EFFECT OF ORGANIC AND INORGANIC FERTILIZERS ON THE GROWTH AND VEGETATIVE YIELD OF GREEN AMARANTH (*Amaranthus viridis*)

A THESIS

BY

MD. TANJID HOSSAIN

Student No. 1701139

Session: July-December 2023

MASTER OF SCIENCE (M.S.)

IN

SOIL SCIENCE

DEPARTMENT OF SOIL SCIENCE

HAJEE MOHAMMAD DANESH SCIENCE AND TECHNOLOGY UNIVERSITY

DINAJPUR-5200

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Submitted to the

Department of Soil Science

Hajee Mohammad Danesh Science and Technology University, Dinajpur

in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE (M.S.)

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JUNE, 2024

DEDICATED

TO MY

BELOVED FAMILY

ACKNOWLEDGEMENTS

I would like to express my ever gratefulness and endless praises to the Almighty Allah ' Who has enabled me to carry out this piece of research work and present the thesis for the degree of Master of Science (M.S) in Soil Science.

With profound pleasure and privilege, I would like to express my deepest sense of gratitude and indebtedness to my honorable teacher and supervisor ***Professor Dr. A.K.M. Mosharof Hossain****, Department of Soil Science, Hajee Mohammad Danesh Science and Technology University (HSTU), Dinajpur for his constant and scholastic guidance, untiring assistance, valuable suggestion, continuous inspiration and immense help throughout the tenure of this research work and also preparation of this thesis.*

Deep appreciation and profound regards to my co-supervisor ***Prof. Dr. Md. Shahadat Hossain Khan****, Department of Soil Science, Hajee Mohammad Danesh Science and Technology University (HSTU), Dinajpur for his valuable guidance, untiring supervision, cordial support, high encouragement and co-operation for carrying out research and preparing the thesis.*

I also express my respect and thankfulness to all teachers of the Department of Soil Science, HSTU, Dinajpur for their good advice and co-operation during the period of this study.

Finally, I express my gratefulness and deepest appreciation to my beloved parents and friends for their blessings, immeasurable sacrifice, endless prayer and continuous inspirations throughout my academic life to reach this level of higher education.

The Author

ABSTRACT

A field experiment was carried out at the Research Field, Department of Soil Science, Hajee Mohammad Danesh Science and Technology University, Dinajpur, during the period from November 2023 to February 2024 in Rabi season to evaluate the efficacy of different organic and inorganic fertilizers on the growth and vegetative yield of green amaranth. The experiment was laid out in Randomized Complete Block Design (RCBD) having six treatments with three replications. The treatments were as follows; T_1 = Control, T_2 = 100% NPK, T_3 = 100% (compost+cowdung), T_4 = 25% NPK + 75%(compost+cowdung), T_5 = 50% NPK+50%(compost+cowdung),T_6 =75% NPK + 25%(compost+cowdung). The experimental soil belongs to the Old Himalayan Piedmont Plain (AEZ-1). The soil was sandy loam in texture having pH 5.60, organic matter content 0.82%, total N 0.080%, available P 3.30 ppm, exchangeable K 0.52meq 100 g^{-1} soil and available S 7.53ppm. The tallest plant height (6.97, 30.73, and 38.80 cm at 15, 30, 45 DAS respectively) was found in the treatment T_6 and the shortest plant height (5.76, 12.50, and 15.80 cm at 15, 30, and 45 DAS, respectively) was observed in T_1 (control). The maximum number of leaves (5.60, 8.70, 10.70 at 15, 30, and 45 during final harvest, respectively) was recorded in the treatment T_5 whereas the minimum number of leaves (5.10, 7.30, 9.30 at 15, 30, 45 during final harvest, respectively) was found in the T_1 (control). The treatment T_5 produced the highest both fresh and dry shoot weight (6.23 and 3.78 t ha^{-1} respectively) but the lowest fresh and dry shoot weight (1.16 and 0.52 t ha^{-1} respectively) was obtained from the control treatment (T_1). The maximum fresh and dry root weight (2.29 and 1.28 t ha^{-1}, respectively) was found in T_5 and tallest root length (7.89 cm) was recorded from the treatment T_6 and the minimum both fresh and dry root weight (0.42 and 0.19 t ha^{-1}, respectively) and smallest root length (6.20 cm) was observed in the T_1 (control).Application of organic and inorganic fertilizers resulted in a considerable influence on the properties of the post-harvest soils such as pH, organic matter content, total N, available P, exchangeable K and available S. In post-harvest soil, the combined application of NPK and compost gave positive results. It also increased soil fertility status. The highest percentage of total N of and available S (0.112 % and 18.05 ppm, respectively) were found in T_6 treatment and lowest percentage of N and available S (0.056 % and 5.73 ppm, respectively) were in T_1 treatment. The highest available P (9.772 ppm) and exchangeable K (0.160 meq/100 g soil) were found in both cases at T_5 and the lowest available P and K (3.063 ppm and 0.050 meq/100 g soil, respectively) was in T_1 (control) treatment. The highest pH (7.20) was observed for T_3 treatment while T_1 showed the lowest value (5.60). In post-harvest

soil electrical conductivity was statistically different for different treatments. The soil electrical conductivity percentage was highest(0.328 ms) in T_2 which was statistically similar with T_3 and the soil electrical conductivity percentage was lowest(0.050ms) in T_1 . The soil organic matter percentage was highest (1.400 %) in T_3 treatment which was statistically identical to T_4 and T_5 . The lowest organic matter content (0.887 %) was found in T_1 treatment. Finally, it can be concluded from the present study that the application of organic manures with the recommended doses of inorganic fertilizers showed better performance in respect of vegetative growth of green amaranth and also increased the fertility status in soil. Moreover, 50% NPK + 50% compost and cowdung (T_5) gave better performance than other combinations in all aspects. So, compost with inorganic fertilizers will be profitable for green amaranth cultivation

CONTENTS

CONTENTS (Contd.)

CONTENTS (Contd.)

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

ABBREVIATIONS AND ACRONYMS

°C	Degree Celsius
AEZ	Agro Ecological Zone
BADC	Bangladesh Agricultural Development Corporation
BARC	Bangladesh Agricultural Research Council
CD	Cow dung
Cm	Centimeter
DAS	days after sowing
EC	Electrical conductivity
et al.	And others
FAO	Food and Agricultural Organization
g	Gram
ha^{-1}	Per hectare
HSTU	Hajee Mohammad Danesh Science and Technology University
K	Potassium
Kg	Kilogram
LSD	Least significant difference
m	Meter
N	Nitrogen
OM	Organic matter
P	Phosphorus
$plant^{-1}$	Per plant
$plot^{-1}$	Per plot
ppm	Parts per million
RCBD	Randomized Complete Block Design
S	Sulphur
VC	Vermicompost
(mS/m)	mili Siemens per meter

CHAPTER I

INTRODUCTION

Green amaranth (*Amaranthus viridis* L) belongs to the genus Amaranthus and the family Amaranthaceous which is collectively known as amaranths. It is a cosmopolitan genus of herbs. But green amaranth or stem amaranth which also known as i/unto in bangla is commonly used as lea& and stem vegetable. It is mainly grown in summer and rainy season. It is an important popular vegetable in Bangladesh, because of its cheapest price, quick growing character and higher yield potential (Hossain. 1996). It is widely grown as a green vegetable in tropical and subtropical region of Asia, Africa and Central America (Hardwood, 1980). Green amaranth is fairly rich in vitamin-A, ascorbic acid and fibers. It has an appreciable amount of iron, calcium, phosphorus, riboflavin, thiamine and niacin (Thompson and Kelly. 1988). It also contains about 43 calorie per bog of edible portion which is higher than that of any other common vegetables except potato and taro (Chowdhury, 1967). Its wider environmental adaptability, higher nutritive value, good taste, less risk to crop failure and various biotic and abiotic factors indicate that there is enough scope for its promotional cultivation. It can be harvested after 30 days after sowing. Stem amaranth is considered as a potential upcoming subsidiary food crop for future (Teutonico and Knott 1985). It is also considered to be the cheapest vegetable in the market and it could be rigidly described as a poor man's vegetable in Bangladesh (Shanmugavelu, 1989). Food scarcity has been and will remain a major concern for Bangladesh as population growth is 1.34% (BBS, 2013). Increased production of vegetable is important for balanced and healthy food intake. Total vegetable production in Bangladesh is about 1879.83 thousand tons per year of which 61.9% is produced in Rabi and 38.09% is in Kharif season (BBS. 2010). It shows that maximum vegetable production is concentrated during the months of November and April. Thus a serious scarcity of vegetables creates from May to September and the price becomes high. So malnutrition is acute during late summer in Bangladesh. Amaranth can be cultivated as the year round crop. Beside these, this crop proved to be best fitting in cropping 1 system as a short duration crop. As the soil type and weather are suitable, stem amaranth can play an important role to minimize the scarcity of vegetable during lean period (Hossain. 1996; Talukder, 1999). Thus green amaranth ultimately plays a vital role in taking balanced food and helps to improve farmers' socio-economic condition. Green amaranth is being cultivated in an area of 26,338 acres and 69667 tons that is increasing day by day due to high yield, easy cultivation process with nutritional value (BBS. 2013). The average yield of stem amaranth is only 2.64 t/acres in Bangladesh, which is much lower as compared to other amaranth growing countries. For attaining considerable production and quality yield for any crop it is necessary to proper management including ensuring the availability of essential nutrient. Fertilizer plays a vital role for proper growth and development of stem amaranth. Fertilizer application in appropriate time, appropriate dose and proper method is the prerequisite of amaranth cultivation (Islam. 2003). It grows well in a fertile, clay loam soil because it requires considerable amounts of nutrients to sustain rapid growth in short time. Stem amaranth responds greatly to major essential elements like N, P and K in respect of its growth and yield (Mital, 1975: Singh ci al.. 1976; Thompson and Kelly, 1988). Its production can be increased by adopting improved cultural practices. But most of the amaranth growers cultivate this crop in fallow land without following any management practices or fertilizer. In Bangladesh, specially the nitrogenous fertilizer is the most critical input for increasing crop production and had been recognized as the central element for agricultural development (Monira, 2007). A large amount of nitrogen is required for leaf and stem growth of vegetables (Opena el all. 1988). It plays a vital constituent of protein, nucleic acid and chlorophyll and progressively increases the marketable yield (Obreza and Vavrina, 1993). It is also the most different element to manage in a fertilization system such that an adequate, but not excessive amount of nitrogen is available during the entire growing season (Anon., 1992). Urea is the most commonly used nitrogenous fertilizer in Bangladesh. Generally, it is applied as basal and as top dressed at different growth stages for vegetable cultivation. It contains about 46% nitrogen. But excessive application of urea is not only uneconomical, it also induces different physiological disorder, causes health hazards, creates problem to the environment including the pollution of soil, air and water along with the increase of production cost. So an adequate supply of nitrogen is essential for vegetative growth, and desirable yield (Yoshizawa and Roan, 1981) Organic farming is one of the most important factors of crop production as well as to harvest high yield. Organic manure may play a vital role to improve soil fertility as well as supply of primary, secondary and micronutrients for crops. It also helps to maximize soil organic matter and water holding capacity of soil, minimize the soil temperature and develop the favorable soil structure (Monira es 01., 2007). Continuous use of chemical fertilizers accelerates the depletion of organic matters from soil. Most of the soils of Bangladesh have less than 1.5% and in some cases less than 1% organic matter (Zaman and Rahman, 1986). Organic manure increases the nutrient availability and reduces the chemical fertilizer cost. These facts suggest that there is an ample scope to increase stem amaranth yield in per unit area with appropriate use of organic nitrogen as organic manures exert a major role on crop production (Gaur ci at, 1984). 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 ci al., 2001; Rahman ci at, 2005). As the practice of animal husbandry is common in the rural area of Bangladesh. cow dung can easily be found and applied in the field. It encompasses profitable vegetable yield and unacceptable loss to the soil environment. So application of cow dung is affordable and eco-friendly. Recently organic farming including cow dung related researches are being encouraging to avoid pollution from agrochemicals (Belay et al., 2001). The principal aims of using these as expressed in the recent studies are to produce crops with high nutritional qualities, to maintain and increase long term soil fertility and to minimize use of agrochemicals to avoid pollution arise from their uses. There is no denying of the fact that regular use of cow dung has a remarkable effect in improving the physiochemical properties of the soil and ultimately the soil health but only as a supplement rather than as a substitute for fertilizers (Halvin et al., 2003). There is a great possibility of increasing amaranth yield per unit area with the appropriate use of urea fertilizer as nitrogen source and cow dung in Bangladesh. The balanced use of urea fertilizer and cow dung enhances the growth and development of green amaranth as well as ensuring the availability of other essential nutrients for the plant. Information on the use of appropriate levels of urea along with cow dung with particular reference to green amaranth cultivation is lacking in general. In this aspect, the present study, therefore, is undertaken to investigate the effect of urea fertilizer and cow dung on green amaranth with the following objectives:

- To examine the single effect of different levels of urea and cow dung application on the growth and yield of BARI Data-I.
- To study the interaction effect of different levels of nitrogen fertilizer and cow dung application on growth and yield of green amaranth.
- To quantify the suitable rate of urea fertilizer and cow dung for its cultivation.

CHAPTER II

REVIEW OF LITERATURE

Green amaranth or stem amaranth is one of the important summer vegetables in Bangladesh as well as in many other countries of the world. The crop has received less concentration of the researchers because normally it grows with less care or management practices. For that a very few studies on growth, yield and development of amaranth have been carried out in our country. The research work so far done in Bangladesh is not adequate and conclusive. Nevertheless, some of the important research findings related to nitrogen fertilizer and cow dung so far available at home and abroad on this crop have been reviewed in this chapter under the following headings:

2.1 Effect of inorganic fertilizers on growth and yield

Green amaranth cultivar was supplied with 10, 30. 60 and 90 kg N ha' in a field experiment conducted by Rathore et at (2004) in Rajasthan. India during the winter seasons of 1997-1998 and 1998-1999 to identify the optimum doses. As much as 90 kg ha' N fertilizer gave significantly higher yield, better growth and higher values for yield components. Application of N enhanced the growth and yield attributes significantly, whereas harvest index remained unaffected.

Islam (2003) reported that fertilizer doses at the rate of 200, 100 and 200 kg/ ha of urea, triple super phosphate and muriate of potash respectively and maintaining other agricultural practices properly the average yield of amaranth could be raised up to 45 to 50 t/ ha.

Three field experiments were conducted at the Taiwan Agricultural Research Institute experimental farm by Yung ci at (2003) to evaluate the growth response of amaranth at different nitrogen fertilizer rates during the 2001-2002 growing season. Data on the total leaf chlorophyll, aboveground nitrogen and chlorophyll meter readings from leaves were collected at harvest. Regression analysis indicated positive linear correlation between total leaf chlorophyll and chlorophyll meter readings and between above ground nitrogen and total leaf chlorophyll. It suggests that chlorophyll meter is a suitable tool for the assessment of chlorophyll and nitrogen status in amaranth plants.

Ayodele ci at (2002) conducted a field experiment to evaluate the effect of N fertilizer @0. 50, 100 and 200 kg ha' on growth and yield of amaranth, plant height, number of leaves produced, fresh and dry weights of plant parts increased with increased nitrogenous fertilizer rate. Application of fertilizer at 200 kg N ha-1 increased leaf production upto 75%, on the other hand yield increased up to 114% with the application of 200 kg N ha-1 The unfertilized plants also had yellowish green coloration compared to the brighter green color observed in fertilized plants.

Thapa and Maity (2002) carried out a field experiment in the sandy loam of West Bengal. India during the summer seasons of 1998 and 1999 to study the effect of different levels of N 50, 100 and 150 kg ha^{-1}' on the growth and yield of *Arnaranihus sp.* cv. local. The response in terms of growth components such as plant height, number of leaves and number of branches, leaf area index, and dry matter production was highest at the highest nutrient levels. The highest yields of 100,75, 101.5 were obtained from treatments with N 150 kg ha-1.

Seeds of amaranth (*Arnaranihus sp.* cultivated under 8 N levels (0, 50, 100.,150, 200, 300, 350 and 400 kg ha^{-1}') were evaluated for protein content, protein yield per hectare and some starch characteristics by Hevia ci at (2000). The protein content fluctuated between 16.5% (at 0kg N ha-1) and 18.4% (at 200 kg N ha-1). The protein yield per hectare fluctuated between 457.2 (at 0 kg N ha-1) and 973.4 kg ha-1 (at 300 kg N ha-1) and was characterized by a quadratic regression as a response to fertilizer application. The starch characteristics were not significantly affected by any of the N levels.

Das and Ohosh (1999) conducted a field experiment on amaranth during winter, summer and rainy seasons of 1996-1997 with 4 levels of nitrogenous fertilizer 40. 80 and 120 kg ha-1 in Kalyani, India. From their experiment they reported that yield components and seed yield increased with increasing N up to 120 kg N ha-1.

Talukdar (1999) conducted an experiment at the Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur. Different growth attributing characters was 1.9 recorded and found that fertilizer dose with 200-100-200 kg ha-1 of urea, triple super phosphate and muriate of potash, respectively gave the highest stcm yield 355.75 g plant-1 and green yield 94.41 t ha-1.

The effect of nitrogen fertilizer on amaranth yield, yield components, growth and development was investigated by Myers (1998) with five levels of nitrogen fertilizer and three cultivars. Yield was responsive to nitrogen application, but high rates of fertilizer can negatively affect grain yield.

In a field experiment during summer 1990/92 at Kinnaur, Himachal Pradesh, India by Saini and Shekhar (1998) to find out the effect of nitrogen fertilizer 0. 30, 60,90 and 120 kg ha-1 on growth and yield of amaranth and reported that yield and most yield components increased significantly upto 90 kg N ha-1 and then decreased.

In small plot trials on dernopodzolic soil in the mountain region with 0. 60 or 120 kg ha-1 N fertilizer by Ozhiganovaela L (1996) and reported that the effect of seed inoculation on N-fixing activity in the rhizosphere varied greatly with plant growth stage and N rate but there were marked increases at flowering without N fertilizer and at fruiting with N inoculation increased plant height and aboveground and root fresh weight at all growth stages. Fresh matter yield increased from 29.9-3 1.2 t ha-1 without inoculation to 36.1, 46.8 and 43.0 t with 0, 60 and 120 kg N, respectively, when seeds were inoculated. Inoculation reduced plant nitrate content and increased crude protein content.

Acar (1996) carried out a field experiment to study the effects of nitrogen fertilizer rates on yield and yield components of two amaranth cultivars in 1995 in Samsun. Turkey. with. 3. 6, 9 or 12 kg N ha' day'. From the results it was noted that there were no significant effect of N on seed yield and yield components. There were highly significant positive correlations between seed yield and both cultivars and 1000 seed weight.

A garden experiment was carried out by Anten and Werger (1996) with amaranth grown from seed, in dense stands in which a size hierarchy of nearly equally aged individuals had developed in order to investigate how nitrogen allocation patterns in plants are affected by their vertical position in the vegetation. Canopy structure, vertical patterns of leaf nitrogen distribution and leaf photosynthetic characteristics were determined in both dominant and subordinate plants. The amount of N which is reallocated from the oldest to the younger, more illuminated leaves higher up in the vegetation may depend on the sink strength of the younger leaves for nitrogen.

Rashid (1993) reported that at the fertilizer dose of 200, lOU and 200 kg ha-1 with urea, super phosphate and muriate of potash, respectively amaranth gave the highest yield. The average yield at this fertilizer dose ranged from 35-40 t ha-1.

Hamid et al. (1989) in an experiment used 200 kg urea, 100 kg triple super phosphate and 200 kg muriate of potash ha-1 and reported that significant variation were present among 12 amaranth lines (4 exotic and 8 local) for plant diameter which was positively correlated with yield. The exotic germplasm AM 0008 was the highest yielding, producing 234.401 ha-1.

Among the local germptasm highest yield produced was 122.40 t ha-1 and lowest yield was 42.80 t ha-1. Plant height of some exotic and local lines varied from 70.20 to 131.60 cm. The nunther of leaves and plant diameter plant-1 in local cultivars ranged from 72 to 162 and 5.30 to 9.30 mm, respectively.

Subhan (1989) conducted a field experiment at Lembang from August to September 1988 to find out the effect of doses N @ 0, 30, 70 and 110 kg ha-1 and application time of nitrogen fertilizer on growth and yield of amaranth applied as a single application at sowing or as a split application at sowing and 10 days after sowing. Leaf number and stem diameter were not affected by N application. Plant height, leaf area and fresh weight increased with increasing N application but root length was reduced by high N application. The highest yields were obtained with a split application of 110kg N ha-1.

Mohideen ci at (1985) conducted an experiment for an evaluation program in amaranth under the all Indian coordinated vegetable improvement project at the Tamil Nadu Agriculture University. A promising clipping type (A.83) was released as Co. 3 amaranth over local type after testing for five seasons. Fertilizer doses were 85 kg N. 60 kg P and 60 Kg K ha-1 respectively. The leaf stem ratio was. 2.00 and the yield performance of this stain was recorded a mean yield of 3.716 kg ha-1. Highest plant height was recorded as 172.5 cm. The mean weight of 8 types of amaranth was 276 g.

Vijayakumar et al. (1982) conducted an experiment with nitrogen at 0, 80, 100 or 120 kg ha4and recorded plant height and which were ranged from 16.05 to 57.25 cm at 30 DAS, 34.95-70.25 cm at 45 DAS and 65 to 122.15 cm at 60 DAS from highest doses of fertilizer.

In Himachal Pradesh, at the rate of 60. 50 30 kg NPK ha^{-1}, respectively, were recommended for getting the best yield of vegetables (Anon, 1978). Grubben and Sioten (1977) in an experiment on amaranth recommended fertilizer dose of amaranth as a mixture of 10-10-20 N-P-K applied at 400 kg ha^{-1}' for plants to be uprooted and at 600 kg hi' for plant to be harvested, respectively.

Intensive selection work investigated by Kamalanathan et al.(1973) at vegetable section, Agriculture College and Research Institute. Coimbatore has resulted with release of a new strain Co. I amaranth suited to Tamil Nadu. Fertilizers were used as 85 kg N, 60kg P and 60kg K hi1. The average yield of this new strain is 18.70 t ha-1 green with 31 to SI percent increase over local types. The leaves and stems are succulent, tasty and nutritious. It can be grown throughout the year for use as 'Mulaikeeral' and 'Thandukeerai'.

2.2 Effect of Organic fertilizers on growth and yield

Suthamathy and Seran (2011) conducted an experiment to evaluate the growth and yield response of red onion (*Allium ascalonicum* L.) growth with sandy soil, cow dung, coir dust and paddy husk ash. The results indicated that potting materials have significant effect on the growth and yield of red onion grown in different potting media. Maximum number of leaves per plant, highest plant height and maximum yield were recorded in sandy soil: cattle manure: paddy husk ash at ratio of 6:2:1. It was also noted that the yield per plant increased more than two fold in sandy soil: cattle manure: paddy husk ash at ratio of 6:2:1 over control (medium 1). Usage of paddy husk ash as a potting material in medium preparation would improve the growth and yield performances of red onion grown in pot culture technique.

Parwada *et al.,* (2011) found that the higher yield of sweet potato was recorded on effect of mustard oil cake compared with chicken manure.

Adewale *et al.,* (2011) studied to assess the effect of different rates of poultry manure on the yield of garlic. The treatments compared were five poultry manure rates (0, 5, 10, 15, 20 t ha). The lowest yield was obtained from the yield of the control; all the treatments had significantly higher yields than the control. The highest yield was recorded on plants that received poultry manure at 20 t ha^{-1} '. This could be attributed to increase the quality of nutrients from this rate of poultry manure.

Nasreen *et al.,* (2009) were investigated on the response of garlic (var. BARI Garlic-2) to zinc, boron and poultry manure application along with a blanket dose of 150 kg N. 50 kg P, 100 kg K and 40 kg S ha1 was evaluated through field trails in the Grey Terrace Soil under AEZ 25. Application of zinc, boron and poultry manure had significantly increased plant height, number of leaves plant-1. cloves bulb-1, diameter and weight of bulb and yield ha-1. The highest yields were obtained from the Zn and B, kg ha-1 plus 5 t ha-1, poultry manure treatment and it was significantly higher than all other treatments.

Yahaya (2008) found the yield of garlic increased as the quality of poultry manure increased. Plants that received cow dung at 20 t ha-1 had the highest average number of cloves per bulb of 5.7. followed by those that received poultry manure at 15 t ha-1 with an average of 5.3 cloves bulb-1. The ability of cow dung to increase the performance of garlic could also be attributable to the fact that organic manures improve both physical and chemical soil properties

Shaheen *et al.* (2007) showed organic fertilizers has positive effect on root growth by improving the root rhizosphere conditions (structure, humidity, etc.) and also plant growth is encouraged by increasing the population of microorganisms. They also observed higher plant growth from cow dung compared to sheep manure. Ilalvin *et al.*(2003) may be ascribed cow dung to increase availability of nutrients in the soil for uptake by plant roots that may have enhanced vegetative growth through increasing cell division and elongation.

Jablonska *et al.* (2002) stated that the highest yield of vegetable cultivated in the second year after organic fertilizer application were obtained afler ploughing the field pea, cow dung and the mixture of oat + field pea.

Zakaria and Vimala *et al.*(2002) found the high nitrogen content of composted dairy manure and cow dung has contributed to a higher yield (fresh and dry mass) of onion than that of vegetables treated with poultry manure or alkaline stabilized composted dairy manure. However, the combination of organic fertilizer (green manure, palm oil mill effluent) and inorganic fertilizer (N, P and K) produced yields of cucumber and cabbage that were higher than those of plants treated with green manure or palm oil mill effluent alone.

Belay *et al.* (2001) stated that organic fertilizers are considered as a source of organic matter for soil. It may be used as a substitute to the chemical fertilizers because it gives plains food elements for longer period and also increases soil fertility by increasing the activity of soil microorganisms.

Salman. M. (2001) showed the effect of plant growth in carrot with the application of digested poultry slaughter house waste with cow dung as nitrogen source, gave the higher yield

Frank (2000) confirm the application of mustard oil cake which affect on number of onion leaves as it increased with an increase in the quantity of the mustard oil cake applied. Plants that received mustard oil cake at 4.5 t ha-1 had the highest value of number of leaves while the yield of onion also showed highest.

Rahman (2000) carried out an experiment and found that plant height of TPS seedlings was significantly influenced by the application of cow dung. The highest plant height (75.28 cm) at 100 days was obtained from the highest dose of cow dung (100 t ha-1).

Nambiar *et al.*(1998) showed sustainable crop production could be possible through the integrated use of organic manure and chemical fertilizers. A suitable combination of organic and inorganic sources of nutrients is necessary for a sustainable agriculture that will provide good quality true seeds of onion. Integrated use of organic manures and chemical fertilizers would be quite promising not only in providing greater stability in production, but also in maintaining higher soil fertility status.

Singer *et al.*(1998) found that addition of organic fertilizer improves soil structure, which can encourage root development and leads to encourage growth of different crops.

Barman and das (1996) treated green grain (Vignaradiala) with organic amendments: cow dung, poultry manure and mustard oil cake each at 2 t ha" alone and highest yields were given by mustard oil cake.

Meena and Gupta (1996) conducted a field experiment by supplying to t ha1 of FMY. Gobar gas spent slurry or digested willow dust, or 3 t mustard oil cake, or 0- 120 kg N ha1 to potato cv. Kufri Chandramukhi. Tuber yield was highest with mustard oil cake (16.2 t ha") and 120 kg N (16.3 t ha-1).

Barman and Das (1996) treated green gram (Vigna rod/ala) organic amendments: Neem cake, cow dung, poultry manure and mustard oil cake each at 2 t ha-1 alone and in combined application of seed dressing, followed by organic amendments at I t N ha-1 each. It was found effective in improving plant growth chameteristics and yield.

Majumdar and Mondal (1994) made a study on the effect of soil amendment with NPK (40:20:20) and mustard and Neem oil cake on rosella (Hibiscus sabdarefa). The fibre yield planu' in NPK and mustard oil cake at I t ha-1 were significantly higher compared with control; besides, higher disease incidence was revealed in the treated.

Adhikari *et al.,* (1992) conducted a field trial on carrot cv. Kufri Badshah, gave 150 kg nitrogen as urea + 40 t cow dung. 3.2 t mustard oil cake or 20 t cow dung. 1.6 t mustard oil cake or 10 t poultry liner ha-1 to give a total nitrogen application in each treatment of about 310 kg ha-1. Carrot yield and net profit were highest with application of 150 kg nitrogen as urea + 20 t poultry liner ha-1.

Sharma a al. (1986) conducted field traits during 1982-84, and found that, nitrogen used as Neem cake coated urea gave significantly higher yields than nitrogen as urea. Emergence was not effect significantly. Mondal and Chowdhury (1980) showed that, when 100, 50 or 25% of the added nitrogen was derived from groundnut cake or 50 or 25% was provided by FYM, average yields were 27.6, 26.3, 28.4, 24.7 and 22.7 t ha-1, respectively

2.3 Combined effect of organic and inorganic fertilizers on growth and yield

Mazumder (2004) reported that the optimum yield of amaranth was obtained from BAR! Data-I at Bangladesh Agricultural Research Institute, Gazipur. The highest yields ranged from 3040 t/ ha as crops were sown between February to March and the fertilizer doses were 100 kg urea, 50 kg triple super phosphate, lOU kg muriate of potash and 5 ton cow dung per hectare respectively.

An experiment was carried out by Linkui et al. (2002) in Shanghai, China to investigate the effect of different bio-fertilizers on the yield and quality of 3-coloured amaranth. Fertilizers were applied at the rate of 1.9 kg plot'. Amaranth receiving biofertilizers showed a yield increase of 15-38% compared to those receiving exclusive vegetable fertilizers.

The effect of cow dung and nitrogen fertilizers on the growth, yield and nutrient uptake to amaranth was studied by Akanbi (2000) in Nigeria. Twelve treatments derived from a factorial combination of four levels of cow dung (0. 1.5. 3.0 and 4.5 had) and three levels of fertilizer (0,30 and 60kg N haS ') were carried out on a sandy loam soil. The application of cow dung and N-fertilizer enhanced plant growth with respect to the control treatments. Plant height, plant diameter, number of leaves, leaf area per plant, dry matter and shoot fresh yield were all significantly affected by different levels of cow dung in combination with or without N-fertilizers.

The performance of four varieties Arnaranthus hpochondriacs 1008. Amaranthus Irvpochondriacs K 372, Arnaranihus cruentus I 7-GUA. Amaranihuscn enius 29- UAS were investigated by Jamriska (1996) by using 85kg N. 40-60 kg P.60-65 kg K haS ' with biofertilizer in respect of seed yield, stand density and height, inflorescence length and its height and 1000 seed weight. Among varieties Amaranthus cruentus 17-QUA was the best with the greatest yield of 3.29 t ha^{-1}.

A comparative study on yield and quality of some amaranth genotypes was done by Hossain (1996) in the Bangabandhu Sheikh Mujibur Rahman Agricultural University. Fertilizer dose was cow dung, urea, triple super phosphate and muriate of potash as 20 ha-1, 200, lOU and 200 kg ha', respectively. Different growth and yield contributing characters were evaluated. He found highest yield 81.24 t-1 had with maximum doses of fertilizer combination.

A study was conducted by Apaza (1994) in representative areas of the central valley of Tarija in Bolivia. Two species of amaranth were evaluated for their response to eight levels of fertilizer: control treatment, chemical (40-40-20) and (80-8040) NPK, organic (7.5 t ha', 15 t ha1 dried ovine manure), mixed (20-20-10+3.75 t ha' and 60- 60-30+11.25 t ha"). Highest response was found both chemical and mixed fertilizer 80% and 295 higher than control treatment and organic respectively.

Moniruzzaman (1987) reported that optimum yield of amaranth could be found at the rate of 10-12 t cow dung, 12 kg urea, 8-10 kg triple super phosphate and 5-7 kg muriate of potash bigha", respectively.

Rajagopat *et al.,* (1977) reported from a total of 65 types of amaranth were assembled from all over Tam II Nadu and other parts of India and evaluated for yield of greens and others attributes from 1972 onwards by applying recommended fertilizer and organic manure. The Co. I was used as standard for this evaluation. Further work on the improvement program of this crop in Tamil Nadu Agricultural University by Department of Horticulture, resulted in identification of A. 25 as a promising selection with high yield potential coupled with good edible plant qualities.

CHAPTER III

MATERIALS AND METHODS

A study was conducted to find out the effect of different organic and inorganic fertilizers on the growth and yield of green amaranth. This chapter presents a short description about experimental period, site description, soil and climatic condition of the experimental area, experimental details, treatments, experimental design and layout, intercultural operations, data collection and statistical analysis. The details of experiments and methods are described below-

3.1 Experimental period

The experiment was conducted in Rabi season during the period from November 2023 to December 2023

3.2 Description of the experimental site

The field experiment was conducted at the north side of the Central Mosque of Hajee Mohammad Danesh Science and Technology University, Dinajpur-5200. The geographically the experimental field is located at 25.69º N latitude ; 88.65º E longitude and 40 m above sea level. The Agro Ecological Zone (AEZ) of the area is the Old Himalayan Piedmont Plain (AEZ-1) (Appendix-I

3.3 Soil characteristics

The soil of the experimental plot was sandy loam with pH 5.60. The initial soil (0-15 cm depth) test revealed that the soil contained 0.080% total nitrogen, 3.30 ppm available phosphorus, 0.52 meq/100g soil exchangeable potassium, 7.53 ppm available sulphur. General soil type was Non calcareous flood plain and the parent material of this soil was alluvial deposit. The details of the plot soil have been presented in table 3.1.

Table 3.1. Morphological, physical and chemical characteristics of the initial soil of the experimental field

A. Morphological characteristics of the initial soil sample

Characteristics	Value
General Soil type	Non – calcareous Brown Floodplain Soil
Parent Material	Piedmont alluvium
Drainage	Moderately well drained
Topography	High land
Flood level	Above flood level

B. Physical characteristics of the initial soil sample

Characteristics	Value
Sand	56.00 %
Silt	34.00 %
Clay	10.00 %
Textural class	Sandy loam

C. Chemical characteristics of the initial soil sample

Characteristics	Value
Ph	5.60
Organic matter (%)	0.82
Electrical conductivity (mSm^{-1})	0.14
Total N(%)	0.080
Available P(ppm)	3.30
Exchangeable K(meq/100g soil)	0.52
Available S (ppm)	7.53

3.4 Climatic condition

The climate of the experimental site was under the subtropical climate, characterized by three distinct seasons, the winter season from November to December. There was no rainfall during the months of December,. The average maximum temperature of experimental site during the period of study was 2°C and the average minimum temperature was 13.33°C. Details of the meteorological data of air temperature, relative humidity and rainfall during the period of the experiment was collected from the weather station of Bangladesh Wheat and Maize Research Institute, Dinajpur and has been presented in Appendix II.

3.5 Planting materials

A local variety of Amaranth was used as a test crop in the experiment. It was green amaranth (*Amaranthus viridis*.) and leafy type quick growing short duration summer vegetable. Seeds are collected from the sell center of Bangladesh Agricultural Development Corporation (BADC), Noshipur, Dinajpur.

3.6 Treatments of the experiment

There are 6 treatments with 3 replications for conducting the whole experiment which were as follows:

T_1 = Control

T_2 = 100% NPK

T_3 = 100% (Compost+Cowdung)

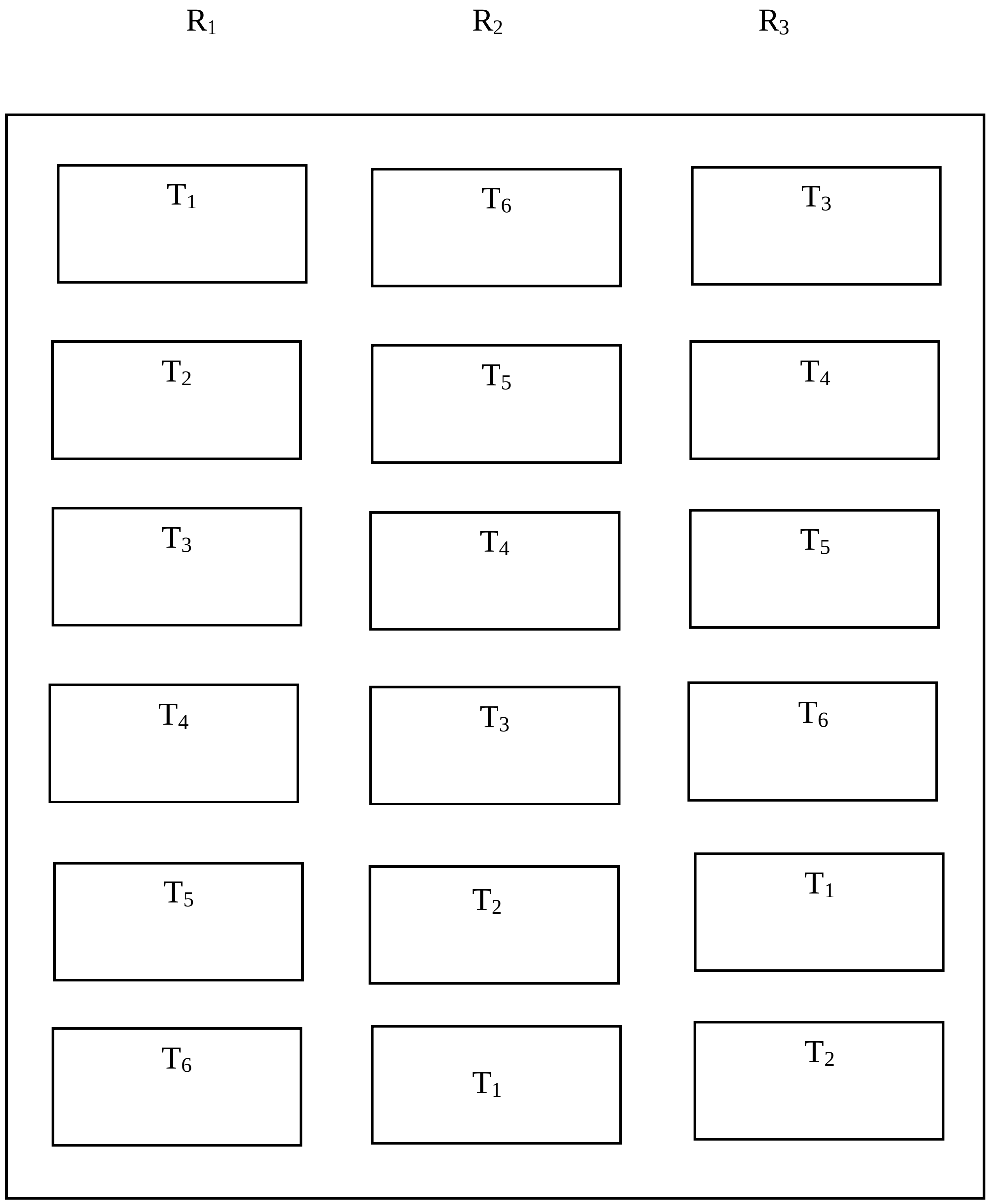
T_4 = 75% (Compost+ Cowdung) +25% NPK

T_5 = 50% (Compost+Cowdung)+50% NPK

T_6 = 25%(Compost+ Cowdung) +75% NPK

3.7 Experimental design and layout

The experiment was laid out following Randomized Complete Block Design (RCBD) with three replications. There were three blocks and each block containing 6 plots. Thus, the total number of plots was 18. The size of unit plot was $1m^2$ (1 m × 1 m). The distance between the plot to plot and the row to row were maintained 0.5 m and 0.25 m, respectively.



3.1: Layout of the experimental plot

3.8 Land preparation

The experimental land was prepared with the help of power tiller by three successive ploughing and cross-ploughing followed by laddering. Weeds and crop residues of previous crops were removed from the field. The experimental plot was divided into unit plots in accordance with the experimental design.

3.9 Manure and fertilizer application

The full dose of K from muriate of potash (MP), and P from triple super phosphate(TSP) were applied to all experimental plots as per treatments. One third of N from urea was applied as basal dose during the final land preparation and the rest of urea was applied 20 days after sowing.NPK and Compost per plot requirements were calculated as per the treatments respectively. The recommended dose was $N_{75}P_{18}K_{30}S_{9}$, (Fertilizer Recommendation Guide, 2018. Page-100) from full amounts of TSP, MoP. As organic fertilizer was applied before four days of final land preparation. Chemical compositions of the manures have been given below

Table 3.2. Chemical compositions of organic manure

Name of organic fertilizers	Nutrient content (%)			
	N	P	K	S
Cow dung	1.92	0.29	0.75	0.21
Compost	1.48	0.28	1.27	0.32

3.10 Seed sowing

Seeds were sown in well-prepared land on 1st November 2023. The seeds were sown at about 1.3 cm depth by broadcasting method and covered uniformly with light soil for proper germination at 1.5-2.0 kg ha^{-1}.

3.11 Intercultural operation

After the establishment of crops, various intercultural operations were accomplished for better growth and development of the green amaranth crops.

3.11.1 Thinning

Thinning was done 10 days after sowing (DAS) and 20 DAS. Thinning was done in the entire unit plots with special care to maintain constant plant population per plot.

3.11.2 Weed control

Weddings were done to keep the plots free from weeds, which ultimately ensured better growth and development. It keeps the soil aerated by breaking the soil crust. It also conserves the soil moisture. The newly emerged weeds were uprooted carefully by mechanical means.

3.11.3 Irrigation and drainage

Irrigation was done as and when the field seemed dry to each plot to ensure sufficient moisture for normal crop growth. Proper drainage facilities were developed to avoid stagnation of water.

3.12 Harvesting

Red amaranths were harvested at 45-50 days after sowing, on 1st December 2023, when the plant growth was maximum for use as vegetable. Harvesting was done plot wise by uprooting the plants by hand carefully and calculated yield plot^{-1} in kg and then it was converted in ton ha^{-1}.

3.13 Data collection

The data on the following parameters were collected from each treatment.

- Plant height
- Number of leaves plant^{-1}
- Shoot weight plot^{-1}
- Root weight plot^{-1}
- Root length
- Total N content
- Available P
- Exchangeable K
- Available S
- Soil pH
- Electrical conductivity (EC)

- Organic matter (OM)
- Particle density

3.14 Detailed Procedures for Recording Data

A brief outline of the data collecting procedure followed during the experiment is given below:

3.14.1 Plant height

Plant height was measured from the soil level to the terminal leaf using a meter scale in centimeter (cm). From each unit plot 5 sample plants were measured, and mean value was recorded. Plant height was recorded periodically to observe the growth parameters of plants at 15, 30, 45 DAS and final harvest.

3.14.2 Number of leaves plant^{-1}

To estimate the number of leaves per plant, leaves were counted at 15, 30, 45 DAS and final harvest from 5 selected plants. All the leaves of selected plants were counted separately, and mean value was calculated.

3.14.3 Shoot weight plot^{-1}

The fresh shoot weight of individual plot was measured with the electrical balance in gram (g), and then dried in the sun to remove the extra moisture and later dry weight was recorded in gram (g) and converted into ton ha^{-1}.

3.14.4 Root weight plot^{-1}

After the final harvest, the fresh root of individual plot was weighed with electrical balance in gram (g). Then the roots were oven dried for 72 hours at 70^{o}C. Dry weight (g) plot^{-1} was taken with the help of an electronic balance and converted into t ha^{-1}.

3.14.5 Root length

The length of the root of the selected 10 plant per plot was measured in centimeter (cm) after harvest.

3.14.6 Soil analysis for chemical properties and essential nutrients

Soil samples were collected from each pot at three different points and then mixed to form one composite sample for each replication. The samples were sealed in plastic bags and transported to the lab, and then plant detritus and other fragments were removed. After air-dried, the soil samples were ground and passed through a 2 mm sieve for analysis of total N content, available P, exchangeable K, available S, soil pH, electrical conductivity (EC), organic matter (OM).

3.14.6.1 Total Nitrogen content

Total nitrogen was determined by Micro-Kjeldahl method (Jackson, 1973). Total N content of soil was determined following the micro-Kjeldahl method. The soil was digested with H_2O_2 and conc. H_2SO_4 in presence of a catalyst mixture (K_2SO_4: $CuSO_4.5H_2O$: Se in the ratio of 10: 1: 0.1) and the nitrogen in the digest was determined by distillation with 40% NaOH followed by titration of distillate trapped in H_3BO_3 with0.01N H_2SO_4 (Page *et al.*, 1982).

3.14.6.2 Available phosphorus (P)

Phosphorus was extracted from soil samples by the sodium bicarbonate (0.5 M, pH8.5) method according to Olsen *et al.* (1954) and determined by the ascorbic acid–molybdenum blue method at wavelength of 660 nm in Spectro-photometer as described by Jackson (1973).

3.14.6.3 Exchangeable potassium (K)

The exchangeable cations like potassium (K) extracted with 1 N ammonium acetate and determined using the Flame photometer (Jackson, 1973).

3.14.6.4 Available Sulphur (S)

Available S was determined by 0.15% CaCl2 extraction method (Page *et al.*, 1982).

3.14.6.5 Soil pH

The soil pH was determined in 1:2.5 soil: water suspension by potentiometric method using glass electrode pH meter (Jackson, 1973).

3.14.6.6 Electrical conductivity (EC)

Electrical conductivity was determined with the help of a conductivity meter following Jackson (1973).

$$\text{Electrical conductivity of soil} = \text{observed EC of soil} \times K$$

3.14.6.7 Soil organic matter content (OM)

Organic carbon in soil was determined by Walkley and Black's (1934) wet oxidation method. The underlying principle is to oxidize the organic carbon with an excess of 1 N $K_2Cr_2O_7$ in presence of conc. H_2SO_4 and to titrate the residual $K_2Cr_2O_7$ solution with 1 N $FeSO_4$ solution. The OM content was calculated by multiplying the percent OC with the van Bemmelen factor of 1.724 (Piper, 1950).

$$\% \text{ Organic matter} = \% \text{ Organic carbon} \times 1.724$$

3.14.7 Particle density

The particle density of a soil = dry mass (g) of soil / volume of soil particles. Where D_p is particle density; ODwt is oven-dry weight of soil; V_s is volume of solids. Particle density takes into account the mass and volume occupied by the solid particles only. It excludes the volume occupied by air and water. June 24, 2021

The **particle density** of a soil = dry mass (g) of soil / volume of soil particles.

$$Dp = ODwt/Vs$$

Where D_p is particle density; ODwt is oven-dry weight of soil; V_s is volume of solids. Particle density takes into account the mass and volume occupied by the solid particles only

3.15 Statistical analysis

The collected data on various parameters were statistically analyzed with the help of the computer package programme Statistix 10. The significance of differences between treatments was estimated by Tukey HSD at 5% level of probability (Gomez and Gomez, 1984).

CHAPTER IV

RESULTS AND DISCUSSION

This experiment was performed to know the effect of different organic and inorganic fertilizers on the growth and vegetative yield of green amaranth. Data on different levels of growth parameters and post-harvest soil test were recorded to find out the suitable fertilizer mixtures for green amaranth production. The results have been presented by graphs and tables, discussed and possible interpretations are given under the following heading:

4.1 Physical properties of plant

4.1.1 Plant height

The plant height of green amaranth varied significantly for different treatments at different days after sowing (DAS) (Table 4.1). Among the treatments, at 15 DAS, T_6 exhibited the tallest plant height (6.97 cm) which was statistically similar to T_5 (6.95 cm), while T_1 had the lowest height (5.83 cm), indicating that T_6 and T_5 promoted the most rapid early growth. Moving to 30 DAS, T_6 continued to lead with the highest plant height (30.74 cm), while T_1 remained the lowest value (12.50 cm). This trend persisted at 45 DAS, with T_6 boasting the highest value (38.80 cm), and T_1 maintaining the lowest value (15.80 cm). Similarly, Oroka (2016) reported that vermicompost alone and in mixture with NPK significantly increased the plant morphological parameters and yield and yield components. Ali *et al.* (2018) also found similar trends.

4.1.2 Number of leaves plant^{-1}

The number of leaves of green amaranth plant statistically significant at different days after sowing (DAS) for six different treatments (Table 4.2). At 15 DAS, T_4 and T_5 had the highest number of leaves (5.60), while T_1 had the lowest (5.30). As the days progressed to 30 DAS, T_4 again exhibited the highest leaf count (8.70), while T_1 remained at the lowest (7.30). Finally at 45 DAS, with T_6 having the highest number of leaves (10.70) and T_1 having the lowest (9.60). Overall, the data indicates that T_6 consistently outperformed other treatments in terms of leaf production at all DAS stages, while T_1 consistently had the fewest leaves. Kashem *et al.* (2015) stated that number of leaves was influenced significantly by the application of vermicompost and NPK fertilizer in the growth media. In addition, Saha *et al.* (2022) found that vermicompost has a positive effect on green amaranth production.

Table 4.1: Effect of different treatments on plant height of green amaranth at different DAS

Treatments	Plant height (cm)		
	At 15 DAS	**At 30 DAS**	**At 45 DAS**
T_1	5.83 b	12.50 e	9.02 f
T_2	5.76b	23.80 c	14.79 e
T_3	6.06b	15.08 d	17.01 d
T_4	6.80a	28.07b	18.71 c
T_5	6.95 a	28.92 b	22.04 b
T_6	6.97 a	30.73 a	24.51 a
CV	5.03	2.09	1.42
LSD	0.26	0.39	0.34

Values in a column with different letters are significantly different at $p \leq 0.05$ applying LSD.

CV% = Coefficient of variation

LSD=Least Significant Difference

Here,

T_1 = Control

T_2 = 100% NPK

T_3 = 100% (Compost+Cowdung)

T_4 = 75% (Compost+ Cowdung)+ 25% NPK

T_5 = 50% (Compost+ Cowdung) + 50% NPK

T_6 = 25% (Compost+ Cowdung) + 75% NPK

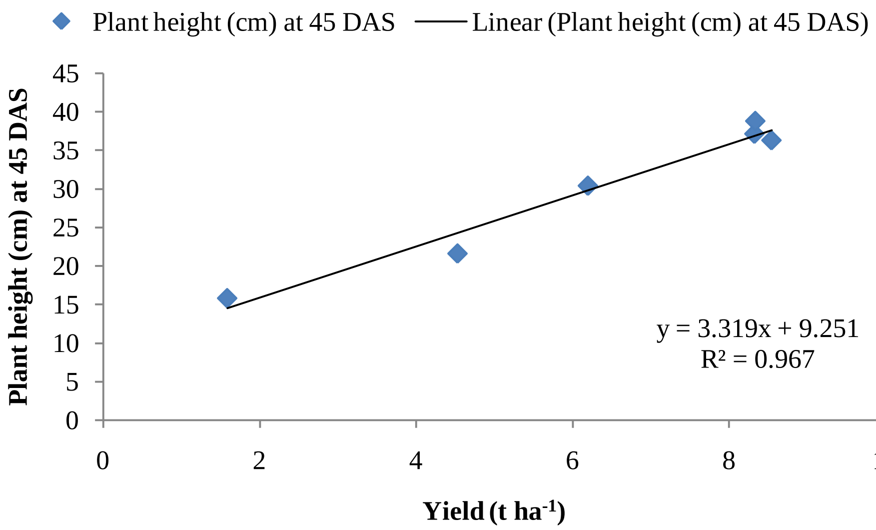


Figure 4.1: Showing the of different treatments on plant height of green amaranth at 45 DAS

Table 4.2: Effect of treatments on number of leaves plant^{-1} of green amaranth at different DAS

Treatments	Number of leaves plant^{-1}		
	At 15 DAS	**At 30 DAS**	**At 45 DAS**
T_1	5.30 bc	7.30 c	9.60c
T_2	5.20c	8.00b	9.50 cd
T_3	5.10c	7.40c	9.30 d
T_4	5.60a	8.70a	10.60ab
T_5	5.60a	8.60a	10.38 b
T_6	5.50 ab	8.60 a	10.70 a
CV	2.43	1.50	1.42
LSD	0.107	0.099	0.116

Values in a column with different letters are significantly different at $p \leq 0.05$ applying LSD.

CV% = Coefficient of variation

LSD=Least Significant Difference

Here,

T_1 = Control

T_2 = 100% NPK

T_3 = 100% (Compost+Cowdung)

T_4 = 75% (Compost+ Cowdung)+ 25% NPK

T_5 = 50% (Compost+ Cowdung) + 50% NPK

T_6 = 25% (Compost+ Cowdung) + 75% NPK

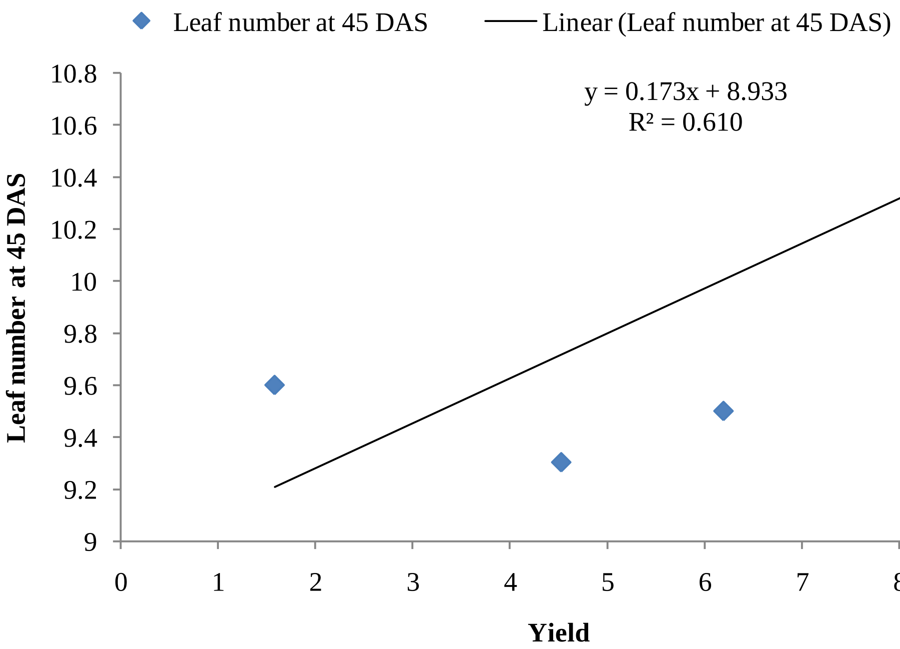


Figure 4.2: Showing the treatments on number of leaves plant^{-1} of green amaranth at 45 DAS

4.1.3 Shoot weight

The shoot both fresh and dry weight of green amaranth were significantly different among different treatments (Table 4.3). In terms of fresh shoot weight, T_1 had the lowest weight (1.16 t ha^{-1}), while T_5 had the highest fresh shoot weight (6.23 t ha^{-1}) which was statistically similar with T_6 (6.10 t ha^{-1}). This indicates a clear trend of increasing fresh shoot weight from T_1 to T_6, with T_5 being the most productive in terms of fresh shoot weight.

When considering dry shoot weight of green amaranth, a similar pattern emerges. T_1 again had the lowest dry shoot weight (0.52 t ha^{-1}), while T_5 had the highest dry shoot weight (3.78 t ha^{-1}) which was statistically similar with T_6 (3.18 t ha^{-1}). This consistent pattern demonstrates that T_5 consistently outperformed the other treatments in terms of both fresh and dry shoot weight. Similar results were reported also by Kashem *et al.* (2015) and Alam *et al.* (2007).

4.1.4 Root weight

There was a significant variation for both fresh and dry root weight of green amaranth across the treatments (Table 4.4). In terms of fresh root weight, T_1 had the lowest weight (0.42 t ha^{-1}), while T_5 had the highest fresh root weight (2.29 t ha^{-1}) which was statistically similar with T_6 (2.23 t ha^{-1}). This indicates a clear trend of increasing fresh root weight from T_1 to T_6, with T_5 being the most productive in terms of fresh root weight.

Similarly, when considering green amaranth dry root weight, T_1 had the lowest dry root weight (0.19 t ha^{-1}), while T_5 had the highest dry root weight (1.39 t ha^{-1}) which was statistically similar with T_6 (1.28 t ha^{-1}). Again, this consistent pattern demonstrates that T_5 consistently outperformed the other treatments in terms of both fresh and dry root weight. Alam *et al.* (2007) also suggested that vermicompost (5 t ha^{-1}) + NPK (100%) can be economically and environmentally suitable. The results are in consonance with the findings of Kashem *et al.* (2015).

4.1.5 Root length

The green amaranth root length was statistically different due to different treatments (Table 4.4). The highest root length (7.89 cm) was observed in treatment T_6. On the other hand, the lowest root length (6.20 cm) was found in treatment T_1. This data clearly demonstrates a progressive increase in root length from T_1 to T_6, with treatment T_6 exhibiting the most extensive root growth, while treatment T_1 has the shortest root length among the treatments. Similar result was reported also by Ali *et al.* (2018) that vermicompost addition with recommended dose of chemical fertilizers performed better compared to only inorganic fertilizers.

Table 4.3: Effect of treatments on shoot fresh and dry weight of green amaranth

Treatments	Shoot weight (t ha^{-1})	
	Fresh	**Dry**
T_1	1.16 c	0.52 d
T_2	4.53 ab	2.23 bc
T_3	2.99 bc	1.59 cd
T_4	6.08 a	3.49 a
T_5	6.25 a	3.18 ab
T_6	6.10 a	3.78 a
CV	25.82	24.14
LSD	0.953	0.486

Values in a column with different letters are significantly different at $p \leq 0.05$ applying LSD.

CV% = Coefficient of variation

LSD=Least Significant Difference

Here,

T_1 = Control

T_2 = 100% NPK

T_3 = 100% (Compost+Cowdung)

T_4 = 75% (Compost+ Cowdung)+ 25% NPK

T_5 = 50% (Compost+ Cowdung) + 50% NPK

T_6 = 25% (Compost+ Cowdung) + 75% NPK

Table 4.4: Effect of treatments on root fresh and dry weight, root length of green amaranth

Treatments	Root weight (t ha^{-1})		Root length (cm)
	Fresh	Dry	
T_1	0.42 c	0.19 c	6.20 d
T_2	1.66 ab	0.82 b	6.80 c
T_3	1.53 b	0.67 b	6.80 c
T_4	2.24ab	1.49 a	7.10 b
T_5	2.29 a	1.28 a	7.81 a
T_6	2.23 ab	1.39 a	7.89 a
CV	22.88	14.80	1.43
LSD	0.323	0.117	0.083

Values in a column with different letters are significantly different at $p \leq 0.05$ applying LSD.

CV% = Coefficient of variation

LSD=Least Significant Difference

Here,

T_1 = Control

T_2 = 100% NPK

T_3 = 100% (Compost+Cowdung)

T_4 = 75% (Compost+ Cowdung)+ 25% NPK

T_5 = 50% (Compost+ Cowdung) + 50% NPK

T_6 = 25% (Compost+ Cowdung) + 75% NPK

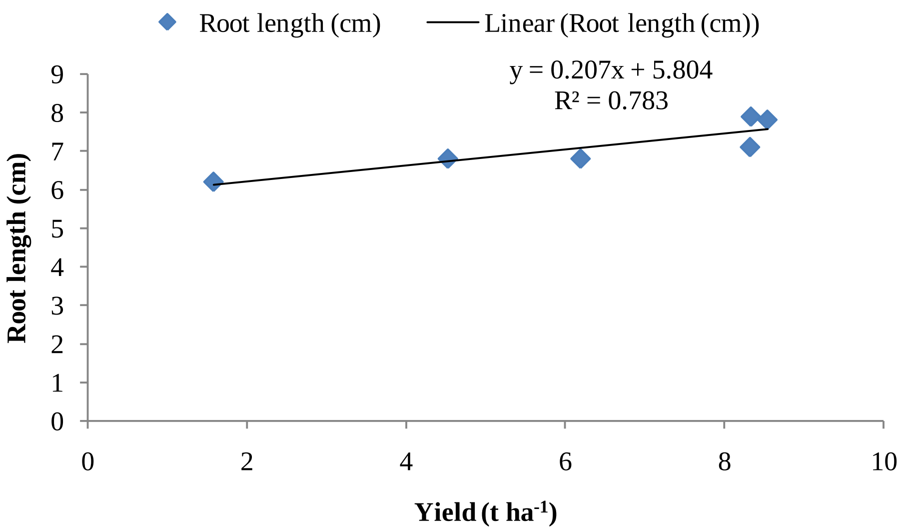


Figure 4.4: Effect of treatments on root length of green amaranth

4.2 Chemical properties of post harvest soil

4.2.1 Soil pH

The different treatments for green amaranth had a significant effect on post-harvest soil pH (Table 4.6). In the initial, soil pH was 5.60. After applying treatments, treatment T_3 exhibited the highest pH level (7.20), representing the treatment with the most alkaline soil. In contrast, treatment T_1 had the lowest pH level (6.80), indicating the treatment with the most acidic soil. This data illustrates a clear range of pH values across the treatments, with treatment T_4 showing the highest soil alkalinity, while treatment T_1 displayed the lowest soil pH, indicating acidity.

4.2.2 Electrical conductivity (EC)

There were no significant variations in EC levels of post-harvest soil across the treatments for green amaranth crop (Table 4.6). Before applying the treatments, the EC was 0.14 mS/m. However, applying treatments, among these treatments, the highest EC value (0.331 mS/m) was observed in treatment T_3, while the lowest EC value (0.50 mS/m) was found in treatments T_1.

4.2.3 Organic matter (OM) content in soil

Organic matter content of post-harvest soil differed significantly for six different treatments (Table 4.6). In the initial soil, organic matter (OM) content was 0.82. After treatment application, treatment T_3experienced the highest organic matter content (0.987%). In contrast, treatment T_1 had the lowest organic matter content (0.887%), indicating the treatment with the least organic matter. This data illustrates a clear difference in organic matter content across the treatments; with treatments T_3 had the highest levels of organic matter, while treatment T_1 displayed the lowest organic matter content among the treatments. Likewise, vermicompost with inorganic fertilizer had a positive effect in case of organic matter of post-harvest soil reported by Kashem *et al.* (2015).

Table 4.5: Effects of organic and inorganic fertilizers on soil pH, electrical conductivity and organic matter content of the post-harvest soils for green amaranth production

Treatments	Soil pH	Electrical conductivity (mS/m)	Organic matter content (%)
T_1	5.60 b	0.05 c	0.88 c
T_2	6.45 c	0.32 a	0.94 c
T_3	7.20 a	0.33 a	1.40 a
T_4	6.45 c	0.11 c	0.98 bc
T_5	6.70 b	0.07 b	0.94 c
T_6	6.70 b	0.22 c	0.17 b
CV	1.47	20.46	9.57
LSD	0.080	0.031	0.082
Initial soil	5.60	0.14	0.82

Values in a column with different letters are significantly different at $p \leq 0.05$ applying LSD.

CV% = Coefficient of variation

LSD=Least Significant Difference

Here,

T_1 = Control

T_2 = 100% NPK

T_3 = 100% (Compost+Cowdung)

T_4 = 75% (Compost+ Cowdung)+ 25% NPK

T_5 = 50% (Compost+ Cowdung) + 50% NPK

T_6 = 25% (Compost+ Cowdung) + 75% NPK

4.2.4 Particle density

There were no significant variations in particle density of post-harvest soil across the treatments for green amaranth crop (Table 4.6). Before applying the treatments, the particle density was g/cc. However, applying treatments, among these treatments, the highest particle density value (2.25 g/cc) was observed in treatment T_6, while the lowest particle density value (2.15 g/cc) was found in treatments T_3.

Table 4.6: Effect of treatments on particle density of the post-harvest soils for green amaranth production

Treatments	Particle density (g cc^{-1})
T_1	2.24 a
T_2	2.28 ab
T_3	2.15 d
T_4	2.18 cd
T_5	2.22 bc
T_6	2.25 ab
CV	1.50
LSD	0.027
Initial soil	2.24 a

Values in a column with different letters are significantly different at $p \leq 0.05$ applying LSD.

CV% = Coefficient of variation

LSD=Least Significant Difference

Here,

T_1 = Control

T_2 = 100% NPK

T_3 = 100% (Compost+Cowdung)

T_4 = 75% (Compost+ Cowdung)+ 25% NPK

T_5 = 50% (Compost+ Cowdung) + 50% NPK

T_6 = 25% (Compost+ Cowdung) + 75% NPK

4.2.5 Total N

There were significant differences in the total N of post-harvest soil of green amaranth for different treatments (Table 4.5). Before applying treatment, total N percentage was 0.080. After post-harvest soil analysis, among these treatments, the highest nitrogen content of 0.112% was observed in treatment T_6 which was statistically similar with T_2 and T_3. In contrast, the lowest nitrogen percentage (0.056%) noticed in treatment T_1which was statistically similar with T_4 and T_5. These measurements provide valuable insights into the variations in nitrogen levels under different treatment conditions, with treatment T_6 displaying the highest nitrogen content among the treatments. Ali *et al.* (2018) conducted an experiment and found that post-harvest soil analysis showed a higher amount of total N contents than in initial soil.

4.2.6 Available P

Available phosphorus (P) concentrations of post-harvest soil were significantly influenced by different treatments for green amaranth cultivation (Table 4.5). In the initial soil, available P was 3.30 ppm. After post-harvest soil analysis, among these treatments, treatment T_5 exhibited the highest phosphorus concentration (9.72 ppm). In contrast, treatment T_1 had the lowest phosphorus concentration at 3.06 ppm, representing the treatment with the lowest phosphorus levels. This data illustrates a notable contrast in phosphorus content across the treatments, with treatment T_5 showing the highest phosphorus concentration, while treatment T_1 displays the lowest. Zhenyu and Yongliang (2005) found that employing vermicompost could increase available nutrients for crops.

4.2.7 Exchangeable K

The exchangeable K in post-harvest soil varied significantly for different treatments (Table 4.5). Before applying treatment, the exchangeable K in initial soil was 0.52 meq/100 g soil. After post-harvest soil analysis, among these treatments, treatment T_5 showed the highest potassium concentration (0.16 meq/100 g soil). Conversely, treatment T_1 had the lowest potassium concentration (0.05 meq/100 g soil), representing the treatment with the lowest potassium levels. This data highlights a clear gradient in potassium content from T_1 to T_5, indicating that treatment T_5 possesses the highest potassium concentration, while treatment T_1 exhibits the lowest. This statement was also supported by Ali *et al.* (2018).

4.2.8 Available S

Statistically significant differences were found in post-harvest soil available sulfur (S) concentrations for different treatments (Table 4.5). In the initial soil, available S was 7.53 ppm. After post-harvest soil analysis, among these treatments, treatment T_5 had the highest sulfur concentration (19.50 ppm). In contrast, treatment T_1 showed the lowest sulfur concentration (5.73 ppm). This data reveals a clear ascending trend in sulfur content from T_1 to T_6, indicating that treatment T_6 has the highest sulfur concentration, while treatment T_1 has the lowest. Similar results were also found by Kashem *et al.* (2015) and Zhenyu and Yongliang (2005).

Table 4.7: Effects of organic and inorganic fertilizers on total N, available P, exchangeable K and available S of the post-harvest soils for green amaranth production

Treatments	Nutrients content			
	Total N (%)	Available P (ppm)	Exchangeable K (meq/100 g soil)	Available S (ppm)
T_1	0.056 c	3.06 f	0.05 a	5.73 f
T_2	0.110 b	7.40 a	0.06 d	17.84 a
T_3	0.110 b	4.06 f	0.09 b	5.77 e
T_4	0.082 a	5.27 e	0.12 a	7.53 d
T_5	0.076 c	9.77 a	0.16 a	19.50 c
T_6	0.112 b	8.72 b	0.14 c	18.05 b
CV	6.38	0.56	5.39	0.33
LSD	0.011	0.026	0.004	0.029
Initial soil	0.080	3.30	0.52	7.53

Values in a column with different letters are significantly different at $p \leq 0.05$ applying LSD.

CV% = Coefficient of variation

LSD=Least Significant Difference

Here,

T_1 = Control

T_2 = 100% NPK

T_3 = 100% (Compost+Cowdung)

T_4 = 75% (Compost+ Cowdung)+ 25% NPK

T_5 = 50% (Compost+ Cowdung) + 50% NPK

T_6 = 25% (Compost+ Cowdung) + 75% NPK

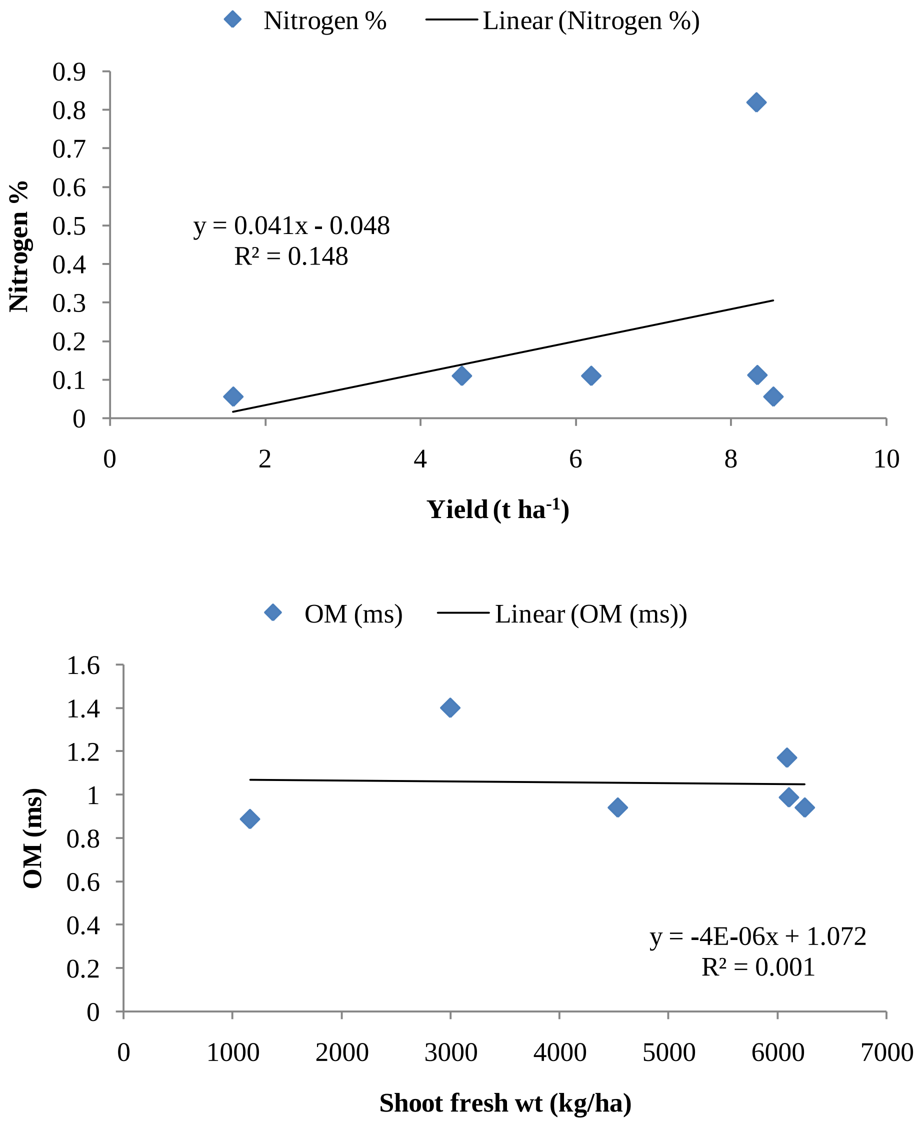


Figure 4.4: Effects of organic and inorganic fertilizers on total N, OM of the post-harvest soils for green amaranth production

CHAPTER V

SUMMERY AND CONCLUSIONS

5.1 Summery

The experiment was conducted at Soil Science Research Field, Hajee Mohammad Danesh Science and Technology University, Dinajpur, during the period of November 2023 to February 2024 with a view to evaluate the effects of different organic and inorganic fertilizers on the vegetative growth and yield of green amaranth. The experimental soil belongs to the Old Himalayan Piedmont Plain (AEZ-1) The soil was sandy loam in texture having pH 5.60, organic matter content 0.82%, total N 0.080%, available P 3.30 ppm, exchangeable K 0.52meq 100 g^{-1} soil and available S 7.53 ppm The experiment was laid out in a Randomized Complete Block Design (RCBD). There were six treatments with three replications in the experiment. So, the total number of plots was 18. The unit plot size was (1 m × 1 m) = 1 m^2. Different levels of inorganic and organic fertilizers were used as treatment viz T_1 = Control, T_2 = 100% NPK, T_3 = 100% Compost + Cowdung, T_4 = 75% Compost+ Cowdung + 25%NPK, T_5 = 50% Compost+ Cowdung+50% NPK, T_6 = 25% Compost+ Cowdung+ 75% NPK. Compost was applied before four days of final land preparation. Per plot requirements NPK were calculated as per the treatments andfull amounts of TSP, MOP were applied as basal dose. Urea was applied in 2 equal splits: one half was applied at basal dose during final land preparation and the rest was applied at 15 DAS (Day After Sowing). Seeds were sown on 1st November 2023. The crop was allowed to grow until maturity and intercultural operations such as weeding, and irrigation were done whenever required in order to support normal growth of the plant. The crop was harvested on 20th December 2023. Plot wise yield and yield components were recorded. Soil samples were collected before fertilizers application and after harvest. Initial and post-harvest soil samples were analyzed for physical and chemical properties of soil using the standard methods. All the data were statistically analyzed by F test and the mean differences were judged by Tukey HSD by means of Statistix 10 software.

The results revealed that the vegetative growth of green amaranth as well as plant height, number of leaves $plant^{-1}$, shoot weight $plot^{-1}$, root weight $plot^{-1}$, root length and nutrients content in post-harvest soil i.e., total N content, available P, exchangeable K, available S, soil pH, electrical conductivity (EC), organic matter (OM) responded significantly due to application of organic and inorganic fertilizers.

The tallest plant height (6.970, 30.737, and 38.800 cm at 15, 30, 45 during final harvest respectively) was found in the treatment T_6 and the shortest plant height (5.76, 12.50, and 15.80 cm at 15, 30, and 45 during final harvest, respectively) was observed in T_1 (control).

The maximum number of leaves (5.60, 8.70, 10.70 at 15, 30, and 45 during final harvest, respectively) was recorded in the treatment T_5 whereas the minimum number of leaves (5.10, 7.30, 9.30 at 15, 30, 45 during final harvest, respectively) was found in the T_1 (control).

The treatment T_5 produced the highest both fresh and dry shoot weight (6.248 and 3.780 t ha^{-1} respectively) but the lowest fresh and dry shoot weight (1.159 and 0.519 t ha^{-1} respectively) was obtained from the control treatment (T_1).

The maximum fresh and dry root weight (2.295 and 1.280 t ha^{-1}, respectively) was found in T_5 and tallest root length (7.89 cm) was recorded from the treatment T_6 and the minimum both fresh and dry root weight (0.425 and 0.190 t ha^{-1}, respectively) and smallest root length (6.20 cm) was observed in the T_1 (control).

Application of organic and inorganic fertilizers resulted in a considerable influence on the properties of the post-harvest soils such as pH, organic matter content, total N, available P, exchangeable K and available S. In post-harvest soil, the combined application of NPK and compost gave positive results. It also increased soil fertility status. The highest percentage of total N of and available S (0.112 % and 18.05 ppm, respectively) were found in T_6 treatment and lowest percentage of N and available S (0.056 % and 5.73 ppm, respectively) were in T_1 treatment. The highest available P (9.772 ppm) and exchangeable K (0.160 meq/100 g soil) were found in both cases at T_5 and the lowest available P and K (3.063 ppm and 0.050 meq/100 g soil, respectively) was in T_1 (control) treatment. The highest pH (7.20) was observed for T_3 treatment while T_1 showed the lowest value (5.60). In post-harvest soil electrical conductivity was statistically different for different treatments. The soil electrical conductivity percentage was highest(0.328 ms) in T_2 which was statistically similar with $T_3$and the soil electrical conductivity percentage was lowest(0.050ms) in T_1 . The soil organic matter percentage was highest (1.400 %) in T_3 treatment which was statistically identical to $T_4$and T_5. The lowest organic matter content (0.887 %) was found in T_1 treatment. Finally, it can be concluded from the present study that the application of organic manures with the recommended doses of inorganic fertilizers showed better performance in respect of vegetative growth of green amaranth and also increased the fertility status in soil. Moreover, 50% NPK + 50% (compost and cowdung) (T_5) gave better performance than other combinations in all aspects. So, compost with inorganic fertilizers will be profitable for green amaranth cultivation

5.2 Conclusions

From the results of the study, it may be concluded that:

i. Integrated use of organic and inorganic fertilizers (NPK) can significantly increase the vegetative growth of green amaranth and also produced the maximum yield.

ii. Application of 50% NPK + 50%(Compost+Cowdung) satisfactorily increased the amount of organic matter, total N, available P, exchangeable K and available S in soil to some extent.

5.3 Recommendation

a. Application of 50% NPK with 50%(compost and cowdung) may be suggested for the production of green amaranth in the soil of Old Himalayan Piedmont Plain.
b. Considering the above observation further study may be needed to enhance the soil fertility status by combined application of organic and inorganic fertilizers to ensure the better growth and yield performance of green amaranth in different agro ecological zones (AEZ) of Bangladesh for regional adaptability.

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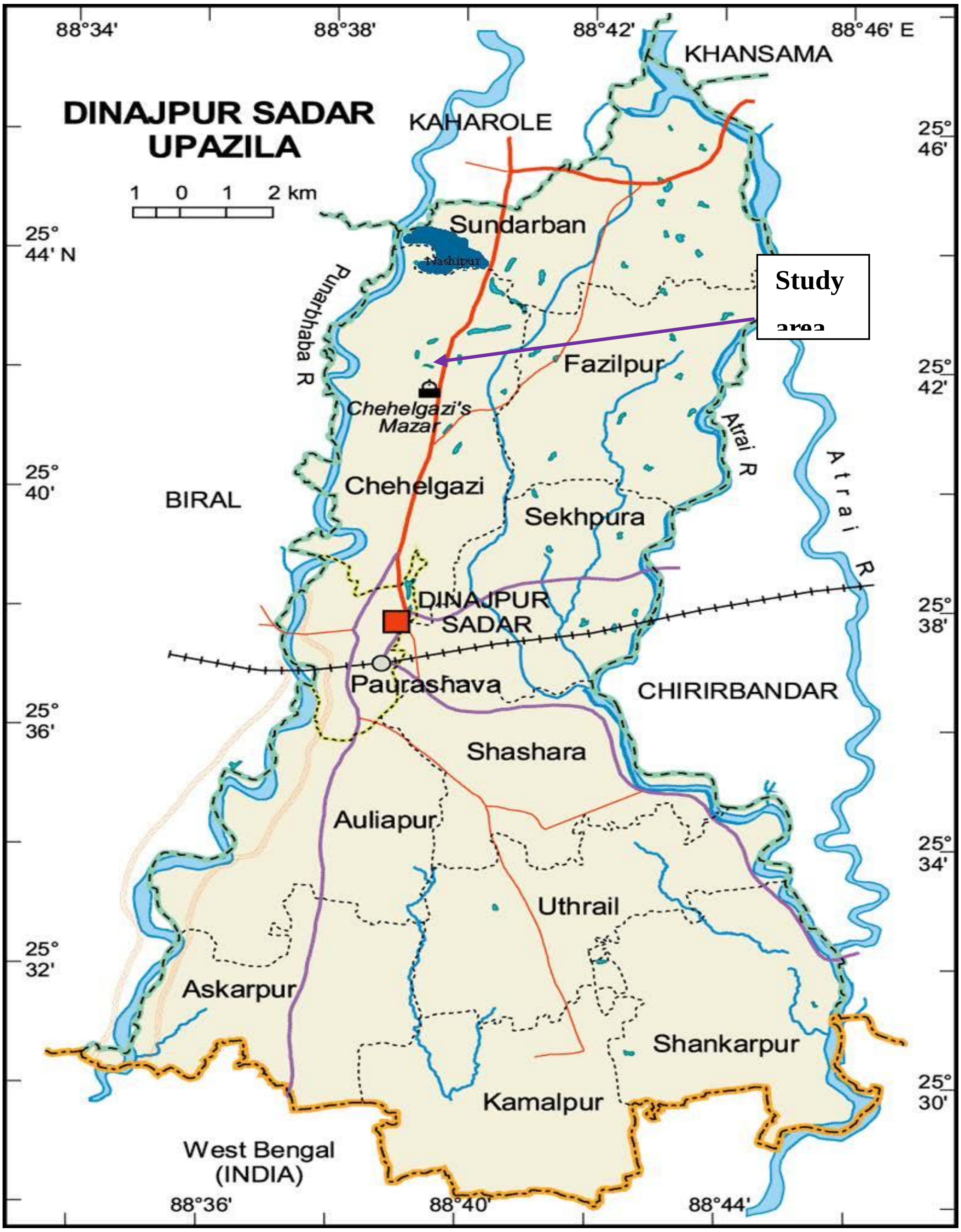
APPENDICES

Appendix I. Location of the experimental site (map of Dinajpur Sadar Upazila showing the research plot)



Appendix II. Monthly recorded air temperature, relative humidity, and rainfall during the research period (From November 2023 to December 2023)

Year	Month	**Temperature (^{0}C)			** Humidity (%)	**Rainfall (mm)
		Maximum	Minimum	Average (^{0}C)		
2022	December	25	13	19	82	0.0
2023	January	22	12	17	82	7.2
	February	26	15	20	72	17
	March	31	19	25	65	7.6

**Monthly average

Source: Bangladesh Wheat and Maize Research Institute, Nashipur, Dinajpur.

Appendix III. Some photographs of experimental site