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Good Agricultural Practice (GAP) Trials in Brinjal: A Step Toward Safer, Nutritious, and Secure Food Systems in Bangladesh

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ABSTRACT

To validate the Good Agricultural Practices (GAP) standards, a trial of brinjal (variety: Caity) from Ispahani Seed Company was conducted at a farmer's field in Shibpur, Narsingdi, Bangladesh, during the summer season of 2024. The objective was to produce high-quality and safe brinjal following GAP guidelines. The Government of Bangladesh officially authorized the Bangladesh GAP protocol in 2023, providing a framework for producers to cultivate high-quality crops for consumers. All activities in this trial adhered to the Bangladesh GAP protocol to ensure superior brinjal production. A total of 37 decimals of land, owned by Md. Belayet Hossain, was planted with brinjal on March 13, 2024. The crop was managed strictly according to GAP standards. Harvesting took place over a period from May 8, 2024, to July 26, 2024, with a total of 22 harvests. The first harvest was conducted on May 8, 2024, while the final (22nd) harvest occurred 168 days after transplanting, on July 26, 2024. The entire yield was obtained from the 37-decimal plot, with fruit yield per harvest varying depending on the harvest time. The yield ranged from 69.69 kg to 206.19 kg per plot. A similar trend was observed in the fruit yield per hectare, which ranged from 465.23 kg/ha to 1,376.46 kg/ha. These values represent single-harvest yields. The total fruit yield from the 37-decimal plot was 3,045 kg, while the estimated yield per hectare was 20,331 kg. These findings indicate that brinjal production under GAP standards can ensure high-quality yields, contributing to both local and export markets. The economic analysis of brinjal production reveals a positive return on investment, as indicated by the Benefit-Cost Ratio (BCR) was 1.31.

INTRODUCTION

Eggplant, brinjal or aubergine belongs to the family Solanaceae and under the botanical name *Solanum melongena* L. (Thompson, 1951). It is a major vegetable crop throughout the tropics and subtropics (Bose and Som, 1986). Brinjal is the most important vegetable crop concerning total acreage (53,665 ha) and production (587,212 tons) in Bangladesh (BBS, 2023). The average yield is only 10.94 tons per hectare, which is very low compared to other brinjal producing countries. This low yield is mainly due to a lack of high yielding variety as well as pest and disease infestation or due to improper management. Though high yielding variety is an important factor for higher yield. Besides this variety, quality and proper management play important roles in quality and higher yield for farmers. Proper management like judicious use of manure, fertilizer, water, pesticide, and fungicide is the main concern to boost the brinjal yield. Nowadays, farmers are interested in growing quality eggplant, which is safe for consumers. So, to make available quality eggplant, it is needed to ensure all plant husbandry on time with the prescribed amount.

Bangladesh exports eggplants primarily to the Middle East, Europe, and some Southeast Asian countries. The demand in these regions is driven by the popularity of brinjal in diverse cuisines. Exporting eggplants involves several steps including harvesting, sorting, packaging, and transportation. Quality control is crucial to ensure the produce meets international standards. The export process also involves compliance with the regulations of the importing country. The brinjal export sector faces several challenges, among those the main issues related to pests and diseases can impact the quality and quantity of eggplant. There is potential for growth in the brinjal export market due to the increasing global demand for diverse vegetables and the expansion of brinjal export can be achieved following the Bangladesh GAP in brinjal production. Good Agricultural Practices (GAP) represent a comprehensive set of guidelines designed to promote the production of safe, high-quality, and environmentally sustainable agricultural products (FAO, 2003). These practices cover various aspects of farming, including soil management, water use efficiency, pest and disease control, and post-harvest handling (FAO, 2016). By implementing GAP, farmers can enhance productivity, reduce environmental impacts, and meet both local and international market standards (FAO, 2003). The adoption of GAP is critical for improving crop yields, ensuring food safety, and supporting sustainable agricultural development (World Bank, 2007). Very recently Bangladesh government authorized Bangladesh GAP in 2023 and Bangladesh GAP Protocol: Brinjal in 2024 (Bokhtiar *et. al*., 2024), which will help the producers grow quality brinjal for the consumers. As a part of this activity, a validation trial was chalked out with a farmer with 37 decimals (0.15 ha) of land area to grow quality and safe brinjal for the consumers at Shibpur, Narshingdi, Bangladesh.

MATERIALS AND METHODS

Site Selection and Justification

The validation trial of brinjal was conducted at the farmer's (Md. Belayet Hossain) field of Vill: South Joymongol, Shibpur, Narshingdi during the summer season of 2024. The validation trial was at 23.9917º N Latitude and 90.4124º E Longitudes having an elevation of 8.2 m from sea level under the AEZ 28. The land selection was done for the brinjal cultivation trial by the DAE personnel (Md. Bin Sadek, AEO, DAE, Shibpur, Narshingdi and Ms. Josna, SAAO, DAE, Shibpur, Narshingdi).

Land Preparation

The soil and water tests were tested on 08 February 2024 by a certified laboratory (SGS). The land was prepared with 4-5 ploughing by power tiller. The bed was prepared to maintain a 0.7m width and 14.0 m length having a 50 cm drain in between two beds. Fertilizer and manuring (vermicompost were used from the DAE authorized site). Seedling Preparation and Transplanting: Brinjal variety Caity of Ispahani seed company was used in the trial. Thirty-day old seedlings were transplanted in the main field on 09 March 2024. The unit plot size was 14.0 x 0.70m and 20 plants were accommodated in a plot with a plant spacing of 70 cm apart in a single row, the row-to-row distance of 1m with a 50 cm drain.

Plate 1. Seedling transplanting

Fertilization: Fertilizer and manure (vermicompost) were procured from the DAE authorized site. The land was fertilized with organic fertilizer (vermicompost)-N-P-K-S-Zn-B @ 10,000-170-50-125-18-4.3-1.70 kg/ha, respectively (Ahmed et al., 2018). One-third of the organic fertilizer and half of P and full of S, Zn and B were applied during final land preparation. The rest of the organic fertilizer and P and 1/3 of K were applied as basal in the pit 7 (seven) days before transplanting of seedling. One-fifth of N and K were applied top-dressed after 20 days of transplanting. The rest of N and K were applied in equal four instalments at 20 days intervals starting from 20 days after first top-dressing.

Irrigation: Irrigation was provided 6 times during the growing season, carefully scheduled based on the crop's water requirements and prevailing weather conditions. Hose pipe irrigation methods was preferred to ensure efficient water use, targeting the root zone directly and minimizing water wastage. Additionally, flood irrigation was applied 4 times during dry conditions to ensure adequate soil moisture levels. This combination of irrigation techniques helped to maintain optimal soil moisture, supporting healthy plant growth and maximizing yield potential (Allen et al., 1998; Steduto et al., 2012).

Previous Crop History:

The previous crop in the field was country bean, and bitter gourd, which were harvested before the initiation of brinjal cultivation. Consequently, the field required thorough preparation, including soil testing and nutrient replenishment, to address any nutrient deficiencies and prepare it adequately for the eggplant. Additionally, managing any residual pests and diseases from the country bean, and bitter gourd was essential to prevent potential impacts on the subsequent brinjal cultivation. The transition from country bean and bitter gourd to brinjal involved a comprehensive approach to restore soil fertility and ensure optimal growing conditions for the new crop.

Soil and Water Analysis Result:

After conducting soil and water analysis, it was confirmed that no hazardous materials were present in the trial site. Based on these analyses, adjustments were made following the Fertilizer Recommendation Guide (FRG) 2018, with guidance from a soil scientist. The adjusted fertilizer doses, including nitrogen (N), phosphorus (P), potassium (K), sulfur (S), calcium (Ca), magnesium (Mg), zinc (Zn), and boron (B), were applied to the field. Fertilizers were incorporated into the soil prior to planting to ensure nutrient availability and additional applications were made throughout the growing season as needed. Regular monitoring of soil and plant tissue was conducted to ensure optimal nutrient levels and make any necessary adjustments to maximize plant growth and yield.

Intercultural Operations

Intercultural operations of brinjal are crucial for maintaining the health and productivity of the crop throughout the growing season. The successful cultivation of brinjal involved a series of intercultural operations aimed at optimizing plant growth and yield. Irrigation was conducted ten times between April 01, 2024, and July 30, 2024, ensuring consistent soil moisture levels essential for healthy crop development. Mulch Polythene mulch was used to protect weeds and ensure sufficient soil moisture. The bamboo stick was used to support the brinjal crops, to keep the plant upright and to facilitate better air circulation and exposure to sunlight. Intercultural operations like top dressing of fertilizer, irrigation, side pruning of plants, and infested plant parts pruning were done as and when necessary. Efficient drainage systems were also implemented to remove excess water following heavy rains, preventing waterlogging and root rot disease.

Fencing Around the Trial

A physical barrier with nylon net and bamboo stick fencing, was erected around the trial area to protect the crop from livestock, pests and unauthorized access, ensuring the integrity of the trial. The fencing was regularly inspected and maintained to ensure its effectiveness throughout the growing season.

Plate 2: Fencing around the trial

Maintaining Register Book and Documentation

A comprehensive register book was meticulously maintained for the GAP validation trial, documenting all relevant information and activities conducted throughout the project. The register included the name of the farmer, Belayet Hossain, from the village of Shibpur, Narshingdi. It recorded crucial details such as the crop name (Eggplant), variety name (Caity), soil and water test results, and the precise location of the trial site. The trial spanned an area of 37 decimals, with land preparation beginning on 10 March 2024.

Plate 3: A signboard was used to mention important information regarding the GAP trial

Seedlings were transplanted on 13 March 2024, and fencing was completed on 25 March 2024, using nylon net and bamboo sticks. The register also tracked the dates of key operations, including irrigation, weeding, pesticide and fungicide applications, and other intercultural activities such as loosening the soil and removing side suckers. A signboard was used to mention important information regarding the GAP validation trial. Additionally, the number of labourers used for each task was documented to ensure accurate records of resource utilization. This detailed register served as an essential tool for monitoring the trial's progress and ensuring the integrity of the data collected.

Pest Control Using Pesticides

Effective pest and disease management is crucial for ensuring optimal crop productivity. The table presents a list of chemical and biopesticides, their trade names, application doses, and targeted pests or diseases. The use of these products is essential for controlling fungal infections, insect infestations, and mite attacks in crops.

Fungicides:

Carbendazim (Autostin WDG) is applied at 2.0 g/L of water to manage stem blight and phomopsis, both of which can severely affect plant health. Additionally, Carboxin and Thiram (Provax) serve as a seed treatment at 2.5 g/kg seed, protecting against seedborne pathogens and ensuring healthy seedling development.

Insecticides:

Several chemical insecticides are included in the list, each targeting specific pests:

- **Imidacloprid (Imitaf 20 SL)** at 1.0 ml/L is effective against adult whiteflies, aphids, and jassids, which are common sap-feeding pests that weaken plants.
- **Thiamethoxam (Actara 25 WG)** at 0.25 g/L is another systemic insecticide used for controlling aphids and jassids.
- **Spinosad-based insecticides** (Tracer at 0.5 ml/L and Success at 1.0 ml/L) provide control over eggplant fruit and shoot borer (EFSB) and sucking insects like whiteflies, aphids, and jassids.

Biopesticides and Biorational Insecticides:

The inclusion of biopesticides highlights the trend toward environmentally friendly pest control measures:

- **Fizimite** (3.0 ml/L) is a biopesticide targeting whiteflies and aphids, offering an eco-friendly alternative to chemical insecticides.
- **K-mite**, a microbial biopesticide, is applied at 1.0 ml/L to control mite infestations.
- **Antario**, a biorational insecticide, is used at 1.0 g/L to combat borers, ensuring healthier plant growth.

Miticides

Mite infestations are addressed using **Abamectin (Vertimec 18 EC)** at 1.0 ml/L and **K-mite**. These products effectively reduce mite populations, which can cause severe damage to plant leaves. The table highlights a diverse range of chemical and biopesticides used for managing fungal diseases, insect pests, and mites. While chemical pesticides provide immediate and effective control, biopesticides and biorational alternatives offer sustainable and environmentally friendly solutions. An integrated pest management (IPM) approach combining these products can enhance crop protection while minimizing environmental impact.

Table 1: List of fungicides and pesticides applied to control disease and insect

Sl.	Generic name	Trade name	Application dose	Purpose
1.	Carbendazim	Autostin WDG	2.0 g/L of water	Stem blight, phomopsis
2.	Carboxin and Thiram	Provax	2.5 g/kg seed	Seed treatment
3.	Biorational insecticide	Antario	1.0 g/lit of water	Borer
4.	Imidacloprid	Imitaf 20 SL	1.0 ml/L of water	Adult whitefly, aphids, jassid
5.	Thiamethoxam	Actara 25 WG	0.25 g/L of water	Aphids, jassid
6.	Spinosad	Tracer	0.5 ml/L of water	EFSB
7.	Spinosad	Success	1.0 ml/L of water	Adult whitefly, aphids, jassid
8.	Biopesticide	Fizimite	3.0 ml/L of water	Adult whitefly, aphids
9.	Microbial biopesticide	K-mite	1.0 ml/L of water	Mite
10.	Abamectin	Vertimec 18 EC	1.0 ml/L of water	Mite

Plate 4: The pesticides sprayed by the concerned farmer using standard protective measures viz., aprons, gum boot, hand gloves, mask, goggles, etc. in the trial

Worker Health Safety and Environmental Issues:

To ensure the safety and well-being of all workers, they were provided with protective gear including aprons, masks, hand gloves, caps, and shoes. Additionally, a comprehensive farm instrument manual was issued to guide the proper use of tools and machinery. Worker health, safety, and environmental stewardship were prioritized throughout the GAP validation trial for eggplant. The pesticides were sprayed by the concerned farmers using standard protective measures viz., aprons, gum boot, hand gloves, mask, goggles, etc. The spraying direction was in favour of wind and especially the spraying nozzle was kept towards the pest locations or habitats concerned. These measures not only ensured a safe and healthy working environment but also reinforced the importance of environmental responsibility and the ethical treatment of workers within the framework of Good Agricultural Practices (GAP).

Harvesting Based on Maturity Index with Dates:

The edible matured brinjal fruits were harvested using secateurs and sharp knives, harvested at cooler times of the day (early morning and evening). The harvesting pot was plastic crate instead of bamboo basket, and harvested fruit was kept in a shady place. Postharvest activities were done carefully. After harvesting the fruits were kept on the tarpaulin to sort out the marketable ones, grading the fruits for marketing and kept on crates. Before marketing, the fruits sorting and grading is essential, as packaging material used for transportation, and finally ensure clean management with personal sanitization.

Maximum Residue Level (MRL) Analysis

The pesticides used in brinjal cultivation viz., Spinosad, Thiamethoxam, Imidacloprid, and Carbendazim were analyzed using the SO-IN-MUL-TE-085 method by LC-MS/MS, with a Limit of Quantification (LOQ) set at 0.005. The results indicated that all four compounds were Below the Limit of Quantification (BLQ), meaning their concentrations were too low to be accurately quantified (Table 2). Specifically, Spinosad, Thiamethoxam, Imidacloprid, and Carbendazim were recorded as BLQ, confirming that none of these substances were detected at levels above the LOQ threshold.

Table 2: MRL analysis results of pesticides used in brinjal cultivation

Parameter/ chemicals	Method	Result	Unit
Spinosad	SO-IN-MUL-TE-085 by LC-MS/MS	BLQ (LOQ: 0.005)	mg/kg
Thiamethoxam	SO-IN-MUL-TE-085 by LC-MS/MS	BLQ (LOQ: 0.005)	mg/kg
Imidacloprid	SO-IN-MUL-TE-085 by LC-MS/MS	BLQ(LOQ: 0.005)	mg/kg
Carbendazim	SO-IN-MUL-TE-085 by LC-MS/MS	BLO(LOQ: 0.005)	mg/kg

Farmers' Training:

The training on brinjal production technology with GAP protocol was conducted in Shibpur, Narshingdi on 30-01-2024, with 30 participants in attendance. These sessions focused on equipping farmers with the knowledge and skills needed to implement GAP effectively, thereby enhancing the quality and yield of their eggplant. To inform the GAP protocols regarding brinjal cultivation, thirty farmers including the four farmers concerned were trained in the day long training. The farmers were trained in the GAP activities.

Data Collection:

Maintaining a register book for all information specially the data on days to 1st harvest, number of marketable fruit, average fruit weight, fruit length (cm), fruit diameter (cm), plant height at last harvest (cm), fruit yield per plant (kg), ESFB infestation (%), bacterial wilt (BW) infection (%), yield (t/ha), fruit colour and fruit shape were recorded from selected plants. The information on different characters was statistically analyzed and Analysis of variance (ANOVA) and mean separation of lines were done using R 3.6.3 statistical software. Data for the monthly minimum and maximum temperatures (^{0}C), precipitation (%), and rainfall (mm) were measured during the experimental period and are shown in Fig 1.

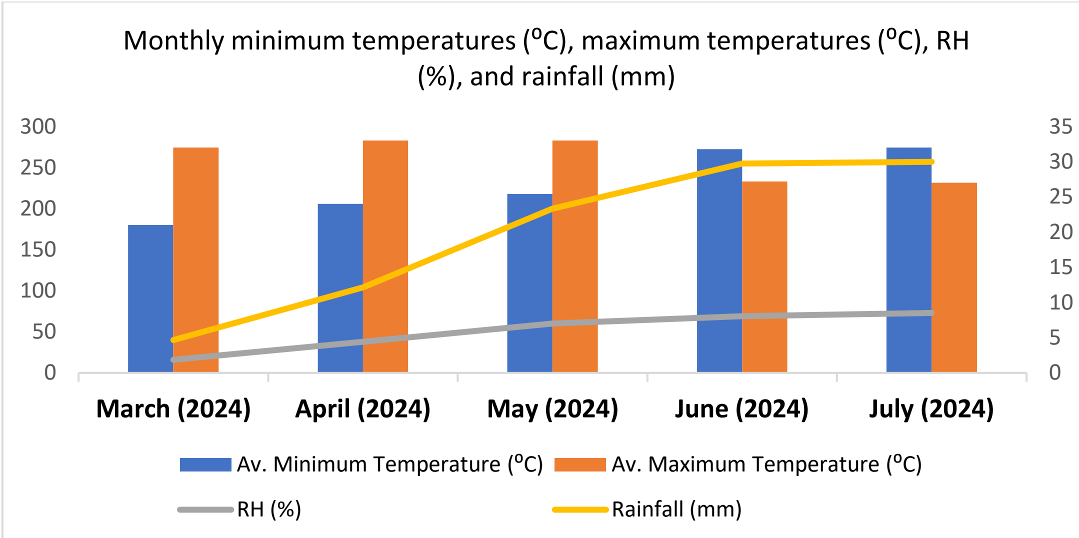

Fig 1: Monthly minimum temperatures (^{0}C), maximum temperatures (^{0}C), RH (%), and rainfall (mm) of Shibpur, Narshingdi, Bangladesh at different harvest stages

RESULTS AND DISCUSSION

The result provides data on the sequential harvest of a crop, showing the number of days to harvest, the number of marketable fruits per plot (37 dec), and the average single fruit weight (g) (Fig 2). Understanding this pattern is crucial for optimizing harvesting schedules, improving market supply, and maximizing yield efficiency.

The number of marketable fruits increased gradually from the first harvest (505 fruits) and peaked at the 9th harvest (1305 fruits). Thereafter, the number of fruits per harvest declined, reaching 530 fruits in the 22nd harvest. This trend suggests that the crop undergoes a peak production period around 116–140 days after planting, after which fruit production starts to decline. Similar yield trends have been observed in previous studies (Singh et al., 2019), indicating that fruit-bearing crops often exhibit an initial growth phase, a peak production period, and a gradual decline in yield. The average single fruit weight ranged from 138 g in the first harvest to a peak of 158 g in the 9th harvest, followed by a gradual decrease in later harvests. This could be due to nutrient depletion in the plants over successive harvests, as reported by Alam et al. (2020). However, the fruit weight remained relatively stable (ranging from 138 g to 155 g) throughout the harvesting period, demonstrating good crop management practices.

After the 9th harvest, the number of marketable fruits steadily declined. By the 22nd harvest, the yield was reduced to almost half of the peak production. This decline can be attributed to plant aging, reduced flowering, and possible depletion of soil nutrients. According to Rahman et al. (2021), frequent harvesting can stress plants, leading to a reduction in fruit set and quality over time. Since peak production occurs between the 6th and 14th harvests, this period should be targeted for intensive market supply. The data suggests that peak production occurs between 116 and 140 days after planting, followed by a gradual decline. While fruit weight remains stable throughout, the number of marketable fruits significantly decreases over time.

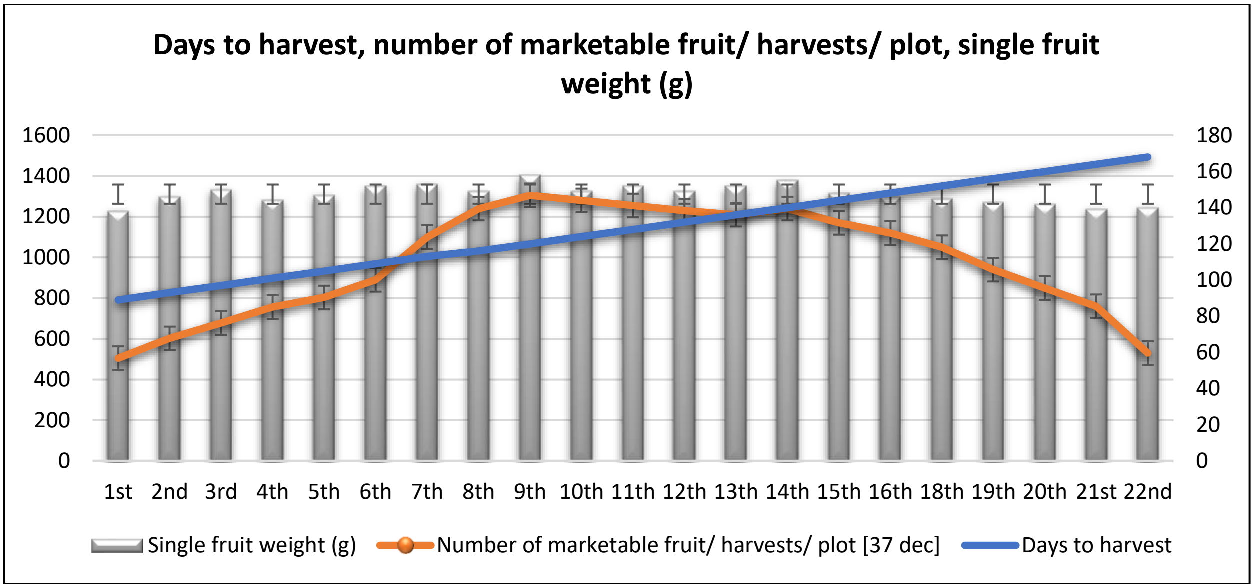

Fig 2: Days to harvest, number of marketable fruit/ harvests/ plot, single fruit weight (g) with different harvest stages

The result presents data on fruit length (cm) and fruit diameter (cm) across 22 sequential harvests. These parameters are critical in determining fruit quality and marketability, as size consistency plays a key role in consumer preference and commercial acceptance. Fruit length varied between 27.5 cm (1st harvest) and peaked at 32.4 cm (14th harvest). The general trend shows an increase in fruit length up to the 14th harvest, after which a gradual decline is observed. The highest fruit lengths were recorded between the 6th and 14th harvests, with values consistently above 31 cm. The decline in fruit length post-14th harvest may be attributed to plant aging, nutrient depletion, and environmental factors affecting growth. According to Alam et al. (2021), fruit length is significantly influenced by soil nutrient availability, pruning, and irrigation practices, which can impact later-stage yields.

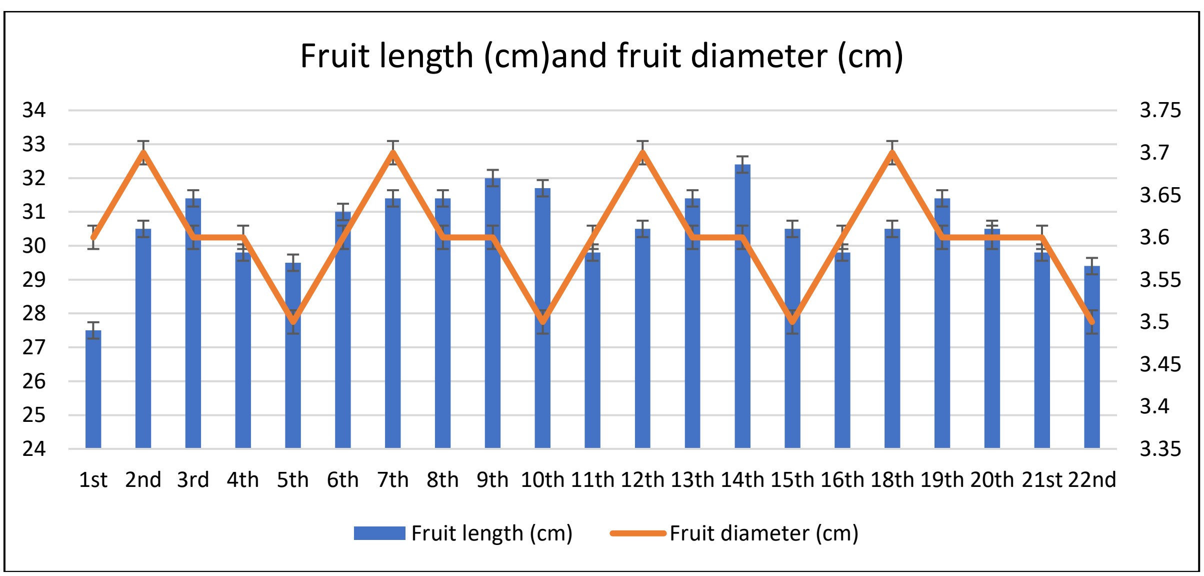

Fig 3: Fruit length (cm) and fruit diameter (cm) with different harvest stages

Fruit diameter remained relatively stable, ranging between 3.5 cm and 3.7 cm. The highest diameter (3.7 cm) was recorded in the 2nd, 7th, 12th, and 18th harvests, indicating a slight fluctuation but overall consistency. The majority of harvests had diameters around 3.6 cm, suggesting minimal variation in fruit width across the harvesting period. Unlike fruit length, diameter did not show a sharp increase or decrease over time. This stability may be linked to genetic factors and controlled growth conditions, as reported by Singh et al. (2020). Since fruit length declined in later harvests, applying balanced fertilizers or organic amendments could sustain longer peak production. Consistent fruit diameter suggests that the crop maintains uniform quality, which is beneficial for market demand and pricing strategies.

There was a significant amount of ESFB infestation and wilt infection observed in the brinjal trial. ESFB infestation was severely observed, and the main cause was the summer, hot and humid conditions during the growing period. Though the infestation range was 10.5-22.5, in the earlier and later stages the infestation was higher compared to the mid stage. It might be due to the lack of control measures. he initial high infestation may be attributed to the presence of adult ESFB populations that laid eggs early in the crop cycle, consistent with findings from Alam et al. (2020), who reported higher infestations in the early fruiting stages.

Very little wilt infection (0-5%) caused by bacteria and fusarium was observed during the growing period. Wilt infection (%) remained below 3% up to the 15th harvest but increased to 4% from the 16th harvest and reached 5% in the last two harvests. This trend is consistent with research by Singh et al. (2021), who noted that wilt infection in solanaceous crops becomes more prevalent as the plant matures due to continuous exposure to soilborne pathogens like Fusarium spp. and Ralstonia solanacearum.

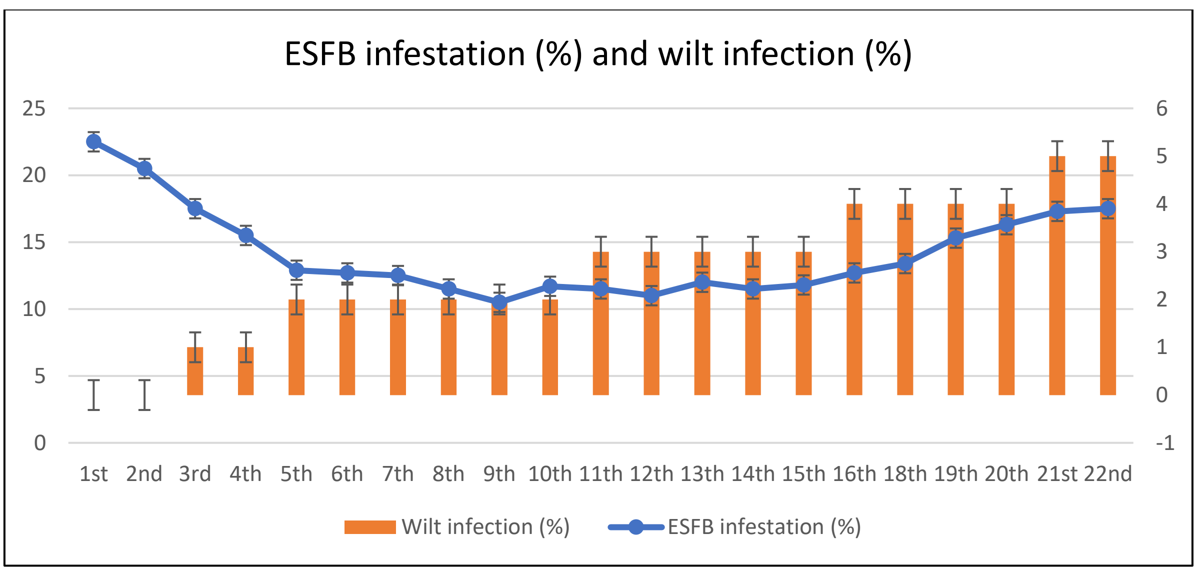

Fig 4: ESFB infestation (%) and wilt infection (%) with different harvest stages

Plate 5: Brinjal is harvested using secateur and proper measures in the trial

Figure 5 presents data on fruit yield across multiple harvest sequences, measured both in kilograms per plot (37 dec) and kilograms per hectare. The trends in the data provide insights into the yield potential of the crop over successive harvests. The fruit yield exhibits an increasing trend during the initial harvests, reaching a peak at the 9th harvest (206.19 kg/plot, 1376 kg/ha). This suggests that the plants reach their maximum productive potential around this period. After the 9th harvest, the yield starts to decline gradually, with the 22nd harvest producing only 74.2 kg/plot (495 kg/ha). The decline in yield over time is likely attributed to plant aging, nutrient depletion, and increased susceptibility to pests and diseases, as seen in the ESFB infestation and wilt infection trends. The trends of yield were as follows.

- **Early Harvests (1st–6th harvests):** The initial yield starts at 69.69 kg/plot (465 kg/ha) and progressively increases due to the continuous growth and establishment of the plants.
- **Mid Harvests (7th–14th harvests):** The yield reaches its peak in this phase, with the highest yield observed in the 9th harvest. The relatively high and stable yield during this period indicates optimal plant health and environmental conditions.
- **Late Harvests (15th–22nd harvests):** A gradual decline in yield is evident, with the 22nd harvest producing significantly lower fruit yield. This decline is often associated with accumulated biotic and abiotic stresses, including increased disease incidence and reduced plant vigor.

The total fruit yield was 3.045 MT and 20.331 MT for 37 decimal areas (plot) and 1 hectare, respectively, which was much optimistic (Table 3). The range of fruit yield (kg/ plot) varied with different harvest times. It was 69.69 to 206.19 kg.

Table 3: Yield parameters of brinjal in unit plot [37 decimal]and one hectare area

Parameter	Unit plot [37 decimal]	One hectare
Fruit yield	3.045 MT	20.331 MT
Minimum yield per harvest	69.69 kg	465.23 kg
Maximum yield per harvest	206.19 kg	1376.46 kg

Successive harvesting without adequate replenishment of nutrients can reduce plant productivity over time. Fluctuations in temperature, humidity, and soil moisture across different harvest periods may also play a role in yield variations.

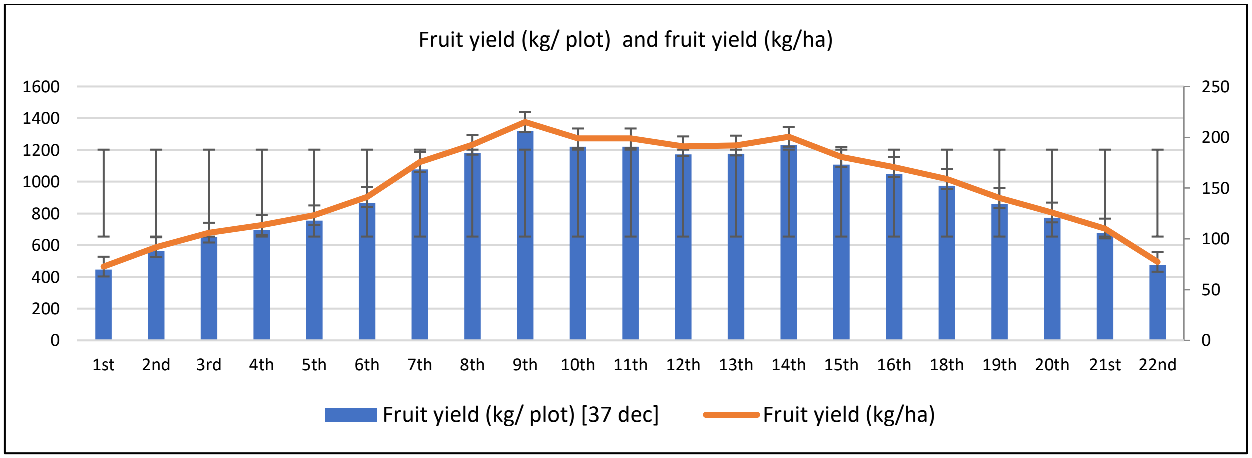

Fig 5: Fruit yield (kg/ plot) and fruit yield (kg/ha) with different harvest stages

The results correlate with the findings of Katarzyna (2013), who mentioned that the marketable yield of fruits harvested after exceeding their optimum maturity stage (18.81 t ha^{-1}), 24.4% higher and early yield (4.80 t ha^{-1}) – by 7.9% lower in comparison to the yield of fruits harvested in their optimum harvesting maturity. In Bangladesh, such hot and humid conditions during the growing season, the produced yield was satisfactory and good enough. So, following the Bangladesh GAP protocol, the farmer produced a significant amount of quality eggplant, which help to get a premium price of the produce.

Fruit Harvest, Sorting, Grading, and Packaging

Brinjal harvesting, sorting, grading, and packaging are crucial steps in maintaining quality and ensuring compliance with Bangladesh GAP standards. So, harvesting was done at the proper maturity stage, when the fruits are firm, glossy, and have attained the desired size. Farmers used clean and sharp tools (secateur) to minimize damage and contamination. After harvesting, sorting was performed to remove damaged, diseased, or deformed fruits, ensuring only high-quality produce moves forward. Grading is then carried out based on size, shape, color, and overall appearance to maintain uniformity and meet market standards. Proper packaging is essential to protect brinjal during transportation and storage. Fruits were packed in clean, ventilated crates, avoiding excessive stacking to prevent bruising. Adopting these GAP-compliant practices enhanced the shelf life, market value, and safety of brinjal, benefited both producers and consumers.

Plate 6: Brinjal sorting, grading, and packaging

Benefit-Cost Analysis

The economic analysis of brinjal production reveals a positive return on investment, as indicated by the Benefit-Cost Ratio (BCR) of 1.31 (Table 4). This suggests that for every 1 Tk spent on production, there is a return of 1.31 Tk, demonstrating the profitability of the venture. The total brinjal yield from the cultivation was 3,045 kg, with a unit price of 30 Tk per kg, leading to a total income of 91,350 Tk. However, after deducting the total expenses of 69,500 Tk, the actual net income stands at 21,850 Tk. Despite the profitability, the relatively moderate BCR suggests that while the production system is economically viable, further optimization may enhance profitability. This indicates a profitable return, though further optimizations in cost management and yield improvement could enhance profitability.

Potential Areas for Improvement Include

Yield Enhancement: Implementing better agronomic practices, adopting high-yielding brinjal varieties, and ensuring adherence to Good Agricultural Practices (GAP) could improve yield and overall returns.

Market Optimization: Exploring better market linkages, value addition, or direct marketing strategies could help secure higher prices for the producer, further increasing income.

Table 4: The economic analysis (BCR) of brinjal production

Brinjal yield (kg)	Unit price (Tk)	Income (Tk)	Expenses (Tk)	Actual income (Tk)	BCR
3045	30	91350	69500	21850	1.31

Farmer's Profile and Reaction

Belayet Hossain, a resident of South Joymongol, Shibpur, Narshingdi successfully cultivated brinjal following Good Agricultural Practices (GAP) standards. He expressed satisfaction with the results, noting that the optimum use of compost, fertilizers, insecticides, fungicides, and irrigation water significantly improved their yield. Compared to his previous farming methods for eggplant, adopting GAP led to better crop performance and higher profitability, confirming the advantages of these sustainable farming practices.

Marketing and Export Opportunity

GAP-produced brinjal can be marketed as a premium, safe, and sustainable product. Strategies include targeting health-conscious consumers, and supermarkets, emphasizing their compliance with international safety standards, and positioning it for export to high-demand markets. Leveraging certifications and promoting the benefits of GAP can also attract buyers looking for quality and traceable produce. The involvement of the Department of Agricultural Marketing (DAM) can establish better marketing channels.

GAP-produced brinjal meets international standards for quality and safety, making it highly competitive in global markets. The adherence to GAP enhances the crop's appeal to foreign buyers, offering farmers the chance to access lucrative export opportunities. This not only boosts income but also strengthens Bangladesh's presence in the international agricultural market.

Challenges

During the plant fruiting stage, heavy rainfall conditions led to the death of some plants, compounded by an outbreak of fusarium wilt. Additionally, the farmer was not fully acquainted habituated with GAP practices, while plant protection measures are complex to them. They are interested in purchasing and applying pesticides and fungicides following the advice of pesticide dealers rather than the Agriculture Officer or GAP Protocol.

CONCLUSION

To overcome these challenges, a coordinated approach is needed under a unified framework involving researchers, DAE, DAM, exporters' associations, and BARC to enhance brinjal exports while ensuring the availability of quality products in the local market. Agricultural entrepreneurs interested in exporting can collaborate with farmers to implement GAP practices. All activities in this trial followed the Bangladesh GAP protocol to ensure high-quality brinjal production. A total of 22 harvests were conducted within the harvest period (08.05.2024 to 26.07.2024), with the first harvest occurring on day 89 (08.05.2024) and the final (22nd) harvest on day 168 (26.07.2024). The trial plot covered 37 decimals of land, from which all fruit yield was obtained. The fruit yield per plot (kg) varied depending on harvest time, ranging from 69.69 to 206.19 kg. A similar trend was observed in fruit yield per hectare, which ranged from 465.23 to 1,376.46 kg/ha. These values represent single-harvest yields. The total fruit yield was 3,045 kg for the 37-decimal plot and 20,331 kg per hectare. The economic analysis of brinjal production reveals a positive return on investment, as indicated by the Benefit-Cost Ratio (BCR) was 1.31.

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