Asian Journal of Advances in Agricultural Research

18(1): 9-21, 2022; Article no.AJAAR.85230
ISSN: 2456-8864

Organic Amendments Influence the Yield of Vegetables and Soil Properties at Charlands in Bangladesh

Md. Safiul Islam Afrad [a*#], G. K. M. Mustafizur Rahman [b#], Mohammad Saiful Alam [b#], Md. Zulfiker Ali [a†] and Aliyu Akilu Barau [c#]

[a] Department of Agricultural Extension and Rural Development, Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Gazipur-1706, Bangladesh.
[b] Department of Soil Science, Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Gazipur-1706, Bangladesh.
[c] Department of Agricultural Extension and Rural development, Usmanu Danfodiyo University, Sokoto, Nigeria.

Authors' contributions

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

Article Information

DOI: 10.9734/AJAAR/2022/v18i130208

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/85230

Original Research Article

Received 13 March 2021
Accepted 22 March 2022
Published 08 April 2022

ABSTRACT

The field experiment was conducted in the Charlands of Bangladesh during November 2021 to March 2022 to find the crop production and soil properties status. A randomized complete block design was followed with six treatments and three replications. The organic amendments were quick compost, standard organic fertilizers, poultry manure and biochar @ 3t/ha. A positive change was found for the application of manures compared to control plot with the crop production and soil fertility status from our experimental findings. The yield per plant of pumpkin was ranged from 27.24 to 85.61 kg and BCR 1.06 to 3.40. The fresh tuber yield of sweet potato was varied from 39.29 to 94.00 t/ha and BCR 1.20 to 3.54. Soil pH was varying from 6.74 to 7.36, OC from 0.69 to 1.82%, total N from 0.074 to 0.145%, available P from 7.49 to 17.66mg/kg, available S from 9.55 to 17.81mg/kg and Zn from 0.536 to 1.134mg/kg. Biochar treated plot showed the best result compered to others. Organic amendments should be recommended in the farmer's field for better crop production and soil fertility status.

[#]Professor;
[†]Scientific Officer;
**Corresponding author: Email: afrad@bsmrau.edu.bd;*

Keywords: Charlands; organic amendments; soil nutrient status and crop yields.

1. INTRODUCTION

The fertility and productivity of the Charlands are very low as compared to other areas [1,2]. Five percent people of Bangladesh live in Charlands [3]. The poorest people live in this vulnerable area [4]. Agriculture is the main occupation of the Charlands people [5]. The soil fertility have always changed due to frequent floods [6]. About ten million people who have the agricultural work in this area [7,8]. For increasing soil nutrient availability most farmers use organic amendments in their cropland field [9-11]. To reduce soil and environment pollution organic amendment with minimum amount of chemical fertilizers can be used [12-15]. Thus, the use of organic materials might be effective to enhance the soil fertility of the charlands. Organic amendments increase the availability of plant nutrient and release slowly [16-18]. The organic amendment biochar increase the most of the soil properties [19]. Soil physicochemical properties are positively improve by the application of organic amendments [20,21]. Crop production can be increased by the help of organic amendments [22,23]. The organic amendment biochar contains high amount of carbon [24,25]. Biochar has a significant influence on soil properties and production of crops [26-29]. Soil physico-chemical properties are improved by the use of biochar with half of chemical fertilizers [30]. Combined use of organic and inorganic manures helps in increasing efficiency of soil nutrient availability [1,31]. Due to the poor soil fertility status of the charlands of Bangladesh, it is crucial to apply available organic materials in combination with synthetic chemical fertilizers for better agricultural production and soil fertility improvement. We conducted the experiment to find out the organic amendments effect on the crop production and soil properties status at the Charlands in Bangladesh.

2. MATERIALS AND METHODS

The location of the experiments were in the Charlands of three districts of Bangladesh such as Char Shaluka, Naobhangar Char and Maijbari Char. The duration was from November 2021 to March 2022. The soil samples were collected from two depth and studied in the laboratory of the Department of Soil Science of Bangabandhu Sheikh Mujibur Rahman Agricultural University. The soil pH was determined by using a digital pH meter potentiometrically in soil to water ratio of 1:2.5 [32]. The organic carbon was measured by the wet oxidation method [32]. The total nitrogen was obtained by the micro Kjeldahl technique [33]. The available P was determined by the Olsen method [34]. The available S was measured by turbidity method using $BaCl_2$ [35]. The available Zn was determined by the DTPA method [36]. A randomized complete block design was followed with six treatments and three replications. The treatments were T_1 (Farmers' practice as control), T_2 (Recommended fertilizer with vermicompost @ 3t/ha), T_3 (Recommended fertilizer with quick compost @ 3t/ha), T_4 (Recommended fertilizer with standard organic fertilizers @ 3t/ha), T_5 (Recommended fertilizer with Poultry Manure @ 3t/ha) and T_6 (Recommended fertilizer with biochar @ 3t/ha). The fertilizer recommendation guide of the Bangladesh Agricultural Research Council was followed for application of required fertilizers [37]. The computer package STATISTICS 10 were used for the measurement of data. The mean differences of the treatments were determined from the least significant difference (LSD) test at 5% level of probability [38].

3. RESULTS AND DISCUSSION

3.1 Results of Pumpkin at the Charlands

3.1.1 The average fruit weight of pumpkin at the Charlands

A significant variation was found of the average fruit weight at the Charlands (Table 1). In Char Shaluka, the average fruit weight were ranged from 3.72 to 6.15kg. In Naobhangar Char, the average fruit weight were varied from 3.80 to 6.25kg. In Maijbari Char, the average fruit weight were ranged from 3.46 to 6.28kg.

3.1.2 The fresh fruit yield per plant of pumpkin at the Charlands

A positive variation was found to the fruit yield per plant at the Charlands (Table 2). In Char Shaluka, the fruit yield per plant ranged from 35.08 to 81.41kg. In Naobhangar Char, the fruit yield per plant ranged from 32.33 to 85.61kg. In Maijbari Char, the fruit yield per plant ranged from 27.24 to 80.45kg.

3.1.3 The total income of pumpkin at the Charlands

A significant variation was found to the total income at the Charlands (Table 3). In Char

Shaluka, the total income ranged from 526217.00 to 1220000.00tk/ha. In Naobhangar Char, the total income ranged from 484971.00 to 1280000.00tk/ha. In Maijbari Char, the total income ranged from 408599.00 to 1210000.00tk/ha.

3.1.4 The total cost of pumpkin at the Charlands

A variation was showed to the total cost at the Charlands (Table 4). In the Charlands, the total cost was varied from 369233.32 to 385559.00 tk/ha.

3.1.5 The Benefit Cost Ratio (BCR) of pumpkin at the Charlands

A significant variation was found to BCR at the Charlands (Table 5). In Char Shaluka, the BCR ranged from 1.37 to 3.23. In Naobhangar Char, the BCR ranged from 1.26 to 3.40. In Maijbari Char, the BCR ranged from 1.06 to 3.19.

3.2 Results of the sweet potato at the Charlands

3.2.1 The number of tuberous roots per plant of sweet potato at the Charlands

A significant variation was obtained from number of tubers roots per plant at the Charlands (Table 6). In Char Shaluka, the number of tubers roots per plant ranged from 32.91 to 54.68. In Naobhangar Char, the number of tubers roots per plant ranged from 33.49 to 53.25. In Maijbari Char, the number of tubers roots per plant ranged from 32.63 to 54.05.

Table 1. Effects of different organic manures for pit experiments with average fruit weight of pumpkin at the Charlands

Treatments	Average fruit weight (kg)		
	Char Shaluka	Naobhangar Char	Maijbari Char
T_1	3.72d	3.80e	3.46d
T_2	5.44c	5.58c	5.61b
T_3	5.34c	5.25d	5.29c
T_4	5.85b	5.99b	5.49bc
T_5	5.96ab	6.06b	6.10a
T_6	6.15a	6.25a	6.28a
CV (%)	2.12	1.79	2.38
SE (±)	0.09	0.08	0.10

T1 (Farmers' practice as control), T2 (Recommended fertilizer with vermicompost @ 3t/ha), T3 (Recommended fertilizer with quick compost @ 3t/ha), T4 (Recommended fertilizer with standard organic fertilizers @ 3t/ha), T5 (Recommended fertilizer with Poultry Manure @ 3t/ha) and T6 (Recommended fertilizer with biochar @ 3t/ha), CV (Co-efficient of Variation), SE (Standard Error for Comparison).

Table 2. Effects of different organic manures for pit experiments with fresh fruit yield per plant of pumpkin at the Charlands

Treatments	Fresh fruit yield per plant (kg)		
	Char Shaluka	Naobhangar Char	Maijbari Char
T_1	35.08d	32.33d	27.24d
T_2	64.55c	67.25bc	65.83bc
T_3	65.72bc	63.73c	69.77abc
T_4	70.67bc	70.34bc	62.67c
T_5	72.84b	73.91b	77.03ab
T_6	81.41a	85.61a	80.45a
CV (%)	6.67	8.33	12.34
SE (±)	3.54	4.46	6.43

T1 (Farmers' practice as control), T2 (Recommended fertilizer with vermicompost @ 3t/ha), T3 (Recommended fertilizer with quick compost @ 3t/ha), T4 (Recommended fertilizer with standard organic fertilizers @ 3t/ha), T5 (Recommended fertilizer with Poultry Manure @ 3t/ha) and T6 (Recommended fertilizer with biochar @ 3t/ha), CV (Co-efficient of Variation), SE (Standard Error for Comparison).

Table 3. Effects of different organic manures for pit experiments with total income (tk/ha) of pumpkin at the Charlands

Treatments	Total income (tk/ha)		
	Char Shaluka	Naobhangar Char	Maijbari Char
T_1	526217.00d	484971.00d	408599.00d
T_2	968229.00c	1010000.00bc	987426.00bc
T_3	985732.00bc	955960.00c	1050000.00abc
T_4	1060000.00bc	1060000.00bc	940022.00c
T_5	1090000.00b	1110000.00b	1160000.00ab
T_6	1220000.00a	1280000.00a	1210000.00a
CV (%)	6.67	8.33	12.34
SE (±)	53124.00	66854.00	96477.00

T1 (Farmers' practice as control), T2 (Recommended fertilizer with vermicompost @ 3t/ha), T3 (Recommended fertilizer with quick compost @ 3t/ha), T4 (Recommended fertilizer with standard organic fertilizers @ 3t/ha), T5 (Recommended fertilizer with Poultry Manure @ 3t/ha) and T6 (Recommended fertilizer with biochar @ 3t/ha), CV (Co-efficient of Variation), SE (Standard Error for Comparison).

Table 4. Effects of different organic manures for pit experiments with Total cost (tk/ha) of pumpkin at the Charlands

Treatments	Total cost (tk/ha) at the Charlands
T_1	385559.00
T_2	369233.32
T_3	375233.32
T_4	378233.32
T_5	369233.32
T_6	378233.32

T1 (Farmers' practice as control), T2 (Recommended fertilizer with vermicompost @ 3t/ha), T3 (Recommended fertilizer with quick compost @ 3t/ha), T4 (Recommended fertilizer with standard organic fertilizers @ 3t/ha), T5 (Recommended fertilizer with Poultry Manure @ 3t/ha) and T6 (Recommended fertilizer with biochar @ 3t/ha).

Table 5. Effects of different organic manures for pit experiments with BCR (total cost basis) of pumpkin at the Charlands

Treatments	BCR (Total cost basis)		
	Char Shaluka	Naobhangar Char	Maijbari Char
T_1	1.37d	1.26d	1.06c
T_2	2.63c	2.73bc	2.67ab
T_3	2.63c	2.54c	2.79ab
T_4	2.80bc	2.79bc	2.49b
T_5	2.96ab	3.00ab	3.13a
T_6	3.23a	3.40a	3.19a
CV (%)	6.68	8.31	12.34
SE (±)	0.14	0.18	0.26

T1 (Farmers' practice as control), T2 (Recommended fertilizer with vermicompost @ 3t/ha), T3 (Recommended fertilizer with quick compost @ 3t/ha), T4 (Recommended fertilizer with standard organic fertilizers @ 3t/ha), T5 (Recommended fertilizer with Poultry Manure @ 3t/ha) and T6 (Recommended fertilizer with biochar @ 3t/ha), CV (Co-efficient of Variation), SE (Standard Error for Comparison)

3.2.2 The fresh yield of biomass of sweet potato at the Charlands

A positive change was found in the fresh yield of biomass at the Charlands (Table 7). In Char Shaluka, the fresh yield of biomass ranged from 21.46 to 41.65 t/ha. In Naobhangar Char, the fresh yield of biomass ranged from 22.25 to 42.27 t/ha. In Maijbari Char, the fresh yield of biomass ranged from 22.46 to 42.32t/ha.

3.2.3 The fresh yield of tuber of sweet potato at the Charlands

A significant variation was found to fresh yield of tuber at the Charlands (Table 8). In Char

Shaluka, the fresh yield of tuber ranged from 40.32 to 92.62t/ha. In Naobhangar Char, the fresh yield of tuber ranged from 39.74 to 91.99t/ha. In Maijbari Char, the fresh yield of tuber ranged from 39.29 to 94.00t/ha.

3.2.4 The total income of sweet potato at the Charlands

A positive effect was found to total income at the Charlands (Table 9). In Char Shaluka, the total income ranged from 604850.00 to 1390000.00tk/ha. In Naobhangar Char, the total income ranged from 596100.00 to 1380000.00tk/ha. In Maijbari Char, the total income ranged from 589400.00 to 1410000.00tk/ha.

3.2.5 The total cost at the Charlands of sweet potato at the Charlands

A variation was found to total cost at the Charlands (Table 10). In the Charlands, the total cost was varied from 391683.48 to 491559.00 tk/ha.

3.2.6 The benefit cost ratio (BCR) of sweet potato at the Charlands

A significant variation was obtained from BCR at the Charlands (Table 11). In Char Shaluka, the BCR ranged from 1.23 to 3.54. In Naobhangar Char, the BCR ranged from 1.21 to 3.51. In Maijbari Char, the BCR ranged from 1.20 to 3.52.

Table 6. Effects of different organic manures for field experiments with Number of tuberous roots per plant of sweet potato at the Charlands

Treatments	Number of tuberous roots per plant		
	Char Shaluka	Naobhangar Char	Maijbari Char
T_1	32.91c	33.49c	32.63c
T_2	47.56b	46.28b	46.64b
T_3	47.28b	46.29b	46.51b
T_4	48.57b	47.61b	48.03b
T_5	53.41a	52.92a	52.50a
T_6	54.68a	53.25a	54.05a
CV (%)	2.12	2.04	2.19
SE (±)	0.82	0.78	0.84

T1 (Farmers' practice as control), T2 (Recommended fertilizer with vermicompost @ 3t/ha), T3 (Recommended fertilizer with quick compost @ 3t/ha), T4 (Recommended fertilizer with standard organic fertilizers @ 3t/ha), T5 (Recommended fertilizer with Poultry Manure @ 3t/ha) and T6 (Recommended fertilizer with biochar @ 3t/ha), CV (Co-efficient of Variation), SE (Standard Error for Comparison)

Table 7. Effects of different organic manures for field experiments with fresh yield of biomass of sweet potato at the Charlands

Treatments	Fresh yield of biomass (t/ha)		
	Char Shaluka	Naobhangar Char	Maijbari Char
T_1	21.46d	22.25c	22.46e
T_2	35.82bc	35.02b	34.58d
T_3	37.24b	36.25b	36.83c
T_4	35.48c	34.75b	35.60cd
T_5	40.36a	41.10a	40.05b
T_6	41.65a	42.27a	42.32a
CV (%)	2.66	2.84	3.05
SE (±)	0.77	0.82	0.88

T1 (Farmers' practice as control), T2 (Recommended fertilizer with vermicompost @ 3t/ha), T3 (Recommended fertilizer with quick compost @ 3t/ha), T4 (Recommended fertilizer with standard organic fertilizers @ 3t/ha), T5 (Recommended fertilizer with Poultry Manure @ 3t/ha) and T6 (Recommended fertilizer with biochar @ 3t/ha), CV (Co-efficient of Variation), SE (Standard Error for Comparison)

3.3 Effect of Different Organic Amendment on Soil Chemical Properties in the Charlands

3.3.1 The soil pH at the Charlands

After three-year judicious application of organic fertilizers, soil pH significantly influenced by different organic matter treated treatments (Table 12). At 0-15cm soil depth, in Char Shaluka, the soil pH ranged from 7.16 to 7.36. In Naobhangar Char, the soil pH ranged from 7.19 to 7.35. In Maijbari Char, the soil pH ranged from 7.17 to 7.34. At 15-30cm soil depth, in Char Shaluka, the soil pH ranged from 6.76 to 6.96. In Naobhangar Char, the soil pH ranged from 6.74 to 6.98. In Maijbari Char, the soil pH ranged from 6.75 to 6.95.

3.3.2 The soil organic carbon at the Charlands

The OC content of the Charlands soil was significantly increased by different organic amendment treatments after three-year application (Table 13). At 0-15cm soil depth, in Char Shaluka, the soil OC was extended from 0.97 to 1.82 (%). In Naobhangar Char, the soil OC was extended from 0.97 to 1.80 (%).In Maijbari Char, the soil OC was extended from 0.94 to 1.82 (%). At 15-30cm soil depth, in Char Shaluka, the soil OC was extended from 0.69 to 1.62 (%). In Naobhangar Char, the soil OC was extended from 0.73 to 1.59 (%). In Maijbari Char, the soil OC was extended from 0.72 to 1.59 (%).

Table 8. Effects of different organic manures for field experiments with fresh yield of tuber of sweet potato at the Charlands

Treatments	Fresh yield of tuber (t/ha)		
	Char Shaluka	Naobhangar Char	Maijbari Char
T_1	40.32c	39.74c	39.29c
T_2	81.30b	80.45b	80.20b
T_3	80.92b	80.16b	80.94b
T_4	80.88b	79.65b	80.98b
T_5	92.32a	91.54a	91.96a
T_6	92.62a	91.99a	94.00a
CV (%)	2.16	2.28	2.31
SE (±)	1.37	1.44	1.47

T1 (Farmers' practice as control), T2 (Recommended fertilizer with vermicompost @ 3t/ha), T3 (Recommended fertilizer with quick compost @ 3t/ha), T4 (Recommended fertilizer with standard organic fertilizers @ 3t/ha), T5 (Recommended fertilizer with Poultry Manure @ 3t/ha) and T6 (Recommended fertilizer with biochar @ 3t/ha), CV (Co-efficient of Variation), SE (Standard Error for Comparison)

Table 9. Effects of different organic manures for field experiments with total income (tk/ha) of sweet potato at the Charlands

Treatments	Total income (tk/ha)		
	Char Shaluka	Naobhangar Char	Maijbari Char
T_1	604850.00c	596100.00c	589400.00c
T_2	1220000.00b	1210000.00b	1200000.00b
T_3	1210000.00b	1200000.00b	1210000.00b
T_4	1210000.00b	1190000.00b	1210000.00b
T_5	1380000.00a	1370000.00a	1380000.00a
T_6	1390000.00a	1380000.00a	1410000.00a
CV (%)	2.16	2.28	2.31
SE (±)	20621.00	21555.00	22032.00

T1 (Farmers' practice as control), T2 (Recommended fertilizer with vermicompost @ 3t/ha), T3 (Recommended fertilizer with quick compost @ 3t/ha), T4 (Recommended fertilizer with standard organic fertilizers @ 3t/ha), T5 (Recommended fertilizer with Poultry Manure @ 3t/ha) and T6 (Recommended fertilizer with biochar @ 3t/ha), CV (Co-efficient of Variation), SE (Standard Error for Comparison)

Table 10. Effects of different organic manures for field experiments with Total cost (tk/ha) of sweet potato at the Charlands

Treatments	Total cost (tk/ha) at the Charlands
T_1	491559.00
T_2	391683.48
T_3	397683.48
T_4	400683.48
T_5	391683.48
T_6	400683.48

T1 (Farmers' practice as control), T2 (Recommended fertilizer with vermicompost @ 3t/ha), T3 (Recommended fertilizer with quick compost @ 3t/ha), T4 (Recommended fertilizer with standard organic fertilizers @ 3t/ha), T5 (Recommended fertilizer with Poultry Manure @ 3t/ha) and T6 (Recommended fertilizer with biochar @ 3t/ha)

Table 11. Effects of different organic manures for field experiments with BCR (total cost basis) of sweet potato at the Charlands

Treatments	BCR (Total cost basis)		
	Char Shaluka	Naobhangar Char	Maijbari Char
T_1	1.23c	1.21c	1.20c
T_2	3.11b	3.08b	3.07b
T_3	3.05b	3.03b	3.05b
T_4	3.03b	2.98b	3.03b
T_5	3.54a	3.51a	3.52a
T_6	3.47a	3.44a	3.52a
CV (%)	2.16	2.32	2.32
SE (±)	0.05	0.05	0.05

T1 (Farmers' practice as control), T2 (Recommended fertilizer with vermicompost @ 3t/ha), T3 (Recommended fertilizer with quick compost @ 3t/ha), T4 (Recommended fertilizer with standard organic fertilizers @ 3t/ha), T5 (Recommended fertilizer with Poultry Manure @ 3t/ha) and T6 (Recommended fertilizer with biochar @ 3t/ha), CV (Co-efficient of Variation), SE (Standard Error for Comparison)

3.3.3 The total nitrogen (%) at the Charlands

The soil total N content was significantly increased by different treatments after three-year application with organic fertilizers (Table 14). At 0-15cm soil depth, in Char Shaluka, the soil total N was varied from 0.095 to 0.145 (%). In Naobhangar Char, the soil total N was varied from 0.095 to 0.144 (%). In Maijbari Char, the soil total N was varied from 0.096 to 0.144 (%). At 15-30cm soil depth, in Char Shaluka, the soil total N was varied from 0.075 to 0.108 (%). In Naobhangar Char, the soil total N was varied from 0.074 to 0.108 (%). In Maijbari Char, the soil total N was varied from 0.074 to 0.103 (%).

3.3.4 The available phosphorus (mg/kg) at the Charlands

The soil available P was remarkably influenced by different treatments after three-year application of organic fertilizers (Table 15). At 0-15cm soil depth, in Char Shaluka, the soil available P was ranged from 9.42 to 17.66 (mg/kg). In Naobhangar Char, the soil available P was ranged from 9.41 to 17.36 (mg/kg). In Maijbari Char, the soil available P was ranged from 9.66 to 17.29 (mg/kg). At 15-30cm soil depth, in Char Shaluka, the soil available P was ranged from 7.90 to 14.59 (mg/kg). In Naobhangar Char, the soil available P was ranged from 7.71 to 14.35 (mg/kg). In Maijbari Char, the soil available P was ranged from 7.49 to 14.45 (mg/kg).

3.3.5 The available sulphur (mg/kg) at the Charlands

Three-year application of organic fertilizers had significant effect on the available S content in the Charlands soil (Table 16). At 0-15cm soil depth, in Char Shaluka, the soil available S was ranged from 11.53 to 17.74 (mg/kg). In Naobhangar Char, the soil available S was ranged from 11.62 to 17.81 (mg/kg). In Maijbari Char, the soil available S was ranged from 11.43 to 17.68 (mg/kg). At 15-30cm soil depth, in Char Shaluka, the soil available S was ranged from 9.70 to 14.62 (mg/kg). In Naobhangar Char, the soil available S was ranged from 9.56 to 14.47

(mg/kg). In Maijbari Char, the soil available S was ranged from 9.55 to 14.48 (mg/kg).

3.3.6 The available zinc (mg/kg) at the Charlands

Three-year application of organic fertilizers significantly increased the Zn content in Charlands soil (Table 17). At 0-15cm soil depth, in Char Shaluka, the Zn content varied from 0.783 to 1.133 (mg/kg). In Naobhangar Char, the Zn content varied from 0.783 to 1.134 (mg/kg). In Maijbari Char, the Zn content varied from 0.781 to 1.134 (mg/kg). At 15-30cm soil depth, in Char Shaluka, the Zn content varied from 0.557 to 0.989 (mg/kg). In Naobhangar Char, the Zn content varied from 0.536 to 0.981 (mg/kg). In Maijbari Char, the Zn content ranged from 0.550 to 0.988 (mg/kg).

Table 12. Effect of different organic matters on post-harvest soil pH content (0-15 and 15-30cm depth) of the Charlands

Treatments	Post-harvest soil pH					
	0-15 cm depth			15-30 cm depth		
	Char Shaluka	Naobhangar Char	Maijbari Char	Char Shaluka	Naobhangar Char	Maijbari Char
T_1	7.16b	7.19c	7.17b	6.76b	6.74b	6.75c
T_2	7.36a	7.35a	7.33a	6.94a	6.98a	6.95a
T_3	7.34a	7.29b	7.27a	6.96a	6.95a	6.95a
T_4	7.35a	7.35a	7.33a	6.96a	6.96a	6.94ab
T_5	7.34a	7.34ab	7.34a	6.95a	6.94a	6.94b
T_6	7.36a	7.34ab	7.34a	6.96a	6.94a	6.95a
CV (%)	0.34	0.39	0.61	0.18	0.34	0.10
SE (±)	0.02	0.02	0.04	0.01	0.02	0.01
Critical levels	4.50					

T1 (Farmers' practice as control), T2 (Recommended fertilizer with vermicompost @ 3t/ha), T3 (Recommended fertilizer with quick compost @ 3t/ha), T4 (Recommended fertilizer with standard organic fertilizers @ 3t/ha), T5 (Recommended fertilizer with Poultry Manure @ 3t/ha) and T6 (Recommended fertilizer with biochar @ 3t/ha), CV (Co-efficient of Variation), SE (Standard Error for Comparison)

Table 13. Effect of different organic matters on post-harvest soil OC (%) content (0-15 and 15-30cm depth) of the Charlands

Treatments	Post-harvest soil OC (%)					
	0-15 cm depth			15-30 cm depth		
	Char Shaluka	Naobhangar Char	Maijbari Char	Char Shaluka	Naobhangar Char	Maijbari Char
T_1	0.97c	0.97c	0.94c	0.69d	0.73d	0.72c
T_2	1.65b	1.65b	1.65b	1.48b	1.57ab	1.57a
T_3	1.69b	1.67b	1.67b	1.37c	1.46c	1.48b
T_4	1.71b	1.71ab	1.71b	1.52b	1.49bc	1.56ab
T_5	1.71b	1.70ab	1.70b	1.52b	1.52abc	1.58a
T_6	1.82a	1.80a	1.82a	1.62a	1.59a	1.59a
CV (%)	3.17	3.89	3.81	2.43	3.86	3.05
SE (±)	0.04	0.05	0.05	0.03	0.04	0.04
Critical levels	1.00					

T1 (Farmers' practice as control), T2 (Recommended fertilizer with vermicompost @ 3t/ha), T3 (Recommended fertilizer with quick compost @ 3t/ha), T4 (Recommended fertilizer with standard organic fertilizers @ 3t/ha), T5 (Recommended fertilizer with Poultry Manure @ 3t/ha) and T6 (Recommended fertilizer with biochar @ 3t/ha), CV (Co-efficient of Variation), SE (Standard Error for Comparison)

Table 14. Effect of different organic matters on post-harvest soil N (%) content (0-15 and 15-30cm depth) of the Charlands

Treatments	Post-harvest soil N (%)					
	0-15 cm depth			15-30 cm depth		
	Char Shaluka	Naobhangar Char	Maijbari Char	Char Shaluka	Naobhangar Char	Maijbari Char
T_1	0.095d	0.095d	0.096d	0.075c	0.074b	0.074d
T_2	0.134c	0.134c	0.135c	0.096b	0.103a	0.086c
T_3	0.137bc	0.135bc	0.136bc	0.095b	0.102a	0.086c
T_4	0.140ab	0.137bc	0.137bc	0.093b	0.103a	0.091bc
T_5	0.140ab	0.141ab	0.141ab	0.107a	0.108a	0.098ab
T_6	0.145a	0.144a	0.144a	0.108a	0.108a	0.103a
CV (%)	2.36	2.63	2.02	3.81	4.54	4.90
SE (±)	0.003	0.003	0.002	0.003	0.004	0.004
Critical levels	0.10					

T1 (Farmers' practice as control), T2 (Recommended fertilizer with vermicompost @ 3t/ha), T3 (Recommended fertilizer with quick compost @ 3t/ha), T4 (Recommended fertilizer with standard organic fertilizers @ 3t/ha), T5 (Recommended fertilizer with Poultry Manure @ 3t/ha) and T6 (Recommended fertilizer with biochar @ 3t/ha), CV (Co-efficient of Variation), SE (Standard Error for Comparison)

Table 15. Effect of different organic matters on post-harvest soil P (mg/kg) content (0-15 and 15-30cm depth) of the Charlands

Treatments	Post-harvest soil P (mg/kg)					
	0-15 cm depth			15-30 cm depth		
	Char Shaluka	Naobhangar Char	Maijbari Char	Char Shaluka	Naobhangar Char	Maijbari Char
T_1	9.42c	9.41c	9.66c	7.90c	7.71d	7.49c
T_2	15.74b	15.78b	15.70ab	12.40b	12.10c	13.53b
T_3	15.61b	15.59b	15.62ab	13.17ab	13.57ab	13.79ab
T_4	14.95b	15.25b	14.99b	13.20ab	13.24abc	13.49b
T_5	15.72b	14.74b	14.68b	13.62ab	12.91bc	13.84ab
T_6	17.66a	17.36a	17.29a	14.59a	14.35a	14.45a
CV (%)	3.67	4.60	6.28	7.83	5.56	3.60
SE (±)	0.45	0.55	0.75	0.80	0.56	0.38
Critical levels	7.00					

T1 (Farmers' practice as control), T2 (Recommended fertilizer with vermicompost @ 3t/ha), T3 (Recommended fertilizer with quick compost @ 3t/ha), T4 (Recommended fertilizer with standard organic fertilizers @ 3t/ha), T5 (Recommended fertilizer with Poultry Manure @ 3t/ha) and T6 (Recommended fertilizer with biochar @ 3t/ha), CV (Co-efficient of Variation), SE (Standard Error for Comparison)

Table 16. Effect of different organic matters on post-harvest soil available S (mg/kg) content (0-15 and 15-30cm depth) of the Charlands

Treatments	Post-harvest soil S (mg/kg)					
	0-15 cm depth			15-30 cm depth		
	Char Shaluka	Naobhangar Char	Maijbari Char	Char Shaluka	Naobhangar Char	Maijbari Char
T_1	11.53d	11.62c	11.43c	9.70c	9.56c	9.55d
T_2	16.54bc	16.58ab	16.50ab	12.74b	12.19b	12.63bc
T_3	16.32bc	16.24b	16.38ab	12.82b	12.85b	12.50bc
T_4	16.10c	16.09b	16.05b	12.92b	12.57b	12.16c
T_5	16.83b	15.86b	15.74b	13.32b	12.15b	13.19b
T_6	17.74a	17.81a	17.68a	14.62a	14.47a	14.47a
CV (%)	2.43	4.65	4.72	4.01	4.73	3.09
SE (±)	0.31	0.60	0.60	0.42	0.48	0.31
Critical levels	8.00					

T1 (Farmers' practice as control), T2 (Recommended fertilizer with vermicompost @ 3t/ha), T3 (Recommended fertilizer with quick compost @ 3t/ha), T4 (Recommended fertilizer with standard organic fertilizers @ 3t/ha), T5 (Recommended fertilizer with Poultry Manure @ 3t/ha) and T6 (Recommended fertilizer with biochar @ 3t/ha), CV (Co-efficient of Variation), SE (Standard Error for Comparison)

Table 17. Effect of different organic matters on post-harvest soil Zn (mg/kg) content (0-15 and 15-30cm depth) of the Charlands

Treatments	Post-harvest soil Zn (mg/kg)					
	0-15 cm depth			15-30 cm depth		
	Char Shaluka	Naobhangar Char	Maijbari Char	Char Shaluka	Naobhangar Char	Maijbari Char
T_1	0.783d	0.783c	0.781c	0.557c	0.536b	0.550c
T_2	1.119bc	1.119b	1.120b	0.975b	0.973a	0.979ab
T_3	1.118bc	1.117b	1.119b	0.976b	0.977a	0.975b
T_4	1.114c	1.113b	1.115b	0.975b	0.973a	0.974b
T_5	1.128ab	1.125ab	1.120b	0.973b	0.972a	0.986a
T_6	1.133a	1.134a	1.134a	0.989a	0.981a	0.988a
CV (%)	0.57	0.69	0.70	0.68	2.19	0.64
SE (±)	0.005	0.006	0.006	0.005	0.016	0.005
Critical levels	0.50					

T1 (Farmers' practice as control), T2 (Recommended fertilizer with vermicompost @ 3t/ha), T3 (Recommended fertilizer with quick compost @ 3t/ha), T4 (Recommended fertilizer with standard organic fertilizers @ 3t/ha), T5 (Recommended fertilizer with Poultry Manure @ 3t/ha) and T6 (Recommended fertilizer with biochar @ 3t/ha), CV (Co-efficient of Variation), SE (Standard Error for Comparison)

4. CONCLUSION

A positive change was found for the application of manures compared to control plot with the crop production and soil fertility status from our experimental findings. The yield per plant of pumpkin was ranged from 27.24 to 85.61 kg and BCR 1.06 to 3.40. The fresh tuber yield of sweet potato was varied from 39.29 to 94.00 t/ha and BCR 1.20 to 3.54. Soil pH was varying from 6.74 to 7.36, OC from 0.69 to 1.82%, total N from 0.074 to 0.145%, available P from 7.49 to 17.66mg/kg, available S from 9.55 to 17.81mg/kg and Zn from 0.536 to 1.134mg/kg. Biochar treated plot showed the best result compered to others. Organic amendments should be recommended in the farmer's field for better crop production and soil fertility status.

ACKNOWLEDGEMENT

Special thanks to the Krishi Gobeshona Foundation (KGF) for financial assistance for continuing the study through a project code (TF 63-Char/17).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Afrad MSI, Rahman GKMM, Alam MS, Ali MZ, Barau AA. Effects of Organic and Inorganic Fertilizers on Growth and Yield of Different Crops at Charlands in Bangladesh. Asian Journal of Advances in Agricultural Research. 2021;17(3):27–40.
2. Rahman MA, Jahiruddin M, Kader MA, Islam MR, Solaiman ZM. Sugarcane bagasse biochar increases soil carbon sequestration and yields of maize and groundnut in charland ecosystem. Archives of Agronomy and Soil Science. 2021;1–14.
3. Environment and GIS Support Project for Water Sector Planning. Riverine Chars in Bangladesh: Environmental dynamics and management issues. University Press; 2000.
4. Haque M. Vulnerability of the Charland Dwellers to Climate Change: Various Adaptation Practices in Bangladesh. In Building Sustainable Communities. Palgrave Macmillan, Singapore. 2020;75–85.
5. Islam MN, Hossain MA, Mohiuddin M, Mian MAK, Biswas M. A survey on crops and cropping of char areas in Bangladesh. Unfavourable Eco-System: Crop Production under Charland Eco-System. Agronomy Division, Bangladesh Agricultural Research Institute, Gazipur. 2016;55–68.
6. Roy BK, Ullah MB, Rahman MH. Climate Change Impact in Charlands in Central Area of Bangladesh: Assessing Vulnerability and Adaptation by the Farming Communities. Journal of Environmental Science and Natural Resources. 2014;7(2):59–63.
7. Karim MA. Upscaling mungbean-Rice pattern in the charlands of Kurigram. Pilot Project Final Report. Krishi Gobeshona Foundation-World Bank. Bangladesh Agricultural Research Council Complex (Dhaka). 2014;1–47.
8. Ashley S, Kat K, Hossain A, Nandi S. The Chars Livelihood Assistance Scoping Study Final Report. DFID (Dhaka). 2000;1–49.
9. Islam M, Islam A. A brief account of bank erosion, model studies and bank protective works in Bangladesh. REIS Newsletter. 1985;2:11–13.
10. Rahman MM, Alam MS, Kamal MZU, Rahman GKMM. Organic sources and tillage practices for soil management. In Resources Use Efficiency in Agriculture. Springer, Singapore. 2020b;283–328.
11. Ali MZ, Alam MS, Rahman GKMM, Rahman MM, Islam MM, Kamal MZ, Hossain MS. Short-term effect of rice straw application on soil fertility and rice yield. Eurasian Journal of Soil Science. 2021;10(1):9–16.
12. Dhaliwal SS, Naresh RK, Mandal A, Walia MK, Gupta RK, Singh R, Dhaliwal MK. Effect of manures and fertilizers on soil physical properties, build-up of macro and micronutrients and uptake in soil under different cropping systems: a review. Journal of Plant Nutrition. 2019;42(20):2873–2900.
13. Barua S, Molla AH, Haque MM, Alam MS. Performance of Trichoderma-enriched bio-organic fertilizer in N supplementation and bottle gourd production in field condition. Hort. Internat. J. 2018;2:106–114.
14. Islam MM, Urmi TA, Rana M, Alam MS, Haque MM. Green manuring effects on crop morpho-physiological characters, rice

yield and soil properties. Physiology and Molecular Biology of Plants. 2019;25(1):303–312.
15. Rahman MM, Sultana M, Rahman GKMM, Solaiman ARM, Alam MS. Effect of different organic composts on soil fertility and tomato yield. Bangladesh Journal of Soil Science. 2015a;37(1):25–34.
16. Song X, Liu M, Wu D, Griffiths BS, Jiao J, Li H, Hu F. Interaction matters: Synergy between vermicompost and PGPR agents improves soil quality, crop quality and crop yield in the field. Applied Soil Ecology. 2015;89:25–34.
17. Karim MA, Quayyum MA, Samsuzzaman S, Higuchi H, Nawata E. Challenges and opportunities in crop production in different types of char lands of Bangladesh: diversity in crops and cropping. Tropical Agriculture and Development. 2017;61(2):77–93.
18. Chaudhuri PS, Paul TK, Dey A, Datta M, Dey SK. Effects of rubber leaf litter vermicompost on earthworm population and yield of pineapple (Ananas comosus) in West Tripura, India. International Journal of Recycling of Organic Waste in Agriculture. 2016;5(2):93–103.
19. Masulili A, Utomo WH, Syechfani MS. Rice husk biochar for rice based cropping system in acid soil 1. The characteristics of rice husk biochar and its influence on the properties of acid sulfate soils and rice growth in West Kalimantan, Indonesia. Journal of Agricultural Science. 2010;2(1):39.
20. Rahman GKMM, Rahman MM, Alam MS, Kamal MZ, Mashuk HA, Datta R, Meena RS. Biochar and organic amendments for sustainable soil carbon and soil health. In Carbon and nitrogen cycling in soil. Springer, Singapore. 2020a;45–85.
21. Knoblauch C, Maarifat AA, Pfeiffer EM, Haefele SM. Degradability of black carbon and its impact on trace gas fluxes and carbon turnover in paddy soils. Soil Biology and Biochemistry. 2011;43(9):1768–1778.
22. Yamato M, Okimori Y, Wibowo IF, Anshori S, Ogawa M. Effects of the application of charred bark of Acacia mangium on the yield of maize, cowpea and peanut and soil chemical properties in South Sumatra, Indonesia. Soil science and plant nutrition. 2006;52(4):489–495.
23. Chan KY, Van Zwieten L, Meszaros I, Downie A, Joseph S. Using poultry litter biochars as soil amendments. Soil Research. 2008;46(5):437–444.
24. Saffari N, Hajabbasi MA, Shirani H, Mosaddeghi MR, Owens G. Influence of corn residue biochar on water retention and penetration resistance in a calcareous sandy loam soil. Geoderma. 2021;383:114734.
25. Irfan M, Hussain Q, Khan KS, Akmal M, Ijaz SS, Hayat R, Rashid M. Response of soil microbial biomass and enzymatic activity to biochar amendment in the organic carbon deficient arid soil: a 2-year field study. Arabian Journal of Geosciences. 2019;12(3):95.
26. Afrad MSI, Rahman GKMM, Alam MS, Ali MZ, Barau AA. Effects of Organic Amendments on Yield Performance of Winter and Summer Seasons Vegetables at Charlands in Bangladesh. Annals of plant sciences. 2022;11(1):4628–4647.
27. de Sousa LJR, de Moraes SW, de Medeiros EV, Duda GP, Corrêa MM, Martins FAP,... Hammecker C. Effect of biochar on physicochemical properties of a sandy soil and maize growth in a greenhouse experiment. Geoderma. 2018;319:14–23.
28. Razzaghi F, Obour PB, Arthur E. Does biochar improve soil water retention? A systematic review and meta-analysis. Geoderma. 2020;361:114055.
29. Tanure MMC, da Costa LM, Huiz HA, Fernandes RBA, Cecon PR, Junior JDP, da Luz JMR. Soil water retention, physiological characteristics, and growth of maize plants in response to biochar application to soil. Soil and Tillage Research. 2019;192:164–173.
30. Khalid CU, Shahzad S, Nadir NM, Saboor A, Yaqoob S, Salim M, Khalid M. Integration of biochar and chemical fertilizer to enhance quality of soil and wheat crop (*Triticum aestivum* L.). PeerJ PrePrints. 2016;4:e1631v1.
31. Kumar R, Lal M, Naresh RK, Kumar M, Yadav S, Kumar R, ... Rajput P. Influence of Balanced Fertilization on Productivity, Nutrient Use Efficiency and Profitability of Rice in Inceptisol: A Review. International Journal of Current Microbiology and Applied Sciences. 2020;9(1):568–590.
32. Page AL, Keeney DR. Methods of soil analysis. American Society of Agronomy; 1982.

33. Bremner JM. Total nitrogen. Methods of soil analysis. American Society of Agronomy, Mongrn. 1982;10,(2):594–624.
34. Olsen SR. Estimation of available phosphorus in soils by extraction with sodium bicarbonate (No. 939). US Department of Agriculture; 1954.
35. Fox RL, Olson RA, Rhoades HF. Evaluating the sulfur status of soils by plant and soil tests. Soil Science Society of America Journal. 1964;28(2):243–246.
36. Lindsay WL, Norvell WA. Development of a DTPA soil test for zinc, iron, manganese, and copper. Soil science society of America journal. 1978;42(3):421–428.
37. BARC (Bangladesh Agricultural Research Council). Fertilizer Recommendation Guide-2018, BARC, Bangladesh Agricultural Research Council, Farmgate, Dhaka; 2018.
38. Gomez KA, Gomez AA. Statistical procedures for agricultural research. John Wiley & Sons; 1984.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/85230