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Research Article

Effect of Vermicompost and Inorganic Fertilizer on the Growth and Yield Performance of Okra (*Abelmoschus esculentus* L.)

Tasnova Tasin[1], Riad Mahmud[1], Tarikul Islam[1], Faria Naznin[1]✉, Nadia Islam[1], Mominul Hoque Dep[2], Md. Nahid Hashan[1] and Md. Atiqur Rahman Bhuiyan[1]

[1]Department of Agriculture, Faculty of Science, Noakhali Science and Technology University, Noakhali-3814, Bangladesh

[2]Faculty of Agriculture, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh

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Correspondence

Faria Naznin

✉: farianaznin586@gmail.com

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ABSTRACT

Okra is a ubiquitous annual vegetable for its taste and dietary value. The field experiment pursued the effects of vermicompost and inorganic fertilizer on the growth and production of okra. We used three types of fertilizer in this study: control (T_3); vermicompost (T_1) [5 t/ha]; inorganic fertilizer (T_2) [Urea: 80 kg/ha, TSP: 60 kg/ha, MoP: 60 kg/ha]; and two varieties of okra, Super Shomy F_1 (V_1) and BARI Dherosh-1 (V_2). Our experiment has some parameters like the height of the okra plants, the length, weight, and diameter of a single pod, the number of leaves, the length of the petiole, the length of the leaves, the days to first flowering, the total pods per plant, the weight of the pods per plant, and the total yield (ton/ha) that are related to vermicompost and inorganic fertilizer. Results showed that all growth and yield parameters were highest in the Super Shomy F1 variety compared to BARI Dherosh-1. Among fertilizer management treatments, vermicompost recorded significant results over inorganic fertilizer on all parameters except leaf number and days prior to first flowering. The control group yielded the lowest outcome across all parameters. As part of the fertilizer management treatment's interaction effect with variety, the highest yield (16.37 t/ha) was measured in V_1T_1 (Super Shomy F_1 × vermicompost), followed by V_1T_2 (14.50 t/ha), and V_2T_1 (12.50 t/ha). V_2T_3 (BARI Dherosh-1 × control) showed the lowest performance (5.4 t/ha). The experiment suggests that applying vermicompost encourages okra to grow and yield more.

Introduction

Okra (*Abelmoschus esculentus* L.) is a member of the Mallow family. Usually it is known as “Lady's Finger." Most of the places in Bangladesh, it is known as "Dherosh," and their relative country, India, is called “Bhendi” or “Bihindi”. It is a perennial vegetable crop that grows from seeds in regions with tropical and subtropical climates (Singh et al., 2014; Paul et al., 2023). Okra has a comprehensive, far-extending range as a vegetable throughout East Asia and the Indian subcontinent (Rao et al., 2019). People in Bangladesh as well as all over the world of every individual class receive its soft, gelatinous, and delicious fruits as a vegetable (Biswas et al., 2016).

Pods of okra are sticky, low in calories, and rich in edible dietary fibers (Kumar et al., 2013). Not only saturated fats and cholesterol are low but also minerals like K, Ca, P, and Mg are abundant in pods. Moreover, some important chemical compounds, for instance, vitamin B1, vitamin B2, vitamin B3, vitamin B9, ethanedioic acid (HOOC-COOH.2H2O), carotene, and amino acids are present in pods (Romdhane et al., 2020). Okra has several treatment characteristics and may offer protection from a number of diseases such as diabetes, chronic gastrointestinal disorders, and cardiovascular disease. Okra's fiber content can help to avoid dyschezia and improve blood cholesterol levels (Gemede et al., 2015). Okra has many kinds of potential uses due to the various ways its leaves, buds, flowers, pods, stems, and seeds are utilized. The entire plant is edible and has food, non-food, and medical services (Das et al., 2019). Vegetable production in Bangladesh changes throughout the year. Winter offers an abundance of vegetables, whereas their availability decreases throughout the summer.

Cite This Article

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In the Kharif season (April to September), almost 30% of the total number of vegetables is grown, with the remaining 70% of vegetables cultivated and yielded during the Rabi season (October to March) (Chauhan and Bhandari, 2016). Although okra can be grown almost annually, its production in Bangladesh is mainly concentrated during the summer (Dash et al., 2013). Using inorganic fertilizer in agricultural fields significantly leads to environmental degradation, decrease soil fertility, declined agricultural production, and soil degradation (Ali et al., 2005). At present, farmers use organic manure because of its availability and price than inorganic fertilizer (Alam et al., 2007). In addition, organic fertilizers may lessen pollution from chemical fertilizer production (Rathier and Frink, 2005). Earthworms and microorganisms bio-oxidize organic substrates to form vermicompost and it is a cheap organic amendment (Lim et al., 2019). The procedure of fermenting organic waste using earthworms is called vermicomposting. Earthworms can eat more than their body weight per day. Earthworms may convert to 300 tons of compost from 1000 tons of moist organic manure (Chatterjee et al., 2021). These converted elements are exceptionally rich in key soil microbes and micronutrients such as P, K, and N (Baghel et al., 2018). Seedlings may grow rapidly as well as vigorously. There occurs improvement of root formation, stem elongation, biomass, vegetable, and ornamental plants using vermicompost (Tomati et al., 1988). Vermicompost contains readily available nutrients such as nitrate, ammonium nitrate, exchangeable phosphorus, soluble potassium, calcium, and magnesium (Chanda et al., 2011).

As a biofertilizer, vermicompost is a meager cost and a renewable source through which plants get nutrients that supplement chemical fertilizer. It acts as an excellent, nutrient-rich fertilizer that is completely ecological and chemical-free. Biofertilizers are vital because they maintain soil health and reduce chemical pollution (Shishehbor et al., 2013). The study aimed to evaluate and compare the impression of vermicompost and inorganic fertilizers on okra growth and yield and identify an optimal combination of variety and treatment to enhance okra production for Noakhali's farmers.

Materials and Methods

Experimental site, soil and climate

The study was carried out from November 1, 2021, to May 15, 2022, at an agro farm named Bismillah Agro Production, Noakhali Sadar Upzilla, Noakhali, Bangladesh. The experimental field had a sandy loam soil texture with a medium-high elevation and a somewhat alkaline pH. Typically, the fertility level is moderate but relatively low in organic matter. The pH range of the soil is 7.5-8.3, indicating a high salinity level. The experimental site was in a subtropical climate with frequent heavy precipitation and brief dry spells for most of the year. Noakhali faces an average annual temperature of 25.6 °C and receives a yearly rainfall of 3,302 mm. During the experiment, meteorological data on temperature, relative humidity, and precipitation were gathered from the Maizdee weather station in Noakhali.

Experimentation and crop husbandry

There were used two varieties of okra such as V_1=Super Shomy F_1, V_2= BARI Dherosh-1. Table 1 represents a short description of the variety used in the study. The experiment composed of two factors, Factor A: Variety (2)- Super Shomy F_1 (V_1) and BARI Dherosh-1 (V_2), and Factor B: Fertilizer management (3)- Vermicompost (5 t/ha) (T_1), Inorganic fertilizer (80, 60 and 60 kg/ha of urea, TSP and MoP, respectively) (T_2) and Control (no fertilizer and manure) (T_3). Thus, the total number of plots were (2×2×3) = 18. The seeds were planted using the line sowing technique during the rabi season, particularly on February 5, 2022. Before planting, the seeds were mixed with ash and spread out equally across the land. Following 7 days from seeding, the seeds exhibited consistent and simultaneous germination. A substantial quantity of weeds was discovered, and removing them was carried out three times in the specific areas where it was required. After five to six days of germination, only the robust seedlings were retained for growth in each respective location, while the remaining seedlings were eliminated. We visually estimated the irrigation requirement one week after planting. Whenever the plants in a particular area exhibited signs of withering, the affected plots were immediately watered using a hosepipe until the entire area was adequately saturated. A severe insect infestation seriously hampered the establishment of seedlings in the field. The cutworms were managed by a combination of mechanical methods and the application of Bavistin 50WP, Furadan 5G, and Ripcord 10EC when required. Also, sick leaves that exhibited discoloration and a yellowish hue were gathered from the plant and eliminated from the field. The green pods were collected every 3 days whenever they reached the stage suitable for consumption, precisely when they were delicate and fresh and measured between 8-13 cm in length.

Table 1. Description about variety of Okra

Varieties	Scientific name	Source	characteristics	Yield
V_1=Super Shomy F1	*Abelmoschus esculentus*	A.R. Malik Seed company	Year round and high yielding variety, flowering initiating within 30-32 days after planting, fruiting within 35-38 days, fruit surface smooth and color attractive green, fruit/plant 32-34, highly virus resistance, adapted high temperature and high rainfall.	18-22 t/ha
V_2= BARI Dherosh-1	*Abelmoschus esculentus*	Bangladesh Agricultural Research Institute (BARI)	Year-round variety, flowering initiating within 45 days after planting, within 5-6 days after flowering fruit harvest and fruit harvest one day alter, fruit color green, fruit/plant 20-25 and resistance to yellow mosaic virus.	14-17 t/ha

Statistical analysis

The data collected from the experiment was analyzed in the statistical software Minitab 17, which is developed by Minitab Inc., located in State College, PA, USA. The significant differences between the means of the treatments were evaluated by applying the Least Significant Difference (LSD) with a significance level of 5%.

Results and Discussion

Morphological traits

Plant height (cm)

The height of the plants was considerably affected by the various varieties at a probability level of 1% at 60 days after sowing. The highest plant height (86.15 cm) was observed in V_1 (Super Shomy F_1), and the lowest one (73.55 cm) was observed in V_2 (BARI Dherosh-1). After sowing 60 days, plant height had shown significant variation after applying various treatments. The highest plant height (94.83 cm) was measured in vermicompost rather than the control (63.68 cm) (Figure 1). The relationship between variety and fertilizer management did not have a noticeable impact on plant height. Shishehbor et al. (2016) reported similar research finding found that application of vermicompost (a dose of 20 t/ha) resulted in the tallest plant height.

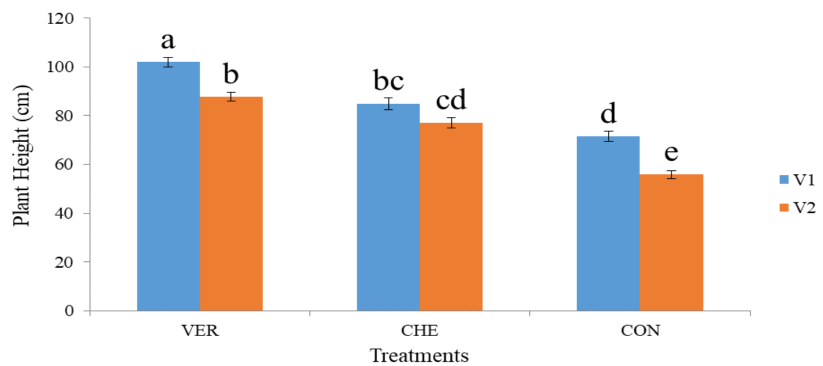

Figure 1. Treatment-variety interaction on plant height and length (Here, VER= vermicompost, CHE= chemical fertilizers, and CON= control). The presence of vertical bars depicts the standard error of the mean for each interaction. The letters represent 5% statistically significant differences between variety and treatment.

Leaf Length (cm)

For variety, leaf length showed highly significant variation at 60 days after sowing (DAS). The variety Super Shomy F_1 showed the most extended leaf length (21.00 cm), followed by BARI Dherosh-1, which was 15.32 cm. For fertilizer management treatment, leaf length showed a highly significant variation at 60 DAS. From the study, we found the longest leaf length in T_1 (vermicompost), 22.22 cm, and the shortest leaf length in T_3 (control), 12.57 cm (Figure 2). For the interaction between variety and fertilizer management, no significant variation was observed at 60 DAS. The finding corroborates the report of Karmegam and Daniel (2005), who reported that vermicompost, increased the leaf length of okra.

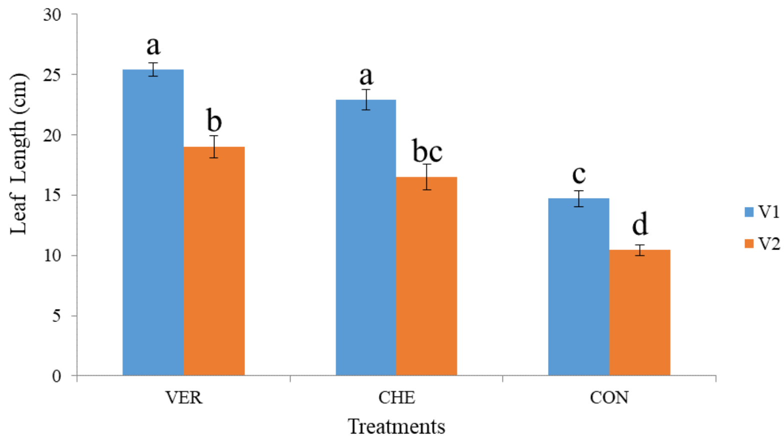

Figure 2. Treatment-variety interaction on leaf length (Here, VER=vermicompost, CHE=chemical fertilizers and CON=control). The presence of vertical bars depicts the standard error of the mean for each interaction. The letters represent 5% statistically significant differences between variety and treatment.

Petiole Length (cm)

The variety significantly impacted the length of the petiole at 60 DAS. The longest petiole length (19.49) cm was observed in V_1 (Super Shomy F_1), and the shortest one (12.40 cm) was measured in V_2 (BARI Dherosh-1). Petiole length was also affected by fertilizer management. According to this experiment, the longest petiole length shown in T_1 (Vermicompost) was 18.18 cm, and T_3 (control) shown the shortest petiole length which was 11.83 cm. Comparable findings have been noted by Karmegan and Daniel (2005), who reported that vermicompost significantly increases petiole length. There was a significant variation in interaction between variety and treatment on petiole length. The longest petiole length (22.90 cm) was found in V_1T_1 (Super Shomy F_1 with Vermicompost), while the shortest petiole length (9.47 cm) was found in V_2T_3 (BARI Dherosh-1 with control) (Figure 3).

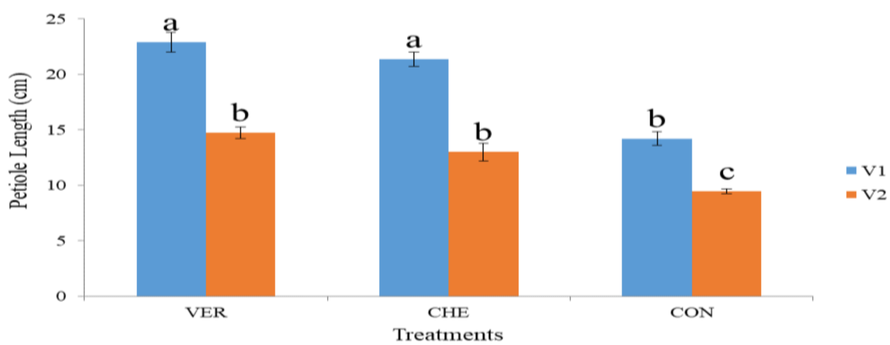

Figure 3. Treatment-variety interaction on petiole length (Here, VER=vermicompost, CHE=chemical fertilizers and CON=control). The presence of vertical bars depicts the standard error of the mean for each interaction. The letters represent 5% statistically significant differences between variety and treatment.

Leaf Number per plant

The variety had a significant impact on the length of the petiole at 60 DAS. The highest value (9.16) was observed in V_1 (Super Shomy F_1), while V_2 (BARI Dherosh-1) showed the lowest value (9.11). Different fertilizer management treatments significantly influenced the leaf number. T_2 (chemical fertilizers) shown the highest value (17.6), and the lowest value (9.43) was observed in T_3 (control). Comparable findings have been noted by Kashem et al. (2015), who observed that applying chemical fertilizers to okra significantly increases leaf number. The interaction between variety and fertilizer management treatment had no significant effect. Numerically, the highest value (22.33) was found in V_1T_2 (Super Shomy F_1 with chemical fertilizer), and the lowest value (7.26) was found in V_2T_3 (BARI Dherosh-1 with control) (Figure 4).

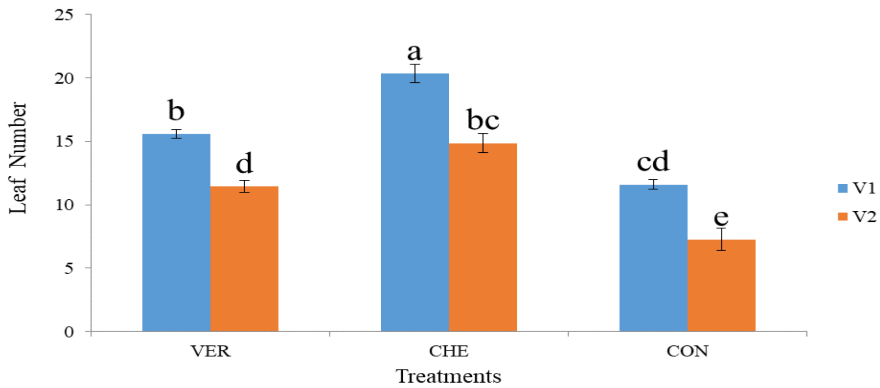

Figure 4. Treatment-variety interaction on leaf number (Here, VER=vermicompost, CHE=chemical fertilizers and CON=control). The presence of vertical bars depicts the standard error of the mean for each interaction. The letters represent 5% statistically significant differences between variety and treatment.

Days to Flowering

Variety exerted a significant effect on flowering time. The variety Super Shomy F_1 took a shorter time (38.81 days) for flowering, whereas BARI Dherosh-1 took longer days for flowering (43.33). Fertilizer management greatly affected flowering days. Chemical fertilizer (T_2) required the shortest time for flowering (35.88 days), whereas control (T_3) required the longest time (45.6 days) (Figure 5). No significant interaction between variety and fertilizer management treatment affects flowering days. The result showed that days to first flowering were at their minimum with the application of NPK fertilizer by Karmegam and Daniel (2005).

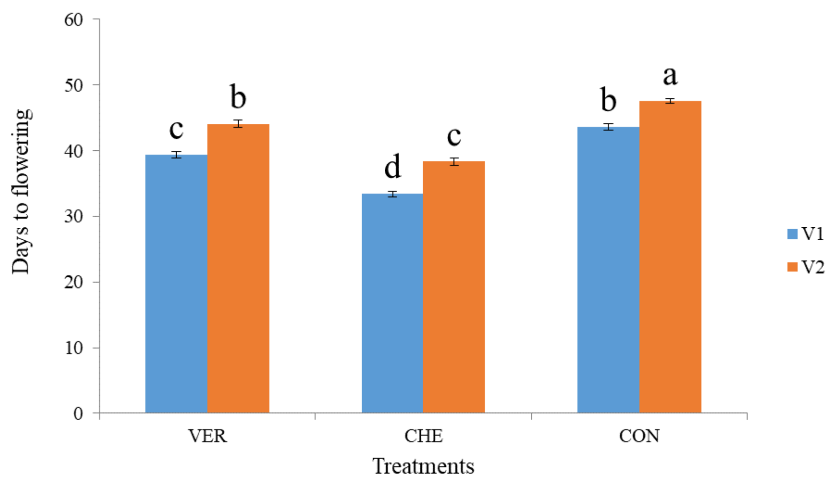

Figure 5. Treatment-variety interaction on days to flowering (Here, VER=vermicompost, CHE=chemical fertilizers and CON=control). The presence of vertical bars depicts the standard error of the mean for each interaction. The letters represent 5% statistically significant differences between variety and treatment.

Yield attributing traits

Single pod Length (cm)

Varieties have a considerable impact on the length of the pod. The higher pod length (12.42 cm) was observed in Super Shomy F_1, while the lower fruit length (10.51 cm) was observed in BARI Dherosh-1. A considerable influence of fertilizer management treatments was seen on the single pod length of okra. The most considerable fruit length (12.8 cm) was recorded in T_1 (Vermicompost), and the shortest fruit length (9.4 cm) was observed in T_3 (control). Saha et al. (2016) reported a similar research finding found the maximum pod length with the application of vermicompost. There is no significant effect of variety and treatment on okra fruit length (Figure 6).

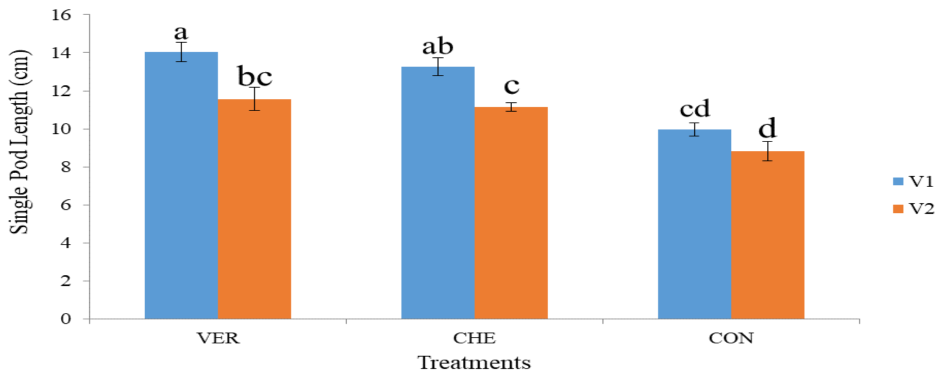

Figure 6. Treatment-variety interaction on single pod length (Here, VER=vermicompost, CHE=chemical fertilizers and CON=control). The presence of vertical bars depicts the standard error of the mean for each interaction. The letters represent 5% statistically significant differences between variety and treatment.

Single Pod Weight (g)

Varieties dramatically affected the weight of a single pod. The higher pod weight (13.67 g) was found in the Super Shomy F_1 variety (V_1), and the lower pod weight (12.11 g) was found in BARI Dherosh-1 (V_2). A considerable influence of fertilizer management treatments was seen on the single pod weight of okra. The highest single pod weight (14.38 g) was found in T_1 (Vermicompost). The lowest weight of a single pod (10.63 g) was found in T_3 (Control) (Figure 7). The maximum single pod weight was recorded with vermicompost (Ansari and Kumar, 2010). Variety-treatment interaction did not affect okra pod weight. Equivalent results were discovered (Saha et al., 2016).

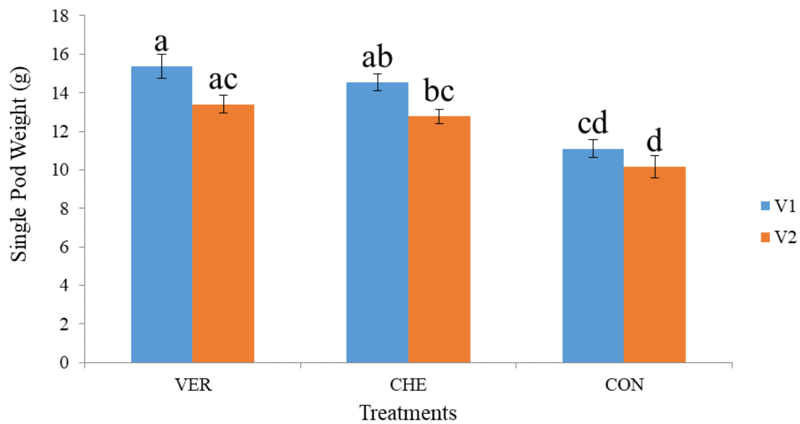

Figure 7. Treatment-variety interaction on single pod weight (Here, VER=vermicompost, CHE=chemical fertilizers and CON=control). The presence of vertical bars depicts the standard error of the mean for each interaction. The letters represent 5% statistically significant differences between variety and treatment.

Single pod diameter (cm)

For variety, significant variations were found in single pod diameter of okra. The broader diameter (1.64 cm) was found in Super Shomy F_1 (V_1), while the narrower diameter (1.43 cm) was found in BARI Dherosh-1 (V_2). For fertilizer management treatment, significant variations were found in single pod diameter. As shown in Figure 8, T1 (Vermicompost) appeared to have the broadest diameter (1.71 cm), while T_3 (Control) had the narrowest (1.24 cm) diameter of a single pod. The results of Saha et al. (2016), who discovered the highest single pod diameter using vermicompost, corroborate the discovery. The interaction of variety and fertilizer management treatment did not significantly affect the single pod diameter of okra. Comparable findings have been noted by Kashem et al. (2015).

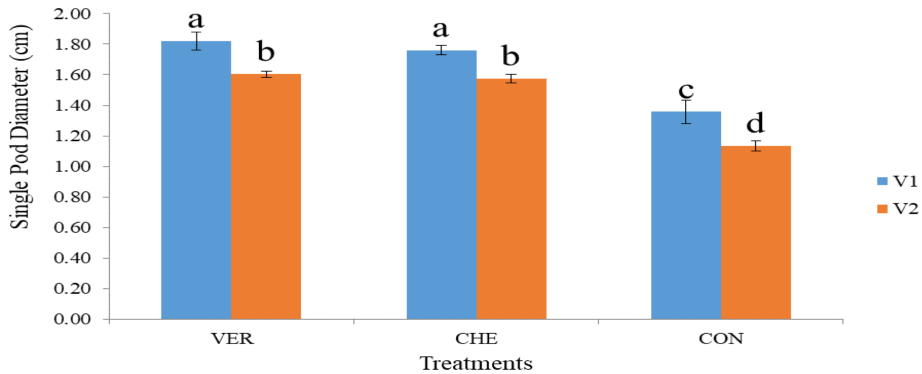

Figure 8. Treatment-variety interaction on single pod diameter (Here, VER=vermicompost, CHE=chemical fertilizers and CON=control). The presence of vertical bars depicts the standard error of the mean for each interaction. The letters represent 5% statistically significant differences between variety and treatment.

Total pods per plant

Varietal variation has a substantial impact on total pods per plant. Super Shomy F_1 (V_1) had the highest pod number at 29.52 per plant, while BARI Dherosh-1 (V_2) had the lowest at 19.30 per plant. The number of okra pods per plant varied significantly between treatments for managing fertilizer. The number of pods decreased to 15.90 in T_3 (Control) from a maximum of 30.76 in Vermicompost (T_1). Equivalent results were noted by Saha et al. (2016), who observed the maximum number of pods per plant by incorporating organic fertilizer.

According to the total pods per plant, there was a statistically significant interaction between variety and fertilizer management treatment (0.05). Throughout the experiment, V_1T_1, which consisted of Super Shomy F_1 with vermicompost, produced the maximum number of pods (37.00), and V_2T_3, there were the fewest pods per plant (12.80) when BARI Dherosh-1 was used as a control (Figure 9).

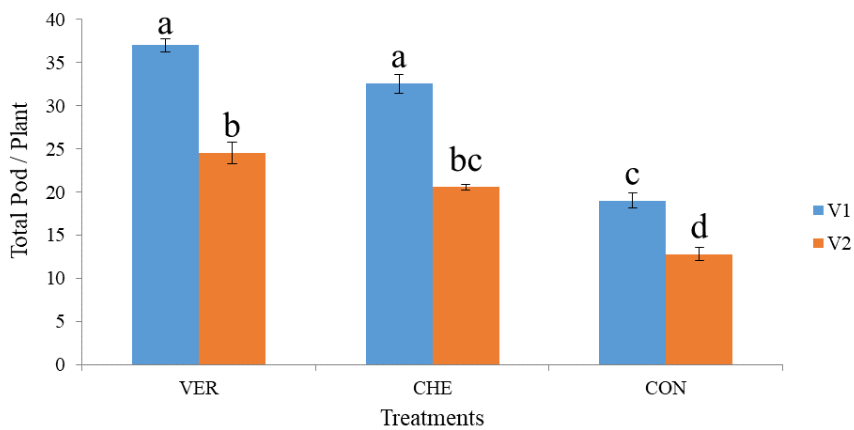

Figure 9. Treatment-variety interaction on total pod/plant (Here, VER=vermicompost, CHE=chemical fertilizers and CON=control). The presence of vertical bars depicts the standard error of the mean for each interaction. The letters represent 5% statistically significant differences between variety and treatment.

Weight of pods per plant (g)

The different cultivars significantly influenced the weight of pods per plant. The Super Shomy F_1 (V_1) variety had the highest weight of pods per plant, measuring 413.25 g, whereas the BARI Dherosh-1 variety had the lowest weight of pods per plant, measuring 245.76 g. Fertilizer management treatments showed significant variations in the weight of pods per plant (0.01). There were noticed from our experiment the maximum pod weight (470.15 g) was in T1 (Vermicompost), whereas the minimum (170.16 g) was in T_3 (Control). Saha et al. (2016) found that the highest number of pods per plant with applying vermicompost in okra plants. The interaction of variety and fertilizer management treatment exhibited significant variation in the total weight of pods per plant. Throughout the experiment, V_1T_1 (Super Shomy F_1 with vermicompost) produced the maximum weight of pod per plant (595.39 g), and V_2T_3 (BARI Dherosh-1 with control) had the minimum weight of pod per okra plant (129.90 g) (Figure 10).

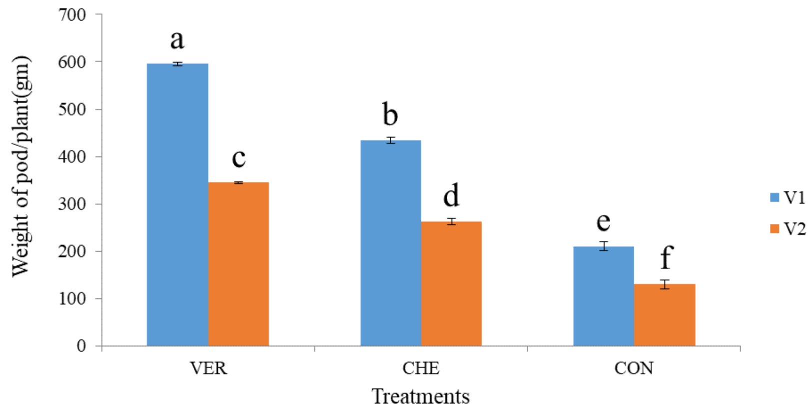

Figure 10. Treatment-variety interaction on weight of pod/plant (Here, VER=vermicompost, CHE=chemical fertilizers and CON=control). The presence of vertical bars depicts the standard error of the mean for each interaction. The letters represent 5% statistically significant differences between variety and treatment.

Yield (ton/ha)

The different cultivars significantly impacted the yield of okra per hectare. The Super Shomy F_1 (V_1) variety showed a great number of pods output per hectare, measuring 12.81 tons, whereas the BARI Dherosh-1 variety had the lowest pod yield at 9.74 tons. There were notable differences in the fruit output of okra per hectare among the various fertilizer management treatments. It was found from our experiment the highest yield per hectare (14.43 tons), whereas the lowest yield was in T_3 (control). The study found that organic fertilizer resulted in the maximum yield per hectare compared to inorganic fertilizer regarding okra growth and production (Saha et al., 2016).

Yield per hectare varied considerably with variety and fertilizer management. Throughout the experiment, Super Shomy F_1 with vermicompost (V_1T_1) produced the maximum yield per hectare (16.37 tons), and BARI Dherosh-1 with control (V_2T_3) produced the lowest yield per hectare of okra (5.43 tons) (Figure 11).

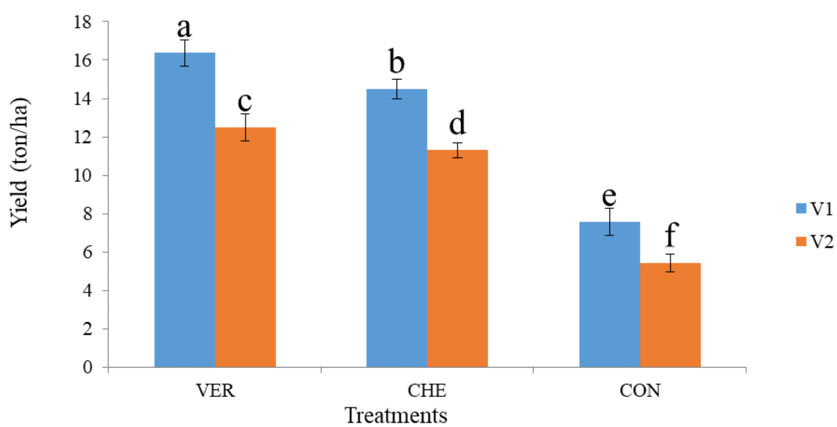

Figure 11. Treatment-variety interaction on total yield/ha (Here, VER=vermicompost, CHE=chemical fertilizers and CON=control). The presence of vertical bars depicts the standard error of the mean for each interaction. The letters represent 5% statistically significant differences between variety and treatment.

Conclusion

Super Shomy F_1 showed superior performance over BARI Dherosh-1. Among fertilizer management treatments, vermicompost resulted in higher yield, and okra's growth and yield characteristics were positively impacted. Almost all parameters were recorded highest result in vermicompost. Inorganic fertilizer showed maximum leaf number and minimum days to flower. The lowest results were recorded in control. The interaction between variety and fertilizer management treatment substantially impacted several parameters, including petiole length, total pods per plant, weight per plant, and yield per hectare. The best result was found in the Super Shomy F_1 variety with vermicompost. Compared to inorganic fertilizer, the experiment demonstrates that the okra plant's growth and yield parameters were improved by mixing vermicompost with the soil. According to the study, 5 tons per hectare vermicompost may increase okra yield instead of inorganic fertilizers.

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Conflict of interest statement

The writers did this research and wrote the article without financial, personal, or other conflicts of interest.

References

Ansari, A. A. and Kumar, S. 2010. Effect of vermiwash and vermicompost on soil parameters and productivity of okra (*Abelmoschus esculentus*) in Guyana. Current Advances in Agricultural Sciences (An International Journal), 2(1), 1-4.

Alam, M. N., Jahan, M. S., Ali, M. K., Islam, M. S. and Khandaker, S. M. A. T. 2007. Effect of vermicompost and NPKS fertilizers on growth, yield and yield components of red amaranth. Australian Journal of Basic and Applied Sciences, 1(4), 706-716.

Ali, S., Khan, M. A., Habib, A., Rasheed, S. and Iftikhar, Y. 2005. Management of yellow vein mosaic disease of okra through pesticide/bio-pesticide and suitable cultivars. International Journal of Agriculture and Biology, 7(1), 145-147.

Biswas, A., Hossain, M. M., Alam, Z. and Islam, M. M. 2016. Nutritive value and yield potential of okra (*Abelmoschus esculentus* L. *Moench*) genotypes. Bangladesh Journal of Agricultural Research, 41(3), 541-554.

Baghel, B., Sahu, R. and Pandey, D. 2018. Vermicomposting an economical enterprise for nutrient and waste management for rural agriculture. International Journal of Current Microbiology and Applied Sciences, 7(2), 3754-3758. DOI: https://doi.org/10.20546/ijcmas.2018.702.444

Chauhan, K. S., & Bhandari, Y. M. 2016. Pod development and germination studies in okra (*Abelmoschus esculentus* L. *Moench*). Indian Journal of Agricultural Science, 206-215.

Chatterjee, D., Dutta, S. K., Kikon, Z. J., Kuotsu, R., Sarkar, D., Satapathy, B. S. and Deka, B. C. 2021. Recycling of agricultural wastes to vermicomposts: Characterization and application for clean and quality production of green bell pepper (*Capsicum annuum* L.). Journal of Cleaner Production, 315, 128115. DOI: https://doi.org/10.1016/j.jclepro.2021.128115

Chanda, G. K., Bhunia, G. and Chakraborty, S. K. 2011. The effect of vermicompost and other fertilizers on cultivation of tomato plants. Journal of Horticulture and Forestry, 3(2), 42-45.

Das, S., Nandi, G. and Ghosh, L. K. 2019. Okra and its various applications in drug delivery, food technology, health care and pharmacological aspects-a review. Journal of Pharmaceutical Sciences and Research, 11(6), 2139-2147.

Dash, P. K., Rabbani, M. G. and Mondal, M. F. 2013. Effect of variety and planting date on the growth and yield of okra. International Journal of Bioscience, 3(9), 123-131. doi: http://dx.doi.org/10.12692/ijb/3.9.123-131

Gemede, H. F., Ratta, N., Haki, G. D., Woldegiorgis, A. Z. and Beyene, F. 2015. Nutritional quality and health benefits of okra (*Abelmoschus esculentus*): A review. Journal of Food Process Technology, 6(458), 2.

Kumar, A., Kumar, P., and Nadendla, R. 2013. A review on: *Abelmoschus esculentus* (Okra). *International Research* Journal of Pharmaceutical and Applied Sciences, 3(4), 129-132.

Kashem, M. A., Sarker, A., Hossain, I. and Islam, M. S. 2015. Comparison of the effect of vermicompost and inorganic fertilizers on vegetative growth and fruit production of tomato (*Solanum lycopersicum* L.). Open Journal of Soil Science, 5(02), 53. Doi: https://doi.org/10.4236/ojss.2015.52006 .

Lim, S. L., Lee, L. H. and Wu, T. Y. 2016. Sustainability of using composting and vermicomposting technologies for organic solid waste biotransformation: recent overview, greenhouse gases emissions and economic analysis. Journal of Cleaner Production, 111, 262-278. Doi: https://doi.org/10.1016/j.jclepro.2015.08.083

Paul, S.K., Gupta, D.R., Ino, M., Hirooka, Y. and Ueno, M. 2023. Biological characterization of *Fusarium buharicum* induced wilt of okra and its management. Journal of Plant Pathology, https://doi.org/10.1007/s42161-023-01557-0

Rathier, T. M., and Frink, C. R. 1989. Nitrate in runoff water from container grown juniper and Alberta spruce under different irrigation and N fertilization regimes. Journal of Environmental Horticulture, 7(1), 32-35. Doi: https://doi.org/10.24266/0738-2898-7.1.32

Rao, S. R., Nongsiang, R. H. and Devi, M. K. 2019. Okra-an important vegetable crop of India.

Romdhane, M. H., Chahdoura, H., Barros, L., Dias, M. I., Corrêa, R. C. G., Morales, P., ... and Ferreira, I. C. 2020. Chemical composition, nutritional value, and biological evaluation of Tunisian okra pods (*Abelmoschus esculentus* L. *Moench*). Molecules, 25(20), 4739.

Shishehbor, M., Madani, H., and Ardakani, M. R. 2013. Effect of vermicompost and biofertilizers on yield and yield components of common millet (*Panicum miliaceum*). Annals of Biological Research, 4(2), 174-180.

Saha, S. R., Islam, A. F. M. S., Hasan, M. M. and Rob, M. M. 2016. Yield attributes and yield of okra as influenced by cultivars at Sylhet region. Journal of Bangladesh Agricultural University, 14(1), 13-16.

Singh, P., Chauhan, V., Tiwari, B. K., Chauhan, S. S., Simon, S., Bilal, S. and Abidi, A. 2014. An overview on okra (*Abelmoschus esculentus*) and it's importance as a nutritive vegetable in the world. International journal of Pharmacy and Biological sciences, 4(2), 227-233.

Tomati, U., Grappelli, A., and Galli, E. 1988. The hormone-like effect of earthworm casts on plant growth. Biology and Fertility of Soils, 5, 288-294.