Original Research Article

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

ABSTRACT

The experiment was conducted at the farmer's fields of three Charlands in Bangladesh during November 2021 to March 2022 having the objectives of assessing the effects of organic amendments on yield of different crops and soil properties at Charlands in Bangladesh. The experiments were established in a randomized complete block design using six treatments and three replications. Treatments of the experiments were T_1 = FP (Farmers' Practice) (Control), T_2 = RF (Recommended Fertilizer) + Vermicompost (3t/ha), T_3 = RF (Recommended Fertilizer) + Quick Compost (3t/ha), T_4 = RF (Recommended Fertilizer) + Standard Organic Fertilizers (3t/ha), T_5 = RF (Recommended Fertilizer) + Poultry Manure (3t/ha) and T_6 = RF (Recommended Fertilizer) + Biochar (3t/ha). Results of the experiment reveal that application of organic manures along with inorganic fertilizers produced significant ($p<0.05$) variation in production of pumpkin and sweet potato and post-harvest soil nutrient status compared to Farmer's practice treatment. In pumpkin experiments, among the Charlands, the maximum yield per plant 85.61kg was recorded in T_6 treatment from Naobhangar Char and the minimum 27.24kg in T_1 treatment from Maijbari Char. The highest BCR 3.40 was recorded in T_6 treatment from Naobhangar Char and the lowest BCR 1.06 in T_1 treatment from Maijbari Char. In sweet potato experiment, among the Charlands, the maximum fresh yield of tuber 94.00t/ha was recorded in T_6 treatment and the minimum 39.29t/ha in T_1 treatment from Maijbari Char. The highest BCR 3.54 was recorded in T_6 treatment from Char Shaluka and the lowest BCR 1.20 in T_1 treatment from Maijbari Char. Among the Charlands, the highest soil pH (7.36) was found in T_6 treatment from Char Shaluka (0-15cm soil depth) and the lowest soil pH (6.74) in T_1 treatment from Naobhangar Char (15-30cm soil depth). The highest soil OC (1.82 %) was recorded in T_6 treatment from both Char Shaluka and Maijbari Char (0-15cm soil depth) and the lowest soil OC (0.69%) in T_1 treatment from Char Shaluka (15-30cm soil depth). The highest soil total N (0.145%) was found in T_6 treatment from Char Shaluka (0-15cm soil depth) and the lowest soil total N (0.074%) in T_1 treatment from both Naobhangar Char and Maijbari Char (15-30cm soil depth). However, among the Charlands, the highest soil available P (17.66mg/kg) was obtained in T_6 treatment from Char Shaluka (0-15cm soil depth) and the lowest soil available P (7.49mg/kg) in T_1 treatment from Maijbari Char (15-30cm soil depth). The highest soil available S (17.81mg/kg) was found in T_6 treatment from Naobhangar Char (0-15cm soil depth) and the lowest soil available S (9.55mg/kg) in T_1 treatment from Maijbari Char (15-30cm soil depth). The maximum soil Zn (1.134mg/kg) was found in T_6 treatment from both Naobhangar Char and Maijbari Char (0-15cm soil depth) and the minimum soil Zn (0.536mg/kg) in T_1 treatment from Naobhangar Char (15-30cm soil depth). With the application of organic manures in the crop land field, the yield of different crop was increased as well as the soil fertility status was also improved.

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

1. INTRODUCTION

Charlands are newly established land in river beds which status is poor in fertility [1, 2]. Charlands, the riverine sand and silt landmasses, perform as a result of the dynamics of erosion and deposition in the rivers. With an estimated to be 0.72 m ha in Bangladesh, which is about 5% of the country area and about 6.5 m people (5% of the country's population) live in the charlands [3]. The chars are one of the most susceptible agroecosystems in Bangladesh and

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home to the poorest and marginal people [4]. The char dwellers mainly depend on agriculture and agriculture-related activities, as opportunities for off-farm activities are very minimum there [5]. The char economy is predominantly agricultural, relying on the floods to sustain fertility [6]. Most of the plant nutrients viz. N, P, K, Zn, S and B were found below the critical level for crop production, though variations of the nutrient status within a field of each char were conspicuous [6]. An estimated 5 to 10 million char dwellers, who live mostly on agriculture, are some of the poorest and most vulnerable people particularly those who live on the island/attached river chars in Bangladesh [7, 8].

Farmers use organic materials such as poultry manure, compost, cowdung, rice straw and others for their beneficial effects on soil health by improving soil physicochemical properties and by increasing macro and micro nutrient availability [9, 10, 11]. Moreover, the integrated nutrient management i.e., minimum usages of chemical fertilizers with organic materials such as value-added bio-organic fertilizer, animal manures, crop residues, green manuring and composts are alternatives to avoid excessive usages of nitrogenous and phosphorus contained fertilizers that have enough chance to pollute our soil and environment [12, 13, 14]. Thus, use of organic materials might be effective to enhance the soil fertility of the charlands. Vermicompost (VC) amendment acts as a slow-release fertilizer and can directly increase crop production through increased availability of plant nutrients. It indirectly promotes soil quality by improving soil structure and stimulating microbial activity relative to conventional chemical fertilization [15, 16, 17]. Biochar application decreased soil bulk density, whereas increased porosity, available soil water content, organic carbon (OC), soil pH, available P, cation exchange capacity (CEC), exchangeable K, and Ca [18]. The incorporation of biochar derived from rice husk into soils could significantly improve soil physicochemical properties [19], such as soil moisture content, water holding capacity, BD, available-N nutrients, etc., in paddy fields, [20] and thereby increase crop yield [21, 22]. Biochar, a carbon-rich compound, resulting from the pyrolysis process of different biomasses acts as an alternative or complementary organic amendment [23, 24]. Positive effects of biochar application on soil physical, chemical and biological properties and on crop yield were reported in the study [25, 26, 27, 28]. Biochar and 50% of recommended dose of NPK was most effective for improving soil physico-chemical properties viz., BD, particle density, porosity, pH, EC, organic matter, SOC, total N, available P, K, soil microbial biomass C, and soil microbial biomass N at 0–30 cm depth [30]. The efficiency of nutrients can be increased through the integrated use of organic manures and chemical fertilizers [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. Therefore, the objective of this study was to determine the effects of organic fertilizers on soil properties and yield of different crops at Charlands in Bangladesh.

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2. MATERIALS AND METHODS

The experiment was conducted at the farmer's field in Char Shaluka of Sariakandi upazila under Bogura district, Naobhangar Char of Jamalpur Sadar upazila in Jamalpur district and Maijbari Char of Kazipur upazila in Sirajgonj district during November 2021 to March 2022 to investigate the effects of different organic fertilizers along with inorganic fertilizers application on yield of different crops (pumpkin and sweet potato) and soil properties. Geographically Char Shaluka is located in between 24° 44' to 25° 04' north latitude and 69° 45' to 89° 31' east longitude, Naobhangar Char in between 24°42' and 24°58' north latitudes and in between 89°52' and 90°12' east longitudes, Maijbari Char in between 24°32' and 24°46' north latitudes and in between 89°32' and 89°48' east longitudes. The post-harvest soil samples were collected from a depth of surface (0-15 cm) and sub-surface (15-30 cm) from the selected experimental plot to assess the nutrient status of the Charlands soil for pH, organic carbon (%), total N (%), available P (mg/kg), available S (mg/kg), Zn (mg/kg), exchangeable K (cmol (+)/kg), exchangeable Ca (cmol (+)/kg), exchangeable Mg (cmol (+)/kg) and CEC (cmol (+)/kg) by following the standard methods. The soil samples were analyzed in the laboratory of the Department of Soil Science of Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU).

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Soil pH was measured potentiometrically using a digital pH meter in the supernatant suspension of soil to water ratio of 1:2.5 [32]. Organic carbon was determined following the wet oxidation method [32]. The percentage total nitrogen was obtained by using the micro Kjeldahl technique [33]. Available P was

calculated following Olsen method [34]. Available S was measured by turbidity method using $BaCl_2$ [35]. Available Zn was determined by DTPA method [36]. Exchangeable K, Ca, Mg and CEC were determined by 1N NH_4OAc method [37]. The experiments were established in a randomized complete block design by using six treatments and three replications. Treatments of the experiments were T_1 = FP (Farmers' Practice) (Control), T_2 = RF (Recommended Fertilizer) + Vermicompost (3t/ha), T_3 = RF (Recommended Fertilizer) + Quick Compost (3t/ha), T_4 = RF (Recommended Fertilizer) + Standard Organic Fertilizers (3t/ha), T_5 = RF (Recommended Fertilizer) + Poultry Manure (3t/ha) and T_6 = RF (Recommended Fertilizer) + Biochar (3t/ha). In all the plots, chemical fertilizer was applied in line with the fertilizer recommendation guide of the Bangladesh Agricultural Research Council [38]. For pumpkin the required amount of urea, TSP, MoP, gypsum, zinc sulphate and boric acid were as follows: Recommended Fertilizer (RF): N-P-K-S-Zn-B @ 100-48-80-28-3-2.1 kg/ha. For sweet potato the required amount of urea, TSP, MoP, gypsum and zinc sulphate were as follows: Recommended Fertilizer (RF): N-P-K-S-Mg-Zn-B @ 140-60-140-20-12-3.0-1.5 kg/ha. Experimental crops yield data were collected and analyzed statistically with the help of computer package STATISTIX 10. The mean differences of the treatments were obtained from least significant difference (LSD) test at 5% level of probability for the interpretation of results [39].

3. RESULTS AND DISCUSSION

3.1 Results of the field trial pumpkin at the Charlands

The field trials were conducted at the three selected sites (Char Shaluka, Naobhangar Char and Maijbari Char). The test crops under the trial were pumpkin and sweet potato. The yield data of the crops have been described under the following sub headings.

3.1.1 Average fruit weight (kg) of pumpkin at the Charlands

The pumpkin experiments presented a significant variation with regard to average fruit weight at all the Charlands (Table 1). In Char Shaluka, the average fruit weight ranged from 3.72 to 6.15kg and the highest average fruit weight 6.15kg was recorded in T_6 (RF+ Biochar) treatment which was closely followed by T_5 treatment but the lowest average fruit weight 3.72kg was obtained from T_1(Farmers' practice) treatment. In Naobhangar Char, the average fruit weight ranged from 3.80 to 6.25kg and the maximum average fruit weight 6.25kg was recorded in T_6 (RF+ Biochar) treatment but the minimum average fruit weight 3.80kg was obtained from T_1 (Farmers' practice) treatment. In Maijbari Char, the average fruit weight ranged from 3.46 to 6.28kg and the highest average fruit weight 6.28kg was recorded in T_6 (RF+ Biochar) treatment which was closely followed by T_5 treatment but the lowest average fruit weight 3.46kg was obtained from T_1 (Farmers' practice) treatment. In a study, significant variation was present of average fruit weight that ranged from 1.51 to 4.20 kg [40]. From an experiment it was obtained the average fruit weight of pumpkin in the range of 1.33 to 9.10 kg [41]. The average fruit weight ranged from 1.41 to 5.78 kg in the study [42].

3.1.2 Fresh fruit yield per plant (kg) of pumpkin at the Charlands

The pumpkin experiments exhibited a significant variation with regard to fruit yield per plant at all the Charlands (Table 2). In Char Shaluka, the fruit yield per plant ranged from 35.08 to 81.41kg and the maximum yield per plant 81.41kg was recorded in T_6 (RF+ Biochar) treatment but the minimum yield per plant 35.08kg was obtained from T_1 (Farmers' practice) treatment. In Naobhangar Char, the fruit yield per plant ranged from 32.33 to 85.61kg and the highest yield per plant 85.61kg was recorded in T_6 (RF+ Biochar) treatment while the lowest yield per plant 32.33kg was obtained from T1(Farmers' practice) treatment. In Maijbari Char, the fruit yield per plant ranged from 27.24 to 80.45kg and the highest yield per plant 80.45kg was recorded in T_6 (RF+ Biochar) treatment which was closely followed by T_3 and T_5 treatments but the lowest yield per plant 27.24kg was obtained from T_1(Farmers' practice) treatment. It was found significant variation in yield per plant in different Pumpkin genotypes in the range of 5.94 to 36.12 kg [40].

3.1.3 Total income (tk/ha) of pumpkin at the Charlands

The pumpkin experiments showed a significant variation due to long term incorporation of different organic amendments with regard to total income at all the Charlands (Table 3). In Char Shaluka, the total income ranged from 526217.00 to 1220000.00tk/ha and the maximum total income 1220000.00tk/ha was recorded in T_6 (RF+ Biochar) treatment but the minimum total income 526217.00tk/ha was obtained from T_1 (Farmers' practice) treatment. In Naobhangar Char, the total income ranged from 484971.00 to 1280000.00tk/ha and the

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highest total income 1280000.00tk/ha was recorded in T_6 (RF+ Biochar) treatment while the lowest total income 484971.00tk/ha was obtained from T_1(Farmers' practice) treatment. In Maijbari Char, the total income ranged from 408599.00 to 1210000.00tk/ha and the highest total income 1210000.00tk/ha was recorded in T_6 (RF+ Biochar) treatment which was statistically similar with T_3 and T_5 treatments but the lowest total income 408599.00 tk/ha was obtained from T_1(Farmers' practice) treatment.

3.1.4 Total cost (tk/ha) of pumpkin at the Charlands

The pumpkin experiments presented a variation with regard to total cost at all the Charlands (Table 4). In the Charlands, the total cost in T_1 (385559.00 tk/ha), T_2 (369233.32 tk/ha), T_3 (375233.32 tk/ha), T_4 (378233.32 tk/ha), T_5 (369233.32 tk/ha) and T_6 (378233.32 tk/ha). Moreover, the maximum total cost was recorded in T_1 (385559.00 tk/ha) treatment and minimum total cost was obtained from T_2 and T_5 (369233.32 tk/ha) treatments.

3.1.5 Benefit cost ratio (BCR) (Total cost basis) of pumpkin at the Charlands

The pumpkin experiments revealed a significant variation due to long term incorporation of different organic amendments with regard to BCR (Total cost basis) at all the Charlands (Table 5). In Char Shaluka, the BCR ranged from 1.37 to 3.23 and the maximum BCR 3.23 was recorded in T_6 (RF+ Biochar) treatment which is statistically similar to T_5 treatment but the minimum BCR 1.37 was obtained from T_1 (Farmers' practice) treatment. In Naobhangar Char, the BCR ranged from 1.26 to 3.40 and the highest BCR 3.40 was recorded in T_6 (RF+ Biochar) treatment which is statistically similar to T_5 treatment while the lowest BCR 1.26 was obtained from T_1 (Farmers' practice) treatment. In Maijbari Char, the BCR ranged from 1.06 to 3.19 and the highest BCR 3.19 was recorded in T_6 (RF+ Biochar) treatment which was closely followed by T_5 treatment but the lowest BCR 1.06 was obtained from T_1 (Farmers' practice) treatment.

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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

T_1= FP (Control), T_2=RF+ Vermicompost (3t/ha), T_3=RF+ Quick Compost (3t/ha), T_4=RF+ Standard Organic Fertilizer (3t/ha), T_5=RF+ Poultry Manure (3t/ha), T_6=RF+ Biochar (3t/ha), FP= Farmers' practice, RF= Recommended fertilizer, CV= Co-efficient of Variation, SE= Standard Error for Comparison, in a column figures having similar letter (s) do not differ significantly whereas figures with dissimilar letter (s) differ significantly as per LSD at 5% level of significant.

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

T_1= FP (Control), T_2=RF+ Vermicompost (3t/ha), T_3=RF+ Quick Compost (3t/ha), T_4=RF+ Standard Organic Fertilizer (3t/ha), T_5=RF+ Poultry Manure (3t/ha), T_6=RF+ Biochar (3t/ha), FP= Farmers' practice, RF=

Recommended fertilizer, CV= Co-efficient of Variation, SE= Standard Error for Comparison, in a column figures having similar letter (s) do not differ significantly whereas figures with dissimilar letter (s) differ significantly as per LSD at 5% level of significant.

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

T_1= FP (Control), T_2=RF+ Vermicompost (3t/ha), T_3=RF+ Quick Compost (3t/ha), T_4=RF+ Standard Organic Fertilizer (3t/ha), T_5=RF+ Poultry Manure (3t/ha), T_6=RF+ Biochar (3t/ha), FP= Farmers' practice, RF= Recommended fertilizer, CV= Co-efficient of Variation, SE= Standard Error for Comparison, in a column figures having similar letter (s) do not differ significantly whereas figures with dissimilar letter (s) differ significantly as per LSD at 5% level of significant.

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

T_1= FP (Control), T_2=RF+ Vermicompost (3t/ha), T_3=RF+ Quick Compost (3t/ha), T_4=RF+ Standard Organic Fertilizer (3t/ha), T_5=RF+ Poultry Manure (3t/ha), T_6=RF+ Biochar (3t/ha), FP= Farmers' practice, RF= Recommended fertilizer.

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

T_1= FP (Control), T_2=RF+ Vermicompost (3t/ha), T_3=RF+ Quick Compost (3t/ha), T_4=RF+ Standard Organic Fertilizer (3t/ha), T_5=RF+ Poultry Manure (3t/ha), T_6=RF+ Biochar (3t/ha), FP= Farmers' practice, RF= Recommended fertilizer, CV= Co-efficient of Variation, SE= Standard Error for Comparison, in a column figures having similar letter (s) do not differ significantly whereas figures with dissimilar letter (s) differ significantly as per LSD at 5% level of significant.

3.2 Results of the field trial sweet potato at the Charlands

3.2.1 Number of tuberous roots per plant of sweet potato at the Charlands

The yellow sweet potato experiments showed a significant variation with regard to number of tubers roots per plant at all the Charlands (Table 6). In Char Shaluka, the number of tubers roots per plant ranged from 32.91 to 54.68 and the maximum number of tubers roots per plant 54.68 was recorded in T_6 (RF+ Biochar) treatment which was closely followed by T_5 treatment but the lowest number of tubers roots per plant 32.91 was obtained from T_1(Farmers' practice) treatment. In Naobhangar Char, the number of tubers roots per plant ranged from 33.49 to 53.25 and the maximum number of tubers roots

per plant 53.25 was recorded in T_6 (RF+ Biochar) treatment which was closely followed by T_5 treatment but the lowest number of tubers roots per plant 33.49 was gotten from T_1 (Farmers' practice) treatment. In Maijbari Char, the number of tubers roots per plant ranged from 32.63 to 54.05 and the maximum number of tubers roots per plant 54.05 was recorded in T_6 (RF+ Biochar) treatment which was closely followed by T_5 treatment but the lowest number of tubers roots per plant 32.63 was obtained from T_1(Farmers' practice) treatment. In the study report it was found that the number of tuberous roots per plant was 6.53 [43].

3.2.2 Fresh yield of biomass (t/ha) of sweet potato at the Charlands

The sweet potato experiments indicated a significant variation with regard to fresh yield of biomass at all the Charlands (Table 7). In Char Shaluka, the fresh yield of biomass ranged from 21.46 to 41.65 t/ha and the maximum fresh yield of biomass 41.65 t/ha was recorded in T_6 (RF+ Biochar) treatment but the lowest fresh yield of biomass 21.46t/ha was obtained from T_1(Farmers' practice) treatment. In Naobhangar Char, the fresh yield of biomass ranged from 22.25 to 42.27 t/ha and the maximum fresh yield of biomass 42.27 t/ha was recorded in T_6 treatment but the lowest fresh yield of biomass 22.25t/ha was obtained from T_1(Farmers' practice) treatment. In Maijbari Char, the fresh yield of biomass ranged from 22.46 to 42.32t/ha and the maximum fresh yield of biomass 42.32t/ha was recorded in T_6 treatment but the lowest fresh yield of biomass 22.46t/ha was obtained from T_1(Farmers' practice) treatment.

3.2.3 Fresh yield of tuber (t/ha) of sweet potato at the Charlands

The sweet potato experiments showed a significant variation with regard to fresh yield of tuber at all the Charlands (Table 8). In Char Shaluka, the fresh yield of tuber ranged from 40.32 to 92.62t/ha and the maximum fresh yield of tuber 92.62t/ha was recorded in T_6 treatment which was statistically similar with T_5 treatment but the lowest fresh yield of tuber 40.32t/ha was found from T_1 (Farmers' practice) treatment. In Naobhangar Char, the fresh yield of tuber ranged from 39.74 to 91.99t/ha and the maximum fresh yield of tuber 91.99t/ha was recorded in T_6 treatment which was statistically similar with T_5 treatment but the lowest fresh yield of tuber 39.74t/ha was obtained from T_1 (Farmers' practice) treatment. In Maijbari Char, the fresh yield of tuber ranged from 39.29 to 94.00t/ha and the maximum fresh yield of tuber 94.00t/ha was recorded in T_6 treatment which was similarly followed by T_5 treatment. On the other hand, the lowest fresh yield of tuber 39.29t/ha was obtained from T_1 (Farmers' practice) treatment. It was showed 23.12 t/ha average production of tuber in a report [44]. It was found yield of tuber 22.83 t/ha in the experiment [43].

3.2.4 Total income (tk/ha) of sweet potato at the Charlands

The sweet potato experiments showed a significant variation due to long term incorporation of different organic amendments with regard to total income at all the Charlands. In Char Shaluka, the total income ranged from 604850.00 to 1390000.00tk/ha and the maximum total income 1390000.00tk/ha was recorded in T_6 treatment which was similarly followed by T_5 treatment but the minimum total income 604850.00tk/ha was obtained from T_1 (Farmers' practice) treatment. In Naobhangar Char, the total income ranged from 596100.00 to 1380000.00tk/ha and the highest total income 1380000.00tk/ha was recorded in T_6 treatment which was similarly followed by T_5 treatment while the lowest total income 596100.00tk/ha was obtained from T_1(Farmers' practice) treatment. In Maijbari Char, the total income ranged from 589400.00 to 1410000.00tk/ha and the highest total income 1410000.00tk/ha was recorded in T_6 treatment which was similar with T_5 treatment but the lowest total income 589400.00tk/ha was obtained from T_1(Farmers' practice) treatment (Table 9).

3.2.5 Total cost (tk/ha) at the Charlands of sweet potato at the Charlands

The sweet potato experiments presented a variation with regard to total cost at all the Charlands. In the Charlands, the total cost in T_1 (491559.00 tk/ha), T_2 (391683.48 tk/ha), T_3 (397683.48 tk/ha), T_4 (400683.48 tk/ha), T_5 (391683.48 tk/ha) and T_6 (400683.48 tk/ha). Moreover, the maximum total cost was recorded in T_1 (491559.00 tk/ha) treatment and minimum total cost was obtained from T_2, T_3 and T_5 (391683.48 tk/ha) treatments (Table 10).

3.2.6 Benefit cost ratio (BCR) (Total cost basis) of sweet potato at the Charlands

The sweet potato experiments unveiled a significant variation due to long term incorporation of different organic amendments with regard to BCR (Total cost basis) at all the Charlands. In Char Shaluka, the BCR ranged from 1.23 to 3.54 and the maximum BCR 3.54 was recorded in T_5 (RF+ Poultry Manure) treatment which was similarly followed by T_6 treatment but the minimum BCR 1.23 was obtained from T_1 (Farmers' practice) treatment. In Naobhangar Char, the BCR ranged from 1.21

to 3.51 and the highest BCR 3.51 was recorded in T_5 treatment which was similarly followed by T_6 treatment while the lowest BCR 1.21 was obtained from T_1 (Farmers' practice) treatment. In Maijbari Char, the BCR ranged from 1.20 to 3.52 and the highest BCR 3.52 was recorded in T_5 and T_6 treatments but the lowest BCR 1.20 was obtained from T_1 (Farmers' practice) treatment (Table 11).

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

T_1= FP (Control), T_2=RF+ Vermicompost (3t/ha), T_3=RF+ Quick Compost (3t/ha), T_4=RF+ Standard Organic Fertilizer (3t/ha), T_5=RF+ Poultry Manure (3t/ha), T_6=RF+ Biochar (3t/ha), FP= Farmers' practice, RF= Recommended fertilizer, CV= Co-efficient of Variation, SE= Standard Error for Comparison, in a column figures having similar letter (s) do not differ significantly whereas figures with dissimilar letter (s) differ significantly as per LSD at 5% level of significant.

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

T_1= FP (Control), T_2=RF+ Vermicompost (3t/ha), T_3=RF+ Quick Compost (3t/ha), T_4=RF+ Standard Organic Fertilizer (3t/ha), T_5=RF+ Poultry Manure (3t/ha), T_6=RF+ Biochar (3t/ha), FP= Farmers' practice, RF= Recommended fertilizer, CV= Co-efficient of Variation, SE= Standard Error for Comparison, in a column figures having similar letter (s) do not differ significantly whereas figures with dissimilar letter (s) differ significantly as per LSD at 5% level of significant.

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

T_1= FP (Control), T_2=RF+ Vermicompost (3t/ha), T_3=RF+ Quick Compost (3t/ha), T_4=RF+ Standard Organic Fertilizer (3t/ha), T_5=RF+ Poultry Manure (3t/ha), T_6=RF+ Biochar (3t/ha), FP= Farmers' practice, RF= Recommended fertilizer, CV= Co-efficient of Variation, SE= Standard Error for Comparison, in a column figures having similar letter (s) do not differ significantly whereas figures with dissimilar letter (s) differ significantly as per LSD at 5% level of significant.

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

T_1= FP (Control), T_2=RF+ Vermicompost (3t/ha), T_3=RF+ Quick Compost (3t/ha), T_4=RF+ Standard Organic Fertilizer (3t/ha), T_5=RF+ Poultry Manure (3t/ha), T_6=RF+ Biochar (3t/ha), FP= Farmers' practice, RF= Recommended fertilizer, CV= Co-efficient of Variation, SE= Standard Error for Comparison, in a column figures having similar letter (s) do not differ significantly whereas figures with dissimilar letter (s) differ significantly as per LSD at 5% level of significant.

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

T_1= FP (Control), T_2=RF+ Vermicompost (3t/ha), T_3=RF+ Quick Compost (3t/ha), T_4=RF+ Standard Organic Fertilizer (3t/ha), T_5=RF+ Poultry Manure (3t/ha), T_6=RF+ Biochar (3t/ha), FP= Farmers' practice, RF= Recommended fertilizer.

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

T_1= FP (Control), T_2=RF+ Vermicompost (3t/ha), T_3=RF+ Quick Compost (3t/ha), T_4=RF+ Standard Organic Fertilizer (3t/ha), T_5=RF+ Poultry Manure (3t/ha), T_6=RF+ Biochar (3t/ha), FP= Farmers' practice, RF= Recommended fertilizer, CV= Co-efficient of Variation, SE= Standard Error for Comparison, in a column figures having similar letter (s) do not differ significantly whereas figures with dissimilar letter (s) differ significantly as per LSD at 5% level of significant.

3.3 Effect of different organic amendment on soil chemical properties in the Charlands

The post-harvest samples were collected from the three selected Charlands (Char Shaluka, Naobhangar Char and Maijbari Char) in two different depths i.e., 0-15cm and 15-30cm. Chemical analyses of the collected soil samples were completed in the laboratory of the Department of Soil Science at BSMRAU.

3.3.1 Soil pH at the Charlands

The effects of different treatments on soil pH in the research field of the Charlands is presented in table 12. After three-year judicious application of organic fertilizers, soil pH significantly influenced by different organic matter treated treatments. At 0-15cm soil depth, in Char Shaluka, the soil pH ranged from 7.16 to 7.36. The maximum soil pH (7.36) was in the T_2 and T_6 treatments which was statistically similar with T_3, T_4 and T_5 treatments, while the lowest soil pH value (7.16) was in T_1 treatment. In Naobhangar Char, the soil pH ranged from 7.19 to 7.35. The maximum soil pH (7.35) was in the T_2 and T_4 treatments which was statistically similar with T_3, T_5 and T_6 treatments, while the lowest soil pH value (7.19) was in T_1 treatment. In Maijbari Char, the soil pH ranged from 7.17 to 7.34. The maximum soil pH (7.34) was in the T_5 and T_6 treatments which was statistically similar with T_2, T_3 and T_4 treatments, while the lowest soil pH value (7.17) was in T_1 treatment. At 15-30cm soil depth, in Char Shaluka, the soil pH ranged from 6.76 to 6.96. The maximum soil pH (6.96) was in the T_3, T_4 and T_6 treatments which was statistically similar with T_2 and T_5 treatments, while the lowest soil pH value (6.76) was in T_1 treatment. In Naobhangar Char, the soil pH ranged from 6.74 to 6.98. The maximum soil pH (6.98) was in the T_2 treatment which was statistically similar with T_3, T_4, T_5 and T_6 treatments, while the lowest soil pH value (6.74) was in T_1 treatment. In Maijbari Char, the soil pH ranged from 6.75 to 6.95. The maximum soil pH (6.95) was in the T_2, T_3 and T_6 treatments which was statistically similar with T_4 treatment, while the lowest soil pH value (6.75) was in T_1 treatment. The pH ranged from (6.99 to 8.2) in the charland soil of the study [7]. The range of pH (5.62-7.80) in the charland soil of the study [17].

3.3.2 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 (%). The significantly highest soil OC content (1.82%) was observed in the T_6 treatment. The lowest soil OC content (0.97%) was noted in T_1 treatment. In Naobhangar Char, the soil OC was extended from 0.97 to 1.80 (%). The significantly highest soil OC content (1.80%) was observed in the T_6 treatment which was statistically similar to T_4 and T_5 treatments. The lowest soil OC content (0.97%) was noted in T_1 treatment. In Maijbari Char, the soil OC was extended from 0.94 to 1.82 (%). The significantly highest soil OC content (1.82%) was observed in the T_6 treatment. The lowest soil OC content (0.94%) was noted in T_1 treatment. At 15-30cm soil depth, in Char Shaluka, the soil OC was extended from 0.69 to 1.62 (%). The significantly highest soil OC content (1.62%) was observed in the T_6 treatment. The lowest soil OC content (0.69%) was noted in T_1 treatment. In Naobhangar Char, the soil OC was extended from 0.73 to 1.59 (%). The significantly highest soil OC content (1.59%) was observed in the T_6 treatment which was statistically similar to T_2 and T_5 treatments. The lowest soil OC content (0.73%) was noted in T_1 treatment. In Maijbari Char, the soil OC was extended from 0.72 to 1.59 (%). The significantly highest soil OC content (1.59%) was observed in the T_6 treatment which was statistically similar to T_2, T_4 and T_5 treatments. The lowest soil OC content (0.72%) was noted in T_1 treatment. The OC ranged from 0.99 to 1.02% in the charland soil of the study [7]. The range of OC (0.28-1.56%) in the charland soil of the study [17].

3.3.3 Total nitrogen (%) at the Charlands

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 (%). The significantly highest soil total N content (0.145%) was found in the T_6 treatment which was statistically similar with T_4 and T_5 treatments. The lowest soil total N content (0.095%) was recorded in T_1 treatment. In Naobhangar Char, the soil total N was varied from 0.095 to 0.144 (%). The significantly highest soil total N content (0.144%) was found in the T_6 treatment which

was statistically similar with T_5 treatment. The lowest soil total N content (0.095%) was recorded in T_1 treatment. In Maijbari Char, the soil total N was varied from 0.096 to 0.144 (%). The significantly highest soil total N content (0.144%) was found in the T_6 treatment which was statistically similar with T_5 treatments. The lowest soil total N content (0.096%) was recorded in T_1 treatment. At 15-30cm soil depth, in Char Shaluka, the soil total N was varied from 0.075 to 0.108 (%). The significantly highest soil total N content (0.108%) was found in the T_6 treatment which was statistically similar with T_5 treatment. The lowest soil total N content (0.075%) was recorded in T_1 treatment. In Naobhangar Char, the soil total N was varied from 0.074 to 0.108 (%). The significantly highest soil total N content (0.108%) was found in the T_5 and T_6 treatments which was statistically similar with T_2,T_3 and T_4 treatments. The lowest soil total N content (0.074%) was recorded in T_1 treatment. In Maijbari Char, the soil total N was varied from 0.074 to 0.103 (%). The significantly highest soil total N content (0.103%) was found in the T_6 treatment which was statistically similar with T_5 treatment. The lowest soil total N content (0.074%) was recorded in T_1 treatment. Soil N content was 0.11 % in the charland soil of the study [7]. The range of N (0.02-0.21%) in the charland soil of the study [17].

3.3.4 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). The significantly highest soil available P (17.66mg/kg) was found in the T_6 treatment. The lowest soil available P (9.72mg/kg) was noted in T_1 treatment. In Naobhangar Char, the soil available P was ranged from 9.41 to 17.36 (mg/kg). The significantly highest soil available P (17.36mg/kg) was found in the T_6 treatment. The lowest soil available P (9.41mg/kg) was noted in T_1 treatment. In Maijbari Char, the soil available P was ranged from 9.66 to 17.29 (mg/kg). The significantly highest soil available P (17.29mg/kg) was found in the T_6 treatment which was statistically similar to T_2 and T_3 treatments. The lowest soil available P (9.66mg/kg) was noted in T_1 treatment. At 15-30cm soil depth, in Char Shaluka, the soil available P was ranged from 7.90 to 14.59 (mg/kg). The significantly highest soil available P (14.59mg/kg) was found in the T_6 treatment which was statistically similar to T_3, T_4 and T_5 treatments. The lowest soil available P (7.90mg/kg) was noted in T_1 treatment. In Naobhangar Char, the soil available P was ranged from 7.71 to 14.35 (mg/kg). The significantly highest soil available P (14.35mg/kg) was found in the T_6 treatment which was statistically similar to T_3 and T_4 treatments. The lowest soil available P (7.71mg/kg) was noted in T_1 treatment. In Maijbari Char, the soil available P was ranged from 7.49 to 14.45 (mg/kg). The significantly highest soil available P (14.45mg/kg) was found in the T_6 treatment which was statistically similar to T_3 and T_5 treatments. The lowest soil available P (7.49mg/kg) was noted in T_1 treatment. The P content varied from 10 to 18 mg/kg in the charland soil of the study [7]. The range of P (3.00-20.00 mg/kg) in the charland soil of the study [17].

3.3.5 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). Among the treatments, T_6 gave the significantly highest soil available S (17.74mg/kg) content. The lowest soil available S (11.53mg/kg) was detected in T_1 treatment. In Naobhangar Char, the soil available S was ranged from 11.62 to 17.81 (mg/kg). Among the treatments, T_6 gave the significantly highest soil available S (17.81mg/kg) content which was statistically similar to T_2 treatment. The lowest soil available S (11.62mg/kg) was detected in T_1 treatment. In Maijbari Char, the soil available S was ranged from 11.43 to 17.68 (mg/kg). Among the treatments, T_6 gave the significantly highest soil available S (17.68mg/kg) content which was statistically similar to T_2 and T_3 treatments. The lowest soil available S (11.43mg/kg) was detected in T_1 treatment. At 15-30cm soil depth, in Char Shaluka, the soil available S was ranged from 9.70 to 14.62 (mg/kg). Among the treatments, T_6 gave the significantly highest soil available S (14.62mg/kg) content. The lowest soil available S (9.70mg/kg) was detected in T_1 treatment. In Naobhangar Char, the soil available S was ranged from 9.56 to 14.47 (mg/kg). Among the treatments, T_6 gave the significantly highest soil available S (14.47mg/kg) content. The lowest soil available S (9.56mg/kg) was detected in T_1 treatment. In Maijbari Char, the soil available S was ranged from 9.55 to 14.48 (mg/kg). Among the treatments, T_6 gave the significantly highest soil available S (14.47mg/kg) content. The lowest soil available S (9.55mg/kg) was detected in T1

treatment. while S ranged from 2.84 in to 14.81 mg/kg in the charland soil of the study [7]. The range of S (2.05-56.40 mg/kg) in the charland soil of the study [17].

3.3.6 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, organic amendments were varied the Zn content from 0.783 to 1.133 (mg/kg). Among the treatments, the biochar treated treatment T_6 showed the maximum Zn content (1.133mg/kg) which was statistically similar to T_5 treatment and the minimum Zn content (0.783mg/kg) in T_1 treatment. In Naobhangar Char, organic amendments were varied the Zn content from 0.783 to 1.134 (mg/kg). Among the treatments, the biochar treated treatment T_6 showed the maximum Zn content (1.134mg/kg) which was statistically similar to T_5 treatment and the minimum Zn content (0.783mg/kg) in T_1 treatment. In Maijbari Char, organic amendments were varied the Zn content from 0.781 to 1.134 (mg/kg). Among the treatments, the biochar treated treatment T_6 showed the maximum Zn content (1.134mg/kg) and the minimum Zn content (0.781mg/kg) in T_1 treatment. At 15-30cm soil depth, in Char Shaluka, organic amendments were varied the Zn content from 0.557 to 0.989 (mg/kg). Among the treatments, the biochar treated treatment T_6 showed the maximum Zn content (0.989mg/kg) and the minimum Zn content (0.557mg/kg) in T_1 treatment. In Naobhangar Char, organic amendments were varied the Zn content from 0.536 to 0.981 (mg/kg). Among the treatments, the biochar treated treatment T_6 showed the maximum Zn content (0.981mg/kg) which was statistically similar to T_2, T_3, T_4 and T_5 treatments and the minimum Zn content (0.536mg/kg) in T_1 treatment. In Maijbari Char, organic amendments were varied the Zn content from 0.550 to 0.988 (mg/kg). Among the treatments, the biochar treated treatment T_6 showed the maximum Zn content (0.988mg/kg) which was statistically similar to T_2 and T_5 treatments and the minimum Zn content (0.550mg/kg) in T_1 treatment. Zinc varied from 0.63 in to 0.93 mg/kg in the charland soil of the study [7]. The range of Zn (0.39-2.20 mg/kg) in the charland soil of the study [17].

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					

T_1= FP (Control), T_2=RF+ Vermicompost (3t/ha), T_3=RF+ Quick Compost (3t/ha), T_4=RF+ Standard Organic Fertilizer (3t/ha), T_5=RF+ Poultry Manure (3t/ha), T_6=RF+ Biochar (3t/ha), FP= Farmers' practice, RF= Recommended fertilizer, CV= Co-efficient of Variation, SE= Standard Error for Comparison, in a column figures having similar letter (s) do not differ significantly whereas figures with dissimilar letter (s) differ significantly as per LSD at 5% level of significant.

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					

T_1= FP (Control), T_2=RF+ Vermicompost (3t/ha), T_3=RF+ Quick Compost (3t/ha), T_4=RF+ Standard Organic Fertilizer (3t/ha), T_5=RF+ Poultry Manure (3t/ha), T_6=RF+ Biochar (3t/ha), FP= Farmers' practice, RF= Recommended fertilizer, CV= Co-efficient of Variation, SE= Standard Error for Comparison, in a column figures having similar letter (s) do not differ significantly whereas figures with dissimilar letter (s) differ significantly as per LSD at 5% level of significant.

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					

T_1= FP (Control), T_2=RF+ Vermicompost (3t/ha), T_3=RF+ Quick Compost (3t/ha), T_4=RF+ Standard Organic Fertilizer (3t/ha), T_5=RF+ Poultry Manure (3t/ha), T_6=RF+ Biochar (3t/ha), FP= Farmers' practice, RF= Recommended fertilizer, CV= Co-efficient of Variation, SE= Standard Error for Comparison, in a column figures having similar letter (s) do not differ significantly whereas figures with dissimilar letter (s) differ significantly as per LSD at 5% level of significant.

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					

T_1= FP (Control), T_2=RF+ Vermicompost (3t/ha), T_3=RF+ Quick Compost (3t/ha), T_4=RF+ Standard Organic Fertilizer (3t/ha), T_5=RF+ Poultry Manure (3t/ha), T_6=RF+ Biochar (3t/ha), FP= Farmers' practice, RF= Recommended fertilizer, CV= Co-efficient of Variation, SE= Standard Error for Comparison, in a column figures having similar letter (s) do not differ significantly whereas figures with dissimilar letter (s) differ significantly as per LSD at 5% level of significant.

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					

T_1= FP (Control), T_2=RF+ Vermicompost (3t/ha), T_3=RF+ Quick Compost (3t/ha), T_4=RF+ Standard Organic Fertilizer (3t/ha), T_5=RF+ Poultry Manure (3t/ha), T_6=RF+ Biochar (3t/ha), FP= Farmers' practice, RF= Recommended fertilizer, CV= Co-efficient of Variation, SE= Standard Error for Comparison, in a column figures having similar letter (s) do not differ significantly whereas figures with dissimilar letter (s) differ significantly as per LSD at 5% level of significant.

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					

T_1= FP (Control), T_2=RF+ Vermicompost (3t/ha), T_3=RF+ Quick Compost (3t/ha), T_4=RF+ Standard Organic Fertilizer (3t/ha), T_5=RF+ Poultry Manure (3t/ha), T_6=RF+ Biochar (3t/ha), FP= Farmers' practice, RF= Recommended fertilizer, CV= Co-efficient of Variation, SE= Standard Error for Comparison, in a column figures having similar letter (s) do not differ significantly whereas figures with dissimilar letter (s) differ significantly as per LSD at 5% level of significant.

4. CONCLUSION

Results of the experiment showed that application of organic manures along with inorganic fertilizers treatments produced significant ($p<0.05$) variation in production of pumpkin and sweet potato and post-harvest soil nutrient status compared to Farmer's practice treatment. In pumpkin experiments, among the Charlands, the maximum yield per plant 85.61kg was recorded in T_6 treatment from Naobhangar Char and the minimum 27.24kg in T_1 treatment from Maijbari Char. The highest BCR 3.40 was recorded in T_6 treatment from Naobhangar Char and the lowest BCR 1.06 in T_1 treatment from Maijbari Char. In sweet potato experiments, among the Charlands, the maximum fresh yield of tuber 94.00t/ha was recorded in T_6 treatment and the minimum 39.29t/ha in T_1 treatment from Maijbari Char. The highest BCR 3.54 was recorded in T_6 treatment from Char Shaluka and the lowest BCR 1.20 in T_1 treatment from Maijbari Char. Among the Charlands soil, the highest pH (7.36) was found in T_6 treatment from Char Shaluka (0-15cm soil depth) and the lowest pH (6.74) in T_1 treatment from Naobhangar Char (15-30cm soil depth). Among the Charlands soil, the highest OC (1.82 %) was recorded in T_6 treatment from both Char Shaluka and Maijbari Char (0-15cm soil depth) and the lowest OC (0.69%) in T_1 treatment from Char Shaluka (15-30cm soil depth). The highest soil total N (0.145%) was found in T_6 treatment from Char

Shaluka (0-15cm soil depth) and the lowest total N (0.074%) in T_1 treatment from both Naobhangar Char and Maijbari Char (15-30cm soil depth). However, among the Charlands soil, the highest available P (17.66mg/kg) was obtained in T_6 treatment from Char Shaluka (0-15cm soil depth) and the lowest available P (7.49mg/kg) in T_1 treatment from Maijbari Char (15-30cm soil depth). The highest soil available S (17.81mg/kg) was found in T_6 treatment from both Naobhangar Char (0-15cm soil depth) and the lowest available S (9.55mg/kg) in T_1 treatment from Maijbari Char (15-30cm soil depth). The maximum soil Zn (1.134mg/kg) was found in T_6 treatment from both Naobhangar Char and Maijbari Char (0-15cm soil depth) and the minimum Zn (0.536mg/kg) in T_1 treatment from Naobhangar Char (15-30cm soil depth). After long term application of organic fertilizer in the crop land field, the yield of different crop was increased as well as the soil fertility status also improved.

Comment [MF17]: cropland

Comment [MF18]: the different crops

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