

Research Article

Effect of integrated nutrient management on growth and yield of radish

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ABSTRACT

Integrated Nutrient Management (INM) is necessary to enhance sustainable yield in an eco-friendly way. A field experiment was conducted in the research field of Midwest Academy and Research Institute College of Live Sciences, Tulsipur, Dang from November 2018 to January 2019 to investigate the effect of integrated nutrient management on growth and yield of radish. Mino Early variety was used in the experiment. The experiment was laid out on Randomized Complete Block Design with four replications and five treatments. Nitrogen (N) was supplied through different sources. The treatment combinations were: control (T1), 100% recommended N through chemical fertilizer (T2), 50% recommended N through chemical fertilizer + 50% N through farmyard manure (FYM) (T3), 50% recommended N through chemical fertilizer + 50% N through poultry manure (T4) and 50% recommended N through chemical fertilizer + 50% N through vermicompost (T5). Significant effect was noted on leaf numbers, root length, root diameter and yield per ha but no significant effect was noted on the germination percentage and plant height. The highest germination percentage (77.00%), plant height (13.27 cm), root length (16.94 cm), root diameter (3.01 cm), and yield per ha (16.55 t/ha) was recorded at T4 (50% recommended N through chemical fertilizer + 50% N through poultry manure). T5 (50% recommended N through chemical fertilizer + 50% N through vermicompost) recorded the highest leaf numbers (10.40). In our experiment, T4 (50% recommended N through chemical fertilizer + 50% N through poultry manure) was found to be superior, so in inner terai places like Tulsipur, Dang it is suggested to apply 50% recommended N through chemical fertilizer + 50% N through poultry manure to obtain a high yield of radish.

Keywords: Growth, integrated nutrient management, radish, yield

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INTRODUCTION

Radish (*Raphanus sativus* L.) belongs to the family Cruciferae. Radish is a herbaceous annual plant that grows quickly. The main edible portion of radish is fleshy roots which develop from both the primary root and the hypocotyl. The pungency of radish is due to isothiocyanates and red color is due to anthocyanin pigment. Radish has wider climatic adaptation, easy cultivation methods and multi-uses. It can be eaten raw as a salad or cooked as a vegetable. It is a good source of vitamin C and minerals like calcium, potassium and phosphorus. The roots are also useful in urinary complaints and piles. Young leaves are also cooked as vegetables. It is one of the popular root vegetables of Nepal. In every part of Nepal, radish is grown as a single or mixed crop. In Nepal, the radish was cultivated on an area of 18,250 hectares in the period 2018/19 with the production of 287,200 metric tonnes (MoALD, 2020). Similarly, in Dang, the radish was grown on an area of 171 hectares in the period 2018/19 with the production of 2,808 metric tonnes (MoALD, 2020).

Integrated Nutrient Management (INM) is defined as the use of inorganic, organic and biological nutrient sources in optimum condition to achieve and sustain optimum yield without harming the soil ecosystem and environment. INM helps to obtain agronomically feasible, economically viable, environmentally sound and sustainable high crop yields (Kafle *et al.*, 2019). Organic manure like farmyard manure (FYM), poultry manure and vermicompost should also be used as they also make the soil fertile and give nutrition to plant. FYM helps to improve crop growth by providing nutrition and improving the physical, chemical and biological properties of soil (Mengistu & Mekonnen, 2012). Vermicompost brings positive changes in both soil quality and productivity than chemical fertilizers (Ansari & Sukhraj, 2010). Similarly, another organic manure i.e. poultry manure has a high amount of nitrogen, phosphorus and potassium than manure of other animals (Duncan, 2005). Poultry manure also helps to improve the water holding capacity, aeration and fertility status of soil (Khatri *et al.*, 2019).

Nowadays chemical fertilizers are the main source of nutrients. But continuous use of only chemical fertilizers causes nutritional imbalance and harmful effects on properties of soil, radish as well as on human health. Considering their harmful effects on soil, environment as well as on the quality of radish it is necessary to find out an eco-friendly alternative that improves the production and quality of radish. Integrated Nutrient Management is an alternative for sustained crop production rather than the use of chemical fertilizer only. The combined use of organic manures with reduced doses of chemical fertilizer will help to get higher yields and will also help to maintain the soil health and reduce pollution problems created by the non-judicious use of chemical fertilizers. Similarly, the balanced application of both inorganic and organic fertilizer is necessary for the optimum growth of radish roots inside the soil (Chapagain, *et al.*, 2010). Dong *et al.* (2005) reported that the application of poultry, chicken and pig manure resulted in a better quality of radishes with the lesser accumulation of heavy metals. Noor *et al.* (2007) obtained the highest yield of radish by the application of 5.0 t/ha poultry manure + 75% RDF. Sentiyangla *et al.* (2010) recorded an increase in development, production and yield of radish root with the combined application of 50% FYM + 50% NPK + biofertilizers as compare to 100% NPK. Keeping the above facts in view this experiment was conducted to evaluate the effect of INM on the growth and yield

parameters of radish and to determine the appropriate combination of INM among different treatments.

MATERIALS AND METHODS

Experimental site

The experiment was laid out in the field of horticulture research farm of Midwest Academy and Research Institute (MARI) College of Live Sciences, Tribhuvan University, Tulsipur, Dang, Nepal. Geographically, the experimental field is situated is at 28° 07' 01.49" N latitude, 82° 17' 48.40" E longitude and an elevation of 643 masl. The duration of the experiment was from November 2018 to January 2019. The location falls on the inner Terai (plain) area with a humid subtropical climate. The climatic data of the experimental site during the experiment is shown in Figure 1. The soil of the experimental site had pH 6.52, 3.63% organic matter, 0.18% total nitrogen, 54 kg/ha available P₂O₅ and 136 kg/ha available K₂O.

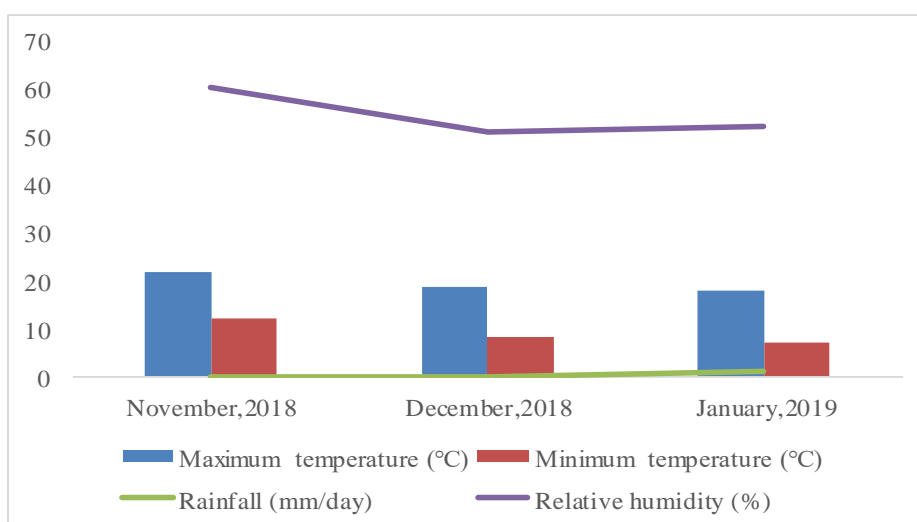


Figure 1: Monthly climatic data of the experimental site during the experiment. (Source: NASA Power)

Experimental material, design and treatment

The variety of radish used in the experiment was Mino Early. In Nepal, Mino Early variety was registered in 1990 (Krishi Diary, 2018). The seed of Mino Early was taken from Agrinepal Agrovet Tulsipur Dang. The experiment was laid out in Randomized Complete Block Design (RCBD) with four replications. Each replication consists of five treatments. All the treatments were randomized separately in each replication. The net area of the experimental field was 104.5 m² (11 m × 9.5 m) in which the individual plot measured 4 m² (2 m × 2 m). The total number of plots was 20. The spacing between plots was 0.25 m while the spacing between replication was 0.5 m. Seeds of radish were sown on 26th November, 2018 at the depth of 1.25 cm by maintaining the space of 20 cm × 20 cm (row × plant). Nitrogen (N), phosphorus (P) and potassium (K) were applied in all treatments except in the control treatment. The recommended dose of chemical fertilizer for radish is 100 kg N, 80 kg P and 40 kg K per ha (Singh & Bhandari, 2015). In our experiment nitrogen (N) was applied through chemical fertilizer (urea) and organic matter (FYM, poultry manure and

vermicompost). The treatment combination of the experiment is in Table 1. Phosphorus (80 kg/ha) and potassium (40 kg/ha) were applied through single super phosphate and muriate of potash respectively. Fertilizers were applied in rows before the sowing of seed. The first irrigation was given on 6th December, 2018 and the subsequent irrigations were given at an interval of 5 to 8 days. Weeding was done manually at 15 and 30 days after germination. Harvesting of radish was done manually on 20th January, 2019.

Table 1: Treatment details of the experimental field

S.No.	Treatment	Sources of Nitrogen
1	T1	Control
2	T2	100% recommended N through chemical fertilizer
3	T3	50% recommended N through chemical fertilizer + 50% N through farmyard manure (FYM)
4	T4	50% recommended N through chemical fertilizer + 50% N through poultry manure
5	T5	50% recommended N through chemical fertilizer + 50% N through vermicompost

Data recorded

Randomly five plants were tagged from each plot for recording data. Growth parameters (germination percentage, plant height and number of leaves) and yield parameters (root length, root diameter and yield per ha) were recorded from tagged plants. The number of germinated plants was counted and based on the number of germinated plants the germination percentage was calculated. Plant height (cm) was measured from the base just above the soil surface to the top of the plant until maturity. Similarly, the number of leaves was counted until maturity. Further, the root length (cm) was measured from the crown to the distal end of the root by manual scale. Similarly, the root diameter (cm) was measured with the help of vernier calipers. Further, the yield of each treatment was calculated, based on that yield of each treatment, the yield per ha (t/ha) of each treatment was calculated. At last, the average value of all parameters for each treatment was calculated.

Statistical analysis

R studio was used to analyze the data. The Analysis of Variance (ANOVA) in Randomized Complete Block Design (RCBD) was used to determine the level of significance. The significant differences between treatments were determined using Duncan's Multiple Range Test (DMRT). The treatment means were compared by the Least Significant Difference (LSD) test at 1% and 5% level (Gomez & Gomez, 1984; Shrestha, 2019).

RESULTS AND DISCUSSION

Growth parameters

No significant difference was noted in the germination percentage and plant height but the significant effect was noted on the number of leaves (Table 2). Although no significant effect was recorded on the germination percentage of plants, T4 (50% recommended N through chemical fertilizer + 50% N through poultry manure) recorded the maximum germination percentage which was 77.00 % followed by 76.25 % at T3 (50% recommended N through chemical fertilizer + 50% N through FYM). The minimum plant germination percentage (74.75 %) was recorded at T2 (100% recommended N through chemical fertilizer). Poultry

manure has the property to decompose rapidly and release all essential nutrients for the crop (Boateng *et al.*, 2006). Due to this property of poultry manure, the crops of T4 got nutrition quickly on time so T4 might have recorded the maximum germination percentage. Similarly, the plant height was non-significant but the highest plant height (13.27 cm) was found at T4 (50% recommended N through chemical fertilizer + 50% N through poultry manure) followed by 12.39 cm at T3 (50% recommended N through chemical fertilizer + 50% N through FYM). The lowest plant height (10.07 cm) was obtained at T1 (control). T4 recorded the highest plant height it might be because the nitrogen present in poultry manure is easily available to plants because 30% of nitrogen present in poultry manure is in nitrate or ammonical form (Sunassee, 2001). Subedi *et al.* (2018) and Shahu *et al.* (2018) recorded a similar result on radish. They reported the highest plant height by the combined application of chemical fertilizer and poultry manure. Devkota *et al.* (2020) in broadleaf mustard noted the highest plant height with the combined application of chemical fertilizer and poultry manure. Further, the number of leaves varied from 7.60 to 10.40. T5 (50% recommended N through chemical fertilizer + 50% N through vermicompost) recorded the highest number of leaves which was 10.40 followed by 10.35 at T4 (50% recommended N through chemical fertilizer + 50% N through poultry manure) while the lowest number of leaves (7.65) was recorded at T1 (control). The increase in the number of leaves of radish in T5 (50% recommended N through chemical fertilizer + 50% N through vermicompost) might be due to the availability of vital micro and macronutrient with vermicompost (Jaisankar, 2018). Zucco *et al.* (2015) recorded the increased number of leaves on tomato with the application of vermicompost.

Table 2: Effect of integrated nutrient management on growth parameters of radish at Tulsipur, Dang in 2018/19

Treatments	Germination (%)	Plant height (cm)	Number of leaves
T1	76.00	10.07	7.60b
T2	74.75	12.13	9.45a
T3	76.25	12.39	9.13ab
T4	77.00	13.27	10.35a
T5	75.25	11.40	10.40a
LSD (0.05)	3.57	2.54	1.78
CV %	3.06	13.89	12.37
Grand mean	75.85	11.85	9.39
F test	NS	NS	*

Treatments means followed by the common letter or letters within the column are not significantly different among each other based on DMRT at 5% level of significance. LSD = Least significant difference, CV = Coefficient of variation, *= Significant at $P \leq 0.05$ and NS= Non significant.

Yield parameters

The yield parameters (root length, root diameter and yield per ha) of Mino Early were significantly influenced by the various treatments (Table 3). Among various treatments, T4 (50% recommended N through chemical fertilizer + 50% N through poultry manure) obtained the highest root length (16.94 cm) followed by 16.17 cm at T3 (50% recommended N through chemical fertilizer + 50% N through FYM) while the lowest root length (13.41 cm) was obtained at T1 (control). Similarly, data in Table 3 showed that the maximum root diameter (3.01 cm) was recorded in treatment T4 (50% recommended N through chemical fertilizer + 50% N through poultry manure) followed by 2.88 cm at T5 (50% recommended N through chemical fertilizer + 50% N through vermicompost). The minimum root diameter

(1.98 cm) was recorded under the treatment T1 (control). Further, yield per ha varied from 6.41 t/ha to 16.55 t/ha. The highest yield (16.55 t/ha) was recorded at T4 (50% recommended N through chemical fertilizer + 50% N through poultry manure) followed by 14.38 t/ha at T3 (50% recommended N through chemical fertilizer + 50% N through FYM), while the lowest yield per hectare (6.41 t/ha) was observed at T1 (control). The highest root length, root diameter and yield per ha in T4 might be due to the reason that poultry manure can provide all thirteen essential plants nutrients i.e. nitrogen (N), phosphorous (P), potassium (K), calcium (Ca), magnesium (Mg), sulfur (S), manganese (Mn), copper (Cu), zinc (Zn), chlorine (Cl), boron (B), iron (Fe), and molybdenum (Mo) in good amount (Chastain *et al.*, 2001). Similarly, both liquid and solid excreta are excreted without loss of urine due to which poultry manure is rich in organic matter and essential plant nutrients than the manure of other animals (Ewulo, 2005). Similarly, Olasekan *et al.* (2019) reported that poultry manure improves the physical and chemical properties of soil and also the yield components of radish. Kiran *et al.* (2018) and Shahu *et al.* (2018) also recorded similar findings on the root length, root diameter and yield per ha of radish.

Table 3: Effect of integrated nutrient management on yield parameters of radish at Tulsipur, Dang in 2018/19

Treatments	Root length (cm)	Root diameter (cm)	Yield per ha (t/ha)
T1	13.41c	1.98c	6.41c
T2	15.53ab	2.41bc	12.05b
T3	16.17ab	2.53ab	14.38ab
T4	16.94a	3.01a	16.55a
T5	15.16bc	2.88ab	11.57b
LSD (0.05)	1.76	0.50	3.84
CV %	7.39	12.59	20.40
Grand mean	15.44	2.56	12.19
F test	*	**	**

*Treatments means followed by the common letter or letters within the column are not significantly different among each other based on DMRT at 5% level of significance. LSD = Least significant difference, CV = Coefficient of variation, * = Significant at $P \leq 0.05$ and ** = Significant at $P \leq 0.01$.*

CONCLUSION

The combination of 50% recommended N through chemical fertilizer + 50% N through poultry manure recorded the highest plant germination percentage, plant height, root length, root diameter and yield per ha. So in a place like Tulsipur, Dang it is suggested to use the combination of 50% recommended N through chemical fertilizer + 50% N through poultry manure to obtain a higher yield of radish.

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Authors' Contributions

B. Basnet, A. Aryal, A. Neupane, B. K.C., N.H. Rai and S. Adhikari designed, performed the experiment, recorded data, analyzed data and wrote the paper. P. Khanal recorded the data, wrote and edited the paper. M. Basnet supervised the experiment.

Conflict of Interest

The authors declare no conflict of interest regarding the publication of this manuscript.

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