Turkish Journal of Agriculture - Food Science and Technology, 12(6): 932-939, 2024
DOI: https://doi.org/10.24925/turjaf.v12i6.932-939.6636

Turkish Journal of Agriculture - Food Science and Technology

Available online, ISSN: 2148-127X | www.agrifoodscience.com | Turkish Science and Technology Publishing (TURSTEP)

Effects of Different Sources of Fertilizers on Growth and Yield of Radish (*Raphanus sativus* L.)

Kabita Bhusal[1,a], Asmita Paudel[2,b,*], Bhawana Bhatta[3,c], Kaushila Bista[3,d], Saroj Sapkota[4,e]

[1]*Department of Agribotany and Conservation Ecology, Agriculture and Forestry University, Rampur, Chitwan, Nepal*
[2]*Department of Agricultural Economics and Agri-business Management, Agriculture and Forestry University, Nepal*
[3]*Department of Horticulture, Agriculture and Forestry University, Nepal*
[4]*Assistant Professor, Department of Agribotany and Conservation Ecology, Agriculture and Forestry University, Nepal*
[*]*Corresponding author*

ARTICLE INFO

Research Article

Received : 29.12.2023
Accepted : 20.03.2024

Keywords:
Raphanus sativus L.
Organic Manures
Poultry manure
Growth Parameters
Yield Parameters

ABSTRACT

Radish is a widely cultivated root crop susceptible to chemicals for its growth and development. The experiment was conducted to study the effect of different sources of organic fertilizers on growth and yield parameters in the Tokinashi variety of radish. The experiment was laid out using one factorial completely randomized block design with six treatments replicated four times. Vermicompost, goat manure, chemical fertilizers (NPK), poultry manure, farmyard manure and control were the applied treatments. Various growth and yield parameters of radish were measured and assessed at 15-day intervals. Various growth and yield parameters of radish were measured and assessed at 15-day intervals. Growth parameters were observed at 15, 30, 45, and 60 days after sowing. For yield parameters, destructive samples were taken and observed at 30 DAS and 45 DAS and harvested at 60 DAS. The assessments of plant growth and yield parameters showed that poultry manure (PM) treatments were superior. At the time of harvesting, the treatment comprising poultry manure had considerably greater plant height (30.55 cm), leaf length (29.44cm), leaf breadth (10.78cm), leaf number per plant (9.23), root diameter (10.33cm) and root length (20.16cm) with superior yield per ha (33.59 mt ha^{-1}). Poultry manure significantly enhanced root yield and was positively correlated with all growth parameters. The highest benefit-cost (B: C) ratio was recorded in chemical fertilizer (3.99), which was statistically at par with poultry manure (3.81), suggesting that poultry manure might potentially replace chemical fertilizers for the Tokinashi variety of radish cultivation.

[a] *kabitabhusal2018@gmail.com* *https://orcid.org/0009-0004-5697-459X*
[b] *paudelasmita143@gmail.com* *https://orcid.org/0000-0002-4838-4563*
[c] *bhawanabhatta2074afu@gmail.com* *https://orcid.org/0009-0003-0576-2151*
[d] *bistakaushila02@gmail.com* *https://orcid.org/0009-0002-7593-0424*
[e] *ssapkota@afu.edu.np* *https://orcid.org/0009-0001-6851-5110*

Introduction

Radish (*Raphanus sativus* L.) is a root vegetable crop of the Brassicaceae family that is successfully grown in temperate and tropical areas all over the world (Etesami et al., 2016). It is cultivated primarily for its tenderous tuberous root used in salads or as a cooked vegetable being rich in carbohydrates, proteins, vitamin A, and vitamin C, with additional health benefits (Shrestha & Thapa, 2018). Radish has a 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 a diuretic and laxative (Kushwah et al., 2020). It has gained popularity among Nepalese farmers because of its wide range of adaptability, ease of cultivation, and multiple uses. Area under radish cultivation, total production and average productivity is about 16,641 ha, 256,013 tons and 15.38 t ha^{-1} respectively, in Nepal (MOALD, 2020/21).

In Nepal, vegetable farming has significant potential, yet a considerable quantity of vegetables are imported annually. The encountered challenges in vegetable farming in Nepal, including lower root crop production, are attributed to untimely availability of fertilizers, drainage problems, weeds, pests and diseases, poor cultural practices, leaching of the nutrients from the soil, and low soil fertility (Annisha et l., 2019). An important agro-technique in determining radish proliferation and yield is nutrition (organic and inorganic) (Pant & Oli, 2021).

Each crop has its own specific nutrient requirements for obtaining optimum output. Nutrients required for crops can be obtained either from organic or inorganic sources. Organic sources include fertilizers like farmyard manure (FYM), poultry manure (PM), goat manure (GM), and vermicompost (VC) that enhance the soil quality and supply vital nutrients to plants, while inorganic sources include synthetic fertilizers.

Despite the misconception among farmers that chemical fertilizers increase productivity, there is a growing popularity of organic agriculture in Nepal, aimed at preserving the environment and the desire to prevent the contamination of agricultural products with chemicals (fertilizers and pesticides) (Ashraf et al., 2014). Organic manures are essential in mitigating the negative impacts of chemical fertilizers while maintaining yield characteristics (Wang et al., 2018).

It is difficult to increase the area under cultivation but the scientific technology of cultivation practices of radish can be advanced to increase the production. For this, optimum nutrition should be given from a variety of sources, including organic, inorganic, and bio-fertilizers (Subedi et al., 2018).

Therefore, the current research was conducted to evaluate the effects of different level of organic fertilizers on the growth and yield of radish and identify the appropriate source of fertilizers that will supply the necessary nutrients required for radish production at Tilottama Municipality of Rupandehi district, Nepal.

Materials and Methods

The field experiment was done to study the response of different fertilizers on the growth and yield parameters of radish at Tilottama Municipality of Rupandehi District of Nepal from 5th March 2023 to 5th May 2023.

Details of Research Site

The field experiment was conducted in Mahuwari village, Tilottama Municipality-11, Rupandehi district, Nepal in spring season, from 5th March 2023 to 5th May 2023. Rupandehi district has a tropical climate and is located in the Terai region in the western part of Nepal. This district is popular for agricultural production including seasonal and off-seasonal vegetable production. Geographically, this region lies within 27°36' North latitude to 85°05' longitude with an altitude of 1795 m above sea level.

Agro-meteorological Parameters of the Experimental Site

The meteorological information such as maximum and minimum temperature, average temperature, rainfall, and relative humidity were collected from the Office of Hydrology and Meteorology, Bhairahawa, Rupandehi district. The experimental site is characterized by three distinct seasons: rainy season (June to October), winter season (November to March), and spring season (April to May). The research was started in March which had a maximum temperature of 31.34°C and a minimum temperature of 15.58°C with 67% relative humidity and 1.95 mm rainfall. The maximum (35.73°C) and minimum (18.83°C) temperature with relative humidity 66.8% and rainfall 20.05 mm were noticed during the crop period in April. Similarly, during May, the maximum temperature was 37.32°C and the minimum temperature was 21.23°C with a relative humidity of 70% and rainfall of about 0 mm.

Physico-chemical Properties of Soil

Soil samples were collected from each replication, then it was shaded, dried, grounded, sieved, and sent to the laboratory to determine the nutrient status of the experimental site.

Details of Operations

The field was ploughed twice, harrowed and leveled by planking. The weeds and leftover crop residue were removed from the field, after which it was partitioned into different sections following the experimental layout. Organic fertilizers were applied 10 days prior to seed sowing, while chemical fertilizers were applied at the time of sowing. 6 kg of farmyard manure, 1.12 kg of poultry manure, 2.5 kg of vermicompost, and 2.76 kg of goat manure per plot were applied respectively, ensuring that each plot received the recommended dose of nitrogen. Chemical fertilizers were applied in 2 doses, half as basal dose at sowing and half as split dose 30 days after sowing. The individual plot size was 4 m^2 with 2 m length and 2 m breadth. Radish seeds were sown at a spacing of 20cm * 20 cm. There were tens of rows in each plot, with ten plants in each row. Thus, each plot had 100 plants. Daily light irrigation was done for the earlier 7 days. After that, field was irrigated twice a week to 7 days prior of the harvest. Thinning out was done at 15 DAS. First weeding, followed by hoeing, was done at 20 DAS while second weeding was carried at 40 DAS. To control the radish from pest damage, spraying of cow urine in 1:5 concentration was done 5 times each after 5 days interval after 20 DAS. Radish was harvested at 60 DAS.

Table 1. Physico-chemical properties of soil sample of the experimental field

SN	Parameters	Average Content	Methods
1.	Soil texture	Clay loam	Hydrometer
2.	Soil pH	6.50 (Moderately acidic	Potentiometric (1:2.5)
3.	Soil organic matter (%)	1.78 (Low)	Walkey and Black (Sikora et al. 1996)
4.	Total nitrogen (%)	0.09 (Medium)	Kjedahl distillation (Bremner, 1960)
5.	Available phosphorus (P_2O_5 kg ha^{-1})	71.64 (High)	Modified Olsens' Biocarbonate (Carter & Gregorich, 2006)
6.	Available potassium (K_2O kg ha^{-1})	100.32 (Medium)	Amonium acetate (Schollenberger & Simon, 1945)

(Source: Lumbini Agro-Environmental Lab Pvt. Ltd., 2023)

Table 2. Nutrient contents of different applied fertilizers

Fertilizers	Nitrogen %	P_2O_5 (%)	K_2O (%)
Farmyard manure	1%	0.87	2.56
Poultry manure	3.2%	2.00	2.80
Vermicompost	2.0%	0.75	2.00
Goat manure	1.3%	0.80	0.72

(Source: Lumbini Agro-Environmental Lab Pvt. Ltd., 2023) (Note: Nutrients content in the organic manure was calculated on dry weight basis)

Table 3. Effect of different fertilizers on plant height and number of leaves of radish (*Raphanus sativus* L.) at Tilottama Municipality, Rupandehi, 2023

Treatments	Plant height (cm)				No. of leaves			
	15 DAS	30 DAS	45 DAS	60 DAS	15 DAS	30 DAS	45 DAS	60 DAS
Vermicompost	8.70^{b}	18.15^{b}	23.93^{b}	25.77^{b}	4.48^{abc}	6.55^{b}	8.78^{b}	7.53^{b}
Goat Manure	8.04^{b}	17.73^{bc}	19.85^{c}	21.08^{c}	4.30^{bc}	6.33^{b}	8.05^{c}	7.18^{b}
Chemical Fertilizer	10.14^{a}	20.45^{a}	24.93^{b}	26.24^{b}	4.58^{ab}	6.50^{b}	8.48^{bc}	7.18^{b}
Poultry Manure	8.73^{b}	21.11^{a}	28.99^{a}	30.55^{a}	4.63^{a}	7.45^{a}	10.45^{a}	9.23^{a}
Farm Yard Manure	7.93^{b}	16.55^{cd}	19.40^{c}	20.59^{c}	4.25^{c}	5.30^{c}	6.75^{d}	5.93^{c}
Control	7.74^{b}	15.89^{d}	18.89^{c}	19.93^{c}	3.95^{d}	4.68^{d}	6.10^{e}	5.33^{d}
SEm (±)	0.2	0.22	0.21	0.20	0.20	0.09	0.07	0.06
$LSD_{0.05}$	1.21	1.30	1.28	1.23	1.12	0.57	0.43	0.38
CV (%)	9.41	4.72	3.75	3.39	9.85	6.17	3.52	3.08
F test	**	**	**	**	**	***	***	***
Grand mean	8.54	18.31	22.66	24.03	7.57	6.11	8.10	7.06

Means followed by the same letter (s) in a column are not significantly different at 5% level of significance as determined by DMRT. *, **, and *** represent significant at 5%, 1% and 0.1% level respectively. NS=non-significant, SEm = Standard error of the mean, LSD = Least significant difference, CV = Coefficient of variation and DAS = Days after sowing.

Observation and Data Collection

During the experiment, various observations were made on growth parameters at 15, 30, 45 and 60 days after sowing while yield attributes were observed at 30, 45, and 60 days after sowing. Two rows were selected as destructive rows from where destructive samples were taken to observe root parameters such as root length, root diameter and root weight at 30 and 45 DAS respectively. Ten sample plants were selected from six net rows. The growth and yield related parameters were observed at interval of 15 days. Financial analysis was performed for different treatments using following calculations.

- Gross income = Yield (kg/ha)×price/kg radish
- Total cost = Cost of land preparation, labors, seeds, fertilizers, irrigation, etc.
- Net return = Gross income- Total cost
- B: C ratio = Net return /Total cost

Data Analysis and Interpretation

The collected data were tabulated using MS EXCEL and analyzed using the R stat software package. Duncan's Multiple Range Test (DMART) was employed to determine the significant differences between the mean values at 5% significance level. The significant differences were determined by using the following format of ANOVA table. The data was analyzed, and findings were discussed and related to the available literature.

Results

Growth parameters were observed at 15, 30, 45 and 60 days after sowing while yield parameters were observed at 30, 45 and 60 days after sowing during the experiment. The results so obtained are described below in the table as well as figure wherever suitable.

Growth Parameter

Plant height and number of leaves

The plant height and number of leaves of radish were found to be significantly influenced by different fertilizers at all growth stages, as illustrated in Table 3. During 15 days after sowing, tallest plant height (10.14) was observed from chemical fertilizer while at other stages (30, 45 and 60 days after sowing), the tallest plant height was observed in the poultry manure (21.11, 28.99, and 30.55 cm). During all stages (15, 30, 45 and 60 days after sowing) the shortest plant height was observed in control (7.74, 15.89, 18.89, 19.93), respectively. During all stages (15, 30, 45 and 60 days after sowing), highest number of leaves was observed in the poultry manure (4.63, 7.45, 10.45, and 9.23 cm) as compared to the control condition (3.95, 4.68, 6.10, 9.23), respectively.

Leaf length and leaf breadth

The leaf length and breadth of radish were found to be significantly influenced by different fertilizers at all growth stages, as illustrated in Table 4. In general, there was an increase in leaf length and breadth up to the harvesting stage of radish. Among all treatments, maximum leaf length of 29.44 cm and leaf breadth of 10.78 cm were observed from treatment with poultry manure at 60 DAS. While minimum leaf length and leaf breadth were recorded from the control at all days of observation.

Yield and Yield Attributes

Root length and root diameter

The root length and diameter of radish were significantly influenced by different fertilizers at all growth stages as illustrated in Table 5. During all stages (30, 45 and 60 days after sowing), longest root length was observed in the poultry manure (11.24, 19.09, and 20.16) as compared to the control condition (6.25, 8.28 and 20.16), respectively. Likewise, during all stages (30, 45 and 60 days after sowing), widest root diameter was observed in the poultry manure (4.63, 8.66, and 10.33) as compared to the control condition (2.23, 4.04 and 6.53), respectively.

Fresh weight of leaf and root

The fresh root weight and leaf weight of radish were found to be significantly influenced by different fertilizers at all growth stages as illustrated in Table 6. During all stages (30, 45 and 60 days after sowing), maximum fresh root weight was observed in the poultry manure (48.00, 82.58, and 179.10) as compared to the control condition (28.17, 58.67 and 179.10), respectively. While at all stages (30, 45 and 60 days after sowing), maximum fresh leaf weight was observed in the poultry manure (33.42, 56.75, and 131.10) as compared to the control condition (20.83, 40.67 and 70.08), respectively.

Table 4. Effect of different fertilizers on leaf length and leaf breadth of radish (*Raphanus sativus* L.) at Tilottama Municipality, Rupandehi, 2023

Treatments	Leaf length (cm)				Leaf breadth (cm)			
	15 DAS	30 DAS	45 DAS	60 DAS	15 DAS	30 DAS	45 DAS	60 DAS
Vermicompost	7.64^{b}	17.56^{b}	23.04^{b}	24.80^{b}	2.78^{bc}	4.21^{c}	6.51^{c}	7.46^{c}
Goat Manure	7.24^{b}	17.17^{b}	19.08^{c}	20.20^{c}	2.55^{cd}	4.15^{c}	5.09^{d}	5.67^{d}
Chemical Fertilizer	9.19^{a}	19.53^{a}	23.98^{b}	25.21^{b}	2.92^{ab}	4.62^{b}	7.42^{b}	8.31^{b}
Poultry Manure	7.62^{b}	20.11^{a}	28.00^{a}	29.44^{a}	3.19^{a}	5.25^{a}	9.76^{a}	10.78^{a}
Farm Yard Manure	6.97^{b}	15.57^{b}	18.45^{c}	19.71^{c}	2.52^{cd}	3.48^{d}	5.06^{d}	5.72^{d}
Control	6.76^{b}	15.54^{b}	18.04^{c}	19.08^{c}	2.27^{d}	3.29^{d}	4.87^{d}	5.33^{d}
SEm (±)	0.20	0.25	0.22	0.21	0.05	0.06	0.13	0.12
$LSD_{0.05}$	1.12	1.53	1.32	1.29	0.28	0.39	0.76	0.70
CV (%)	9.85	5.80	4.01	3.71	6.83	6.17	7.86	6.46
F test	**	***	***	***	***	***	***	***
Grand mean	7.57	17.51	21.76	23.07	2.71	4.17	6.45	7.21

Means followed by the same letter (s) in a column are not significantly different at 5% level of significance as determined by DMRT. *, **, and *** represent significant at 5%, 1% and 0.1% level respectively. NS=non-significant, SEm = Standard error of mean, LSD = Least significant difference, CV = Coefficient of variation and DAS = Days after sowing.

Table 5. Effect of different fertilizers on root length and root diameter of radish (*Raphanus sativus* L.) at Tilottama Municipality, Rupandehi, 2023

Treatments	Root length (cm)			Root diameter (cm)		
	30 DAS	45 DAS	60 DAS	30 DAS	45 DAS	60 DAS
Vermicompost	7.26^{c}	10.00 ^{c}	15.70 ^{bc}	2.62 ^{cd}	5.28 ^{b}	6.97 ^{c}
Goat Manure	6.56 ^{d}	8.77 ^{de}	15.56 ^{bc}	2.65 ^{cd}	4.68 ^{c}	6.73 ^{c}
Chemical Fertilizer	8.86 ^{b}	17.39 ^{b}	18.20 ^{ab}	3.29 ^{b}	5.49 ^{b}	9.40 ^{b}
Poultry Manure	11.24 ^{a}	19.09 ^{a}	20.16 ^{a}	4.63 ^{a}	8.66 ^{a}	10.33 ^{a}
Farm Yard Manure	7.46 ^{c}	9.26 ^{d}	18.07 ^{ab}	3.08 ^{bc}	4.19 ^{d}	7.15 ^{c}
Control	6.25 ^{d}	8.28 ^{e}	14.89 ^{c}	2.23 ^{d}	4.04 ^{d}	6.53 ^{c}
SEm (±)	0.11	0.10	0.46	0.08	0.08	0.10
$LSD_{0.05}$	0.65	0.62	2.80	0.47	0.48	0.60
CV (%)	5.4	3.41	10.86	10.19	5.86	5.06
F test	***	***	***	***	***	***
Grand mean	7.94	12.13	17.10	3.08	5.39	7.85

Means followed by the same letter (s) in a column are not significantly different at 5% level of significance as determined by DMRT. *, **, and *** represent significant at 5%, 1% and 0.1% level respectively. NS=non-significant, SEM = Standard error of mean, LSD = Least significant difference, CV = Coefficient of variation and DAS = Days after sowing

Yield per hectare (t ha^{-1}) & Total biomass yield per ha (t ha^{-1})

The yield (root yield) per hectare of radish was found to be significantly influenced by different fertilizers. Poultry manure resulted in the highest yield (33.59 t ha-1) and highest biological yield (85.63 t ha-1), significantly higher than other treatments. Similarly, yield with chemical fertilizer (28.46 t ha^{-1}) was statistically at par with vermicompost application (26.13 t ha^{-1}). The minimum yield was recorded in control (17.24 t ha^{-1}).

Correlation Between Different Plant Parameters

Table 8 shows the simple correlation (r) between different plant parameters. The correlation study based on correlation coefficient revealed that all parameters taken during the study had a positive and significant correlation with each other. Number of leaves per plant and yield was highly correlated (r=0.93) which means increase in number of leaves per plant increased the yield of radish. Similarly, leaf length and breadth both were found positively and significantly correlated with yield, which means an increase in the length and breadth of leaves increased the yield of radish. Root length and root diameter were found positively and significantly correlated with yield (r=0.80 and r=0.78) respectively which means increase in root length of plant increased the root yield and same as in root diameter.

Relation Between Different Growth Parameters with Yield of Radish

Plant height and number of leaves showed strong linear positive correlation with the yield of radish (Figure 1 and 2). Leaf length and breadth showed a strong linear positive correlation with the yield of radish (Figure 3 and 4). Root length and root diameter showed strong linear positive correlation with the yield of radish (Figure 5 and 6).

Financial Analysis of Radish Production

Net return and B:C ratio varied with different fertilizers applied during cultivation of radish as shown by Table 9. Radish is an important marketable commodity with high value and demand for salad. At the time of harvest price of spring radish in Rupandehi district was NRs. 30000 mt^{-1}. The highest net return (NRs. 798612.5 ha^{-1}) was recorded with poultry manure application. Higher profit was due to higher root yield of radish. The lowest net return (NRs. 282000 ha^{-1}) was recorded at the control treatment. Highest B:C ratio (3.99:1) was observed at the treatment with chemical fertilizer which was statistically at par with poultry manure (3.81:1). On the contrast, lowest B:C ratio (2.3 :1) was observed from the control treatment.

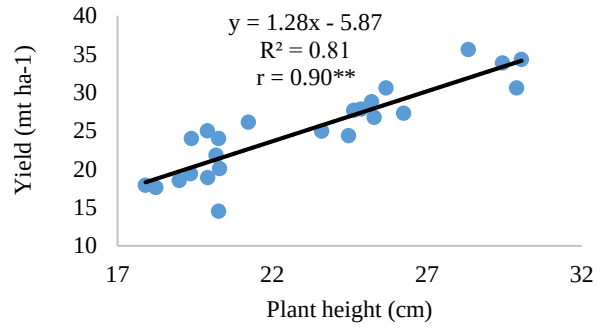

Figure 1. Relationship between plant height (cm) and yield of radish (mt ha-^{1})

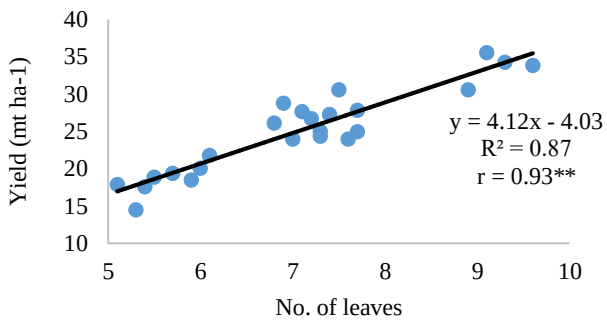

Figure 2. Relationship between number of leaves and yield of radish (mt ha-^{1})

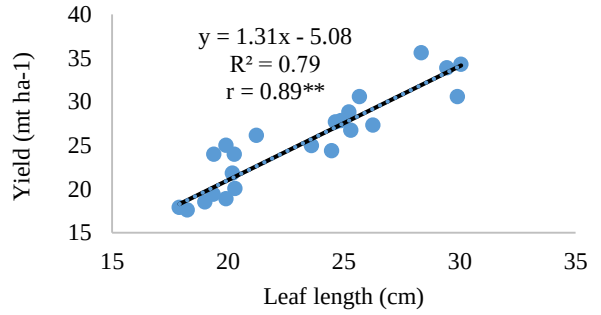

Figure 3. Relationship between leaf length (cm) and yield of radish (mt ha-^{1})

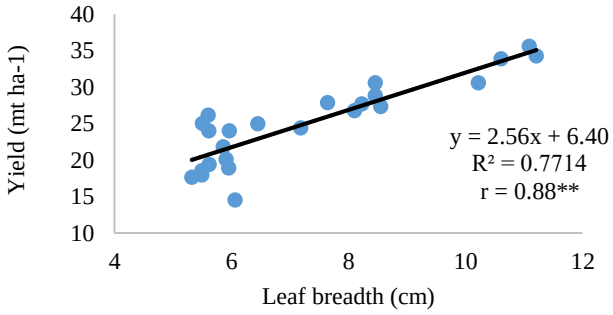

Figure 4. Relationship between leaf breadth (cm) and yield of radish (mt ha-^{1})

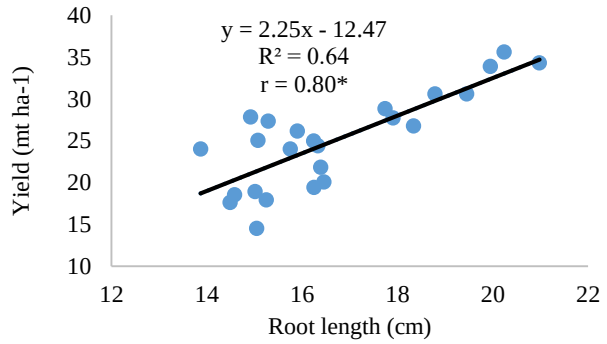

Figure 5. Relationship between root length (cm) and yield of radish (mt ha-^{1})

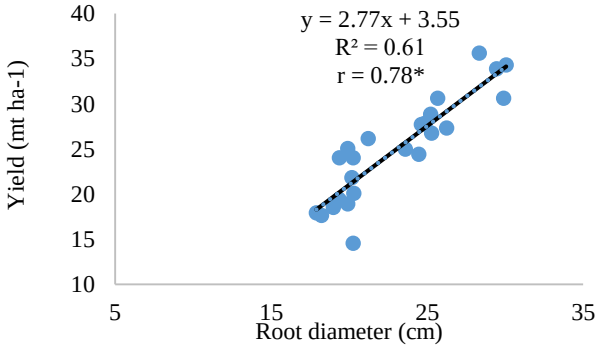

Figure 6. Relationship between root diameter (cm) and yield of radish (mt ha-^{1})

Table 6. Effect of different fertilizers on fresh root weight and leaf weight of radish (*Raphanus sativus* L.) at Tilottama Municipality, Rupandehi, 2023

Treatments	Fresh root wt. (g plant^{-1})			Fresh leaf wt. (g plant^{-1})		
	30 DAS	45 DAS	60 DAS	30 DAS	45 DAS	60 DAS
Vermicompost	39.75^{b}	63.92^{c}	150.90^{c}	25.15^{bc}	47.08^{c}	104.54^{b}
Goat Manure	33.33^{c}	64.50^{c}	137.95^{d}	22.50^{cd}	45.25^{c}	99.18^{b}
Chemical Fertilizer	40.17^{b}	74.75^{b}	163.80^{b}	27.00^{b}	53.67^{b}	108.85^{b}
Poultry Manure	48.00^{a}	82.58^{a}	179.10^{a}	33.42^{a}	56.75^{a}	131.10^{a}
Farm Yard Manure	38.15^{b}	59.69^{d}	113.15^{e}	27.92^{b}	44.51^{c}	79.83^{c}
Control	28.17^{d}	58.67^{d}	103.35^{f}	20.83^{d}	40.67^{d}	70.08^{d}
SEm (±)	0.65	0.35	1.3	0.47	0.43	1.58
$LSD_{0.05}$	3.91	2.10	7.83	2.81	2.57	9.54
CV%	6.85	2.07	3.68	7.13	3.56	6.40
F test	***	***	***	***	***	***
Grand mean	37.93	67.35	141.37	26.14	47.99	98.93

Means followed by the same letter (s) in a column are not significantly different at 5% level of significance as determined by DMRT. *, **, and *** represent significant at 5%, 1% and 0.1% level of significance respectively. NS=non-significant, SEm = Standard error of mean, LSD = Least significant difference, CV = Coefficient of variation and DAS = Days after sowing.

Table 7. Effect of different fertilizers on total (biomass) yield per plot and total biomass yield per hectare of radish (*Raphanus sativus* L.) at Tilottama Municipality, Rupandehi, 2023

Treatments	Yield ha^{-1} (t ha^{-1})	Biomass yield ha^{-1} (t ha^{-1})
Vermicompost	26.13^{bc}	70.51^{c}
Goat Manure	24.79^{c}	65.46^{d}
Chemical Fertilizer	28.46^{b}	75.26^{b}
Poultry Manure	33.59^{a}	85.63^{a}
Farm Yard Manure	19.95^{d}	53.27^{e}
Control	17.24^{e}	48.07^{f}
SEm (±)	0.43	0.58
$LSD_{0.05}$	2.57	3.47
CV%	3.45	3.45
F test	***	***
Grand mean	66.37	66.37

Means followed by the same letter (s) in a column are not significantly different at 5% level of significance as determined by DMRT. *, **, and *** represent significant at 5%, 1% and 0.1% level respectively. NS=non-significant, SEM = Standard error of mean, LSD = Least significant difference, CV = Coefficient of variation and DAS = Days after sowing.

Table 8. Correlation between plant parameters

	Yield	Leaf breadth	Root diameter	Root length	No of leaves	Plant height	Leaf length
Yield	1						
Leaf breadth	0.87**	1					
Root diameter	0.78*	0.88**	1				
Root length	0.80*	0.87**	0.94**	1			
No of leaves	0.93**	0.83**	0.69*	0.74*	1		
Plant height	0.90**	0.96**	0.83**	0.84**	0.88**	1	
Leaf length	0.89**	0.96**	0.83**	0.84**	0.88**	0.99**	1

Note: Numeric value (placed in parentheses and italicized) below the coefficient value represents their respective p-value; ** Correlation is significant at the 0.01 level (2-tailed); * Correlation is significant at the 0.05 level (2-tailed)

Table 9. Financial analysis of radish production at different sources of organic and inorganic fertilizer at Tilottama Municipality, Rupandehi, 2023

Treatments	Total Cost	Net Return	B:C ratio
Vermicompost	200000	584 068.8 ^{c}	2.92 ^{b}
Goat Manure	198000	545 812.5 ^{c}	2.75 ^{bc}
Chemical Fertilizer	170900	682 900.0 ^{b}	3.99 ^{a}
Poultry Manure	209088	798612.5 ^{a}	3.81 ^{a}
Farm Yard Manure	174000	424725.0 ^{d}	2.44 ^{cd}
Control	120000	282000.0 ^{e}	2.35 ^{d}
SEm (±)	-	11523.62	0.06
$LSD_{0.05}$	-	69471.85	0.36
CV%	-	8.35	7.92
F test	-	***	***
Grand mean	179833.3333	551913.5	3.04

Means followed by the same letter (s) in a column are not significantly different at 5% level of significance as determined by DMRT. *, **, and *** represent significant at 5%, 1% and 0.1% level of significance respectively. NS=non-significant, SEm = Standard error of mean, LSD = Least significant difference, CV = Coefficient of variation and DAS = Days after sowing

Discussion

Growth Parameters

Plant Height and Number of Leaves

Plant height and number of leaves were found significantly higher with poultry manure application among different fertilizers. Higher nutrient content of poultry manure might have resulted the highest plant height. Similar results were observed by Zeid et al. (2015) who reported highest plant height in radish when poultry manure is used alone or in conjunction with inorganic fertilizer. This result are in line with Subedi et al. (2018) who reported the treatment with poultry manure were superior in growth parameters such as plant height in radish cultivation. Mbatha (2008) also observed maximum plant height of carrot with poultry manure treatment. Mbatha et al. (2014) found that radish plants treated with poultry manure produced a greater number of leaves. Likewise, Mbatha (2008) also reported that organic fertilizer positively increased the number of leaves, and poultry manure produced the best results. Plants treated with poultry manure (20t ha^{-1}) revealed significantly higher number of leaves in carrot at time of harvesting (Dauda et al., 2008).

Leaf length and breadth

Analyzing the result of effect of various sources of fertilizers on leaf length and breadth of radish, treatment with poultry manure recorded the maximum result followed by chemical fertilizer. Similar result was found in research of radish conducted in Chitwan (Khatri et al.,

2019). Likewise, minimum leaf length and breadth were observed from control treatment. The high nutrients and nitrogen in poultry manure allow better nutrient absorption and optimal conditions for vegetative development, resulting in increased leaf length and width (Mbatha, 2008). The result obtained was in line with Kiran et al. (2019).

Yield Parameters

Root length and root diameter

Maximum root length of 20.16 cm and root diameter of 10.33 cm were recorded from treatment with poultry manure followed by chemical fertilizer while minimum root length and root diameter was obtained from control treatment. Agbede (2021) also reported that root length and diameter under treatment consisting poultry manure alone was significantly higher. Poultry manure resulted highest root length and diameter of carrot (Snr, Addo, Logah, & Kyere, 2020). The inclusion of phosphorus (2%) in poultry manure, which was administered to plots, may have contributed to the longer roots. Phosphorus promotes root growth, allowing for higher nutrient uptake and transportation (Goodlass et al., 1997).

Fresh weight of leaves and root

Poultry manure application resulted significantly higher fresh weight of both radish leaves and root, whereas the control treatment yielded the lowest weight for both leaves and roots. Suojala (2003), reported that the highest fresh weight for both leaves and roots was achieved when poultry manure was applied to carrot crops. Similiarly, Zeid et al. (2015) also revealed that poultry manure was most effective and resulted higher shoot and root weight in radish as poultry manure boosted leaf weight over time by enhancing photosynthesis, energy storage, cell division, and enlargement. Also, the result was in line with (Baitilwake et al., 2011) who observed poultry manure results higher fresh and dry yield of chinese cabbage and amaranthus. Poultry manure's ability to supply all 13 essential plant nutrients likely contributes to superior root length, diameter and yield (Basnet et al., 2021).

Total biomass yield (ton per hectare) and (root) yield

The yield parameters such as total weight per plant (g), yield per plot (kg), root yield per hectare (ton per hectare) and yield per hectare (ton per hectare) were found superior in treatment with poultry manure and the minimum result was observed from the control treatment. Zakaria and Vimala (2002) recorded a similar result, who observed higher yields with poultry manure for lettuce and tomatoes. The result was in line with Khatri et al., (2019) who revealed that among various sources of organic and inorganic fertilizers applied on radish , poultry manure treatment resulted in maximum root weight and maximum total weight of radish. Likewise, the maximum yield of radish was obtained from poultry manure among different manures applied (Uddain et al., 2010). Deep, loose soil is crucial for root expansion, and poultry manure enhances root growth by improving soil's physical, chemical, and biological conditions, fostering better development (Agbede ,2021). The result was also in line with Ljoyah and Sophie (2009), who revealed the use of decomposed poultry manure significantly improve cabbage yield. High nitrogen and nutrient content of poultry manure create favorable conditions for nutrient absorption, promoting root system development, vegetative growth, photosynthesis, and higher yields (Uddain et al., 2010). Poultry manure's richness in organic matter is attributed by its unique excretion process, retaining both liquid and solid waste (Ewulo, 2005).

Conclusions

In accordance with the study's findings, the radish variety Tokinashi responded favorably to the use of different fertilizers in terms of its growth and yield characteristics. When compared to the other treatments, Radish responded better in treatment with poultry manure. Growth parameters such as plant height, leaf length, leaf breadth, and number of leaves per plant were found to be superior in treatment with poultry manure. Poultry manure recorded superior yield parameters (i.e., root length, root diameter, shoot weight, root weight, yield per plot and yield per hectare). The correlation between different growth and yield parameters of radish were found positive and strongly correlated. Among the various sources of organic manure, poultry manure was found to be a more beneficial source, with the highest B: C ratio among the applied fertilizers. The study concluded that poultry manure treatment was an appropriate choice over other organic sources of fertilizers for radish cultivation at Tilottama Municipality, Rupandehi district.

References

Agbede, T. (2021). Effect of tillage, biochar, poultry manure and NPK 15-15-15 fertilizer, and their mixture on soil properties, growth and carrot (Daucus carota L.) yield under tropical conditions. Heliyon, 7(6).

Annisha, A., Islam, M. A., Hossain, M., & Hafiz, M. M. (2019). Growth and yield of carrot influenced by organic and inorganic fertilizers with irrigation interval. Journal of the Bangladesh Agricultural University, 17 (3), 338-343.

Ashraf, M. A., Maah, M. J., & Yusoff, I. (2014). Soil contamination, risk assessment and remediation. Environmental risk assessment of soil contamination, 1, 3-56.

Baitilwake, M. A., Bolle, S. D., Salomez, J., Mrema, J. P., & Neve, S. D. (2011). Effects of manure nitrogen on vegetables yield and nitrogen efficiency in Tanzania.

Basnet, B., Aryal, A., Neupane, A., Bishal, K. C., Rai, N. H., Adhikari, S., & Basnet, M. (2021). Effect of integrated nutrient management on growth and yield of radish. Journal of Agriculture and Natural Resources, 4(2), 167-174.

Bremner, J.M. (1960) Determination of Nitrogen in Soil by the Kjeldahl Method. Journal of Agricultural Sciences, 55, 11-33.

Carter, M., & Gregorich, E. (2006). Soil sampling and methods of analysis. Lewis Publ. Boca Rat. FL, 481–483.

Dauda, S., Ajayi, F., & Ndor, E. (2008). Growth and yield of water melon (Citrullus lanatus) as affected by poultry manure application. Journal of Agriculture and Social Sciences, 4(3), 121-124.

Etesami, M., Tajpour, F., Khosravi, M., & Biabani, A. (2016). Effect of Organic Manure Mixture on growth and yield of Radish (Raphanus Sativus L). Directory of Open Access Journals, 296-301. doi: https://doi.org/10.22067/jhorts4.v0i0.35833

Ewulo, B. (2005). Effect of Poultry Dung and Cattle Manure on Chemical Properties of Clay and Sandy Clay Loam Soil. Journal of Agriculture and Veterinary Advances, 4(10), 839-841.

Goodlass, G., Rahn, C., Shepherd, M. A., Chalmers, A. G., & Seeney, F. M. (1997). The nitrogen requirement of vegetables: comparisons of yield response models and recommendation systems. Journal of Horticultural Science, 72(2), 239-254.

Khatri, K. B., Ojha, R. B., Pande, K. R., & Khanal, B. R. (2019). The effects of different sources of organic manures in growth and yield of radish (Raphanus sativus L.). International Journal of Applied Sciences and Biotechnology, 7(1), 39-42.

Kiran, M., Jilani, M. S., Waseem, K., Khan, M. S., Haq, F., Nadim, M. A., & Shaheen, S. (2019). Integrated use of organic and inorganic fertilizers on the growth and yield of radish. Sarhad Journal of Agriculture, 35(3), 933-941.

Kushwah, L., Sharma, R. K., Kushwah, S. S., & Singh, O. P. (2020). Influence of organic manures and inorganic fertilizers on growth, yield and profitability of radish (Raphanus sativus L.). Annals of Plant and Soil Research, 22(1), 14–18.

Ljoyah, M., & Sophie, V. L. (2009). Effects of different levels of decomposed poultry manure on yield of cabbage (Brassica oleraceae L.) at anse Boileau, Seychelles. Agro- Science, 8(1), 20-23.

Mbatha, A. (2008). Influence of organic fertilisers on the yield and quality of cabbage and carrots. Doctoral dissertation, University of the Free State. Retrieved from http://hdl.handle.net/11660/1722

Mbatha, A. N., Ceronio, G. M., & Coetzer, G. M. (2014). Response of carrot (Daucus carota L.) yield and quality to organic fertilizer. South African Journal of Plant and Soil, 31(1), 1-6.

MOALD. (2020/21). Statistical Information On Nepalese Agriculture. Kathmandu: MOALD.

Pant, K. R., & Oli, B. (2021). Efficacy of Nitrogen on Growth and Yield of Radish (Raphanus sativus L.) from Different Sources of Organic Manures. nternational Journal of Applied Sciences and Biotechnology, 9(3), 203-212.

Schollenberger, C.J. and Simon, R.H. (1945) Determination of Exchange Capacity and Exchangeable Bases in Soil-Ammonium Acetate Method. Soil Science, 59, 13-24. http://dx.doi.org/10.1097/00010694-194501000-00004

Shrestha, A., & Thapa, B. (2018). Effect of different doses of nitrogen on growth and yield parameters of radish (Raphanus sativus l.) in mid-hills of Nepal. Horticulture International Journal, 2(6). https://www.academia.edu/71085588/

Sikora, L., V. Yakovchenko, C. Cambardella and J.W. Doran. 1996.Assessing soil quality by testingorganic matter. In: F. Magdoff et al. (eds.). Soil Organic Matter: Analysis and Interpretation.SSSA Spec. Pub. 46. American Society of Agronomy, Madison, WI

Snr, P. A., Addo, J. S., Logah, V., & Kyere, C. .. (2020). Effect of Different Soil Amendments and Variety on the Growth and Yield of Carrot (Daucus carota L.). International Journal of Plant & Soil Science, 32(10), 16-25.

Subedi, S., Srivastav, A., Sharma, M., & Shah, S. (2018). Effect Of Organic And Inorganic Nutrient Sources On Growth, Yield And Quality Of Radish (Raphanus Sativus L.) Varieties In Chitwan, Nepal. SAARC Journal of Agriculture, 16 (1), 61-69.

Suojala, T. (2003). Compositional and quality changes in white cabbage during harvest period and storage. The Journal of Horticultural Science and Biotechnology, 78(6), 821-827.

Uddain, J., Chowdhury, S., & Rahman, M. J. (2010). Efficacy of different organic manures on growth and productivity of radish (Raphanus sativus L.). International Journal of Agriculture, Environment and Biotechnology, 3(2), 189- 193.

Wang, Y., Zhu, Y., Zhang, S., & Wang, Y. (2018). What could promote farmers to replace chemical fertilizers with organic fertilizers? J clean prod, 882-890. doi:10.1016/j.jclepro.2018.07.222

Zakaria, A., & Vimala, P. (2002, July). Research and development of organic crop production in Malaysia. Paper presented at expert group workshop on presentation of technical guidelines on organic cultivation of tropical and subtropical fruits, 22-56.

Zeid, H. A., Wafaa, H. M., Abou El Seoud, I. I., & Alhadad, W. A. (2015). Effect of organic materials and inorganic fertilizers on the growth and soil fertility of radish plants (Raphine's sativus) grown in sandy soil. Middle East J. Agric. Res, 4(1), 77-87.