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RESEARCH PAPER

A Comparative Study on Field and Floating Cultivation of Capsicum, Tomato and Brinjal

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ABSTRACT

The current investigation was conducted to assess the growth and yield performance of capsicum, tomato, and brinjal in two different growing conditions i.e., field and floating conditions. The experiment was executed in a Randomized Complete Block Design (RCBD) with three replications. The performance of capsicum, tomato, and brinjal was assessed based on their plant height (cm), branches/plant, leaves/plant, number of flowers/plants, number of fruits/plants, single fruit weight (gm), fruit weight/plant (kg), fruit weight/plot (kg), and yield (t/ha). Based on the results of the parameters, there were no significant differences between field and floating bed cultivation in the vegetative stage, but significant differences were found in yield attributes. The highest yield of tomato (19.35 t/ha) and brinjal (12.08 t/ha) was identified in the field-based methods. Alternatively, the highest yield of capsicum (7.36 t/kg) was found in floating-based methods. This study clearly indicates the successful cultivation of capsicum, tomato, and brinjal existing in both field and floating bed systems. Therefore, floating farming would be a better option for the cultivation of capsicum, tomato, and brinjal by farmers at riparian wetlands during high and extended flooding periods.

Key words: Field bed, Floating bed, Growth, Yield

Introduction

Bangladesh is an agriculture-based developing country where the impoverished rely on agriculture for survival. This country confronts the multifaceted effects of climate change in the form of flooding, cyclones, rising sea levels, drainage congestion, salinity in freshwater systems, and so on (Saha, 2010). Among these natural disasters, flooding is the most recurrent one. During monsoon floods, many people in flooded regions face food shortages and malnutrition due primarily to the loss of standing crops and income. Climate change alters farming practices in low-lying, flood-prone locations (Ahmed, 2006; Awal, 2014; Islam *et al.*, 2015; Bala *et al.*, 2020). Due to these changes, some areas of the nation remain flooded for an extended time (Chowdhury and Moore, 2017; Kabir *et al.* 2019; Kabir *et al.* 2020). To overcome this problem, farmers in these regions can obtain food and nutrients from their floating gardens, a way of utilizing wetlands that are sustainable. (Alam and Chowdhury, 2018). They could be switching to a different method of farming. Besides new technology adoption, Indigenous methods *viz.* floating cultivation can be effective in this phenomenon. It is performed in the southern Bangladeshi floodplains, specifically in Barisal, Pirojpur, Gopalgonj, and Satkhira(Chowdhury and Moore, 2017; Islam *et al.* 2019; Kabir *et al.* 2019). This cultivation technique is locally known as 'VasomanChash' (Haq *et al.* 2016; Alam and Chowdhury, 2018) and 'hydroponics' (Irfanullah *et al.* 2008) in the scientific community. It supplies adaptation advantages through crop production in monsoon-season wetlands (Rahman, 2014), and found its beneficial effects on nutritional security, household income, and land-use capability (Irfanullah *et al.*, 2011). In addition, floating vegetable production in Bangladesh was designated as a "Globally Important Agricultural Heritage System (GIAHS)" by the Food and Agriculture Organization (FAO) of the United Nations on 15 December 2015 for its uniqueness, longevity, and flexibility in the agricultural world (Alam and Chowdhury, 2018; Oo *et al.*, 2022)

The floating cultivation system involves the utilization of aquatic plants to create a floating platform or raft of suitable dimensions. This platform serves as a foundation for cultivating vegetables and other crops, as well as nurturing seedlings during the rainy season. Water hyacinth (*Eichhornia crassipes* Mart. Solms.) is a predominant aquatic plant in Bangladesh and is utilized as the primary constituent for constructing floating platforms. This traditional cultivation technique is ecofriendly which means utilizing the natural resources of wetlands to grow vegetables and other crops almost all year round. (Irfanullah *et al.* 2011). Vegetables grown on floating beds include turmeric, eggplant (brinjal), pumpkin, taro, wax gourd, ridged gourd, bitter gourd, taro, and wax gourd. During the winter season spinach, bottle gourd, yard-long bean, bean, capsicum, tomato, potato, cabbage, kohlrabi, turnip, radish, carrot, onion, green chili, and garlic are cultivated. Some vegetables are also grown on the bed all year round, in rotation (Saha, 2010; Rahman, 2011).

Tomato, brinjal, and capsicum are among the most important vegetables and have a substantial impact on the livelihood of smallholder producers. In Bangladesh, the traditional practice of cultivating capsicum, tomato, and brinjal plants primarily involves soil-based farming techniques. However, in waterlogged areas, particularly in the southwest region, floating bed cultivation has garnered significant attention in recent years. Hence, the present study was undertaken to examine the growth and productivity of capsicum, tomato, and brinjal plants grown on floating beds and in conventional soil-based systems.

Materials and Method

Experimental site

The present study was conducted during the Rabi season, from November 2022 to March 2023, in the Agricultural Research Field of Noakhali Science and Technology University (NSTU), located in Noakhali-3814, Bangladesh. The practice of floating cultivation was conducted in a deep canal situated in a specific corner of the university premises, considered by a substantial presence of water hyacinth. The experimental site belongs to Young Meghna Estuarine Flood Plain under the soil of Agro Ecological Zones (AEZ)-18.

Planting materials

The experiment was implemented with the seeds of hybrid cultivars, namely California Wonder (F1 hybrid Capsicum), Baahubali (F1 hybrid Tomato), and Green Ball (F1 hybrid Brinjal). The seeds were exposed to overnight soaking in water in order to facilitate the identification and subsequent removal of seeds of lower quality. Seeds with potential viability were sowed onto a seedbed by dibbling method to initiate the process of germination. At first 1m × 1m sized holes were made and then, 2-3 seeds were placed in each of the holes. After seed germination, one seedling was maintained per hole. Following the process of germination, seedlings that were 25DAS (days after sowing) old were subsequently transplanted into both field and floating beds.

Experimental design

Two-factor Randomized Complete Block Design (RCBD) was followed, where, Factor A included three Crops (Capsicum, tomato, and brinjal) and Factor B included two growing conditions (Field and floating bed).

Floating bed preparation

The initial construction of the floating beds required just a few locally available materials. At first, a pair of long bamboo structures were positioned on top of a cluster of fully developed water hyacinths. These bamboos served as a support system, allowing for the accumulation of immature hyacinth plants above the mature ones. Afterward, the process of gathering the water hyacinths started by pulling them from both sides of the bamboo and subsequently flattening them underfoot. The above process was executed until the desired vertical and horizontal dimensions of the bed were achieved. Bamboo poles were used to secure the positioning of floating beds as a preventative measure against damage due to wave action or drifting. The bed was left 25 days before planting seedlings for decomposition of the top layer of water hyacinth. The size of each bed was 8.3 m^2 (4.6 m × 1.8 m). In this process, three beds were prepared.

Field preparation and seedling transplantation

The experimental land was ploughed twice to improve the soil structure and water-holding capacity. Weeds and previous crop residues were removed from the field. The size of each experimental block was 2.8 m^2 (1.8 m × 1.5 m). The total size of the experimental field was 25m^2 (18m ×15m). The space between blocks and plots was 0.4m. The plots were designed and ridges were created for growing seedlings on the top of the bed. Irrigation and drainage channels were made by making furrows in the spaces between the plots. Before being transplanted into the field, the seedlings were adequately irrigated. Then, the 25 DAS old seedlings were transferred to the designated experimental plot during the late afternoon. The experimental plot was irrigated after the process of transplantation. Furrow irrigation was done for the purpose of providing water to plants, and sprinkle irrigation was applied as needed. The seedlings were stalked with 2 m long bamboo poles 2 weeks after transplantation. Pruning, weeding by hand pulling, and other horticultural and agronomical procedures were performed when necessary.

Application of fertilizers

Urea, Triple Super Phosphate (TSP), Muriate of Potash (MoP), and Gypsum were used as nutrient sources for soil as recommended by BARC. During the final stage of land preparation, the entire amount of TSP, MoP, and Gypsum was broadcasted on the soil surface (Table 1). Urea was applied in three split doses. Half of the urea was applied during final land preparation, and the other half was applied in two equal installments as a top dressing. In addition to the application of 8.36 gm of Furadan (Fana 5g), the soil was treated as a protective measure against various types of insects and nematodes.

Table 1. Applied doses of fertilizers in the soil as recommended by BARC.

Name of the fertilizers	Dose	Application		
		Final land preparation	1st installment	2nd installment
Urea	1.2 kg	600 g	300 g	300 g
TSP	900 g	900 g	-	-
MOP	450 g	450 g	-	-
Gypsum	210 g	210 g	-	-

Data collection procedure
Data related to the following parameters were recorded from the experimental plots. The highest point of each plant was determined in cm, extending from the plant's base to its apex, using a tape measure. At 20, 40, and 60 days after transplanting (DAT), the plant height (cm), branches per plant, and leaves per plant were recorded. Days to first flowering (DAT) were calculated as the number of days from transplantation to the first flower opening. It was considered when the flower was fully bloomed. The number of flowers per plant, number of fruits per plant, single fruit weight (gm), fruit weight per plant (kg), fruit weight per plot (kg), and yield (ton/ha) were also recorded.

Statistical analysis
The data were statistically analyzed using Minitab statistical software. Descriptive and inferential statistical tools were used. A T-test was performed to evaluate the significant differences between the two factors. Numerical data are presented as means ± standard error of the mean.

Results and Discussion

Plant height
The plant height measurements of capsicum, tomato, and brinjal were recorded at 20, 40, and 60 days after transplanting (DAT). Based on the data described in Figure 1, it is evident that there were no significant variations in the height of capsicum, tomato, and brinjal plants among the field and floating beds. The results demonstrated statistical equivalence between both treatments. The plant height of capsicum, tomato, and brinjal does not exert any visible difference in cultivation practices, whether in field-based or floating-based systems.

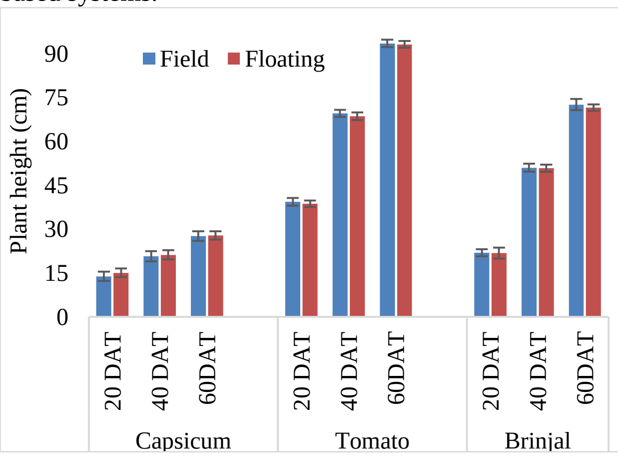

Figure 1: Average plant height (cm) of capsicum, tomato, and brinjal at 20, 40, and 60 days after transplanting (DAT). Statistical analysis was performed by Minitab statistical software and values (means ± standard errors) of treatment groups were attained from three independent replications.

Number of branches per plant
The data on the number of branches per plant of capsicum, tomato, and brinjal were recorded at 20, 40, and 60 days after transplanting (DAT). There is no evidence of substantial variation observed in the number of branches of capsicum, tomato, and brinjal plants between the field and floating beds (Figure 2). The findings indicated that there was a statistically similar outcome between both treatments. The cultivation practices for capsicum, tomato, and brinjal do not exhibit any discernible variations, no matter whether they are grown in field-based or floating-based systems.

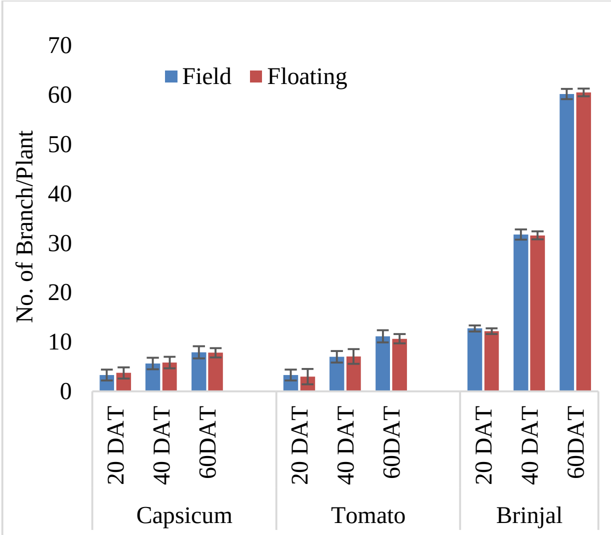

Figure 2: Average number of branches per plant of capsicum, tomato, and brinjal at 20, 40, and 60 days after transplanting (DAT). Statistical analysis was performed by Minitab statistical software and values (means ± standard errors) of treatment groups were attained from three independent replications.

Number of leaves per plant
Regarding the number of leaves per plant, the maximum number of leaves 66.83, 31.08, and 12.83 were found in capsicum, tomato, and brinjal respectively at 60 DAT under the field condition (Figure 3). These results were found to be statistically identical to the results obtained under floating bed conditions. The results of the study revealed a similar outcome between field beds and floating beds. There are no apparent distinctions in the cultivation methods used to cultivate capsicum, tomato, and brinjal in both field-based and floating-based systems.

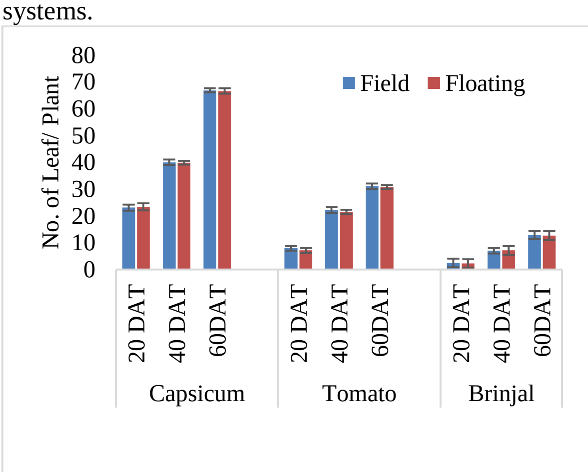

Figure 3: Average number of leaves per plant of capsicum, tomato, and brinjal at 20, 40, and 60 days after transplanting (DAT). Statistical analysis was performed by Minitab statistical software and values (means ± standard errors) of treatment groups were attained from three independent replications.

First flower initiation
Days to first flowering data (DAT) were recorded as the number of days from transplantation to the first flower

opening. It was considered when the flower was fully bloomed. No significant variation was observed in the initial flowering of capsicum, tomato, and brinjal plants when tested in both field and floating conditions (Figure 4). Based on the findings, it can be figured out that field and floating cultivation methods do not have a significant impact on the first flower initiation of capsicum, tomato, and brinjal.

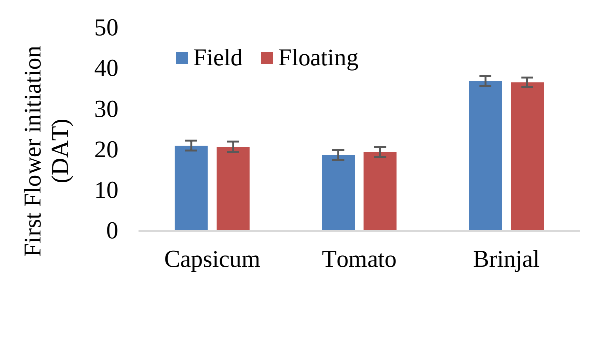

Figure 4: Average data of first flowering initiation of capsicum, tomato, and brinjal plants in the field and floating bed conditions. Statistical analysis was performed by Minitab statistical software and values (means ± standard errors) of treatment groups were attained from three independent replications.

Number of flowers per plant

In relation to the total amount of flowers per plant, it was observed that capsicum, tomato, and brinjal exhibited the highest number of flowers, with values of 18.92, 15.38, and 12.50 respectively, as represented in Figure 5, under field conditions. The statistical analysis revealed that the results were determined to be distinct from the outcomes observed in regard to floating bed conditions. The findings of the study indicated that the number of flowers per plant is an identical result between field and floating bed conditions.

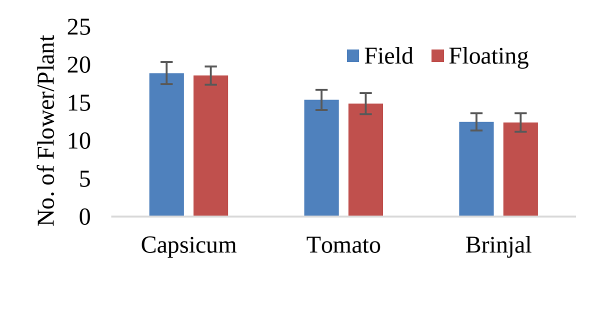

Figure 5: Average number of flowers per plant of capsicum, tomato, and brinjal in the field and floating bed conditions. Statistical analysis was performed by Minitab statistical software and values (means ± standard errors) of treatment groups were attained from three independent replications.

Number of fruits per plant

Based on the data presented in Table 2, it is evident that there are significant differences present in the number of fruits per plant between field-based and floating-based cultivation systems for capsicum, tomato, and brinjal. The field condition provided the highest number of brinjal fruits (6.08). Notably, this result was statistically different from the number of fruits obtained in the floating bed condition. In the case of tomato, the maximum number of fruits per plant (13.83) was found in field conditions that were statistically similar to the floating bed conditions. Conversely, a significant inequality was observed in the production of capsicum. The study indicated that the floating-bed conditions resulted in a higher average number of capsicum fruits per plant (6.94) compared to the soil-based conditions. The cultivation of capsicum in floating bed conditions exhibited superior performance.

Single fruit weight

Significant variations in single-fruit weight were observed among capsicum, tomato, and brinjal plants. The data is presented in Table 2. In field-based cultivation, the maximum weight of a single tomato fruit was recorded as 79.18 gm, although the maximum weight of a single brinjal fruit was found to be 139.92 gm. However, in floating-based cultivation, the minimum weight of a single tomato fruit was observed to be 70.72 gm, and the minimum weight of a single brinjal fruit was recorded as 135.67 gm. In the context of capsicum cultivation, it was observed that the maximum weight of a single capsicum fruit was recorded as 72.89 gm in floating beds, while the minimum weight of fruit was found to be 69.11 gm in field-based conditions. Therefore, the cultivation on floating-based has a significant impact on the single fruit weight of capsicum. The study results indicate that capsicum exhibited a remarkably higher level of performance when cultivated in floating beds. In contrast, tomato and brinjal exhibited superior performance in terms of single fruit weight within a soil-based cultivation system. This result is supported by the previous findings of Mondal *et al.* (2022) who also reported that floating bed cultivation with the combination of organic and inorganic fertilizers in equal proportion exhibited a beneficial response in individual fruits weight of okra and cucumber. Chotimah *et al.* (2020) reported that the highest fruit weight was found in melon under a *Salvinia molesta* based floating bed.

Table 2. Effects of field and floating bed cultivation on number of fruits per plant and single fruit weight (gm).

Treatments	No. of fruits/plant			Single fruit weight (g)		
	Capsicum	Tomato	Brinjal	Capsicum	Tomato	Brinjal
Field	5.08±0.14	13.83±0.36	6.08±0.08	69.11±0.87	79.18±0.63	139.92±0.93
Floating	6.94±0.08	13.50±0.14	4.83±0.08	72.89±0.66	70.72±0.64	135.67±0.65
Level of significant	**	NS	**	**	**	**

The asterisk symbol (**) represents statistically significant differences at P≤ 0.01 between treatments, SE (±) = Standard Error, NS= Non-significant. The numerical data is presented in a table of means together with the standard error of the mean.

Fruit weight per plant

Considerable differences in fruit weight per plant have been identified among capsicum, tomato, and brinjal plants (Table 3). In field-based cultivation, the maximum fruit weight per plant was observed to be 1.35 kg for tomatoes and 0.84 kg for brinjals. At the same time, in floating bed cultivation, the minimum fruit weight per plant was found to be 1.03 kg for tomatoes and 0.63 kg for brinjals. In the context of capsicum cultivation, it was observed that the highest recorded fruit weight per plant was 0.59 kg in floating beds, while the lowest recorded fruit weight per plant was 0.37 kg in field-based conditions. According to the findings of Mondal *et al.* (2023), the highest fruit weight per plant of okra and cucumber was observed in the floating beds with a thickness of 2.5 m. A similar finding was described by Mondal *et al.* (2022).

Fruit weight per plot

Substantial variation in fruit weight per plot was observed among capsicum, tomato, and brinjal plants (Table 3). The study observed that the highest recorded fruit weight per plot was 5.39 kg for tomatoes and 3.37 kg for brinjals in soil cultivation. Alternatively, the lowest recorded fruit weight per plot was 4.15 kg for tomatoes and 2.54 kg for brinjals in floating bed cultivation. In contrast, the floating bed cultivation method yielded the highest average capsicum fruit weight per plot, measuring 2.19 kg. Conversely, the field cultivation method resulted in the lowest average capsicum fruit weight per plot, measuring 1.42 kg. The findings of the study noted that capsicum demonstrated significantly superior performance in terms of fruit weight per plot in the context of floating bed cultivation. On the other hand, tomato and brinjal demonstrated outstanding performance when cultivated in the field.

Yield

A considerable difference was observed among the capsicum, tomato, and brinjal in terms of yield, as indicated in Table 3. The study observed that soil cultivation resulted in the highest yield of tomato (19.35 tons/ha) and brinjal (12.08 tons/ha), while floating bed cultivation yielded the lowest tomato (14.88 tons/ha) and brinjal (9.12 tons/ha) harvest. On the other hand, the floating bed cultivation method exhibited the highest capsicum yield at 7.36 tons/ha, while the field cultivation method yielded the lowest at 4.81 tons/ha. The findings of the study revealed that capsicum showed a greater yield when cultivated using floating bed techniques instead of traditional field cultivation methods. However, the field cultivation of tomato and brinjal showed exceptional performance. According to Siaga *et al.* (2018), the results of their study indicated that chili peppers grown using a floating culture system exhibited superior performance in comparison to the conventionally cultivated system. The findings of our study align with the previous findings reported by Mondal *et al.* (2022) in their research on okra and cucumber, Mondal *et al.* (2023) in their investigation of red amaranth, Indian spinach, and cucumber, and Chotimah *et al.* (2020) in their study on melon.

Table 3. Effects of field and floating bed cultivation on fruit weight/plant, fruit weight/plot and yield /ha.

Treatments	Fruit weight/plant (kg)			Fruit weight/plot (kg)			Yield (tons/ha)		
	Capsicum	Tomato	Brinjal	Capsicum	Tomato	Brinjal	Capsicum	Tomato	Brinjal
Field	0.37±0.01	1.35±0.04	0.84±0.01	1.42±0.02	5.39±0.16	3.37±0.02	4.81±0.08	19.35±0.57	12.08±0.09
Floating	0.59±0.01	1.03±0.04	0.63±0.01	2.19±0.02	4.15±0.16	2.54±0.05	7.36±0.08	14.88±0.58	9.12±0.18
Level of significant	**	**	**	**	**	**	**	**	**

The asterisk symbol (**) represents statistically significant differences at P≤ 0.01 between treatments, SE (±) = Standard Error, NS= Non-significant. The numerical data is presented in a table of means together with the standard error of the mean.

Conclusion

Based on the findings of this study, it can be inferred that both floating bed and field cultivation had a beneficial impact on the productivity of capsicum, tomato, and brinjal crops. There were no significant differences observed in vegetative parameters; however, significant variations were detected in yield attributes, specifically the number of fruits/plants, the weight of individual fruits (in gm), the weight of fruits/plant (in kg), the weight of fruits/plot (in kg), and overall yield (in tons/ha). The cultivation systems implemented in the field showed a notable increase in yields for tomato and brinjal crops. Instead, the floating bed system showed a higher yield of capsicum compared to soil-based cultivation methods. In spite of no additional inorganic nutrient supply, floating cultivation showed similar growth performance to field cultivation in the case of all the crops considered in this experiment. Regarding assessing the yield performance of this study, it was observed that tomato and brinjal exhibited higher yields in soil-based cultivation, however, capsicum had significantly superior yield qualities in floating cultivation. Hence, the present study clearly indicates the successful cultivation of capsicum, tomato, and brinjal existing in both field and floating bed systems.

Conflict of interest

The authors have clarified that there are no conflicts of interest associated with this research.

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