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Research Article

Efficacy of Nitrogen on Growth and Yield of Radish (*Raphanus sativus* L.) from Different Sources of Organic Manures

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Abstract

For the quantitative evaluation of the efficacy of Nitrogen through different plant nutrient sources in the growth and yield of radish, the field experiment was conducted from March 2020 to June 2020 in an Inceptisol with sandy loam soil of the research field of G. P. Koirala College of Agriculture and Research Centre, Gothgaun, Morang, Nepal. The experiment was carried out in a Randomized Complete Block Design with eight treatments (Biogas Byproduct, Poultry Manure, Goat Manure, Farmyard Manure, Vermicompost, Packaged Organic Manure, Recommended Dose of Chemical Fertilizer, and Control) and four replications. Forty Day (released in 1994 AD) variety of radish was used as a test crop. The recommended 100 kg N per hectare was supplied from each treatment, calculated based on the nitrogen content of each nutrient source. Results showed that there was a significant difference in almost all studied parameters from all treatments over control ($P \leq 0.05$). The highest total fresh biomass yield (123.415 Mt/ha) and highest delta fresh shoot yield (22.806 Mt/ha) were recorded from the application of a recommended dose of fertilizer, and the highest delta fresh root yield (30.127 Mt/ha) was obtained from the application of FYM. The experiment suggests that the application of FYM significantly increased root yield and was positively correlated with other parameters, which might be a good alternative for chemical fertilizers.

Keywords: Farmyard Manure; Goat Manure; Organic Manures, Radish; Root Yield; Delta Yield

Introduction

Radish (*Raphanus sativus L.*) is a popular cool-season crop of the family Brassicaceae, having an RR genome with 18 somatic chromosome numbers. *R. sativus* was assumed to be developed around the Mediterranean region by the natural and artificial crossing between *R. landra* and *R. maritimus* (Kitamura, 1958). Furthermore, *R. raphanistrum*, *R. maritimus*, *R. landra*, and *R. rostras* were presumed to be involved in the origin of radish (Banga, 1976). Radish is an important quick-growing, herbaceous root vegetable crop grown for its freshly edible roots throughout the world. The enlarged young tender tuberous roots and hypocotyl of radish are consumed mainly as raw for salad. Dried radish and fermented radish (*Sinki*) are also common in most parts of Nepal. Sundried radish roots are consumed cooked during the offseason for cultivation and also used for long-term storage. It is estimated that sundried radish has an increased amount of sucrose and proline as well as branched-chain amino acids (Kumakura *et al.*, 2017). Whereas, the *sinki* consists of a good amount of organic acids, Ca, Fe, and K (Tamang and Sarkar, 1993; Khadka and Lama, 2020). Moreover, the young plants removed by thinning are used as leafy vegetables. The leaves of radish are dominated by Ca and Fe as mineral sources (Aykroyd, 1937). Besides roots and green leaves, its fresh edible pods usually called '*mungras*' are eaten raw or cooked as vegetables and are rich in minerals and vitamins.

Major portions of sandy loam soil are occupied by sand particles followed by enough silt and low clay particles due to which the properties are primarily governed by sand particles (Brady and Weil, 2019). Higher aeration, lower water retention & low crop production (Burke *et al*., 1989), lower nutrient content, lower CEC, and lower buffer capacity are the major characteristics of sandy loam soil than loam and clayey soil (White, 1987; Brady and Weil, 2019). The inherent fertility was usually low in sandy loam soil where the applied fertilizers readily leached as nitrate which is governed by its higher drainage capacity (Gaines and Gaines, 1994). Nitrogen application controls the overall growth, yield, and quality of radish (Brintha and Seran, 2009). Moreover, the lower production of radish in farmer's fields is partially due to insufficient nutrient supply (Gautam and Khatiwada, 1997). Sandy loam soil is mainly present in most of the Morang district (Tandan *et al*., 2015) due to which nitrogen is mainly a limiting nutrient.

In most parts of the country, nitrogen is supplied mainly in the form of urea and di-ammonium phosphate (DAP) with increased use and dependency (Raut *et al*., 2011). Nepal is entirely dependent on imported fertilizer which causes uncertainty to ensure the supply of quality fertilizer in the required quantity and time (Shrestha, 2010; Bista *et al*., 2016). There is no chemical fertilizer factory in Nepal and the present combined demand for urea, DAP, and muriate of potash (MoP) is 785,000 tons per annum (Baran Mazumdar, 2012). Chemical fertilizers create adverse effects in the environment while demanding a high amount of energy and cost (Oad *et al*., 2004), seeking alternative cheap organic sources of nutrients (Kumar *et al*., 2014). It is necessary to fertilize the soil with both organic and inorganic fertilizers for the optimum growth of radish (Chapagain *et al*., 2010).

Organic manures play an important role in compensating chemical fertilizers while maintaining yield characteristics (Wang *et al*., 2018; Geng *et al*., 2019). FYM, biogas slurry, poultry manure, goat manure, vermicompost, and packaged organic manure are easily available in Morang. There are no clear recommendations for the use of organic manure as they differ in their nutrient sources, composting as well as mineralization rate. So, this study aimed to know the response of different organic manures in the growth and yield parameters of radish, the best potential source of organic manure in fulfilling the nitrogen requirement, and to know the best alternative manure for chemical fertilizer for radish grown in sandy loam soil of Gothgaon, Morang.

Materials and Methods

The field experiment was conducted in the research field of GPCAR, Gothgaon, Morang, Nepal from March 2020 to June 2020. The latitude, longitude, and altitude of the experimental site were 26°40′51″, 87°21′11″, and 143 masl. The soil of the experimental site was quantitatively analyzed at Soil and Fertilizer Testing Laboratory, Jhumka, Sunsari and reported as sandy loam having soil pH 6.4, organic carbon 3.10% (medium), and available N, P, and K content 0.15(medium), 23.0 (low) and 65.0 (low) kg per hectare respectively. The experiment was set in a randomized complete block design with eight treatments (Biogas byproduct, Poultry Manure, Goat Manure, Farm Yard Manure, Vermicompost, Packaged Organic Manure, Recommended Dose of Chemical Fertilizer and Control) and four replications. Nitrogen was supplied at the rate of 100kg per hectare from each source and urea was applied as a source of nitrogen from recommended dose of chemical fertilizer.

Field and Plot Dimension

The total area allocated for the experimental field was 280.5m^2 (18.7m×15m) including guard row (1m×1m outer margin). The spacing between replications was 1m whereas between treatments was 0.5m. Each replication contained 8 plots with an area of 2.8m^2 (2m × 1.4m) per plot. A total of 70 plants were maintained at spacing 0.2m ×0.2m where 0.05m of the gap was maintained from each side of the plot. The plot was raised to about 0.2m.

Manure and Fertilizer Application

Poultry manure, goat manure, farmyard manure, and biogas by-products were applied at the rate of 1.23 kg, 5.72kg, 6.84kg, and 9.43kg per respective plot and were applied 25-day before seed sowing. 3.2 kg of vermicompost and 3.4 kg of packaged organic manure were applied at the time of sowing (Table 1). Half dose of urea (46% N) was applied at the time of sowing and the remaining half dose was applied at 20 DAS. Manure and fertilizer requirement to meet a recommended dose of N was calculated on a dry weight basis after lab testing of N content in manure.

Data Observation and Statistical Analysis

Data was collected at 20, 28, 36, and 45 DAS where plant height, leaf count, leaf length, leaf breadth, root length, root diameter, root yield and shoot yield were observed. Two sample plants were taken randomly from each plot with a destructive sampling technique. Plant height was measured from the top portion of the canopy to the ground level. For the number of leaves, all leaves were counted from each plant excluding basal premature leaves. For leaf length and leaf breadth, the four longest leaves were taken from each plant, and length was measured from the top of the leaf margin to the bottom of the petiole, whereas, leaf breadth was measured from the widest portion of the same leaf. Root length was measured from the root head to the bottom of the root. The plant height, leaf length, leaf breadth, and root length were measured using the ruler scale. Since the root of radish was not perfectly cylindrical, it was measured from four points dividing the radish root into three equal parts along its length. The root diameter was measured using the Vernier caliper.

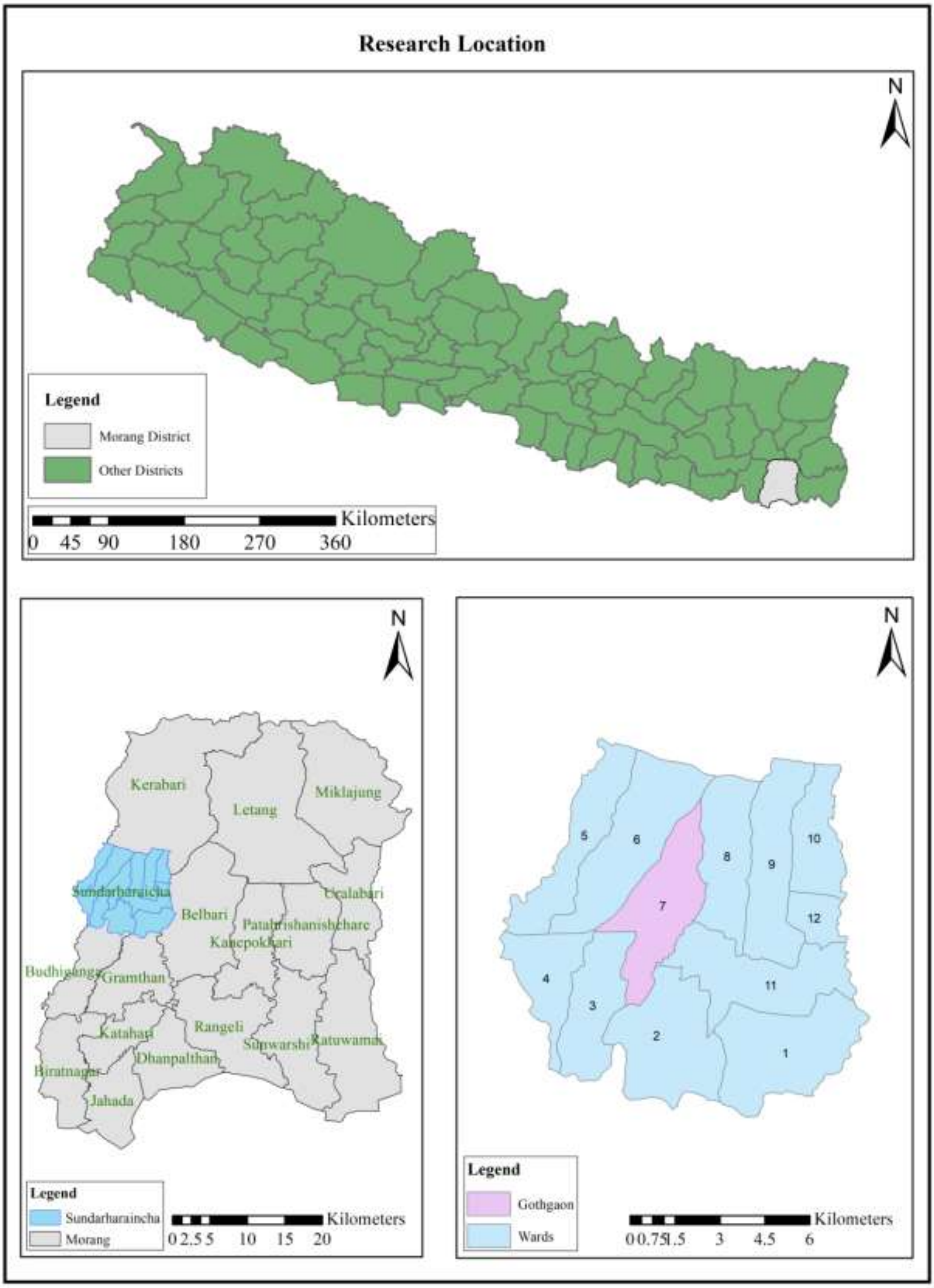

Fig. 1: Research site map

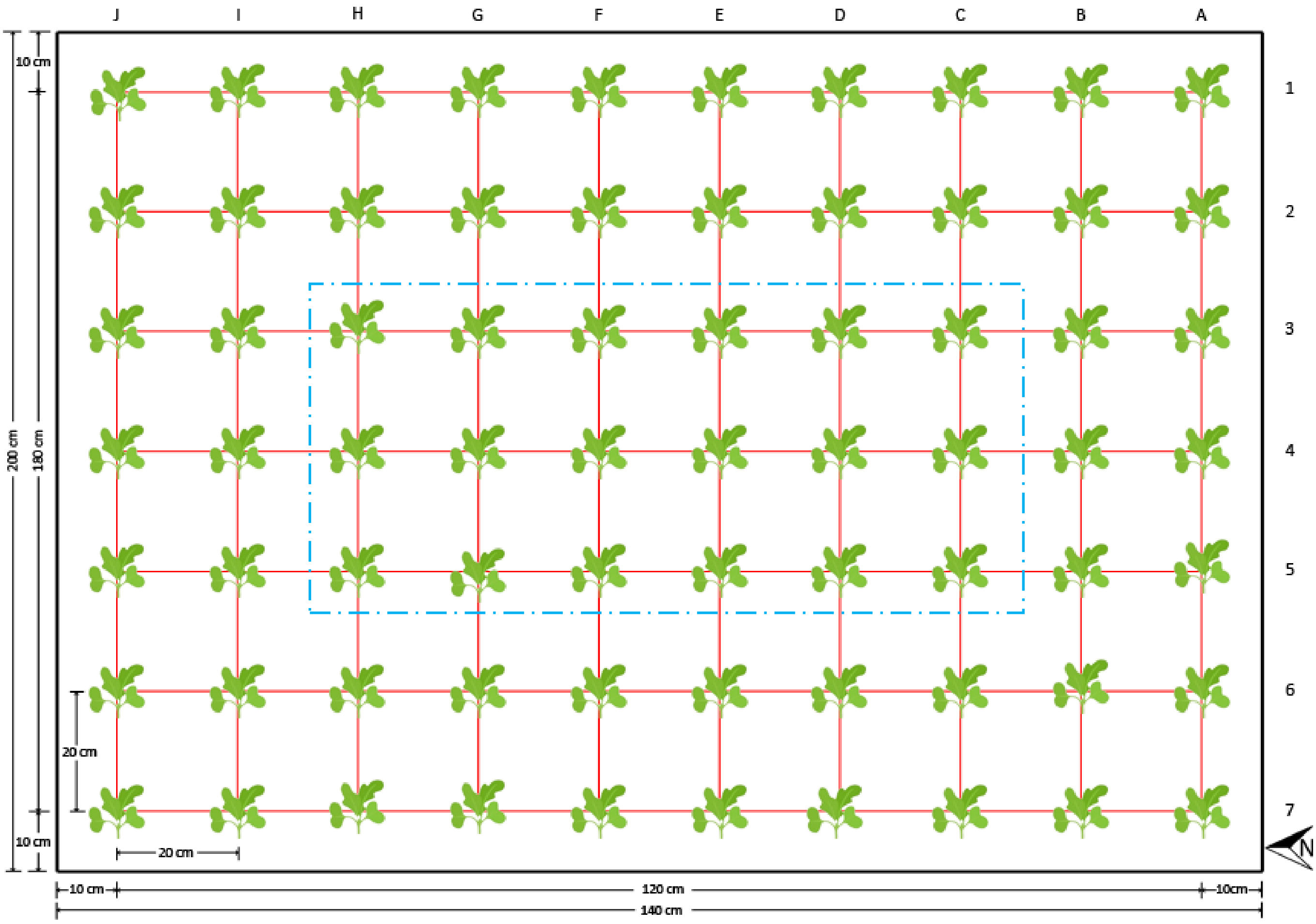

Fig. 2: Planting layout of the individual plot, sample plants (plants within the blue dashed line), and plant matrix number for individual plants

Table 1: Nutrient status of organic manures and fertilizer

Manures	Nitrogen (%)	Manure Equivalent to 100 kg N (kg/ha)	Moisture Content on Wet Basis (%)	Total Manure Required Per Plot (kg)
Poultry Manure	3.25	3077	30	1.23
Goat Manure	0.89	11236	45	5.72
Farm Yard Manure	0.91	10989	55	9.43
Biogas By-product	0.66	15152	55	9.43
Vermicompost	1.25	8000	30	3.2
Packaged Organic Manure	1.50	6667	45	3.4
Urea	46.00	217	*	0.06

Note: Nutrient content in the organic manure was calculated on the dry weight basis
* Moisture content on urea was assumed to be 0

The collected data were tabulated & processed on Microsoft Excel 2016. The one-way ANOVA was done to see the significance level, and the means were separated by Duncan's Multiple Range Testing (DMRT) at a 5% level of significance using RStudio Desktop (version 1.3.1.1093), and correlation analysis was done to see the correlation between parameters and fresh biomass using IBM SPSS Statistics 21.

Result and Discussion

Goat Manure (GM) and farmyard manure (FYM) equally performed best for leaf number at 20 days after sowing (DAS). There was no statistically significant difference between treatments for leaf number at 28DAS. The highest leaf number at 36DAS was recorded from FYM which was statistically significant from other treatments but similar with GM. Also, at 45DAS, the application of urea recorded the highest leaf number which was significantly different from other treatments. The highest plant height at 20DAS was recorded from FYM and at 45DAS, it was observed from the application of GM, which was significantly different from other treatments. There were no statistically significant differences observed between treatments at 28DAS and 36DAS for the plant height. The lowest leaf number and plant height were recorded from Control at all stages (Table 2).

There was no significant difference between treatments at a 5% level of significance for leaf breadth at 20DAS. Also, there was no statistically significant difference between the applications of any treatments at 28 DAS. However, at 36 DAS, the highest leaf breadth was recorded from the application of FYM and at 45DAS it was recorded from the application of urea, where, both of them were statistically significant from other treatments. The highest leaf length recorded at 20DAS was from the application of GM which was similar to other treatments except for the control. There was no statistically significant difference between treatments at 28DAS for leaf length. Similarly, the highest leaf length at 36DAS and 45DAS was recorded from the application of GM, where it was significantly different from other treatments except FYM at 36DAS. The lowest leaf breadth and leaf length were recorded from Control at all stages (Table 3**:** Effect of N on leaf breadth and leaf length provided from different nutrient sources).

The highest root length was recorded from biogas byproduct (BGP) at 20DAS and 28DAS which were similar to FYM at 20DAS and significantly different from other treatments at 28DAS. Similarly, the highest root length was obtained from urea at 36DAS which was similar to FYM, vermicompost, BGP, and GM. Also, at 45DAS highest root length was recorded from FYM which was not significantly different from other treatments except control. The highest root diameter was recorded from GM at 20DAS, 28DAS, and 36DAS where it was not significantly different from treatments except packaged OM (POM) and control at 20DAS, BGP, POM, and control at 28DAS, and BGP and urea at 36 DAS. Similarly, at 45DAS, the highest root diameter was recorded from FYM, which was significantly different from other treatments. The lowest root length and root diameter were recorded from the control at all stages (Table 4**:** Effect of N on root length and root diameter provided from different nutrient sources).

The highest total fresh biomass (123.415 Mt/ha) and delta fresh shoot biomass (22.806 Mt/ha) was recorded from the RDF application. The highest delta fresh root biomass (30.127 Mt/ha) was recorded from the FYM application. The lowest total fresh biomass was recorded from CTRL treatment. Similarly, the lowest delta root biomass was recorded from the PM application (5.934 Mt/ha) and the lowest delta fresh shoot biomass was recorded from FYM (5.973Mt/ha) application (

Table **5**: Effect of N on total biomass, delta root, and shoot biomass yield of radish provided from different nutrient sources)

FYM performed best for root length at maturity which might be due to the reduction of soil bulk density by the application of FYM and root diameter during all stages of growth significantly (Houlbrooke *et al*., 1997; Shirani *et al*., 2002). In addition, the highest delta fresh root biomass was recorded from FYM. The FYM possesses a positive effect on increasing the soil carbon while applied alone or incorporated with bio-fertilizers and inorganic fertilizers (Chaudhary *et al*., 2005; Chumyani *et al*., 2012). Also, the FYM results in the greater average mean diameter of soil aggregates and the higher percentage of macro-aggregates, and the mean weight diameter was assumed considered to be increased with the increase in soil organic carbon concentration (Su *et al*., 2006). Ayer *et al*., (2019) also reported that the application of FYM along with conditioner and RDF increase the root yield significantly. FYM may increase the growth and root development and improve the overall physical, chemical, and biological properties which help better nutrient absorption and utilization by plants resulting in better plant growth (Kanaujia, 2013). This conclusion was also supported by (Choudhary *et al*., 2002), who reported that the application of FYM increased the overall performance of radish crops. However, the increased root yield and improvement in the yield parameters from the application of FYM also might be due to its application in very high quantity as compared to other treatments, which might increase the supply of phosphorus, potassium, and other macro and micro-nutrients than from other treatments. The increased application of FYM applied increases the soil porosity and water holding capacity while decreases the bulk density (Rasool *et al*., 2008), which ultimately helps in the root growth and development.

Table 2: Effect of N on leaf number and plant height provided from different nutrient sources

Treatments	**Leaf Number**				**Plant Height (cm)**			
	20DAS	**28DAS**	**36DAS**	**45DAS**	**20DAS**	**28DAS**	**36DAS**	**45DAS**
Poultry Manure	6.875^{ab}	18.425	14.000^{ab}	16.000^{ab}	14.863^{ab}	26.163	29.138	28.700^{bc}
Goat Manure	7.625^{a}	18.994	15.625^{a}	17.875^{ab}	15.288^{ab}	26.963	30.375	31.863^{a}
Farmyard Manure	6.750^{ab}	18.694	16.000^{a}	16.250^{b}	15.575^{a}	27.325	29.338	27.713^{c}
Vermicompost	6.750^{ab}	18.363	11.875^{b}	16.250^{b}	15.175^{ab}	25.813	28.050	28.413^{bc}
Biogas byproduct	7.625^{a}	18.619	13.250^{b}	17.625^{ab}	14.513^{ab}	26.275	28.788	28.038^{c}
Packaged OM	6.500^{b}	17.750	13.250^{b}	15.750^{b}	13.950^{ab}	25.738	27.325	28.138^{c}
Urea	6.875^{ab}	17.719	13.250^{b}	19.125^{a}	13.038^{bc}	25.675	29.000	31.050^{ab}
Control	6.250$^{\mathbf{b}}$	17.194	11.750^{b}	13.250^{c}	11.138^{c}	24.663	26.225	26.663^{c}
Grand Mean	6.907	18.220	13.625	16.516	14.192	26.077	28.530	28.822
SEM (±)	0.034	0.080	0.096	0.091	0.105	0.120	0.128	0.107
CV,%	7.958	6.997	11.247	8.855	10.078	7.353	7.178	5.963
F-Test	*	NS	**	***	**	NS	NS	**

Means followed by the same letter (s) in a column are not significantly different at 5% level of significance(P≤ 0.05); SEM: Standard Error of Mean; CV: Coefficient of Variation; ***: Significant at 0.1% level of significance; **: Significant at 1% level of significance; *: significant at 5% level of significance; NS: not significant at 5% level of significance; DAS: Days After Sowing

Table 3: Effect of N on leaf breadth and leaf length provided from different nutrient sources

Treatments	**Leaf Breadth (cm)**				**Leaf Length (cm)**			
	20DAS	**28DAS**	**36DAS**	**45DAS**	**20DAS**	**28DAS**	**36DAS**	**45DAS**
Poultry Manure	6.034	9.738	10.416^{cd}	9.678^{cd}	15.541^{a}	27.603	31.594^{ab}	31.506^{bc}
Goat Manure	6.616	10.600	12.128^{a}	10.688^{b}	16.403^{a}	29.175	34.341^{a}	35.019^{a}
Farmyard Manure	6.178	10.197	10.847^{bc}	10.075^{bc}	16.078^{a}	29.113	33.209^{a}	31.341^{cd}
Vermicompost	5.984	9.909	10.425^{cd}	10.041^{bc}	15.656^{a}	27.879	32.347^{ab}	30.722^{cd}
Biogas byproduct	6.413	9.843	11.191^{abc}	9.978^{bc}	15.684^{a}	28.150	32.266^{ab}	31.185^{cd}
Packaged OM	5.900	9.757	10.375^{cd}	9.775^{c}	15.184^{a}	27.094	30.200^{bc}	30.013^{cd}
Urea	6.334	9.916	11.697^{ab}	12.003^{a}	14.703^{a}	27.256	32.672^{ab}	34.041^{ab}
Control	4.984	8.888	9.562^{d}	9.013^{d}	11.619^{b}	26.597	28.675^{c}	28.600^{d}
Grand Mean	6.055	9.856	10.830	10.106	15.109	27.858	31.913	31.553
SEM (±)	0.042	0.047	0.043	0.030	0.081	0.108	0.110	0.109
CV,%	11.151	7.683	6.371	4.883	8.612	6.197	5.507	5.525
F-Test	NS	NS	***	***	**	NS	**	***

Means followed by the same letter (s) in a column are not significantly different at 5% level of significance (P≤ 0.05); SEM: Standard Error of Mean; CV: Coefficient of Variation; ***: Significant at 0.1% level of significance; **: Significant at 1% level of significance; NS: not significant at 5% level of significance; DAS: Days After Sowing

Table 4: Effect of N on root length and root diameter provided from different nutrient sources

Treatments	Root Length (cm)				Root Diameter (mm)			
	20DAS	28DAS	36DAS	45DAS	20DAS	28DAS	36DAS	45DAS
Poultry Manure	14.025^{ab}	19.000^{ab}	23.950^{ab}	27.463^{a}	2.282^{a}	9.620^{a}	29.413^{ab}	37.660^{bc}
Goat Manure	13.263^{bc}	17.850^{b}	25.650^{a}	27.975^{a}	2.643^{a}	10.336^{a}	31.665^{a}	39.837^{b}
Farmyard Manure	15.350^{a}	18.438^{ab}	24.788^{a}	28.925^{a}	2.186^{a}	10.002^{a}	30.156^{ab}	44.935^{a}
Vermicompost	14.500^{ab}	19.138^{ab}	24.513^{a}	27.738^{a}	2.304^{a}	8.475^{a}	28.405^{abc}	38.958^{bc}
Biogas byproduct	15.400^{a}	20.113^{a}	25.288^{a}	28.713^{a}	2.611^{a}	7.497^{ab}	30.577^{a}	37.884^{bc}
Packaged OM	11.500^{cd}	15.825^{cd}	22.000^{bc}	27.825^{a}	2.042^{ab}	7.950^{ab}	26.938^{bc}	36.890^{bc}
Urea	14.850^{ab}	17.400^{bc}	25.688^{a}	28.075^{a}	2.262^{a}	8.344^{a}	30.765^{a}	39.932^{b}
Control	9.963^{d}	15.175^{d}	21.338^{c}	24.325^{b}	1.422^{b}	5.252^{b}	26.100^{c}	34.257^{c}
Grand Mean	13.606	17.867	24.152	27.630	2.219	8.434	29.252	38.794
SEM (±)	0.079	0.071	0.089	0.095	0.028	0.119	0.129	0.186
CV%	9.233	6.402	5.883	5.505	20.424	22.503	7.058	7.664
F-Test	***	***	**	*	*	*	*	**

Means followed by the same letter (s) in a column are not significantly different at 5% level of significance($P \leq 0.05$); SEM: Standard Error of Mean; CV: Coefficient of Variation; ***: Significant at 0.1% level of significance; **: Significant at 1% level of significance; *: significant at 5% level of significance; DAS: Days After Sowing

Table 5: Effect of N on total biomass, delta root, and shoot biomass yield of radish provided from different nutrient sources

Treatments	Fresh Yield (Mt/ha)		
	Total Biomass	Delta Root Biomass	Delta Shoot Biomass
Poultry Manure	90.836^{cd}	5.934	7.137
Goat Manure	108.677^{abc}	18.190	12.722
Farmyard Manure	113.865^{ab}	30.127	5.973
Vermicompost	100.222^{bc}	13.071	9.386
Biogas byproduct	101.230^{bc}	9.813	13.652
Packaged OM	90.603^{cd}	6.710	6.128
Urea	123.415^{a}	22.845	22.806
Control	77.764^{d}	0	0
Grand Mean	100.827		
SEM (±)	0.829		
CV%	13.150		
F-Test	**		

Means followed by the same letter (s) in a column are not significantly different at 5% level of significance($P \leq 0.05$); SEM: Standard Error of Mean; CV: Coefficient of Variation; **: Significant at 1% level of significance;

Table 6: Pearson's Correlation Coefficient Matrix

	biomass	Shoot Yield	Root Yield	Plant Height	Leaf Number	Leaf Length	Leaf Breadth	Root Length	Root Diameter
biomass	1								
Shoot Yield	.718**	1							
Root Yield	.937**	.431*	1						
Plant Height	.566**	.597**	.435*	1					
Leaf Number	.561**	.745**	.354*	.540**	1				
Leaf Length	.644**	.579**	.545**	.890**	.578**	1			
Leaf Breadth	.788**	.787**	.628**	.700**	.702**	.721**	1		
Root Length	.594**	.550**	.495**	.283	.335	.420*	.452**	1	
Root Diameter	.767**	.270	.880**	.250	.287	.482**	.442*	.540**	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);

The response of radish with applied manures was calculated based on delta yield, where FYM performed best for root yield and urea performed best for shoot yield. Despite lower root yield from urea compared with FYM, the highest total fresh biomass obtained was due to the production of the significantly higher shoot biomass, where the application urea yielded significantly highest leaf number and recorded significantly higher leaf breadth of leaves at maturity. Furthermore, from the correlation analysis, it was observed that leaf number and leaf breadth had the highest correlation coefficient with shoot yield (r=o.745 and r=0.787 respectively). The increase in the length of a leaf was due to the elongation of the leaf where leaf elongation rate (LER) depends on N supply and was expressed mostly through cell production. A similar result was observed by Yoshida *et al*., (1969), who reported that the increased supply of nitrogen markedly increases the leaf length. The result obtained was also supported by Brix and Ebell, (1969), who reported that nitrogen increases leaf length and the number of leaves. The lower root yield from the application of urea might be its toxicity to seedlings at early stages due to the presence of biuret which might interfere with N metabolism and protein synthesis (Mikkelsen, 1990).

Furthermore, the application of goat manure increased the root diameter higher than other treatments at early stages, increased leaf length almost at all stages of development of Forty Day radish significantly, and significantly increased the plant height at harvest. These results of goat manures on yield parameters were also supported by Ojeniyi *et al*., (2019) who reported that the application of GM increased the plant height, root length, and nutrient content in the leaves while the bulk density of soil decreases with the application of GM. Furthermore, Poultry manure performed not so well in this experiment for any of the recorded parameters, where the lowest delta root biomass was recorded from the application of PM. This inferior result from the poultry manure might be due to the loss of nutrients by storing the manure. Amanullah *et al*., (2007) reported that the storing of PM to reduce the moisture content causes the loss in nutrient content. Despite high N content and other good properties of PM, handling and application issues might be considered had reduced the quality of manure. Furthermore, the nutrients contained in the PM were also prone to leaching. Similarly, the inferior result from the application of vermicompost, biogas byproduct, and packaged organic manure might be due to the poor nutrient supplying capacity, nutrient loss, and lower quantity of available phosphorus, available potassium, and macro and micronutrient content of manures compared to other treatments.

The correlation study based on correlation coefficient suggests that all parameters taken during the study had a positive correlation and almost all have significant correlation with each other. The root yield had a positive very high correlation(r=.937) with total fresh biomass followed by a high correlation of leaf breadth(r=0.788), and root diameter (r=0.767). The least correlation coefficient with fresh biomass was observed from leaf number (r=0.561). Moreover, the highest correlation coefficient with root yield was obtained from root diameter (r=0.767). But, there was no significant correlation observed from shoot yield, plant height, and leaf number with root diameter. Furthermore, root diameter was highly correlated with root yield (r=0.880). Also, leaf breadth had a positively high correlation with shoot yield (r=0.787), leaf length(r=0.721), and leaf number (0.702). Similarly, there was no significant correlation between leaf number and plant height (Table 6**:** Pearson's Correlation Coefficient Matrix).

These results have generally conformed to those of earlier works. Panwar and Kashyap, (2003) reported that root length and root diameter had a significant and positive correlation with yield. Moreover, Khatri *et al*., (2019), also reported that root length had a positive and significant correlation with total biomass yield.

The correlation study revealed that there were positive associations between yield parameters with total biomass yields. Improvement on total fresh biomass could be done by improvement on other parameters

Conclusion

The application of different commonly available organic manures significantly improved the yield and yield attributing parameters of Forty Day radish. Based on the data and findings of the study, the FYM performed better to yield and yield attributing parameters of radish compared to other organic manures, therefore, FYM may be considered as a good alternative for urea as a source of nitrogen in Morang district, Nepal.

Suggestion

The research was confined to single climatic and topographic conditions and must be conducted at diversified climate, topography, and soil textures in long term for rigid conclusions. The physical and chemical effects of different manures on the soil before and after must be considered in further researches to assess the sustainability in the use of manures.

Conflict of Interest

The authors declare that there is no conflict of interest with this study.

Authors' Contribution

Krishna Raj Pant: Conception and design, data acquisition, analysis and interpretation of data, drafting of the manuscript, and final approval of the manuscript.

Biplov Oli: Conception and design, critical revision of the manuscript as for important intellectual content, and final approval of the manuscript.

Final form of the manuscript was approved by both authors.

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