International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2019; 7(6): 2972-2974

Received: 16-09-2019
Accepted: 18-10-2019

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Influence of organic manures, inorganic fertilizers and their combinations on growth and quality of radish (*Raphanus sativus* L.)

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Abstract
A field investigation was carried out during *rabi* season of 2015-16 at Vegetable Research Farm, College of Horticulture, Mandsaur (MP) to study the influence of organic manures, inorganic fertilizers and their combinations on growth and quality of radish. The experiment consisted of 10 different treatments of organic manures, inorganic fertilizers and their combinations i.e. T_1 RDF(100:80:50 kg NPK/ha), 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), 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). These treatments were evaluated under Randomized Block Design (RBD) with 3 replications. Application of recommended dose of fertilizers through combination of fertilizer and organic manures significantly increased the crop growth and yield attributes and root yield as compared to other treatments. The application of 75% NPK + 25% nitrogen through vermicompost (T_6) resulted in maximum values of growth attributes *viz.*, fresh weight of shoot (91.5 g), dry weight of shoot (9.2 g) and SPAD value (57.49) at harvesting stage. The quality attributes viz. fiber content (763.67 mg/100 g), TSS (5ºBrix) and ascorbic content (37.17 mg/100g) in roots were also reported maximum by the application of 75% NPK + 25% nitrogen through vermicompost.

Keywords: Organic manure, vermicompost, radish, quality attributes, poultry manure, FYM

Introduction
Radish (*Raphanus sativus* L.) is a member of brassicaceae family and popular root vegetable grown all over world. In India it is widely cultivated in northern and southern plains, as well as in hills. It can be cultivated under cover for early production but large scale production in field is more common in India. Radish is grown for its young tender tuberous root which is consumed either raw as salad or cooked as a vegetable. Radish has cooling effect, prevents constipation and increases appetite. It is recommended for patients suffering from piles, liver troubles and jaundice. The juice of fresh leaves is used as diuretic and laxative.

Radish is a good source of vitamin- C (ascorbic acid), containing 15-40 mg per 100 g of edible portion and supplies a variety of minerals. Trace elements in radish include aluminum, barium, lithium, manganese, silicon, titanium, fluorine and iodine (up to 18 u g/10 g). Beside tender leaves which are used as greens are rich in vitamin-A and C. 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 isothiocynates (Bose *et al*., 2000) [1].

Radish is an annual or biennial herb depending on types. The leaves are very from 10-15 cm in small – rooted cultivars to as much as 45 cm long in large rooted cultivars. The edible portion of radish roots develops from both the primary root and the hypocotyls. Radish roots are varying greatly in size, shape and other external characters as well as the length of time they remain edible. The size may vary from 2.5 cm to 90 cm in length depending on cultivars. The inflorescence of radish is a typical terminal raceme of cruciferae. The flower is small, white, rose or iliac in colour with purple veins in bractless raceme. Pods are 3-7 cm long and up to 1.5 cm in diameter with 6-12 seeds and long conical beak. Radish seeds are globose, about 3 mm in diameter.

Chemical fertilizers deteriorate the quality of produce and are expensive too, leading to reduction in 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 crop (Kumar *et al.*, 2013) [4]. The escalating prices of chemical fertilizers and its detrimental impact on the soil, environment and human health urged the farmer to adopt organic manures and bio-fertilizers that offers the sustainable crop production and soil fertility. The application of organic manures such as FYM, vermicompost, neem cake and biodynamic manure has a positive effect on crop production (Mali *et al*., 2018) [8]. In recent years use of organic manures like FYM, vermicompost and neem cake for improving the productivity of crop and maintaining soil fertility and productivity of soil is gaining prominence (Mahokar *et al*., 2007 and Kushwah *et al*., 2019) [7, 6]. Vermicompost is a rich source of micro and macro nutrients, vitamins, growth hormones and enzymes. FYM is not a rich source of nutrients, increase organic carbon content to the soil and improves soil physical properties.

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 biofertilizers 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) [3, 5] Keeping the above facts in view, a field experiment was conducted to find out the effect of organic manures, inorganic fertilizers and their combinations on growth and quality of radish.

Materials and Methods

The present investigation was carried out during *rabi* season of 2015-16 at the research farm of Department of Vegetable Science, College of Horticulture, Mandsaur (M.P.) situated latitude of 23º 45' to 24º13' North, longitude of 74º 44' to 75º18' East and at an altitude of 435.20 m above mean sea level. The experiment was conducted in medium black (Vertisols) clay soils. The initial soil sample of experimental field had 7.2 pH, 0.46 dSm^{-1} electrical conductivity, low (144 Kg/ha) nitrogen, medium (33.40 kg/ha) phosphorus and high (419 kg/ha) potassium. The experiment was disigned in factorial randomized block design with three replications. The experiment was consisted ten treatments namely, T_1- RDF (100:80:50 kg NPK 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, 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 and T_{10}-50% NPK + 50% N through poultry manure. The variety under study was Japanese White. Seeds were sown on 15th December, 2015 by hand dibbling method maintain row to row distance of 30 cm and plant to plant distance 10 cm. Gap filling was done to maintain desired plant population in the plots. Nitrogen, Phosphorus and Potassium were provided through urea, DAP and muriate of potash according to the treatment. Full quantity of phosphorus, potash and 1/3 of nitrogen was applied at basal at the time of sowing while the remaining was applied 15 and 30 days after sowing. Organic manures viz., FYM, vermicompost and poultry manure were incorporated as per treatment to respective plots prior to sowing on the basis of nitrogen percentage. The nitrogen content in FYM, vermicompost, and poultry manure was 0.5%, 1.5% and 2% respectively. Optimum soil moisture was maintained in the field by regular irrigation. Observations were recorded on plant growth parameters and quality attributes of radish roots. The data obtained on various observations for each treatment were statically analyzed as per the standard procedure.

Results and Discussion

Growth attributes

The data presented in Table 1 and 2 showed significant effect of organic manures, inorganic fertilizers and their combinations on growth attributes of carrot at all the growth stages. Application of 75% NPK + 25% N through vermicompost (T_6) recorded maximum fresh weight of shoot (12.73, 83.67 and 91.50 g) and dry weight of shoot (1.24, 8.21, 9.20 g) was recorded at 30, 45 DAS and at harvesting stage, while minimum fresh weight of shoot (8.03, 59.67 and 74.07 g) dry weight of shoot (0.8, 5.57, 7.27 g) was observed under the treatment T_2 (100% N through FYM) at 30, 45 DAS and at harvesting stage, respectively. It was recorded that weight of shoot increased with the increased in days after sowing. The increase in fresh weight of leaves may be due to higher level of nitrogen. The nitrogen is also synthesized in to amino acids which are built in to complex protein and help in promising the luxurious growth of crop (Kumar *et al*., 2014) [3, 5]. Similar findings have been reported by Uddain *et al*. (2010) [11] in radish and Singh *et al*. (2007) [9] in carrot.

Among the treatments, T_6 (75% NPK + 25% N through vermicompost) recorded the maximum SPAD value (59.75, 60.05, 57.49) during the different stages followed by T_7 (75% NPK + 25% N through poultry manure), while the minimum SPAD value (50.45, 51.21, 48.71) was observed with T_2 (100% N through FYM) at all the stages of crop growth. This might be due to efficient absorption and assimilation of nitrogen from the manure by the plant which serves as a constituent of chlorophyll which has been reported to by directly proportional to photosynthetic potential and yield of any give plant (Zeid *et al*., 2015) [12].

Quality parameter

Quality parameter of the radish root was studied with respect to fiber content (mg/100 g edible portion), T.S.S, (^{0}Brix) and ascorbic acid content (mg/100 g edible portion) after harvesting. The data presented in Table 2 revealed significant influences of organic manures, inorganic fertilizers and their combinations on fiber content in radish. Treatments had significant influence on fiber content in root after harvest. Highest fiber content (763.67 mg/100 g edible portion) was determined with T_6 (75% NPK + 25% N through vermicompost) treatment. Lowest Fiber content (505.33 mg/100g edible portion) noted in case of T_2 (100% N through FYM) treatment.

The data revealed significant influence of organic manures, inorganic fertilizers and their combinations on total soluble solids content in roots of radish. Highest total soluble solid content (5^0Brix) was determined with T_6 (75% NPK + 25% N through vermicompost) treatment with significant difference than other treatments. Minimum total soluble solid content (3.81^0Brix) was found in treatment T_2 (100% N through FYM). It might be due to accumulation of more reserve substances in root. Similar results have been also reported by Sunandarani and Mallareddy (2007) [10] and Kumar *et al*. (2014) [3, 5] in carrot and Degwale (2016) [2] in garlic.

Treatments had significant influence on ascorbic acid in root after harvest. Highest ascorbic acid (37.17 mg/100 g) was

determined with T_6 (75% NPK + 25% N through vermicompost) treatment which was significantly superior over other treatments. Lowest Ascorbic acid content (27.00 mg/100 g) was found in T_2 (100% N through FYM). Kumar *et al.* (2014) [3, 5] reported that organically fertilized soils generally produce plants with lower amount of nitrogen than chemically fertilized once because of which it would be expected that organic crops would be have more vitamin-C and higher chemical quality than conventional crops.

Table 1: Effect of organic manures, inorganic fertilizers and their combinations on fresh and dry weight of shoot of radish

Treatments	Fresh weight of shoot (g)			Dry weight of shoot (g)		
	30 DAS	45 DAS	At harvesting	30 DAS	45 DAS	At harvesting
Control-RDF(100:80:50 kg NPK/ha)	9.03	63.50	77.03	0.90	6.28	7.64
100% N through FYM	8.03	59.67	74.07	0.80	5.57	7.27
100% N through Vermicompost	8.63	61.07	76.67	0.85	5.91	7.43
100% N through Poultry manure	8.57	60.33	75.90	0.86	5.87	7.41
75% NPK + 25% N through FYM	10.43	71.33	80.33	1.00	6.80	7.87
75% NPK + 25% N through Vermicompost	12.73	83.67	91.50	1.24	8.21	9.20
75% NPK + 25% N through Poultry manure	11.50	77.37	85.87	1.11	7.50	8.47
50% NPK + 50% N through FYM	9.40	65.17	77.18	0.92	6.51	7.67
50% NPK + 50% N through Vermicompost	10.37	70.83	80.30	1.00	6.61	7.77
50% NPK + 50% N through Poultry manure	9.67	70.00	79.33	0.93	6.73	7.73
SEm±	0.41	2.12	1.85	0.04	0.24	0.24
CD at 5%	1.22	6.31	5.50	0.12	0.71	0.72

Table 2: Effect of organic manures, inorganic fertilizers and their combinations on SPAD value and quality of radish

Treatments	SPAD value in leaves			Fiber Content (mg/100 g)	TSS (^{0}Brix)	Ascorbic acid (mg/100 g)
	30 DAS	45 DAS	At harvesting			
Control-RDF(100:80:50 kg NPK/ha)	53.12	52.31	49.81	549.67	4.13	32.33
100% N through FYM	50.45	51.21	48.71	505.33	3.81	27.00
100% N through Vermicompost	52.93	52.13	49.63	544.00	4.05	31.33
100% N through Poultry manure	50.48	51.33	48.83	516.00	4.03	30.67
75% NPK + 25% N through FYM	55.63	56.02	53.52	640.00	4.47	33.67
75% NPK + 25% N through Vermicompost	59.75	60.05	57.49	763.67	5.00	37.17
75% NPK + 25% N through Poultry manure	56.42	56.54	54.04	675.33	4.55	34.33
50% NPK + 50% N through FYM	53.25	52.63	50.13	584.67	4.15	32.33
50% NPK + 50% N through Vermicompost	55.47	55.44	52.94	608.67	4.37	33.00
50% NPK + 50% N through Poultry manure	53.27	53.52	51.02	596.00	4.25	32.67
SEm±	1.04	0.97	0.97	27.18	0.128	0.96
CD at 5%	3.09	2.86	2.90	80.75	0.380	2.87

Conclusion

From this study it is concluded that with the application of 75% NPK through fertilizer plus 25% N through vermicompost enhanced growth of carrot as well as improved quality attributes in radish root can be achieved.

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