

Organic matter and Indigenous Vegetables in Sack under Waterlogged in Southwest Bangladesh

Abstract

A study on Prospect and profitability of Indigenous Vegetables (Kalmi, Helencha and Malancha Shak) was conducted in Shyamnagar Upazila of Satkhira district at waterlogged condition during September, 2020 to May, 2021. In the experiment three vegetables were used and the treatments were- T_0 = Control (noorganic matter), T_1 = 75% organic matter+ 25 % soil, T_2 = 50 % organic matter +50% soil, T_3 = 25% organic matter+ 75 % soil. There was significant difference among the treatments and different indigenous marshy leafy vegetables. The maximum yield, Gross and Net income and BCR in all the vegetables were observed in T_1 (where 75% organic matter+ 25 % soil were used). In case of comparative analysis of different vegetables, the highest yield, gross and net income and BCR were also recorded from Helencha Shak and that was the lowest in Kalmi Shak.

Introduction

Vegetables are considered as one of the most important food crops due to their high nutritive value, relatively higher yield and higher return. In addition to its nutritional value, it lowers poverty in developing nations like Bangladesh by creating jobs, raising incomes, and creating jobs (Mitra & Yonus, 2018). In Bangladesh, the last forty years have seen an enormous increase in the production of vegetables. Because Bangladesh (BD) is a large low-lying country, it is thought to be the most climate vulnerable nation in the world (Karim & Mimura 2008; The Asian Development Bank 2010; The World Bank 2011; USAID 2018).

Approximately 8,000 hectares of flooded land in the district regions of Khulna and Jessore, Bangladesh. There are a number of reasons for the growing flood zones on the South West coast, including siltation of rivers, insufficient dredging and the occurrence of extreme weather (Formal Situation Report, 2020). Waterlogging currently affects about 5% of Bangladesh's entire land area (Rahman et al 2009). The Bangladesh Department of Forestry predicts that by 2100, it would rise to 14%. (Bangladesh Department of Forest, 2016).

Sack farming makes it possible for people to cultivate food in areas that are waterlogged, have little water, and little access to excellent soil. In areas where access to arable land and water is limited, people can grow food thanks to the sacks. Sack gardens' portability, compact size, affordability, effectiveness, productivity, and contributions to food security are their key features.

A high-productivity soil mixture is placed inside of previously used feed and fertilizer sacks. On top of the bags or in holes carved into the sidewalls, vegetables are cultivated. By halting agricultural output 60–90 cm above the earth, this innovative method is incredibly efficient in assisting families in adapting to saline intrusion and waterlogging (Angrish and Datta, 2006). Thus, growing vegetables in sacks solves the problems of wet land, small space and lack of arable land. Sack cultivation is a useful technique for optimizing vegetable production on small plots of land.

On the other hand, Organic matter provides essential macro- and micronutrients and bioactive substances that enhance the quality and value of vegetable crops. It containing small amounts of organic matter have been found to be more effective in boosting crop production. It improves soil quality, maintains crop yields and increases the nutrient content of vegetables. These fertilizers are effective in promoting vegetable growth, preventing pests and diseases, and improving vegetable yield and quality (Singh et al., 2017).

So, in current situation, importance is given to the cultivation of vegetables in Sack in the waterlogged conditions as an alternative way of vegetable cultivation in this region. The aim of this study was to determine the performance and profitability of growing indigenous vegetables under the influence of organic matter in the waterlogged of southwestern Bangladesh.

Material and Methods

The field experiments were conducted in the waterlogged condition in Khulna University campus Khulna district and Shyamnagar Upazila of Satkhira district during the period from September 2020 to June 2021. The following experiments were conducted in Sack under waterlogged condition in the south-west Bangladesh. The experiments were laid out in a Completely Randomized Design (CRD) with five replications. The three indigenous vegetables were used planting materials of which were collected from different areas of south-west Bangladesh.

Factor A: Three indigenous vegetables

1. Kalmishak (*Ipomoea aquatica*)
2. Helencha (*Enhydra fluctuans*)
3. Malancha (*Jussiaea repens*)

Factor B: 4 levels of growing media:

1. T0 = Control (no organic matter),
2. T1 = 75% organic matter + 25 % soil,
3. T2 = 50 % organic matter + 50% soil,
4. T3 = 25% organic matter + 75 % soil.

No. of sacks: $4 \times 3 \times 5 = 60$

Seedlings/cuttings of the vegetables were produced and 30 days old seedlings/cuttings were transplanted to the respective sacks containing different levels of organic matter. The recommended levels of organic matter were mixed with the soil. The sacks were then placed in the submerged/waterlogged condition. All the intercultural operation was done following standard cultivation methods of the crops. The side of the sacks was 90 cm \times 60 cm (sacks). These hollow open-end cylindrical mesh bags were fixed vertically on fertilized puddled soil and was kept stretched round its periphery by inserting 3-4 tough dry bamboo sticks (90 cm length) and few strong bamboo pegs along its inner walls, which was acted as pillars. The bamboo sticks and bamboo pegs were inserted 15 cm in soil for the firmness of the column. Gunny bag reinforced soil columns was tied with pillars using jute threads/plastic rope outwardly in circular fashion. The soil columns were left as such for fifteen days for drainage of excess water from the soil column.

After that, vegetables seedlings/cuttings were transplanted on top of the columns properly hoed by Nirani up to 10 cm depth. Seedling was sprayed repeatedly with fungicides and systemic insecticides as and when necessary to prevent pest and disease attack (Ghorai *et al.*, 2013; 2014 and 2016). Data was collected on yield, and profitability (Cost of production, Gross Return, net return and Benefit cost ratio).

Data analysis:

Data on different parameters was analyzed through Analysis of variance using computer software Statistix-10. Duncan's New Multiple Range Test (DMRT) was performed to determine the significant difference among the means within the parameters.

Results and Discussion

The findings of the experiment in which 3 marshy land indigenous vegetables were cultivated to determine their profitability are presented in this section in the following headings.

1. Kalmi Shak (*Ipomoea aquatica*)

Yield per sack

The average yield of Kalmi Shak was varied significantly among the levels of manure used per sack (Table 1). The highest yield per sack (6.70 kg) was found in T₁ where soil (%): organic matter (%), 25: 75 was used followed by T₂ (5.30 kg), where 50 % organic matter + 50% soil was used per sack. The lowest yield (3.40 Kg/Sack) was recorded from the control (T₀) where no organic matter was used.

Cost of production per sack

The average cost of production of Kalmi Shak was not varied significantly among the levels manure used per sack (Table 1). However, numerically the highest cost of production of per sack (200 BDT/sack) was found T₁ and the lowest cost of production (125 BDT/sack) was recorded from the control (T₀).

Table 1. Impact of growing media containing different levels of soil and organic matters on yield and profitability of Kalmi Shak in sack

| Treatment | Yield sack ⁻¹ (Kg) | Cost sack ⁻¹ (Taka) | Gross income sack ⁻¹ | Net Income sack ⁻¹ (Taka) | BCR sack ⁻¹ |
|----------------|----------------------------------|-----------------------------------|------------------------------------|---|---------------------------|
| T ₀ | 3.40d | 125d | 170.00d | 45.00c | 1.36b |
| T ₁ | 6.50a | 200a | 325.00a | 125.00a | 1.625a |
| T ₂ | 5.30b | 175b | 265.00b | 90.00b | 1.51ab |
| T ₃ | 4.23c | 150c | 211.67c | 61.67c | 1.41b |
| LS | ** | ** | ** | ** | * |
| LSD | 0.47 | 1.5 | 23.25 | 23.25 | 0.16 |

Note: T₀= Control (no organic matter), T₁ = 75% organic matter + 25 % soil, T₂ = 50 % organic matter + 50% soil, T₃ = 25% organic matter + 75 % soil. LS= Level of Significance
LSD = Least Significant Difference. Data in a column with same letter do not differ significantly and data with different letter differ significantly. **= Significant at 1% levels. * = Significant at 5% level, NS= Not significant

Gross income per sack

The average gross income of Kalmi Shak was varied significantly among the levels manure used per sack (Table 1). The highest gross income per sack (325.00 BDT/Sack) was found in T₁, where soil (%): organic matter (%), 25: 75 was used followed by T₂ (265.00 BDT), where soil (%): organic matter (%), 50: 50 was used. The lowest gross income (170.00 BDT) was recorded from the control (T₀).

Net income per sack

The average net income of Kalmi Shak was varied significantly among the levels of manure used per sack (Table 1). The highest net income per sack (125.00 BDT) was found in T₁, where soil (%): organic matter (%), 25: 75 was used followed by T₂ (90.00 BDT) where soil: organic matter, 50:50 was used. The lowest net income (45.00 BDT) was observed in the control (T₀).

Benefit cost ratio per sack

The average benefit cost ratio of Kalmi Shak was significant among the levels manure used per sack and (Table 1). The highest benefit cost ratio per sack (1.62) was found in T₁, where soil (%): organic matter (%), 25: 75 of recommended dose was used and the lowest benefit cost ratio (1.36) was observed in T₀, where no organic matter was used.

2. Helencha (*Enhydra fluctuans*)

Yield per sack

The average yield of Helencha Shak was varied significantly among the levels manure used per sack (Table 2). The highest yield of per sack (7.76 kg) was found in T₁, where soil (%): organic matter (%), 25: 75 was used followed by T₂ (6.32 kg), where 50 % organic matter +50% soil was used per sack. The lowest yield (4.07 Kg/Sack) was recorded from the control (T₀).

Cost of production per sack

The average cost of production of Helencha Shak was not varied significantly among the levels manure used per sack (Table 2). However, numerically the highest cost of production of per sack (200 BDT/sack) was found in when T₁ and the lowest cost of production (125 BDT) was recorded from the control (T₀).

Table 2. Impact of growing media containing different levels of soil and organic matters on yield and profitability of Helencha Shak in sack

| Treatment | Yield sack ⁻¹ | Cost sack ⁻¹ | Gross income sack ⁻¹ | Net Income sack ⁻¹ | BCR sack ⁻¹ |
|----------------|--------------------------|-------------------------|---------------------------------|-------------------------------|------------------------|
| T ₀ | 4.07d | 125d | 162.67d | 37.67c | 1.30c |
| T ₁ | 7.76a | 200a | 310.53a | 110.53a | 1.55a |
| T ₂ | 6.32b | 175b | 252.67b | 77.67b | 1.44b |
| T ₃ | 4.87c | 150c | 194.67c | 44.67c | 1.30c |
| LS | ** | ** | ** | ** | ** |
| LSD | 0.28 | 1.5 | 11.23 | 11.23 | 0.071 |

Note: T₀= Control (no organic matter), T₁ = 75% organic matter+ 25 % soil, T₂ = 50 % organic matter + 50% soil, T₃ = 25% organic matter+ 75 % soil. LS=Level of Significance LSD = Least Significant Difference. Data in a column with same letter do not differ significantly and data with different letter differ significantly. **= Significant at 1% levels. NS= Not significant

Gross income per sack

The average gross income of Helencha Shak was varied significantly among the levels manure and fertilizer combination used per sack (Table 2). The highest gross income per sack (310.53 BDT) was found in T₁, where soil (%): organic matter (%), 25: 75 was used followed by T₂ (252.67 BDT), where soil (%): organic matter (%), 50: 50 was used. The lowest gross income (162.67 BDT/sack) was recorded from the control (T₀) where no organic matter was used.

Net income per sack

The average net income of Helencha Shak was varied significantly among the levels of manure used per sack (Table 2). The highest net income per sack (110.53 BDT) was found in T₁, where soil (%): organic matter (%), 25: 75 was used followed by T₂ (77.67 BDT) where soil: organic matter, 50:50 was used. The lowest net income (37.67 BDT) was observed in the control (T₀) where no organic matter was used.

Benefit cost ratio per sack

The average benefit cost ratio of Helencha Shak was significant among the levels manure used per sack (Table 2). The highest benefit cost ratio per sack (1.55) was found in T₁, where soil (%): organic matter (%), 25: 75 of recommended dose was used followed by T₂ (1.44) where soil: organic matter, 50:50 was used and the lowest benefit cost ratio (1.30) was observed in T₀.

3. Malancha Shak (*Jussiaea repens*)

Yield per sack

The average yield of Malancha Shakwas varied significantly among the levels manure used per sack (Table 3). The highest yield of per sack (6.70 kg/Sack) was found in T₁, where soil (%): organic matter (%), 25: 75 was used followed by T₂ (5.52 kg), where 50 % organic matter +50% soil was used per sack. The lowest yield (4.17 Kg/Sack) was recorded from the control (T₀) where no organic matter was used.

Cost of production per sack

The average cost of production of Malancha Shakwas not varied significantly among the levels manure used per sack (Table 3). However, numerically the highest cost of production of per sack (200 BDT/sack) was found in when T₁ and the lowest cost of production (125 BDT/Sack) was recorded from the control (T₀).

Gross income per sack

The average gross income of Malancha Shakwas varied significantly among the levels manure and fertilizer combination used per sack (Table 3). The highest gross income per sack (268.00 BDT/Sack) was found in T₁ followed by T₂ (220.80 BDT/sack). The lowest gross income (166.67 BDT/sack) was recorded from the control (T₀).

Table 3 Impact of growing media containing different levels of soil and organic matters on yield and profitability of Malancha Shak in sack

| Treatment | Yield sack ⁻¹ (Kg) | Cost sack ⁻¹ (Taka) | Gross income sack ⁻¹ | Net Income sack ⁻¹ (Taka) | BCR sack ⁻¹ |
|----------------|----------------------------------|-----------------------------------|------------------------------------|---|------------------------|
| T ₀ | 4.17d | 125d | 166.67d | 41.67d | 1.033a |
| T ₁ | 6.70a | 200a | 268.00a | 68.00a | 1.34a |
| T ₂ | 5.52b | 175b | 220.80b | 45.80b | 1.26b |
| T ₃ | 4.50c | 150c | 180.00c | 30.00c | 1.20b |
| LS | ** | ** | ** | ** | ** |
| LSD | 0.29 | 1.5 | 11.42 | 11.42 | 0.069 |

Note: T₀= Control (no organic matter), T₁ = 75% organic matter+ 25 % soil, T₂ = 50 % organic matter + 50% soil, T₃ = 25% organic matter+ 75 % soil. LS=Level of Significance LSD = Least Significant Difference. Data in a column with same letter do not differ significantly and data with different letter differ significantly. **= Significant at 1% levels. NS= Not significant

Net income per sack

The average net income of Malancha Shakwas varied significantly among the levels of manure used per sack (Table 3). The highest net income per sack (68.00 BDT/Sack) was found in T₁ followed by T₂ (45.80 BDT/Sack). The lowest net income (41.67 BDT) was observed in the control (T₀) where no organic matter was used.

Benefit cost ratio per sack

The average benefit cost ratio of Malancha Shakwas significant among the levels manure used per sack (Table 3). The highest benefit cost ratio per sack (1.34) was found in T₁, where soil (%): organic matter (%), 25: 75 of recommended dose was used and the lowest benefit cost ratio (1.20) was observed in T₃, where 25% organic matter was used.

4. Comparison of average yields and profitability of different treatments

Yield per sack

The comparative average yield of the vegetable crops used in the experiment was varied significantly (Table. 4). The highest yield of per sack (7.0 kg) was found in T₁ followed by T₂ (5.7 kg/sack). The lowest yield was recorded from T₀ (3.9 Kg/sack).

Cost of production per sack

The average cost of production varied considerably among the sack (Table 4). The highest production cost (200 BDT/bag) was for T₁ and the lowest production cost (125 BDT/bag) was for the control group (T₀) where no organic matter was used.

Table 4. Comparative yield and profitability of the treatments

| Treatment | Yield sack ⁻¹ (Kg) | Cost sack ⁻¹ (Taka) | Gross income sack ⁻¹ | Net income sack ⁻¹ (Taka) | BCR sack ⁻¹ |
|----------------|----------------------------------|-----------------------------------|------------------------------------|---|------------------------|
| T ₀ | 3.9d | 125d | 166.45d | 41.45c | 1.23d |
| T ₁ | 7.0a | 200a | 301.18a | 101.18a | 1.51a |
| T ₂ | 5.7b | 175b | 246.16b | 71.16b | 1.40b |
| T ₃ | 4.5c | 150c | 195.45c | 45.45c | 1.30c |
| LS | ** | ** | ** | ** | ** |
| LSD | 0.38 | 1.5 | 24.42 | 24.42 | 0.089 |

Note: T₀= Control (no organic matter), T₁ = 75% organic matter+ 25 % soil, T₂ = 50 % organic matter + 50% soil, T₃ = 25% Organic matter+ 75 % soil. LS=Level of Significance LSD = Least Significant Difference. Data in a column with same letter do not differ significantly and data with different letter differ significantly. **= Significant at 1% levels.

Gross income per sack

There was significant variation among the treatments in respect of gross income of per sack (Table 4). The highest gross income per sack (301.18 BDT/sack) was observed in by T₂ (246.16 BDT/sack). The lowest gross income (166.45 BDT/sack) was recorded from T₀.

Net income per sack

Significant variation was observed in respect of net income of per sack (Table 4). The highest net income (101.18 BDT/sack) was observed in T₁ followed by T₂ (71.16 BDT/sack). The lowest net income (41.45 BDT/sack) was recorded from the Treatment T₀

Benefit Cost Ratio (BCR) per sack

The highest benefit cost ratio was obtained from T₁ (1.51) followed by T₂ (1.40) and that was lowest in T₀ (1.23).

5. Comparison of average yields and profitability of different vegetable crops

Yield per sack

The comparative average yield of the vegetable crops used in the experiment was varied significantly (Table. 5). The highest yield of per sack (5.76 kg) was found in the Helencha Shak followed by Malancha Shak (5.22 kg/sack). The lowest yield was recorded from Kalmi Shak (4.86 Kg/sack).

Cost of Production per sack

The cost of production was not varied among the vegetables. In all the vegetable crops the average cost was same, which was BDT 162.50/sack.

Gross income per sack

There was significant variation among vegetable crops in respect of gross income of per sack (Table 5). The highest gross income per sack (242.92 BDT/sack) was observed in Kalmi Shak followed by helencha Shak (230.14 BDT/sack). The lowest gross income (208.87 BDT/sack) was recorded from MalanchaShak.

Net income per sack

There was significant variation among vegetable crops in respect of net income of per sack (Table 5). The highest net income (80.42 BDT/sack) was observed in KalmiShak followed by

HelenchaShak (67.64 BDT/sack). The lowest net income (46.37 BDT/sack) was recorded from the MalanchaShak. The average sale price of all the vegetables crops was the same.

Table 5. Comparative yield and profitability of the three indigenous vegetables

| Vegetables | Yield sack ⁻¹ (Kg) | Average Cost sack ⁻¹ (BDT) | Gross income sack ⁻¹ (BDT) | Net Income sack ⁻¹ (BDT) | BCR sack ⁻¹ |
|---------------|----------------------------------|--|--|--|---------------------------|
| Kalmi Shak | 4.86c | 162.50 | 242.92a | 80.42b | 1.48b |
| Helencha Shak | 5.76a | 162.50 | 230.14b | 67.64a | 1.40a |
| Malancha Shak | 5.22b | 162.50 | 208.87c | 46.37b | 1.21b |
| LS | ** | NS | ** | ** | ** |
| LSD | 0.99 | - | 39.94 | 39.34 | 0.16 |

Data in a column with same letter do not differ significantly and data with different letter differ significantly. NS= Not significant. **= Significant at 1% level. LS=Level of Significance

Benefit Cost Ratio (BCR) per sack

The benefit cost ratio was significantly different among the vegetable crops (Table 5). The highest benefit cost ratio per sack was obtained from Kalmi Shak (1.48) followed by Helencha Shak (1.40) and Malancha Shak (1.21).

Discussion

The maximum yields, gross and net income and BCR were recorded from the T₁ (50 % Organic matter + 50% soil was used) followed by T₂ (50 % Organic matter + 50% soil). In the higher levels of organic matter provided more nutrient supply to the crop. So, the yield was higher. Organic matter generally improves soil quality in terms of various parameters such as physical, chemical and biological properties, macro- and micro-nutrient availability, indicating improved soil health (Singh et al., 2019). So, the yield, gross and net income was increased. BCR is also high when net income increases. On the other hand, T₀= Control (no organic matter) had comparatively low yield. Organic matter increases the average yield on an about 70% to 80% compared to control (without organic matter).

The average sale price of all the vegetables crops was the same. So, due to higher yield in Helencha Shak gave the higher gross income. Helencha Shak produced more larger-sized branches and leaves, which added to the overall weight. Various factors, including species, cultivar, agronomic factors and climatic factors influenced the growth and yield (Khan et al., 2022; Naafe et al., 2022 and Haque et al., 2022). The Helencha Shak had the best yield per sack followed by the Malancha and Kalmi Shak.

Conclusion

The commercial cultivation of selected indigenous marshy vegetables in waterlogged condition are prospective and profitable. The maximum yields, gross and net income and BCR were recorded from the T₁ (50 % organic matter + 50% soil was used). In the comparative analysis of the three vegetables Helencha Shak gave the highest performance in respect of all the parameter studied followed by Malancha Shak and Kalmi Shak.

Recommendation

The experiments were conducted in Shyamnagar Upazila of Satkhira district only. Similar experiments could be conducted in the other areas of the region and the country for final recommendation.

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