing the better growth of radish (Khalid *et al*., 2015) [7]. By increasing the cation and anion exchange capacities in the soil, vermicompost would have decreased the loss of nitrogen by increasing soil organic matter and soil structure, consequently increasing the root weight and fresh weight of plant. (Gore and Sreenivasa, 2011) [4] stated that, important macro and micronutrients, necessary amino acids, growth-promoting compounds including Indole Acetic Acid (IAA) and Gibberellic Acid (GA) as well as beneficial microorganisms are supplied to plants by the frequent and timely application of jeevamrut, which contributes to the improvement of plant growth and development, thereby increasing the root weight and fresh weight of the plant. The results are in accordance with the findings of (Jat *et al*., 2017) [5], (Mali *et al*., 2018) [11] and (Patel, 2019) [13] in radish respectively.

The root yield per plot is a major horticultural trait, because it directly influences the root yield of radish produced in a unit area. Treatment T_9 had the highest root yield per plot (8.04 Kg), which was statistically equal to treatments T_7 and T_1, while treatment T_2 had the lowest root yield per plot (3.50 Kg). (Singh, 2018) [18] stated that the increase in root yield per plot in treatment T_9 could be attributed to the integrated application of organic manures and chemical fertilizers, which resulted in the accumulation of humus substances, which could have mobilised the reserve food materials to the sink via increased activity of hydrolysing and oxidizing enzymes. One of the key features of vermicompost is that as earthworms break down various organic wastes, the majority of the nutrients and their constituents are changed into forms that plants can absorb more readily. This improves the growth and development of the crop, which results in a higher yield. According to (Sanoos, 2019) [16], soil application of fermented liquid jeevamrut to radish crop reduces nutrients loss by leaching, soil fixing, and volatilization. This eventually boosts soil fertility and nutrient availability to plants, promoting better growth of radish thus increasing the yield. Similar results have been also reported by (Kumar *et al*., 2014) [9], (Mehwish *et al*., 2016) [12] and (Verma *et al*., 2017) [24].

Table 2: Effect of Integrated Nutrient Management on yield parameters

Treatments	Days to marketable maturity	Number of leaves per plant	Root length (cm)	Root diameter (cm)	Root weight (g)	Fresh weight of plant (g)	Root yield per plot (Kg)
T_1	64.67	14.67	23.28	2.92	131.17	170.57	7.48
T_2	73.67	11.44	18.53	2.09	103.73	121.33	3.50
T_3	71.67	10.97	19.17	2.17	96.67	133.06	3.99
T_4	70.34	12.21	20.34	2.21	109.90	139.23	4.44
T_5	65.34	14.34	22.83	3.04	126.33	159.00	6.96
T_6	69.00	12.98	21.13	2.34	113.80	144.46	5.53
T_7	63.00	14.91	24.06	3.35	138.47	174.47	7.85
T_8	68.67	13.53	21.91	2.47	116.93	149.93	6.10
T_9	60.67	15.27	24.96	3.21	149.56	185.56	8.04
T_{10}	67.34	13.87	22.08	2.68	121.77	155.10	6.57
MEAN	67.43	13.41	21.82	2.64	120.83	153.27	6.04
CD $_{0.05}$	4.25	0.72	2.04	0.26	19.36	23.58	1.06
SE(m)	1.42	0.24	0.68	0.08	6.46	7.87	0.35
C.V.	3.65	3.14	5.41	5.72	9.27	8.90	10.20

Effect of Integrated Nutrient Management on Soil properties

A. The application of organic manures such as vermicompost and jeevamrut, along with chemical fertilizers like NPK, has resulted in an increase in the nitrogen content available in the soil. Treatment T_9, which consisted of 50% RDF of NPK, 25% N through vermicompost, and the application of Jeevamrit at a 5% weekly interval, recorded the highest nitrogen content in the soil (260.12 kg/ha). This treatment was statistically similar to treatments T_7 (50% RDF of NPK, 25% N through Sheep Manure, and the application of Jeevamrit at a 5% weekly interval) and T_5 (50% RDF of NPK, 25% N through FYM, and the application of Jeevamrit at a 5% weekly interval), which recorded nitrogen contents of 253.86 kg/ha and 245.89 kg/ha, respectively. On the other hand, treatment T_2 (50% RDF of NPK and 50% N through FYM) had the lowest available nitrogen content (210.46 kg/ha). The addition of organic manures in conjunction with chemical fertilizers may be attributed to the increased activity of nitrogen-fixing bacteria, leading to a significant increase in the availability of nitrogen.

Additionally, the incorporation of organic material improves mineralization, thereby enhancing the availability of nitrogen. Singh (2018) [18] mentioned that the increase in available nitrogen content in beds treated with INM techniques is possibly due to the release of native soil nitrogen and nutrient mineralization from vermicompost. Arora *et al*. (2011) [1] also reported an increase in nitrogen content with the addition of vermicompost, attributing it to the stimulation of soil microbial activity, improvement in soil porosity, maintenance of soil temperature, and ultimately, the enhancement of nitrogen content. Jeevamrut, a liquid formulation, has been identified by Yogananda *et al*. (2018) [26] as an effective organic formulation for increasing crop output and improving soil nutrient status. The application of jeevamrut at a 5% weekly interval may have contributed to the increase in nitrogen content observed in treatment T_9 (50% RDF of NPK, 25% N through vermicompost, and the application of jeevamrut at a 5% weekly interval).

B. Data pertaining to available phosphorous has been presented in table 3. An examination of the data has revealed a significant disparity among the various combinations of treatments involving organic and inorganic nutrient sources. Treatment T_9, which involved the application of 50% RDF of NPK, 25% N through vermicompost, and the use of jeevamrut at a 5% concentration on a weekly basis, recorded the highest value for available phosphorus at 25.60 kg/ha. Conversely, treatment T_2, which consisted of 50% RDF of NPK and 50% N through FYM, recorded the lowest value for available phosphorus at 16.81 kg/ha. The increase in available phosphorus can likely be attributed to the concurrent use of organic manures and inorganic fertilizers. Phosphorus is absorbed by plants in the form of $H_2PO_4^{2-}$at lower pH levels and in the form of $H_2PO_4^{2-}$ at higher pH levels, as it is a constituent of adenosine diphosphate (ADP) and adenosine triphosphate (ATP). The enzymatic activity of microbial organisms in the soil treated with vermicompost facilitates the release and retention of phosphate. The solubilization of phosphorus by organic acids generated during the decomposition of organic manures, as well as the release of phosphorus by inorganic fertilizers, may account for the highest recorded value of available phosphorus in plots receiving organic manures in conjunction with inorganic fertilizers. When organic matter decomposes, complex organic anions and hydroxyl acids such as tartaric, citric, malonic, and malic acids are released. These compounds may have chelated Al^+, Fe^{+3}, and Ca^{+2} and reduced their ability to precipitate phosphate, thus enhancing the availability of phosphorus. These findings align with those of Bhattarai and Rana (2012) [2] in their study on radish.

C. Analysis of the data revealed notable variation in the levels of available potassium across different combinations of treatments. In the current study, the highest content of available potassium (171.15 kg/ha) was observed in treatment T_1, which involved the application of the recommended dose of farmyard manure (100 q/ha) and NPK (100 kg N, 48 kg P, 36 kg K/ha). This result was statistically similar to the content recorded in treatments T_9 (50% recommended dose of NPK + 25% N through vermicompost + application of jeevamrut @ 5% at weekly interval) (168.09 kg/ha) and T_7 (50% recommended dose of NPK + 25% N through Sheep Manure (19 q/ha) + application of Jeevamrut @ 5% at weekly interval) (165.82 kg/ha). On the other hand, the lowest content of available potassium (148.08 kg/ha) was observed in treatment T_2, which involved the application of 50% recommended dose of NPK + 50% N through farmyard manure. The increase in available potassium can potentially be attributed to the heightened activity of microorganisms, which aid in the solubilization of non-exchangeable potassium. Additionally, the release of organic acids during decomposition and the mobilization of potassium may also contribute to its increased availability. This phenomenon has been previously documented in carrot cultivation by Vithwel and Kanaujia (2013) [25].

D. For optimal radish growth, it is essential to maintain a soil pH level ranging from 6 to 7. This pH range ensures the availability of nitrogen and phosphorus, which are crucial nutrients for the plants. The table presents the data on soil pH levels, with the initial pH before sowing recorded at 7.09. Among the different treatments, the highest soil pH value of 7.02 was observed in treatment T_1, where the recommended dose of FYM (100 q/ha) and NPK (100 kg N, 48 kg P, 36 kg K/ha) were applied. On the other hand, the lowest pH value of 6.97 was recorded in treatment T_9, which involved the application of 50% RDF of NPK, 25% N through Vermicompost (10.75 q/ha), and the use of Jeevamrut @ 5% at weekly intervals. The overall mean pH was determined as 7.02. The application of both organic manures and chemical fertilizers in combination resulted in the release of organic acids during the decomposition process of the organic manures. This release of organic acids contributed to the decline in soil pH specifically observed in treatment T_9. Singh *et al*. (2020) [19] also reported a decrease in soil pH when organic manures were applied alongside inorganic fertilizers. Additionally, they suggested that the acidifying effect of organic acids produced during the decomposition process of organic manures could be the underlying reason for the decrease in soil pH.

E. Soil electrical conductivity serves as a crucial indicator of soil health, exerting influence on crop yield, the availability of plant nutrients, and the activity of soil microorganisms. Upon analysis of the collected data, a significant disparity in soil electrical conductivity was observed across the different treatments. The data revealed that the treatment labeled T_1, which consisted of the recommended dose of Farm Yard Manure (FYM) at a rate of 100 q/ha, as well as NPK fertilizers at a rate of 100 kg N, 48 kg P, and 36 kg K/ha, recorded the highest soil electrical conductivity value of 0.212 dS/m (Control). Conversely, the lowest soil electrical conductivity value of 0.186 dS/m was observed in treatment T_9. Singh *et al*. (2020) [19] documented a reduction in the electrical conductivity of soil when treated with a combination of various organic and inorganic fertilizers. The addition of organic manure was found to contribute to this decrease in soil electrical conductivity, which can be attributed to the leaching of insoluble salts, thereby enhancing soil permeability and pH levels.

F. Analysis of the data indicates a significant disparity among the various treatments for soil organic carbon. The treatment T_{10}, consisting of 50% RDF of NPK, 25% N through Vermicompost (10.75 q/ha), and the application of Panchagavya at a rate of 3% on a weekly basis, recorded the minimum organic carbon content as the basal dose. Conversely, treatment T_1, which involved the recommended dose of FYM (100 q/ha) and NPK at a rate of 100 kg N, 48 kg P, 36 kg K/ha, recorded the maximum organic carbon content. One possible explanation for the increased organic carbon content could be attributed to the combined application of FYM and NPK in higher quantities. This practice has been observed to enhance the organic matter content and microbial population in the soil, ultimately leading to an increase in organic carbon content. A similar outcome was reported by Vithwel and Kanaujia (2013) [25] in their study on carrot cultivation.

Table 3: Effect of Integrated Nutrient Management on different soil properties

Treatments	Nitrogen (kg/ha)	Phosphorous (kg/ha)	Potassium (kg/ha)	pH	EC (dS/m)	OC (%)
Initial value	202.16	16.59	144.24	7.09	0.216	0.66
T_1	202.16	16.59	144.24	7.02	0.212	0.88
T_2	250.65	23.71	171.15	7.01	0.208	0.86
T_3	210.46	16.81	148.08	7.00	0.205	0.83
T_4	213.55	17.08	151.60	6.98	0.203	0.79
T_5	245.89	22.60	162.20	6.99	0.193	0.81
T_6	224.39	19.79	154.34	7.01	0.200	0.80
T_7	253.86	24.35	165.82	6.99	0.188	0.78
T_8	231.04	21.56	156.34	7.00	0.197	0.76
T_9	260.12	25.60	168.09	6.97	0.186	0.74
T_{10}	238.27	22.34	159.11	6.98	0.194	0.72
MEAN	234.77	21.15	159.02	6.99	0.198	0.79
$CD_{0.05}$	12.46	0.89	8.27	N/S	0.008	0.07
SE(m)	4.16	0.29	2.76	0.03	0.003	0.02
C.V.	3.07	2.44	3.01	0.78	2.199	5.07

Benefit: Cost ratio

The data on benefit: cost ratio indicates that treatment T_7 (50% RDF of NPK + 25% N through Sheep Manure (19 q/ha) + application of Jeevamrit @ 5% at weekly interval) had the highest benefit: cost ratio of 3.36. This was followed by treatment T_1 (Recommended dose of FYM (100 q/ha) and NPK (100 kg N, 48 kg P, 36 kg K/ha). On the other hand, treatment T_2 (50% RDF of NPK + 50% N through FYM (50 q/ha)) had the lowest benefit: cost ratio of 1.41.

Table 4: Economics of treatments

Treatments	Total root yield (q/ha)	Total cost of cultivation (Rs/ha)	Gross Income (Rs/ha)	Net Income (Rs/ha)	B:C ratio
T_1	332.44	77,312.00	3,32,440.00	2,55,128.00	3.29
T_2	155.55	64,476.00	1,55,550.00	91,074.00	1.41
T_3	177.33	65,876.00	1,77,330.00	1,11,454.00	1.69
T_4	197.33	75,976.00	1,97,330.00	1,21,354.00	1.59
T_5	309.33	79,196.00	3,09,330.00	2,30,134.00	2.90
T_6	245.77	96,451.00	2,45,770.00	1,49,319.00	1.54
T_7	348.88	79,896.00	3,48,880.00	2,69,984.00	3.36
T_8	271.11	97,151.00	2,71,110.00	1,73,959.00	1.79
T_9	357.33	84,946.00	3,57,330.00	2,72,384.00	3.20
T_{10}	292.00	1.,02,201.00	2,92,000.00	1,89,799.00	1.85
$CD_{0.05}$	9.295	3,589	12,629	7,889	0.20

Conclusion

In the current experiment, it was observed that treatment T_9, which consisted of 50% RDF of NPK, 25% N through Vermicompost (10.75 q/ha), and application of Jeevamrut at 5% weekly intervals, demonstrated superior results in terms of growth and yield traits. This was followed by treatment T7, which consisted of 50% RDF of NPK, 25% N through Sheep manure (19 q/ha), and application of Jeevamrut at 5% weekly intervals. The treatment T_7 also recorded the highest quality parameters. On the other hand, the treatment T_1, which involved the recommended dose of FYM (100 q/ha) and NPK (100 kg N, 48 kg P, 36 kg /ha), exhibited the maximum soil pH (7.02) and electrical conductivity (0.212 dS/m). Additionally, the organic carbon content (0.88%) was also highest in treatment T_1. Treatment T_9 recorded the maximum available nitrogen (260.12 kg/ha) and phosphorus (25.60 kg/ha), while treatment T_1 had the highest potassium content (171.15 kg/ha). The treatment T_7 achieved the maximum benefit-cost ratio. Therefore, it can be concluded that the integrated application of organic manures, inorganic fertilizers, and liquid manures like jeevamrut should be employed in radish cultivation as it enhances the yield and quality of the produce.

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