**Impacts of Cow Dung and Poultry Manure on the Growth and Nutrient Content of Red Amaranth** **Grown in A Mixture of Acid and Calcareous Soils**

**Integrated Effects of Cow Dung, Poultry Manure and Soil Mixing on the Growth and Nutrient Content of Red Amaranth**

**A Comparative Study on the Effects of Cow Dung and Poultry Manure on the Growth and Nutrient Content of Red Amaranth Grown in A Mixture of Acid and Calcareous Soils**

ABSTRACT

An incubation study followed by a pot experiment was conducted to evaluate the effects of cow dung and poultry manure on the growth of red amaranth grown in the manipulated soil (mixing acid and calcareous soils). Acid and calcareous soils were mixed at different ratios and the changes in pHs were observed for 18 days of incubation. The ratio 1:3 (calcareous: acid soils) showed the best pH and thus chosen for pot experiment with red amaranth. The pot experiment was carried out with the manipulated soil (control-where no amendment was added), cow dung (3, 6 and 9 t/ha) and poultry manure (2, 4 and 6 t/ha). Treatment responses were evaluated in terms of plant height, fresh matter, dry matter production and contents of N, P, K, S, Ca, Mg, Cu, Fe, Mn and Zn in plant shoots. It is evident from the experiment that the plant growth was best in the manipulated soil (control) than those of the acid and calcareous soils. The maximum plant height, fresh and dry weight, nutrient contents of plants and their uptake were observed with the highest dose of cow dung (except for the S, Mg and Zn) and medium dose of poultry manure (except for the N, S, Mg and Fe). In the post harvested manipulated soil, the maximum nutrient contents were resulted with the higher doses of cow dung (except for the S, Cu, Mn and Zn) and poultry manure (except for the K, Ca, Mg and Fe) treatments. The results of the present study revealed that soil manipulation (mixing of acid and calcareous soils) can be a suitable reclamation process while the addition of organic manures can also improve soil health suggested that the process of reclamation and application of organic manures acted synergistically. But further research is needed for their sustainable and environmental concerns under variable climate and crop responses.

INTRODUCTION

Agriculture in Bangladesh faces the challenge of producing crops from its limited land resource to meet up the huge demand of foods for its ever-growing population. The scope is limited to bring new land under cultivation. Therefore, management of lands particularly which are deficient in nutrients, for increased production is of immense necessary (Rahman and Azam, 2005).

Soils are neither “good” nor “bad” because the distinction is often based on their intended use. However, many soils have characteristics that need specific management interventions desirable to avoid problems for agricultural use or to prevent environmental degradation. Problem soil is the soil that causes additional problems from the engineering point of view as a result of the circumstances of its composition or a change in environmental conditions. Both acid and calcareous soils are considered as problem soils because of their nutrient deficiency.

In the context of agricultural problem soils, acid soils are highly weathered and contain large quantities of Al and Fe hydrous oxides that have the ability to adsorb major elements onto their surfaces such that much of added nutrients are fixed instead of being made available for crop use (Akinrinade *et al*., 2006). Plants grown in acid soils can experience a variety of symptoms including aluminium (Al), hydrogen (H), and/or manganese (Mn) toxicity, as well as nutrient deficiencies of calcium (Ca) and magnesium (Mg) ( Brady and Weil, 2002). It is a major environmental and economic concern. If untreated, acidity will become a problem in the subsurface soils, which are more difficult and expensive to ameliorate. Acidic soils cause significant losses in production and where the choice of crops is restricted to acid tolerant species and varieties, profitable market opportunities may be reduced.

On the other hand, calcareous soils are soils in which a high amount of calcium carbonate dominates the problems related to agricultural land use. They are sometimes reffered to as alkaline soils, but they are distinguishable from other soils with high pH. The pH range of calcareous soils is from 7.0 to 8.5 (Yaalon, 1957). In calcareous soils where pH is high and CaCO3 is dominated, plants suffer low availability of P and K would cause problems more serious than their deficiencies. They generally have low contents of organic matter, nitrogen, phosphorous and other micronutrient especially zinc and iron (Lucas and Knezek,1972).

By mixing the acid and calcareous soils, we may get a manipulated soil which might hopefully provide all essential elements present in soluble and available forms. In this manipulated soil the pH will attain near neutral condition. Nutrient availability in soil depends on pH. Most plant nutrients are available in neutral soil having pH 6.6 to 7.4. This is a new idea. This can be called a reclamation process in which one problematic soil reclaims another problematic soil. They neutralize each other so that plant nutrients can be available.

Application of different types of organic manures and NPK fertilizer enhanced availability of soil nutrients and increased cation exchange capacity considerably in both acid and calcareous soils. The applications of organic manures performed favorably the same or better than NPK fertilizer. They can improve the health of the manipulated soil.

Organic sources are the major components of sustainable agriculture. There are many organic sources in Bangladesh. The main organic source is cattle manure and another important source is poultry manure. The production of cattle manure in the countries is about 225 million tons and that from other animals and poultry is about 9.3 million tons per year (BBS, 2004). Cattle has 0.74% N, 0.28% P, 0.163% K and poultry litter has 1.52% N, 0.62% P, and 0.526 % K (Islam *et.* *al*., 2006). By using the organic manure soil fertility is increased and quality crops can be produced (Huda, 2002).

Animal manures are derived from animal feces which can be used as organic fertilizer in agriculture. It can maintain a healthy soil environment for plant growth and development. This can reduce the use of chemical fertilizers in agriculture, which indirectly helps a friendly environment. Further organic manure like cow dung is a good source of plant nutrients (Solaiman and Rabbani, 2006) and cow dung and poultry manure could be beneficially applied in agronomic and horticultural crop production (Noor *et al*. 2001, Rahman *et al.*2005). Under these circumstances, the present study was undertaken to verify the ability of cow dung and poultry manure with respect to red amaranth production.

As one of the nutritious and delicious vegetables red amaranth is a popular vegetable in Bangladesh because of its cheapest price, quick growing character and higher yield potential. Additionally it is considered as a potential subsidiary food crop (Tutonic and Knorr, 1985). Thus Amaranth plays a predominant role both in nutrition and food security.

Some studies were conducted by Hossain and Ahammad (2007) and Sattar *et. al.* (2007) on the effects of cow dung and poultry manure on soil properties, growth and yield of red amaranth in Bangladesh. But no study was conducted on the effect of cow dung and poultry manure in the manipulated soil.

In accordance of consideration of the above discussed factors, the present study was undertaken with the following objectives:

* To know the nutrient status of the acid and calcareous soils.
* To determine the status of elements after manipulation.
* Response of red amaranth (lal shak) to the manipulated soil amended with cow dung and poultry manure.

MATERIALS AND METHODS

The experiment was carried out to evaluate the response of the manipulated soil, a mixture of acid and calcareous soil, to the production of red amaranth and thereby determining its nutrient content. The experiment also emphasized on the effect of cow dung and poultry manure on the growth of red amaranth. The experiment was conducted in the Department of Soil, Water and Environment, University of Dhaka.

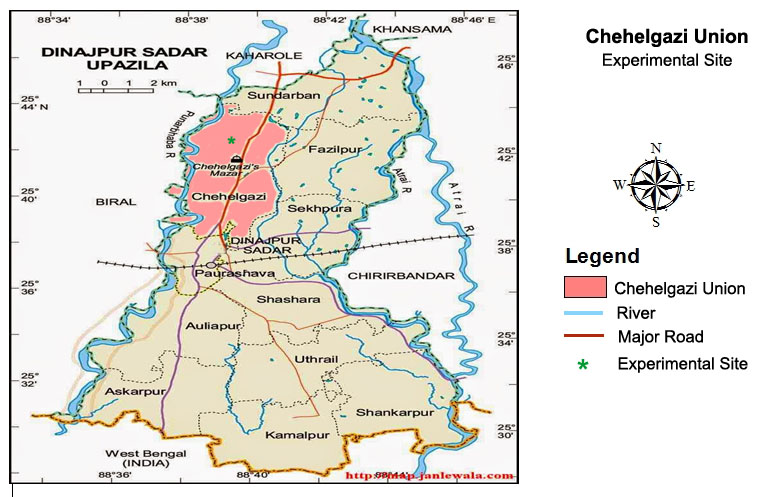
The work for the completion of the experiment was divided into three parts:

* Incubation study
* Pot experiment
* Physical and chemical analysis

**3.1 Collection of soil sample for pot experiments**

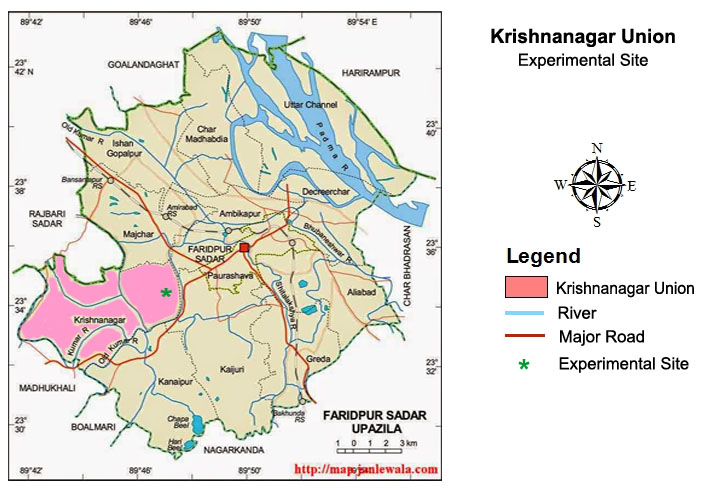
**3.1.1 Selection of sampling site and location**

Two distinguished soil types were collected from two different area of Bangladesh. Acid soils was collected from Binnapara, which is village of Chehelgazi union of Dinajpur Sadar upazilla in Dinajpur district (Fig.3.1).The geographic location of Binnapara is 25042/52.58//N and 88039/36.07// E. The sampling area is situated adjoining to a homestead area of the village.



**Fig.3.1: Map of Chehelgazi union**

On the other hand, calcareous soil was collected from Poschim Gangabardi, a village of Krishnonagar union of Faridpur Sadar upazilla in Faridpur district (Fig. 3.2). The spatial location of the sampling site is 23034/59//N and 89047/17.9//E. Soil sample was collected from a highland field which is used for pulse and vegetable cultivation.



**Fig.3.2: Map of Krishnanagar union**

Collected acid soil of Binnapara are Non-Calcareous Brown floodplain soils belong to Pirgacha series.

* **Pirgacha series:**

This series comprises seasonally flooded, moderately well drained soils of silt loam texture with relative low soil reaction which limits crop potentialities. The soil series, texture and various physico-chemical properties of the sampling soils are listed in Table 3.4.

On the contrary, collected calcareous soil of Poschim Gangabardi is a Calcareous Dark Grey Floodplain soil belongs to Sara series.

* **Sara series:**

This series comprises of soils of loamy texture, low water holding capacity and partially flooded during monsoon. The top soils contain lime and are moderately to highly alkaline in reaction. Diagnostic horizons and features recognized in this pedon are an umbric epipedon from the surface to 10 inches, and an argillic horizon from 10 to 96 inches that has tongues and coatings of albic material throughout. Different physical and chemical properties of the soils are listed in Table 3.4.

**3.1.2 Climate**

Binnapara has a tropical wet and dry climate. The annual maximum temperature of Binnapara ranges from 23.80C to 34.60C and the minimum between 24.30C to 19.30C with a mean temperature of 29.60C (maximum) and 18.80C (minimum). The average annual rainfall here is 1727mm.

Poschim Gangabardi has a tropical climate. The average annual temperature is 25.3°C (maxium) and 19.20C (minimum). In winter, there is much less rainfall than in summer. About 1873 mm of precipitation falls annually.

**3.1.3 Agricultural Practices**

Binnapara, from where the acid soil has been collected, is a poor locality and people are largely dependent on agriculture. In this area, vegetables are mostly grown. The prevailing crop patterns are potato- maize- fallow, winter vegetables - summer vegetables and chilly- brinjal. However, aman is cultivated in relative low lands.

In Poschim Gangabardi, the soil is light textured featuring low water holding capacity. That’s why; rice is not cultivated here in large scale. Various types of pulses are grown predominately. Besides, chilly, wheat, brinjal, mustard, potato, sesame etc. also are popular among the local peasants. Combined cultivation of pulses and sugarcane is a common practice. However, the yield of wheat, mustard and potato is not up to the mark, claimed by native farmers. In addition, scarcity of irrigation water and low water holding capacity of the soils sometimes enforce local farmers to leave their land fallow during dry season.

**3.1.4 Soil sample collection**

The bulk of soil samples were collected by composite soil sampling method representing 0-15 cm depth from the surface as suggested by the USDA (1951). A good number of soil samples were collected at the definite intervals along a traverse line through an auger and all the samples were put in a plastic bag. Two paper tags with required information such as date, depth of sampling, name etc. were put, one inside and the other one outside the bag. Then the bag was sealed with a rope and transported to the laboratory.

**3.1.5 Processing of soil sample**

The collected soil samples were dried in the air for 4 days (at 40oC) by spreading it in a thin layer on a clean piece of paper once it was transported to the laboratory. Visible roots and debris were removed from the soil samples and discarded. For hastening the drying process, the soil samples were exposed to sunlight. After air-drying, a portion of larger and massive aggregates were broken down by gently crushing them using a wooden hammer. Ground samples were screened to pass through a 2mm stainless still sieve. The sieved samples were then mixed thoroughly for making the composite sample. Soil samples were preserved in plastic containers and labeled properly marking the soil name, sample number, date of collection etc. The soil samples were used for various physical analyses and also for the determination of organic carbon content of soil.

A portion of soil samples (2 mm sieved) were further ground and screened to pass through a 0.5 mm sieve. The sieved sample was mixed thoroughly for making composite sample and was preserved for chemical and physicochemical analyses of the soil.

The bulk soil sample for pot experiment was air dried, cleared off of the debris and crushed to make the bigger clods smaller. These soils were used for the sowing of red amaranth (lal shak) seeds.

**3.2 Incubation Study**

In order to determine the effect of soil manipulation (mixing acid and calcareous soil at different ratios) on soil pH and EC, an incubation study was carried out in the laboratory of Department of Soil, Water and Environment, University of Dhaka.

For the incubation study, 500ml sized 25 conical flask were taken. Each flask was marked in accordance with the treatments. Air dried 2mm sieved acid and calcareous soils were taken separately. Soils were mixed at different ratios shown in Table 3.1. Then manipulated soils were taken in the conical flask according to their marked. Moisture content at 80% was maintained for all flasks. Soils samples were kept for incubation for 12 days. During incubation, sequential measurement of pH and EC was carried out at five different time intervals (0, 2, 4, 6 and 12 days) to determine the change of soil pH and EC after manipulation.

Table 3.1: Different ratios of mixing acid and calcareous soil

|  |  |  |  |
| --- | --- | --- | --- |
| Ratio | Amount of calcareous soil | Amount of acid soil | No of pots |
| 1 (7:1) | 70 | 10 | 5 |
| 2 (3:1) | 60 | 20 | 5 |
| 3 (5:3) | 50 | 30 | 5 |
| 4 (1:1) | 40 | 40 | 5 |
| 5 (1:3) | 20 | 60 | 5 |

**3.2.1 Effects of soil manipulation on the change in soil pH and EC**

The changes in pH and EC of the manipulated soils during 18 days of incubation at different ratios are presented in Table 3.2 and 3.3.

**Table 3.2: Changes in soil pHs during 18 days of incubation**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Ratios | pH | | | | |
| 0 day | 3 days | 6 days | 9 days | 18 days |
| Ratio 1 | 8.49 | 7.49 | 7.41 | 7.64 | 7.66 |
| Ratio 2 | 8.20 | 7.31 | 7.24 | 7.41 | 7.47 |
| Ratio 3 | 8.18 | 7.34 | 7.26 | 7.18 | 7.37 |
| Ratio 4 | 7.5 | 7.0 | 7.08 | 7.10 | 7.39 |
| Ratio 5 | 6.9 | 6.39 | 6.27 | 6.37 | 6.38 |

**Table 3.3: Effects of soil manipulation on the change in soil EC**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Ratios | EC | | | | |
| 0 day | 3 days | 6 days | 9 days | 18 days |
| Ratio 1 | 209.7 | 187.7 | 203 | 181.8 | 182.59 |
| Ratio 2 | 247.5 | 216 | 194.2 | 203 | 190 |
| Ratio 3 | 274.9 | 240.2 | 198.5 | 201 | 187 |
| Ratio 4 | 315 | 305 | 210 | 205 | 200 |
| Ratio 5 | 335 | 306 | 232 | 215 | 190.5 |

Ratio 1:3 shows suitable pH result for the growth of red amaranth. So, this ratio was taken for pot experiment.

**3.3 Initial Characteristics of acid, calcareous and manipulated soil**

Some physicochemical properties of the acid, calcareous and mixture of acid and calcareous (manipulated) soils were analyzed before the setup of the experiment in order to evaluate the initial nutrient status of the soils. The results of these analyses are presented in Table 3.4.

**Table 3.4: Initial characteristics of the acid, calcareous and manipulated (mixed) soils**

|  |  |  |  |
| --- | --- | --- | --- |
| Characteristics | Acid soil | Calcareous soil | Manipulated 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 |
| EC (µS/cm) | 447.0 | 176.0 | 509.0 |
| 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 |

**3.4 Net-house experiment**

**3.4.1 Test crop used for the experiment**

The vegetable under the study was red amaranth. This particular variety has gained popularity among the farmers of Bangladesh for their high yield potential. Matured seeds of uniform size were selected for sowing.

**3.4.2 Rate of fertilizers, cow dung and poultry manure**

According to the fertilizer recommendation guide-2012, the additional nutrients i.e. nitrogen (N), phosphorus (P), potassium (K), and sulphur (S) required for the optimum growth of red amaranth were added from Urea, TSP (Triple Super Phosphate), MP (Murite of Pottash) and Gypsum fertilizers, respectively. The addition rate of Urea, TSP, MP and Gypsum was 120 kg/ha, 60kg/ha, 40 kg/ha and 16.67 kg/ha soil respectively.

The rate of application of cow dung and poultry manure was (3, 6 and 9 t/ha) and (2, 4 and 6t/ha), respectively, according to the experimental set up. The nutrient contents of cow dung and poultry manure are shown in Table 3.5.

**Table 3.5: The nutrient contents of cow dung and poultry manure**

|  |  |  |
| --- | --- | --- |
| Parameters | Cow dung (%) | Poultry manure (%) |
| OC | 6.65 | 8.96 |
| N | 0.40 | 1.33 |
| P | 0.20 | 0.60 |
| K | 0.31 | 0.80 |
| S | 0.09 | 0.12 |
| Ca | 0.30 | 0.62 |
| Mg | 0.15 | 0.30 |

**3.4.3 Experimental design**

In this experiment twenty seven earthen pots were used. The pots were supplied with cow dung and poultry manure at different rates along with controls. Fig. 3.3 shows the design used for red amaranth. The experiment was carried out following a randomized block design.

|  |  |  |
| --- | --- | --- |
| Layout of the experiment | | |
| TAR1 | T6R2 | TCR3 |
| TCR1 | T5R2 | T1R3 |
| T0MR1 | T4R2 | T3R3 |
| T1R1 | T3R2 | T0MR3 |
| T2R1 | T2R2 | T4R3 |
| T3R1 | T1R2 | TAR3 |
| T4R1 | T0MR2 | T6R3 |
| T5R1 | TCR2 | T5R3 |
| T6R1 | TAR2 | T2R3 |

**Fig. 3.3: Experimental pot design used for red amaranth**

Here,

TA= Acid soil

TC= Calcareous soil

T0M = Mixture of acid and calcareous soils, henceforth termed as manipulated soil (Control).

T1 = Cow dung applied at the rate of 3 t/ha in the manipulated soil.

T2 = Cow dung applied at the rate of 6 t/ha in the manipulated soil.

T3 = Cow dung applied at the rate of 9 t/ha in the manipulated soil.

T4 = Poultry manure applied at the rate of 2 t/ha in the manipulated soil.

T5 = Poultry manure applied at the rate of 4 t/ha in the manipulated soil.

T6 = Poultry manure applied at the rate of 6 t/ha in the manipulated soil.

R1, R2 and R3 are the replication number

**3.4.4 Pot preparation**

Soil was manipulated through mixing acid and calcareous soils in a ratio of 1:3. For each pot, 1 kg calcareous soil and 3 kg acid soil was mixed thoroughly. For the experiment, 3kg sized earthen pot was collected. Every pot was marked in accordance with the treatment. Air dried and manipulated 2kg soil samples were put in each pot. Poultry manure and cow dung were mixed with the soil according to the experimental set up. Whole amount of phosphorus (P), potassium (K), and sulphur (S) and half of the nitrogen (N) were applied as basal during pot preparation. Remaining nitrogen was applied at 15 days after sowing under moist soil condition and mixed thoroughly with the soil. 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.

**3.4.5 Sowing seeds**

Certified uniform amaranth seed samples were collected from Krishibid nursery at Khamarbari, Farmgate, Dhaka. The seeds were of BARI-1 variety. Seeds were sowing on 15thMay, 2016. 10-12 seeds were sown in each pot. After germination pruning was done and 6-8 seedling were kept in each pot and allowed them to grow.

**3.4.6 Plant culture**

Tap water was used every day for irrigation in the pot to maintain moist condition. But during the rainy days no irrigation was done. Weeds were removed manually. Positions of the pots were changed every alternative day to allow equal exposure of each pot to sunlight. Adequate plant protection measures were taken during the growing period. Visual observation like general growth, deficiency or toxicity symptoms, chlorosis, necrosis, pest or insect infection etc. were noted during the growth period of the plants.

**3.5 Collection of samples after pot experiment**

**3.5.1 Collection of Plant Samples**

The plants were allowed to grow for 45days and then sampling of plants were done by cutting them carefully 1cm above the soil. The plants were put into the plastic bag with proper labeling and immediately brought them in the laboratory.

**3.5.2 Preparation of Plant Samples**

The fresh weight and height of collected plant samples were taken. Fresh weight was measured with an electric balance immediately after cutting and height of plants was measured with a measuring tape. Then the samples were cut down into small pieces and first air dried and then oven dried at 700 ± 50Cfor 48 hours. Oven dried weights of the plant samples were also taken. After oven drying the plant samples were ground with mortar and pestle and passed through 0.5 mm stainless sieve. The sieved plant samples were then stored in plastic bottles and preserved in dry place for chemical analysis.

**3.5.3 Collection of post-harvest soil samples**

After harvesting the plant, soil samples from each pot were collected. The unwanted materials were separated from soil. The soil samples were then air dried, grounded and passed through 2mm sieve. These sieved soil samples are then stored in plastic bottles for subsequent analysis.

**3.6 Laboratory Analyses and Analytical Procedure**

**3.6.1 Soil analysis**

**Moisture Content**

The amount of moisture in the air dry soil was determined by drying known amount of soil in an oven at 1050 C for 24 hour until constant weight was obtained and the moisture was calculated from the loss of the moisture from the sample (Black, 1965).

**Particle Size Analysis**

The particle size analysis of the soil was carried out by hydrometer method (Black, 1965). The textural classes were determined by Marshall’s triangular co-ordinates as driven by the United States Depatment of Agriculture (USDA, 1951).

**Soil pH**

Soil samples were measured electrochemically with the help of glass electrode pH meter. The ratio of soil and water was 1: 2.5 as described by Jackson (1973).

**Organic Carbon and Organic Matter**

The organic carbon content of the soil was determined by wet oxidation method of Walkely and Black using normal potassium dichromate and sulphuric acid mixture and rapid titration with 1N ferrous sulphate solution (Jackson, 1973). Organic matter content of the soil was determined by multiplying the percent value of organic carbon by conventional Van Bemmelen’s factor of 1.724 (Piper, 1950).

**Cation Exchange Capacity (CEC)**

The cation exchange capacity of the soil samples were determined by extracting the soilwith normal ammonium acetate followed by replacing ammonium-N in the exchange complex by 1N NaCl (pH 7). The displaced ammonium-N was distilled with 40% NaOH and evolved NH3 was absorbed in 4% boric acid having mixed indicator. The excess of the acid was back titrated with standard 0.01064115 N H2SO4 acids (Huq and Alam, 2005).

**Total Nitrogen**

Total nitrogen of the soil was determined by micro Kjeldahl’s method following concentrated sulphuric acid (H2SO4) digestion (Jackson, 1973). The distillation of digested samples 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 (H2SO4).

**Total Phosphorus**

The total phosphorus content of the samples was determined by colorimetric method using a spectrophotometer wave length ranging from 400 to 490 nm (according to the sensitivity needed) by developing yellow color with vanadomolybdate after the extract was collected by digesting the soil with Aqua-regia (HCl:HNO3 = 3:1) as described by Jackson (1962).

**Total Potassium**

The total potassium content in soil samples was determined by the Aqua-regia digestion method using concentrated HCl and concentrated HNO3 in the ratio of 3:1. After collection of the extract, the amount of available potassium was measured by flame photometer (Gallenkamp) (Jackson, 1962).

**Total Sulphur**

After digestion of the soil, it was extracted with Aqua-regia (HCl:HNO3 = 3:1), the extract was used to determine the total sulphur content by turbidimetric method (Huq and Alam, 2005). It was measured by spectrophotometer at 420 nm.

**Available Nitrogen**

The soil was leached with 1N KCl solution to bring ammonium from colloid surface to the solution by cation of the salt solution. The soil leachate was distilled with 40% NaOH which was given off ammonia that was collected on a 2% boric acid and mixed indicator. The distillate was titrated against 0.00995N sulphuric acid (H2SO4). The nitrate ammonia was determined by reducing the nitrate to ammonia by suitable reducing agent (i.e.,33 Devarda’s alloy) in 40% and then ammonia formed from nitrate N was determined by alkali distillation (Huq and Alam, 2005).

**Available Phosphorus**

Soil available phosphorus was extracted by using the Bray and Kartz method for pH less than 7 and Olson method for pH greater than 7. The extract was estimated by colorimetric method following the blue color method using Ascorbic acid (Huq and Alam, 2005). The extract was analyzed by a spectrophotometer at 880 nm.

**Available Potassium**

The available potassium of the samples was estimated by the flame photometer with filters of 766 or 769 nm after extracting the soil with 1N Ammonium acetate at pH 7.0 (Huq and Alam, 2005).

**Available Sulphur**

The sulphur content was determined by turbidity of suspended barium sulphate using Tween-80 as stabilizer and the turbidity was measured by spectrophotometer at 420 nm (Huq and Alam, 2005).

**Determination of Available Ca, Mg, Cu, Fe, Zn and Mn**

The soil was extracted with neutral normal ammonium acetate (Jackson, 1962). To determine Cu, Fe, Zn and Mn extracted samples were acidified with nitric acid. Analyses were done following section 3.7.1.6.9.

**3.6.2 Plant Analysis**

**Total Nitrogen**

Total nitrogen of plant samples was determined as described in section 3.7.1.6.1.

Digestion of Plant SamplesPlant samples were digested with 10 ml of concentrated Nitric acid at 1100 C for about 2 hour. The 5 ml of 62% perchloric acid was added in each sample and the mixture was digested for 30 min. at 2200 C.

**Total Phosphorus**

The total phosphorus content of the samples was determined by colorimetric methodusing a spectrophotometer wave length ranging from 400 to 490 nm (according to thesensitivity needed) by developing yellow color with vanadomolybdate after the extractwas collected by digesting the soil with HNO3-HClO4 (Jackson, 1962).

**Total Potassium**

The total potassium content of the plant sample was determined by the HNO3-HClO4 digestion method. The extract was used to determine the amount of total potassium by flame photometer (Jackson, 1962).

**Total Sulphur**

After digestion of the samples with HNO3-HClO4, the extract was used to determine the total sulphur content by turbidimetric method (Huq and Alam, 2005). It was measured by spectrophotometer at 420 nm.

**Determination of Total Ca, Mg, Cu, Fe, Zn and Mn**

From digest of the plant samples, total Ca, Mg, Cu, Fe, Zn and Mn were determined by the Varian atomic absorption spectrophotometer (AAS).

**3.7 Statistical Analysis**

After laboratory analysis of the samples, data were statistically analyzed using Microsoft excel and presented in graph.

RESULTS AND DISCUSSION

**4.1 Growth parameters of Red Amaranth**

Growth is the progressive development of an organism. It can be also defined as an increase in volume, which is accompanied by the change in form. It is usually described to give some quantitative expressions to the amount of growth by a plant during a given period of time. Various methods have been adapted to measure plant growth. Mayer and Anderson (1962) have employed increase in length of the stem and root or other organ of the plant, increase in the area of leaves and increase in dry and fresh weight of plant. Of the various parameters plant height, fresh shoot weight (at maturity), dry weight were considered for the present investigation (Table 4.1 a, b)

**Table 4.1a: Effects of soil manipulation on the growth parameters of red amaranth**

|  |  |  |  |
| --- | --- | --- | --- |
| Treatment  t/ha | Height  cm/plot | Fresh matter  t/ha | Dry matter  t/ha |
| TA | 22.00 | 9.77 | 0.55 |
| TC | 21.64 | 9.23 | 0.52 |
| T0M | 25.00 | 12.03 | 1.21 |

**Table 4.1b: Effects of Cow dung and Poultry manure on the growth parameters of red amaranth grown in manipulated soil**

|  |  |  |  |
| --- | --- | --- | --- |
| Treatment  t/ha | Height  cm/plot | Fresh matter  t/ha | Dry matter  t/ha |
| T0M | 25.00 | 12.03 | 1.21 |
| T1 | 31.66 | 20.33 | 2.39 |
| T2 | 34.50 | 21.76 | 2.53 |
| T3 | 35.28 | 24.56 | 2.61 |
| T4 | 33.95 | 24.07 | 2.25 |
| T5 | 37.03 | 26.99 | 2.37 |
| T6 | 32.99 | 25.68 | 2.23 |
| LSD at 5% | NS | 4.25 | 0.65 |

**4.1.2 Plant height**

The height of red amaranth plants were recorded and presented in Figs. 4.5 (a, b). Plant height recorded in manipulated (control, T0M) soil showed best performance than those of individual acid (TA) and calcareous (TC) soils (Fig. 4.5a).

**Fig.4.5: Effects of soil manipulation, cow dung and poultry manure on the height of red amaranth**

The ANOVA Table showed that the overall effects of cow dung and poultry manure on plant height were not significant (Appendix 1). The application of cow dung in the manipulated soils was found to be increased the plant height and the maximum increase was recorded in the T3 treatment where the highest amount (9t/ha) of cow dung was applied. The increases of plant height over control (T0M) were 27, 38 and 41 % by the T1, T2 and T3 treatments, respectively, which indicate that the plant height increased with the increased rate of cow dung application. This suggests that more than 9 t/ha of cow dung maybe effective for the manipulated soils and for this further research is needed under variable dose, variety and climatic condition.

On the other hand, poultry manure also showed an increase in plant height up to 4 t/ha (T5) and thereafter decreased with the highest rate of 9t/ha (T6). The increase in plant height was 36, 48 and 31% due to addition of 2, 4 and 6 (T4, T5, T6) ton poultry manure per hector over the control (T0M), respectively. These results indicate that the second dose (4 t/ha) of poultry manure ranked first and the highest dose (6t/ha) showed negative effect compared to the second dose.

Fig. 4.5b showed that poultry manure was superior to cow dung as the maximum height (37.03 cm) was obtained with poultry manure at 4t/ha (T5).

The present finding closely associated with Jin *et. al*., (1996), who reported that the application of cow dung increased the plant height of red amaranth. Similar results were also reported by Budhan *et. al.*, (1991) in rice.

**4.1.3 Fresh weight of red amaranth**

The fresh weight of red amaranth plants were recorded and the data presented in Figs. 4.6 (a, b). The fresh weight of red amaranth was found to be highest in manipulated soil compared to the acid (TA) and calcareous soil (TC) (Fig. 4.6a).

**Fig.4.6: Effects of soil manipulation, cow dung and poultry manure on the fresh weight of red amaranth**

The different treatments of cow dung and poultry manure influenced the fresh weight of red amaranth. The results showed an increase in fresh weight at 1% significant level (Appendix 2).

Application of cow dung in the manipulated soil was found to be increased the fresh weight of plants with the increase in amount of cow dung from 3 to 9 t/ha (T1 to T3) significantly over the control (T0M). These indicate that the maximum fresh weight of plants with cow dung treatment was recorded at T3 treatment, where the highest amount of cow dung was applied.

On the other hand, Poultry manure resulted an increase in fresh weight of plants over the control at 0.1% significant level though the highest rate, T6, decreased in comparison to T5 (the medium dose). The maximum fresh weight was observed with treatment T5, the medium dose of poultry manure(poultry manure @ 4t/ha). The Application of organic manures probably increased nitrogen in the soil which positively affected leaf fresh weight and quality of the leaves because nitrogen stimulates plant vegetative growth and increases leaf area; as a result increment in the leaf area increases the rate of plant photosynthesis and thus higher leaf quality and leaf weight.

Noor *et al*. (2007) reported the highest fresh yield of red amaranth was achieved by 5 t ha-1 poultry manure, which also corroborates the findings of the present study. With respect to fresh weight of individual plant, stem, leaf and gross yield of stem amaranth coincided with those reported by Rajagopal *et al.* (1977) and Hossain (1996). Additionally, plant height enhancement and fresh weight production as regards to cow dung, poultry manure and urea as different N sources were compatible (Gaur *et al*., 1984 and Monira *et al*., 2007).

Okokoh and Bisong (2011) reported that higher yield of fresh leaf and fresh stem in Amaranth were obtained when poultry manure was used. Also good growth of vegetables due to the effect of poultry manure has been reported in bush okra (*Crochorus olitoris*) and the common bean by Massomo and Rweyemany (1989).

**4.1.4 Dry weight of red amaranth**

The dry weight of red amaranth plants was recorded and the data presented in Figs. 4.7 (a, b). The manipulated soil (T0M) had the higher value of dry weight of red amaranhus than those of individual acid and calcareous soil (Fig. 4.7a). However, acid and calcareous soil behaved almost in a similar way showing an identical performance so far the dry weight of the plant is concerned.

**Fig.4.7: Effects of soil manipulation, cow dung and poultry manure on the dry weight of red amaranth**

The effect of cow dung and poultry manure on dry weight of red amaranth plant is significant at 1% level (Appendix 3). Results showed that application of cow dung (3, 6, 9) t/ha (T1, T2, T3) increased the shoot dry weight with maximum weight at T3 treatment where the highest dose (9 t/ha) of cow dung was applied. These indicate that the plant height increased with the increased rate of cow dung application.

Poultry manure resulted an increase in dry weight of shoot over the control at 1% significant level though the highest rate T6 decreased than T5 (medium dose). The maximum dry weight of red amaranth with poultry manure treated soil was observed with treatment T5 (4t/ha). This indicate that the second highest dose (4t/ha) of poultry manure performed better and the highest dose (6t/ha) showed negative effect compared to the medium dose.

The present finding closely associated with Islam, (2006), who reported that application of organic manure increased dry matter content.

**4.2 Mineral Nutrition**

**4.2.1Major element status of red amaranth**

The concentration of N, P, K, S, Ca and Mg in red amaranth plants were presented in Table 4.2 (a, b).

**Table 4.2a: Effects of soil manipulation on the major element contents of red amaranth**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Treatment (t/ha) | N content (%) | P content (%) | K content (%) | S content (%) | Cacontent (%) | Mgcontent (%) |
| TA | 1.40 | 0.24 | 1.65 | 0.38 | 0.40 | 0.73 |
| TC | 1.02 | 0.33 | 1.74 | 0.22 | 1.60 | 1.44 |
| T0M | 1.47 | 0.38 | 1.84 | 0.25 | 0.60 | 0.73 |

**Table 4.2b: The concentration of N, P, K, S, Ca and Mg in red amaranth plants grown in manipulated soil as influenced by cow dung and poultry manure**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Treatment (t/ha) | N content (%) | P content (%) | K content (%) | S content (%) | Cacontent (%) | Mgcontent (%) |
| T0M | 1.47 | 0.38 | 1.84 | 0.25 | 0.60 | 0.73 |
| T1 | 1.54 | 0.40 | 1.93 | 0.27 | 0.68 | 0.88 |
| T2 | 1.59 | 0.53 | 2.30 | 0.34 | 0.77 | 1.02 |
| T3 | 1.81 | 0.57 | 2.50 | 0.30 | 0.83 | 0.94 |
| T4 | 1.55 | 0.58 | 2.12 | 0.29 | 0.70 | 0.98 |
| T5 | 1.76 | 0.62 | 2.52 | 0.34 | 0.81 | 0.86 |
| T6 | 1.81 | 0.46 | 2.31 | 0.39 | 0.81 | 1.11 |
| LSD at 5% | 0.16 | 0.09 | 0.33 | NS | 0.10 | NS |

**4.2.1.1 Nitrogen**

Nitrogen is the key element of plant nutrition. The concentration of nitrogen in red amaranth plant is presented in Figs. 4.8 (a, b). The higher value of N was observed in plants grown in the manipulated soil (T0M) than those of acid (TA) and calcareous (TC) (4.8a) soils.

**Fig.4.8: Effects of soil manipulation, cow dung and poultry manure on the N content of red amaranth**

It is observed that different treatments of cow dung and poultry manure increased the nitrogen content of red amaranth compared to control. The effects of the treatments were significant at 1% level (Appendix 4). The test of significance was calculated by the ANOVA and LSD methods.

Cow dung treated plants showed an increase in N content ranged from 1.54% to 1.81% at 3 t/ha (T1) and 9 (T3) t/ha, respectively. The maximum content of N was found in red amaranth plant treated with 9 ton cow dung per hector (T3). Application of cow dung at 3t/ha (T1) and 6t/ha (T2) increased N contents of plant but not significant compared to control. However, the highest dose of cow dung (T3) showed a significant increase at 1% level relative to the control.

Poultry manure was found to be increased in N content with the increased amounts of poultry manure. The maximum content of N was recorded in plant treated with 6 ton poultry manure per hector (T6). The lowest dose (T4) of poultry manure showed no significant increase, while the medium (T5) and the highest dose (T6) showed a significant increase over the control (T0M).

Asghar *et al.* (2009) reported that integrated use of organic waste and N fertilizer significantly increased the N uptake by radish. Similar results were also reported by Djurovka *et al*. (2009). The present results are partially agreed with above findings.

**4.2.1.2 Phosphorus**

The P content in red amaranth plant was analyzed and the data presented in Figs. 4.9 (a, b). Results showed that the content of P in red amaranth plants grown in the manipulated soil were higher than plant grown in individual acid and calcareous soils. The reason might be the favorable pH condition in the manipulated soil for the growth of plants.

**Fig.4.9: Effects of soil manipulation, cow dung and poultry manure on the P content of red amaranth**

All the treatments of cow dung and poultry manure showed positive effects on the phosphorus content of the amaranth plant. The different treatments of cow dung and poultry manure significantly increased the phosphorus content of amaranth plant at 0.1% level (Appendix 5). The maximum phosphorus content in the amaranth shoots was observed with the T5 treatment, the medium dose of poultry manure (4t/ha).

Cow dung application at 3t/ha (T1) showed an increase in P content of shoot but not significantly. However, increase in amount of cow dung from 3 to 6 t/ha (T2) had resulted an increase in P content significantly (1%) even over the control (T0M). The highest rate of cow dung cause an increase in P significantly over control but not significantly increase with T2, the medium dose of cow dung.

Poultry manure resulted an increase in P content of shoot significantly over the control (T0M) except the highest rate (T6) of poultry manure applied where it increased not significantly. Data showed that variation between T4 and T5 was not significant but variation between T5 and T6 was significant at 1% level. The variation in most of the treatments among themselves is not statistically significant.

Asghar *et al.*, 2009 reported significant increment of P concentration was observed with enriched compost. The use of organic manure enhanced the fertilizer use efficiency (Muneshwar et al., 2001; Nevens and Reheul, 2003).

**4.2.1.3 Potassium**

The change in K content in red amaranth plant with different effects was analyzed and presented in Figs. 4.10 (a, b). The content of K in red amaranth was found to be increased than that of individual acid and calcareous soil.

**Fig.4.10: Effects of soil manipulation, cow dung and poultry manure on the K content of red amaranth**

The different treatments of cow dung and poultry manure increased the potassium content of amaranth shoots significantly at 1% level (Appendix 6).

Application of cow dung at the rate of 3 t/ha (T1) increased the plant P content but not significantly over the control. But the other two doses (T2 and T3) significantly increased the K content of plants over the control. Data showed that variation between T1 and T2 was significant but variation between T2 and T3 was not significant.

All the doses of poultry manure significantly increased the K content of red amaranth plants except the lower dose (2 t/ha). Poultry manure showed an increase in K content up to 4 t/ha (T5) and thereafter a decrease with the highest rate (T6) of 9 t/ha than the medium rate (T5). Among all the treatments of cow dung and poultry manure, highest K content was recorded in treatment T5, the medium dose of poultry manure at 4t/ha.

In barely, the highest K uptake was found due to an addition of organic manure than nitrogen fertilizer (Kumawat and Jat, 2005), which partly supports our findings.

**4.2.1.4 Sulphur**

The response of in red amaranth shoot for different treatments was analyzed and the data presented in Figs. 4.11 (a, b). The amount of S content in acid soil (TA) containing amaranth shoot was higher than that of calcareous soil (TC). In manipulated (control) soil, the S level was in between them.

**Fig.4.11: Effects of soil manipulation, cow dung and poultry manure on the S content of red amaranth**

The different treatments of cow dung and poultry manure increased the sulphur content of amaranth plants but not significantly (Appendix 7). The maximum sulphur content in the amaranth plant was observed with the T6 treatment, the highest dose of poultry manure (6t/ha).

Cow dung application at the rate of 3t/ha (T1) to 6t/h (T2) showed an increase in S content of shoot from 8% to 36% compared to the control (T0M). Further addition of cow dung (T3) showed a decrease in S content than the medium dose (T4) of it but increased 20% over the control (T0M).

Poultry manure resulted an increase in S content of shoot with increasing dose of it. Addition of 2 t/ha (T5) to 6 t/ha (T6) poultry manure caused an increase of S content 16% to 56% over the control (T0M).

The present finding corresponded with other findings. Such as in barely, the highest S uptake was also recorded in the plots receiving poultry manure and the minimum S uptake was observed in the control (Kumawat and Jat, 2005).

**4.2.1.5 Calcium**

Calcium (Ca) content of red amaranth was recorded and presented in Figs. 4.12 (a, b). The highest Ca content was found in calcareous soil containing red amaranth shoot and the lowest value found in case of acidic soil. The control soil containing Ca content was in between acid and calcareous soil.

**Fig.4.12: Effects of soil manipulation, cow dung and poultry manure on the Ca content of red amaranth**

Calcium content of red amaranth shoot due to cow dung and poultry manure treatment showed variation over the control and significantly increase at 1% level (Appendix 8).

Cow dung treated plants showed an increase in calcium content 0.68% to 0.83% at 3 t/ha and 9 t/ha respectively. Maximum content of Ca was found in red amaranth plant treated with 9 ton cow dung per hector.

Poultry manure treated red amaranth showed variation in Ca content between 0.70% and 0.81%. Treatment of 4 ton and 6 ton poultry manure per hector showed lower content of Ca and remain same, that is 0.81% in both the treatments. Increase in Ca content over the control varied between 13.33% to 38.33% and 16.67% to 35.0% over the control due to cow dung and poultry manure respectively.

Results showed that higher doses of poultry manure, that is 4 and 6 t/ha showed the unfavorable effect on Ca content.

**4.2.1.6 Magnesium**

Magnesium (Mg) content of red amaranth plants varied with treatments (Figs. 4.13 a, b). Mg concentration found highest in plants grown in calcareous soils (TC) and lowest in acidic soils (TA) and plants grown in manipulated soil remained in between them.

**Fig.4.13: Effects of soil manipulation, cow dung and poultry manure on the Mg content of red amaranth**

The effects of cow dung and poultry manure of red amaranth shoot is not statistically significant (Appendix 9).

Result showed that among the three doses of cow dung from 3 to 9 t/ha varied from 0.88 to 0.94%. Highest content of Mg was found in 6 ton cow dung treated plant. Higher doses of cow dung increased the Mg content over the control ranging from 20.54 to 39.73%. Further higher dose of cow dung decreased the Mg content.

Similarly, poultry manure showed an overall increase of Mg content with increasing amount of poultry manure. The maximum content of Mg was recorded in plant treated with 6 ton poultry manure per hector, that means at maximum rate. Mg content increased from 9.49% to 52.05% over the control. Minimum content of Mg was found in plant treated with 4 ton poultry manure per hector which was 9.49% higher than the control.

Almost similar findings were reported by Agbede *et al.* (2008) who observed that, the increased availability of nutrients in soil due to application of the manure expectedly led to increased uptake of Ca and Mg. He observed the effect of poultry manure on leaf nutrient composition of sorghum and found that Ca content increases from 0.81 % to 14% Mg content increases from 0.28 to 0.51%. This result is also similar to Ewulo *et al.*, (2008) who found that manure applications increases leaf Ca and Mg concentrations of tomato.

**4.2.2 Micronutrient contents of red amaranth**

The concentration of Cu, Fe, Mn and Zn in red amaranth plants were presented in Table 4.3 (a, b). Addition of organic manure increased the concentration of micronutrients.

**Table 4.3a: Effects of soil manipulation on the micronutrient contents of red amaranth**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Treatment (t/ha) | Cu content (mg/kg) | Fe content (mg/kg) | Mn content (mg/kg) | Zn content (mg/kg) |
| TA | 2.30 | 380.17 | 180.00 | 45.91 |
| TC | 6.55 | 200.14 | 77.00 | 30.63 |
| T0M | 4.70 | 290.20 | 140.10 | 35.07 |

**Table 4.3b: Micronutrients content of red amaranth grown in manipulated soil as influenced by cow dung and poultry manure**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Treatment (t/ha) | Cu content (mg/kg) | Fe content (mg/kg) | Mn content (mg/kg) | | Zn content (mg/kg) |
| T0M | 4.70 | 290.20 | 140.10 | | 35.07 |
| T1 | 4.45 | 300.08 | 145.20 | | 38.34 |
| T2 | 6.75 | 320.38 | 156.5 | | 42.33 |
| T3 | 7.00 | 350.21 | 160.50 | | 40.37 |
| T4 | 6.90 | 310.28 | 140.20 | | 36.10 |
| T5 | 5.80 | 328.18 | 158.00 | | 39.84 |
| T6 | 5.20 | 335.22 | 155.60 | | 36.20 |
| LSD at 5% | 0.92 | 11.92 | | NS | NS |

**4.2.2.1 Copper**

Copper (Cu) content of red amaranth plants is presented in Figs. 4.14 (a, b). Cu concentration found highest in plants grown in calcareous soils (TC) and lowest in acidic soils (TA) and plants grown in manipulated soil remained between them.

**Fig.4.14: Effects of soil manipulation, cow dung and poultry manure on the Cu content of red amaranth**

The overall effect of cow dung and poultry manure on Cu content of red amaranth shoot is significant at 0.1% level (Appendix 10). Cow dung treated plants have higher Cu content with the highest dose of it. Lower dose of cow dung showed not significant increase over the control while the other doses of cow dung showed significant increase over the control and themselves. But poultry manure treated plants show a decreasing trend with increasing dose of it.

**4.2.2.2 Iron**

The concentration of Iron (Fe) in red amaranth shoot was analyzed and the data presented in Figs. 4.15 (a, b). The amount of Fe content in acidic soil containing amaranth shoot was higher than that of calcareous soil. In manipulated (control) soil, the Fe level was in between them.

**Fig.4.15: Effects of soil manipulation, cow dung and poultry manure on the Fe content of red amaranth**

The different treatments of cow dung and poultry manure increased the Fe content of amaranth shoots through significantly at 0.1 % level (Appendix 11). The maximum Fe content in the amaranth shoot was observed with the T3 treatment, the highest dose of cow dung (9t/ha). Both cow dung and poultry manure showed positive response on Fe content of amaranth shoots. Fe content increased with increasing dose of both cow dung and poultry manure.

**4.2.2.3 Manganese**

The variation in concentration of manganese with different treatments in red amaranth shoot was analyzed and the data presented in Figs. 4.16 (a, b). The amount of Mn content in acidic soil containing amaranth shoot was higher than that of calcareous soil. In manipulated (control) soil, the Mn level was in between them. Mixture of the acid and calcareous soil reduces Mn toxicity.

**Fig.4.16: Effects of soil manipulation, cow dung and poultry manure on the Mn content of red amaranth**

The different treatments of cow dung and poultry manure increased the Mn content of amaranth shoots but not significantly (Appendix 12). The maximum Mn content in the amaranth shoot was observed with the T3 treatment, the highest dose of cow dung (9t/ha). Both cow dung and poultry manure showed positive response on Mn content of amaranth shoots. Mn content increases with increasing dose of both cow dung and poultry manure except the highest dose of poultry manure which increased than the control but decrease than its medium dose.

**4.2.2.4 Zinc**

Zinc (Zn) content of red amaranth shoots is presented in Figs. 4.17 (a, b). Zn concentration found highest in plants grown in acid soils and lowest in calcareous soils and plants grown in manipulated soil remained between them.

**Fig.4.17: Effects of soil manipulation, cow dung and poultry manure on the Zn content of red amaranth**

The overall effect of cow dung and poultry manure on Zn content of red amaranth shoot is not significant (Appendix 13). Cow dung treated plants have higher Zn content with the medium dose (6t/ha) of it. Higher dose of cow dung caused a decrease in Zn content than the medium dose but higher than the control. Poultry manure treated plants showed an increase in Zn content up to the medium dose. Higher dose cause a decrease in Zn content than the medium dose.

Magkos *et al.* (2003) reported that although a small number of studies have been published, slightly higher contents of minerals such as Fe, Mn, Zn, Cu have been obtained in organic vegetables.

CONCLUSION

Among the different problem soils, acid and calcareous soils could display a high agricultural potential if they were to be reclaimed by appropriate methods. Acid soils face acidity, aluminium (Al), hydrogen (H), and/or manganese (Mn) toxicity, as well as nutrient deficiencies of calcium (Ca) and magnesium (Mg). On the other hand calcareous soils generally have low contents of organic matter, nitrogen, phosphorous and other micronutrient especially zinc and iron along with the adverse effects of high pH. By mixing acid and calcareous soils, the soil pH and the nutrients have come to a balanced state.

Based on the findings of the experiment, it can be said that the pH, CEC, organic carbon, major nutrients (N, P, K, S, Ca and Mg) and micronutrients (Cu, Fe, Mn and Zn) status of the manipulated soil (control) are favorably influenced by soil manipulation (mixing of acid and calcareous soils). The nutrients which are lower in acid soil, balanced by calcareous soil after manipulation. On the other hand, the deficiencies in calcareous soil are maintained by the acid soil after manipulation. So, the manipulated soil (control) performed better height, fresh and dry weight of red amaranth plant than those of the individual acid and calcareous soils. Status of nutrients (N, P, K, S, Ca, Mg, Cu, Fe, Mn and Zn) in the red amaranth plant was also better in manipulated soil than those of acid and calcareous soils.

Moreover, the use of animal manure in crop production is desirable as it had variable impacts on the growth and yield of crops. It is a good alternative to chemical fertilizer and has sustainability effects on soil. The use of animal manure improves soil organic matter status, nutrient availability and good crop yield as well as ensures stability of soil structure. So, for the improvement of the manipulated soil cow dung and poultry manures were also added.

The highest plant height, fresh weight and dry matter production were obtained with the highest dose of cow dung (9 t/ha) and medium dose of poultry manure (4t/ha) in the manipulated soil. Application of cow dung in the manipulated soil was found to be increased N, P, K, Ca, Cu, Fe and Mn contents with the increasing rate of cow dung but S, Mg and Zn contents increased up to the medium dose (6t/ha). On the other hand, poultry manure resulted highest nutrient content with the medium dose of it (4t/ha), except for the N, S, Mg and Fe, where the highest value obtained with the highest dose (6t/ha). In case of uptake of nutrients of the plants similar trend was followed.

In the post harvested manipulated soil, cow dung application increased nutrient content up to the highest dose (9t/ha), except for the S, Cu, Mn and Zn. In case of poultry manure, the highest dose (6t/ha) exerted the highest value of the nutrients, except for the K, Ca, Mg and Fe.

It can be concluded that Bangladesh is an agricultural country and its economy mainly depends on agriculture. On the other hand, because of the having problems in many our lands and use of excessive chemical fertilizers to reclaim them, our soil is losing its natural fertility and productivity capacities. So, it can be suggested that a problem soil can be reclaimed by another problem soil and for the improvement of its fertility, productivity animal manure can be added. However, this requires a detailed study to come to a more precise conclusion that can be used in national as well as global interest.