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

Shamima Nasrin [a++*], Md. Abdul Mannan [b#], Sabiha Sultana [b#], Rebaka Sultana [c], Kamiliya Kader [a†] and Nargis Parvin [d++]

[a] *Bangladesh Jute Research Institute (BJRI), Dhaka-1207, Bangladesh.*
[b] *Agrotechnology Discipline, Khulna University, Khulna-9208, Bangladesh.*
[c] *Department of Horticulture, Sher-e Bangla Agricultural University, Dhaka-1207, Bangladesh.*
[d] *Bangladesh Rice Research Institute (BRRI), Bangladesh.*

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

A study on the prospect and profitability of indigenous vegetables (Kalmi, Helencha and Malancha Shak) was conducted in Shyamnagar Upazila of Satkhira district in waterlogged conditions from September 2020 to May 2021. In the study, three indigenous vegetables (*Ipomoea aquatica*, *Enhydra fluctuans* and *Jussiaea repens*) were tested with four levels of growing media viz., T_0,

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++ *Senior Scientific Officer;*
\# *Professor;*
† *Scientific Officer;*
**Corresponding author: Email: shamimakbd.seema@gmail.com;*

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control (no organic matter); T_1, 75% organic matter+ 25 % soil; T_2, 50 % organic matter +50% soil; T_3, 25% organic matter+ 75% soil. Results show a 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. In the 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.

Keywords: Organic matter; indigenous vegetables; food crops; waterlogged.

1. INTRODUCTION

Vegetables are considered one of the most important food crops due to their high nutritive value, relatively higher yield, and economic returns. In addition to its nutritional value, it lowers poverty in developing nations like Bangladesh by creating jobs and raising incomes [1]. 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 [2,3,4,5]. Approximately 8,000 hectares of flooded land in the district regions of Khulna and Jessore, Bangladesh. There are several reasons for the growing flood zones on the South West coast, including siltation of rivers, insufficient dredging and extreme weather [6] Waterlogging currently affects about 5% of Bangladesh's entire land area [7]. The Bangladesh Department of Forestry predicts that by 2100, it will rise to 14% [8].

Sack farming makes it possible for people to cultivate food in waterlogged areas with little water and have little access to excellent soil. In areas with limited access to arable land and water, 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 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 [9].

Thus, growing vegetables in sacks solves the problems of wetland, 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 contains small amounts of organic matter is more effective in boosting crop production. It improves soil quality, maintains crop yields and increases the nutrient content of vegetables [10,11,12]. These fertilizers are effective in promoting vegetable growth, preventing pests and diseases, and improving vegetable yield and quality [13].

So, in the current situation, importance is given to the cultivation of vegetables in Sacks in waterlogged conditions as an alternative way of vegetable cultivation in this region [14,15,16]. This study aimed to determine the growth performance, yield and profitability of growing indigenous vegetables under the influence of organic matter in the waterlogged of southwestern Bangladesh.

2. MATERIALS 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 conditions in southwest Bangladesh. The experiments were laid out in a Completely Randomized Design (CRD) with five replications. The three indigenous vegetables were used panting materials which were collected from different areas of southwest Bangladesh.

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 × 60 com (sacks).

List 1. List of Factor A and Factor B for growing media

Sl.	Factor A: Three indigenous vegetables	Factor B: 4 levels of growing media
1.	Kalmi shak (*Ipomoea aquatica*)	T0= Control (no organic matter),
2.	Helencha (*Enhydra fluctuans*)	T1 = 75% organic matter + 25% soil
3.	Malancha (*Jussiaea repens*)	T2 = 50% organic matter + 50% soil
4.		T3 = 25% organic matter + 75% soil

These hollow open-end cylindrical mesh bags were fixed vertically on fertilized puddled soil and were kept stretched around its periphery by inserting 3-4 tough dry bamboo sticks (90 cm length) and a few strong bamboo pegs along its inner walls, which acted as pillars [17-20]. The bamboo sticks and bamboo pegs were inserted 15 cm into the soil for the firmness of the column. Gunny bag-reinforced soil columns were tied with pillars using jute threads/plastic rope outwardly in a circular fashion. The soil columns were left as such for fifteen days for drainage of excess water from the soil column.

After that, vegetable 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 attacks [21,22,23]. Data was collected on yield, and profitability (Cost of production, Gross Return, net return and Benefit-cost ratio).

2.1 Data analysis

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

3. 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.

3.1 Kalmi Shak (*Ipomoea aquatica*)

Yield per sack: The average yield of Kalmi Shak varied significantly among the levels of manure used per sack (Table 1). The highest yield per sack (6.70 kg) was found in T_1 where soil (%): organic matter (%), 25: 75 was used followed by T_2 (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 (T_0) where no organic matter was used [24,25].

Cost of production per sack: The average cost of production of Kalmi Shak did not vary significantly among the levels of manure used per sack (Table 1). However, numerically the highest cost of production per sack (200 BDT/sack) was found T_1 and the lowest cost of production (125 BDT/sack) was recorded from the control (T_0).

Gross income per sack: The average gross income of Kalmi Shak varied significantly among the levels of manure used per sack (Table 1). The highest gross income per sack (325.00 BDT/Sack) was found in T_1, where soil (%): organic matter (%), 25: 75 was used followed by T_2 (265.00 BDT), where soil (%): organic matter (%), 50: 50 was used. The lowest gross income (170.00 BDT) was recorded from the control (T_0).

Net income per sack: The average net income of Kalmi Shak varied significantly among the levels of manure used per sack (Table 1). The highest net income per sack (125.00 BDT) was found in T_1, where soil (%): organic matter (%), 25: 75 was used followed by T_2 (90.00 BDT) where soil: organic matter, 50:50 was used. The lowest net income (45.00 BDT) was observed in the control (T_0).

Benefit-cost ratio per sack: The average benefit-cost ratio of Kalmi Shak was significant among the levels of manure used per sack and (Table 1). The highest benefit-cost ratio per sack (1.62) was found in T_1, where soil (%): organic matter (%), 25: 75 of the recommended dose was used and the lowest benefit-cost ratio (1.36) was observed in T_0, where no organic matter was used.

3.2 Helencha (*Enhydra fluctuans*)

Yield per sack: The average yield of Helencha Shak varied significantly among the levels of manure used per sack (Table 2). The highest yield per sack (7.76 kg) was found in T_1, where soil (%): organic matter (%), 25: 75 was used

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: T_0= Control (no organic matter), T_1 = 75% organic matter + 25 % soil, T_2 = 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 letters differ significantly. **= Significant at 1% levels. * = Significant at 5% level, NS= Not significant*

followed by T_2 (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 (T_0).

Cost of production per sack: The average cost of production of Helencha Shak did not vary significantly among the levels of manure used per sack (Table 2). However, numerically the highest cost of production per sack (200 BDT/sack) was found in when T_1 and the lowest cost of production (125 BDT) was recorded from the control (T_0).

Gross income per sack: The average gross income of Helencha Shak varied significantly among the levels of manure and fertilizer combination used per sack (Table 2). The highest gross income per sack (310.53 BDT) was found in T_1, where soil (%): organic matter (%), 25: 75 was used followed by T_2 (252.67 BDT), where soil (%): organic matter (%), 50:50 was used. The lowest gross income (162.67 BDT/sack) was recorded from the control (T_0) where no organic matter was used.

Net income per sack: The average net income of Helencha Shak varied significantly among the levels of manure used per sack (Table 2). The highest net income per sack (110.53 BDT) was found in T_1, where soil (%): organic matter (%), 25: 75 was used followed by T_2 (77.67 BDT) where soil: organic matter, 50:50 was used. The lowest net income (37.67 BDT) was observed in the control (T_0) where no organic matter was used.

Benefit-cost ratio per sack: The average benefit-cost ratio of Helencha Shak was significant among the levels of manure used per sack (Table 2). The highest benefit-cost ratio per sack (1.55) was found in T_1, where soil (%): organic matter (%), 25: 75 of the recommended dose was used followed by T_2 (1.44) where soil: organic matter, 50:50 was used and the lowest benefit-cost ratio (1.30) was observed in T_0.

3.3 Malancha Shak (*Jussiaea repens*)

Yield per sack: The average yield of Malancha Shakwas varied significantly among the levels of manure used per sack (Table 3). The highest

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: T_0= Control (no organic matter), T_1 = 75% organic matter+ 25 % soil, T_2 = 50 % organic matter + 50% soil, T3 = 25% organic matter+ 75 % soil. Level of Significance LSD = Least Significant Difference. Data in a column with the same letter do not differ significantly and data with different letters differ significantly. **= Significant at 1% levels. NS= Not significant* yield per sack (6.70 kg/Sack) was found in T_1, where soil (%): organic matter (%), 25: 75 was used followed by T_2 (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 (T_0) where no organic matter was used.

Cost of production per sack: The average cost of production of Malancha Shakwas did not vary significantly among the levels of manure used per sack (Table 3). However, numerically the highest cost of production per sack (200 BDT/sack) was found in when T_1 and the lowest cost of production (125 BDT/Sack) was recorded from the control (T_0).

Gross income per sack: The average gross income of Malancha Shak varied significantly among the levels of manure and fertilizer combination used per sack (Table 3). The highest gross income per sack (268.00 BDT/Sack) was found in T_1 followed by T_2 (220.80 BDT/sack). The lowest gross income (166.67 BDT/sack) was recorded from the control (T_0).

Net income per sack: The average net income of Malancha Shak 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 T_1 followed by T_2 (45.80 BDT/Sack). The lowest net income (41.67 BDT) was observed in the control (T_0) where no organic matter was used.

Benefit-cost ratio per sack: The average benefit-cost ratio of Malancha Shak was significant among the levels of manure used per sack (Table 3). The highest benefit-cost ratio per sack (1.34) was found in T_1, where soil (%): organic matter (%), 25:75 of the recommended dose was used and the lowest benefit-cost ratio (1.20) was observed in T_3, where 25% organic matter was used.

3.4 Comparison of Average Yields and Profitability of Different Treatments

Yield per sack: The comparative average yield of the vegetable crops used in the experiment varied significantly (Table 4). The highest yield per sack (7.0 kg) was found in T_1 followed by T_2 (5.7 kg/sack). The lowest yield was recorded from T_0 (3.9 kg/sack).

Cost of production per sack: The average cost of production varied considerably among the sacks (Table 4). The highest production cost (200 BDT/bag) was for T_1 and the lowest production cost (125 BDT/bag) was for the control group (T_0) where no organic matter was used.

Gross income per sack: There was significant variation among the treatments in respect of gross income per sack (Table 4). The highest gross income per sack (301.18 BDT/sack) was observed in T_2 (246.16 BDT/sack). The lowest gross income (166.45 BDT/sack) was recorded from T_0.

Net income per sack: Significant variation was observed in respect of net income per sack (Table 4). The highest net income (101.18 BDT/sack was observed in T_1 followed by T_2 (71.16 BDT/sack). The lowest net income (41.45 BDT/sack) was recorded from the Treatment T_0

Benefit Cost Ratio (BCR) per sack: The highest benefit-cost ratio was obtained from T_1 (1.51) followed by T_2 (1.40) and that was lowest in T_0 (1.23).

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: T_0= Control (no organic matter), T_1 = 75% organic matter+ 25 % soil, T_2 = 50 % organic matter + 50% soil, T3 = 25% organic matter+ 75 % soil. Level of Significance LSD = Least Significant Difference. Data in a column with same letter do not differ significantly and data with different letters differ significantly.
***= Significant at 1% levels. NS= Not significant*

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: T_0= Control (no organic matter), T_1 = 75% organic matter+ 25 % soil, T_2 = 50 % organic matter + 50% soil, T_3 = 25% Organic matter+ 75 % soil. Level of Significance LSD = Least Significant Difference. Data in a column with same letter do not differ significantly and data with different letters differ significantly.
***= Significant at 1% levels.*

3.5 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 varied significantly (Table. 5). The highest yield 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 Malancha Shak.

Net income per sack: There was significant variation among vegetable crops in respect of net income per sack (Table 5). The highest net income (80.42 BDT/sack was observed in Kalmi Shak followed by Helencha Shak (67.64 BDT/sack). The lowest net income (46.37 BDT/sack) was recorded from the Malancha Shak. The average sale price of all the vegetable crops was the same.

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).

3.6 Discussion

The maximum yields, gross and net income and BCR were recorded from T_1 (50% Organic matter + 50% soil was used) followed by T_2 (50 % Organic matter + 50% soil). The higher levels of organic matter provided more nutrient supply to the crop. So, the yield was higher [26,27]. Organic matter generally improves soil quality in terms of various parameters such as physical, chemical and biological properties, and macro- and micro-nutrient availability, indicating improved soil health [28]. So, the yield, gross and net income were increased. BCR is also high when net income increases. On the other hand,

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 letters differ significantly.
*NS= Not significant. **= Significant at 1% level. LS=Level of Significance*

T_0= Control (no organic matter) had a comparatively low yield. Organic matter increases the average yield by about 70% to 80% compared to control (without organic matter).

The average sale price of all the vegetable crops was the same. So, due to higher yield, Helencha Shak gave a higher gross income. Helencha Shak produced 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 [29,30,31]. The Helencha Shak had the best yield per sack followed by the Malancha and Kalmi Shak.

4. CONCLUSION

The commercial cultivation of selected indigenous marshy vegetables in waterlogged conditions is prospective and profitable. The maximum yields, gross return, net return and BCR were recorded from the T_1 (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 parameters studied followed by Malancha Shak and Kalmi Shak.

5. 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.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Authors are fully responsible for the originality, validity, and integrity of the content. We must ensure it complies with all Asian Journal of Soil Science and Plant Nutrition's publication ethics policies.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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