Indian Journal of Agricultural Sciences **95** (2): 229–232, February 2025/Short Communication
https://doi.org/10.56093/ijas.v95i2.148259

Growth and yield responses of radish (*Raphanus sativus*) to different types and doses of organic manures in mid-hill region of Uttarakhand

BHATT H[1], SINGH K C[1]*, PANT S C[1], HAOBIJAM J W[2], SERAM D[2], BHOSALE T A L[1] and RATURI G[1]

College of Horticulture, Veer Chandra Singh Garhwali Uttarakhand University of Horticulture and Forestry, Bharsar, Uttarakhand 246 123, India

Received: 08 February 2024; Accepted: 20 December 2024

Keywords: Dry matter, Organic manures, Radish, TSS, Vitamin C

Several scientists from different parts of the world postulated the risks that things like overusing chemical fertilisers, low fertility, insecticide resistance and plant diseases pose to agriculture and the environment (Cetin *et al.* 2022, Ma *et al.* 2021). Organic manures like livestock and poultry manures could be an excellent alternative source of nutrients instead of fertilizers such as in organic farming where the use of synthetic chemicals is prohibited. Furthermore, the use of manures in place of chemical fertilizers is more economical and aids in minimizing the environmental pollution (Zhou *et al.* 2005). The nutrient richness of manures in terms of NPK and organic matter and their positive influence on crop production have been well addressed by multiple researchers (Chen *et al.* 1996, Zhou *et al.* 2005) and are gaining attentions among a large number of people turning on to emphasizing the roles of manures in agriculture. According to the literature, materials such as cattle manure, poultry litter, swine slurry or horse manure are considered as biological soil amendments of animal origin (BSAAOs), and they play an important role in providing nutrients, improving the soil and producing quality products (Sharma and Reynnells *et al.* 2016, Marie *et al.* 2022). As nutrient toxicity is far more complicated in management than deficiency, there seemed to have a wide window for exploring the optimum doses of manures that would escape the toxicity-related problems in the soil. Keeping the above facts in due consideration and taking the concept of soil sustainability for better agricultural cultivation and production, an utmost attempt was made to test the optimum dose of different organic manures and their combinations concerning the growth and production of radish, a root crop belonging to family Brassicaceae.

[1]College of Horticulture, Veer Chandra Singh Garhwali Uttarakhand University of Horticulture and Forestry, Bharsar, Uttarakhand; [2]Lovely Professional University, Punjab. *Corresponding author email: chandrakumarkh@gmail.com

The present study was carried out in 2021 at College of Horticulture, Veer Chandra Singh Garhwali Uttarakhand University of Horticulture and Forestry, Bharsar, Uttarakhand to investigate the response of radish (*Raphanus sativus* L.) to certain types and doses of organic manures under polyhouse condition. The experiment was laid out in a randomized complete block design (RCBD) replicated thrice involving treatments, T_1, Control; T_2, FYM 100%; T_3,Vermicompost 100%; T_4, Goat manure 100%; T_5, Neem cake 100%; T_6, FYM 50% + Vermicompost 50%; T_7, FYM 50% + Goat manure 50%; T_8, FYM 50% + Neem cake 50%; T_9, Vermicompost 50% + Goat manure 50%; T_{10}, Vermicompost 50% + Neem cake 50%; T_{11}, Goat manure 50% + Neem cake 50%; T_{12}, FYM 25% + Vermicompost 25% + Goat manure 25% + Neem cake 25%. These manures were applied during field preparation 12 days before sowing. Radish variety, Pusa cheitki was grown following the spacing of 45 cm × 20 cm. Five random healthy plants were selected and observations were recorded from each treatment on the growth, yield, and its different attributes. The recorded data were statistically analyzed using analysis of variance (ANOVA) and the mean values were compared at a 5% level of significance by t-test.

Germination parameters: Least days were taken by radish plant for initial germination (3.00 days) and 50% germination (5.33 days) in T_4 and the maximum germination percentage (94.44%) was recorded in T_6. Better germination performance of radish seedlings on manure-treated plots over control might be due to the organic nutrient sources which are rich in humus and hence enable nitrogen fixation by microbes, and as microbial decomposition regulates nitrogen supply to the plants which creates better conducive environments (Table 1). These favourable conditions seemed to have created a medium for better nutrient absorption and favours faster and better germination, growth and development of the root system which in turn reflects better vegetative growth and photosynthetic activity. Organic manure also improved the water-holding capacity of the soil

Table 1 Germination attributes of radish in response to different organic manures and its combinations

Treatments	Days to initial germination ± SE(m)	Days to 50% germination ± SE(m)	Germination% ± S.E(m)
T_1	6.33±0.33	9.33±0.33	88.88±1.38
T_2	4.00*±0.33	6.00*±0.00	88.88±2.77
T_3	4.33*±0.66	8.33±0.33	87.50±2.40
T_4	3.00*±0.00	5.33*±0.33	90.27±1.38
T_5	3.66* ±0.66	6.66*±0.33	83.33±2.40
T_6	4.33*±0.33	7.66*±0.33	94.44±1.38
T_7	4.33*±0.33	8.00*±0.00	93.05±2.77
T_8	4.33*±0.66	6.66*±0.33	90.27±1.38
T_9	4.00*±0.00	6.33*±0.33	87.50±2.40
T_{10}	3.66*±0.33	6.66*±0.33	93.05±1.38
T_{11}	4.00*±0.57	7.66*±0.33	91.66±2.40
T_{12}	3.66*±0.66	7.00*±0.57	93.05±1.38
LSD	1.35	1.02	6.01

*Significant at 5% level of significance as compared to control. Refer to methodology for Treatment details.

and moisture helps in germination and rapid cell elongation leading to longer root system formation. Consequently, good quality root yield would be obtained through organic manure application.

Yield attributes: There was a noticeable difference in the yield metrics observed across the various treatments (Table 2). It is possible that the increased activity of soil microorganisms and PGRs like auxin, cytokines, and gibberellins in T_{10} contributed to the highest fresh weight of leaves/plant (182.26 g) at harvest. Vermicompost also has an antagonistic effect on soil-borne diseases, which is beneficial to plant health. Dass *et al.* (2008) also reported that vermicompost helped increase vegetable and fruit yields. At harvest, the fresh weight of root/plant in T_2 was the highest (181.60 g). Sujatha *et al.* (2020) found a parallel pattern in radish. Organic manures improve cation exchange capacity (CEC), water holding capacity (WHC) and phosphate availability, as stated by Kumari *et al.* (2017). The highest fresh root yield was witnessed in T_2 (2.17kg/plot and 20.180 t/ha) followed by T_4 (20.153 t/ha) which was statistically at par. All the treatments with organic manures and its combinations boosted radish yield and the increment ranged from 36.55–67.55% against control. This could be attributed to the influencing potentials of organic manures which include soil aeration improvement. It also enriches the soil with microorganisms and incorporating useful enzymes such as phosphatase and cellulase. Soil microbial activity increases by a factor of 10–20 when organic manures are introduced (Sujatha *et al.* 2020). Soil that has been enriched by micro-organisms through organic manures typically retains more nutrients for longer periods of time without negatively impacting the environment, in addition to having more desirable aesthetic qualities, lower levels of contaminants, facilitated plant growth hormones, higher levels of soil enzymes, and a greater microbial population. Both Sittirungsum *et al.* (2001) and Sujatha *et al.* (2020) corroborate this finding. Adekiya *et al.* (2019) also reported that radish benefited from the application of 5 t/ha poultry manure in terms of leaf weight, root length, root weight and root girth. Multiple numbers of researchers also reported appreciable improvements in soil properties owing to the cultivation of radish. The roots of radish happened to uphold

Table 2 Yield response of radish under the influence of different organic manures and its combinations

Treatment	Fresh weight per plant (g) ± SE(m)		Root yield ± SE(m)		Per cent increased in yield over control	Cost benefit ratio
	Leaves	Root	kg/plot	t/ha		
T_1	69.26±17.07	58.93±15.49	0.70±0.18	6.547±1.721	-	1:1.15
T_2	152.53*±10.17	181.60*±14.24	2.17*±0.17	20.180*±1.582	67.55	1:3.80
T_3	127.80*±7.81	112.93±20.41	1.35±0.24	12.547±2.267	47.82	1:1.34
T_4	135.80*±10.32	181.40*±30.45	2.17*±0.36	20.153*±3.384	67.51	1:3.21
T_5	124.13*±24.31	109.60±32.60	1.31±0.39	12.177±3.623	46.23	1:0.59
T_6	145.73*±6.96	178.66*±22.10	2.14*±0.26	19.853*±2.456	67.01	1:3.15
T_7	143.73*±2.37	179.73*±16.28	2.15*±0.19	19.970*±1.811	67.21	1:3.45
T_8	114.66*±3.89	165.46*±23.78	1.98*±0.28	18.383*±2.644	64.38	1:2.10
T_9	111.06*±10.42	92.73±13.74	1.11±0.16	10.303±1.525	36.45	1:1.03
T_{10}	182.26*±6.87	159.93*±4.17	1.91*±0.05	17.770*±0.465	63.15	1:1.73
T_{11}	145.33*±14.09	175.93*±33.21	2.11*±0.39	19.547*±3.691	66.50	1:2.14
T_{12}	133.13*±8.84	128.86*±14.01	1.54*±0.16	14.317*±1.556	67.55	1:1.60
LSD	30.33	55.05	0.66	6.118	-	-

*Significant at 5% level of significance as compared to control.
Refer to methodology for Treatment details.

residual nitrogen in the soil until they get dried, after which upon decomposition, the crop releases the accumulated nitrogen in the succeeding season and thus radish, as a cover crop not only provides nitrogen sources for the succeeding crops (Weil *et al.* 2009), but also aids in preventing leaching losses of nitrogen (Weil and Kremen 2007). Abdalla *et al.* (2019) also reported the potential of forage radish as a cover crop in minimizing leaching loss of nitrogen. Hike in soil organic carbon content in wolfberry orchards in different soil types owing to the application of well decomposed sheep manure (in various doses) along with forage radish grown as a cover crop has also been reported by Wang *et al.* (2024). Acharya *et al.* (2024) also claimed similar incident in silage corn-sorghum rotation system.

Qualitative analysis: Treatment T_3 yielded the highest levels of total soluble sugar (4.23°B) and ascorbic acid (17.61 mg/100 g) (Table 3). T_{10} had the highest root dry matter (8.84 g/100 g), maybe because the plant nutrients were more easily absorbed after being solubilized by the combination of vermicompost and neem cake. T_6 also accumulated more reserve food substances in the roots, which may explain why its leaves had the highest dry matter (10.71 g). Directly or indirectly, organic sources aid in the increased availability and uptake of soil nutrients, which may have the final impact of enhancing crop production and quality without impairing the soil's physicochemical qualities. Therefore, optimal fertilisation using organic manures is required and advised for the development of high-quality radishes. Adekiya *et al.* (2019) observed that the application of poultry manure at a rate of 5 t/ha significantly impacted the elemental concentrations of macro nutrients (N, P, K, Ca, and Mg) in radish.

Table 3 Quality parameters of radish in response to different types of organic manures and its combinations

Treatment	TSS (°B) ± S.E(m)	Vitamin C (mg/100 g) ± SE(m)	Dry matter of root/ 100 g ± SE(m)	Dry matter of leaves/100 g ± SE(m)
T_1	4.00±0.11	13.15±0.06	6.27±0.16	9.62±0.31
T_2	3.93±0.08	16.65*±0.08	6.28±0.10	10.04±0.12
T_3	4.23±0.06	17.61*±0.08	6.73±0.27	10.06±0.09
T_4	3.90±0.05	16.44*±0.15	6.39±0.15	9.51±0.17
T_5	3.50*±0.05	16.50*±0.16	6.93*±0.34	9.36±0.50
T_6	4.10±0.15	14.57*±0.21	7.97*±0.39	10.71*±0.44
T_7	3.93±0.08	14.92*±0.01	7.68*±0.14	9.41±0.22
T_8	3.23*±0.18	14.86*±0.05	6.44±0.13	9.12±0.35
T_9	3.83±0.12	14.87*±0.01	6.04±0.06	9.67±0.32
T_{10}	3.46*±0.20	15.53*±0.21	8.84*±0.09	9.84±0.20
T_{11}	2.83*±0.03	15.67*±0.03	6.80±0.07	9.00±0.54
T_{12}	3.16*±0.08	15.86*±0.09	7.00*±0.04	10.02±0.08
LSD	0.35	0.36	0.55	0.89

*Significant at 5% level of significance as compared to control. Refer to methodology for Treatment details.

Correlation analysis: Correlation studies of yield and Vitamin C versus days taken for initial germination respectively indicated a negative correlation, which was statistically non-significant (Supplementary Fig. 1). This study suggested that delayed germination resulted in lesser yield as well as Vitamin C content in the radish crop. Hence, ensuring timely germination could be a promising trait for improving the yield and Vitamin C content in radish.

Economics of the experiment: When it comes to agricultural farming, profit depends not only on the productivity of the crop but also on the quality of the produce in association with the competitive price in the market, the departmental thrust area of work and the master research proposals. The highest gross return, net return, and cost-benefit ratio (₹4,03,556/ha, ₹31,949/ha and 1:3.80, respectively) were obtained in treatment T_2 whereas, the least cost-benefit ratio was obtained in the treatment T_5 due to higher rate of neem cake. Juan *et al.* (2010) also reported that integration of organic sources of nutrients such as cattle manure with N-fertilizer witnessed a cost-effective nutrient source.

SUMMARY

The present study was carried out in 2021 at College of Horticulture, Veer Chandra Singh Garhwali Uttarakhand University of Horticulture and Forestry, Bharsar, Uttarakhand to investigate the response of radish to certain types and doses of organic manures under polyhouse condition. Twelve different treatment combinations, viz. T_1 (Control); T_2 (FYM 100%); T_3 (Vermicompost 100%); T_4 (Goat manure 100%); T_5 (Neem cake 100%); T_6 (FYM 50% + Vermicompost 50%); T_7 (FYM 50% + Goat manure 50%); T_8 (FYM 50% + Neem cake 50%); T_9 (Vermicompost 50% + Goat manure 50%); T_{10} (Vermicompost 50% + Neem cake 50%); T_{11} (Goat manure 50% + Neem cake 50%); T_{12} (FYM 25% + Vermicompost 25% + Goat manure 25% + Neem cake 25%). The earliest initial germination (3.00 days) was seen in T_4, maximum germination per cent (94.44%) in T_6, greatest fresh biomass of leaves and roots/plant in T_{10} and T_2 (182.26 g and 181.60 g, respectively) and the highest yield (20.180 t/ha) was also recorded in T_2 resulting the highest cost-benefit ratio (1: 3.80). T_3 provided highest TSS (4.23°B) and ascorbic acid (17.61 mg/100 g) and highest root dry matter (8.84 g/100 g) in T_{10}. Among the treatments tested, T_2 was found to be the best for obtaining the highest yield, highest net return, highest cost-benefit ratio, and also performed well in terms of quality and growth parameters in the temperate hilly regions of Uttarakhand. It can further be concluded that organic manures provided appreciable results in radish cultivation. Therefore, FYM @100% shall be recommended for the radish growers to derive maximum profits.

REFERENCES

Abdalla M, Hastings A, Cheng K, Yue Q, Chadwick D, Espenberg M, Truu J, Rees R M and Smith P. 2019. A critical review of the impacts of cover crops on nitrogen leaching, net greenhouse

gas balance and crop productivity. *Global Change Biology* **25**: 2530–43. https://doi.org/10.1111/gcb.14644

Acharya P, Ghimire R and Acosta-Martinez V. 2024. Cover crop-mediated soil carbon storage and soil health in semi-arid irrigated cropping systems. *Agriculture, Ecosystems and Environment.* **361**: 108813. https://doi.org/10.1016/j.agee.2023.108813

Adekiya A O, Agbede T M, Aboyeji C M, Dunsin O and Simeon V T. 2019. Effects of biochar and poultry manure on soil characteristics and the yield of radish. *Scientia Horticulturae* **243**: 457–63. https://doi.org/10.1016/j.scienta.2018.08.048

Cetin M, Aljama A M O, Alrabiti O B M, Adiguzel F, Sevik H and Zeren C I. 2022. Using topsoil analysis to determine and map changes in Ni Co pollution. *Water, Air, Soil Pollution* **233**: 1–11.

Chen L, Dick W A, Streeter J G and Hoitink H A J. 1996. Ryegrass utilization of nutrients released from composted biosolids and cow manure. *Compost Science Utilization* **4**: 73–83. https://doi.org/10.1007/s11270-022-05762-y

Dass A, Lenka N K, Patnaik U S and Sudhishri S. 2008. Integrated nutrient management for production economics and soil improvement in winter vegetables. *International Journal of Vegetable Science* **14**(2): 104–20. https://doi.org/10.1080/19315260801934266

Juan W M C, Arthur B C F, Edson L C and Anarlete A. 2010. Cattle manure and N-urea in radish crop (*Raphanus sativus*). *Ciencia E Investigacion Agraria* **37**(1): 45–53. http://dx.doi.org/10.4067/S0718-16202010000100004.

Kumari P J, Singh S P, Rolaniya M J and Mahala P. 2017. Performance of organic manures, inorganic fertilizer and plant density of yield and quality of radish. *International Journal of Agricultural Science Research* **7**(2): 261–66. http://doi.org./10.37273/chesci.cs20530121

Ma J, Chen Y, Wang K, Huang Y and Wang H. 2021. Re-utilization of Chinese medicinal herbal residues improved soil fertility and maintained maize yield under chemical fertilizer reduction. *Chemosphere* **283**: 131262. https://doi.org/10.1016/j.chemosphere.2021.131262

Marie AL, Deborah A N, Thomas R W, Patricia D M, Sharma M and Donnelly C. 2022. Differential survival of *Escherichia coli* and *Listeria* spp. in north-eastern US soils amended with dairy manure compost, poultry litter compost, and heat-treated poultry pellets and fate in raw edible radish crops. *Journal of Food Protection* **85**(12): 1708–15. https://doi.org/10.4315/JFP-21-261

Sittirungsum T, Dohi H, Ueno R, Shiga Y, Nakamura R, Horia H and Kamada K. 2001. Influence of farmyard manure on the yield and quality in pac-choi and Japanese radish. *Bulletin of Hokkaido Prefectural Agricultural Experiment Station* **80**: 11–20.

Sharma M and Reynnells R. 2016. Importance of soil amendments: Survival of bacterial pathogens in manure and compost used as organic fertilizers. *Microbiology Spectrum* **4**(4): 1–13. https://doi.org/10.1128/microbiolspec.PFS-0010-2015

Sujatha G, Lalithadevi B, Priyanka G, Sudheer K K and Vanaja S P. 2020. Studies on effect of different organic manures on growth and yield of radish (*Raphanus sativus* L.). *International Journal of Current Microbiology and Applied Sciences* **9**(5): 1936–44. https://doi.org/10.20546/ijcmas.2020.905.221

Wang F, Li W, Gao Y, Zhu L, Chen H, Yang L, Weil R R, Wang T and Nan X. 2024. Radish cover crop and manure alter organic carbon characteristics and improve soil physicochemical properties as well as wolfberry yields. *Agriculture, Ecosystems and Environment* **371**: 109097. https://doi.org/10.1016/j.agee.2024.109097

Weil R and Kremen A. 2007. Thinking across and beyond disciplines to make cover crops pay. *Journal of the Science of Food and Agriculture* **87**: 551–57. https://doi.org/10.1002/jsfa.2742

Weil R, White C and Lawley Y. 2009. Forage radish: New multi-purpose cover crop for the Mid-Atlantic. *Fact Sheet* **824**: 1–8.

Zhou D M, Hao X Z, Wang Y J, Dong Y H and Cang L. 2005. Copper and Zn uptake by radish and pakchoi as affected by application of livestock and poultry manures, *Chemosphere* **59**(2): 167–75. https://doi.org/10.1016/j.chemosphere.2004.11.008.