ISSN (Online): 2091-2609
DOI Prefix: 10.3126/ijasbt

International Journal of Applied Sciences and Biotechnology (IJASBT)

Research Article

Effect of Different Doses of Vermicompost and Inorganic Fertilizer on Growth and Yield of Radish (*Raphanus sativus*) Varieties in Kaski, Nepal

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Article Information

Received: 16 October 2025
Revised version received: 8 December 2025
Accepted: 11 December 2025
Published: 22 December 2025

Cite this article as:
S. Marahatta (2025) Int. J. Appl. Sci. Biotechnol. Vol 13(4): 153-161. DOI: 10.3126/ijasbt.v13i4.87750

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Abstract

The research was conducted at Kaski, Nepal from March to June 2021 to study different doses of vermicompost and inorganic fertilizers on growth and yield of radish (*Raphanus sativus)* The experiment was laid out in a two-factor Randomized Complete Block Design (RCBD) with 12 treatments and 3 replications. The first factor was variety—Tokinashi and Mino Early—and the second factor was fertilizer level, consisting of six treatments: control (no fertilizer), 75% vermicompost + 25% inorganic fertilizer, 50% vermicompost + 50% inorganic fertilizer, 25% vermicompost + 75% inorganic fertilizer, 100% inorganic fertilizer, and 100% vermicompost. Vegetative parameters were recorded at 20, 30, 40 and 50 days after sowing whereas yield parameters: biological yield per plant, economic yield per plant, root length and root diameter were recorded at 55 days after sowing. It has been observed that the growth and yield attributing characters of radish were significantly affected by variety and fertilizer levels. Mino early recorded highest result for all vegetative parameters. However, highest yield attributing characters was recorded from Tokinashi. The combination of inorganic fertilizer with 50-75% with vermicompost gave better result in terms of both growth and yield attributing parameters than 100% inorganic fertilizer alone. Interaction effect of variety and fertilizer levels for all parameters at all dates of observations was found to be non-significant. Overall, the highest yielded was from variety, Tokinashi (4.55kg/m^2) and the fertilizer combination of 50% vermicompost + 50% inorganic fertilizer (5.61kg/m^2). Therefore, this combination is recommended for late-season radish production in Kaski, Nepal.

Keywords: *Raphanus sativus*; vermicompost; inorganic fertilizer; integrated nutrient management; growth and yield.

Introduction

Nepal is an agricultural country, and agriculture is the mainstay of Nepalese economy. Agricultural cultivated land comprises 21% of total land area and agriculture contributes 27.59% to national GDP (MoF, 2019). Vegetables are mostly grown in Nepal after fruits. The area and production under vegetables is increasing day by day. Vegetables cover 297,195 hectare area with production of 4,271,270mt in Nepal (MOALD, 2019). Kaski is one of the major vegetable hubs of the country. Government project Prime Minister Agriculture Modernization Project (PMAMP) has recognized this district as the vegetables superzone with the aim of promotion, expansion, mechanization and commercialization of vegetable production in its area. The area, production and yield under vegetables in Kaski is 5344 ha, 75,276 mt and 14.09 mt/ha respectively (MOALD, 2021). Among different vegetables, radish is one of the most popular vegetable crops of Nepal. It is cultivated mainly in kitchen garden for home consumption and can be successfully grown throughout the year in hills of Nepal. Root is mainly the edible part of radish. However, leaves are also consumed as fresh vegetable. In Unani, Greeko-

Arab and Indian folk medicine, radish is used as a household remedy for the treatment of many diseases such as jaundice, gallstone, liver diseases, rectal prolapse, indigestion, and other gastric pains (Banihani, 2017). It is principally a cool season vegetable, but Asiatic varieties can tolerate higher temperature than European varieties. The growth and yield of radish greatly depend upon favorable soil and climatic conditions. Moreover, radishes have much potential to perform valuable functions within organic cropping systems (Gruver *et al*., 2014).

Radish being a short duration crop, nutrition during this short period is of utmost importance for its proper growth and development. Inorganic fertilizers contain nutrients that have been broken down already into the most basic of its components for easy absorption by the plants. Yet, it can also be washed away easily when watering or irrigating the plants (Evanylo and Alley, 1997). Inorganic fertilizers are not entirely composed of the nutrients needed by the plants. They also contain salts and other compounds. These are not absorbed by the plants, so they are left behind in the soil and build up over time. When found in large amounts in the soils, these compounds can alter the chemistry of the soil that makes it less ideal for planting (Manivannan *et al*., 2009). These toxic compounds may also get washed away when watering the plants and seep into groundwater. Inorganic fertilizers are subjected to easy breakdown in soil compared to organic manures and, therefore, easily contaminate soil, water, and air. Moreover, continuous use of them can cause excessive leaching of nutrients and salinity-induced plant stress (Chaoui *et al*., 2003). Major source of contamination is from nitrogenous and phosphatic fertilizers (Kundu and Mandal, 2009), which affect soil properties, runoff cause water contamination, or sometime escape to atmosphere affecting air quality thereby enhanced contribution to greenhouse gases contributing to climate change (Rashmi and Chakravarthy, 2020).

Though chemical fertilizers increase crop production; their overuse has hardened the soil, decreased fertility, strengthened pesticides, polluted air and water, and released greenhouse gases, thereby bringing hazards to human health and environment as well (Pahalvi *et al*., 2021). The adverse effect of these synthetic chemicals on human health and environment can only be reduced or eliminated by adopting new agricultural technological practices such as shifting from chemical intensive agriculture which includes the use of organic inputs such as manure, biofertilizers, biopesticides slow-release fertilizer etc. which would improve the application efficiency as well as use efficiency of the fertilizers. Opting organic farming will create a healthy natural environment and ecosystem for the present as well as future generation (Kumar *et al*., 2019).

Vermicompost is a product of the biological degradation and the consequent stabilization of the organic substance by the activity of microorganisms and earthworms. In comparison with the common composts, the vermicompost contains predominantly higher quantities of nutrients in the total and also in available forms (Van Groenigen *et al*., 2014). The content of the plant-growth regulators in vermicompost is 5 even 6 times higher than in the classical composts (Pathma and Sakthivel, 2012). Vermicompost provides vital macronutrients N, P_2O_5, K_2O, Ca and Mg along with micronutrients as Fe, Mn, Zn and Cu. Use of vermicompost for vegetable production in large scale can solve the problem for disposal of wastes and solve the problem of lack of organic manure. On the other hand, a judicious combination of organic and inorganic sources of nutrients might be helpful to obtain a good economic return with good soil health for the subsequent crops. Earthworms consume large quantities of organic matter, and excrete soil as cast and this cast have several enzymes and rich in plant nutrients, beneficial bacteria and mycorrhizae (Tripathi *et al*., 2015). Performance of plant growth depends on availability of soil nutrients which is related to the judicious application of chemical fertilizers and organic manure. Use of organic fertilizers like vermicompost by farmers is low and limited studies on the effect of vermicompost and inorganic fertilizers on growth and yield of radish are reported. So, in this study, different combination of vermicompost with inorganic fertilizer are studied for the assessment of growth and yield parameters in different radish varieties. This study will serve as a reference and guideline to the different stakeholders involved in radish production.

Materials and Methods

Experimental Site

The research was conducted in February to June 2021 to study the effective dose of vermicompost and inorganic fertilizer in growth and yield of radish varieties. The field trial was conducted in the coordinates of Latitude 28.2622°N and Longitude 84.0167°E. The site was purposively selected as it was assigned as the vegetables superzone under PMAMP within the district. Within the growing period, the environmental conditions are shown in Fig. 1. the highest temperature recorded was 31°C whereas lowest temperature recorded was 12°C. The relative humidity was in range of 17-39.5%. The total precipitation was 65.75mm.

Chemical Properties of Soil

The experimental field was under mono cropping of tomato under plastic house. Soil sample was taken by digging pit of 25 cm depth in diagonally from the research field of area 21m*6m before planting radish seeds and made composite to test chemical properties of soil. The sample was sent for further analysis in Regional Soil Testing Laboratory, Pokhara, Kaski, 2021. The results of soil properties are shown in Table 1.

Experimental Design

A Completely Randomized Block Design (RCBD) with two factors was employed under homogeneous field conditions to simulate farmer's fields. The treatments used in the experiment are shown in Table 2.

Urea, SSP and MOP were taken as source of Nitrogen, Phosphorous and Potassium respectively. The amount of vermicompost was calculated on the basis Phosphorous required as per RDF. The calculation for the fertilizer requirements is shown in Table 3. Each treatment was replicated 3 times; each block with 12 plots within them. The net plot size was of dimension 1.2 m*1.6 m i.e. 1.92 m^2 and 50 cm alley was left between plots as well as blocks.

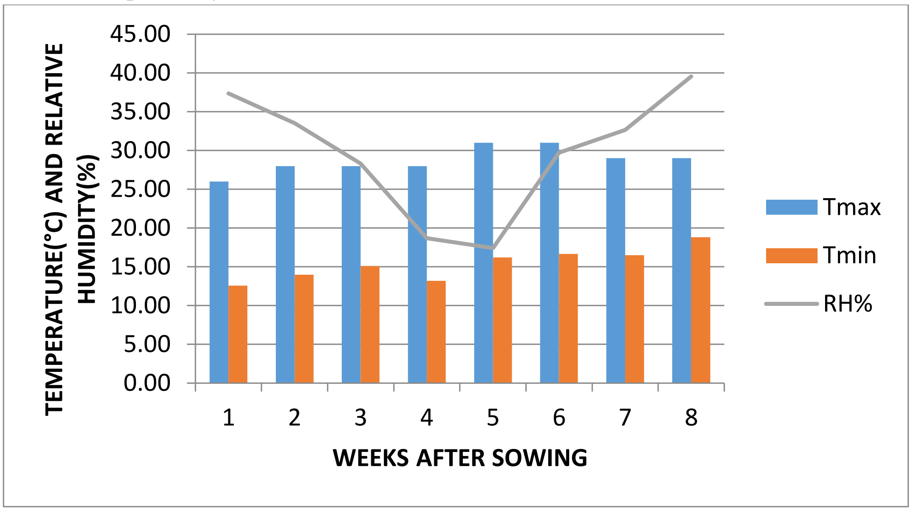

Fig. 1: Weekly average maximum and minimum temperature and relative humidity during the crop period. (Source: Nepal Hydrological and Meteorological Department, 2021)

Table 1: Physio-chemical properties of soil of the experimental field as per the reports of soil test.

Soil Properties	Values	Rating
Soil Texture	-	Sandy Loam
Soil pH	6.7	Neutral
Nitrogen (%)	0.11	Medium
Phosphorous (Kg/ha)	45.66	Medium
Potassium (Kg/ha)	244.92	Medium
Organic Matter (%)	2.1	Low

Table 2: Treatments, varieties, and fertilizer combinations used in the experiment.

Factor	Variety / Fertilizer Combination	Description
Variety	Tokinashi	Early-maturing radish variety
	Mino Early	Popular radish variety in mid-hills
Fertilizer	Control	No fertilizer applied
	75% vermicompost + 25% inorganic fertilizer	Partial organic + inorganic
	50% vermicompost + 50% inorganic fertilizer	Equal organic and inorganic
	25% vermicompost + 75% inorganic fertilizer	Mostly inorganic fertilizer
	100% inorganic fertilizer	Full recommended dose (RDF)
	100% vermicompost	Full organic dose

Table 3: Estimated N, P, and K applied per hectare for each fertilizer treatment. VC: Vermicompost (N:P:K = 1.75:1:0.75); RDF: Recommended dose of fertilizer (100:80:40 kg N:P:K/ha).

Fertilizer Composition	N (kg/ha)	P (kg/ha)	K (kg/ha)	Description
Control	0	0	0	No fertilizer
75% VC + 25% RDF	24.5 + 25 = 49.5	16 + 20 = 36	12 + 10 = 22	Partial organic + inorganic
50% VC + 50% RDF	16.7 + 50 = 66.7	11 + 40 = 51	8.6 + 20 = 28.6	Equal organic and inorganic
25% VC + 75% RDF	8.8 + 75 = 83.8	5.3 + 60 = 65.3	4.5 + 30 = 34.5	Mostly inorganic
100% RDF	100	80	40	Full inorganic dose
100% VC	57	32	24	Full vermicompost dose

Field Preparation and Maintenance

The field was ploughed thoroughly two times with mini tiller and then levelled which made field suitable for seeding. The seeds were sown in raised bed Regular watering was carried out as required for proper germination. Vermicompost, half dose of Urea and full dose of SSP and MOP were broadcasted as basal dose, remaining half of urea in two split doses at 15 and 25 days after sowing. Gap filling was done as and when needed. First irrigation was given immediately after sowing. Afterwards, it was given once in 3 days up to one week before of harvest. Weeding was carried once a week throughout the research period manually and earthing up was done after 5 weeks of sowing seeds. To control seedling damping off, contact fungicide (SAAF trade name) was applied to the main field at the rate of 2 gram per liter of water. One month after sowing, problem of larvae of Cabbage butterfly was seen in the field and destroying the leaves severely. Thus, to control these larvae of Cabbage Butterfly, Cyperin-10 (Cypermethrin 10% E.C) insecticide at the rate of 2mL/L of water was sprayed using sprayer. Harvesting was done manually with hands at 55 days after sowing.

Sampling

Each plot contained 48 plants which was the sampling frame. Out of these, 10 plants in each plot were selected by simple random sampling technique in each plot for data collection. Two types of parameters i.e. growth and yield parameters were chosen for evaluation of five sample plants. The height of 10 sample plants in each plot was recorded at 20, 30, 40 and 50 days after sowing in centimeter from ground level up to the growing point with the graduated ruler. In each plot, number of leaves in 10 sample plants were counted and recorded in successive stages of growth. Leaf breadth of 10 sample plants was recorded from topmost portion, middle portion and lowermost portion in centimeter and averaging was done from each plot at same days previously mentioned. The maximum spreading of leaves as North-South and East-West was measured with the help of measuring tape and averaging was done to measure canopy cover at same days previously mentioned. Root length was measured with the help of measuring tape from crown to the lowermost tip. Similarly, root diameter was measured at crown, middlemost portion and lowermost portion of root with the help of Vernier Caliper and averaging was done. The biological and economic yield per plant was taken from 10 sample plants and measured with the help of weighing balance. In addition, yield (kg/m^2) was calculated from 10 sample plants and the area from 10 sample plants was converted to 1m^2 and finally yield was expressed in kg/m^2.

Tabulation and Analysis of Data

The obtained data was tabulated in Microsoft Excel and R studio (v4.0.0) was used to analyze the data. ANOVA for all the characters was performed by 'F' variance ratio test that was used for analyzing the significance of variety and doses of vermicompost and inorganic fertilizer on production of Radish. Mean, Standard Deviation, Coefficient of Variation for all the treatments were calculated. The mean was evaluated by Duncan's Multiple Range Test (DMRT) according to (Gomez & Gomez, 1984) for interpretation level of Probability. The significance was determined using format of ANOVA table. The R studio (v4.0.0) was used to find the coefficient of variance, grand mean, and standard error of mean. For comparing the yield from plots of different treatments, percentage increase in yield over control was calculated using the following formula given by (Kansagara, 2018); Increase in yield over control (%) = [T-C/C] ×100 where, T = yield obtained from the treated plot; C = yield obtained from the control plot.

Results and Discussion

Days to 50% Germination

50% germination was observed earlier in Mino early variety than Tokinashi variety. Poor germination of seeds of Tokinashi was also observed in a study by (Chapagain *et al*. 2010). Among the fertilizers, 50% germination was observed earlier in 100% vermicompost followed by 75% vermicompost + 25% inorganic fertilizer in both varieties. Growth parameters

Plant Height

Plant height of the two varieties was not significantly different at 20 days after sowing, but significant differences were observed at 30, 40, and 50 days after sowing (Table 4). Fertilizer levels had no significant effect at 20 days after sowing, whereas significant effects were observed at later stages. At 30 days after sowing, Mino Early recorded the greatest height (31.13 cm) and Tokinashi the smallest (27.44 cm). Among fertilizers, 100% vermicompost produced the tallest plants (33.32 cm), statistically similar to 75% vermicompost + 25% inorganic, while the control (24.15 cm) and 100% inorganic gave the smallest heights. At 40 days after sowing, Mino Early again showed the tallest plants (43.88 cm) and Tokinashi the shortest (37.14 cm). The maximum height among fertilizers was observed with 100% vermicompost (43.42 cm), statistically similar to 75% VC + 25% inorganic and 25% VC + 75% inorganic, and comparable to 50% VC + 50% inorganic and 100% inorganic. The control recorded the lowest height (36.74 cm). At 50 days after sowing, Mino Early reached 51 cm, while Tokinashi was 49.5 cm. The tallest plants were in 75% VC + 25% inorganic (52.5 cm), statistically similar to 100% VC and comparable with 50% VC + 50% inorganic and 25% VC + 75% inorganic. The control (47.38 cm) and 100% inorganic produced the shortest plants. No significant variety and fertilizer interaction was observed for plant height at any observation date.

Table 4: Plant height (cm) of different radish varieties at different days of observations as influenced by different doses of vermicompost and inorganic fertilizers.

Treatments	Plant height (cm)			
	20DAS	30 DAS	40 DAS	50DAS
Varieties				
Tokinashi	16.01	27.44[b]	37.14[b]	49.5[b]
Mino Early	16.55	31.13[a]	43.88[a]	51[a]
SEM (+/-)	0.26	0.48	0.79	0.5
F-test	NS	***	***	*
LSD (=0.05)	0.75	1.42	2.31	1.45
CV%	6.67	7	8.25	4.18
Fertilizer levels				
Control	15.61	24.15[d]	36.74[b]	47.38[c]
75% vermicompost+25% inorganic	16.66	32.37[ab]	41.64[a]	52.5[a]
50% vermicompost+50% inorganic	16.29	29.7[c]	40.02[ab]	50.12[ab]
25% vermicompost+75% inorganic	15.83	30.03[bc]	41.21[a]	49.98[abc]
100% inorganic	16.74	26.15[d]	40.03[ab]	49.38[bc]
100% vermicompost	16.55	33.32[a]	43.42[a]	52.14[a]
SEM (+/-)	0.44	0.84	1.36	0.86
F-test	NS	***	*	**
LSD (=0.05)	1.3	2.46	4	2.51
CV%	6.67	7	8.25	4.18
Grand mean	16.28	29.28	40.51	50.25
Variety*Fertilizer level				
SEM (+/-)	0.63	1.18	1.93	1.21
F-test	NS	NS	NS	NS
LSD (=0.05)	1.84	3.47	5.66	3.56

Note: DAS, Days after sowing; ns, non-significant; *, significant at 0.05 P value; **, significant at 0.01 P value; ***, significant at 0.001 P value. Same letter(s) within column represent non-significant difference at 0.05 level of significance based on Duncan Multiple Range Test.

Number of Leaves

Number of leaves differed significantly between the two varieties at 20, 30, and 50 days after sowing (Table 5). Fertilizer levels had a significant effect on number of leaves at all observation dates. At 20 days after sowing, Mino Early produced the highest number of leaves (4.66) and Tokinashi, the lowest (4.37). Among fertilizers, 75% vermicompost + 25% inorganic gave the highest number of leaves (4.77), statistically similar to 100% vermicompost and comparable with other fertilizer levels, while the control recorded the lowest number (4.13). At 30 days after sowing, Mino Early again recorded the highest number of leaves (9.09) and Tokinashi, the lowest (8.20). The maximum leaf number among fertilizers was observed in 100% vermicompost (9.53), statistically similar to 75% vermicompost + 25% inorganic and significantly higher than other treatments, whereas the control produced the fewest leaves (7.73). At 40 days after sowing, the highest number of leaves was recorded in 100% vermicompost (14.93), statistically similar to 75% vermicompost + 25% inorganic and comparable with 50% VC + 50% inorganic and 25% VC + 75% inorganic. The lowest number of leaves was obtained from the control (12.0), statistically similar to 100% inorganic. At 50 days after sowing, Mino Early produced the highest number of leaves (16.21) and Tokinashi, the lowest (14.33). Among fertilizers, 75% vermicompost + 25% inorganic recorded the highest leaf number, significantly higher than the control (12.63) and statistically comparable with 100% inorganic, while other fertilizer levels were similar. No significant variety × fertilizer interaction was observed for number of leaves at any observation date.

Breadth of the Longest Leaf

Breadth of the longest leaf differed significantly between the two varieties at all observation dates and fertilizer levels had a significant effect on leaf breadth at 30, 40, and 50 days after sowing (Table 6). At 20 days after sowing, Mino Early recorded the widest leaf (5.91 cm) and Tokinashi the narrowest (3.64 cm). At 30 days after sowing, Mino Early again showed the highest leaf breadth (9.11 cm) and Tokinashi the lowest (6.04 cm). Among fertilizers, 100% vermicompost produced the widest leaves (8.52 cm), statistically similar to 75% vermicompost + 25% inorganic and 50% VC + 50% inorganic, and significantly higher than other treatments, while the control gave the smallest leaves (6.70 cm). At 40 days after sowing, Mino Early had the widest leaves (13.81 cm) and Tokinashi the narrowest (8.89 cm). Fertilizer-wise, 100% vermicompost produced the highest leaf breadth (12.40 cm), statistically similar to 75% VC + 25% inorganic and comparable with 50% VC + 50% inorganic and 25% VC + 75% inorganic, whereas the control recorded the lowest value (9.31 cm). At 50 days after sowing, Mino Early again had the widest leaf (14.31 cm) and Tokinashi the narrowest (10.57 cm). The highest leaf breadth among fertilizers was recorded in 75% VC + 25% inorganic (13.77 cm), statistically similar to 100% vermicompost (13.33 cm) and comparable with 50% VC + 50% inorganic and 25% VC + 75% inorganic, while the control had the lowest value (10.42 cm). No significant variety × fertilizer interaction was observed for leaf breadth at any observation date.

Canopy Cover

Canopy cover of the two varieties was not significantly different at 20 days after sowing, but significant differences were observed at 30, 40, and 50 days after sowing (Table 7). Fertilizer levels had no significant effect at 20 days after sowing, whereas significant effects were observed at later stages (Table 7). At 30 days after sowing, Mino Early recorded the highest canopy cover (35.90 cm) and Tokinashi the lowest (30.76 cm). Among fertilizers, 100% vermicompost produced the highest canopy cover (35.88 cm), statistically similar to 75% VC + 25% inorganic and 50% VC + 50% inorganic, and comparable with 25% VC + 75% inorganic and 100% inorganic, while the control gave the lowest value (28.74 cm). At 40 days after sowing, Mino Early again had the highest canopy cover (52.50 cm) and Tokinashi the lowest (48.75 cm). Fertilizer-wise, 75% VC + 25% inorganic recorded the highest canopy cover (54.11 cm), statistically similar to 100% VC and 50% VC + 50% inorganic, and comparable with 25% VC + 75% inorganic and 100% inorganic, whereas the control had the lowest value (45.19 cm). At 50 days after sowing, Mino Early recorded the widest canopy (45.17 cm) and Tokinashi the narrowest (41.56 cm). Among fertilizers, 50% VC + 50% inorganic produced the highest canopy cover (45.96 cm), statistically comparable with 75% VC + 25% inorganic, 100% VC, and 25% VC + 75% inorganic, while the control had the lowest value (39.25 cm). No significant variety × fertilizer interaction was observed for canopy cover at any observation date.

Table 5: Number of leaves of different radish varieties at different days of observations as influenced by different doses of vermicompost and inorganic fertilizers.

Treatments	Number of leaves			
	20DAS	**30 DAS**	**40 DAS**	**50DAS**
Varieties				
Tokinashi	4.37[b]	8.2[b]	13.45	14.33[b]
Mino Early	4.66[a]	9.09[a]	14.16	16.21[a]
SEM (+/-)	0.08	0.2	0.27	0.44
F-test	*	**	NS	**
LSD (=0.05)	0.24	0.57	0.78	1.28
CV%	7.76	9.59	8.19	12.14
Fertilizer levels				
Control	4.13[b]	7.73[c]	12[c]	12.63[b]
75% vermicompost+25% inorganic	4.77[a]	9.4[ab]	14.87[a]	16.38[a]
50% vermicompost+50% inorganic	4.57[ab]	8.48[bc]	14.23[ab]	15.88[a]
25% vermicompost+75% inorganic	4.32[ab]	8.37[bc]	13.8[ab]	15.79[a]
100% inorganic	4.57[ab]	8.35[bc]	13.02[bc]	14.59[ab]
100% vermicompost	4.73[a]	9.53[a]	14.93[a]	16.36[a]
SEM (+/-)	0.14	0.34	0.46	0.76
F-test	*	**	**	*
LSD (=0.05)	0.42	0.99	1.35	2.22
CV%	7.76	9.59	8.19	12.14
Grand mean	4.51	8.64	13.81	15.27
Variety*Fertlizer level				
SEM (+/-)	0.2	0.48	0.65	1.07
F-test	NS	NS	NS	NS
LSD (=0.05)	0.59	1.4	1.92	3.14

Note: DAS, Days after sowing; ns, non-significant; *, significant at 0.05 P value; **, significant at 0.01 P value. Same letter(s) within column represent non-significant difference at 0.05 level of significance based on Duncan Multiple Range Test.

Table 6: Breadth (cm) of longest leaf of different radish varieties at different days of observations as influenced by different doses of vermicompost and inorganic fertilizers.

Treatments	**Breadth of the longest leaf (cm)**			
	20DAS	**30 DAS**	**40 DAS**	**50DAS**
Varieties				
Tokinashi	3.64[b]	6.04[b]	8.89[b]	10.57[b]
Mino Early	5.91[a]	9.11[a]	13.81[a]	14.31[a]
SEM (+/-)	0.12	0.2	0.19	0.24
F-test	***	***	***	***
LSD (=0.05)	0.35	0.58	0.55	0.72
CV%	11.5	11.15	7.02	8.34
Fertilizer levels				
Control	4.23	6.7[c]	9.31[c]	10.42[c]
75% vermicompost+25% inorganic	4.45	7.85[ab]	12.25[a]	13.77[a]
50% vermicompost+50% inorganic	4.63	7.73[abc]	11.66[ab]	12.48[ab]
25% vermicompost+75% inorganic	4.37	7.3[bc]	11.66[ab]	12.83[ab]
100% inorganic	4.28	7.37[bc]	10.81[b]	11.82[b]
100% vermicompost	4.53	8.52[a]	12.4[a]	13.33[a]
SEM (+/-)	0.21	0.35	0.33	0.42
F-test	NS	*	***	***
LSD (=0.05)	0.61	1.01	0.95	1.24
CV%	11.50	11.15	7.02	8.34
Grand mean	4.42	7.57	11.35	12.44
Variety*Fertilizer level				
SEM (+/-)	0.29	0.49	0.46	0.6
F-test	NS	NS	NS	NS
LSD (=0.05)	0.86	1.43	1.35	1.76

Note: DAS, Days after sowing; ns, non-significant; *, significant at 0.05 P value; **, significant at 0.01 P value; ***, significant at 0.001 P value. Same letter(s) within column represent non-significant difference at 0.05 level of significance based on Duncan Multiple Range Test.

Table 7: Canopy cover (cm) of different radish varieties at different days of observations as influenced by different doses of vermicompost and inorganic fertilizers.

Treatments	**Canopy cover (cm)**			
	20DAS	**30 DAS**	**40 DAS**	**50DAS**
Varieties				
Tokinashi	14.21	30.76[b]	48.75[b]	41.56[b]
Mino Early	15.71	35.9[a]	52.5[a]	45.17[a]
SEM (+/-)	0.64	0.72	1.1	0.63
F-test	NS	***	*	***
LSD (=0.05)	1.87	2.11	3.24	1.85
CV%	18.13	9.16	9.25	6.17
Fertilizer levels				
Control	13.44	28.74[b]	45.19[b]	39.25[c]
75% vermicompost+25% inorganic	15.77	35.34[a]	54.11[a]	45.27[ab]
50% vermicompost+50% inorganic	14.8	35.49[a]	52.73[a]	45.96[a]
25% vermicompost+75% inorganic	15.28	32.08[ab]	50.63[ab]	43.65[ab]
100% inorganic	15.44	32.44[ab]	48.2[ab]	42.03[bc]
100% vermicompost	15.02	35.88[a]	52.88[a]	44.02[ab]
SEM (+/-)	1.11	1.25	1.91	1.09
F-test	NS	**	*	**
LSD (=0.05)	3.25	3.65	5.61	3.22
CV%	18.13	9.16	9.25	6.17
Grand mean	14.96	33.33	50.62	43.36
Variety*Fertilizer level				
SEM (+/-)	1.57	5.17	2.7	1.55
F-test	NS	NS	NS	NS
LSD (=0.05)	4.59	1.76	7.93	4.53

Note: DAS, Days after sowing; ns, non-significant; *, significant at 0.05 P value; **, significant at 0.01 P value; ***, significant at 0.001 P value. Same letter(s) within column represent non-significant difference at 0.05 level of significance based on Duncan Multiple Range Test.

Yield Parameters

Varieties differed significantly for biological yield per plant (Table 8). Mino Early produced the highest biological yield (421.16gm) and Tokinashi the lowest (369.71gm). Fertilizer levels significantly affected biological yield, with 100% vermicompost producing the highest yield (450.63gm), statistically similar to 75% VC + 25% inorganic, 50% VC + 50% inorganic, and 25% VC + 75% inorganic, while the control recorded the lowest value (310.67 g) (Table 8). Economic yield per plant also differed significantly between varieties, with Tokinashi producing the highest yield (181.8gm) and Mino Early the lowest (153.07gm) (Table 8). Among fertilizers, 50% VC + 50% inorganic gave the highest economic yield (224.3gm), statistically similar to 75% VC + 25% inorganic and significantly higher than other treatments, while the control produced the lowest yield (114.93 gm) (Table 8).

Root diameter varied significantly between varieties, with Tokinashi recording the largest diameter (26.99mm) and Mino Early the smallest (23.34mm). Fertilizer levels significantly influenced root diameter, with 100% vermicompost producing the largest roots (27.83mm), statistically comparable with 75% VC + 25% inorganic, 50% VC + 50% inorganic, and 25% VC + 75% inorganic, while the control recorded the smallest roots (22.17mm). Root length differed significantly between varieties, with Tokinashi producing the longest roots (27.73 cm) and Mino Early the shortest (26.09cm). Fertilizer-wise, 75% VC + 25% inorganic gave the highest root length (29.15cm), statistically similar to 100% VC and 50% VC + 50% inorganic, and comparable with 25% VC + 75% inorganic and 100% inorganic, while the control recorded the lowest value (23.78cm).Total yield (kg/m²) also differed significantly between varieties, with Tokinashi producing the highest yield (4.55kg/m²) and Mino Early the lowest (3.83kg/m²). Among fertilizers, 50% VC + 50% inorganic produced the highest yield (5.61kg/m²), statistically similar to 75% VC + 25% inorganic and significantly higher than other treatments, while the control recorded the lowest yield (2.87kg/m²). No significant variety × fertilizer interaction was observed for any yield parameter.

Table 8: Yield parameters of different radish varieties at different days of observations as influenced by different doses of vermicompost and inorganic fertilizers.

Treatments	Yield parameters				
	Biological yield per plant(gm)	**Economic yield per plant(gm)**	**Root diameter (mm)**	**Root length (cm)**	**Yield (kg/m²)**
Varieties					
Tokinashi	369.71^{b}	181.8^{a}	26.99^{a}	27.73^{a}	4.55^{a}
Mino Early	421.16^{a}	153.07^{b}	23.34^{b}	26.09^{b}	3.83^{b}
SEM (+/-)	12.95	9.31	0.63	0.53	0.23
F-test	*	*	***	*	*
LSD (=0.05)	37.97	27.29	1.85	1.55	0.68
CV%	13.89	23.58	10.61	8.32	23.58
Fertilizer levels					
Control	310.67^{c}	114.93^{c}	22.17^{c}	23.78^{b}	2.87^{c}
75% vermicompost+25% inorganic	432.6^{ab}	177.94^{ab}	26.07^{ab}	29.15^{a}	4.45^{ab}
50% vermicompost+50% inorganic	402.83^{ab}	224.3^{a}	25.85^{ab}	27.68^{a}	5.61^{a}
25% vermicompost+75% inorganic	413.7^{ab}	161.89^{bc}	24.78^{abc}	26.58^{ab}	4.05^{bc}
100% inorganic	362.17^{bc}	157.87^{bc}	24.28^{bc}	26.25^{ab}	3.94^{bc}
100% vermicompost	450.63^{a}	167.68^{b}	27.83^{a}	28.02^{a}	4.19^{b}
SEM (+/-)	22.42	16.12	1.09	0.91	0.4
F-test	**	**	*	**	**
LSD (=0.05)	65.77	47.27	3.2	2.68	1.18
CV%	13.89	23.58	10.61	8.32	23.58
Grand mean	395.43	167.44	25.16	26.91	4.19
Variety * Fertilizer level					
SEM (+/-)	31.71	22.79	1.54	1.29	0.57
F-test	NS	NS	NS	NS	NS
LSD (=0.05)	93	66.85	4.52	3.79	1.67

Note: DAS, Days after sowing; ns, non-significant; *, significant at 0.05 P value; **, significant at 0.01 P value; ***, significant at 0.001 P value. Same letter(s) within column represent non-significant difference at 0.05 level of significance based on Duncan Multiple Range Test.

Conclusion

Appropriate variety selection and rational use of fertilizers is required for proper growth and high yield of radish. From above results, it can be concluded that, among two varieties, Mino early is superior in terms of above ground yield whereas Tokinashi is superior in terms of below ground yield. The combination of 50% vermicompost+ 50% inorganic fertilizer resulted in highest economic yield, the combination of 75% vermicompost+ 25% inorganic fertilizer resulted in highest root length, and 100% vermicompost resulted in highest root diameter as well as total biological yield. Hence, vermicompost application is found to be efficient to increase the production of radish varieties. Further studies should be directed to determine the relationships in multiple seasons and in other regions of radish cultivation. Future research can be conducted on qualitative analysis of the produce of different varieties and different combinations of fertilizer levels.

Conflict of Interest

Author declares that there is no conflict of interest with the present publication.

Acknowledgements

The author gratefully acknowledges the Prime Minister Agriculture Modernization Project (PMAMP), Project Implementation Unit (Vegetables – Superzone), Kaski, Nepal and the Agriculture and Forestry University (AFU), Nepal for their financial support and facilitation of this research.

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