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Effect of different levels of organic fertilizer on growth, yield and economic benefits of radish (*Raphanus sativus* L.)

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ABSTRACT

An experiment was carried out at A-to-Z Agro Farm Bagatipara, Natore, Bangladesh from October to December 2020, to study the growth, yield and economic benefits of radish (Raphanus sativus L, V: Rocky 45) as influenced by different levels of organic fertilizer (Kazi organic fertilizer). The experiment was laid out in a Randomized Complete Block Design (RCBD) comprising four treatments with three replications. The treatment combinations were T_0 (no organic fertilizer), T_1 (organic fertilizer 5 t ha^{-1}), T_2 (organic fertilizer 10 t ha^{-1}), T_3 (organic fertilizer 15 t ha^{-1}), respectively. Data were recorded from different stages of plant growth on plant height at different days after sowing, number of leaves per plant, leaf length, leaf breadth, root length, root diameter, fresh weight of root per plant, gross yield and marketable yield. All the recorded parameters were statistically significant among the treatments. The tallest plant (40.92 cm) was recorded from T_3 (organic fertilizer 15 t ha^{-1}), whereas the shortest plant height plant (25.84 cm) was obtained from the control T_0 (no organic fertilizer). Highest number of leaves (16.56), leaf length (33.02 cm), leaf breadth ((8.74 cm), root length (19.33 cm), root diameter (3.50 cm), fresh weight of root per plant (129.89 g), gross yield (36.37 t ha^{-1}), marketable yield (36.37 t ha^{-1}) and also the highest benefit cost ratio (2.67) was found in treatment T_3 (organic fertilizer 15 t ha^{-1}) whereas lowest data recorded from control T_0 (no organic fertilizer). Results conclude that application of organic fertilizer 15 t ha^{-1} for radish cultivation gave better growth, yield and economic benefits.

***Key Words**: Radish, Organic fertilizer, Growth, Yield and Benefit cost ratio.*

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I. Introduction

Radish (*Raphanus sativus* L.) belongs to the family Cruciferae, genus *Raphanus* and species *sativus* and it has 2n = 18 chromosomes. Radish is known as Mula in Bangladesh. It is a herbaceous plant. It has a fusiform-shaped stem and an underground-modified root (Rashid, 1999). It is a popular root vegetable

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grown worldwide in tropical, sub-tropical, and temperate regions. Radish originated in four places: South-West Asia, East Asia, the Mediterranean, and the South Asian Tropics (Vavilov, 1926). Depending on its purpose, it is grown mainly as an annual vegetable and biennial crop. Radish is especially a cool-season vegetable crop. But, Asian varieties are more temperature tolerant than European varieties. In Bangladesh, radishes can be grown almost all year round except for few months in summer (Rashid, 1983). Radish is becoming popular day by day among all classes of people. Radish is grown and consumed all over the world and it is an excellent source of carbohydrates, proteins, vitamin A, vitamin C, folic acid, potassium, riboflavin magnesium, iron and calcium (Bakhsh et al., 2006; Zohary and Hopf, 2000). Antioxidants such as catechin, pyrogallol, vanillic acid, and other phenolic compounds are abundant in radish. In Bangladesh, the young tuberous roots of radish plants can be eaten raw in salads or stir-fried and cooked as a vegetable. Young radish leaves can be cooked, half-fried and eaten as vegetables. Vegetables are essential agricultural items for people's survival, and the vegetable sector is a significant contributor to the national economy and people's livelihood (Ali et al., 2022a; Sahu, 2004). Radish grows well in all regions of Bangladesh (Ghosh et al., 2014). Farmers in Bangladesh generally cultivate radish on large-scale, but urban farmers generally cultivate the crop in their homesteads and roofs. Currently, 26228 hectares of land in Bangladesh is cultivated by radish, producing 286543 metric tons of radishes annually (BBS, 2020).

Reducing the synthetic chemical content in foods is a priority of some agricultural researchers, so research is now being carried out on organic farming. Reduce the use of chemically synthesized inputs to achieve this. The introduction of organic farming and the increase in demands for organically produced crops can play an important role in reducing cultivation of chemically produced crops. Organic farming is an agricultural practice that excludes synthetic fertilizers, fungicides, pesticides and plant growth regulators (Lampkin et al., 2000). Organic farming is a comprehensive production management method that improves agro-ecosystem, including biodiversity, biological cycles, and soil biological activity (Seufert et al., 2017). Growth and yield of radishes depend on proper nutrients in soil, which depends on the proper application of manures and fertilizers. Farmers in Bangladesh commonly use inorganic fertilizers to get high yields for crop production (Ali et al., 2023; Ali et al., 2022b; Arora, 2008). Increased usage of inorganic fertilizer in soil harms the physical and chemical qualities of the soil (Ansari, 2005). Using inorganic fertilizer to continue cropping increases production for a few years, but it is ineffective in the long run and causes soil degradation (Satyanarayana et al., 2002).

Organic fertilizers play an important role in plant growth as a source of all necessary macro and micronutrients in available forms during mineralization and improving physical and chemical properties of soils (Chaterjee et al., 2005). Organic fertilizers are made from plant and vegetable residues, animal matter and animal excreta (Singh et al., 2020). Organic fertilizer is also called organic manure. Organic fertilizers contain low nitrogen, phosphorus, potassium, sulfur and some micronutrients, which help radish growth and root development. Organic fertilizers improve the soil structure, aeration, slow-release nutrients, which support root development, leading to growth and yield of radish. Organic fertilizers play an essential role in organic crop production, which is socially acceptable, economically feasible, eco-friendly and sustainable. Organic matter reduces soil erosion, increasing water holding capacity and physio-chemical and biological conditions of the soil. So, organic agriculture is economically feasible to practice when the farmers can obtain a premium price for their product. The present experiment was conducted to determine the effect of organic fertilizer on the growth, yield and economic benefits of radish.

II. Materials and Methods

Experimental site and soil

The experiment was conducted at A-To-Z Agro Farm, Bagatiprara, Natore, Bangladesh, from October to December 2020 in the agro-ecological zone (AEZ 11) of High Ganges River Floodplain. The soil characteristics of the experimental site were loamy, having a pH (8.2).

Experimental treatments and design

The experiment was laid out in a Randomized Complete Block Design (RCBD), Comprising four treatments with three replications. The treatments were T_0 (no organic fertilizer), T_1 (organic fertilizer 5-ton ha^{-1}), T_2 (organic fertilizer 10 ton ha^{-1}), T_3 (organic fertilizer 15 ton ha^{-1}). An area of 30 m^2 was

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divided into three equal blocks. Each block was divided into four plots where four treatments were randomly allotted. Thus, the experiment field had 12 (4 × 3) unit plots. The size of each plot was 2 m × 1 m. The distance between blocks and between plots was kept at 0.5 m and 0.25 m, respectively.

Seed collection

Rocky 45 (variety) radish was used as experimental planting material. The seeds of this variety were collected from "Sojib Seed Store", Jamnagar Bazar, Bagatipara, Natore.

Land preparation

The land selected for the experiment was opened on 10th October, 2020 with the help of a power tiller and then it was kept open to sun for 7 days prior to further ploughing. Afterwards, it was prepared by ploughing and cross ploughing followed by laddering. Deep ploughing was done to have a good tilth, which was necessary for getting a better yield of this crop. The weeds and stubbles were removed after each laddering. Simultaneously, the clods were broken and the soil was made into good tilth.

Organic fertilizer application

Crop was fertilized with organic fertilizer, which was applied as per treatment. In the present study, organic fertilizer was used for the experiment as per treatment. The organic fertilizer was collected from the local market. Total concentrations of major nutrients in organic fertilizer are presented in Table 01.

Table 01. Composition of organic fertilizer

Organic Carbon	10-25%
Nitrogen	0.5-4.0%
C:N (Max)	20:01
Phosphorus	0.5-1.5%
Potassium	1.0-0.5%
Sulfur	0.1-0.5%
Zinc (Max)	0.10%

Sowing of seeds

The radish seeds were sown in the unit plot on 20th October, 2020. The seed was sown by line sowing method. Seeds were sown in the unit plot maintaining plant spacing of 25 cm × 15 cm after germination each unit plot of the experiment field was with 56 plants.

Intercultural operation

Seedlings emergence was completed within seven days. Then, thinning was done after 15 days of sowing. Weeding was done two times in plots to keep plots free from weeds. Irrigations were given by hand sprayer when needed. Neem leaf extract and garlic juice were applied four times to control insects and fungicides.

Data collection

Data on plant height, number of leaves, leaf length and breadth, root length, root diameter accompanied with fresh weights, gross yield and marketable yield of radish were recorded from eight plants randomly selected from each plot. Data were collected at 25, 35 and 45 days after sowing (DAS).

Statistical analysis

After the collected data were subjected to statistical analysis to analyze the treatment variance. The mean values for all the parameters were calculated and the analysis of variances for the characters was accomplished by F variance test. The significance of difference between pair of means was tested by the least significant difference (LSD) test at 1% levels of probability (Gomez and Gomez, 1984). Then BCR (Benefit Cost Ratio) based profitability was assessed.

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III. Results and Discussion

Plant height

Plant height is a significant growth contributing characteristic for crops. Heights of the plants were recorded from all T_0, T_1, T_2 and T_3 treatments. Effect of various levels of organic fertilizer on plant height on different days after sowing (25, 35 and 45) was found statistically significant at 1% level of probability ($p<0.01$) (Table 02). The highest plant height (19.74 cm) at 25 days after sowing was recorded in treatment T_3 (organic fertilizer 15 t ha^{-1}), followed by treatment T_2 (18.07 cm), T_1 (18.00 cm), and T_0 (14.11 cm), respectively. In case of 35 days after sowing, the highest plant height (33.00 cm) was recorded in treatment T_3 (organic fertilizer 15 t ha^{-1}), followed by treatment T_2 (29.17 cm), T_1 (26.57 cm) and T_0 (22.71 cm), respectively. At harvest, the tallest plant (40.92 cm) was observed in T_3 (organic fertilizer 15 t ha^{-1}), which was statistically different from T_2 (organic fertilizer 10 t ha^{-1}) during the period of plant growth. The shortest plant (25.84 cm) was obtained from the control T_0 (no organic fertilizer) followed by T_1 (organic fertilizer 5 t ha^{-1}). This shows that applying 15 t ha^{-1} organic fertilizer gave the highest plant height 45 days after sowing. Plant height of radish was significantly increased by the application of organic manures (Umar et al., 2019; Satish, 2016).

Leaf number

A large number of leaves indicates better growth and development of a crop. It is also directly related to the yield of crops. Number of leaves per plant was significantly affected by different levels of organic fertilizer at 25, 35 and 45 days after sowing (different growth stages) (Table 02). The highest number of leaves (10.11) at 25 DAS was recorded from treatment T_3 (organic fertilizer 15 t ha^{-1}) and the lowest data (6.78) was notified from control T_0 (no organic fertilizer). In case of 35 DAS, maximum leaves (14.22) were obtained in treatment T_3 (organic fertilizer 15 t ha^{-1}), whereas the lowest data (10.11) was recorded in control T_0 (no organic fertilizer). At harvest, the highest number of leaves per plant (16.56) was observed in T_3 (organic fertilizer 15 t ha^{-1}), which was statistically identical with T_2 (organic fertilizer 10 t ha^{-1}) during the period of plant growth. The lowest number of leaves per plant (12.22) was obtained from the control T_0 (no organic fertilizer) followed by T_1 (organic fertilizer 5 t ha^{-1}) with (14.00). This shows that the application of 15 t ha^{-1} organic fertilizer has the highest mean number of leaves. Various organic manure treatments significantly increased the number of leaves per plant radish (Satish, 2016).

Leaf length

Leaf length was significantly affected due to different levels of organic fertilizer at different growth stages ($p<0.01$) (Table 02). At harvest, the highest leaf length (33.02 cm) was observed from treatment T_3 (organic fertilizer 15 t ha^{-1}) followed by treatment T_2 (28.18 cm), T_1 (27.06 cm), where the lowest leaf length (22.36 cm) was obtained from the treatment T_0 (no organic fertilizer). This result suggested that applying different levels of organic fertilizer increased the leaf length of radish. Leaf length was significantly increased by the application of organic manures (Rabbee et al., 2020).

Table 02. Effect of organic fertilizer on vegetative growth of radish

Treatment	Plant height (cm) at different DAS			No. of leaves/plant at different DAS			Leaf length(cm) at different DAS			Leaf breadth(cm) at different DAS		
	25	35	45	25	35	45	25	35	45	25	35	45
T_0	14.11	22.71	25.84	6.78	10.11	12.22	13.28	20.32	22.36	3.02	4.81	5.32
T_1	18.00	26.57	32.23	9.00	11.00	14.00	15.29	23.63	27.06	4.08	6.38	6.54
T_2	18.07	29.17	33.82	9.00	11.56	14.67	15.86	27.27	28.18	4.32	6.98	7.29
T_3	19.74	33.00	40.92	10.11	14.22	16.56	17.09	31.10	33.02	4.92	8.44	8.74
CV (%)	2.34	1.58	1.40	5.66	4.62	2.45	3.53	3.21	1.44	5.11	3.64	2.66
LSD (0.01)	1.24	1.34	1.41	1.49	1.64	1.06	1.64	2.48	1.20	0.63	0.73	0.56
Level of significance	**	**	**	**	**	**	**	**	**	**	**	**

T_0 = no organic fertilizer, T_1 = organic fertilizer 5-ton ha^{-1}, T_2 = organic fertilizer 10 ton ha^{-1}, T_3 = organic fertilizer 15 ton ha^{-1}; CV = Co-efficient of variation; LSD = Least Significant Difference; ** = Significant at 1% level of probability

Leaf breadth

Leaf breadth was affected significantly by different levels of organic fertilizer at different growth stages (Table 02). At harvest, the highest leaf breadth (8.74 cm) was observed in treatment T_3 (organic fertilizer 15 t ha^{-1}). The lowest leaf breadth (5.32 cm) was obtained in control treatment T_0 (no organic fertilizer). This result suggested that applying different levels of organic fertilizer increased the leaf

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breadth of radish. Leaf breadth was significantly increased by the application of organic manures (Rabbee et al., 2020).

Root length

Root length was affected significantly by different levels of organic fertilizer at the time of harvest (Figure 01). The longest root length (19.33 cm) was found in treatment T_3 (organic fertilizer 15 ton ha^{-1}) and the lowest root length (5.76 cm) was recorded in treatment T_0 (no organic fertilizer). This result showed that applying different levels of organic fertilizer increased the root length of radish. Different levels of organic fertilizers significantly influenced root length of radish (Umar et al., 2019).

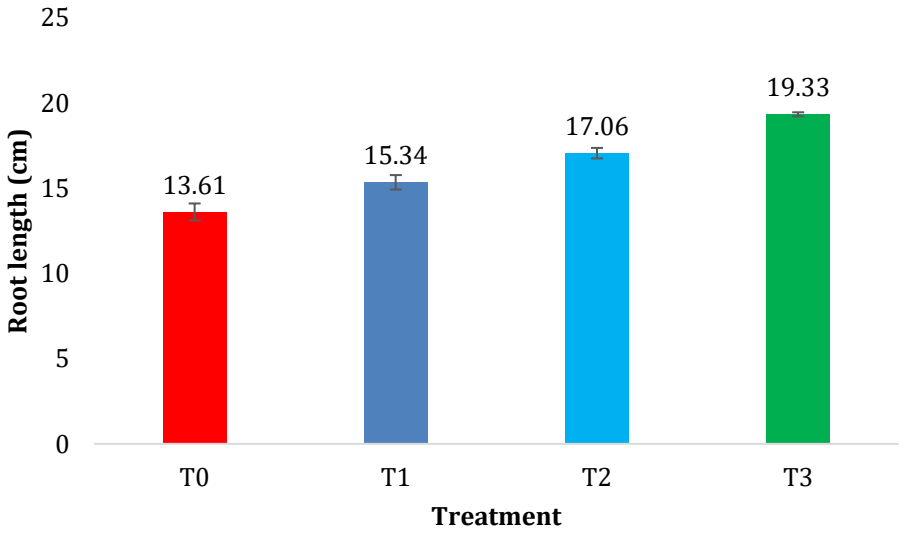

Figure 01. Effects of organic fertilizer on root of radish

Root diameter

Root diameter of the plants was recorded from all T_0, T_1, T_2 and T_3 treatments (Figure 2). Applying different levels of organic fertilizer affected root diameter significantly ($p<0.01$). The highest root diameter (3.50 cm) was observed in treatment T_3 (organic fertilizer 15 ton ha^{-1} and that of the lowest (1.91 cm) was recorded in treatment T_0 (no organic fertilizer). This result showed that applying different levels of organic fertilizer increased the root diameter of radish. Different organic manures significantly influence root diameter of radish (Islam, 2016).

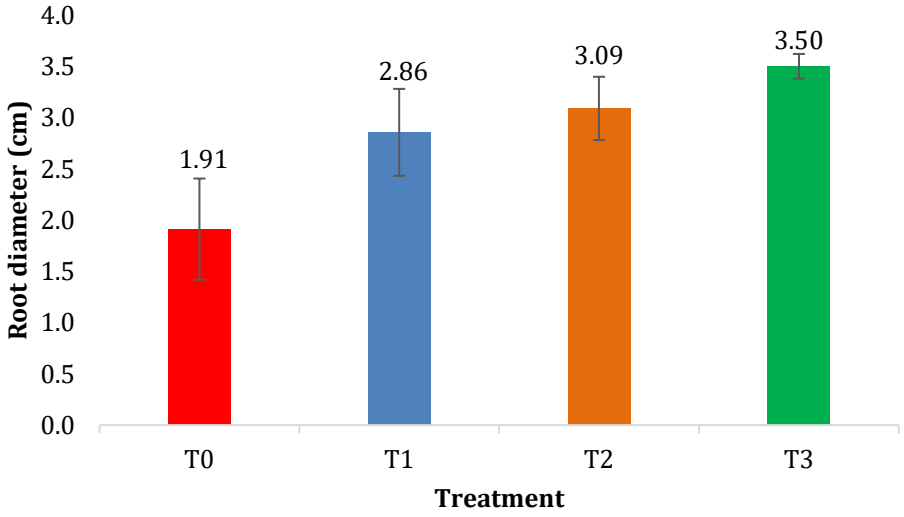

Figure 02. Effects of organic fertilizer on root diameter of radish

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Fresh weight of root per plant

The effect of different treatments on plant fresh weight of root was significant ($p<0.01$) (Table 03). At harvest, the highest fresh weight of root per plant (129.89 gm) was observed in treatment T_3 (organic fertilizer 15 ton ha^{-1}), followed by treatment T_2 (72.61 gm), T_1 (55.44 gm), where the lowest fresh weight of root per plant (23.00 gm) was obtained from the treatment T_0 (no organic fertilizer). This result showed that applying different levels of organic fertilizer increased the fresh weight of radish. Fresh weight of root was significantly affected due to the application of different levels of organic fertilizer (Umar et al., 2019).

Gross yield

Gross yield of radish was positively influenced by various treatments (Table 03 and Figure 03). However, variation among the treatments corresponding to radish yield per hectare was significant ($p<0.01$). Generalized trend observed for yield was that yield per hectare increased with the increase in organic fertilizer dose ($T_0 > T_1 > T_2 > T_3$), respectively. The highest yield (36.37 t ha^{-1}) was found in treatment T_3 (organic fertilizer 15t ha^{-1}) and the lowest yield (6.44 t ha^{-1}) was recorded in treatment T_0 (no organic fertilizer). This result showed that applying different levels of organic fertilizer increased gross yield of radish. Different levels of organic fertilizers significantly influenced the gross yield of radish (Umar et al., 2019). Radish gross yield was significantly affected due to effect of organic manure (Satish, 2016).

Marketable yield

Achieved marketable yield of radish was significant due to application of different levels of organic fertilizer (Table 03 and Figure 03). The highest marketable yield (36.37 t ha^{-1}) was observed in treatment T_3 (organic fertilizer 15t ha^{-1}), followed by treatment T_2 (20.33 t ha^{-1}), T_1 (15.52 t ha^{-1}) where the lowest marketable yield (6.44 t ha^{-1}) was obtained from the control treatment T_0 (no organic fertilizer). Islam (2016) also found that using organic manure, like Poultry, provided maximum economic efficiency.

Table 03. Effect of organic fertilizer on the yield attributes of radish

Treatment	Root weight (gm)	Gross yield (ton/ha)	Marketable yield (ton/ha)
T_0	23.00	6.44	6.44
T_1	55.44	15.52	15.52
T_2	72.61	20.33	20.33
T_3	129.89	36.37	36.37
CV (%)	6.36	6.36	6.36
LSD (0.01)	13.52	3.79	3.79
Level of significance	**	**	**

T_0 = no organic fertilizer, T_1 = organic fertilizer 5-ton ha^{-1}, T_2 = organic fertilizer 10 ton ha^{-1}, T_3 = organic fertilizer 15 ton ha^{-1}; CV=Co-efficient of variation; LSD=Least Significant Difference; **=Significant at 1% level of probability

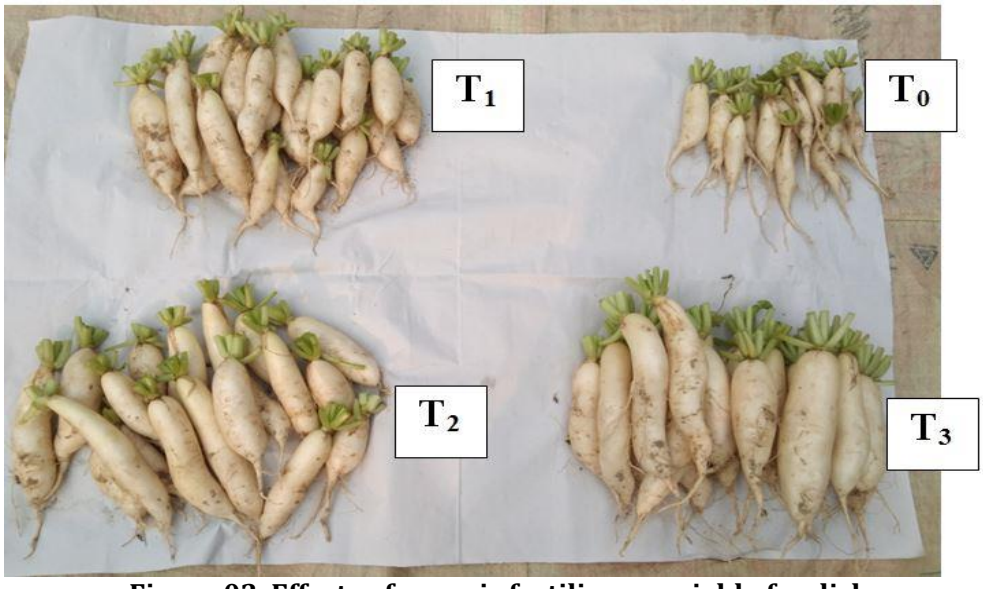

Figure 03. Effects of organic fertilizer on yield of radish

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Economic performance of radish

The partial budget analysis on the effect of organic fertilizer doses on radish production is presented in Table 04**.** The total cost of production ranges between tk. 54500 ha^{-1} and tk. 204500 ha^{-1} among the different treatments. The variation was due to different levels of organic fertilizer. The highest cost of production tk. 204500 ha^{-1} was involved in treating T_3 (organic fertilizer 15 t ha^{-1}) followed by T_2 (organic fertilizer 10 t ha^{-1}) while the lowest cost of production Tk. 54500 ha^{-1} was involved in the treatment of T_0 (no organic fertilizer) followed by T_1 (organic fertilizer 5 t ha^{-1}). The highest gross income (Taka 545550 ha^{-1}) was obtained from treatment T_3, which received organic fertilizer (15 t ha^{-1}), followed by treatment T_2 (Taka 243960 ha^{-1}), which received organic fertilizer (10 t ha^{-1}), and treatment T_1 (Taka 186288 ha^{-1}) which received organic fertilizer (5 t ha^{-1}). All the treatments resulted in higher gross income over the control (Taka 57960 ha^{-1}). The highest net return Tk. 341050 ha^{-1} was obtained from the treatment T_3 (organic fertilizer 15t ha^{-1}). The lowest net return Tk. 3460 ha^{-1} was obtained from the treatment T_0 (no organic fertilizer). The benefit cost ratio (BCR) was found to be the highest (2.67) in the treatment T_3 (organic fertilizer 15t ha^{-1}). The lowest BCR (1.06) was recorded from treatment T_0 (no organic fertilizer). Islam (2016) found that combination of poultry manure with ash provided maximum economic efficiency.

Table 04. Effect of organic fertilizer on economic performance of radish cultivation

Treatment	Gross income (Tk/ha)	Total cost of production (Tk/ha)	Net return (Tk/ha)	BCR (Benefit Cost Ratio)
T_0	57960	54500	3460	1.06
T_1	186288	104600	81688	1.78
T_2	243960	154500	89460	1.58
T_3	545550	204500	341050	2.67

T_0 = no organic fertilizer, T_1 = organic fertilizer 5-ton ha^{-1}, T_2 = organic fertilizer 10 ton ha^{-1}, T_3= organic fertilizer 15 ton ha^{-1}, BCR= Benefit Cost Ratio

IV. Conclusion

The results indicated that organic fertilizer doses positively impacted the growth and yield parameters of radish. Additionally, applied organic fertilizer had significant effect on yield and BCR too. But comparative results of various parameters studied in the present investigation suggested that T_3 was the best treatment because yield was highest (36.37 t ha^{-1}) in treatment T_3 and also the highest BCR (2.67) was found in treatment T_3 (organic fertilizer 15 ton ha^{-1}). However, the present study was only conducted in winter of 2020 at A-To-Z Agro Farm. Therefore, recommending treatment T3 (organic fertilizer 15 ton ha-1) as fertilizer dose necessitates regional and multi-location trials. Finally, yield followed by BCR suggests that treatment T_3 (organic fertilizer 15 ton ha^{-1}) has the potential to be recommended as a suitable organic fertilizer dose for growth and yield of radish cultivation.

V. References

[1]. Ali, M. S., Majumder, D., Hasan, R., Al Aff, T., Mohammad, N. and Hossen, K. (2022b). Effect of different levels of nitrogen, phosphorus and potassium on the growth and yield of cucumber (*Cucumis sativus* L.) in the coastal region of Bangladesh. Research in Agriculture Livestock and Fisheries, 9(2), 117-123. https://doi.org/10.3329/ralf.v9i2.61617

[2]. Ali, M. S., Majumder, D., Mohammad, N., Islam, M. M., Ahmed, R. and Hossen, K. (2022a). Short term growth of red amaranth (*Amaranthus gangeticus*) by using urea fertilizer and Gibberellic acid. Research in Agriculture Livestock and Fisheries, 9(2), 97-102. https://doi.org/10.3329/ralf.v9i2.61615

[3]. Ali, M. S., Majumder, D., Talukder, S. K., Zahid, Z. H., Datta, P., Rahman, M. J. and Hossen, K. (2023). Effect of nitrogen, phosphorus and potassium on the growth and yield performance of garlic (*Allium sativum* L.) in coastal zone of Bangladesh. Research in Agriculture Livestock and Fisheries, 10(1), 53-60. https://doi.org/10.3329/ralf.v10i1.66220

[4]. Ansari, A. (2005). Effect of organic farming on soil nutrients and quality of carrot: (Doctoral dissertation). MS Thesis, Department of Environmental Science, Bangladesh Agricultural University, Mymensingh. 101p.

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EISSN: 2312-7945, ©2023 The Authors, Research paper

[5]. Arora, M., Kiran, B., Rani, S., Rani, A., Kaur, B. and Mittal, N. (2008). Heavy metal accumulation in vegetables irrigated with water from different sources. Food chemistry, 111(4), 811-815. https://doi.org/10.1016/j.foodchem.2008.04.049

[6]. Bakhsh, K. H. U. D. A., Ahmad, B. A. S. H. I. R., Gill, Z. A. and Hassan, S. A. R. F. R. A. Z. (2006). Estimating indicators of higher yield in radish cultivation. International Journal of Agriculture and Biology, 8(6), 783-787.

[7]. BBS. (2020). Yearbook of Agricultural Statistics of Bangladesh. Bangladesh Bureau of Statistics, Ministry of Planning, Dhaka, Bangladesh. p. 334-335.

[8]. Chaterjee, B., Ghanti, P., Thapa, U. and Tripathy, P. (2005). Effect of organic nutrition in sprouting broccoli (*Brassica oleracea* L. var. italica Plenck). Vegetable Science, 33(1), 51-54.

[9]. Ghosh, P., Dash, P. K., Rituraj, S. and Mannan, M. A. (2014). Effect of salinity on germination, growth and yield of radish (*Raphanus sativus* L.) varieties. International Journal of Biosciences, 5(1), 37-48. https://doi.org/10.12692/ijb/5.1.37-48

[10]. Gomez, K. A. and Gomez, A. A. (1984). Statistical procedures for agricultural research. John wiley & sons. New York. pp. 64.

[11]. Islam, K. S. (2016). Growth, yield and economic benefits of radish as influenced by manures and mulching (Doctoral dissertation). Department of Horticulture, Sher-e-bangla Agricultural University, Dhaka-1207.

[12]. Lampkin, N., Padel, S. and Foster, C. (2000). Organic farming. In CAP regimes and the European countryside: prospects for integration between agricultural, regional and environmental policies. pp. 221-238. Wallingford UK: CABI Publishing. https://doi.org/10.1079/9780851993546.0221

[13]. Rabbee, H. E., Methela, N. J., Hossain, B. and Suhel, R. I. (2020). Growth and yield response of Broccoli to vermicompost and farmyard manure. Journal of Bioscience and Agriculture Research, 25, 2107-2113. https://doi.org/10.18801/jbar.250220.257

[14]. Rashid, M. M. (1983). Shabjir Chash. Bangladesh Agricultural Research Institute, Joydebpur, Gazipur, pp: 106-110.

[15]. Rashid, M. M. (1999). Shabji Beggan 2nd edition, Rashid Publication House, Dhaka, pp: 261-263.

[16]. Sahu, P. K. (2004). Statistical analysis of vegetable production in India, China, and the world. Journal of vegetable crop production, 10(1), 3-9. https://doi.org/10.1300/J068v10n01_02

[17]. Satish, D. (2016). Effect of different organic manure on growth and yield of Radish (*Raphanus sativus L.*). MSc. Thesis, Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior R.A.K College of Agriculture Sehore 466001.

[18]. Satyanarayana, V., Vara Prasad, P. V., Murthy, V. R. K. and Boote, K. J. (2002). Influence of integrated use of farmyard manure and inorganic fertilizers on yield and yield components of irrigated lowland rice. Journal of plant nutrition, 25(10), 2081-2090. https://doi.org/10.1081/PLN-120014062

[19]. Seufert, V., Ramankutty, N. and Mayerhofer, T. (2017). What is this thing called organic?–How organic farming is codified in regulations. Food Policy, 68, 10-20. https://doi.org/10.1016/j.foodpol.2016.12.009

[20]. Singh, T. B., Ali, A., Prasad, M., Yadav, A., Shrivastav, P., Goyal, D. and Dantu, P. K. (2020). Role of organic fertilizers in improving soil fertility. Contaminants in agriculture: sources, impacts and management, 61-77. https://doi.org/10.1007/978-3-030-41552-5_3

[21]. Umar, U. M., Ibrahim, I. and Obidola, S. M. (2019). Growth and Yield of Radish (*Raphanus sativus* L.) as influenced by different levels of kalli organic fertilizer on the Jos Plateau. Asian Journal of Research in Crop Science, 4(4), 1-8. https://doi.org/10.9734/ajrcs/2019/v4i430078

[22]. Vavilov, N. I. (1926). Studies on the origin of cultivated plants. Institut Botanique Appliqué et d'Amelioration des Plantes, Leningrad.

[23]. Zohary, D. and Hopf, M. (2000). Domestication of plants in the Old World: The origin and spread of cultivated plants in West Asia, Europe and the Nile Valley (No. Ed. 3). Oxford university press.

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