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# Effect of integrated nutrient management on growth and yield of radish (*Raphanus sativus* L.) cv. Japanese white

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**Abstract**
An experiment was conducted at Horticultural Research Farm, Department of Horticulture, B.A. College of Agriculture, Anand Agricultural University, Anand with a view to study the "Effect of integrated nutrient management on growth and yield of radish (*Raphanus sativus* L.) cv. Japanese white" during *rabi* season of year 2021-22. The experiment was arranged in Randomized Block Design with 14 treatments and 3 replications. Among the all different treatments, treatment T14 [50% NPK + 25% VC + 25% PM + Seed treatment of Anubhav Bio NPK consortium (5 ml/kg of seed)] recorded significantly maximum plant height (35.34 and 35.62 cm), number of leaves (14.07 and 14.93) at 45 DAS & at time of harvest respectively. Maximum fresh weight of shoot (157.85 g), dry weight of shoot (12.9 7 g) and leaf area (216.29 cm 2), root length (27.39 cm), root diameter (3.55 cm), fresh weight of root (196.68 g), root to shoot ratio (1.32), root yield (36.42 t/ha) of radish root aft er harvesting were also recorded maximum with the treatment T14.

**Keywords:** INM, growth, yield, radish, Japanese white

## Introduction
Radish (*Raphanus sativus* L.) is one of the most important root crops belonging to the family cruciferae having chromosome number is 2n = 18. The center of origin of radish is Europe and Western Asia. It is grown both in tropical and temperate regions of the world. Radish is grown for its edible young, tender and fusiform roots which are eaten raw as a salad or cooked as a vegetable and the leafy tops are very rich in vitamin A, B, C and minerals particularly calcium and iron. The roots are good appetizer, effective in curing liver, gall bladder and urinary disorders and piles. Trace elements in radish include aluminium, barium, lithium manganese, silicon, titanium, fluorine and iodine (Up to 18 µg/10 g). Roots are also rich in carbohydrate and protein. Pink skinned radish is generally richer in ascorbic acid than the white skinned one. The characteristics pungent flavor of radish is due to the presence of volatile isothiocyanates (Bose *et al*., 2000) [5].

Being a short duration and quick growing crop, the root growth should be rapid and uninterrupted in radish. Hence, for the production of good quality radish, optimum nutrition through organic, inorganic and use of biofertilizer are essential for sustainable production. Organic agriculture practices rely upon recycling of crop residues, animal manure, farm organic residues and wastes etc. in view of higher cost of synthetic fertilizers and its contribution to poor health of soil and water it becomes imperative to go for alternative and cheaper source like organic manures (Kumar *et al.*, 2014) [19].

Integrated nutrient management is the use of inorganic, organic and biological nutrient sources in optimum condition to achieve and sustain optimum yield without harming the soil ecosystem and environment. Integrated nutrient management helps to obtain agronomical feasible, economically viable, environmentally sound and sustainable high crop yields (Kafle *et al.*, 2019) [14]. Organic manure like FYM, poultry manure and vermicompost should also be used as they also make the soil fertile and give nutrition to plant. FYM helps to improve crop growth by providing nutrition and improving the physical, chemical and biological properties of soil (Mengistu & Mekonnen, 2012) [21]. Vermicompost brings positive changes in both soil quality and productivity than chemical fertilizers (Ansari & Sukhraj, 2010) [1]. Similarly, another organic manure i.e. poultry manure has a high amount of nitrogen, phosphorus and potassium than manure of other animals (Duncan, 2005) [8]. Poultry manure also helps to improve the water holding capacity, aeration and fertility status of soil (Khatri *et al.*, 2019) [17].

## Materials and Methods

An investigation was carried out during *rabi* season of the year 2021-22 at Horticultural Research Farm, Department of Horticulture. B.A. College of Agriculture, A. A. U., Anand. The experiment was conducted in Randomized Block Design with 3 replications and 14 treatments i.e. T1: Absolute Control, T2: RDF (80:40: 80 NPK kg/ha), T3: FYM (20 t/ha), T4: 75% FYM + 25% RDF, T5: Vermicompost (5 t/ha), T6: 75% Vermicompost + 25% RDF, T7: Poultry manure (4 t/ha), T8: 75% Poultry manure + 25% RDF, T9: 50% NPK + 50% FYM + Seed treatment of Anubhav Bio NPK consortium (5 ml/kg of seed) T10: 50% NPK + 50% PM + Seed treatment of Anubhav Bio NPK consortium (5 ml/kg of seed) T11: 50% NPK + 50% VC + Seed treatment of Anubhav Bio NPK consortium (5 ml/kg of seed), T12: 50% NPK + 25% FYM + 25% PM + Seed treatment of Anubhav Bio NPK consortium (5 ml/kg of seed), T13: 50% NPK + 25% FYM + 25% VC + Seed treatment of Anubhav Bio NPK consortium (5 ml/kg of seed), T14: 50% NPK + 25% VC + 25% PM + Seed treatment of Anubhav Bio NPK consortium (5 ml/kg of seed). The data were recorded on plant height (cm), number of leaves per plant, leaf area (cm2), fresh weight of shoot (g), dry weight of shoot ( g), root length (cm), root diameter (cm), root to shoot ratio, fresh weight of root (g), root yield per plot (kg/plot ), root yield per ha (t/ha).

The plant height was measured from ground level to the tip of longest leaf at 30, 45 DAS and at the time of harvest from five tagged plants and their mean was worked out. Total number of leaves counted for five randomly selected plants and counted at 30, 45 DAS and at harvest and their mean was worked out. The fresh weight of shoot of five plants at harvest was measured from selected tagged plants and the average fresh weight of shoot expressed in gram (g). The same shoot were dried in oven at 60 °C till constant weight was achieved and their dry weight of shoot was recorded. Leaf area of five plants was recorded with the help of digital leaf area meter. The length of root from five randomly selected plants in each plot was recorded by means of scale from apex to the base of the root and the average is expressed in centimeters. The root diameter was recorded with the help of vernier calipers and the average was expressed in centimeter (cm). Randomly selected five fresh root was measured their weight after harvest and the average fresh weight of root was expressed in gram. Root and shoot ratio was calculated for five randomly selected plants from each plot. Harvesting was done manually when the roots attained maximum size, colour and full maturity. The roots of net plots were harvested separately and also weighed separately by used weighing balance and expressed in kg per plot. It was used to calculate the yield in tones per hectare.

### Statistical Analysis

The data collected for different observations were statistical analysised as described by Panse and Sukhatme (1967) [22].

## Result and Discussion

### Growth parameters

Growth parameter *viz.*, plant height and number of leaves at 30, 45 DAS and at harvest were found significant differences in the present investigation. The Plant height and number of leaves at 30 DAS was found non-significant. However, it was found significant at 45 DAS and at harvest time. Maximum plant height at 45 DAS (35.34 cm) and at harvesting time (35.62 cm) was recorded in treatment T14 [(50% NPK + 25% VC + 25% PM + Seed treatment of Anubhav Bio NPK consortium (5 ml/kg of seed)] and it was at par with T11 [(50% NPK + 50% VC + Seed treatment of Anubhav Bio NPK consortium (5 ml/kg of seed)] i.e. 34.71 and 34.92 cm, T6 [75% Vermicompost + 25% RDF] i.e. 34.50 and 34.74 cm, T13 [50% NPK + 25% FYM + 25% VC + Seed treatment of Anubhav Bio NPK consortium (5 ml/kg of seed)] i.e. 34.15 and 34.26 cm and T12 [ 50% NPK + 25% FYM + 25% PM + Seed treatment of Anubhav Bio NPK consortium (5 ml/kg of seed)] i.e. 33.75 and 33.81 cm at 45 DAS and at harvesting time respectively. While minimum plant height at 45 DAS (29.67 cm) and at harvest time (29.93 cm) was observed in control. Maximum number of leaves per plant at 45 DAS (14.07) and at harvest time (14.93) were recorded in treatment T14 [50% NPK + 25% VC + 25% PM + Seed treatment of Anubhav Bio NPK consortium (5 ml/kg of seed)], which was at par with treatment T11 [50% NPK + 50% VC + Seed treatment of Anubhav Bio NPK consortium (5 ml/kg of seed)] i.e. 13.93 and 14.40, T6 [75% Vermicompost + 25% RDF] i.e. 13.80 and 14.47, T13 [50% NPK + 25% FYM + 25% VC + Seed treatment of Anubhav Bio NPK consortium (5 ml/kg of seed)] i.e. 13.53 and 13.93 and T12 [50% NPK + 25% FYM + 25% PM + Seed treatment of Anubhav Bio NPK consortium (5 ml/kg of seed)] i.e. 13.27 and 13.80 at 45 DAS and at harvesting time respectively. While minimum number of leaves per plant at 45 DAS (11.73) and at harvest time (12.00) was observed in control. (Table1).

The significantly maximum fresh weight of shoot (157.85 g), dry weight of shoot **(**12.97 g**)** and leaf area (216.29 cm2) was recorded in treatment T14 [50% NPK + 25% VC + 25% PM + Seed treatment of Anubhav Bio NPK consortium (5 ml/kg of seed)] while, the lowest fresh weight of shoot (93.46 g), dry weight of shoot (7.42 g) and leaf area (147.68 cm2) was observed in treatment T1 (Control). (Table 2).

The significant increase in plant height may be due to the supplement of major and minor nutrients, through different organic manures in various levels, which increased the photosynthetic activity, chlorophyll formation, nitrogen metabolism and auxin contents in the plant which ultimately resulted into overall improving the plant height. The findings are in agreement with the findings of Singh *et al*. (2017) [24] in radish, Pawar (2010) [23] in carrot and Singh (2012) [25] in turmeric.

Maximum number of leaves per plant could be due to all nutrients resulted in luxurious vegetative growth of plant. Moreover, applications of vermi compost and poultry manure along with fertilizer helped in development of the physical, chemical and biological properties of soil which helps in better nutrient absorption and utilization by plant. Seed inoculation of biofertilizers might have helped to increase the biological nitrogen fixation and availability of phosphorous required for strong vegetative growth, ultimately contributed to production of more number of leaves per plant. Besides, it may also be due to rapid elongation and multiplication of cell in the presence of adequate quantity of nitrogen (Barman *et al.*, 2014) [3]. The results are comparable with Kirad *et al*., (2010) [16], Vithwel and Kanaujia (2013) [24], Pawar (2010) [23] in carrot, Khalid *et al.*, (2015) [16] in radish.

The maximum fresh and dry weight of shoot at harvesting stage was recorded in treatment T14 it might be due to higher plant height and more number of leaves and maximum leaf area in this treatment as compared to the rest of treatments. It

was due to combine application of NPK and Vermicompost may enhance the nitrogen content in the plant which leads to the increase in the chlorophyll content of leaf and ultimately increases the fresh weight of shoot. Better availability of nutrients and the balanced C/N ratio might have increased synthesis of higher chlorophyll index. The present investigation was inconsistent with the results of Kushwah *et al*., (2016) [20], Kumar *et al.* (2014) [19], Jat (2015) [12] in radish and Yadav *et al.* (2021) [28] in turnip.

Increasing the rate of nitrogen fertilizer affected leaf dry mass because nitrogen stimulates plant vegetative growth and increases leaf area. As a result increased in leaf area enhances the rate of plant photosynthesis and thus increases dry matter production.

**Table 1:** Integrated nutrient management on plant height and number of leaves of radish cv. Japanese white

| Treatment | | Plant height (cm) | | | Number of leaves per plant | | |
|---|---|---|---|---|---|---|---|
| | | 30 DAS | 45 DAS | At harvest | 30 DAS | 45 DAS | At harvest |
| T1 | Absolute Control | 14.06 | 29.67 | 29.93 | 6.20 | 11.73 | 12.00 |
| T2 | RDF (80 :40: 80 NPK kg/ha) | 14.21 | 32.14 | 32.64 | 6.73 | 12.60 | 12.87 |
| T3 | FYM (20 t/ha) | 14.12 | 30.13 | 30.33 | 6.40 | 11.93 | 12.20 |
| T4 | 75% FYM + 25% RDF | 14.63 | 31.99 | 32.14 | 6.47 | 12.40 | 12.67 |
| T5 | Vermicompost (5 t/ha.) | 14.34 | 31.44 | 31.65 | 6.53 | 12.20 | 12.47 |
| T6 | 75% Vermicompost + 25% RDF | 15.75 | 34.50 | 34.74 | 6.93 | 13.80 | 14.47 |
| T7 | Poultry manure (4 t/ha) | 14.16 | 30.71 | 30.94 | 6.60 | 12.07 | 12.33 |
| T8 | 75% Poultry manure + 25% RDF | 14.73 | 32.79 | 32.94 | 6.67 | 12.87 | 13.13 |
| T9 | 50% NPK + 50% FYM + Seed treatment of Anubhav Bio NPK consortium (5 ml/kg of seed) | 14.60 | 32.63 | 32.76 | 6.40 | 12.67 | 12.93 |
| T10 | 50% NPK + 50% PM + Seed treatment of Anubhav Bio NPK consortium (5 ml/kg of seed) | 14.91 | 32.93 | 33.32 | 6.80 | 12.93 | 13.53 |
| T11 | 50% NPK + 50% VC + Seed treatment of Anubhav Bio NPK consortium (5 ml/kg of seed) | 15.89 | 34.71 | 34.92 | 7.00 | 13.93 | 14.40 |
| T12 | 50% NPK + 25% FYM + 25% PM + Seed treatment of Anubhav Bio NPK consortium (5 ml/kg of seed) | 14.94 | 33.75 | 33.81 | 6.80 | 13.27 | 13.80 |
| T13 | 50% NPK + 25% FYM + 25% VC + Seed treatment of Anubhav Bio NPK consortium (5 ml/kg of seed) | 15.47 | 34.15 | 34.26 | 6.87 | 13.53 | 13.93 |
| T14 | 50% NPK + 25% VC + 25% PM + Seed treatment of Anubhav Bio NPK consortium (5 ml/kg of seed) | 16.14 | 35.34 | 35.62 | 7.20 | 14.07 | 14.93 |
| S. Em. + | | 0.55 | 0.75 | 0.76 | 0.19 | 0.30 | 0.38 |
| CD at 5% | | NS | 2.19 | 2.20 | NS | 0.88 | 1.13 |
| C.V. (%) | | 6.44 | 4.01 | 4.00 | 4.96 | 4.10 | 5.06 |

**Table 2:** Integrated nutrient management on fresh weight, dry weight of shoot (g) and leaf area (cm2) of radish cv. Japanese white

| Treatment | | Fresh weight of shoot (g) | Dry weight of shoot (g) | Leaf area (cm2) |
|---|---|---|---|---|
| T1 | Absolute Control | 93.46 | 7.42 | 147.68 |
| T2 | RDF (80 :40: 80 NPK kg/ha) | 118.69 | 10.46 | 172.32 |
| T3 | FYM (20 t/ha) | 102.11 | 7.76 | 159.91 |
| T4 | 75% FYM + 25% RDF | 113.19 | 9.50 | 167.16 |
| T5 | Vermicompost (5 t/ha.) | 107.15 | 9.11 | 162.53 |
| T6 | 75% Vermicompost + 25% RDF | 141.77 | 12.11 | 204.61 |
| T7 | Poultry manure (4 t/ha) | 106.29 | 8.63 | 160.71 |
| T8 | 75% Poultry manure + 25% RDF | 128.81 | 10.76 | 181.54 |
| T9 | 50% NPK + 50% FYM + Seed treatment of Anubhav Bio NPK consortium (5 ml/kg of seed) | 123.75 | 10.74 | 175.53 |
| T10 | 50% NPK + 50% PM + Seed treatment of Anubhav Bio NPK consortium (5 ml/kg of seed) | 131.19 | 11.19 | 185.63 |
| T11 | 50% NPK + 50% VC + Seed treatment of Anubhav Bio NPK consortium (5 ml/kg of seed) | 147.51 | 12.37 | 207.98 |
| T12 | 50% NPK + 25% FYM + 25% PM + Seed treatment of Anubhav Bio NPK consortium (5 ml/kg of seed) | 133.85 | 11.41 | 192.58 |
| T13 | 50% NPK + 25% FYM + 25% VC + Seed treatment of Anubhav Bio NPK consortium (5 ml/kg of seed) | 135.45 | 11.73 | 195.49 |
| T14 | 50% NPK + 25% VC + 25% PM + Seed treatment of Anubhav Bio NPK consortium (5 ml/kg of seed) | 157.85 | 12.97 | 216.29 |
| S. Em. + | | 5.86 | 0.39 | 4.65 |
| CD at 5% | | 17.03 | 1.14 | 13.52 |
| C.V. (%) | | 8.16 | 6.50 | 4.46 |

**Yield parameters**

Root length (cm), root diameter (cm), fresh weight of root (g), root to shoot ratio (Table 3), yield (kg/plot) and yield (t/ha) were significantly influenced by various treatments in the present experiment (Table 4). The maximum root length (27.39 cm), root diameter (3.55 cm), root to shoot ratio (1.32) was observed in T14 [50% NPK + 25% VC + 25% PM + Seed treatment of Anubhav Bio NPK consortium (5 ml/kg of seed)] and it was at par with T11 and T6 (60 kg N/ha + 12.5 t/ha FYM + 5 t/ha Vermicompost) at harvest. The lowest was recorded in control.

Significantly maximum fresh root weight (196.68 g) was recorded in treatment T14 [50% NPK + 25% VC + 25% PM + Seed treatment of Anubhav Bio NPK consortium (5 ml/kg of seed)]. The minimum fresh root weight (107.29 g) was recorded with T1 (control). The maximum root yield per plot (18.36 kg) and per hectare (36.42 t/ha) was significantly recorded in T14 with the application of [50% NPK + 25% VC + 25% PM + Seed treatment of Anubhav Bio NPK consortium (5 ml/kg of seed)]. The lowest root yield was recorded in T1 (control).

The increasing in yield parameters might be due to better plant growth in all aspects resulted in more translocation of photosynthates from leaves (source) to root (sink), led to increased root length. Decrease in bulk density and increase in porosity and water holding capacity of the soil due to organic nutrient sources might have contributed in increased root diameter of the plants. Similar type of findings was also reported by Jagadeesh *et al.* (2018) [11] in beet root, Chaudhary *et al.* (2015) [5] in cabbage and Dhangar (2016) [6] in carrot. Increased marketable root yield due to accumulation of humus substances could have mobilized the reserve food materials to the sink through increased activity of hydrolyzing and oxidizing enzymes and high C: N ratio with better nutrients availability in a readily available form. Nitrogen is the major constituent of chlorophyll, proteins and

amino acids, the synthesis of which is accelerated by the increased supply of nitrogen in soil (Arnon, 1943; Gupta and Rao, 1979; and Verma *et al*., 1974) [2, 9, 26]. Increased yield due to better availability of nutrients and the balanced C: N ratio might have increased the synthesis of carbohydrates which ultimately promoted greater yield (Jose *et al.,* 1988). These aggregates affect the soil fertility and often determine the retention and movement of water, diffusion of gases, growth and development of roots in the soil which contributed to the growth of the plant. In addition to this, application of organics helps the soil micro-organisms to produce poly saccharides and thus leads to better soil structure useful for root growth (Balasubramanian, 1972) [3].

**Table 3:** Effect of integrated nutrient management on root length, root diameter, fresh weight of root and root: shoot of radish cv. Japanese white

| Treatment | | Root length (cm) | Root Diameter (cm) | Fresh weight of root (g) | Root: Shoot |
|---|---|---|---|---|---|
| T1 | Absolute Control | 22.40 | 2.31 | 0.85 | 107.29 |
| T2 | RDF (80 :40: 80 NPK kg/ha) | 24.34 | 2.78 | 1.10 | 133.91 |
| T3 | FYM (20 t/ha) | 22.72 | 2.46 | 0.92 | 121.55 |
| T4 | 75% FYM + 25% RDF | 23.86 | 2.69 | 1.08 | 130.24 |
| T5 | Vermicompost (5 t/ha.) | 23.63 | 2.54 | 1.06 | 123.35 |
| T6 | 75% Vermicompost + 25% RDF | 26.63 | 3.39 | 1.26 | 182.14 |
| T7 | Poultry manure (4 t/ha) | 23.08 | 2.53 | 0.97 | 121.17 |
| T8 | 75% Poultry manure + 25% RDF | 24.71 | 2.94 | 1.15 | 145.75 |
| T9 | 50% NPK + 50% FYM + Seed treatment of Anubhav Bio NPK consortium (5 ml/kg of seed) | 24.46 | 2.81 | 1.13 | 140.76 |
| T10 | 50% NPK + 50% PM + Seed treatment of Anubhav Bio NPK consortium (5 ml/kg of seed) | 24.87 | 3.01 | 1.17 | 154.20 |
| T11 | 50% NPK + 50% VC + Seed treatment of Anubhav Bio NPK consortium (5 ml/kg of seed) | 27.24 | 3.43 | 1.29 | 184.40 |
| T12 | 50% NPK + 25% FYM + 25% PM + Seed treatment of Anubhav Bio NPK consortium (5 ml/kg of seed) | 25.31 | 3.14 | 1.19 | 157.89 |
| T13 | 50% NPK + 25% FYM + 25% VC + Seed treatment of Anubhav Bio NPK consortium (5 ml/kg of seed) | 25.89 | 3.33 | 1.22 | 167.94 |
| T14 | 50% NPK + 25% VC + 25% PM + Seed treatment of Anubhav Bio NPK consortium (5 ml/kg of seed) | 27.39 | 3.55 | 1.32 | 196.68 |
| S. Em. ± | | 0.61 | 0.086 | 5.40 | 0.02 |
| CD at 5% | | 1.79 | 0.25 | 15.70 | 0.07 |
| C.V. (%) | | 4.32 | 5.08 | 6.34 | 3.95 |

**Table 4:** Effect of integrated nutrient management on yield of radish cv. Japanese white

| Treatment | | Yield (kg/plot) | Yield(t/ha) |
|---|---|---|---|
| T1 | Absolute Control | 11.06 | 21.94 |
| T2 | RDF (80 :40: 80 NPK kg/ha) | 15.33 | 30.41 |
| T3 | FYM (20 t/ha) | 13.17 | 26.12 |
| T4 | 75% FYM + 25% RDF | 14.66 | 29.08 |
| T5 | Vermicompost (5 t/ha.) | 14.33 | 28.44 |
| T6 | 75% Vermicompost + 25% RDF | 17.28 | 34.29 |
| T7 | Poultry manure (4 t/ha) | 13.76 | 27.30 |
| T8 | 75% Poultry manure + 25% RDF | 15.86 | 31.47 |
| T9 | 50% NPK + 50% FYM + Seed treatment of Anubhav Bio NPK consortium (5 ml/kg of seed) | 15.67 | 31.09 |
| T10 | 50% NPK + 50% PM + Seed treatment of Anubhav Bio NPK consortium (5 ml/kg of seed) | 15.95 | 31.65 |
| T11 | 50% NPK + 50% VC + Seed treatment of Anubhav Bio NPK consortium (5 ml/kg of seed) | 17.61 | 34.94 |
| T12 | 50% NPK + 25% FYM + 25% PM + Seed treatment of Anubhav Bio NPK consortium (5 ml/kg of seed) | 16.06 | 31.87 |
| T13 | 50% NPK + 25% FYM + 25% VC + Seed treatment of Anubhav Bio NPK consortium (5 ml/kg of seed) | 16.41 | 32.56 |
| T14 | 50% NPK + 25% VC + 25% PM + Seed treatment of Anubhav Bio NPK consortium (5 ml/kg of seed) | 18.36 | 36.42 |
| S. Em. ± | | 0.61 | 1.21 |
| CD at 5% | | 1.77 | 3.51 |
| C.V. (%) | | 6.84 | 6.84 |

## Conclusions

From the present investigation it can concluded that combine application of 50% NPK of (RDF (80:40: 80 NPK kg/ha) + 25% Vermicompost + 25% Poultry manure + Seed treatment of Anubhav Bio NPK consortium (5 ml/ kg of seed) recorded the highest growth in terms of plant height, number of leaves, fresh and dry weight of shoot, leaf area and yield parameter such as root length, root diameter, root to shoot ratio and yield of radish crop.

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