Dhaka Univ. J. Biol. Sci. **31**(2): 329-342, 2022 (July) DOI: https://doi.org/10.3329/dujbs.v31i2.60891

IMPACTS OF COW DUNG AND POULTRY MANURE ON THE MINERAL NUTRIENT UPTAKE OF RED AMARANTH GROWN IN A MIXTURE OF ACID AND CALCAREOUS SOILS

SADIA BINTAY SOLIAMAN, MD. BAYAZID HOSSAIN*, MITHUN KUMAR SAHA, RAMESWAR MANDAL AND MD. HARUNOR RASHID KHAN

Department of Soil, Water and Environment, University of Dhaka, Dhaka-1000, Bangladesh

Key words: Soil acidity, Calcareousness, Manipulated soil, Cow dung, Poultry manure, Red amaranth, Plant uptake, Post-harvest soil

Abstract

A pot experiment was performed in the net house to observe the influence of cow dung and poultry manure on the growth of red amaranth grown in the amended soil (mixture of acid and calcareous soil). Acid soil was mixed with calcareous soil at a ratio of 3:1 for experiment with red amaranth. The pot experiment was conducted with the mixed soil indicated by T_{0M} (control-where no amendment was added), three different rates of cow dung such as T_1 (3 ton/ha), T_2 (6 ton/ha) and T_3 (9 ton/ha) and three rate of poultry manure designated as T_4 (2 ton/ha), T_5 (4 ton/ha) and T_6 (6 ton/ha). Treatment responses were evaluated in terms of different parameters including uptake of nutrients by plants and post-harvest properties of soil such as physico-chemical properties and residual nutrient content of the soil. It is evident from the experiment that the uptake of the plant nutrients was the best in the mixed soil (T_{0M}-control) than those of the acid (T_A) and calcareous soils (T_C). On the other hand, T_3 (9 ton cow dung/ha) showed the highest uptake of nutrients except for S and Mg among the all treatments. In the post-harvest soil, the maximum nutrient contents increased in the highest doses of cow dung (except for the S, Cu, Mn and Zn) and poultry manure (except for the K, Ca, Mg and Fe) treatments. Results of the study showed that soil amendment (mixture of acid and calcareous soil) can be a suitable reclamation process while the addition of organic manures can also improve soil health.

Introduction

Industry-based booming economy of Bangladesh is shrinking the likeliness to get new land for more agricultural production. As a consequence, management of the lands having problem in crop production has gained immense attention of researchers[1]. Soil acidity and calcareousness are two of the most prevailing problem soils of Bangladesh. Approximately 27% of agricultural land of this country is acidic while calcareousness has been found to be problematic in lands covering about 27,000 sq. km[2]. Plants grown in the soil of low pH soils may the scarcity of basic cations such as calcium, magnesium,

*Author for correspondence: <bayazid@du.ac.bd>.

potassium etc. and toxicity of aluminum, manganese, hydrogen etc.[3]. Moreover, large quantities of aluminum and iron hydrous oxides are contained in acid soils which can adsorb and fix major elements when applied as fertilizer and make them unavailable for crop use[4]. Meanwhile, high pH of the soil comes with adverse effects of $CaCO_3$, low content of organic matter, nitrogen, phosphorous and other micronutrient, mainly zinc and iron[5]. By mixing the acid and calcareous soils, we may get an amended soil which might hopefully stabilize the soil pH in neutral point and provide all essential elements present in soluble and available forms.

Crop production in Bangladesh is now coping with several issues related to nutrient deficiency, such as growing intensity of land use, indiscriminate and imbalanced use of synthetic fertilizers, little or without organic manures[6]. On the other hand, soil organic matter is considered as the key component to ensure sustainable and eco-friendly crop productivity. Organic manure is one of the most commonly found and cheap but extremely effective organic matters in Bangladesh. It improves soil physical properties such as soil structure, aeration, infiltration, moisture retention capability etc.[7]. Moreover, cattle and poultry manures increases CEC, organic carbon, soil pH, nitrogen, phosphorus, potassium, calcium, magnesium etc. in a non-hazardous way without environmental pollution[8]. Hence, application of organic manure added with NPK fertilizer might improve the productivity of the manipulated soil than NPK alone.

Red amaranth has gained popularity for its rapid growing nature, cheapest price and higher yield potential and has been playing a vital role to ensure nutrition and food security[9]. Applications of cow dung and poultry manure to red amaranth have showed positive response in growth and yield[10,11]. Some studies were conducted by Miah *et al.*[9], Ghosh *et al.*[6] and Sattar *et al.*[12] on how organic manure, to be specific cow dung and poultry manure affect soil properties, growth and yield of red amaranth in Bangladesh. But no study has been conducted yet to light upon the uptake of mineral nutrient by red amaranth treated with cow dung and poultry manure in the manipulated (mixture of acid and calcareous soil) soil and soil properties of post-harvest soils.

In accordance of consideration of the above, the present study was designed with the following objectives:

a. To determine the major nutrient uptake by red amaranth grown with cow dung and poultry manure.
b. To observe the post-harvest condition of manipulated soil after being treated with organic manures.

Materials and Methods

The study done in the Department of Soil, Water and Environment, University of Dhaka to evaluate the response of the manipulated soil (a mixture of acid and calcareous soil) to the production of red amaranth, to determine its nutrient uptake and thereby properties of post-harvest soil after being treated with cow dung and poultry manure.

Acid soil was collected from Binnapara, a village under Dinajpur Sadar upazilla, of Dinajpur. The GPS location of the sampling site was $25^0 42^/ 52.58^{//}$N and $88^0 39^/ 36.07^{//}$ E. The sampling area is situated adjoining to a homestead area of the village. Collected acid soil of Binnapara was Non-Calcareous Brown floodplain soils belong to Pirgacha series. meanwhile, calcareous soil was gathered from a village named Poschim Gangabardi of Faridpur Sadar upazilla, Faridpur. The GPS location of the area was $23^0 34^/ 59^{//}$N and $89^0 47^/ 17.9^{//}$E. Soil sample was collected from a field of highland which was used mostly for pulse and vegetable cultivation. The collected calcareous soil of Poschim Gangabardi was a Calcareous Dark Grey Floodplain soil belongs to Sara series.

Soil samples were both air-dried for 4 days (at 40^oC) in a thin layer on a clean piece of polythene sheet in the laboratory. Visible debris and roots were expelled. After being air-dried, larger aggregates were crushed by gentle hammering by wooden hammer. A 2 mm stainless still sieve was used to screen the ground samples. After sieving, acid and calcareous soils were mixed properly at a ratio of 3 : 1. Physicochemical properties of the acid, calcareous and mixture of acid and calcareous (amended) soils are presented in Table 1. On the other hand, a part of soil samples (2 mm sieved) was ground more and sieve to pass through a 0.5 mm sieve. The sieved sample was preserved for further chemical and physicochemical analyses.

The pot experiment was conducted taking red amaranth as the test plant. Seeds of uniform size were selected for sowing. A basal dose of N, P, K and S for the growth of red amaranth were added from Urea, TSP, MP and Gypsum fertilizers respectively(13). Urea, TSP, MP and Gypsum were added at the rate of 120 kg N/ha, 60 kg P/ha, 40 kg K/ha and 16.67 kg S/ha soil, respectively. The rate of application of cow dung and poultry manure was (3, 6 and 9 ton/ha) and (2, 4 and 6 ton/ha), respectively. The nutrient content such as OC, N, P, K, S, Ca and Mg of cow dung and poultry manure were 6.65, 8.96; 0.4, 1.33; 0.20, 0.60; 0.31, 0.80; 0.09, 0.12; 0.30, 0.62 and 0.15, 0.30 respectively.

There were nine treatments with three replications.

T_A= Acid soil

T_C= Calcareous soil

T_{0M} = Mixture of acid and calcareous soils, henceforth termed as mixed soil (Control).

T_1 = 3 ton cow dung/ha in the mixed soil.

T_2 = 6 ton cow dung /ha in the mixed soil.

T_3 = 9 ton cow dung /ha in the mixed soil.

T_4 = 2 ton poultry manure/ha in the mixed soil.

T_5 = 4 ton poultry manure/ha in the mixed soil.

T_6 = 6 ton poultry manure /ha in the mixed soil.

Table 1. Physico-chemical characteristics of the acid, calcareous and mixed soils.

Characteristics	Acid soil	Calcareous soil	Mixed soil
Sand (%)	14.80	45.63	25.5
Silt (%)	60.82	36.79	54.40
Clay (%)	24.38	17.58	20.10
Texture	Silt loam	Loam	Silt loam
pH	4.50	8.30	6.38
OC (%)	1.08	0.89	1.005
OM (%)	1.86	1.54	0.173
C.E.C (cmol/kg)	6.46	12.50	9.86
Available N (mg/kg)	192.50	108.0	117.0
Total N (mg/kg)	960.0	1080.0	1067.0
Available P (mg/kg)	5.50	18.80	12.95
Total P (mg/kg)	1572.0	2880.0	2368.0
Available K (mg/kg)	58.53	103.28	80.39
Total K (mg/kg)	2734.0	5144.0	4313.60
Available S (mg/kg)	30.95	15.83	18.90
Total S (mg/kg)	1312.0	6540.0	1681.0
Available Na (mg/kg)	25.0	62.50	6.78
Available Ca (mg/kg)	300.50	3615.0	500.0
Available Mg (mg/kg)	97.50	208.0	179.0
Available Fe (mg/kg)	103.10	15.38	49.40
Available Mn (mg/kg)	37.52	15.70	27.70
Available Cu (mg/kg)	0.67	1.03	0.514
Available Zn (mg/kg)	2.44	1.30	1.118

Air dried and manipulated 2 kg soil samples (3 : 1 acid: calcareous) were put in each pot. Total amount of phosphorus, potassium, sulphur and half of the nitrogen were during soil preparation of pot. Remaining nitrogen was applied at 15 days after sowing seeds. Cow dung and poultry manure were applied one week before sowing due to facilitate decomposition and uniform mixing. Inorganic fertilizer was added 2 day before sowing. Then 10-12 seeds were sown in each pot. Certified uniform red amaranth seeds (BARI-1) were collected from Krishibid nursery at Khamarbari, Farmgate, Dhaka. Weeds were removed by hand.

Plants were grown for 45 days, after then they were harvested as shoots and roots. The plants were put into the plastic bag with proper labeling and immediately brought them in the laboratory. Fresh weight was measured with an electric balance immediately after harvest. Then the samples were chopped down into small pieces and first air dried and then oven dried at $70^0 \pm 5^0C$ for 48 hours. After being oven-dried grinding was done with mortar and pestle and passed and then plant samples were passed through a 0.5 mm stainless sieve. The sieved plant samples were taken in plastic bottles and preserved in dry place for chemical analysis.

After harvesting, soil samples were collected from each treatment. Collected samples were then air dried, grounded and passed through 2 mm sieve and stored in plastic bottles. Hydrometer method was used to determine the particle size analysis[(14)]. Textural classes of the sample soils were done by Marshall's triangular co-ordinates as driven by the United States Department of Agriculture[(15)]. A glass electrode pH meter was utilized to measured soil pH selecting the ratio of soil and water as 1: 2.5. The organic carbon content was determined according to wet oxidation method of Walkely and Black[(16)]. Organic matter content was calculated by multiplying conventional Van Bemmelen's factor of 1.724[(16)] with organic carbon in percentage. Micro Kjeldahl's method[(16)] was used to determine total nitrogen of the soil. The distillation was done with 40% NaOH and the distillate was collected on a 4% Boric acid mixture indicator. The distillates were titrated against 0.00995 N sulphuric acids (H_2SO_4). The total phosphorus content was measured by colorimetric method using a Shimadzu UV-VIS spectrophotometer wave length with a range of 400 to 490 nm by making yellow color with vanadomolybdate after the extract was collected by digesting the soil with aqua-regia ($HCl:HNO_3$ = 3:1) as described by Jackson[(16)]. Total potassium content in soil samples was determined by the aqua-regia digestion method followed by a flame photometer[(16)]. After digestion of the soil with aqua-regia, the extract was used to determine the total sulphur content by turbidimetric method[(18)].

The available nitrogen was determined by reducing the nitrate to ammonia by suitable reducing agent (Devarda's alloy) in 40% and then ammonia formed from nitrate N was determined by alkali distillation[(18)]. Available phosphorus was extracted by using the Bray and Kurtz method for pH less than 7 and Olsen method for pH greater than 7 and determined by a Shimadzu UV-VIS spectrophotometer at 880 nm. Available potassium was estimated by a flame photometer (Jenway PFP7) with filters of 766 or 769 nm after extracting the soil with 1N Ammonium acetate at pH 7.0[(16)]. Sulphur content was determined by turbidity of suspended barium sulphate using Tween-80 as stabilizer and a Shimadzu UV-1800 spectrophotometer at 420 nm[(16)] was used to measure the turbidity. Copper, iron, zinc and manganese were analyzed by atomic absorption spectrophotometer (Varian AA240). The ground plant sample was digested by nitric and perchloric acid. Nutrient contents of plant were determined from the digest. Plant N was measured with the help of Micro-Kjeldhal's method. After wet oxidation with HNO_3 and $HClO_4$, P, S, K, Ca, Mg, Zn Fe, Mn, and Cu of plant were determined by following the procedures mentioned earlier for soil.

The significant difference between treatments was analyzed by using one-way analysis of variance (ANOVA). LSD test was also performed. Statistical analyses were conducted using Microsoft Excel (2010) and SPSS (version 20) at > 95% confidence level ($p < 0.05$).

Results and Discussion

Uptake of nitrogen, phosphorous, potassium, sulphur, calcium and magnesium by Red Amaranth: Uptake of major mineral nutrients in red amaranth shoots were measured (Fig. 1). Data revealed that uptake was better in manipulated (control) soil in comparison to the acid and calcareous soil. This might happen due to favorable soil reaction created in manipulated soil by mixing acid and calcareous soil. The pH obtained here (6.38) is close to the neutral range which facilitated more nutrient availability to plants and thus better nutrient uptake occurred. The application of cow dung (3, 6, 9) ton/ha and poultry manure (2, 4, 6) ton/ha improved the uptake of N, P, S, Ca and Mg in red amaranth shoot significantly ($p \leq 0.05$) for all the treatments in comparison to those in control. Uptake of N, P, S, Ca and Mg generally increased with the increasing rate of cow dung and poultry manure. However, the rate of increase was not a regular one. The highest uptake of N (47.11 mg/pot) was observed in T_3 (9 ton/ha cow dung) while the lowest (15.97 mg/pot) was found for T_{0M} (control) treatment. On the other hand, the highest uptake of P (14.87 mg/pot) was found for T_3 (9 ton/ha cow dung) and the lowest in T_{0M} (control) treatment. Uptake of K by red amaranth was the highest (65.25 mg/pot) for T_3 (9 ton/ha cow dung) and the lowest in T_{0M} (control). Moreover, the highest uptake of S (8.70 mg/pot) was determined in T_6 (6 ton/ha poultry manure) while the lowest (3.03 mg/pot) case was found for the control (T_{0M}) among all the treatments. Highest (21.66 mg/pot) uptake of Ca was obtained in T_3 (9 ton/ha cow dung) and the lowest (7.26 mg/pot) was found in T_{0M} (control). In addition, the uptake of Mg in red amaranth experienced the highest (25.88 mg/pot) uptake in T_2 (6 ton/ha cow dung) while the lowest (8.79 mg/pot) was for the control (T_{0M}) among all the treatments concerned.

It is noted that accumulation of major mineral nutrients showed increase with increasing rate in case of cow dung. In contrast this trend was not followed in case of N, P, K, Ca and Mg when the plant was treated with poultry manure. Higher doses of poultry manure resulted in a decrease in the uptake of N, P, K and Ca in comparison to the lower doses. The reason might be attributed to the adverse effect of highest rate of poultry manure in the plant. But in case of S and Mg no such adverse effect was observed but remained identical to the immediate lower doses of poultry manure.

The increasing uptake of N, P and K by red amaranth with increasing doses could be as a result of the high nitrogen, phosphorus and potassium content in cow dung and poultry manure as reported by Reyhan and Amisalani[19]. Results of this study also concede with the findings of other studies[20,10]. Asghar[21] noted the significant increase of nitrogen uptake by radish in case of integrated use of organic manure and N fertilizer. Similar results were also reported by Djurovka[22]. Significant increase of P concentration was observed with enriched compost[21]. Asghar[21] reported a maximum K uptake where organic manure was applied.

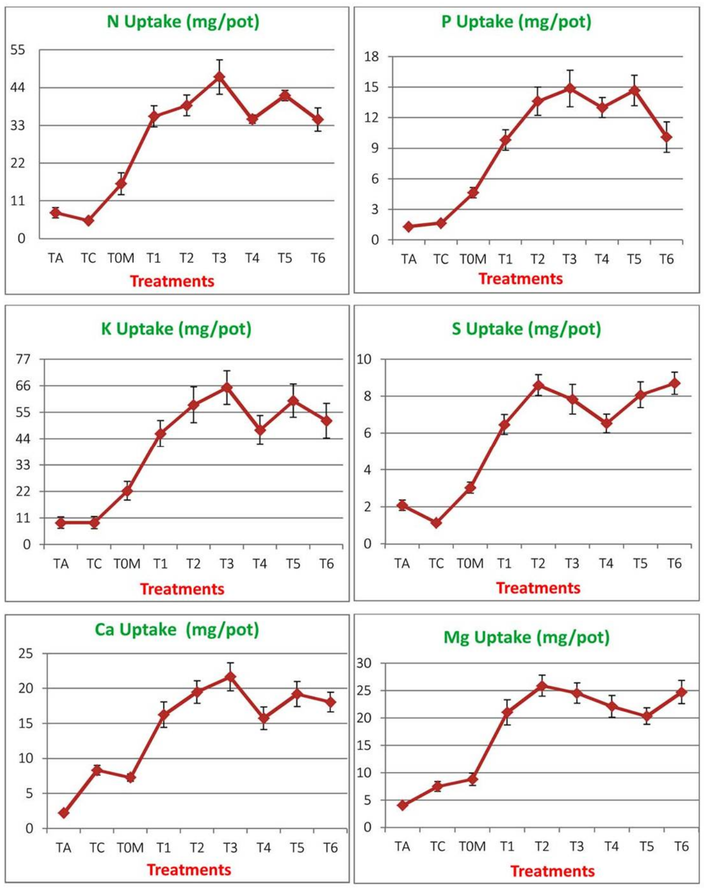

Fig. 1. Uptake of nitrogen, phosphorous, potassium, sulphur, calcium and magnesium by Red Amaranth.

Properties of Post-harvest Soil

Soil pH: The pH of the acid soil (T_A) was the lowest (4.5) whereas the highest (8.2) in calcareous soil (T_C). The manipulated soil (T_{0M} : control) provided optimum pH value for crop growth than those of the individual acid and calcareous soils which might be due to mixing effect of high and low pHs (Table 2). Meanwhile, considering the application doses of cow dung and poultry manure, the pots received cow dung (T_1 to T_3) exerted the maximum reduction of pH value, indicates an increase in acidity though the medium dose of cow dung showed slight increase in pH resulting decrease in acidity over the control (Table 3).

Table 2. Effects of soil manipulation on the available major elements in post-harvest soils.

Treatment (t/ha)	pH	% OC	N content (mg/kg)	P content (mg/kg)	K content (mg/kg)	S content (mg/kg)	Ca content (mg/kg)	Mg content (mg/kg)
T_A	4.50	1.51±0.06	1.06 ± 4.21	10.47 ±0.61	56.67± 3.22	33.61± 2.38	390 ± 12.14	165.53±8.13
T_C	8.30	0.56± 0.03	49.20 ± 3.2	11.80 ±0.26	90.00± 5.53	14.63± 0.92	1440.1±15.0	321.43±15.20
T_{0M}	6.38	1.04± 0.05	54.00±3.67	12.70±0.30	96.33±4.90	17.54±0.81	402.10±9.39	238.95 ±7.32

Table 3. Available major elements in post-harvest mixed soil as influenced by cow dung and poultry manure.

Treatment (t/ha)	pH	% OC	N content (mg/kg)	P content (mg/kg)	K content (mg/kg)	S content (mg/kg)	Ca content (mg/kg)	Mg content (mg/kg)
T_{0M}	6.38	1.04	54.00	12.70	96.33	17.54	402.10	238.95
T_1	6.77	1.19	58.10	13.38	143.67	27.55	480.50	253.88
T_2	6.83	1.24	63.25	14.80	163.00	29.22	562.25	263.78
T_3	6.5	1.36	64.80	17.02	170.00	27.00	746.00	281.00
T_4	6.73	1.30	52.70	14.00	160.67	28.67	502.25	256.63
T_5	7.13	1.41	60.80	15.8	162.67	35.15	612.00	295.00
T_6	6.87	1.49	66.00	15.87	131.00	37.73	590.75	292.83
LSD at 5%		0.28	4.40	NS	45.30	5.11	27.37	16.69

Between the organic treatments, the poultry manure resulted in the highest pH value (7.13) with the T_5 (4 ton/ha) which was due to that the poultry manure contained varying amounts of calcium carbonate(23) but the highest dose (T_6) did not support this findings. The maximum increase (6.5) in acidity, i.e. decrease in pH was noted in treatment having the highest (9 ton/ha) dose of cow dung (T_3). This might be due to organic matter which released organic acids through decomposition leading to a decreasing effect on soil pH(24)(25). Yadav *et al.*(26) reported the significant decrease of soil pH with the addition of farmyard manure.

Organic carbon: The mixed soil (control) had 1.01% organic carbon initially (Table 1) which remained almost same (1.04%) in the post-harvest control soil. The highest (1.51%) organic C content was determined in acid soil (T_A) and the lowest value (0.56%) was recorded in the calcareous soil (T_C). Manipulation of soil provided a medium organic C in between acid and calcareous soil (Table 2). Meanwhile, different treatments of cow dung and poultry manure increased the organic carbon content of soil compared to control at

5% significant level (Table 3). The maximum content of C was found in soil treated with poultry manure at a rate of 6 ton/ha (T_6). The lowest dose (T_4) of poultry manure did not significant in increasing C content, while the medium (T_5) and highest doses (T_6) showed significant increments in C contents. Almost similar trends were observed in the increment in C content with increased rates of poultry manure. Addition of cow dung 3 ton/ha (T_1) and 6 ton/ha (T_2) showed an increased trend in C content of the soil, though the results are not significant. However, the highest dose of cow dung (T_3) showed a significant increase compared to the control at 5% level but the increment was not significant with T_2, the medium dose of cow dung (6 ton/ha).

Application of organic manures such as cow dung and poultry manure exhibit an increase of soil organic carbon as mentioned by several researchers [7][10][20]. Mathew and Nair[27], reported that the organic carbon was increased by the application of organic manure. The positive impact of cow dung and poultry manure on the soil organic carbon might be due to the high organic carbon status and slow decomposition rate of those applied manures[28].

Available nitrogen: The content of available N increased (54 mg/kg) in the mixed soil (T_{0M}- control) in comparison to individual acid (51 mg/kg) and calcareous soils (49 mg/kg) (Table 2). On the other hand, the effects of cow dung and poultry manure on the available N content of amended soil were positively significant at 0.5% level except for T_1 (3 ton/ha cow dung) and T_4 (2 ton/ha poultry manure). Both the cow dung and poultry manure treated soils showed consistent increasing trend in N content with increasing doses (Table 3). However, the maximum content of available N (66 mg/kg) was recorded with 6 ton/ha poultry manure per hector (T_6), while the lowest (52.7 mg/kg) was found in T_4 (2 ton/ha poultry manure).

The trend of increasing available N with increasing rates of manures could be result of increased organic matter content and microbial activities which might have enhanced the decomposition of the organic N. Similar result was reported by Mondal *et al.*, Sanni and Monira *et al*.[7,10,29] . On the contrary, Ogunbanjo *et al.* observed that poultry manure caused the highest soil available N compared to other animal manures[30].

Available phosphorus: Available P was slightly higher (12.7 mg/kg) in manipulated soil (T_{0M}) in comparison to acid (T_A) and calcareous (T_C) soils (11.8 mg/kg and 10.47 mg/kg respectively) as delineated in Table 2. Since phosphorus availability is pH de pendent and at near neutral pH, P availability increases[3]. The present results are in accordance with this. The effects of cow dung and poultry manure on the P content of manipulated soil were not significant. Addition of cow dung increased the soil P content consistently while poultry manure also increased but did not follow the trend (Table 3). The highest content of available P (17 mg/kg) was recorded for the T_3 (9 ton cow dung/ha) treatment and the lowest (13.38 mg/kg) in T_{0M} (control) so far the treatments were considered (Table 3).

Comparison between these two manures indicated that the poultry manure exerted higher response relative to cow dung. Maerere *et al.*[31] reported significant higher residual P in soils treated with poultry manure comparing to other types of manure. These findings are also supported by the reports of Akanni and Ojeniyi[32] and Adeleye *et al.*[33].

Available potassium: The availability of K was higher (96.33 mg/kg) in mixed soil (T_{0M}) in comparison to individual acid (56.67 mg/kg) and calcareous soils (90 mg/kg) as pictured in Table 2. This indicates manipulation increases the available content soil K. On the other hand, the different rates of cow dung and poultry manure significantly increased the available K content of the soil at 5% level comparing to manipulated soil (T_{0M}). The maximum available K content (170 mg/kg) was observed with the T_3 treatment (9 ton cow dung/ha) and the lowest (96.33 mg/kg) in T_{0M} (control) so far the treatment were concerned (Table 3). Poultry manure had resulted an increase in K content of soil significantly over the control, except for the highest rate (T_6) of poultry manure where the increment was not significant.

The present findings partially agree with the results of Olowoake and Adeoye[34], who reported that the organic manure increased soil K. They suggested that increase of available K might be as a result of the slow rate in which their nutrients are released into the soil. Islam[25] evaluated that poultry manure showed the best performance on available K than their combination with inorganic fertilizer.

Available sulphur: The content of available S was found highest (33.61 mg/kg) in acid soil (T_A) followed by (17.54 mg/kg) mixed soil (T_{0M}) (Table 2). On the contrary, considering the treatments applied, the highest available content of available S (37.73 mg/kg) was found in T_6 (6 ton poultry manure/ha) and the lowest (17.54 mg/kg) in control (T_{0M}). The different treatments of cow dung and poultry manure significantly ($p \leq 0.01$) increased the available sulphur content of the soil (Table 3). Increase of available S for increasing doses of poultry manure was found to be consistent but the trend was not same for cow dung doses. Similar finding was reported by Ansari[35]; stated that, the effect of poultry manure was superior to other organic treatments for available S in soil which support this study.

Available calcium: The highest available Ca content (1440.08 mg/kg) was found in calcareous soil (T_C) and the lowest value (390 mg/kg) found in case of acidic (T_A) soil. The control soil (T_{0M}) containing Ca content was in between (402.1 mg/kg) acid and calcareous soil (Table 2). Calcium content of soil after harvest due to cow dung and poultry manure treatment showed variation over the control and among the treatments significantly (at 0.1% level). Maximum content of Ca (746 mg/kg) was found treated with 9 ton cow dung per hector (T_3). On the other hand, the minimum available Ca content was in control treatment. Increasing of available calcium content was consistent with increasing doses of cow dung but highest dose (T_6) of poultry manure caused a decrease in Ca content than the medium dose, T_5 (Table 3). Higher Ca status of cow dung and poultry manure might amend the soils due to the Ca supplied to the soil from the decomposition of these organic amendments. These findings fall in line with the results of several researchers(8,32,36).

Available magnesium: The content of available Mg was found highest (321.43 mg/kg) in calcareous soil and the lowest content of Mg (163.53 mg/kg) was found in acid soil (Table 2). The positive effect of cow dung and poultry manure on soil Mg was significant at 0.1% level except in T_1 (3 ton cow dung/ha). Cow dung application at increasing rate showed consistent increase in Mg content of soil but for poultry manure, it was inconsistent as its highest dose (T_6) caused slight decrease from its medium dose, T_5 (Table 3). Similar reports were attributed by Akannni and Ojeniyi(32) and Adeleye *et al*.(33) as they showed that poultry manure and cattle manure improved Mg status of soil.

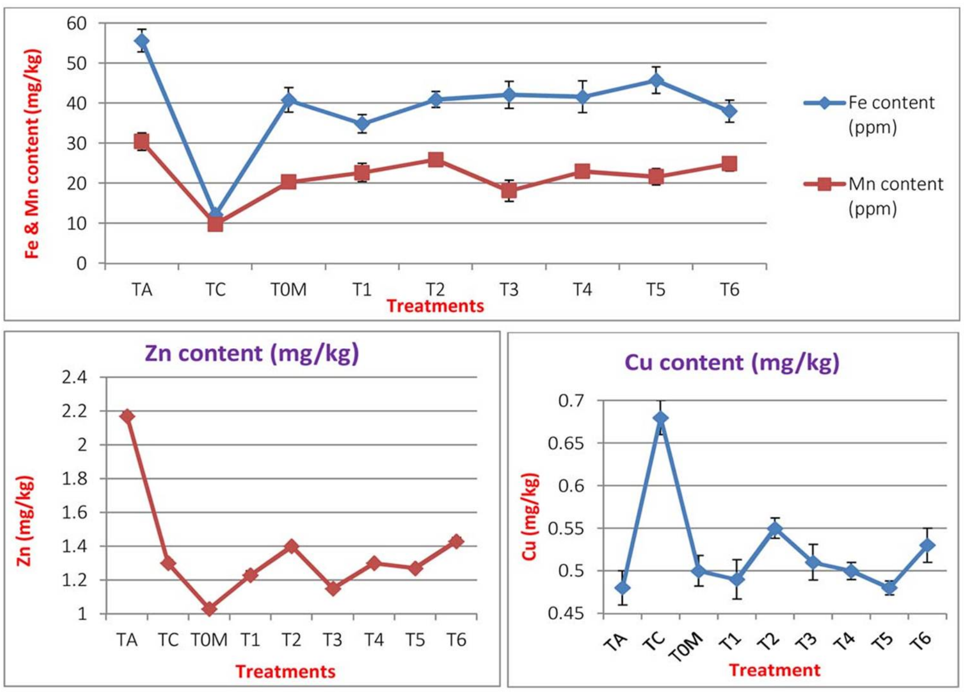

Fig. 2. Effects of soil manipulation, cow dung and poultry manure on Fe, Mn, Zn and Cu content of post-harvest soil.

Micronutrient status in the post-harvested soil: The micronutrients (Cu, Fe, Mn and Zn) content of soil varies considerably with different treatments (Fig. 2). Micronutrients decreased in post-harvest control soil than the initial manipulated soil. This might be due to the uptake of plants. Addition of organic manures increased the concentration of micronutrient comparing to control but no definite trend was observed (Fig. 2)

Conclusion

Based on the findings of the experiment, it can be said that the pH, organic carbon, major nutrients (N, P, K, S, Ca and Mg) and micronutrients (Cu, Fe, Mn and Zn) status of the amended soil (control) were favorably influenced by soil amendment (mixing of acid and calcareous soil). So, the mixed soil (control) performed better uptake of nutrients by red amaranth plant than those of the individual acid and calcareous soils. Moreover, the use of animal manure in crop production is desirable as it had improved the uptake of plant nutrient significantly from the control in case of almost all nutrients. Among the treatments, application of cow dung at a rate of 9 ton/ha (T_3) showed the highest uptake of nutrients except S and Mg. In post-harvest mixed soil, cow dung and poultry manure application improved the physico-chemical status and increased nutrient contents positively. The best performance was showed in T_3 (9 ton cow dung/ha) and T_6 (6 ton poultry manure/ha). Soil of Bangladesh is losing its natural fertility and productivity. So, it can be suggested that acid soil can be reclaimed by mixing with calcareous soil and animal manure can be added for further improvement of soil health.

References

1. Rahman MM and GM Azam 2005. Fertility evaluation of Old Meghna River Floodplain soils in Bangladesh for sustainable agriculture. Chiang Mai J. Sci. **32** (2): 127-137.
2. Hossain MB, HR Khan, S Khanom and SA Hossain 2021. Amelioration of soil acidity by the application of maize straw ash in mixed soil. Dhaka Univ. J. Biol. Sci. **30**(2): 207-219.
3. Brady NC and RR Weil 2002. Soil acidity pp. 363-364. *In: The Nature and Properties of Soils*. 13th edn., Pearson Education Private Ltd., Patparganj, Delhi 110 092, India. pp. 363-364.
4. Akinrinade EA, L Iroh, GO Obigbesan, T Hilger, V Romheld and G Neumann 2006. Response of cowpea varieties to phosphorus supply on an acidic alumi-haplic-Acrisol from Brazil. Nig. J. Soil Sci. **16**: 115-120.
5. Lucas RE and BD Knezek 1972. Climatic and soil conditions promoting micronutrient deficiencies in plants. *In:* J.J. Mortvedt *et al.* (ed.). Micronutrients in Agriculture. Soil Science Society of America, Inc., Madison, WI. pp. 265-288.
6. Ghosh A, M Tahjib-Ul-Arif, SG Chamely, MR Haque, MM Rahman and MAH Bhuiyan 2017. Comparative effect of arbuscular mycorrhiza, cowdung and phosphorus on growth and yield contributing characters of red amaranth (*Amaranthus tricolor* L.) and Indian spinach (*Basella alba* L.). Tropical Plant Research **4**(2): 254-263.
7. Mondal MMA, F Ahmed, KME Nabi, MMA Noo and MTR Mondal 2019. Performance of organic manures on the growth and yield of red amaranth (*Amaranthus tricolor*) and soil properties. Res. Agric. Livest. Fish. **6**(2): 263-269.
8. Ewulo BS 2005. Effect of poultry and cattle manure on sandy clay loam soil. J. Animal & Veterinary Sci. **4**: 839-841.

9. Miah MY, P K Roy, MS Islam and KI Fazal 2013. Stem amaranth yield in response to organic manuring. J. Environ. Sci. & Natural Resources **6**(2): 19 -23.
10. Sanni KO 2016. Effect of compost, cow dung and NPK 15-15-15 fertilizer on growth and yield performance of amaranth (*Amaranthus hybridus*). Int. J. Advanced Sci. Res. **2**: 76-82.
11. Adekiya AO, CM Aboyeji, O Dunsin, FF Asamu, AO Owolabi, CO Aremu, DA Oyetunji, AD Oloye and IO Owolabi 2019. Poultry manure addition affects production, plant nutritional status and heavy metals accumulation in green amaranth (*Amaranthus hybridus*). Intl. J. Agric. Biol. **22**: 993-1000.
12. Sattar MA, MS Ali, AB Siddik and MA Hashem 2007. Effect of different organic fertilizers on growth and yield of mukhi kachu cv. Sali kachu. Bangladesh J. Environ. Sci. **13**(2): 439-442.
13. FRG (Fertilizer Recommendation Guide) 2012. Bangladesh Agricultural Research Council, Government of Bangladesh. pp. 274.
14. Black CA 1965. *Methods of Soil Analysis*. Part 2. Agron. series 9. American society of agronomy. Madison. Wisconsin. pp. 891-899.
15. USDA (United States Department of Agriculture), 1951. Soil Survey Manual. Soil Survey Staff, Bureau of plant Industry, Soils and Agricultural Engineering, United States Department of Agriculture, Washington. Handbook No. 18. pp.205.
16. Jackson ML 1973. *Soil Chemical Analysis*. 1st ed. Prentice-Hall Inc., Englewood Cliffs. NJ. pp. 498
17. Piper CS 1950. *Soil and Plant Analysis*. The University of Adelaide Press. Adelaide. Australia. pp. 368.
18. Huq SMI and MD Alam 2005. *A Handbook on Analyses of Soil, Plant and Water*. BACER-DU, University of Dhaka, Bangladesh. pp. 32-123.
19. Reyhan MK and F Amisalani 2006. Studying the relationship between the vegetation and physicochemical properties of soil: Case study, Tabas region, Iran. Pakistan J. Nutrition **5**: 169-171.
20. Noor S, NC Shil and AT Farid 2007. Integrated nutrient management for radish-tomato-red amaranth-Indian spinach cropping pattern in a homestead area. Bangladesh J. Agric. Res. **32**: 17-28.
21. Asghar HN, M Ishaq, ZA Zahir, M Khalid and M Arshad 2009. Response of radish to integrated use of nitrogen fertilizer and recycled organic waste. (Available at http://www.pakbs.org/ pjbot/ PDFs/ 38(3)/ PJB **38**(3) 691. Pdf. Accessed 23 December 2010).
22. Djurovka MV Markovic and Z Ilin 2009. The effect of nitrogen fertilizer on the dry matter content and mineral elements in radish. (Available at http://www.actahort.org/ members/ showpdf?booknra/rnr=462-17. Accessed 17 June 2009).
23. Camberato J and C Mitchell 2011. Liming value of poultry manures. (Available at http://hubcap. clemson.edu/~ blpprt /acidity2_poultry.html (Accessed 20 June 2011).
24. Chen Y and Y Avenmelech 1986. The role of organic matter in modern agriculture. Soil Ferti. J. **56**(7): 306.

25. Islam MS, S Jamal, MS Hossain, F Ahmed, IU Ahmed and R Yesmin 2006. Effect of manure and chemical fertilizers on growth and yield of red amaranth. Bangladesh. J. Environ. Sci. **12**(1): 217-221.

26. Yadav AC, SK Sharma and BR Batra 2002. Effect of sodic water, FYM and gypsum on the soil, growth and yield of brinjal. Ann. Agric. Bio. Res. **7**(1): 73-77.

27. Mathew T and SS Nair 1997. Physical and chemical properties of rice soils as influenced by organic and inorganic source of nutrients. Indian Journal of Agricultural Research **31**(4): 257–61

28. Cooperband L 2002. Building soil organic matter with organic amendments. Centre for Integrated Agricultural Systems. University of Winsconsin. Mdison, September, 2002. p. 13.

29. Monira US. MY Miah, MAB Mia and GKM Rahman 2007. Tomato fruit yield in response to organic manuring. J. Agril. Edu. Technol. **10**: 93-98.

30. Ogunbanjo OR, JA Omueti, IOJ Jajeoba, JA Omolaiye, IO Abiola and NE Uzokwe 2007. Yield response of maize to animal manures and bulking agents in fortified composts. Int. J. Agric. Sci. **7**(1): 87-98.

31. Maerere AP, GG Kimbi and DLM Nonga 2001. Comparative effectiveness of animal manures on soil chemical properties, yield and root growth of amaranthus (*Amaranthus cruentus L.*). African J. Sci. Technol. **1**(4): 14-21.

32. Akanni DI and SO Ojeniyi 2008. Residual effect of goat and poultry manures on soil properties, nutrient content and yield of amaranthus in southwest Nigeria. Res. J. Agron. **2**(2): 44-47.

33. Adeleye EO, LS Ayeni and SO Ojeniyi 2010. Effect of poultry manure on soil physico-chemical properties, leaf nutrient contents and yield of yam (*Dioscorea rotundata*) on alfisol in south-western Nigeria. J. Am. Sci. **6**(10): 871-878.

34. Olowoake AA, and GO Adeoye 2013. Influence of differently composted organic residues on the yield of maize and its residual effects on the fertility of an Alfisol in Ibadan, Nigeria. Intl. J. Agric. Env. Biotech. **6**(1): 79 - 84.

35. Ansari A 2005. Effect of organic farming on soil nutrients and quality of carrot. Unpublished M. S. Thesis. Dept. of Environ. Sci. Bangladesh Agril. Univ., Mymensingh.

36. Uwah DF, GO Ukoha and J Iyango 2012. Okra performance and soil and water conservation as influenced by poultry manure and organic mulch amendments. J. Food, Agric, Environ. **10**(1): 748-754.

(Manuscript received on 25 April, 2022; revised on 19 June, 2022)