EFFECT OF DIFFERENT SOIL MIXTURES ON THE GROWTH AND YIELD OF TARO (*Colocasia esculenta*) FOR ROOFTOP GARDENING

A THESIS

BY

MD. AL-AMIN

Student No. 1701103

Session: July-December, 2022

MASTER OF SCIENCE (M.S.)

IN

SOIL SCIENCE

DEPARTMENT OF SOIL SCIENCE

HAJEE MOHAMMAD DANESH SCIENCE AND TECHNOLOGY UNIVERSITY

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MD. AL-AMIN

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Approved as to style and contents by

....	....…….
Prof. Dr. Shah Moinur Rahman	**Prof. Dr. Md. Shahadat Hossain Khan**
Supervisor	Co-supervisor

....

Prof. Dr. Shah Moinur Rahman

Chairman

Examination Committee

and

Chairman

DEPARTMENT OF SOIL SCIENCE

HAJEE MOHAMMAD DANESH SCIENCE AND TECHNOLOGY UNIVERSITY

DINAJPUR-5200

JUNE, 2024

DEDICATED

TO MY

BELOVED FAMILY

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I am profoundly grateful to Almighty God, whose boundless grace and blessings have enabled me to complete this research and present this thesis for the degree of Master of Science (MS) in Soil Science.

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Author

ABSTRACT

A pot experiment was conducted at the Research Field, Department of Soil Science, Hajee Mohammad Danesh Science and Technology University, Dinajpur, October 2023 to December 2023 during the Rabi season for assessing the effectiveness mixtures of various organic and inorganic fertilizers on the growth and vegetative yield of taro. The experiment was held in completely randomized design (CRD), with 7 treatments and three replications. The treatments were as follows T_1 = (Control (only soil), T_2 = 70% Soil + 20% VC + 5% Sand + 5% Ash + 2.0 g kg-1 bone meal powder, T_3 = 65% Soil + 25% VC + 5% Sand + 5% Ash + 1.5 g kg^{-1} bone meal powder, T_4 = 70% Soil + 20% VC + 5% Sand + 5% Ash + 1.5 g kg^{-1} bone meal powder, T_5 = 60% Soil + 20% VC + 15% Sand + 5% Ash + 2.0 g kg-1 bone meal powder, T_6 = 60% Soil + 25% VC + 10% Sand + 5% Ash + 1.0 g kg^{-1} bone meal powder, T_7 = 60% Soil + 25% VC + 5% Sand + 10% Ash + 1.0 g kg^{-1} bone meal powder. The experimental soil belongs to the Old Himalayan Piedmont Plain (AEZ-1). The soil was sandy loam in texture having pH 6.6, organic matter content 0.56%, total N 0.08%, available P 4.90 ppm, exchangeable K 0.06 m.e.q 100 g^{-1} soil and available S 5.52 ppm. Application of organic and inorganic fertilizers resulted in a considerable influence on the properties of the post-harvest soils such as the highest total N (0.25%), available S (12.56 ppm) and soil organic matter content (1.20%) and EC (0.18 mSm^{-1}) in T_7 treatment. The application of organic and inorganic fertilizers had a significant effect on the growth and vegetative yield of taro. The highest plant height 56 and 58.33 cm at 15 and 30 DAT at T_7 respectively and after the first harvest 54.67 cm and 59 cm at T_7 respectively. Fresh shoot weight of 1st harvest 60 g at T_7 and at 2nd harvest 60.67 g at T_7, and the longest root length (34 cm) were observed in T_6 treatment. The lowest values most of all the parameters were noticed in the control treatment (T_1). It was evident that the proper use of organic fertilizers in conjunction with chemical fertilizers may significantly boost soil fertility and vegetative development of taro. The study's findings revealed that treatment with T_7 outperformed all other treatments. This study indicate that treating soil with 60% soil, 25% VC, 5% sand, 10% ash and 1.0 gkg^{-1} bone meal powder as a composite appears to be a promising practice for cost-effective taro cultivation in urban rooftop Settings.

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ABBREVIATIONS AND ACRONYMS

°C	Degree Celsius
AEZ	Agro Ecological Zone
BADC	Bangladesh Agricultural Development Corporation
BARC	Bangladesh Agricultural Research Council
cm	Centimeter
DAT	days after transplanting
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)	milli Siemens per meter

CHAPTER I

INTRODUCTION

Colocasia esculenta (taro) is believed to be one of the vital world's most old food crops, with a historical past of more than 2000 years in cultivation. According to Goenaga *et al*. (1991), taro is a most important food crop in areas including Africa, Pacific and the Caribbean and belongs to the family of Araceae. FAOSTAT (2010) ranked taro the fourteenth major vegetable crops, with about 12 million tonnes produced from about 2 million hectares with a yield of 6.5 t ha^{-1}. The crop plays a principal role within the livelihood of farmers in the rural areas, who on the whole resort to cocoyam as their source of everyday energy throughout durations of food shortage and economic stress (Onyeka, 2014). The report of FAO (2012) indicated that nutritionally, taro is superior to cassava and yam with regards to higher protein, mineral and vitamin contents as well as easily digestible starch. According to FAO (1990), the relatively low price of cocoyam compared to yam makes cocoyam a ready alternative for yam during off seasons. In addition, it also brings foreign exchange where it is produced on large scale (Revill *et al*., 2005).

It is an underexploited crop, grown throughout the tropics, especially in the warmer regions for its edible cormels, leaves and petioles. It is a staple food in many countries like the Pacific, Caribbean and Asia and a supplement to potatoes in the southern United States. In Bangladesh, taro is mostly cultivated in the northern and eastern parts of the country. Taro is adapted to a wide variety of soil and climatic conditions and is an integral component of different farming systems adopted in this subcontinent. The crop is mainly used as a vegetable and has good keeping quality compared to other vegetables. As compared to other vegetables, it is a highly remunerative crop and has poteritial industrial uses (e.g., taro starch). A significant proportion of the produce is exported mainly to the Gulf countries, USA and UK. Taro is highly responsive to organic manures and has fewer pest and disease problems as compared to other vegetables. One of the important aspects in organic production of tuber crops is the scientific use of available organic plant nutrients sources and the adoption of organic nutrient management practices to enhance crop productivity while maintaining soil health.

Regardless of its financial abilities as a food and cash crop and it's nutritional worth the crop is under exploited and poorly understood. Onyeka (2014) stated that there is nonexistence of well documented and consolidated understanding on taro cultivation even though the crop is contributing extensively to the food security and earnings of many households. Soil fertility decline is a major constraint to crop production in Bangladesh. Continuous land cultivation without soil amendment is a major means through which the soil losses essential plant nutrients.

Generally, the Pacific and Asian countries produce higher yields of taro than those in the West African countries where it is widely grown (FAO, 1987). Research has indicated that taro yields increased in the tropical soils using inorganic nitrogen fertilizers. According to Manrique (1994), early growth development of taro requires high nitrogen fertilization. Enhanced methods of farming are essential to increase taro yields which may include the use of inorganic fertilizers. (Blamey, 1996; Osorio *et al.*, 2003) as constant farming without fertilization decreases crop yield (Hartemink *et al.*, 2000). The information about inorganic fertilization on taro production is inadequate compared to other agricultural crops. Some researchers have shown that NPK fertilization enhanced growth and corm yield of taro (Udoh *et al.*, 2005 and Shiyam *et al.*, 2007). It is known that taro consumes substantial amounts of potassium (O'Sullivan *et al.*, 1996). The agronomic abilities and value of taro stays unidentified considering the fact that it has remained underutilized and abandoned crop in the country as a result of little awareness on the crop, which has resulted in unsafe levels of reduced economic livelihoods and loss of its genetic diversity (Akwee, 2015).

The practice of producing vegetables on rooftop has been increasing in recent years to facilitate agricultural sustainability in urban areas. Rooftop gardens are becoming an important part of the recent regeneration of urban agriculture and provide alternative spaces to grow vegetable products for urban markets. The production of vegetables on rooftops should not be thought of as an alternative for massive scale vegetable production in rural areas.

For urban agriculture to be most successful; there is a need to increase vegetable crop cultivation within city boundaries. However, land that has traditionally been used for agricultural purposes within urban areas, such as vacant lots, is vulnerable to potential development. Thus, urban agriculture is challenged by the lack of available space in cities to meet current demands for locally produced foods. Green roofs can be used in this capacity to effectively replace green space lost during building construction.

Therefore, rooftop agriculture (particularly green roof production systems) has become an attractive possibility to increase localized urban agriculture. Nowadays, many people are being interested in rooftop agriculture. They have passed their leisure time by getting involved in rooftop agriculture. They can easily get organic and fresh food from rooftop gardening. Moreover, through the spread of greenery on the rooftop, these people are also contributing to create a healthy environment in urban areas.

However, there is limited knowledge about the effect of different soil mixtures on growth and yield of taro in rooftops. The growing medium should contain sufficient organic matter and allow the roots to aerate sufficiently. Rooftop containers can range from simple pots to more elaborate systems. As much as possible locally available and recycled material could be used. In urban condition, the most prominent problems of setting up a rooftop garden are availability of soil, nutrient management, availability of organic matter and other materials for soil mixture preparation. The present study was therefore planned to asses the effect of different soil mixtures on growth and yield of taro in rooftops.

Objectives:

The objectives of this research program are the followings:

i. To know the effects of different soil mixtures on the growth and yield of taro.

ii. To find out the proper combination of soil mixture for vegetative yield of taro production on rooftop.

CHAPTER II

REVIEW OF LITERATURE

Colocasia esculenta (L.) Schott (taro) is an aquatic and semi – aquatic, developing perennial, herbaceous plant belonging to the Araceae family, and native to Asia (Plucknett, 1976). Jianchu *et al*. (2001) reported that deliberation and research continue on the centers of its origin of taro with Northeast India and Melanesia being considered as separate centers of origin and domestication. However, ethno-botanical proof indication suggests that the crop originated from South Central Asia, probably India or the Malay Peninsula. According to Purseglove (1972), undomesticated forms are seen in several parts of South Eastern Asia but have continually spread all over the globe and are currently a staple crop in Asia, Africa, the Caribbean and Pacific (Rao *et al*., 2010). The crop was introduced to the east coast of Africa some 2,000 years ago and was taken to West Africa and later on slave ships to the Caribbean; and is currently cultivated in over 65 countries (USDA, 2001).

Though taro is intensively produced in the Pacific Islands and forms a significant proportion of their diet, West Africa cultivates the largest area and is the leading producer of the crop (FAOSTAT, 2010). A substantial quantity of taro is also produced in the Caribbean region, as well as in most humid or sub-humid areas of Asia. The crop has been found to have naturalized in the Galapagos Islands (Tye, 2001), Canary Islands (GarcÃa-Camacho and Quintanar, 2003; Kunkel 1975) and Africa (Henderson, 2007).

Lawrence (1966) reported that the family Araceae consists of 105 genera with about 1400 - 1500 species scattered principally in the tropics. *Colocasia esculenta* (L.) Schott is one member of the family that exhibits pronounced variations in morphological characteristics. The taro plant is basically a collection of long-stemmed leaves which grows from the swollen stem/corm underground. According to Purseglove (1972), the crop grows about 1 – 2 m in height, and its species is considered to be polymorphic. Characteristic features of the plant are: a corm which lies underneath the soil surface, peltate leaves which grow from the apical bud of the corm and a fibrous root system at the lower portion. It has daughter corms, cormels, and runners which grow laterally. The corm is mainly for the storage of nutrients and has characteristically abundant periderm; food is stored in large, thin walled parenchymatous cells with few poorly developed vascular bundles, presence of mucilage cells, latex cells and ergastic substances like raphides and druses (Miyasaka, 1979).

According to O"Sullivan *et al*. (1996), there are eight known variants of *Colocasia esculenta* of which two are normally cultivated. These are: *Colocasia esculenta* (L.) Schott var. esculenta, which has a large cylindrical corm that grows up to 30 cm in length, 15 cm in diameter, and has only a few cormels; the variety is also referred to as dasheen. The corm constitutes the main edible portion of this type. *Colocasia esculenta* (L.) Schott var. antiquorum, also known as the eddoe type, has a small and globular central corm with a number of fairly large cormels developing from the corm (Lebot and Aradhya, 1991; Purseglove, 1972). Most C. esculenta varieties produce heart-shaped leaves of varying size (20-30 × 30-60 cm).

The daughter corms and cormels together form a substantial quantity of the edible harvest in eddoe taro. Daughter corms develop subsidiary shoots even when the main plant is still growing; however, cormels stay dormant and only develop new shoots after the death of the main plant if left in the soil. The daughter corm and cormels have axillary buds in the axils of the many scale leaves over its body and terminal buds at the tips.

Colocasia esculenta is an essential primary staple food crop cultivated for its fleshy corms and nutritious leaves in several Pacific countries, some parts of Africa, Asia and the Caribbean (Lebot and Aradhya, 1991; Agueguia *et al*., 1992; Opara, 2001). Lee (1999) reported that taro is one of the few staple food crops cultivated for both their leaves and corms making it a very important food crop. The corm and cormels are the main economic parts with its nutritional worth similar to sweet potato (Deo *et al*. 2009). According toboth Onwueme (1999) and Ndon *et al*. (2003), the young leaves and petioles which are sometimes used for food contains about 23% protein on a dry weight basis. It is an important constituent of human diet because taro is a rich source of calcium, phosphorus, iron, vitamin C, thiamine, riboflavin and niacin.

A considerable quantity of taro is produced as a cash crop; some quantities are also produced and consumed on a subsistence basis. Excesses from the subsistence production are sold on the market eventually helping to lessen poverty. In the Pacific Island, taro is gradually becoming a major export commodity providing considerable foreign exchange (Revill *et al*., 2005).

Griffin (1982) emphasized some other economic importance of taro as: taro silage development for use as animal feed (swine); the potential of using taro starch as a raw material in cosmetic and plastic manufacture; and the possibility of using taro alcohol as fuel on remote islands. According to Lee (1999), taro flour and other products are essential components of some infant formulae in the United States and form a considerable constituent of proprietary canned baby foods.

In addition to the above, taro starch is highly digestible because it has granules of sizes below 5 µm and for this reason is highly recommended for infant foods (Nip, 1997; Aboubakar *et al*., 2008). In biodegradable plastics, toilet formulations or aerosol production, it is used as filler (Nip, 1997). Proposed to mimic oil droplet in food emulsions such as mayonnaise, taro starch contributes to reducing the risks of cardiovascular diseases by reducing the consumption of oil (Nip, 1997).

Miyasaka *et al*. (2003) revealed that taro in its native range inhabits tropical zones ranging from sea level to an elevation of 1,800 m, warm temperatures (25-35°C) and high rainfall (1,800-2,500 mm). The crop is adapted to moist environments and can be grown under upland as well as flooded conditions. Taro can grow in areas where the water is standing; and only taro and rice can grow in such areas. Deep planting is required for optimum corm set, because shallow soils provide a restrictive environment for corm and root development. Because of high variability and unpredictability of rainfall and the cost of irrigation, the soil's ability to store water becomes an essential consideration in upland taro cultivation.

Though taro can be grown on range of soil types, best results are achieved on deep well drained, friable loamy soils with pH 5.5 - 6.5. Stony or rocky soils should be avoided because they produce deformed corms and make harvesting difficult. According to Hill *et al*. (1998), the crop has a salinity tolerance threshold (95% of maximum growth) of 4 mM NaCl.

Chumpawade *et al*. (2005) reported that earlier studies on the chemical analysis of plants and the mineral contribution of soils initiated the modern research on plant and nutrition. A list of sixteen (16) elements was completed from the ninety (90) or more elements and the basic concept of plant nutrition were developed in the 20th century. There are six macronutrients out of the sixteen essential elements needed by plants in large quantities which include nitrogen, phosphorus and potassium. According to Hull (2004), a dearth of an essential nutrient makes it difficult for plants to complete reproductive or vegetative stages of their life cycle. The deficiency is specific to the element in question and can be corrected or prevented only by supplying that element. Again, apart from its possible ability to correct some unfavorable microbiological or chemical condition of the soil, the element, contributes directly to the nutrition of the plant. Studies have shown that soil amendments are required after they become depleted of these essential elements in order for crops to remain productive. In order to obtain good-quality produce and high yields, optimal crop nutrition is an essential requirement. Plant nutrient requirements are obtained from both soil reserves and external sources like the atmosphere, fertilizers and organic manures (Roy *et al*., (2006).

Mccann *et al*. (1996) found that Bonemeal can be beneficial for taro plants as it is a good source of phosphorus, which promotes root development and overall plant growth. Applying bonemeal to the soil around taro plants can help improve their vigor and yield. However, it's important not to over apply, as excessive phosphorus can lead to nutrient imbalances in the soil.

Senthilkumar (2012) state that the effect of ash on taro plants can vary depending on factors such as soil composition and the type of ash used. However, generally speaking, ash can contribute to the soil's pH balance and provide some essential nutrients like potassium.

Singh (2008) stated that the effects of vermicompost has been shown to positively affect the growth of taro plants. It enriches the soil with nutrients, enhances soil structure, improves water retention, and promotes microbial activity, leading to better growth, yield, and overall health of taro plants.

Albaho *et al*. (2006) stated that while sand can enhance drainage and prevent water logging, which is beneficial for taro, it also poses challenges such as poor nutrient and water retention. Therefore, a balanced soil mix that includes organic matter or loam along with sand is often recommended for optimal growth of taro plants. Regular monitoring and adjustment of watering and fertilization practices are essential to mitigate the negative effects of sandy soil.

Leaves are essential organs for photosynthesis, which is an essential process that influences crop growth rates. Photosynthesis is affected by the number and/or area of leaves. According to Karadogan and Akgun (2009), the growth and development of leaves is dependent on the plant's photosynthetic efficiency and productivity. Work done by Mouhamed and Ouda (2006) indicated that taro yield is strongly dependent on leaves efficiency for absorption of solar radiation for photosynthesis. According to Lieth and Pasian (1990), various plant factors such as leaf position, leaf age, number of leaves, mutual shading and sink effects, and environmental factors like temperature, light, water availability and nutrition can influence leaf photosynthesis.

Several studies including Boddey *et al*. (1997) and Giller and Cadisch (1995) confirmed that nitrogen is the only plant nutrient which can be added to the soil by biological fixation (BNF), however, the addition of N through BNF is inadequate to cover the loss of N with crop removal, leaching and denitrification for most cropping systems in the tropics. Improvement of crop yield in continuous cultivation needs timely application of N from inorganic and organic sources and is vital to sustain the system.

N is taken by plants as nitrates and to some extent ammonium ion. There is the conversion of nitrate to ammonium in the plant and then utilized to form protein. Nitrogen is associated with vegetative growth of plants (Adams *et al*., 1998). It is also linked with vigorous vegetative growth, photosynthesis, and a dark green colour pigmentation (Havlin *et al*., 2005). Availability of usable nitrogen in most agricultural conditions is a major limiting factor of plant growth and in most tropical soils yields of taro may be improved when inorganic N fertilizers are used. Studies conducted by Manrique (1994) revealed that taro requires relatively high N especially in its early stages of growth.

Phosphorus (P) is another essential macronutrient required for plant growth, but in many regions of the world it is limiting in crop production (Holford, 1997). Cordell *et al*. (2009) revealed that global P fertilizer demand continues to rise while P reserves decline. Phosphorus is used by plants for photosynthesis and nutrient/energy transport and it is therefore, vital for cell division, growth, root lengthening, fruit and seed development, and ripening.

Plant growth retards, root development and tillering are hampered and ripening delayed with P deficiency. Older leaves usually start to show P deficiency symptoms. A bluish-green to reddish colour develops, which can lead to bronze tints and red colour. A shortage of inorganic phosphate in the chloroplast reduces photosynthesis (Roy *et al*., 2006).

The works of O'Sullivan *et al*. (1996) indicates that taro responds to potassium (K) fertilizer because the crop consumes substantial quantities of K. Potassium, one of the most essential elements in healthy soil nutrition, can significantly improve crop yields. It helps in the absorption and retention of water, sturdy stems and contributes to stronger roots, healthy crops that have longer storage life. Potassium aids the plant in using water efficiently, preventing heat damage and many diseases. Several crops depend on adequate potassium supply; they therefore, must rely on fertilizers/soil amendments to add the required quantities of potassium to soil. Potassium is important in recycling nutrients through leaves, roots and stems. K deficiency in taro is seen as a chlorosis along the leaf boundary and subsequent scorching and browning of tips of older leaves. In most plants, it shows shortened internodes, stunted growth, weak stalks, susceptibility to lodging, high incidence of pests and diseases, poor crop quality and low yield (Roy *et al*., 2006).

According to Blamey (1996) the use of inorganic fertilizers is a vital opportunity to improve taro yields and forms a critical component of the required improved taro production systems since yields drop under continuous farming (Hartemink *et al*., 2000). There is abundant literature on the application of inorganic fertilizers in taro production even though the information is limited when compared to other staples.

Mare and Modi (2009) reported that taro responds well to fertilizer application. In 2008, the State of the Future report of the Millennium Project indicated that 50% increase in food production will be needed by 2013 and double in 30 years in order to solve the present food crisis. This will have to be achieved through intensification of production on less available arable land; production intensification must, however, be environmentally safe. Many have projected between 30 and 50% increase in crop yield with nutrient inputs (Stewart, 2002).

The critical factor of soil fertility in most soils of the tropics is organic matter and this account for its use. According to Ikpe and Powel (2002) the addition of poultry manure can be able to sustain soil fertility. Maintaining soil organic matter is one of the ways to improve soil fertility and this is possible through using organic sources of fertilizer.

Many researchers elsewhere have shown that organic based fertilizers are less leached than the inorganic fertilizer (Sridhar and Adeoye, 2003). Because organic based fertilizers are cheap and less likely to pollute ground water unlike chemical fertilizers, their use has found favour in boosting crop production. It improves soil fertility status as well as increasing the income of farmers through increase in yield. Several research works, have shown that complimentary use of organic fertilizers is able to provide the desired higher sustainable crop yields than using only inorganic fertilizer (Adeoye *et al*., 2008; Akanbi *et al*., 2010 and Ogunlade *et al*., 2011).

It is reported that there is the need to ensure soil management through organic matter application to improve crop yields (Ayenigbara, 2000). Uko *et al*. (2013) reported that the slow release of balanced nutrient resources from organic matter during decomposition and the huge residual benefit distributed across a longer time interval makes it superior to inorganic fertilizers (Obi *et al*., 2005). In addition, Muoneke and Asiegbu (1997) indicated that the gradual release of nutrient may render them unavailable to short season crops in the year of application when treatment is done shortly before cropping. Chemical fertilizers do not ensure sustainably of agricultural production since they guarantee only a rapid interim growth and yield improvements (Funda *et al*., 2011, Uko *et al*., 2013). Poultry manure, is an important source of plant nutrients and for that matter an efficient organic fertilizer. Reddy and Reddi (1995) stated that poultry manure has an average N content of 3.03%, P2O5 of 2.63% and 1.4% of K2O. It also improves soil physical properties because it has a rich organic matter content (Ayeni, 2011), and has often been found to increase crop yields.

Suckers are produced as a lateral proliferation of the mother plant. Taro produce suckers few months after planting and these compete with the main plant for water and nutrients and reduce productivity (Oluwafemi, 2013). Suckers physiologically depend on the mother plant for resources that should have been partitioned to the storage organ. Salter and Bonnet (2000) suggested that dormant underground buds from which suckers develop are produced several months before they actually appear. On the other hand, the actual mechanism that triggers the emergence and development of suckers is not well understood. According to Gravois *et al*. (2002), the existence of suckers in sugarcane at harvest is a probable factor for reduced sucrose content in some Louisiana varieties. Again, Gravois *et al*. (2002) suggested that sucker production may be influenced by genetic and environmental conditions because it varies with year and variety.

Studies conducted in the 20th century indicated that sucker production is critically affected by sunlight directly heating the surface of the soil. Though germination of suckers occur several months before they appear in the field, suckers generally develop in fields where crop canopy is easily penetrated by sunlight to reach the soil, causing buds underground to germinate. It must be emphasized that if suckers are not controlled, they will rob the primary leaves of needed nutrients (Oluwafemi, 2013).

It is known that texture (boiled or baked), as well as volatile and non-volatile compounds affect the flavour of tubers. Flavour of food is one of the significant factors considered by consumers but remains the most difficult objective for breeders in breeding programs. Research done by Jansky (2010) showed that owing to a very complex chemistry, boiling results in changes in some compounds; also, due to unknown underlying environmental and genetics factors during growth and storage, breeding methods for improving tuber flavour is difficult and time-consuming.

Most often, consumers accept organic foods as an option for improving dietary value and assume that products are positively affected by organic farming, and that organically produced foods are more flavorsome and nutritious than conventional foods. White *et al.* (2009) in an extensive tubers mineral composition investigation concluded that concentrations of mineral is dependent on genotype and the phytoavailability of different elements to the crop. Relatively few publications are dedicated to comparisons of mineral constitution of tubers from conventional and organic cultivations. It is suggested that conventionally cultivated tubers have lower concentrations of some elements compared to tubers from organically grown crops (Wszelaki *et al*., 2005). As compared to conventional cultivation, organically grown potatoes give more tasty tubers (Rembiałkowska, 2003; Wszelaki *et al*., 2005) which had higher dry matter content (Hajšlova *et al*. 2005) but yields were lowered (Maggio *et al*. 2008). These differences in tuber flavour, dry matter and yields were, however, not reported by other authors (Warman and Havard, 1998; Maggio *et al*., 2008; Hajšlova *et al*., 2005).

Colocasia esculenta production has decreased as a result of urbanization but recent decline in growth and development has resulted from pests and diseases (Hao, 2006). Colocasia diseases significantly decreased the number of active leaves and have reduced yield to about 50% lower globally (Jackson, 1999). *Colocasia esculenta* is affected by a number of infectious diseases caused by bacteria, fungi, viruses and nematodes as well as noninfectious or abiotic factors. Ooka (1994) reported that fungal diseases of taro are the most significant. According to Guarino (2010), taro leaf blight spread was reported in West Africa in 2010 and has spread to other countries including Ghana.

The disease is caused by Phytophthora colocasiae and was first reported in Java. It starts as a purple-brown water-soaked lesion with a yellow liquid oozing from the lesion which enlarges with time and destroys the entire lamina in 10 – 20 days. High temperature and humidity are favourable to spreading the disease. According to Jackson (1996), the disease is spread by wind and splashing rain and is capable of compelling farmers to abandon their crop fields and rely on other staple crops. The disease may occur throughout the year only if conditions (temperature and humidity) are favourable, taro leaf blight can spread the whole field within five to seven days under these favourable conditions (Ooka, 1994). Other diseases of taro include Pythium rot, Sclerotium rot and Cladosporium leaf spot (Evans, 2008).

CHAPTER III
MATERIALS AND METHODS

The experiment was carried out in the central farm of Hajee Mohammad Danesh Science and Technology University, Dinajpur-5200, from October 2023 to December 2023. A brief description of the experimental site, characteristics of soil, climate, planting material, soil collection, soil and pot preparation and sowing, experimental design, treatments, fertilizer doses at different treatments, intercultural operations, harvesting, data collection, soil sample preparation, soil analysis and statistical analysis have been described in this chapter.

3.1 Experimental site

The experiment was conducted at the central farm of Hajee Mohammad Danesh Science and Technology University, Dinajpur-5200, from October 2023 to December 2023. Geographically the experimental site was at 25°13' N latitude and 88°23' E longitude with an elevation of 37.5m above the mean of sea level. It belongs to the Agro Ecological Zone (AEZ-1) named Old Himalayan Piedmont Plain.

3.2 Characteristics of Soil

The general characteristics of the soil are presented in Table 1-3.

Table 3.1. Morphological description of the soil

Morphology	Characteristics
Location	Soil Science Laboratory-1, Department of Soil Science, HSTU
AEZ	Old Himalayan Piedmont plain (AEZ-1)
General soil type	Non- calcareous brown floodplain soil
Parent material	Piedmont alluvium
Drainage	Well drained
Topography	Medium high land
Flood level	Above flood level

Table 3.2. Physical characteristics of the soil of soil Science research field of HSTU

Characteristics	Value
Sand (%)	53.2
Silt (%)	29.6
Clay (%)	17.2
Textural class	Sandy loam

Table 3.3. Chemical characteristics of the initial soil sample.

Characteristics	Value
Soil pH	6.6
Organic Matter (%)	0.56
Total nitrogen (%)	0.08
Available P (ppm)	4.90
Available sulfur (ppm)	5.52
Exchangeable K (m.eq.100g^{-1} soil)	0.06

3.3 Climate

The experimental area belongs to a subtropical climatic zone which has heavy rainfall, high humidity, high temperature, and a relatively long day period during Kharif season (April-September) and scanty rainfall and low humidity, low temperature, and short day period during Rabi season (October-March). The experiment was conducted during Rabi season from October 2023 to December 2023.

3.4 Planting material

The plant material of the experiment was taro (*Colocasia esculenta*) Its leaves are flat, and vary in shape depending on genotype, from heart-shaped to long, narrow and arrow- shaped. The suckers which were obtained from Nazma nursery within the Dinajpur town were planted on 5th October, 2023. Holes were dug with hoes to a depth of about 7–10 cm and one sucker placed gently housed in and soil was pushed around and firmed. . If the environmental conditions are not extreme, taro can grow adaptively and adjust to environmental conditions. In general, it can be harvested four weeks after planting.

3.5 Soil collection, soil and pot preparation

Soil was collected from Soil Science Research Field, HSTU, Dinajpur from a depth of 0-15cm. The collected soil are dried. Weeds and stubbles presented in the soil were removed. Then the all the ingerdients such as soil, sand, cowdung, vermicompost, bone meal along with other chemical fertilizers i.e. Urea, TSP, MP and Gypsum were well mixed in individual amount per pot. The total weight of the soil mixture for one pot was 6 kg. The pots were kept in 7 to 10 days for rest.

3.6 Experimental design

The experiment was laid out Completely Randomized Design (CRD) with 7 treatments and 3 replications. A total of 21 experimental pots were used.

3.7 Treatments

There were seven treatments as follows:

T_1 = Control (only soil)

T_2 = 70% soil + 20% VC + 5% sand + 5% ash + 2.0 g kg^{-1} bone meal powder

T_3 = 65% soil + 25% VC + 5% sand + 5% ash + 1.5 g kg^{-1} bone meal powder

T_4 = 70% soil + 20% VC + 5% sand + 5% ash + 1.5 g kg^{-1} bone meal powder

T_5 = 60% soil + 20% VC + 15% sand + 5% ash + 2.0 g kg^{-1} bone meal powder

T_6 = 60% soil + 25% VC + 10% sand + 5% ash + 1.0 g kg^{-1} bone meal powder

T_7 = 60% soil + 25% VC + 5% sand + 10% ash + 1.0 g kg^{-1} bone meal powder

Where, VC = Vermicompost.

3.8 Fertilizer doses at different treatment

In case of chemical fertilizers, Urea, TSP, MP and Gypsum were also mixed with each treatment mixtures during soil preparation as per 2.45 g kg^{-1}, 0.85 g kg^{-1}, 1.25 g kg^{-1} and 0.49 g kg^{-1} material, respectively.

3.9 Intercultural operations

Intercultural operations were done to ensure normal growth of the crop. The following interculturaloperations were followed:

3.9.1 Weeding

The experimental pots were monitored and weeds were removed regularly from the pots.

3.9.2 Irrigation

The experimental pots were monitored regularly and plants were watered whenever necessary.

3.10 Harvesting

First harvesting was on 5th November, 2024 and second harvesting was on 5th December continued harvesting till the plant growth was maximum for use as vegetable.

3.11 Data collection

First data collection was done on 20th October 2023. As per objectives of the study, some data were collected in final harvest from randomly selected 3 plants from the 10 plants per pot.

I. Plant height

II. Fresh plant weight

III. Root length

IV. Harvestable shoot biomass

3.11.1 Plant height (cm)

The plant height was measured from randomly selected 3 sample plants in centimeter from the ground level to the leaf at the top.

3.11.2 Fresh plant weight after last harvest (g)

Fresh weight of 3 plants from each pot was measured in gram (g) after last harvest and averaged as well.

3.11.3 Fresh Root length (cm)

Length of the root of 1 plant per pot was measured in centimeter (cm) after harvest.

3.11.4 Harvestable shoot biomass (Yield)

The fresh weight of 3 plants shoot biomass was measured with an electrical balance from each treatment and there average was calculated at gram (g).

3.11.5 Soil sample preparation

After harvesting, soil samples were collected from all the pots and sun-dried. Then the dried samples were sieved through a 2mm (10 mesh) sieve. The soil was stored in a clean plastic container for analysis.

3.12 Analysis of soil sample

Chemical properties of all soil samples were analyzed at the Soil Science Laboratory-1, Department of Soil Science, HSTU, Dinajpur. The following analysis of soil sample were done

i. Soil pH
ii. Total N content
iii. Available P
iv. Exchangeable K
v. Available S
vi. Organic carbon
vii. Electrical conductivity

3.12.1 Soil pH

Soil pH was determined using a glass electrode pH meter at 1:2.5, soil-water ratio. The suspension was allowed to stand for one hour with occasional shaking before determination (Jackson, 1967).

3.12.2 Total nitrogen (N)

Soil N was determined was determined by Micro-Kjeldahl method (Bremner and Mulvancey, 1982). The Soil sample (1.0g) was digested with 3 ml concentrated H_2SO_4 and 1.1 g catalyst mixture (K_2SO_4:$CuSO_4.5H_2O$: Se powder in a ratio 100:10:1). N was estimated by distillation with 40% NaOH followed titration distillate trapped in H_3BO_3 indicator solution with 0.01 N (Page *et al*., 1989).

3.12.3 Available phosphorus (P)

Available P was extracted from the soil with 0.5 M sodium bicarbonate solution pH 8.5 (Olsen *et al*., 1954). P in the extract was then determined by developing blue color with $SnCl_2$ reduction of phosphomolybdate complex and color intensity was measured colorimetrically at 660 nm wavelength (Page *et al*., 1989).

3.12.4 Exchangeable potassium (K)

Exchangeable K was determined by the ammonium acetate extraction method using a flame photometer as described by Page *et al*. (1989).

3.12.5 Available sulphur (S)

Available S was determined by extraction the soil sample with 0.01 M $BaCl_2.2H_2O$. The S content in the extract was estimated and the intensity of turbid was measured by spectrophotometer at 420nm wavelength.

3.13 Statistical analysis

The collected data were statistically analyzed to find out the level of significance using a Completely Randomized Design (CRD) with the help of the statistical program ‘‘ANOVA Technique’’. The mean differences were compared by the Least Significant Difference test (LSD test) ata 5% level of significance (Gomez and Gomez, 1984).

CHAPTER IV
RESULTS AND DISCUSSION

4.1 Effect of different soil mixture on growth, yield contributing characters and yield of Taro *(Colocasia esculenta)*

4.1.1 Plant height (cm) and weight (g)

Plant height is one of the important morphological parameters which is always considered as the yield contributor for leafy vegetables. Plant height at 15 and 30 days after planting was taken from each plant from the ground level to the tip of the plant and mean value was calculated in centimeter (cm) and showed significant difference of plant height. The average highest plant height of three selected plants per pot at 15 DAT of taro was recorded 56 at T_7 treatment and the lowest one was recorded in T_1 (24.67). Statistically similar result was found in T_3 and T_4. Gradually decrease in T_6, T_5, T_4 and T_2. The highest plant height at 30 DAT was recorded 58.333 at T_7 and the lowest one was recorded 27.67 in T_1. Gradually decrease in T_6, T_5, T_4, T_3 and T_2. The organic manure application proved to be very effective in increasing the leaf number, height, fresh weight, dry weight, and chlorophyll content.

Different combination of soil mixtures showed insignificant variation on fresh weight of taro plant (Table 4.1) The maximum fresh weight of three selected plant of taro was obtained 60 g in treatment T_7. The lowest fresh weight of taro obtained 31.33 at T_1 which is identical with T_2. Statistically similar with T_1, T_2 and T_3, T_4. Gradually decrease in T_6, T_5.

Application of organic fertilizers probably increased the nitrogen control in the soil which positively affected leaf fresh weight and quality of the leaves because nitrogen stimulates plant vegetative growth and increases leaf area. These nutrients deficient were probably the limiting factor of plant growth and productivity.

Plant height at 15 and 30 days after first harvesting was taken from each plant from the ground level to the tip of the plant and mean value was calculated in centimeter (cm) and showed significant difference of plant height to different plant growing structures (Table 4.1). The average highest plant height of three selected plants per pot at 15 DAT of taro was recorded 54.67 cm at T_7 treatment and the lowest one was recorded in T_1 (21.33 cm) which is identical with T_2. Gradually decrease in T_6, T_5, T_4 and T_3. The highest plant height at 30 DAT was recorded 59 cm at T_7 and the lowest one was recorded 23.67 cm in T_1. Statistically similar in T_3, T_4. Gradually decrease in T_6, T_5 and T_2. The organic manure application proved to be very effective in increasing the leaf number, height, fresh weight, dry weight, and chlorophyll content.

Different combination of soil mixtures showed insignificant variation on fresh weight of taro plant (Table 4.1). The maximum fresh weight of three selected plant of taro was obtained 60.67 g in treatment T_7. The lowest fresh weight of taro obtained 30.333 at T_2. Statistically similar with T_1, T_2 and T_3, T_4. Gradually decrease in T_6, T_5.

Table 4.1. Plant height and weight of taro

Treatments	Plant height at 15 DAT	Plant height at 30 DAT	Fresh weight (g)
T_1	24.67 f	27.67 g	31.33 e
T_2	27.67 e	30.67 f	29.67 e
T_3	33.00 d	36.67 e	41.33 d
T_4	35.67 d	39.00 d	41.67 d
T_5	41.67 c	44.00 c	47.33 c
T_6	48.00 b	52.33 b	55.00 b
T_7	56.00 a	58.33 a	60.00 a
LSD	2.69	1.76	4.176
CV %	3.97	2.41	5.36

Table 4.1.1. Plant height (after 1st harvesting)

Treatments	Plant height at 15 DAT	Plant height at 30 DAT	Fresh weight (g)
T_1	21.33f	23.67 f	32.00 e
T_2	24.00 f	27.67 e	30.00 e
T_3	29.67 e	33.00 d	37.67 d
T_4	33.67 d	36.67 d	41.33 d
T_5	38.67 c	43.00 c	47.67c
T_6	48.00 b	48.33 b	55.00b
T_7	54.67 a	59.00 a	60.67a
LSD	2.80	3.67	5.58
CV %	4.42	5.33	7.21

In the column, figures having similar letter(s) do not differ significantly of probability.
Where,

T_1 = Control (only soil)

T_2 = 70% soil + 20% VC + 5% sand + 5% ash + 2.0 g kg^{-1} bone meal powder

T_3 = 65% soil + 25% VC + 5% sand + 5% ash + 1.5 g kg^{-1} bone meal powder

T_4 = 70% soil + 20% VC + 5% sand + 5% ash + 1.5 g kg^{-1} bone meal powder

T_5 = 60% soil + 20% VC + 15% sand + 5% ash + 2.0 g kg^{-1} bone meal powder

T_6 = 60% soil + 25% VC + 10% sand + 5% ash + 1.0 g kg^{-1} bone meal powder

T_7 = 60% soil + 25% VC + 5% sand + 10% ash + 1.0 g kg^{-1} bone meal powder

Where, VC = Vermicompost.

4.1.2 Root length (cm)

The root length of one selected plant per pot had significantly varied at different soil mixtures (Table 4.4).The highest root length (34 c) was recorded in treatment T_6 which is identical with T_1, T_2, T_3, T_4 and T_7. On the other hand, the lowest one (22.167 cm) was recorded in control treatment in treatment T_5.

Table 4.2. Root length

Treatments	**Root length plant^{-1} (cm)**
T_1	25.67 ab
T_2	27.33 ab
T_3	28.83 ab
T_4	26.00 ab
T_5	22.17 b
T_6	34.00 a
T_7	27.67 ab
LSD	8.57
CV %	11.58

In the column, figures having similar letter(s) do not differ significantly of probability.

Where,

T_1 = Control (only soil)

T_2 = 70% soil + 20% VC + 5% sand + 5% ash + 2.0 g kg^{-1} bone meal powder

T_3 = 65% soil + 25% VC + 5% sand + 5% ash + 1.5 g kg^{-1} bone meal powder

T_4 = 70% soil + 20% VC + 5% sand + 5% ash + 1.5 g kg^{-1} bone meal powder

T_5 = 60% soil + 20% VC + 15% sand + 5% ash + 2.0 g kg^{-1} bone meal powder

T_6 = 60% soil + 25% VC + 10% sand + 5% ash + 1.0 g kg^{-1} bone meal powder

T_7 = 60% soil + 25% VC + 5% sand + 10% ash + 1.0 g kg^{-1} bone meal powder

Where, VC = Vermicompost.

4.2 Impact of different soil mixtures on the chemical properties of the post harvest soil

4.2.1 Total nitrogen (N) in soil

N content in the post harvest soil vared insignificantly. Total N content of the post harvest soil was lower than the initial soil. The total N content of the post harvest soil ranged between 0.05% and 0.25%. The highest N content 0.25% of post harvest soil was found in treatment T_7 and the lowest N content 0.05% of post harvest was recorded in treatment T_1. The initial N content was 0.08%.

4.2.2 Available phosphorus (P) in soil

P content in the post harvest soil vared insignificantly. Total P content of the post harvest soil was lower than the initial soil. The total P content of the post harvest soil ranged between 15.340 ppm and 25.560 ppm. The highest P content 25.560 ppm of post harvest soil was found in treatment T_5 and the lowest N content 15.340 ppm of post harvest was recorded in treatment T_1.The initial N content was 4.90ppm.

4.2.3 Exchangeable potassium (K) in soil

The exchangeable potassium content (K) of the post harvest soil influenced considerably due to the environmental fact (Table 4.3) the exchangeable K content of initial soil was 0.06 meq. $100g^{-1}$ soil and the values of post harvest soil ranged from 0.05 to 0.076 meq $100g^{-1}$ soil. The highest exchangeable K 0.076 meq $100g^{-1}$ soil was found in treatment T_7 and the lowest 0.0500 meq $100g^{-1}$ soil was recorded in treatment T_4.

4.2.4 Available sulphur (S) in soil

The available S content in the studied soil varied significantly and ranged from 6.530 ppm to 12.56 ppm (Table 4.3) the maximum S content (12.56 ppm) was found in treatment T_7 and the lowest (6.53 ppm) one was found in treatment T_2, whereas, the available S content of the initial soil was 5.52 ppm.

Table 4.3. Effect of different soil mixtures on the available N, available P, exchangeable K and total S of the post harvest soil

Treatments	Total N (%)	Available P (ppm)	Exchangeable K (meq $100g^{-1}$ soil)	Available S (ppm)
T_1	0.05 f	15.34 c	0.06 b	7.28 b
T_2	0.11 e	17.38 bc	0.06 b	6.53 b
T_3	0.19 bc	19.63 b	0.07 a	7.03 b
T_4	0.16 cd	24.53 a	0.05 c	11.05 a
T_5	0.14 de	25.56 a	0.06 b	12.31 a
T_6	0.22 ab	23.92 a	0.07 a	11.30 a
T_7	0.25 a	25.35 a	0.07 a	12.56 a
LSD	0.03	3.77	7.07	1.63
CV %	12.70	9.79	6.20	9.45

In the column, figures having similar letter(s) do not differ significantly of probability.

Where,

T_1 = Control (only soil)

T_2 = 70% soil + 20% VC + 5% sand + 5% ash + 2.0 g kg^{-1} bone meal powder

T_3 = 65% soil + 25% VC + 5% sand + 5% ash + 1.5 g kg^{-1} bone meal powder

T_4 = 70% soil + 20% VC + 5% sand + 5% ash + 1.5 g kg^{-1} bone meal powder

T_5 = 60% soil + 20% VC + 15% sand + 5% ash + 2.0 g kg^{-1} bone meal powder

T_6 = 60% soil + 25% VC + 10% sand + 5% ash + 1.0 g kg^{-1} bone meal powder

T_7 = 60% soil + 25% VC + 5% sand + 10% ash + 1.0 g kg^{-1} bone meal powder

Where, VC = Vermicompost.

4.2.5 Organic carbon (%)

The OC value of the post harvest soil showed significant diference (Table 4.4) the highest OC percentage 0.69% was observed in T_7 treatment and the lowest OC percentage value 0.56% was observed in T_1 treatment where, the OC percent of initial soil was 0.56%. The study proved that the OC percentage was increased in post harvest soil compared to the initial soil due to the use of organic manure: e, ash and organic fertilizers ie, vermicompost, bone meal powder in a combination

4.2.6 Organic matter (%)

The OM value of the post harvest soil showed significant difference (Table 4.4) the highest OM percentage 1.20% was observed in T_7 treatment and the lowest OM percentage value 0.98% was observed in T_1 treatment. Where, the OM percent of initial soil was 0.98%. The study proved that the OM percentage was increased in post harvest soil compared to the initial soil due to the use of organic manure: e, ash and organic fertilizers ie, vermicompost, bone meal powder in a combination

4.2.7 pH

The pH shown in Table 4.6 the average per pot was varied significently by various combinations of soil mixtures highest pH 5.95 at T_5 and the lowest pH observed 5.6 at T_6.The initial Soil pH was 6.6.

4.2.8 EC

The EC shown in Table 4.4 the average per pot were varied insignificantly by various combination of soil mixtures Highest EC observed at T_7 (0.18) and the lowest result observed at T_1(0.09).The initial EC was 0.12 mS.

Table 4.4. Effect of different soil mixtures on the Organic carbon (%),Organic matter (%), pH and EC of the post harvest soil

Treatments	OC %	OM %	pH	EC (Sm^{-1})
T_1	0.56 d	0.98 c	5.81 abc	0.09 d
T_2	0.61 bcd	1.06 abc	5.90 ab	0.12 bcd
T_3	0.59 cd	1.03 abc	5.85 abc	0.13 bc
T_4	0.57 d	0.99 bc	5.64 bc	0.10 cd
T_5	0.65 abc	1.13 abc	5.95 a	0.15 ab
T_6	0.67 ab	1.17 ab	5.60 c	0.14 b
T_7	0.69 a	1.20 a	5.75 abc	0.18 a
LSD	0.06	0.19	0.26	0.03
CV %	6.12	9.95	2.58	12.25

In the column, figures having similar letter(s) do not differ significantly of probability.

Where,

T_1 = Control (only soil)

T_2 = 70% soil + 20% VC + 5% sand + 5% ash + 2.0 g kg^{-1} bone meal powder

T_3 = 65% soil + 25% VC + 5% sand + 5% ash + 1.5 g kg^{-1} bone meal powder

T_4 = 70% soil + 20% VC + 5% sand + 5% ash + 1.5 g kg^{-1} bone meal powder

T_5 = 60% soil + 20% VC + 15% sand + 5% ash + 2.0 g kg^{-1} bone meal powder

T_6 = 60% soil + 25% VC + 10% sand + 5% ash + 1.0 g kg^{-1} bone meal powder

T_7 = 60% soil + 25% VC + 5% sand + 10% ash + 1.0 g kg^{-1} bone meal powder

Where, VC = Vermicompost.

CHAPTERERS V
SUMMARY AND CONCLUSION

5.1 Summary

The experiment was conducted at the Net House of HSTU from October 2023 to December 2023 assess the performance of *taro* (*Colocasia esculenta*) under various soil mixture treatments. The soil used belonged to the Agro-Ecological Zone (AFZ 1), known as the Old Himalayan Piedmont Plain, with an initial sandy loam texture. Its initial properties were: pH 6.6, organic matter (OM) 5.6%, total nitrogen (N) 0.08%, available phosphorus (P) 4.90 ppm, exchangeable potassium (K) 0.06 meq100g^{-1} soil, and available sulfur (S) 5.52 ppm.

A total of 21 pots were used according to the different treatments. Fertilizers and manures were incorporated during soil preparation. Suckers were planted on October 5, 2023. The crop was grown to maturity, with intercultural operations (weeding, thinning, irrigation, and pesticide application) conducted as needed to support normal plant growth.

Yield components were recorded from each pot, and soil samples were collected both before fertilizer application and after harvesting. Data were analyzed using the Least Significance Difference (LSD) test at a 5% significance level. The results showed significant improvements in growth and yield characteristics such as plant height, fresh weight and root length due to the application of vermicompost, ash, sand, bone meal powder and various chemical fertilizers in different soil mixture treatments.

The highest plant height in first harvest was observed at 56 cm and 58.33 cm at 15 and 30 days after planting (DAT), respectively, in the T_7 treatment. And in second harvest was observed at 54.67 cm and 59 cm at 15 and 30 days after planting (DAT), respectively in the T_7 treatment. Conversely, the lowest plant height in first harvest was 24.67 cm and 27.67 cm at 15 and 30 DAT in the T_1 treatment. And in second harvest was 21.33 cm and 23.67 cm at 15 and 30 DAT in the T_1 treatment. The highest fresh weight in first harvest was 60 g in the T_7 treatment, and in second harvest was 60.67 g in the T_7 treatment. The lowest in first harvest was 31.33 g in the T_1 treatment and in second harvest was 30 gm in the T_2 treatment. The maximum root length was 34 cm in the T_6 treatment, while the minimum was 22.17 cm in the T_5 treatment.

There were notable variations in the pH of the post-harvest soil, with the highest pH (5.95) recorded in the T_5 treatment and the lowest (5.60) in the T_6 treatment. The highest OM content (1.20%) was observed in the T_7 treatment, while the lowest (0.98%) was in the T_1 (control) treatment. Total N content ranged from 0.25% in the T_7 treatment to 0.05% in the T_1 treatment. Available P content varied from 25.56 ppm in the T_5 treatment to 15.34 ppm in the T_1 treatment. The highest exchangeable K was 0.07 meq100g^{-1} in the T_7 treatment, while the lowest was 0.05 mek100g^{-1} in the T_4 treatment. Available S content ranged from 12.56 ppm in the T_7 treatment to 6.53 ppm in the T_2 treatment. The highest EC was 0.18 in the T_7 treatment, while the lowest was 0.09 in the T_1 (control) treatment.

5.2 Conclusion

The study concludes that the combined effects of the pot soil mixtures significantly influenced both the growth and yield of *taro* (*Colocasia esculenta*). Among all treatments, one demonstrated superior results. Specifically, the soil mixture comprising 60% soil, 25% VC, 5% sand, 10% ash, and 1.0 gkg^{-1} bone meal powder (T_7) yielded the highest growth and yield of *taro* (*Colocasia esculenta*) in pot culture for rooftop cultivation.

5.3 Recommendations

The soil mixture of 60% soil, 25% VC, 5% sand, 10% ash, and 1.0 gkg^{-1} bone meal powder, which was found to be optimal, should be tested with more refined proportions.

This mixture should be tested with other vegetables from the Araceae family for rooftop cultivation in urban areas.

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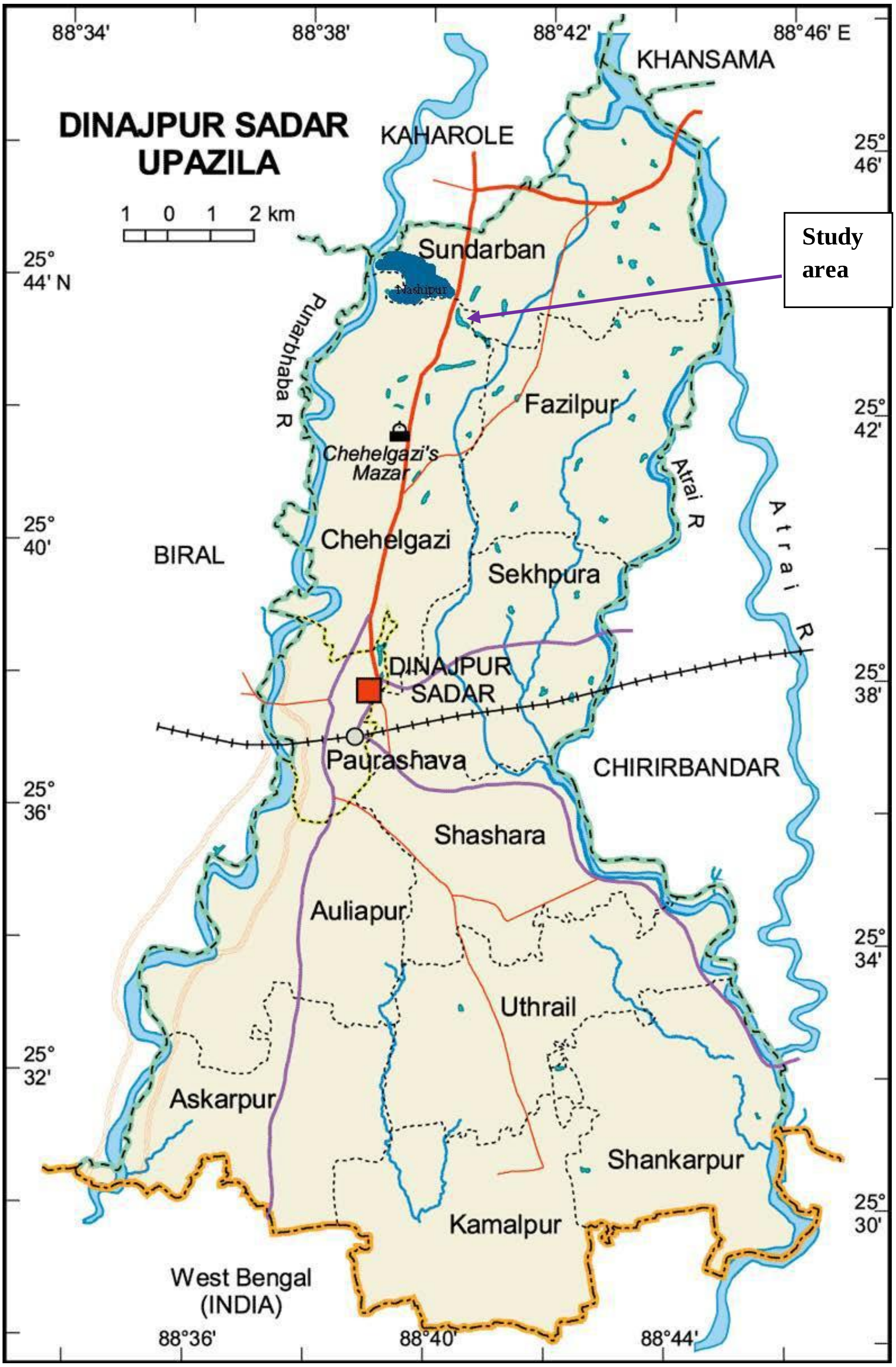
APPENDICES

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



Appendix II. Some photographs of experimental site