Effect of Compost and Fertilizer on Growth, Yield and Quality of Broccoli

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Abstract— *The aimed of the investigation was to evaluate the impact of various organic and inorganic treatments on the growth and yield of broccoli. The experiment utilized a Randomized Complete Block Design (RCBD) with three replications. Five treatment setups were employed: T_1 = Control (Recommended doses of fertilizers: Urea: 250; TSP: 150; MoP: 200; and Boric acid: 12 kg/ha); T_2 = Vermicompost (5 t/ha) + ¼ RDF; T_3 = Vermicompost (3 t/ha) + ¼ RDF; T_4 = Trichocompost (5 t/ha) + ¼ RDF; T_5 = Trichocompost (3 t/ha) + ¼ RDF. The results revealed significant differences across treatments. Vermicompost (T_2) consistently produced the highest values. For all 30, 45 and 60 DAT, T_2 had the tallest plant height (48.18, 63.80 and 64.00 cm), the most leaves (12.60, 15.60 and 15.62), the largest stem diameter (2.14, 2.40 and 2.62 cm), the longest leaf length (43.32 and 52.98 cm), and the greatest leaf breadth (17.58, 21.26 and 22.38 cm). T_2 achieved the highest yield (4.32 kg/plot; 21.33 t/ha), outperforming all other treatments, while T_1 produced the lowest (3.20 kg/plot; 15.80 t/ha). TSS was recorded the highest in T_2 (9.83°Brix), with high ascorbic acid content (88.32 mg/100 g), maximum protein (4.34%), iron content in T_2 (1.44 mg/100 g) and calcium content (47.60 mg/100 g). These findings demonstrated the potential of T_2: Vermicompost (5 t/ha) with 1/4 of the recommended doses of fertilizers (RDF) to be a recommendable fertilizer management practice to boost broccoli productivity and also demonstrate its significance in reducing production cost for farmers.*

Keywords— Vermicompost, Trichocompost, Organic, Yield, Broccoli.

I. INTRODUCTION

About 2.82% of the total land area of Bangladesh is usually involved for vegetable production with a yield of 3.73 million tonnes of vegetables (BBS, 2024). Broccoli (*Brassica oleracea* L. var. *italica*) has become a high-value vegetable crop of growing attention in Bangladesh. It is a member of the Brassicaceae family, involving such products as cabbage, cauliflower and kale (Rabbee *et al*., 2020). Broccoli is a Mediterranean crop, and it is appreciated for its healthy value. It is rich in vitamins A, C, and E and minerals (calcium, iron, and zinc) (Hamza and Al-Taey, 2020). China is the biggest producer of broccoli globally, and it produces approximately 43% of the total (FAO, 2022). In Bangladesh approximate production of cauliflower and broccoli rose 16.2% to 342000 tonnes in the year 2022 (FAOSTAT, 2022). In Bangladesh, production and productivity levels, as well as quality, are highly dependent on the soils and their management. To boost the harvest, farmers regularly use excessive levels of chemical fertilizers, which harm the environment and degrade the soil health (Singh *et al*., 2021).

The effect of compost and fertilizer on the growth and yield of broccoli has been extensively studied, revealing significant benefits from both organic and inorganic amendments; compost usually enhances soil chemical properties, leading to increased nitrogen content, which is crucial for broccoli's growth (Aouass & Kenny, 2022). It has been observed that organic and chemical fertilizers used in a proper balance contribute to sustainable output and lower the degradation of the environment (Al-Taey *et al*., 2019).

Excessive use of chemical fertilizers in broccoli fields has raised concerns about overall soil health and environmental sustainability, causing a shift toward organic fertilizer management practices (Islam *et al.*, 2024; Meem *et al.*, 2024). Vermicompost is produced through the decomposition of organic matter by earthworms. Among available organic fertilizers, vermicompost has gained attention for its ability to enhance soil fertility, microbial activity, and plant growth, leading to improved yield and quality in broccoli and other crops (Rehman *et al.*, 2023; Blouin *et al.*, 2019). Studies consistently report that vermicompost application improves plant height, leaf number, and biomass in broccoli due to enhanced nutrient availability and improved soil structure (Rabbee *et al.*, 2020). Vermicompost improves soil structure, microbial activity, and nutrient supply (Manzoor *et al.*, 2024). Yield increases are attributed to better root development and increased nutrient uptake, with some studies noting up to 20-30% higher yields in vermicompost-treated plots (Alkobaisy *et al.*, 2021). Trichocompost, generated by incorporating *Trichoderma* species in the composting process, supplements nutrients and also acts as a natural biocontrol agent, and *Trichoderma* helps resistance against soil-borne pathogens and promotes plant vigour (Tarafder *et al.*, 2022). Trichocompost can enhance broccoli growth parameters and yield, often by improving disease resistance and stimulating root growth (Islam *et al.*, 2024).

Both vermicompost and trichocompost can be used as key growth promoters, such as for plant height, leaf number, curd initiation, and marketable yield in broccoli, often outperforming conventional fertilizers and other organic manures (Tarafder *et al.*, 2022; Alkobaisy *et al.*, 2021). The integration of these organic manures helps to promote sustainable agriculture, supporting soil health, reducing environmental impact, and achieving the growing consumer demand for organic vegetables (Rehman *et al.*, 2023). Given the increasing demand for organic vegetables and sustainable soil management practices in Bangladesh, optimizing fertilizer management practices for broccoli is important. This study aims to assess the effect of vermicompost on broccoli growth and yield, evaluate the effect of trichocompost on broccoli growth and yield and examine the combined impact of compost and inorganic fertilizer on broccoli growth and yield.

II. MATERIALS AND METHODS

2.1 Site Description:

The research was carried out at the Horticulture Farm, Sher-e-Bangla Agricultural University, Dhaka, Bangladesh, located at 23.074° N latitude and 90.035° E longitude, 8.2 meters above sea level, and was conducted during the rabi season, from October 2022 to March 2023. The field belongs to the Modhupur Tract Agro-Ecological Zones (AEZ-28), characterized by red clay loam soils developed over Modhupur clay with small hillocks surrounded by floodplains. The soil was sandy loam with moderate fertility and a pH of 6.3.

2.2 Experimental Design:

The experiment followed a Randomized Complete Block Design (RCBD) with five replications and five treatments. The total number of plots was 25. Each plot measured 1.5 m × 1.35 m, with 0.5 m spacing between plots and 1.0 m spacing between blocks. Plant spacing was 50 cm between rows and 45 cm between plants (9 plants per plot).

2.3 Seedbed, Field Preparation and Sowing:

The broccoli variety *Gloria F1 Hybrid* was used. A seedbed (3 m × 1 m) was prepared on October 1, 2022. Soil was treated with Sevin 50 WP (5 kg/ha) to control soil insects. Seeds were sown on October 12, 2022, at a depth of 2 cm with 5 cm line spacing. The seedbed was covered with thin polythene to maintain moisture. Seeds were treated with Provax 200 WP at 3 g/kg to prevent fungal diseases such as blight and anthracnose. Seedlings were watered regularly and kept weed-free without chemical inputs. 30-day-old healthy seedlings were transplanted to the main field on November 17, 2022. The field was ploughed, harrowed, and levelled for good tilth. It was exposed to sunlight for a week to reduce soil-borne pathogens. Basal fertilizers were applied during the final ploughing.

2.4 Fertilizer Application:

Fertilizers were applied following the Bangladesh Agricultural Research Institute (BARI, 2025) recommendation. The nutrient doses were: Urea: 250 kg/ha; TSP: 150 kg/ha; MoP: 200 kg/ha; and Boric acid: 12 kg/ha. Full TSP and boric acid were applied at final land preparation. Urea and MoP were applied in two equal splits at 15 and 35 days after transplanting (DAT).

2.5 Treatments:

T_1= Control (Recommended doses of fertilizers: Urea: 250; TSP: 150; MoP: 200; and Boric acid: 12 kg/ha); T_2= Vermicompost (5 t/ha) + ¼ RDF; T_3= Vermicompost (3 t/ha) + ¼ RDF; T_4= Trichocompost (5 t/ha) + ¼ RDF; T_5= Trichocompost (3 t/ha) + ¼ RDF.

2.6 Vermicompost and Trichocompost Application:

Vermicompost was prepared using cowdung, crop residues, and organic wastes through *Eisenia fetida* earthworms at the Horticulture Farm. It was applied before transplanting at the prescribed rates. Trichocompost was collected from ACI Biotech, Dhaka. It was prepared using *Trichoderma harzianum* mixed with cowdung, poultry litter, and plant residues.

2.7 Crop Management and Harvesting:

Seedlings with 5/6 true leaves were transplanted in the afternoon in the main field. Intercultural operations included weeding, earthing-up, irrigation, and pest control. Hand weeding was done at 15, 30, 45, and 60 DAT. Irrigation was applied as needed to maintain soil moisture. Harvesting of broccoli heads began at 70 DAT when they reached marketable size and firmness.

2.8 Data Collection:

2.8.1 Growth characteristics:

- **Plant height (cm) at 30, 45, and 60 DAT:** Plant height was observed from 30 days after transplanting (DAT) to 60 DAT at intervals of 15 days. The height of broccoli plants was measured by starting from the ground to the tip of the longest stem for 9 plants, and the average value was then calculated and recorded in centimeters.
- **Number, length, and breadth of leaves at 30, 45, and 60 DAT:** The number of leaves on each plant was counted and recorded. The lengths of plant leaves from the base of the leaves to the tip and the breadth of leaves on each plant were measured from the widest part of the leaf; the average value was then calculated and recorded in centimeters. The data was collected by averaging the counts from nine plants in each plot. This process was carried out at intervals of 15 days, from 30 days after transplanting (DAT) to 60 DAT.
- **Stem diameter (cm) at 30, 45, and 60 DAT:** Stem diameter was measured at the point where the central head was cut off. The diameter of the stem was recorded with slide calipers and the average of nine values was taken into account and was expressed in centimeters (cm).

2.8.2 Yield and yield contributing characteristics:

- **Head length, breadth and head stem diameter (cm):** Heads from each plant, the length and breadth and the stem diameter of the head were measured and recorded in centimeters.
- **Head weight (g):** The weight of the central head was recorded, excluding the weight of all secondary curds, and expressed in grams.
- **Dry matter content of heads (%):** The fresh weight of the head was recorded, and 100 g of head were taken from the central portion of each head and dried in an oven at 70°C for 72 hours after sun drying for two days. The final weight of the sample was taken and expressed as percent dry matter content.

$$\text{Percent dry matter content (DMC)} = \frac{\text{Oven dry weight of head (g)}}{\text{Fresh weight of head (g)}} \times 100 \tag{1}$$

- **Yield per plant (kg), per plot (kg), and per hectare (t):** The yield per plant was calculated by averaging the weights of nine harvested heads and expressed in kilograms (kg). The yield per unit plot was calculated by adding the yields of all plants of each plot and expressed in kilograms (kg). The yield of head per hectare was calculated by conversion of the weight per plot and recorded in tonnes (t/ha).

2.8.3 Quality characteristics:

- **Total soluble solid (°Brix):** For estimation of TSS content of broccoli, a digital refractometer (MA871; Romania) was used. A drop of broccoli grind was obtained by dropper and placed on the refractometer prism. The refractometer showed a reading of total soluble solids. The refractometer readings were recorded for nine samples, and the average value was recorded in °Brix.

- **Ascorbic acid (mg/100 g):** For the determination of vitamin C content, 10 g of broccoli was ground and homogenized in 100 ml of cold metaphosphoric acid (HPO_3) using a blender for two minutes and filtered through Whatman filter paper No. 2. The clear supernatant was collected for assaying ascorbic acid content by the 2, 6-dichlorophenolindophenol titration method (AOAC, 2005). The vitamin C content of the sample was calculated using the following formula:

$$\text{Vitamin C content (mg/100g)} = \frac{(\mathrm{T} \times \mathrm{d} \times \mathrm{V1})}{(\mathrm{V2} \times \mathrm{W})} \times 100 \tag{2}$$

Where, T = Titre value (ml), d = Dye factor, V1 = Volume to be made (ml), V2 = Volume of extract taken for titration (ml) and W = Weight of sample taken for estimation (g)

- **Protein (%):** Protein content was determined using the AOAC (2005) method. The protein content of the sample on a percentage basis was calculated by using the following formula:

$$\text{Nitrogen (\%)} = \frac{(\mathrm{C}-\mathrm{b}) \times \mathrm{p} \times 0.014 \times \mathrm{d}}{\text{Sample weight}} \times 100 \tag{3}$$

Where, c = reading of the sample, b = blank reading, p = strength of the HCL solution, d = conversion factor (6.25 for vegetables)

Nitrogen percentage was converted into protein by multiplying with a factor 6.25.

- **Iron (mg/100 g) and Calcium (mg/100 g):** Iron and calcium were measured by using the Atomic Absorption Spectroscopy method by hollow cathode lamp at wavelengths of 248.3 nm and 422.7 nm, respectively, using an air acetylene flame, and the measurement results must be within the concentration range of the series solution of standard iron and calcium. The treatment for each sample was repeated five times (AOAC, 2005).

$$\text{Iron/Calcium content (mg/100g)} = \frac{\text{Total concentration} \times \text{dilution factor}}{10 \times \text{sample weight} \times \text{dry factor (D.F)}} \times 100 \tag{4}$$

Where, Drying factor (D.F) = Fresh wt./Dry wt.

2.9 Statistical Analysis:

Data were analyzed using Statistix software (version 10). The mean differences among treatments were tested using ANOVA, and the LSD test was used at a 5% significance level.

III. RESULTS

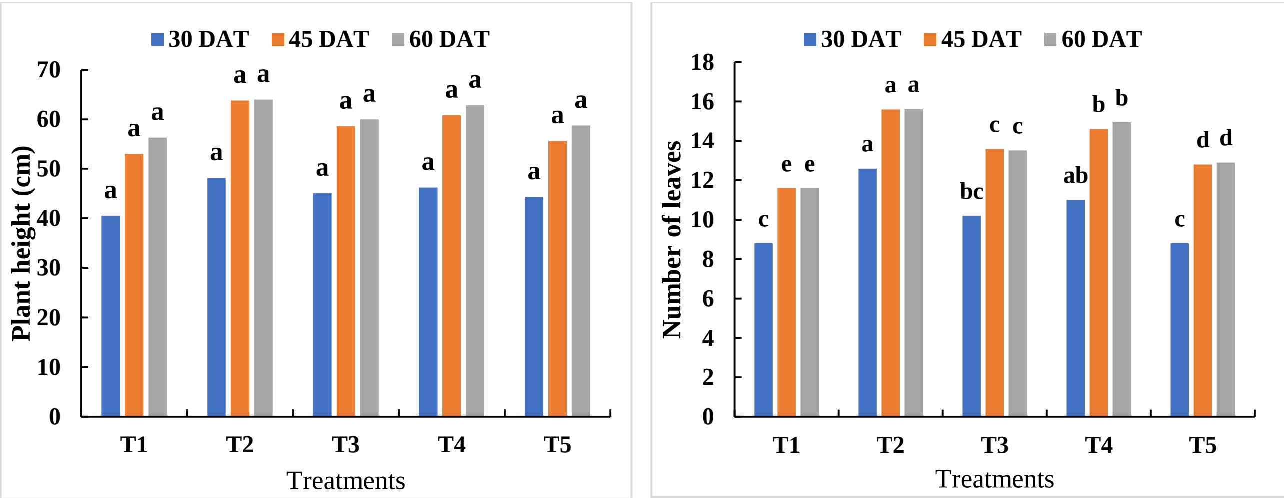
3.1 Growth Characteristics:

3.1.1 Plant height (cm):

Plant height was non-significant among treatments at 30, 45, and 60 DAT (Figure 1A). Although no statistical separation was observed, broccoli plants treated with vermicompost at 5 t ha^{-1} with ¼ RDF (T_2) resulted in the highest plant height (48.18, 63.80, and 64.00 cm) at all growth stages, followed by trichocompost-based treatments (T_4 and T_5). The slight improvement in vegetative growth under organic amendments aligns with earlier reports that showed vermicompost enhances soil nutrient availability and root activity, thereby improving plant stature in *Brassica* crops (Singh *et al*., 2021).

3.1.2 Number of leaves:

The number of leaves showed significant differences at 30, 45, and 60 DAT ($p < 0.05$). T_2 produced the highest number of leaves at 30, 45, and 60 DAT (12.6, 15.6, and 15.62 leaves), followed by T_4 and T_3 (Figure 1B). The control (T_1) produced the lowest leaf numbers. The higher leaf production under vermicompost and trichocompost treatments supports previous studies that showed organic amendments improve leaf initiation and canopy expansion through enhanced nitrogen mineralization (Kumar *et al*., 2023). Increased leaf area and number are linked to improved photosynthetic capacity in broccoli (Syed *et al*., 2023).



(A) (B)

FIGURE 1: Impact of recommended doses of fertilizers (RDF), vermicompost, trichocompost on (A) height of plants (B) number of leaves of broccoli at different days after transplanting (DAT). Different letters within a trait indicate significant differences ($p < 0.05$)

3.1.3 Leaf length (cm):

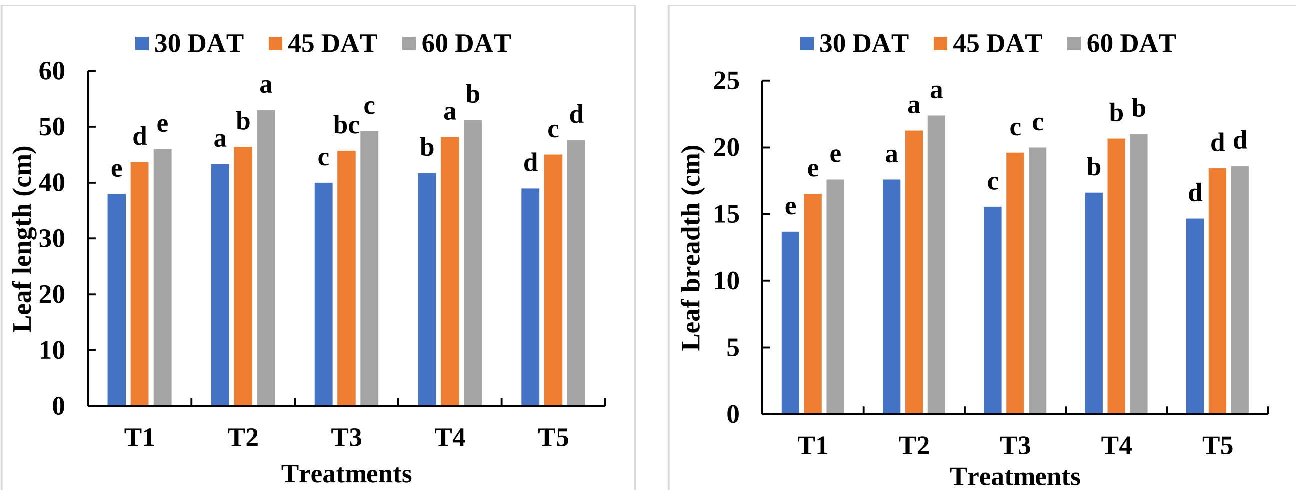
Leaf length resulted in a significant difference at 30, 45, and 60 DAT ($p < 0.05$). T_2 produced the longest leaves at 30 and 60 DAT (43.32 and 52.98 cm), followed by T_4 and T_3, whereas T_1 and T_5 recorded the shortest leaves (Figure 2A). The results indicate that organic fertilizers with partially subsidized RDF enhance vegetative vigour of broccoli. Previous studies show that vermicompost improves leaf expansion through increased cytokinin-like activity and better soil moisture retention (Ievinsh, 2020).

3.1.4 Leaf breadth (cm):

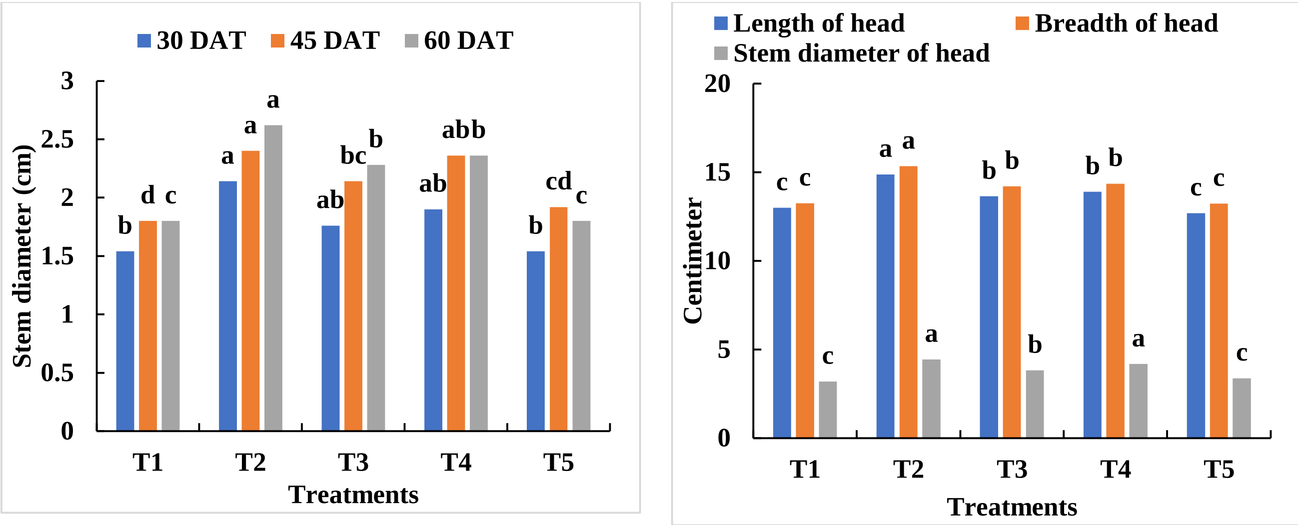
The widest leaves were recorded in T_2 across 30, 45, and 60 DAT (17.58, 21.26, and 22.38 cm), followed by T_4 and T_3 (Figure 2B). The control exhibited the narrowest leaves. Vermicompost treatments ensured wider leaf surfaces were consistent with previous reports indicating improved chlorophyll synthesis due to enhanced soil biological activity and nutrient availability (Suruban *et al.*, 2022; Ievinsh, 2020).

3.1.5 Stem diameter (cm):

Stem diameter varied significantly among treatments at 30, 45, and 60 DAT (Figure 2C). T_2 achieved the thickest stem (2.14, 2.40, and 2.62 cm) at 30, 45, and 60 DAT, followed by the treatment of T_4 and T_3. The control and the trichocompost treatment (T_5) recorded the lowest stem diameters for all 30, 45, and 60 DAT. A better stem diameter is suitable for nutrient transport and structural support in broccoli plants. Vermicompost plays a vital role in increasing stem diameter is well recorded, as its microbial activity stimulates cell division and stem tissue development (Aman *et al.*, 2022).



(A) (B)



(C) (D)

FIGURE 2: Impact of recommended doses of fertilizers (RDF), vermicompost, trichocompost on (A) leaf length (B) leaf breadth (C) stem diameter (D) length of head, breadth of head, stem diameter of head of broccoli at different days after transplanting (DAT). Different letters within a trait indicate significant differences (p < 0.05)

3.2 Yield and Yield Components:

3.2.1 Length of head (cm):

T_2 achieved the greatest head length (14.88 cm), followed by T_4 and T_3, whereas T_1 and T_5 produced shorter heads (Figure 2D). The improvement in head morphology under vermicompost is similar to the findings of Ievinsh (2020), who mentioned that vermicompost improves plant vigour and reproductive organ development through enhanced enzymatic and hormonal activity.

3.2.2 Breadth of head (cm):

Head breadth also varied significantly among all treatments, with T_2 producing the widest heads (15.34 cm), followed by T_4 and T_3, while T_1 and T_5 showed the narrowest heads (Figure 2D). These findings are consistent with observations of organic amendments improving chlorophyll content, leaf expansion, and assimilate allocation, key drivers of head enlargement in broccoli (Ievinsh, 2020).

3.2.3 Stem diameter of head (cm):

Stem diameter showed a significant response to treatment ($p < 0.05$). T_2 and T_4 produced the largest diameters (4.44 cm and 4.18 cm, respectively), while T_1 and T_5 had significantly lower values (Figure 2D). Improved stem diameter after vermicompost and trichocompost application enhanced cell division and structural tissue development supported by humic substances and microbial metabolites (Aman *et al*., 2022).

3.2.4 Head weight (g):

The highest head weight was recorded in T_2 (478.8 g), followed by T_4 (443.6 g) and T_3 (424.4 g), while the control (T_1) produced the lowest value (357.2 g) (Table 1). The superior performance of vermicompost at 5 t ha^{-1} + ¼ RDF is consistent with earlier studies reporting improved nutrient mineralization and soil microbial activity that enhance biomass and head development in broccoli (Kumar *et al*., 2023; Aman *et al*., 2022). The enhanced nutrient uptake associated with vermicompost application has also been shown to increase curd formation and overall yield in *Brassica* crops.

3.2.5 Dry matter content of head (%):

Dry matter content (DMC) of heads was significantly different ($p < 0.05$), with T_2 producing the highest DMC (14.72%), followed by T_4 and T_3. The lowest DMC was observed in T_1 (11.12%) (Table 1). Higher dry matter resulted from organic nutrient sources, drawing a parallel with findings that indicate improved carbohydrate synthesis and soil nutrient accumulation when vermicompost is applied (Suruban *et al*., 2022).

3.2.6 Yield per plant (kg):

Yield per plant increased significantly under all organic treatments ($p < 0.05$). T_2 recorded the highest yield (0.48 kg), followed by T_4 and T_3, while T_1 produced the lowest yield (0.36 kg) (Table 1). Yield improvements with vermicompost followed the results of Aman *et al*. (2022), who showed that integrated organic and inorganic nutrient management enhances nutrient uptake efficiency.

3.2.7 Yield per plot (kg) and yield (t/ha):

Yield per plot and per hectare followed a similar trend, with T_2 achieving the highest yield (4.32 kg/plot; 21.33 t/ha), significantly outperforming all other treatments (Table 1). The second highest yields were recorded in T_4 and T_3, while T_1 produced the lowest (3.20 kg/plot; 15.80 t/ha). Similar findings in broccoli yield treated with vermicompost have been reported by Singh *et al*. (2021), who found that organic nutrient sources enhance soil structure, cation exchange capacity and long-term fertility, which eventually contribute to higher yields in broccoli.

TABLE 1
Effect of recommended doses of fertilizers (RDF), vermicompost, trichocompost on head weight (g), dry matter content of head (%), yield/plant (kg), yield/plot (kg) and yield (t/ha) of broccoli

Treatment	Head weight (g)	Dry matter content of head (%)	Yield/Plant (kg)	Yield/Plot (kg)	Yield (t/ha)
T_1	357.20 e	11.12 d	0.36 e	3.20 b	15.80 b
T_2	478.80 a	14.72 a	0.48 a	4.32 a	21.33 a
T_3	424.40 c	13.42 b	0.43 c	3.86 ab	19.06 ab
T_4	443.60 b	13.66 b	0.45 b	4.22 a	20.84 a
T_5	396.00 d	12.70 c	0.40 d	3.6 ab	17.78 ab
Level of Sig.	**	**	**	**	**
LSD (0.05)	3.76	0.37	0.05	0.73	3.6
CV (%)	0.67	2.07	0.48	14.16	14.16

[Values in the column with distinct letters showed significant differences according to the LSD at a 5% level of significance. Here, T_1= Control (Recommended doses of fertilizers: Urea: 250; TSP: 150; MoP: 200; and Boric acid: 12 kg/ha), T_2= Vermicompost (5 t/ha) + ¼ RDF, T_3= Vermicompost (3 t/ha) + ¼ RDF, T_4= Trichocompost (5 t/ha) + ¼ RDF, T_5= Trichocompost (3 t/ha) + ¼ RDF]

3.3 Quality Characteristics:

3.3.1 Total soluble solid (°Brix):

TSS recorded significant differences under all treatments ($p < 0.05$) and demonstrated that T_2 (vermicompost 5 t/ha + ¼ RDF) produced the highest °Brix (9.83), noticeably higher than the control treatment (T_1, 6.35) (Table 2). Findings suggest that organic fertilizer management with vermicompost is likely to improve the total soluble solid content of broccoli heads (Tiwari *et al.*, 2024).

3.3.2 Ascorbic acid (mg/100 g):

T_2 resulted in high ascorbic acid content (88.32 mg/100 g), significantly different from the control treatments (83.62 mg/100 g) (Table 2). This finding supports previous studies showing integrated nutrient management, combining vermicompost and biofertilizers in broccoli, led to increased ascorbic acid compared to control or full chemical fertilization (Tiwari *et al.*, 2024).

3.3.3 Protein (%):

Protein (%) showed a significant difference in T_2 (4.34%) compared to the control treatment (2.80%) (Table 2). This indicates that reduced chemical fertilizer plus vermicompost supports better nitrogen assimilation into proteins (Wadmare *et al.*, 2019).

3.3.4 Iron (mg/100 g):

Iron content in T_2 (1.44 mg/100 g) resulted in approximately 1.6 times the control treatment (0.87) (Table 2). This indicates vermicompost strongly improves iron uptake or accumulation (Mashkey *et al.*, 2024).

3.3.5 Calcium (mg/100 g):

Calcium content increased significantly for T_2 (47.60 mg/100 g) compared with the control treatment (31.20 mg/100 g) (Table 2). Results indicate that vermicompost application enriched Ca accumulation. The general effect of organic manures on mineral enrichment was observed as the organic matter improves cation exchange capacity and root growth (Mashkey *et al.*, 2024).

TABLE 2
Effect of recommended doses of fertilizers (RDF), vermicompost, trichocompost on total soluble solid (°Brix), ascorbic acid (mg/100 g), protein (%), iron (mg/100 g) and calcium (mg/100 g) content of broccoli

Treatment	Total soluble solid (°Brix)	Ascorbic acid (mg/100 g)	Protein (%)	Iron (mg/100 g)	Calcium (mg/100 g)
T_1	6.35 c	83.62 b	2.80 c	0.87 b	31.20 e
T_2	9.83 a	88.32 a	4.34 a	1.44 a	47.60 a
T_3	7.88 bc	86.48 a	3.61 b	0.90 b	42.00 c
T_4	8.02 b	88.29 a	4.01 ab	1.02 b	45.00 b
T_5	7.85 bc	87.67 a	3.58 b	0.92 b	37.00 d
Level of Sig.	**	**	**	**	**
LSD (0.05)	1.54	2.7	0.5	0.2	1.4
CV (%)	14.41	2.31	10.13	14.15	2.57

[Values in the column with distinct letters showed significant differences according to the LSD at a 5% level of significance. Here, T_1= Control (Recommended doses of fertilizers: Urea: 250; TSP: 150; MoP: 200; and Boric acid: 12 kg/ha), T_2= Vermicompost (5 t/ha) + ¼ RDF, T_3= Vermicompost (3 t/ha) + ¼ RDF, T_4= Trichocompost (5 t/ha) + ¼ RDF, T_5= Trichocompost (3 t/ha) + ¼ RDF]

IV. DISCUSSION

Vermicompost improves root growth, nutritional availability and water capacity because it has abundant microbial composition and humic compounds (Singh *et al*., 2021). Such mechanisms tend to cause small yet significant vegetation growth even in cases in which the statistical evidence is not striking. Nitrogen is extremely important in the development of chlorophyll and the initiation of leaves, and a gradual degradation of nitrogen in vermicompost promotes the continuous vegetation cover (Kumar *et al*., 2023). These results are consistent in agreement with increasing leaf counts with T_2, and it is evident that there is high-rate nutrient-use efficiency with integrated organic-inorganic nutrient management.

The large growth in the diameter of the stem during T_2, T_3, and T_4 indicates that nutrient sources that were composed of compost enhanced the growth of the structure. Vermicompost contains the humic substances and growth-promoting metabolites that stimulate cell division and tissue differentiation (Aman *et al*., 2022). Moisture trapping of the soil, nutrient uptake and the stimulation of hormones directly affects the growth of the leaf - all of which are enhanced by vermicompost (Ievinsh, 2020). The increased surface area of the leaves helps in supporting elevated assimilate production as the number of the leaves is increased. This is in line with previous results in *Brassica* species that organic inputs stimulate the growth of the leaf and canopy, which are critical in the formation of the head.

The strongest response to treatment was in the case of head weight, where T_2 generated significantly heavier head weight compared to all other treatments. This is because the vermiculite quality, which enhances the nutrient mineralization, microbial enzyme activity, and cation exchange capacity, makes it superior to use (Aman *et al*., 2022). All these mechanisms increase partitioning of assimilates to reproductive structures. According to Kumar *et al*. (2023), the current findings were corroborated by the authors who have noted a comparable increase in the head weight and marketable yield of broccoli in nutrient regimes obtained through vermicompost. The increase of the head length and breadth in T_2, T_3 and T_4 is a factor that shows that T_2, T_3 and T_4 with organic amendments have enhanced morphological development in broccoli curds. The growth of the size of the head in organic treatments indicates that the treatment enhanced the reproduction of the body and the partitioning of nutrients. The larger diameter of the head stem in both T_2 and T_4 was observed under high nutrient status of the compost. The presence of a heavier stem at the junction of the head makes the translocation of water and nutrients easier in making curd. This result is also in line with Aman *et al*. (2022), who discovered that the use of vermicompost enhances the development of vascular tissues in the *Brassica* crops. The enhanced yields of organic-amended armaments can be accounted for by the enhanced stem diameter.

Increased DMC of heads under T_2, T_3, and T_4 suggested superior accumulation of carbohydrates. The property of vermicompost as being able to promote nutrient cycling through microbes leads to better carbon assimilation and location of carbon in edible tissues (Ievinsh, 2020). Better quality, firmness, and storability of broccoli have been linked with increased head DMC, proving that organic sources of the nutrients are better. The content of leaf dry matter resembled exactly head DMC, proving that these amendments enabled better physiological efficiency by organic amendment. The increase in DMC in T_2 and T_3 treatments resulted in better chlorophyll activity and nitrogen uptake (Singh *et al*., 2021).

The head weight per plant was significantly higher under the treatments of vermicompost and trichocompost, with the highest yield per plant being the T_2. Aman *et al*. (2022) proved that vermicompost enhances the efficiency of nutrient utilization and growth of the biomass, which is closely connected with the presented results. The agronomic benefit of partially replacing inorganic fertilizer by organic amendments is indicated by the considerably increased plot and hectare yields of T_2 and T_4. The results are similar to Singh *et al*. (2021), who have stated that soil fertility and long-term productivity increase when there is a combination of vermicompost with a low level of chemical fertilizer. The yield-related traits of head length, breadth, stem diameter, and head weight were highest in T_2, while trichocompost treatments (T_4, T_5) also improved on the control. Yield per plant and yield per hectare were the highest in T_2, which supports the idea that vermicompost helps supply nutrients and supports curd growth when applied along with partial RDF (Hasan *et al.,* 2024; Dhatt *et al.,* 2022). The improved dry matter content and weight further support the notion that organic amendments enhance yield and quality, which is supported by various reports (Meem *et al.,* 2024). The low values for the control group demonstrate the necessity of providing organic nutrients for optimal broccoli production. It is most effective to use vermicompost (5 t/ha) and only 1/4 of the chemical fertilizer recommended to increase several qualities like sugar (°Brix), vitamin C, protein, iron, and calcium content (Mashkey *et al.,* 2024; Kumar *et al.,* 2023; Wadmare *et al.,* 2019). This practice recommends organic fertilizer management combined with low chemical fertilizers to help enhance nutritional values by decreasing synthetic fertilizer use. Vermicompost, particularly when combined with partially recommended fertilizer, delivers superior growth, yield and quality in broccoli, with trichocompost providing significant benefits. These findings are strongly supported by recent research and highlighted the value of integrating organic fertilizer management for sustainable and productive broccoli cultivation.

V. CONCLUSION

The use of trichocompost and vermicompost, with 1/4 of the recommended doses of fertilizers (RDF), has the potential to be a valuable agricultural activity for improving broccoli productivity. While this method demonstrates increases in crop yield, it also provides much-needed assistance to farmers. The use of vermicompost and trichocompost has demonstrated positive and synergistic effects on soil health, nutrient availability, and plant growth, which ultimately led to increases in broccoli yield. Farmers are constantly challenged to ensure food security and sustainability in agricultural practices, and incorporating these types of integrated ideas provides long-term hope for regenerative and productive farming. The improvements experienced from using these types of integrated methods demonstrate why research-based methods are important to discover ways that farmers can implement good techniques to improve crop performance and agriculture as a whole.

CONFLICT OF INTERESTS

The authors declare that there are no conflicts of interest related to this article.

REFERENCES

[1] Alkobaisy, J.S., Abdel Ghani, E.T., Mutlag, N.A., & Lafi, A.Sh.A. (2021). Effect of vermicompost and vermicompost tea on the growth and yield of broccoli and some soil properties. *IOP Conference Series: Earth and Environmental Science*, 761, 012008. https://doi.org/10.1088/1755-1315/761/1/012008

[2] Al-Taey, D.K.A., Al-Shareefi, M.J.H., MijweL, A.K., Al-Tawaha, A.R., & Al-Tawaha, A.R. (2019). The beneficial effects of bio-fertilizers combinations and humic acid on growth, yield parameters and nitrogen content of broccoli grown under drip irrigation system. *Bulgarian Journal of Agricultural Science,* 25(5), 959-966.

[3] Aman F., Rahman, M.U., Ara, N., Fatima, F., & Ullah, H. (2022). Response of broccoli (*Brassica oleraceae* var. *italica*) to azotobacterbiofertilizer and vermicompost levels. *Journal of Xi'an Shiyou University, Natural Science Edition,* 18(12), 712-720.

[4] AOAC. (2005). Association of Official Analytical Chemistry. Official Methods of Analysis. Van Nostrand's Encyclopedia of Chemistry. GD Considine (Ed.). Association of Official Analytical Chemists (AOAC). Washington, DC.

[5] Aouass, K., & Kenny, L. (2022). Effect of compost and synthetic fertilizer on soil fertility, yield and nitrogen use efficiency of broccoli crop in arid region of Morocco. *Agricultural Science Digest*, 44(2), 250-254. https://doi.org/10.18805/ag.df-471

[6] BARI (Bangladesh Agricultural Research Institute). (2025). Production technology of Broccoli – Krishi Projukti HatBoi, BARI, Joydehpur, Gazipur, Bangladesh. pp. 187-188.

[7] BBS. (2024). *Yearbook of Agricultural Statistics-2023*. Statistics and Informatics Division, Ministry of Planning, Government of the People's Republic of Bangladesh, Dhaka.

[8] Blouin, M., Barrere, J., Meyer, N., Lartigue, S., Barot, S., & Mathieu, J. (2019). Vermicompost significantly affects plant growth: a meta-analysis. *Agronomy for Sustainable Development*, 39, 34. https://doi.org/10.1007/s13593-019-0579-x

[9] Dhatt, J.S., Singh, K., Kaur, H., & Hundal, S.S. (2022). Efficient utilization of paddy straw and sugarcane bagasse through vermicomposting and its impact on growth, yield and quality of broccoli [*Brassica oleracea* (var.) *italica*]. *Agricultural Science Digest,* 43(6), 802-806. https://doi.org/10.18805/ag.d-5316

[10] FAO. (2022). *World Food and Agriculture - Statistical Yearbook 2022. Rome. https://doi.org/10.4060/cc2211en*

[11] FAOSTAT. (2022). *Structural data from agricultural censuses*. FAOSTAT Analytical Brief 33. Rome.

[12] Hamza, O.M., & AL-Taey, D.K.A. (2020). A study on the effect of glutamic acid and benzyl adenine application upon growth and yield parameters and active components of two broccoli hybrids. *International Journal of Agricultural and Statistical Sciences*, 16(2), 1163-1167. https://connectjournals.com/03899.2020.16.1163

[13] Hasan, M.J., Khatun, K., Mostarin, T., Karishma, K.C., Nadim, M.K.A., & Chowdhury, S.M.A. (2024). Influence of vermicompost and biofertilizer on growth, head yield and quality of broccoli (*Brassica oleracea* L. var. *italica*). *Agricultural Science and Technology*, 16(1), 54-62. https://doi.org/10.15547/ast.2024.01.006

[14] Ievinsh, G. (2020). Review on physiological effects of vermicomposts on plants. In: Meghvansi, M., Varma, A. (eds) Biology of Composts. *Soil Biology,* 58, 63-86. Springer, Cham. https://doi.org/10.1007/978-3-030-39173-7_4

[15] Islam, S., Busra, J., Ali, M.S., Rahaman, S., Shawon, R.A., Islam, M.T., Joy, M.I.H., & Bhuiyan, M.A.R. (2024). Effect of different organic fertilizer on the growth and yield of broccoli (*Brassica oleraceae* var. *italica*). *Research in Agriculture Livestock and Fisheries,* 10(3), 237-245. https://doi.org/10.3329/ralf.v10i3.70813

[16] Kumar, D., Singh, R.B., Kumar, V., Verma, A.K., & Maurya, V. K. (2023). Effect of organic manures and biofertilizers on growth, yield and quality of broccoli. *Biological Forum – An International Journal,* 15(9), 635-639.

[17] Manzoor, A., Naveed, M.S., Ali, R.M.A., Naseer, M.A., UL-Hussan, M., Saqib, M., Hussain, S., & Farooq, M. (2024). Vermicompost: a potential organic fertilizer for sustainable vegetable cultivation. *Scientia Horticulturae*, 336, 113443, https://doi.org/10.1016/j.scienta.2024.113443

[18] Mashkey, V.K., Chamroy, T., Choudhary, D., Rodge, R.R., Pinaky, J., & Sengupta, D. (2024). Broccoli quality and nutrient uptake response to integrated nitrogen management and mulching. *International Journal of Research in Agronomy, 7*(5), 240-243. https://doi.org/10.33545/2618060X.2024.v7.i5d.682

[19] Meem, H.Z., Ali, M., Mehedi, M.N.H., Hossain, M.D., & Howlader, P. (2024). Effect of different sources of organic manures on growth and yield of Broccoli. *Research in Agriculture Livestock and Fisheries,* 11(2), 197-204. https://doi.org/10.3329/ralf.v11i2.76067

[20] Rabbee, H.E., Methela, N.J., Hossain, B., & Suhel, M.R.I. (2020). Growth and yield response of Broccoli to vermicompost and farm yard manure. *Journal of Bioscience and Agriculture Research*, 25(02), 2107-2113. https://doi.org/10.18801/jbar.250220.257

[21] Rehman, S.u., De Castro, F., Aprile, A., Benedetti, M., & Fanizzi, F.P. (2023). Vermicompost: enhancing plant growth and combating abiotic and biotic stress. *Agronomy*, 13(4), 1134. https://doi.org/10.3390/agronomy13041134

[22] Singh, D.P., Rajiv, R., Tomar, S., & Kumari, M. (2021). Integrated nutrient management in broccoli (*Brassica oleracea* var. *italica*). *The Indian Journal of Agricultural Sciences*, 91(11), 1627-1630. https://doi.org/10.56093/ijas.v91i11.118546

[23] Suruban, C. Kader, M.A., & Solaiman, Z.M. (2022). Influence of various composted organic amendments and their rates of application on nitrogen mineralization and soil productivity using Chinese cabbage (*Brassica rapa.* L. var. *Chinensis*) as an indicator crop. *Agriculture*, 12(2), 201. https://doi.org/10.3390/agriculture12020201

[24] Syed, R.U., Moni, S.S., Break, M.K.B., Khojali, W.M.A., Jafar, M., Alshammari, M.D., Abdelsalam, K., Taymour, S., Alreshidi, K.S.M., Taha, M.M.E. and Mohan, S. (2023). Broccoli: A multi-faceted vegetable for health: An in-depth review of its nutritional attributes, antimicrobial abilities, and anti-inflammatory properties. *Antibiotics,* 12(7), 1157. https://doi.org/10.3390/antibiotics12071157

[25] Tarafder, S.K., Biswas, M., Alim, M.A., Mondal, A.B., & Alam, M. (2022). Effects of organic and inorganic sources of nutrient on yield, quality and shelf life of broccoli. *Current Research in Agricultural Sciences,* 9(1), 44-58. https://doi.org/10.18488/cras.v9i1.3020

[26] Tiwari, P.K., Mishra, S.K., Tiwari, D., Singh, A.P., & Tiwari, P.K. (2024). Economic assessment of organic manures and bio fertilizers on quality production in broccoli (*Brassica oleracea* var. *italica* Plenck). *International Journal of Advanced Biochemistry Research,* 8(2), 571-574. https://doi.org/10.33545/26174693.2024.v8.i2g.4205

[27] Wadmare, V.B., Gadhe, K.S., & Joshi, M.M. (2019). Studies on physical and chemical composition of broccoli (*Brassica oleracea* L.). *International Journal of Chemical Studies*, 7(2), 825-828.