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Rohit Kumar
PG Research Scholar· Department of Horticulture, Tilak Dhari Post Graduate College, Jaunpur, Uttar Pradesh, India

Rajaneesh Singh
Professor· Department of Horticulture, Tilak Dhari Post Graduate College, Jaunpur, Uttar Pradesh, India

Hari Baksh
Assistant Professor, Department of Horticulture, Tilak Dhari Post Graduate College, Jaunpur, Uttar Pradesh, India

Raj Pandey
Assistant Professor, Department of Horticulture, Tilak Dhari Post Graduate College, Jaunpur, Uttar Pradesh, India

Aman Srivastav
Assistant Professor, Department of Horticulture, Tilak Dhari Post Graduate College, Jaunpur, Uttar Pradesh, India

Maurya Suhashini Jayprakash
PG Research Scholar· Department of Horticulture, Tilak Dhari Post Graduate College, Jaunpur, Uttar Pradesh, India

Corresponding Author:
Rohit Kumar
PG Research Scholar· Department of Horticulture, Tilak Dhari Post Graduate College, Jaunpur, Uttar Pradesh, India

Effect of organic manures and inorganic fertilizer on growth and yield of radish (*Raphanus sativus* L.) *cv.* Kashi Hans

Rohit Kumar, Rajaneesh Singh, Hari Baksh, Raj Pandey, Aman Srivastav and Maurya Suhashini Jayprakash

Abstract
During the rabi season of 2021–2022, a field study was carried out at the Experimental Unit, Department of Horticulture, Tilak Dhari Post Graduate College, Jaunpur, Uttar Pradesh, to study the effects of organic manures and inorganic fertilizer on growth and yield of radish (*Raphanus sativus* L.) *cv*. Kashi Hans. In second week of September, radish seeds were sown with 30 cm x 15 cm spacing. Eleven treatments were replicated thrice, and the experiment was set up by using randomized block design. The results showed that there was a consistent increase in plant height, number of leaves per plant, and leaf width with crop age that lasted for 45 days. With 100% NPK application, the maximum plant height (30.62 cm), the number of leaves per plant (17.64), and leaf width (17.82 cm) were recorded at the end of the growth cycle, whereas the minimum plant height (13.96 cm), the number of leaves per plant (9.40), and leaf width (11.41 cm) were measured in the control (untreated plants). The maximum root length (27.42 cm), maximum root diameter (5.52 mm), maximum root weight (174.00 g), whole plant weight (332.00 g), fresh weight of leaves (170.00 g), dry weight of root (20.37 g), dry weight of leaves (38.90 g), root yield per plot (7.00 Kg), and root yield per hectare (388.92 q) were recorded with 50% NPK + 50% vermicompost, whereas the minimum root length (17.94 cm), root diameter (1.02 mm), root weight (76.50 g),whole plant weight (272.23 g), fresh weight of leaves (117.11 g), dry weight of root (12.95g), dry weight of leaves (25.04 g), root yield per plot (5.55 kg) and root yield per hectare (170.46 q) were recorded in control.

Keywords: Growth, yield, NPK, vermicompost, inorganic fertilizer

Introduction
The radish (*Raphanus sativus*) is a member of the family Brassicaceae (*Cruciferae*). The number of chromosomes in radish is 2n=18. It is one of the most popular root crops of the rabi season and is highly acclaimed for both its great nutritional and medicinal properties. Both tropical and temperate regions are used for its cultivation. Radish is grown throughout the nation and all year long. The principal growing states are West Bengal, Bihar, Uttar Pradesh, Karnataka, Haryana, and Rajasthan. It is simple to plant between the rows of other vegetables as a companion crop or intercrop. It may be planted on ridges to demarcate plots from one another.

Raphanus sativus is unknown in its natural habitat. Radish is believed to have originated in Europe and Asia. The multicenter origin of this crop, however, was justified by the variation in appearance and ecology among the cultivated types. The likely ancestors of European/temperate radish are a few wild species found in the Mediterranean region. It is also believed that *R. raphanistrum*, a plant commonly found in Europe, is where the cultivated radish got its start. The *R. Sativus f. raphanistroides* Makino (syn. *R. Raphanistroides* Sink) wild species, which survived in Japan's coastal regions, is thought to be the source of the Japanese type. Depending on the cultivar, radish can be an annual or biennial herb. Both the primary root and the hypocotyls develop into the part of the root that is edible. The size, colour, and shape of roots can vary greatly. The roots are tuberous and thickened, they might be spherical, tapered, or cylindrical. The size can range in length from 2.5 cm to 90 cm. The exterior of radish roots often is white, Pink (red), black, and yellow colors are also seen. The pigment anthocyanin is gives pink cultivars their colour. In radish, there are reportedly about 13 anthocyanins. All of the cultivars have white flesh. In bractless racemes, the flowers are white or pink along with purple veins. A 3–7 cm long, up to 1.5 cm in diameter, indehiscent, inflated siliqua with a long, conical beak that holds 6–12 seeds.

Radish pungency is caused by volatile iso-thiocynates, namely (trans-4-methyl-thiobutenyl iso-thiocyanate).The edible section of radish has 15–40 mg of vitamin C per 100 g, and it also contains a number of different minerals.

Popular radish cultivar Kashi Hans was developed through selection; it has soft leaves and straight tapering roots. Root length is 30-35 cm and 3.5-4.2 cm in diameter. After seeding, roots are ready to be harvested 40 to 45 days later. With the introduction of Kashi Hans, planting in North India can take place from September to February.

Although the atmosphere contains a large amount of nitrogen (70–80%) but plants cannot absorb it directly. Therefore, chemical fertilizers are typically used to meet the nitrogen needs of plants. On the other hand, there are some bacteria that can fix atmospheric nitrogen in the roots of plants. The balanced fertilization of radish is a crucial component to improving yield attributes. Nitrogen is applied in various levels to improve plant development and radish production (Patel *et al*., 1992) [6]. Phosphorus is a crucial component of phospholipids, enzymes, and nucleic acid, involved in a variety of metabolic processes, it is also necessary for the transfer of energy within the plant system (Yalwalker *et al.*, 1962) [14]. One of the three main nutrients that plants need, along with nitrogen and phosphorus, is potassium. Potassium gives plants strength and disease resistance, and it is crucial for crop productivity. It performs a crucial role by acting as an activator of various enzymes, including pyruvic kinase activity. Due to the fact that it is always involved in the transit of carbohydrates, and accumulation of both carbohydrates and soluble nitrogen compounds suggests that protein synthesis will be reduced in cases of potassium deficit. There is evidence that potassium has a direct role in the metabolic processes of chloroplasts in leaf tissues as well as in photosynthesis by influencing the actions of guard cells, it controls transpiration via controlling the opening and closing of the stomata. Potassium in these organelles activates the enzymes that produce fat and increases the oil content (Mandal and Chatterjee, 1973) [5].

Farm yard manure (FYM) of highly useful organic manure. Long-term manure tests carried out in numerous locations have shown that integrated nutrient supply systems are superior to chemical fertilizer alone in sustaining crop productivity (Gaur, 1991) [15]. Vermicompost has micro sites that are abundant in readily available carbon and nitrogen (Sudhakar *et al.*, 2002) [10]. The poultry dung contains 60% organic nitrogen as a result of fast mineralization. All crops can be benefited from using poultry manure as a valuable source of plant nutrients. According to Weil and Kroontje (1979) [13], adding poultry manure to soil has a positive impact on soil physical characteristics such bulk density, water holding capacity, and percent water stable aggregation.

Materials and Method

The current study examined the effects of organic manures and inorganic fertilizer on the growth and yield of radish (*Raphanus sativus* L.) *cv*. Kashi Hans during the *Rabi* season of 2021–2022, at the Experimental Unit of the Department of Horticulture, Tilak Dhari Post Graduate College, Jaunpur, Uttar Pradesh. In the second week of September, radish seeds were sown with (30x15) cm spacing. Indian Vegetable Research Institute, Varanasi, generated the seeds of radish *cv*. Kashi Hans. The climate of Jaunpur can be defined as subtropical. Minimum and maximum temperatures in September are 25.5 °C and 32.6 °C, respectively. Minimum relative humidity was 81%, while maximum was 92%. Radish seeds were sown at a depth ranging from 1.5 to 3cm. As part of the treatment, NPK, Vermicompost, Farm Yard Manure, and Poultry Manure were administered to the plots as per the treatments. The treatments were tested using a Randomized Block Design with three replications. The treatments were T_1 (100% NPK), T_2 (100% Farm Yard Manure), T_3 (100% Poultry Manure), T_4(100% Vermicompost), T_5 (75% NPK + 25% Farm Yard Manure), T_6 (75% NPK + 25% Poultry Manure), T_7 (75% NPK + 25% Vermicompost), T_8(50% NPK + 50% Farm Yard Manure) T_9 (50% NPK + 50% Poultry Manure), and T_{10} (50% NPK + 50% Vermicompost) and T_{11} (Control). When the land was being prepared, the appropriate amount of organic manure was applied according to the procedures. Hoeing and combing were done 20 days following sowing to reduce weed competition. Additional plants were trimmed off in order to maintain a consistent plant stand at 15 cm intra-row spacing. To aid in aeration and weed removal, manual hoeing and weeding were done 30 and 45 days following sowing. When the crop reached physiological maturity, it was harvested. The statistical programme used analysis of variance (ANOVA) to analyse the data, and the RBD test with a probability of 5% was used to compare the means.

Result and discussion

Growth characters

The data (Table 1) showed that with increasing crop age, there was a consistent increase in plant height, leaf number per plant, and leaf width. At later phases of development, the rate of growth in these features was slow. With 100% NPK, the maximum plant height (19.94, 28.12, and 30.62 cm), leaf width (10.72, 15.75, and 17.82 cm), and number of leaves per plant (8.96, 16.24, and 17.64 cm) were all reached. In Control the minimum plant height (3.98, 11.14, and 13.96 cm), leaf width (4.75, 9.29, and 11.41 cm), and number of leaves per plant (1.81, 8.48, and 9.40 cm) were noted. The plant height was greatly influenced by T_1 (100% NPK). Increased vegetative growth of plants was caused by cell elongation, cell division, and an increase in plant height, number of leaves per plant, and leaf width due to the presence of readily available form of nitrogen in higher quantities. Similar findings were found, respectively, by Islam *et al.* (2011) [1], Subedi *et al.* (2018) [9], Jadhao *et al.* (1999) [2], and Sharma (2000) [8].

Yield characters

Root length (cm), root diameter (mm), root weight (g), whole plant weight (g), fresh weight of leaves (g), dry weight of roots (g), dry weight of leaves (g), root yield per plot (Kg), and root yield per hectare (q) of radish were all significantly influenced by organic manures and inorganic fertilizer, as shown in Table (2).

Maximum root length (27.42 cm) was observed under treatment T_{10} (50 percent NPK + 50 percent Vermicompost), while minimum root length (17.94 cm) was observed under treatment T_{11} (control). Organic manures may have helped to increase the length of the roots of the plants by decreasing the bulk density of the soil and increasing its porosity and water holding capacity.

Table 1: Effect of organic manures and inorganic fertilizer on plant height, number of leaves per plant and leaf width of radish *cv.* Kashi Hans.

Treatments	Plant height (cm) at DAS			Number of leaves per plant at DAS			Leaf width (cm) at DAS		
	15	30	45	15	30	45	15	30	45
T_1	19.94	28.12	30.62	8.96	16.24	17.64	10.72	15.75	17.82
T_2	10.13	20.12	22.24	4.14	11.36	12.24	6.98	11.94	13.94
T_3	8.78	18.74	21.38	3.72	10.88	11.82	6.42	11.36	13.48
T_4	14.50	24.98	26.44	6.32	13.62	14.58	8.82	13.78	15.74
T_5	11.22	21.84	23.98	5.19	12.18	13.16	7.58	12.52	14.64
T_6	6.94	17.24	19.84	3.11	10.23	11.31	6.01	10.76	12.92
T_7	16.78	26.34	28.54	7.75	14.74	15.70	9.64	14.64	16.62
T_8	5.52	15.94	18.12	2.64	9.72	10.67	5.56	10.24	12.34
T_9	4.84	13.58	15.74	2.02	9.16	10.02	5.08	9.78	11.92
T_{10}	12.62	23.16	25.12	5.82	12.82	13.74	8.14	13.08	15.12
T_{11}	3.98	11.14	13.96	1.81	8.48	9.40	4.75	9.29	11.41
CD at 5%	0.043	0.041	0.040	0.038	0.089	0.043	0.136	0.044	0.041
SE(m)±	0.014	0.014	0.013	0.013	0.030	0.014	0.046	0.015	0.014

The solubilization of plant nutrients by the addition of vermicompost, which increased uptake of NPK, may be responsible for the increase in root length. Finding is consistent with findings of Rajan and Mahalakshmi (2007) [7] and Kumar *et al*., (2014) [4]. Maximum root diameter (5.42 mm) was seen in the T_{10} treatment (50% NPK + 50% Vermicompost), whereas T_{11} (control) had the minimum root diameter (1.02 mm), in radish, Uddain *et al.* (2010) [11] and Kumar *et al.* (2014) [4] showed similar outcomes. Maximum root weight (174.00 g) was seen in the T_{10} treatment (50% NPK + 50% Vermicompost), whereas T_{11} (Control) had the minimum root weight (76.50 g).This was attributed due to the solubilizing impact of Vermicompost, which boosted NPK absorption by solubilizing plant nutrients. As a source of all essential macro and micronutrients in forms that are available during mineralization, organic manure directly contributes to plant growth by enhancing the physical and physiological characteristics of soil, Verma *et al*. (2017) [12] and Kumar *et al.* (2014) [4] both found similar findings in radish. Maximum whole plant weight (332.00 g), fresh leaf weight (170.00 g), dry root weight (20.37 g), and dry leaf weight (38.90 g) were recorded in T_{11} (Control), whereas minimum whole plant weight (272.23 g), fresh leaf weight (117.11 g), dry root weight (12.95 g), and dry leaf weight (25.04 g) were. In relation to this Kumar *et al.* (2014) [4] and Uddain *et al.* (2010) [11] both found similar relevant results.

T_{10} (50% NPK + 50% Vermicompost) recorded the highest root yield per plot (7.00 Kg) and the highest root yield per hectare (388.92 q), whereas T_{11} (Control) recorded the lowest root yield per plot (3.06 Kg) and the lowest root yield per hectare (170.46 q). Many of the nutrients included in vermicompost are converted into more usable forms that plants can more easily absorb through the digestion of the various organic wastes by earthworms. In radish, Uddain *et al.* (2010) [11], Kumar *et al.* (2014) [4], and Kumar *et al.* (2022**)** [3] found similar findings.

Table 2: Effect of organic manures and inorganic fertilizer on root length (cm), root diameter (mm), root weight (g), whole plant weight (g), fresh weight of leaves (g), dry weight of root (g), dry weight of leaves (g), root yield per plot (Kg) and root per hectare (q) of radish *cv.* Kashi Hans

Treatments	Root length (cm)	Root diameter (mm)	Root weight (g)	Whole plant weight (g)	Fresh weight of leaves (g)	Dry weight of root (g)	Dry weight of leaves (g)	Root yield per plot (Kg)	Root yield per hectare (q)
T_1	20.98	2.81	132.18	290.92	135.23	15.86	28.67	5.28	293.35
T_2	24.92	4.12	150.12	312.09	148.50	17.92	34.14	6.00	333.36
T_3	18.62	1.38	116.28	274.21	120.21	13.38	25.68	4.65	258.35
T_4	26.14	4.61	167.24	316.12	154.48	18.74	36.02	6.68	371.24
T_5	22.62	3.22	138.78	294.20	139.03	16.34	30.14	5.55	308.35
T_6	19.74	2.01	124.12	282.32	127.08	14.64	27.04	4.96	275.55
T_7	20.24	2.42	128.75	286.28	131.44	15.14	27.93	5.15	286.13
T_8	23.14	3.74	144.94	301.14	143.92	17.02	31.92	5.79	321.70
T_9	19.04	1.72	120.64	278.72	124.22	14.04	26.36	4.82	267.77
T_{10}	27.42	5.42	174.00	332.00	170.00	20.37	38.90	7.00	388.92
T_{11}	17.94	1.02	76.50	272.23	117.11	12.95	25.04	3.06	170.46
CD at 5%	0.048	0.036	2.093	2.984	0.094	0.053	0.048	0.045	0.381
SE(m)±	0.016	0.012	0.705	1.005	0.032	0.018	0.016	0.015	0.0128

Conclusion

From the results obtained during the present investigation with different treatment combinations of NPK and organic manures on vegetative growth and yield in radish cv. Kashi Hans, it is concluded that application of 100% NPK significantly increased the height of plant, number of leaves, leaf width and root length, root diameter, root weight, whole plant weight, fresh weight of leaves, dry weight of root, dry leaves, root yield per plot and root yield per hectare were maximum in 50% NPK + 50% Vermicompost application.

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