Effect of Organic Manure on Production Performance and Nutritive Values of Napier Cultivars in Coastal Soil

A Thesis

by

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Dedicated to

My beloved parents, who sacrificed for me, inspired and blessed me in every way of my life.

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Abbreviation and non-English Word

Abbreviated form	Elaborated Form
%	Percentage
Ha	Hectare
Cm	Centimeter
M	meter
Kg	Kilogram
MT	Metric Ton
ANOVA	Analysis of variance
ADF	Acid Detergent Fiber
BAU	Bangladesh Agricultural University
BLRI	Bangladesh Livestock Research Institute
C	Carbon
CF	Crude Fiber
CP	Crude Protein
DAP	Days After Planting
DM	Dry Matter
DMRT	Duncan New Multiple Range Test
et al	Et alli; Latin word meaning "and others"
EE	Ether Extract
FAO	The Food and Agriculture Organization
FYM	Farmyard Manure
IVOMID	In-vitro organic matter digestibility
ME	Metabolizable Energy
ME	Metabolisable Energy
MJ	Megajoule
N	Nitrogen
NDF	Neutral Detergent Fiber
OM	Organic Matter
P	Phosphorus
RCBD	Randomized Complete Block Design
SNG	Super Napier Grass
T	Treatment
TDN	Total Digestible Nutrients
V	Variety

CHAPTER I

Introduction

1.1. Background of the study

The scarcity of green fodder is one of the major constraints of dairy farming in Bangladesh. There is no well-defined pasture area in our country. Ruminants of our country mostly depend on crop residues, agro-industrial by-products, naturally grown leaves from trees and native grasses from roadside verges, aquatic plants, and fallows (Tabassum *et al.*, 2008; Khan *et al.*, 2009; Roy *et al.*, 2012; Chawdhury *et al.*, 2016). These areas are used as grazing area for all kinds of ruminants and are not maintained to improve the yield for animal feed. The productivity of these pastures is low (Tabassum *et al.*, 2008) and is influenced by season and climate.

Forages continue to represent the single most important feed resource for livestock in developing countries. Selecting forage species for cultivation must take into consideration the yield, digestibility and nutrient composition (Ansah *et al.*, 2010). Napier grass can provide a continual supply of green forage throughout the year and best fits to all intensive small scale farming systems (Alemayehu, 1997).

It is the preferred forage not just in the tropics but also around the world (Hanna *et al.*, 2004) because to its advantageous characteristics like high photosynthetic and water-use efficiency, resilience to drought and adaptability to a variety of soil conditions (Anderson *et al.*, 2008).

The main cause of cattle productivity issues is a lack of feed. We currently have a limited supply of specified livestock feed resources in our country, which is driving up the demand for fodder production. Our species mostly subsists on typical local grasses, which are seasonal (Amin1, 2016).

A survey-based study results showed that most of the cattle and buffalo farmers prefer solid storage system to manage their manure in Bangladesh. About 35% was used for land fertilization, 47% for burning fuel preparation, 8% for composting and remaining 10% become completely wasted. A very few of cattle manure (4.65%) was utilized by the care of anaerobic digestion. About 20% of poultry manure managed in improved way and the remaining portion was mostly utilized in a very disparage way. In anaerobic digestion system, the produced gas went for home consumption and bio-slurry creates havoc for both farmer and environment. Land fertilization and aquaculture coves its utilization but the amount is too low compared to its production. Above 52% of total bio-slurry become wasted due to limited knowledge and lack of appropriate handling techniques (Khanam *et al.*, 2019) Bangladesh crop land is losing her organic matter gradually due to force to satisfy the food demand of increasing people from limited cultivable land through the intensive use of chemical fertilizer and somewhere it goes down to 0.5% where the standard is value is minimum 3% (Islam *et al.*, 2008).

Under this circumstance there is no alternative of adding organic matter to soil for sustainable and increased crop production. Because it is already established that improvement of soil physical and chemical properties along with organic matter status could be attained through the recycling of different organic wastes in agriculture (Chongrak, 1996). Many cultivars of Napier grass have been developed worldwide to suit the local conditions and there is a wide range of habits, yield potential and nutritive value. Napier grass is fast growing and has a high annual productivity that depends on climatic and soil conditions (Rusdy, 2016). With no or inadequate fertilizers, yields are on the range of 2 to 10 MT/DM/ ha/year (Bogdan, 1977). The composition and digestibility of Napier grasses is highly influenced by harvesting age (Lounglawan *et al.,* 2014). The nutritive value of grasses decreases with advancing maturity. The reduction of digestibility as the harvesting age increases is related to lignin content in the mature plant (Zailan *et al.,* 2016).

Considering the fact, the main purpose of this study is to develop an approach to the cultivation of Napier grass that is both economical and capable of maintaining the grass's nutritional value.

1.2. Justification

Literature review revealed that research in context of organic manure a few studies were done on the effect of growth, yield and quality of Napier grass at coastal region. Organic manure helps in maintaining C:N ratio in the soil and also increases the fertility and productivity of the soil, improves the physical, chemical and biological properties of the soil. Organic manure reduces environmental pollution and has residual effect in the soil even after long time application (Barongo, 2003). Forage crop performances are positively correlated with the two Napiers production and also correlated with organic manure and nutritive values, location, and season (Tessema *et al.,* 2010; Pandey and Roy, 2011). Thus, there is a need to investigate the chemical composition of Napier grass in different age at coastal conditions in Bangladesh. Very few comprehensive research was conducted on the effect of organic manure on Napier grass in coastal soil. Realizing the scenario of the study was conducted to investigate the effect of organic manure on production performances and nutritive values of Napier cultivars (*Pennisetum purpureum*) in coastal soil.

1.3. Objectives of the study

- ✓ To investigate the effect of different types of organic manure on Napier production (BLRI Napier-4, Red Napier).
- ✓ To determine the effect of organic manure on nutritive value of Napier fodder.

CHAPTER II

Review of Literature

2. 1. Information about the Napier grass

2.1.1. Distribution

Napier grass (*Pennisetum purpureum*) is one of the most popular grasses in the tropics and subtropics and it has been the most promising and high yielding fodder, with high nutritional characteristics and adaptability that suppresses most tropical grasses. Napier grass *Pennisetum purpureum (Schum.)*, also known as elephant grass, is a deep-rooted high yielding perennial bunch grass that is native to eastern and central Africa. It was named after Colonel Napier of Bulawayo in Zimbabwe who early in last century urged Rhodesia's Department of Agriculture to explore the possibility of using it for commercial livestock production (Boonman, 1993). Napier or elephant grass (*Pennisetum purpureum*) was first introduced to Malaysia in the 1920s and several cultivars had been introduced since 1950s. Growing forage with a high yield potential and good quality is important to overcome limited supply of roughage during annual drought and reduce the amounts of concentrate needed for cattle farming in the tropics. Napier grass is the most popular fodder used in dairy and feedlot production (Halim *et al.,* 2013). Napier grass is a perennial, tropical C-4 grass that can produce large amounts of forage. However, low temperatures and drought stress limit its productivity and nutritive value as a forage.

It is widespread in the tropical and sub-tropical regions of the world. Napier is the dominant grass species in Uganda, and is mostly found around the shores of Lake Victoria. Napier is native to tropical sub-Saharan Africa (i.e. southern Ethiopia, Kenya, Tanzania, Uganda, Cameroon, Ivory Coast, Ghana, Guinea, Liberia, Nigeria, Sierra Leone, Togo, Angola, Malawi, Mozambique, Zambia and Zimbabwe). This species is widely naturalized in the coastal districts of northern and eastern Australia, coastal Queensland and north-eastern New South Wales. Also present in the coastal districts of south-western and northern Western Australia, in the northern parts of the Northern Territory and on Norfolk Island (Kamal *et al.,* 2016)

Napier is also naturalized in tropical Asia (Bangladesh, China, Philippines, Cambodia, Indonesia, Malaysia, Thailand and Papua New Guinea), Southern USA (California, Texas and Florida), Mexico, Central America, South America (Colombia and Peru), the Caribbean, and in Oceania (New Zealand, the Cook Islands, Micronesia, French Polynesia, Fiji, Guam, Kiribati, New Caledonia, Hawaii, Niue, Palau, the Marshall Islands and the Galapagos Islands) (Bostock and Holland, 2007). Napier or elephant grass, *P. purpureum*, is a robust perennial grass grown for forage mainly in tropical areas of Africa, Asia, south and central America. Napier grass is forming large broad clumps. Its stems are tall and up to 3cm in diameter in the lower part (Bogdan, 1977). Its natural habitat is damp grassland, forest, margins and riverbeds. Mature plants normally reach up to 4m in height and have up to 20 nodes (Henderson and Preston, 1977).

2.1.2. Morphological characteristics of Napier grass

Depending on the type of soil and climate it is planted in, Napier is a perennial grass with a spreading rhizome that typically matures at a height of 2 to 6 meters. It is essentially a grass for hot and humid regions, preferably below 1500 m above sea level (Skerman and Riveros, 1990). It grows best in high rainfall areas of not less than 1000 mm annually. Its well-developed root system enables it to withstand drought and stay green during dry seasons (Skerman and Riveros, 1990). Napier grass is robust, rhizomatous, tufted and has a vigorous root system, developing from nodes of its creeping stolons. The culm is coarse, and may be up to 4 m to 7 m in height. The plant can form dense thick clumps, up to 1 m across. The leaves are flat, linear, and hairy at the base, 100 cm to 120 cm long, 1 cm to 5 cm wide and bluish-green in colour. After planting, Napier grass grows vigorously and can reach 4 m in 3 months (Skerman and Riveros, 1990). Napier has been the promising and high yield grass, giving dry matter yield that surpasses most other tropical grasses, like Guinea grass (*Panicum maximum*) and Rhodes grass (*Chloris gayana*) and higher nutritive value compared to *Brachiaria sp.* and *Panicum sp.* (Gomez *et al.*, 2011). There are around 25 cultivars of Pennisetum grass under cultivation (Kretschemer and Pitman, 2001). Napier is mainly established using stem (cane) cuttings (Wolfang, 1990), with at least three nodes, one of which must remain above the soil when planted. According to Boonman (1994), it can also be established using splits from young plants. Napier grass is vegetally propagated and can withstand repeated cutting and rapidly regenerates producing forage which is palatable to cattle at the leafy stage (Maria *et al.*, 2010). The planting method used does not have any significant effect on sprouting, growth and survival of Napier (Ssekabembe, 1998). Yields ranged from 20 to 80 MT/DM/ha/year under high fertilizer input (Skerman and Riveros, 1990). On farm, dry matter yields of Napier grass from different regions average about 16 MT/ha/year (Wouters, 1987).

Napier grass can produce more dry matter per unit area than any other crop. It can be intercropped with legumes and fodder trees, or as a pure stand. The tender young leaves and stem is highly palatable to livestock (Burton, 1993). Stem cuttings are either inserted into the soil at an angle of 45^0, or buried horizontally in furrows. The optimum time for harvesting this fodder is when the canes are 0.6-0.9 m tall. However, the first cutting should be done after the plants have accumulated a good quantity of nutrient reserves in the rootstocks (Sollenberger *et al.,* 1988). It is the forage of choice not only in the tropics but also worldwide (Hanna *et. al.,* 2004) due to its desirable traits such as tolerance to drought and a wide range of soil conditions, and high photosynthetic and water-use efficiency (Anderson *et. al.,* 2008).

In some countries Napier grass is also called as 'Elephant grass'. Elephant grass is a very large and robust long-lived grass (1-7 m tall) with greenish, yellowish or purplish colored seed-heads. The main stem of the seed-head is rounded. Napier is very robust grass forming large, bamboo-like, clumps (often 2-4 m tall). The leaf sheaths are hairless to stiffly hairy and there is a dense fringe of hairs where they meet the leaf blades. The large leaf blades (20-120 cm long and 1-5 cm wide) have a prominent whitish central vein. The seed-head is spike -like (8-30 cm long and 1.5-3 cm wide). The flower spikelet are surrounded by numerous bristles, one of which is larger than the others (i.e. 2-4 cm long) (Kamal *et al.*, 2016).

2.1.3. Nutritional Value of Napier Grass

Herbage yield of Napier grass affected by the harvesting day after planting (Manson, 1990). The range of protein content of Napier grass varies from 4.4 to 20.4% with the mean around 12% (Rusdy, 2016). This value is not too different from the report of Xie *et al.* (2009) that crude protein of Napier grass ranged from 4% to 5%. Age at harvest is the most important factor affecting crude protein content of elephant grass (Wadi *et al.,* 2004). Khan (2009) stated that Napier grass is highly relished by all type of cattle and buffalos and contains 6-8 % CP, 8-10 % ash, 28-35 % CF, 32-36 % NFE and8-9 MJ ME/kg DM. Haque *et al.* (2009) reported that Napier grass contains 250 g DM/kg green grass, 240 g OM/kg green grass, 25 g P/kg green grass and 2.0 MJ/kg green grass. Khaleduzzaman *et al.* (2007) conducted an experiment with Napier grass using five different doses of nitrogen (0, 40, 80, 120 and 160 kg N/ha) and three doses of Phosphorus (0, 10 and 20 kg P/ha) fertilizer and found that crude protein (CP) and organic matter (OM) contents increased significantly ($P<0.01$) with the increase level of N fertilizer, while acid detergent fiber (ADF) and ash content were decreased for the increasing level of N up to 160 kg N/ha.

Andrade *et al.* (2003) studied with Napier forage in two seasons (rainy season and dry season) and reported that in the rainy season nitrogen fertilizer positively influenced leaf dry matter production. Neutral detergent fiber and acid detergent fiber concentration reduced with the potassium fertilizer addition in the rainy season. Several researchers viz. Mpairwe *et al.* (2003), Kabirizi *et al.* (2000), Muinga *et al.* (1995) reported that the CP and ME values in napier were insufficient for optimum milk production. They recommended that Napier should be supplemented with forage legumes and/or concentrates in order to improve DM intake, digestibility and milk production.

Campos *et al.* (2002) studied with Napier grass and cut the grass from 45 to 105 days, with intervals of 10 days between cuts. A decrease was noticed in the Napier grass fraction degradability with the stage maturity progress. Increased DM and CP contents of Napier was found with increasing the application of nitrogen fertilizer from 0 to 150 kg/ha (Singh *et al.*, 2000). Clatworthy (1998) found the average annual herbage yield of improved grasses varies from 5-15 MT DM/ha under dry land conditions, to 10-40 MT DM/ha under fertilized and irrigated conditions. He also reported the most important feature is the decline in protein content as the wet season progresses (as the plant matures). Protein content is highest in November (8-15 %) and lowest in May/June (1-5%). Fiber content increases from 25-30 % in early growing season to 50 % in late growing season. The low protein content causes low digestibility (total digestibility declines from about 65 % in late November to about 40 % in late June) and feed intake causing energy deficiency. McDonald *et al.* (1988) stated that *P. maximum* one of the most common grasses in the derived savannah region of Nigeria under good conditions its nutritional value is high having up to 12.5 % crude protein, total digestible nutrients (TDN) of 10.2% and calcium, phosphorus and magnesium. Prasad *et al.* (1995) carried out an experiment with four hybrid Napier genotypes with four nitrogen levels (0, 20, 40 and 60 kg N/ha) and found that application of 60 kg N/ha was statistically superior in respect of nutrient content over lower levels of nitrogen in both types of Napier. Schreuder *et al.* (1993) stated that in Kenya, the average dry matter yields vary between 10 and 40 MT DM/ha/year depending on soil fertility, climate, and management. Islam *et al.* (2003) observed that Napier grass on average contains 20% DM, 7 to 10% CP, 70% NDF, 45% ADF.

2.2. Effect of Manure on Fodder Production

Manure from animal agriculture is the largest source of phosphorus (P) loads to the Chesapeake Bay and the second largest source of nitrogen (N). Traditionally, the manure from livestock and poultry has been a valuable resource for farmers as a cost-effective fertilizer. When used appropriately, manure adds nutrients and organic matter that improves soil quality. However, manure's ratio of P to N is often higher than a crop's agronomic need, so application of manure at agronomic N rates frequently contributes to excess P in the soil (RJ Ellison, WR Horwath–2021). Livestock manure conventionally pollutes the environment and it may be turned into wealth through improved management. Total livestock manure management system of Bangladesh is in very vulnerable condition till yet. Solid storage and burning fuel preparation is much more preferred method by the farmers to handle manure through which a huge amount of methane is emitted to the environment annually, polluting our surroundings and creating public health hazards. Amount of utilized manure is very low and major portion of this valuable wealth becomes wasted (Khanam *et al.,* 2019). The soil fertility of Bangladesh is decreasing every year at an alarming speed. Low organic matter content is one of the most important contributing factors for poor fertility status of soils. Organic manure and bio-slurry along with chemical fertilizer can successfully be used to improve the soil health and productivity (Rahman *et al.*, 2016). Integrated use of organic manure and chemical fertilizers would be quite promising not only in providing greater stability in production, but also in maintaining better soil fertility (Tilahun *et al.*, 2013). There are good opportunities to improve soil fertility and crop production by application of organic manure and bio-slurry along with chemical fertilizers. The combined application of farmyard manure (FYM) and inorganic N and P fertilizers improved the chemical and physical properties, which may lead to enhanced and sustainable production of rice (Tilahun *et al.*, 2013). Organic manuring also improves the physical and microbial conditions of soil and enhances fertilizer use efficiency when applied in conjunction with mineral fertilizers. Cow dung, poultry litter, and other biomass wastes are widely used to produce biogas which is potential renewable energy alternative in rural areas of Bangladesh. More than 30,000 biogas plants of varying gas-producing capacities run with cow dung and poultry litter for domestic purposes. These biogas plants generate more than 200,000 tons of bio-slurry on dry weight basis (Islam, 2006). The organic matter content as well as the fertility status of Bangladesh soil is low. Now it is well agreed that depleted soil fertility is a major constraint for higher crop production in Bangladesh and indeed, yield of several crops were declining in some soils (Bhuiyan, 1991). Maintenance of soil fertility is a prerequisite for long term sustainable agriculture and it is certain that organic manure (cow dung, poultry manure and their slurry) with chemical fertilizers can play a vital role in the sustainability of soil fertility and crop production. The yield of rice and soil productivity can be increased substantially with the judicious application of organic manure with chemical fertilizer (Hossaen *et al.*, 2011).

The mineralization of the applied manure is also regulated by temperature condition via microbial activity in applied soil environments. Growth rate in Napier grass is maintained in accordance with mineralized rate of manure nutrients, so as to mitigate the risk of mineral pollution in the productive forage field (Sanusi *et al.*, 2006). The effect of types of fertilizer used on the growth performance and nutritional quality of the grass were evaluated by Shokri Bin Jusoh (2005). The organic fertilizer as either sheep manure alone or as combination with urea gave better growth performance of the grass in terms of tiller height, tiller number and leaf area index over 6 cycles of weeks per cycle. The treatment with 200 kg N/ha of sheep manure gave highest dry matter yield (16 MT/ha/year) compared to control (10 MT/ha/year). The leaf: stem ratio of the grass shows that the leaf fraction increased significantly over time. The urea fertilizer gave higher crude protein (13%) compared to 12% in other treatments. Grass fertilized with mixed fertilizer gave higher NDF (73.21%), ADF (40%) and sheep manure gave higher ash concentration (>10%) and low ADL concentration (<0.25%) (Shokri Bin Jusoh, 2005).

A comprehensive manure management on herbage is essential for forage production by understanding the amount of manure input, absorption of manure nutrients by the herbages and reasonable balance between the inputs of the absorption of forages (Idota *et al.*, 2005). Although grasses respond very quickly to inorganic fertilizer, livestock manure that could be supplied within the farmers premises in an important resource for grass cultivation. These materials also help to improve soil physical properties and increase the activity of beneficial soil microbes.

It is reported that hybrid Napier grass fertilized with adequate organic manure especially poultry manure (2.62% nitrogen, 2.8% phosphorus and 2.82% potash) produced higher yield than those applied with inorganic fertilizer (Jayanthi, 2003). It has also been reported that application of 20 tha^{-1} (or 2 kg/plant) of farm yard manure before planting grass cutting had increased overall production of Napier grass crop (Sidhy, 2003).

High leaf expansion, vigorous tillering and rapid leaf production in tall canopy are characterized as the fundamental factors to achieve high production of Napier grass (Ferraris *et al.,* 1986; Matsuda *et al.,* 1991; Wadi *et al.*, 2003).

Napier grass grows rapidly and requires heavy fertilization to achieve high production (Miyagi, 1981; Mohammad *et al.*, 1988; Sanusi *et al.*, 1999; Wadi *et al.*, 2003).

The growth character as well as forage quality are variable depending on the growth stage of herbages (Hsu *et al.*, 1989; Woodard *et al.,* 1991; Sanusi *et al.*, 1997; Ishii *et al.*, 1999).

Thus the high level of manure input is expected to obtain high level of forage yield in Napier grass (Sanusi *et al.*, 1997).

Absorption of manure nutrients by herbage is depend on the growth of herbage and careful management of fertilization is required to maintain high quality of herbages (Humphreys, 1994). As for supplying herbages to animals, the quality and quantity of herbages should be maintained by choosing the suitable species that can achieve high production with high quality (Mendoza and Schank, 1987).

2.3. Agronomic growth parameters of Napier forage cultivars

2.3.1. Plant Height

Napier grass persists for 8-9 years after planting and can be cut at 45- 60 days intervals. Cutting at 45-60 days intervals resulted in the optimum yield but too frequent cutting at 30 days intervals could reduce yield (Lounglawan *et al.*, 2014). Cuttings the crop at 5, 10, 15, 20 and 25 cm from soil surface were not significantly different for the chemical compositions and digestibility, but cuttings at high levels did reduce ash content and protein content (Tessema *et al.*, 2010).

Phakarmas and Yampracha (2018) conducted an experiment to evaluate the requirement of mogen fertilizer of Pakchong and found that plant height was significantly influenced by the fertilizer treatments at the first cutting but was not significantly different at the second and third cutting period.

A study was conducted by Sarker *et al.* (2019) to compare the potentiality between BLRI Napier-3 (BN-3) and Pakchong (PK) where the fodders were harvested at three cutting intervals (at 70, 80 and 90 days after plantation) and highest plant height (104.6 cm) was observed in PK at 90 days after plantation. By using five nitrogen levels: 0, 15, 20, 25 and 30kg N/ha, an experiment was conducted by Hasan *et al.* (2010) to evaluate the effects of nitrogen fertilizer on growth parameters of Cow pea forage and observed that plant height was significantly ($p<0.01$) influenced by nitrogen fertilizer and highest plant height (96.25 cm) was observed at 25 kg/ha.

2.3.2. Biomass

Significant ($P<0.05$) difference was observed in biomass yield among different treatment group. Biomass yield (MT/ha) was in order of biogas slurry (26.80)>fertilizer (26.56)> broiler litter (22.34)>layer litter (22.20) (Rahman *et al.*, 2015).

Paikar (2010) observed highest fresh yield of Napier fodder among various perennial fodder germplasm. He found fresh and dry yield 42-45 MT/ha and 7-8 t ha^{-1} respectively in the experimental field laboratory of Bangladesh Agricultural University.

Khan (2009) reported that, from Napier about 170-250 MT green fodder/ha/year can be found with 8-10 cuttings. John (2008) worked with Napier and observed that number of tillers per plant showed a significant positive relation with plant height and green fodder yield. It also showed a highly significant and positive relation between fresh yield and plant height, leaf width, number of tillers per plant and crude fiber content. Boonman (1994) reported that Napier grass has been the most promising and high yielding fodder than any other tropical grasses. A yield of 85.4 MT kg/ha without fertilizer application and a record high yield of 130 MT kg/ha with 1320 kg ha^{-1} of nitrogen fertilizer application have been recorded.

According to Boonman (1994), Napier requires 100, 22 and 22 kg/ha of N, P and K respectively, in order to grow well. When cutting and feeding it to cattle, large amounts of nutrients are transferred from the soil to the feeding stall.

Synders *et al.* (1992) reported that Napier yield was 15-20 MT kg/ha/year of DM by using only organic manure. Grant *et al.* (1974) observed that without supplementation, Napier could support daily production of 8-10 kg of milk per cow, and that it has been successfully used as sole feed for ruminants. Yields of Napier grass can range from 12 to 19 MT kg/ha/year on unfertilized soils and 55 MT kg/ha/year on fertilized soils with adequate water supply (Williams, 1980).

Ferraris (1980), Skerman and Riveros (1990) and Vicente-Chandler *et al.* (1959) reported that annual DM yield of Napier grass varied from 18.3 to 49.7 mg/ha/year, 10.7 to 85.9 mg/ha and 25.9-80.7 mg/ha respectively.

Sreenivasan *et al.* (1986) reported that plant height and number of tillers per plant have to exert greater direct influence on fodder yield in Napier grass. The indirect effects of plant height through leaf width and number of tillers per plant contributed more towards green fodder yield. Similarly indirect effects of leaf width through stem thickness, leaf length and plant height were also considerable. Sanusi *et al.* (1997) observed that the high level of manure input is expected to obtain high level of forage yield in Napier grass

2.3.3. Tiller Number and Leaf Number

Nathu Ram Sarker *et al.* (2021) showed that cultivar and location had a significant ($P < 0.001$) effect on biomass yield, plant height and leaf-stem ratio (LSR), while number of tillers were significantly varied with locations. BN-3 yielded the highest biomass (33.32

MT/ha/harvest) at non-drought location (42.98 MT/ha/harvest). The highest plant height was obtained in BN-1 (171.2 cm) at non-drought location (174.6 cm). Number of tillers per hill ranged from 25.4 to 26.3 among cultivars ($p > 0.05$) and the highest tillers were found at non-drought location.

Sirichaiwetchakul *et al.* (2016) conducted an experiment on arbuscular mycorrhizal fungs (AMF) to promote the yield and nutritive values Napier pakchong 1 and found that tiller number was highly significant ($p<0.01$) by moculation of AM fungi. At both cutting stages (130 DAP(2nd cutting) and 60 days regrowth) tiller per plant was significantly influenced by urea fertilizer and found that inoculation of commercial AM fungi had no effect on number of leaves per plant

According to Phakamas and Yampracha (2018) at all cutting periods, the fertilizer treatments did not differ significantly ($p>0.05$) in terms of tiller number, and the treatments based on the combined data of the three cutting times did not differ significantly. Although not significantly different, urea and ammonium sulphate fertilizer at the Department of Livestock's recommended rate and the rate recommended by the soil test kit both had more tillers than unfertilized control and cattle manure, whereas cattle manure applications at both rates were comparable to unfertilized control for this parameter.

A comprehensive study was conducted by Wanghuk *et al.* (2016) to compare 3 cultivars of Napier hybrid grass *(Pennisetum purpureum x P. glaucum*: Pakchong-1, CO-3 and Giant Napier), at 3 cutting periods (40, 60 and 80 days) and found that on the number of tillers per plant, there was a strong cultivar x cutting effect. However, the quantity of tillers reduced dramatically for all cultivars as cutting intervals increased, and CO-3 generated the most tillers at all cutting intervals, whereas Pakchong-1 produced the least.

Ahmed *et al.* (2021) studied to compare Bangladesh Livestock Research Institute developed Napier hybrid-3 (BN-3) *(Pennisetum purpureum*) and Pakchong-1 (*Pennisetum purpureum P. glaucum*) in context of forage growth, biomass yield, and nutritional quality and found that the effects of cultivar and cutting period were significant on leaves per tiller and highest leaves per tiller was produced by BN-3.

2.4. Nutritional Parameters

2.4.1. Crude Protein (CP)

Kebedel (2017) studied on Napier grass (*Pennisetum purpureum* (L.) Schumach) accessions in different agro-ecological zones of Ethiopia and find The CP and in-vitro organic matter digestibility (IVOMD) were higher in the highlands while CP yield, digestible yield and most fiber components were relatively higher in the mid altitude areas indicating that temperature and amount of rainfall and its distribution had an adverse effect on the feed quality of Napier grass. Haryani *et al.* (2018) conducted an experiment to evaluate the yield and nutritive values of ix Napier cultivars at different cutting stages. The nutrient content of harvested plant material was measured, pre-dried in air, and dried in an oven before grinding, and it was discovered that as yield and quality of fodder and concluded that nitrogen application has the cutting interval increased, crude protein and metabolized energy percentage declined significantly.

Eltelib *et al.* (2006) studied on the effect of nitrogen and phosphorus application on growth.forage effect on the growth of plant and protein also influenced by nitrogen.

William (1980) conducted a study on seasonal fertilizer response of Napier grass and found that dry forage yield in optimum fertilizer level on sandy soil around 5 MT/ha/year in dry soil condition and 55 MT/ha/year in sandy clay loam soil with adequate moisture. Digestible nutrient and protein levels of 60 days forage were about 55 % and 10 % respectively.

Delevatti *et al.* (2019) evaluated the effect of nitrogen fertilizer on the nutrient composition of Marandu grass at field salinity level and found that crude protein content increased rather than fiber content by adequate application of nitrogen fertilizer in the grass.

Ullah *et al.* (2010) conducted an experiment on effect of nitrogen fertilizer and harvesting intervals on the forage yield and nutritional value of elephant grass and found that crude protein content decreased with longer harvesting intervals.

Lymbery *et al.* (2013) studied on effect of organic fertilizer on nutrient status of Napier forage and observed that due to the availability of optimal organic fertilizers, feed yields are increased to maximum levels and crude protein content is 16.7 %.

2.4.2. Crude Fiber (CF)

Eltelb *et al.* (2006) studied on the effect of nitrogen and phosphoras application on growth. Forage yield and quality of fodder and found that nitrogen and phosphorus had no effect on crude fiber

Sarkar *et al.* (2004) experimented the effect of different doses of nitrogen fertilizer on yields and chemical composition of Zamboo grass and found that CP, CF, and EE yields increased with increasing fertilizer dose in the first cut, while in the second cut all other adjacent components except CF decreased.

Liangco *et al.* (2019) experimented on chemical composition of super Napier grass silage treated with *Lactobacillus buchneri* and *Lactobacillus plantarum* and found that infectant-treated Super Napier Grass (SNG) silage had higher levels of crude fiber and nutrient detergent fiber compared to untreated treated Super Napier Grass. To determine the effects of three cutting intervals (30, 45 and 60 days) and three cutting heights (5, 10 and 15 cm above ground level) on the yield and nutrient composition of King Napier grass (*Pennisetum purpureum x Pennisetum americanum*) research was done by Lounglawan *et al.* (2014) and found that crude fiber increased with the maturation of plant and crude fiber decreased with the increasing cutting height.

Haryani *et al.* (2018) conducted an experiment to evaluate the yield and nutritive composition of six napier cultivars at different cutting stages. Before grinding, harvested plant material was weighed, pre-dried in the air, and dried in the oven, and it was discovered that increasing the cutting interval considerably increased dry matter and crude fibre. Animasaun *et al.* (2018) experimented on forage yield and nutritional contents of pearl millet and Napier grass and found that the proportion of neutral detergent fibre (NDF) was higher in napier than in the pearl millet.

2.4.3. Dry Matter (DM), Ether Extract (EE) and Ash content

A scientific study was conducted by Zewdu *et al.* (2002) on Napier grass (*Pennisetumn purpureum (L.) Schumach.*) by using a 5 x 3 factorial experiment. The treatments were five fertilizer applications (0 kg/ha N, 46 kg/ha N and 92 kg/ha N) and three plant heights at cutting (0.5m, Im and 1.5m). The average dry matter (DM) yield per cut was 8.211 ha^{-1}, however the dry matter increased as the plant height at cutting and the quantity of nitrogen fertilization increased and also found that total ash was affected by both plant heights at cutting and fertilizer level.

Malahubban *et al.* (2021) experimented to observe the effects of different harvesting time on Napier grass's nutrient composition leaves. Taiwan Napier grass grown under field conditions were harvested on day-15, 30, 45, 60, 75, and 90 after planting and found that Taiwanese dry matter from 75 days after planting to harvesting day 90, the number of Napier grass leaves increased. Every harvesting date had a considerable difference in crude fat, and also found that over the course of 90 days following planting, the crude fat content of Napier leaves fluctuated. The crude fat content of Taiwan Napier grass leaves was lowest at day 90 (1.00%) and highest at early development (day 15) at 3.28 percent. This result reveals that as Taiwan Napier grass grew older, the crude fat content of the grass decreased.

An experiment was conducted by Ahmed *et al.* (2021) to compare Bangladesh Livestock Research institute developed Napier hybrid-3 (BN-3) and Pakchong-1 where the cultivars were harvested at three cutting periods (40, 50, and 60 days) and based on the % DM, and DM yield, BN-3 performed better cutting at 50 days after the first plantation, but Pakchong-

1 performed better cutting at 60 days after the first plantation. Lounglawan *et al.* (2014) conducted an experiment to determine the effects of three cutting intervals (30, 45 and 60 days) and three cutting heights (5, 10 and 15 cm above ground level) on the yield and nutrient composition of King Napier grass (*Pennisetum purpureum* x *Pinnisetum americanum*) and found that with the advancing of age dry matter increased significantly, however the cutting height had no effect on dry matter also found that EE content was unaffected by cutting height and ash content was reduced with increasing curing period.

CHAPTER III

Materials and Methods

3.1. Site of the experiment

The experiment was conducted at Prof. Dr. Purnendu Gain Field Laboratory of Agrotechnology Discipline, Khulna University, Khulna-9208, Bangladesh.

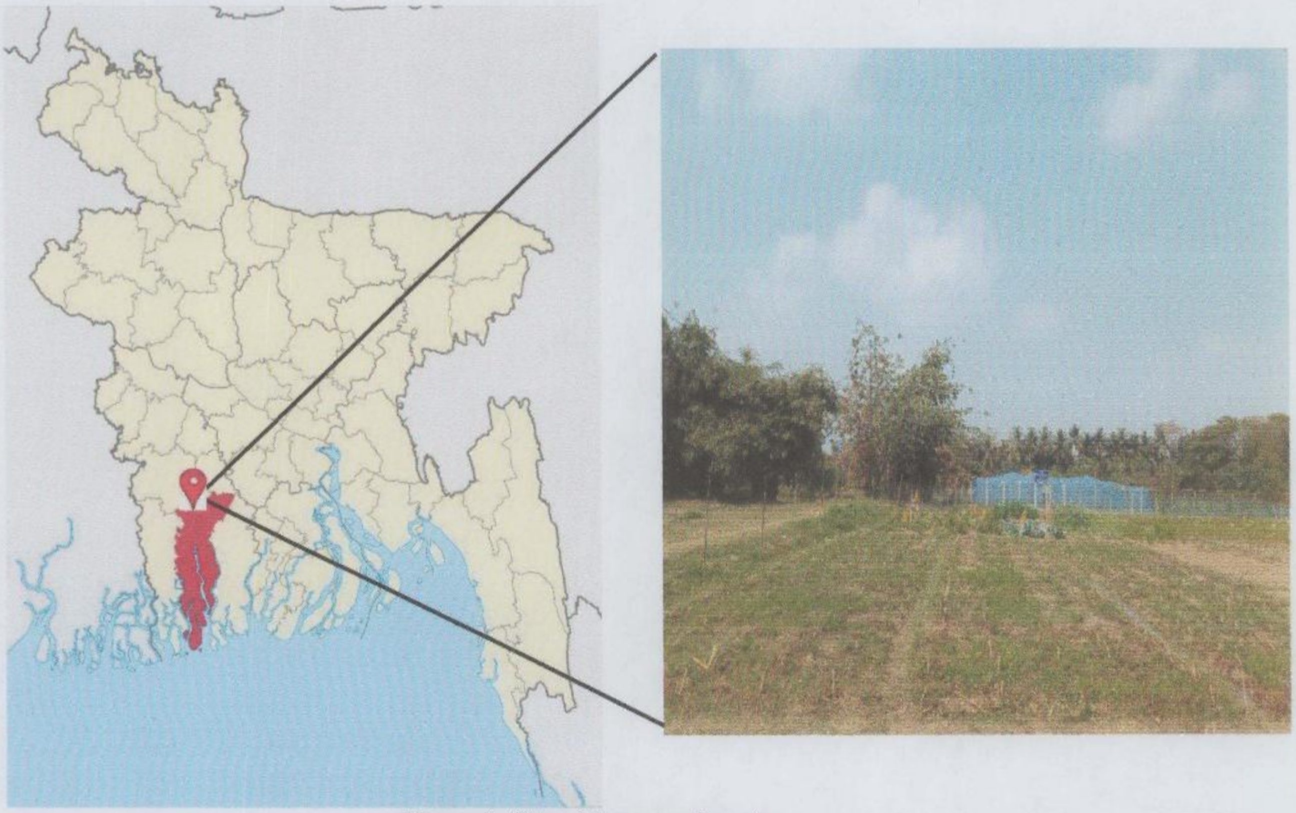


Figure 1. Site of the experiments

3.2. Experimental design

The experiment was incorporated factorial RCBD design with two varieties (V_1=BLRI Napier-4, V_2=Red Napier) and four treatments (T_0 = Control, T_1 = 100% Cow Dung, T_2 = 100% Poultry Manure and T_3 = 100% Sheep Manure) having three replications.

Table 1. Layout of the Experiment

Variety	Treatment	Replication		
		R_1	R_2	R_3
V_1	T_0	$T_0V_1R_1$	$T_0V_1R_2$	$T_0V_1R_3$
V_2		$T_0V_2R_1$	$T_0V_2R_2$	$T_0V_2R_3$
V_1	T_1	$T_1V_1R_1$	$T_1V_1R_2$	$T_1V_1R_3$
V_2		$T_1V_2R_1$	$T_1V_2R_2$	$T_1V_2R_3$
V_1	T_2	$T_2V_1R_1$	$T_2V_1R_2$	$T_2V_1R_3$
V_2		$T_2V_2R_1$	$T_2V_2R_2$	$T_2V_2R_3$
V_1	T_3	$T_3V_1R_1$	$T_3V_1R_2$	$T_3V_1R_3$
V_2		$T_3V_2R_1$	$T_3V_2R_2$	$T_3V_2R_3$
Here, Varieties (V_1 = BLRI Napier-4 and V_2 = Red Napier) and Treatments (T_0 = Control (No Manure), T_1 = 100% Cow Dung, T_2 = 100% Poultry Manure and T_3 = 100% Sheep Manure).				

Total no. of plots: 24, Plot size: $6m^2$

Plant to plant distance= 50 × 60 cm

Row to row distance= 50 × 80 cm

Plot to plot distance= 30.48 cm

3.3. Management practices

The following two cultivars of Napier were examined: BLRI Napier-4 and Red Napier. The stem cuttings of two Napier cultivars were collected from BLRI substation Vanga, Faridpur, Bangladesh. The parent plant was cut at a minimum of three nodes per cutting and were planted 15 cm to 20 cm deep at angles of about 45°.

Figure 2. Land Preparation

recording. The sample was weighed, after sundry and oven dry at 105^0 (130 DAP) and 65^0 (160 DAP) and sample was ready for chemical analysis.

3.7. Chemical Analysis

After each cut, the fresh forage was weighed and subsamples were taken for determination of dry matter, crude protein, crude fiber, ether extract and ash in the Animal Husbandry laboratory.

3.8. Collection and chemical analysis of Sheep Manure, Cow dung and Poultry Manure

The recommended value of NPK for Napier grass is (0-45 of N kg/ha; 0-12 of p kg/ ha; 0-15 of K kg/ha) according to Fertilizer Recommendation Guide- 2018. Sheep manure was collected from the project entitled "Improvement of sheep production in South-Western coastal regions of Bangladesh through proper breeding and feeding techniques". Project No: LS20191163; GARE, BANBEIS, MOE implemented under Agrotechnology Discipline, Khulna University, Khulna-9208, Bangladesh.

Sheep manure was analyzed for content of Nitrogen, P and K, using Kjeldahl Distillation unit, UK; Spectrophotometer TG, China and Flame photometer Jenway, UK, respectively. After reviewing analysis, the sheep manure consists of 0.28% N, 0.0050% P and 1.2536% K. Cow dung was collected from local farmer's farm from Batiaghata, Khulna.

Cow dung was analyzed for content of Nitrogen, P and K, using Kjeldahl Distillation unit, UK; Spectrophotometer TG, China and Flame Photometer Jenway, UK respectively. After reviewing analysis, the cow dung consists of 0.42% N, 0.917% P, 1.02% K.

Poultry droppings was collected from local farmers farm from molliker mor, Batiaghata, Khulna. The poultry manure consists of 2.62% N, 2.8% P, 2.82% K (Jayanthi, 2003).

Figure 5. Cow dung (A), Sheep manure (B) and Poultry manure (C)

3.9. Plantation

Cuttings of the grasses were planted on 17^{th} December 2023 by line method keeping one node under the soil with 45^0 angles and maintaining 50 to 80cm distance between row to row and plant to plant spacing.

3.10. Irrigation and Drainage

Irrigation and drainage were done in each plot when necessary.

Figure 6: Irrigation

3.11. Collection of Data

Agronomical data such as plant height, leaf number, leaf length, leaf width, tiller number, biomass, stem diameter & nutritional data e.g. percentage of dry matter, crude protein ash and ether extract were collected after harvesting of the forage cultivars at two intervals (130 and 160 Days.

3.12. Agronomical parameters

3.12.1. Plant height

Five plants were selected randomly for determination of plant height. The height of each plant was measured from the ground to the top of the upper most of leaf of the plant and mean value of plant height was recorded.

Figure 7: Determination of Plant height

3.12.2. Leaf length and leaf width

The leaf length was measured from the tip of the entire leaf down to the base of the leaf blade. After measuring each leaf length their mean value was recorded.

Figure 8: Measuring leaf width

3.12.3. Tiller number and leaf number

Tiller number and leaf number was counted manually and tillers, which had at least one leaf visible, was counted.

3.12.4. Biomass

Fresh yield was recorded immediately after cutting the fodder by weighing it with a balance, and yield was expressed in tha^{-1}. Weighing the mass was used to calculate the biomass yield of two Napier cultivars.

Figure 9: Measuring biomass of grass using weighing scale

3.12.5. Sample Preparation

After harvesting the grass, the whole grass sample was cut into pieces of less than one cm size with a knife. After taking the sample for dry matter and ash test, rest of the sample was dried at 105^0 C for overnight, grinded with blender machine and kept separately in an airtight sample bottle.

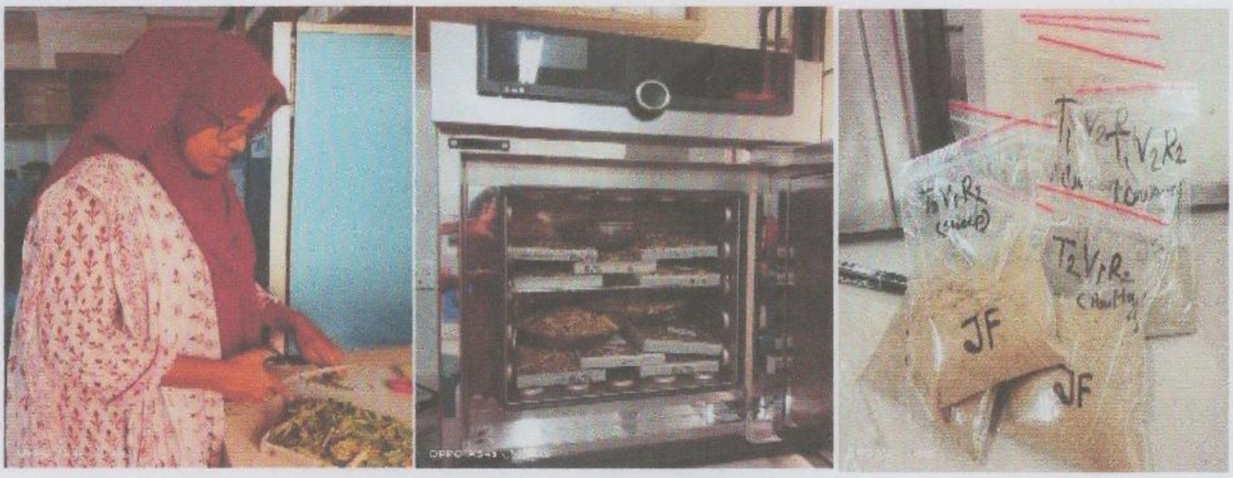


Figure 10: Sample preparation

3.13. Proximate Analysis (Jan-Åke Persson, 2008)

3.13.1. Crude Protein Analysis

Test Procedures:

Digestion

1 g of sample was weighted with an accuracy of ±0.1 mg. For each sample 2 catalyst and 12 ml H_2SO_4 were added and then placed into digestion block. The temperature of the digestion block was taken at 420˚C and sample was heated for 60 minutes until the fumes stopped. Then the sample was taken to cool 50-60˚C.

Distillation

After cooling the sample it was mixed with 50ml distilled water. 50ml NaOH was added with the solution. The digestion flask was then given into the distillation chamber. 30ml Boric acid solution was taken in a conical flask and 3 drops of indicator were added into it. The water flow was previously adjusted. The distillation process was done until the colour of indicator mixture solution did not turn into green colour.

Titration

The sample of the flask was then taken for titration. Then 0.1% H_2SO_4 was taken in burette pipe and added drop wise. The procedure was continued until the colour of the solution of the conical flask turn from green to blue. When the solution colour had changed the titration procedure ended. The strength of the titrate was then recorded.

Calculation

$$CP = \frac{(\text{ml H2SO4 sample} - \text{ml H2SO4 blank}) \times \text{conc.H2SO4 } 14.007 \times 100}{\text{Wight of sample} \times 1000}$$

Crude protein (%) = Nitrogen (%) × Conversion factor *

*= Conversion factors for animal and plant origins ingredients are 6.25.

Figure 11: Determination of crude protein

3.13.3. Crude Fibre Analysis

Test Procedures:

Crude fiber analysis was conducted by using VELP SCIENTIFICA FIWE Raw Fiber Extractor. 1g sample was taken in crucibles were fixed with the channels. 150 ml 1.25% H_2SO_4 was taken in the flask of the analyzer adding 3-5 drops n-octanol as anti-foam agent. The switch of the fiber analyzer was turned on. Boiled exactly for 30 minutes. After 30 minutes, filter the remaining agent. Washing should be done three times with 30 ml (crucible filled to the top) of hot deionized water, connecting each time to compressed air for stirring the content of crucible. After draining last wash, 150 ml 1.25% KOH and 3-5 drops of anti-foam agent were added. Again, after boiling for 30 minutes then washing 3 times, a last washing was done with cold deionized water to cool the crucible and then wash three times the crucible content with 25ml of acetone and stirring by compressed air. The crucible content with 25 ml of acetone was washed. After that crucible were dried at 105° C for one hour in oven and then cooled down in a desiccator to take the dry weight (F_1). The crucibles were placed into a muffle and heated up to 550° C for three hours to reweight after cooling in a desiccator (F_2).

Calculation:

Crude Fibre (%) = $\frac{F1-F2}{F0} \times 100$

Where,

F_0 = Weight of sample in gram

F_1= Weight of oven dried sample in gram

F_2= Weight of ash containing crucible in gram

Figure 12: Determination of crude fiber

3.13.3. Ether Extract

Test method procedure:

Sample: 3 g (F_1) of grounded and homogenized material was weighed in an extraction thimble with 1 mg proximation. (Total weight-thimble weight) = wet sample weight.

Chemicals: Petroleum ether 40-60° C, with an evaporation of residue not higher than 10 mg/L.

Sample drying: dried the thimble one hour in a 125° C oven.

Immersion: Sample containing thimble or the glass crucible containing dry hydrolysed sample were introduced into the extraction equipment. After weighing extract collecting vessel (F2), 40ml of petroleum ether was added. Thimble with sample, assembled with thimble connector to extraction unit. After closing the extraction unit, the cooling water flow started and the heating. When the solvent started boiling, the thimble or glass crucibles were placed into "Immersion" position for 30 minutes.

Washing: After 30 minutes extracted, thimble or glass crucible were placed into "Washing" position for 60 minutes.

Recovery: After washing, the stopcock located under the water, was closed and cooled in condenser and evaporated completely the solvent from the extraction vessel.

Weighing: The extract containing cups were dried in oven at 125° C for 30 minutes and weighed (F_3) it after cooling a desiccator.

Calculation:

Ether Extract (%) = $\frac{W3-W2}{W1} \times 100$

Where,

W_1 = Weight of sample in gram; W_2 = Weight of empty vessel in gram; W_3 = Weight of vessel and ether extract in gram

Figure 13: Determination of Ether extract

3.13.4. Dry matter

Test procedure

Envelopes were weighted (W_1) and weight was recorded to 0.001 g. After harvesting, fresh shoot weight (W_2) of forage was taken and the envelope was filled with sample and dried in oven for 24 hours at 105°C. Thereafter the dried sample containing envelope (W_3) is weighted.

Calculation:

Dry Matter (%) = $\frac{W3-W1}{W2} \times 100$

Where,

W_1 = Weight of envelope in gram; W_2 = Weight of fresh sample in gram and W_3 = Weight of envelope and dried sample in gram

Figure 14: Determination of Dry matter.

3.13.5. Ash Analysis

Test Procedure

Crucibles were placed in muffle furnace, allowing 30 minutes to reach 600˚C. Weight of crucible was recorded to 0.0001g (W_1). About 3g sample was weighted into a crucible which had been tarred. Weight of sample was recorded to 0.0001g (W_2). Ash crucibles containing samples in muffle furnace at 600˚C for 6 hours after the furnace had reached the temperature. Crucibles were allowed to cool in furnace to less than 20˚C and crucibles were placed in desiccator with a vented top. Crucibles were cooled in desiccator to room temperature and were weighed immediately. Weight was recorded to 0.0001g (W_3). Ash% was calculated and reported to one decimal place.

Calculation

$$\text{Ash (\%)} = \frac{W3-W1}{W2} \times 100$$

Where,

W_1 = Weight of crucible in gram

W_2 = Weight of sample in gram

W_3 = Weight of crucible and ash in gram

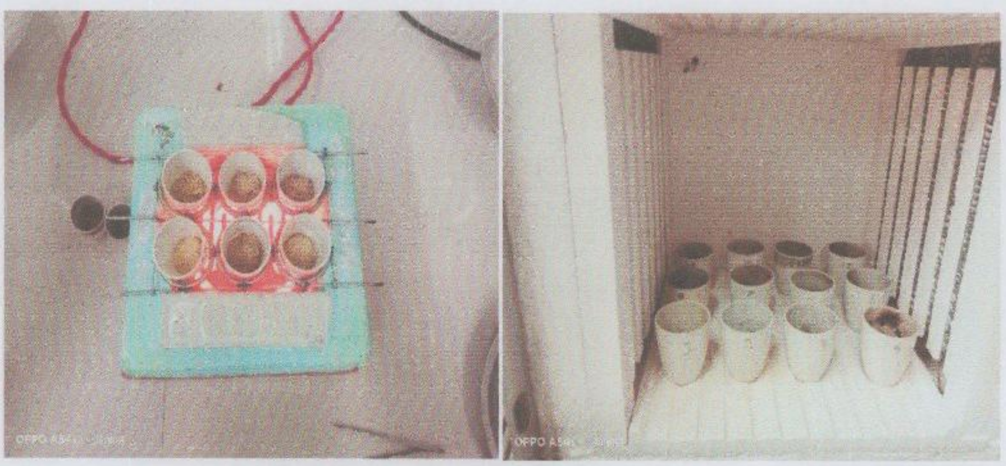


Figure 15: Determination of Ash

3.14. Statistical analysis

Data was evaluated separately by using the analysis of variance (ANOVA). Mean differences were assessed by the Duncan New Multiple Range Test (DMRT). Calculated data on various parameters under study was statistically analysed using 'SPSS' software.

CHAPTER IV

Results and Discussions

4.1. Agronomic growth parameters of two Napier cultivars at 130 DAP

In this study, the effects of different sources of organic manure on different agronomical parameters of BLRI Napier-4 and Red Napier, were assessed at 130 days after planting (DAP). In Table 2, the highest tiller number was found in the interaction effect of T_1V_1 (13.66) while the lowest was found in the interaction effect of T_0V_1 (7.76). The effect of manure application and cultivars had a significant effect ($p<0.038$) on tiller number of forage cultivars. Highest plant height was found in the interaction effect of T_1V_1 (127.78 cm) and lowest was in interaction effect of T_0V_2 (90.83 cm) which was significantly ($p<0.01$) affected. Highest stem diameter was found in the interaction effect of T_1V_1 (3.28 cm) and lowest was in T_0V_2 (1.81 cm) which was significantly ($p<0.01$) differed. Highest leaf length was found in the interaction effect of T_1V_2 (87.68 cm) and lowest was in T_0V_2 (52.60 cm). The interaction of manure application and cultivars had a significant effect ($p<0.02$) on leaf length of forage cultivars. Highest biomass was found in the interaction effect of T_1V_1 (28.30 tha^{-1}) and lowest was in T_0V_2 (12.96 tha^{-1}) which had a significant effect ($p<0.08$) on biomass of forage cultivars. Highest leaf number was found in the interaction effect of T_1V_1 (13.45) and lowest was in T_0V_2 (7.89) which had no significant effect on leaf number of forage cultivars. Highest leaf width was found in the interaction effect of T_1V_1 (3.68 cm) and lowest was in T_0V_2 (2.19 cm) which had no significant effect ($p<0.72$) on leaf width of forage cultivars. In this study showed significant differences ($P<0.05$) in tiller number, plant height, stem diameter, leaf length, and biomass yield across treatment groups, in case of leaf number and leaf width did not exhibit significant difference ($p>0.05$) among the treatments at 130 days after planting.

Islam *et al.* (2017) also observed that number of tiller/hill of BLRI Napier-4 varies from $14.83^{b}\pm 1.02$ to $19.50^{a}\pm 1.05$ in different treatments of organic fertilizer. They found that number of tiller/hill was significantly ($P\leq0.05$) differed among the treatments and maximum observed in layer litter ($19.50^{a}\pm 1.05$) than others. These findings were well consistent with the present findings. Islam *et al.* (2010) revealed that Maize plant height and stem circumference were significantly ($P< 0.01$) influenced by increasing the rate of biogas slurry. The effects of organic fertilizers on morphological characteristics of two Napier cultivars at 130 DAP respectively.

Table 2. Growth parameters of Napier 4th Generation and Red Napier grass genotype at 130 DAP.

Treatment	Variety	Parameters at 130 DAP (Mean ± SE)						
		Tiller Number	Plant Height (cm)	Stem Diameter (cm)	Leaf Number	Leaf Length (cm)	Leaf Width (cm)	Biomass t ha^{-1}
T_0	V_1	7.76^{c}±0.38	101.95^{b}±5.21	1.89±0.18	8.05 ±0.07	58.70^{cd}±3.81	2.56±0.34	16.98^{cd}±0.88
	V_2	8.36^{bc}±0.78	90.83^{b}±2.09	1.81±0.07	7.89±0.97	52.60^{d}±4.24	2.19±0.07	12.96^{d}±0.57
T_1	V_1.	13.66^{a} ±1.44	127.78^{a}±2.02	3.28^{ab}±0.18	13.45±0.07	74.28^{ab}±2.29	3.68±0.31	28.30^{a} ±2.76
	V_2	12.10^{ab} ±1.56	120.36^{a}±1.41	2.82±0.01	11.90±0.14	87.68^{a}±3.28	3.45±0.071	19.86^{bc}±0.71
T_2	V_1	12.29^{ab} ±0.44	125.94^{a}±3.27	3.11^{a}±0.20	9.95±0.07	69.45^{bc}±4.03	3.25±0.071	24.44^{ab}±0.60
	V_2	10.34^{abc}±0.52	121.48^{a}±1.58	2.39±0.12	9.55±0.63	72.65^{b}±3.60	3.01±0.02	21.80^{abc}±1.04
T_3	V_1	12.99^{a} ±1.27	118.29^{a}±4.20	2.59±0.09	11.25±0.35	73.75^{b}±1.34	3.57±0.10	25.20^{ab} ±2.75
	V_2	9.80^{bc}±1.81	125.69^{a}±1.88	2.03±0.35	10.80±1.13	78.35^{ab}±1.06	3.10±0.09	24.02^{ab} ±0.18
P Value		0.03	0.01	0.02	0.40	0.01	0.72	0.04
CV		22.09	11.08	20.30	18.17	15.32	16.49	22.58

***Labled as $p<0.05$ and *** labled as $p<0.01$. NS = non-significant; CV= Coefficient of Variance, Means with different superscripts in a column differ significantly. (T_0= Control), (T_1= Cow Dung), (T_2= Poultry Manure), (T_3= Sheep Manure). (V_1= Napier 4th Generation, V_2= Red Napier)*

Table 3. Correlation matrix of growth parameters of BLRI Napier-4 and Red Napier grass genotype at 130 DAP

Parameters of 130 DAP	**Tiller Number**	**Plant Height (cm)**	**Stem Diameter (cm)**	**Leaf Number**	**Leaf Length (cm)**	**Leaf Width (cm)**	**Biomass ($t\ ha^{-1}$)**
Tiller Number	1.00						
Plant Height (cm)	0.60^{**}	1.00					
Stem Diameter (cm)	0.62^{***}	0.59^{**}	1.00				
Leaf Number	0.76^{***}	0.75^{***}	0.31^{ab}	1.00			
Leaf Length (cm)	0.51^{**}	0.77^{***}	0.16^{ab}	0.75^{***}	1.00		
Leaf Width (cm)	0.83^{***}	0.82^{***}	0.55^{**}	0.88^{***}	0.78^{***}	1.00	
Biomass ($t\ ha^{-1}$)	0.63^{***}	0.88^{***}	0.69^{***}	0.78^{***}	0.59^{**}	0.83^{***}	1.00

** indicates $p<0.05$; *** indicates $p<0.01$ and ab indicates $p>0.05$ (non significant)

The results of Pearson's correlation coefficients analysis among the growth parameters of BLRI Napier-4 and Red Napier grass genotype at 130 DAP are presented in Table 3. Highly significant ($p<0.01$) association was found among tiller number and stem diameter (r = 0.62***), leaf number (r =0.76***), leaf width (0.83***), biomass(r = 0.63***), Highly significant ($p<0.01$) association was also found among plant height with leaf number (r = 0.75***), leaf length (r= 0.77***), leaf width (r = 0.82***), biomass (r = 0.88***), Highly significant ($p<0.01$) association was found between stem diameter and biomass (r = 0.69***). Highly significant ($p<0.01$) association was found among leaf number and leaf length (r = 0.75***), leaf width (r = 0.88***) and biomass (r = 0.78***) and leaf length and leaf width (r = 0.78***) and leaf width and biomass (r = 0.83***). Significant ($p<0.05$) association was found between tiller number and plant height (r = 0.60**), leaf length (r = 0.51**), between plant height and stem diameter (r = 0.59**), stem diameter and leaf width (r = 0.55**) leaf length and biomass (r =0.59**).

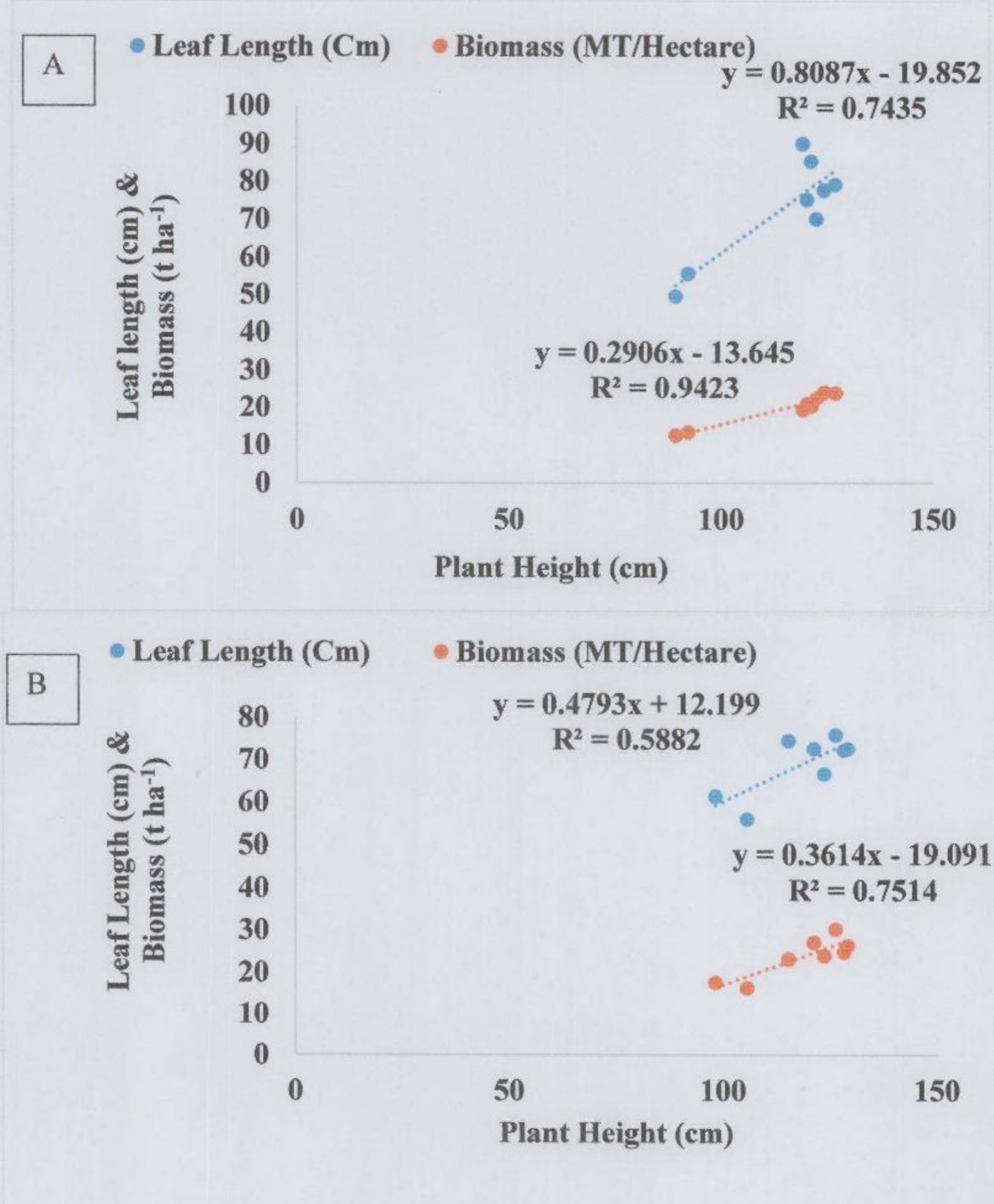


Figure 16: Relationship between Plant Height (cm) and Leaf Length (cm), Biomass (t ha^{-1}) of BLRI Napier-4 (A) and Red Napier grass (B) at 130 DAP.

Regression coefficient between plant height (cm) and leaf length (cm), biomass (t ha^{-1}) of BLRI Napier-4 and Red Napier grass at 130 DAP were stated in Figure 16. It is explained that there was highly positive relationship between plant height and leaf length (R^2 = 0.5882), plant height and biomass (R^2 = 0.7514) at BLRI Napier-4 and also was highly positive correlation between plant height and leaf length (R^2 = 0.7435), plant height and biomass (R^2 = 0.9423) at Red Napier grass.

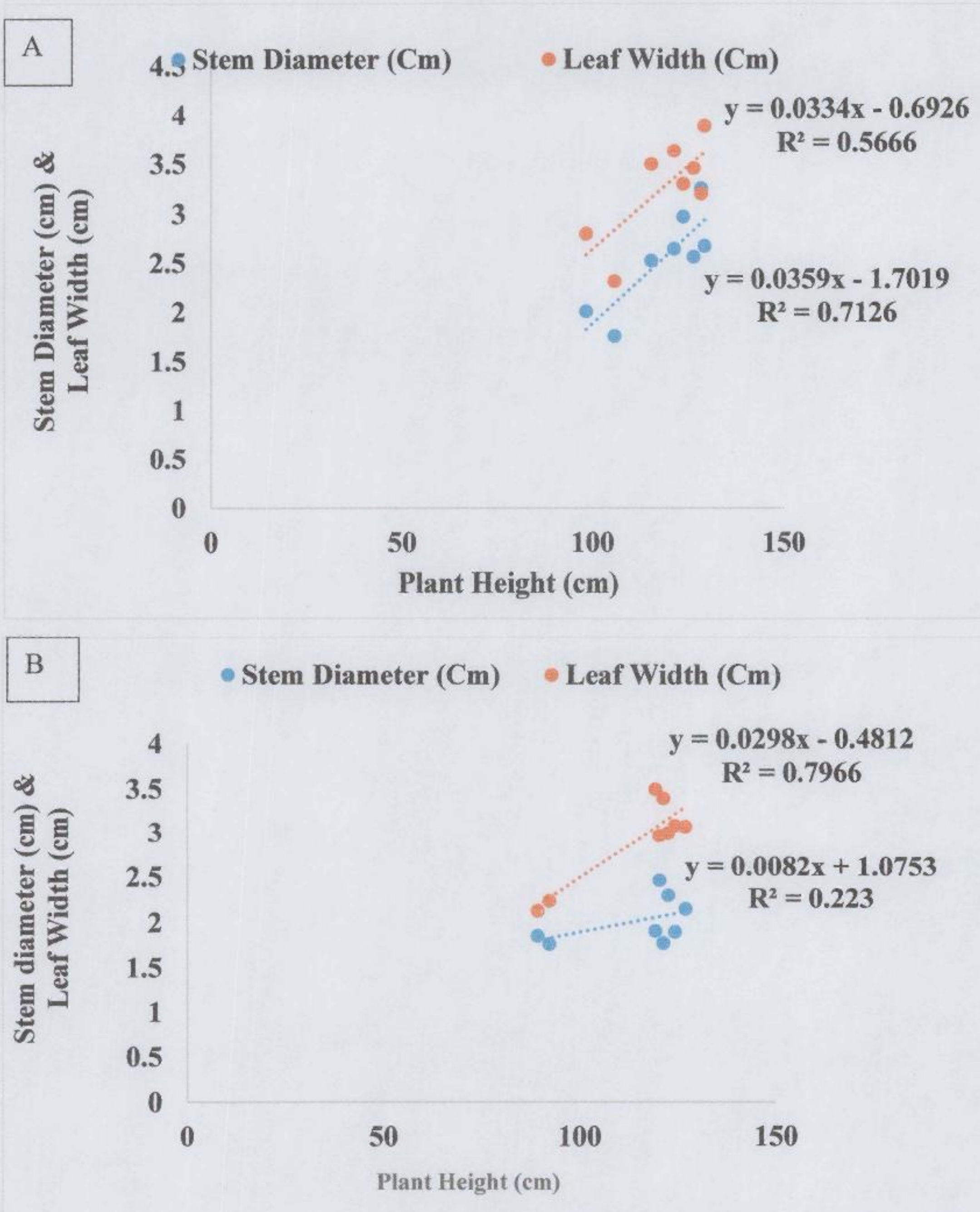


Figure 17: Relationship between Plant Height (cm) and Stem Diameter (cm), Leaf Width (cm) of BLRI Napier-4 (A) and Red Napier grass (B) at 130 DAP.

Regression coefficient between plant height (cm) and stem diameter (cm), leaf width (cm) of BLRI Napier-4 and Red Napier grass at 130 DAP were stated in Figure 17. It is explained that there was highly positive relationship between plant height and stem diameter (R^2 = 0.7126), plant height and leaf width (R^2 = 0.5666) at BLRI Napier-4 and also was highly positive correlation between plant height and stem diameter (R^2 = 0.223), plant height and leaf width (R^2 = 0.7966) at Red Napier grass.

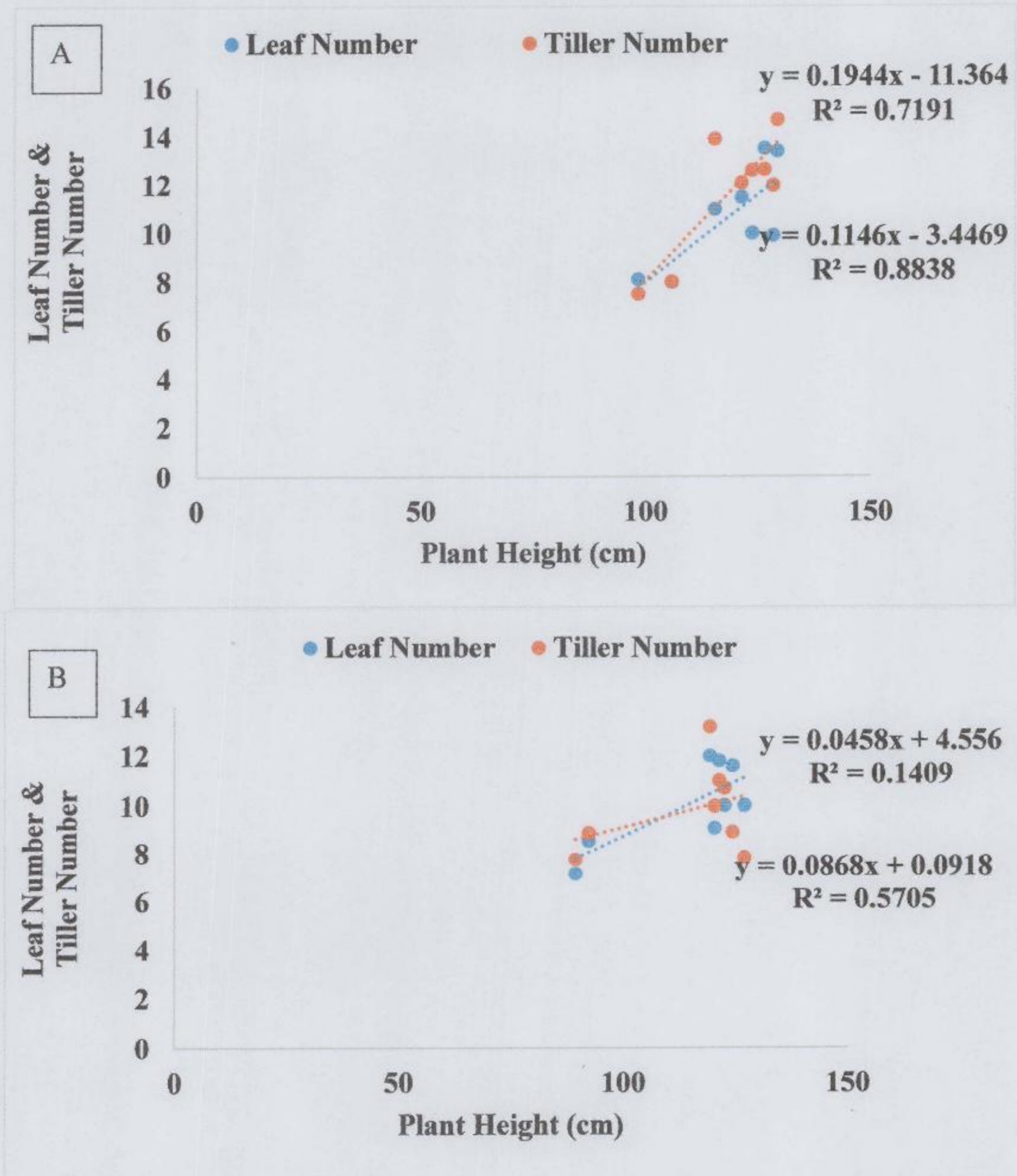


Figure 18: Relationship between Plant Height (cm) and Leaf Number, Tiller Number of BLRI Napier-4 (A) and Red Napier grass (B) at 130 DAP.

Regression coefficient between plant height (cm) and leaf number, tiller number of BLRI Napier-4 and Red Napier grass at 130 DAP were stated in Figure 18. It is explained that there was highly positive relation between plant height and leaf number ($R^2 = 0.8838$), plant height and tiller number ($R^2 = 0.7191$) at BLRI Napier-4 and also was highly positive correlation between plant height and leaf number ($R^2 = 0.1409$), plant height and tiller number ($R^2 = 0.5705$) at Red Napier grass.

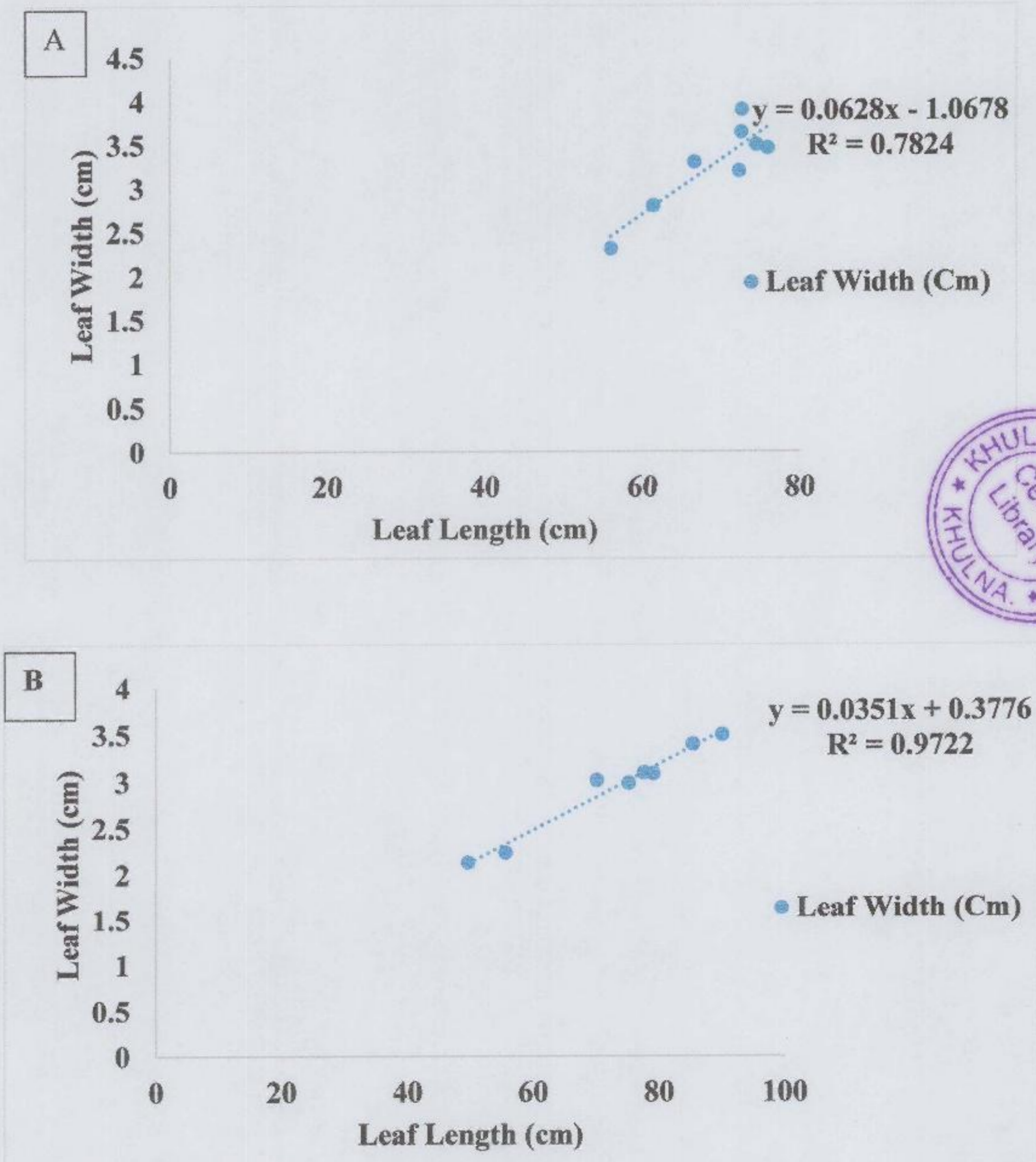


Figure 19: Relationship between Leaf Length (cm) and Leaf Width (cm) of BLRI Napier-4 (A) and Red Napier grass (B) at 130 DAP

Regression coefficient between leaf length (cm) and leaf width (cm) of BLRI Napier-4 and Red Napier grass at 130 DAP were stated in Figure 19. It is explained that there was highly positive relationship between leaf length and leaf width ($R^2 = 0.7824$), at Red Napier also was highly positive relationship between leaf length and leaf width ($R^2 = 0.9722$) at Red Napier grass.

4.2. Growth parameters of two Napier cultivars at 160 DAP.

In Table 4, highest leaf length was found in the interaction effect of T_1V_1 (112.50 cm) and lowest was in T_0V_1 (72.75 cm). The interaction of manure application and cultivars had a highly significant effect (p<0.001) on leaf length of forage cultivars. Highest biomass was found in the interaction effect of T_1V_1 (42.86 t ha^{-1}) and lowest was in T_0V_2 (16.97 t ha^{-1}) which had a highly significant effect (p<0.008) on biomass of forage cultivars. Highest plant height was found in the interaction effect of T_1V_1 (151.96 cm) and lowest was in T_0V_2 (107.02 cm). The effect of manure application and cultivars had a significant effect (p<0.041) on plant height of forage cultivars. Highest stem diameter was found in the interaction effect of T_2V_1 (3.77cm) and lowest was in T_0V_2 (2.11cm) which was significantly (p<0.043) affected. Highest tiller number was found in the interaction effect of T_1V_1 (15.14) and lowest was in T_0V_1 (9.03) and had no significant effect on tiller number of forage cultivars. Highest leaf number was found in the interaction effect of T_1V_1 (15.00) and lowest was in T_0V_1 (9.30) which had no significant effect on leaf number of forage cultivars. Highest leaf width was found in the interaction effect of T_1V_1 (5.56cm) and lowest was in T_0V_2 (3.15cm). The interaction of manure application and cultivars had no significant effect (p<0.999) on leaf width of forage cultivars. Plant height, stem diameter, leaf length and biomass yield demonstrated significance differences (p>0.05) except tiller number, leaf number and leaf width among the treatments at 160 DAP.

According to Ahmed *et al.* (2021) the effects of cultivar and cutting period were significant on plant height and leaves per tiller, where highest plant height (p<0.01) and leaves per tiller (p<0.05) were produced by Napier hybrid-3 and also found that basal circumference, number of tiller, tiller diameter, and diameter of lowest node had no significant effect which is relevent with the findings of this study. Islam *et al.* (2010) revealed that Maize plant height and stem circumference were significantly ($p < 0.01$) influenced by increasing the rate of biogas slurry. In case of biomass yield, our result agreed with the result of Islam *et. al.* (2017). Islam *et al.* (2017) stated that the maximum biomass yield (mt/ha) was observed in layer litter ($16.67^{a}\pm$ 0.89) followed by broiler litter ($10.05^{bc}\pm0.10$), biogas slurry ($08.97^{bc}\pm0.99$) and control group ($06.65^{c}\pm0.90$; respectively. Islam *et al.,* (2010) stated that Poultry liter and biogas slurry increased biomass yield of Maize fodder (*Zea mays*).

The findings collectively emphasize the significant benefits of organic treatments, especially Cow dung and Poultry Manure, in enhancing key agronomic characteristics such as tiller number, plant height, stem diameter, leaf length, and biomass yield in both Napier grass varieties. These results hold promising implications for agricultural practices aiming to improve forage production and contribute to more sustainable and efficient farming methods. However, the non-significant differences observed in leaf number suggest the need for further investigation or a longer study duration to better understand the impact of treatments on this particular parameter.

The effects of organic fertilizers on morphological characteristics of two Napier cultivars at 130 DAP respectively.

Table 4. Growth parameters of BLRI Napier-4 and Red Napier grass genotype at 160 DAP.

Treatment	**Variety**			(Mean ± SE) Parameters at 160 DAP				
		Tiller Number	**Plant Height (cm)**	**Stem Diameter (cm)**	**Leaf Number**	**Leaf Length (cm)**	**Leaf Width (cm)**	**Biomass t ha^{-1}**
T_0	V_1	9.03±0.50	110.36^{c}±1.41	2.37^{c}±0.44	9.30±0.28	72.75^{d}±3.61	3.35±0.07	21.41^{de}±1.48
	V_2	9.64±0.87	107.02^{c}±0.90	2.11^{c}±0.07	9.65±0.21	92.62^{c}±4.22	3.15±0.07	16.97^{e}±0.97
T_1	V1	15.14±0.76	151.96^{a}±2.32	3.28^{ab}±0.18	15.00±0.00	112.50^{a}±3.54	5.56±0.08	42.86^{a}±3.54
	V_2	14.26±0.42	132.97^{b}±3.78	2.82^{bc}±0.01	13.90±0.14	103.45^{ab}±0.07	5.37±0.06	24.63^{de}±1.41
T_2	V_1	12.70±1.27	145.31^{ab}±4.16	3.77^{a}±0.30	12.35±0.07	100.00^{bc}±0.57	4.03±0.28	33.55^{bc}±2.97
	V_2	12.20±0.85	133.35^{b}±6.07	2.68^{bc}±0.16	11.25±0.49	100.55^{bc}±1.20	4.08±0.04	26.28^{cd}±0.95
T_3	V_1	14.15±0.71	151.81^{a}±5.03	3.54^{ab}±0.15	13.70±0.42	101.90^{bc}±0.14	4.94±0.11	34.96^{b}±1.85
	V_2	11.86±1.00	131.38^{b}±3.01	2.39^{c}±0.07	12.85±0.92	101.10_{bc}±0.14	4.74±0.33	26.81^{cd}±2.04
P Value		0.19	0.04	0.04	0.12	<0.001	0.99	0.01
CV		17.77	12.61	20.92	16.31	11.56	19.41	28.63

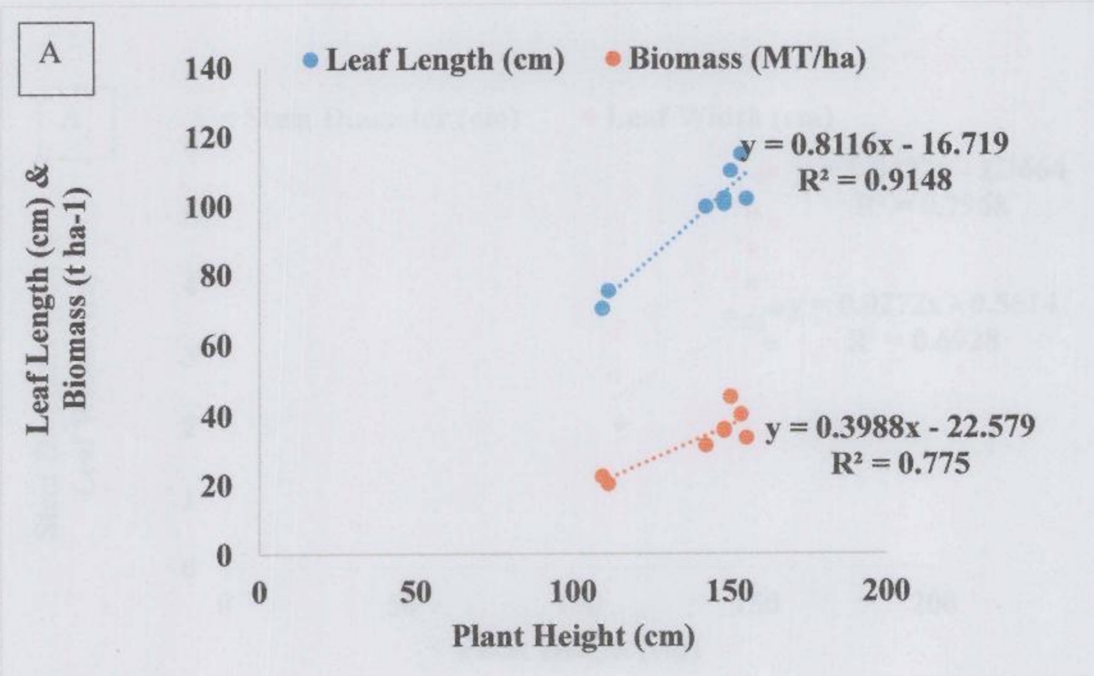
***Labled as $p<0.05$ and *** labled as $p<0.01$. NS = non-significant; CV= Coefficient of Variance, Means with different superscripts in a column differ significantly. (T_0= Control), (T_1= Cow Dung), (T_2= Poultry Manure), (T_3= Sheep Manure). (V_1= Napier 4th Generation, V_2= Red Napier)*

Table 5. Correlation matrix of growth parameters of BLRI Napier-4 and Red Napier grass genotype at 160 DAP.

Parameters at 160 DAP	**Tiller Number**	**Plant Height (cm)**	**Stem Diameter (cm)**	**Leaf Number**	**Leaf Length (cm)**	**Leaf Width (cm)**	**Biomass t ha^{-1}**
Tiller Number	1.00						
Plant Height (cm)	0.84^{***}	1.00					
Stem Diameter (cm)	0.62^{**}	0.84^{***}	1.00				
Leaf Number	0.91^{***}	0.84^{***}	0.62^{**}	1.00			
Leaf Length (cm)	0.81^{***}	0.76^{***}	0.46^{ab}	0.84^{***}	1.00		
Leaf Width (cm)	0.87^{***}	0.81^{***}	0.54^{**}	0.95^{***}	0.79^{***}	1.00	
Biomass t ha^{-1}	0.76^{***}	0.89^{***}	0.80^{***}	0.79^{***}	0.65^{***}	0.72^{***}	1.00

** indicates $p<0.05$; *** indicates $p<0.01$ and ab indicates $p>0.05$ (non significant)

The results of Pearson's correlation coefficients analysis among the growth parameters of BLRI Napier-4 and Red Napier grass genotype at 160 DAP are presented in Table 5. Highly significant (p<0.01) association was found among tiller number and plant height (r = 0.84***), leaf number (r =0.91***), leaf length (r = 0.81***), leaf width (0.87***), biomass (r = 0.76***), highly significant (p<0.01) association was also found among plant height with stem diameter (r = 0.84***), leaf number (r = 0.84***), leaf length (r= 0.76***), leaf width (r = 0.81***), biomass (r = 0.89***), Highly significant (p<0.01) association was found between stem· diameter and biomass (r = 0.80***). Highly significant (p<0.01) association was found among leaf number and leaf length (r = 0.84***), leaf width (r = 0.95***), biomass (r = 0.79***) and leaf length and leaf width (r = 0.79***), biomass (r = 0.65***), and leaf width and biomass (r = 0.72***). Significant (p<0.05) association was found between tiller number and stem diameter (r = 0.62**), between stem diameter and leaf number (r = 0.62**), leaf width (r = 0.54**).



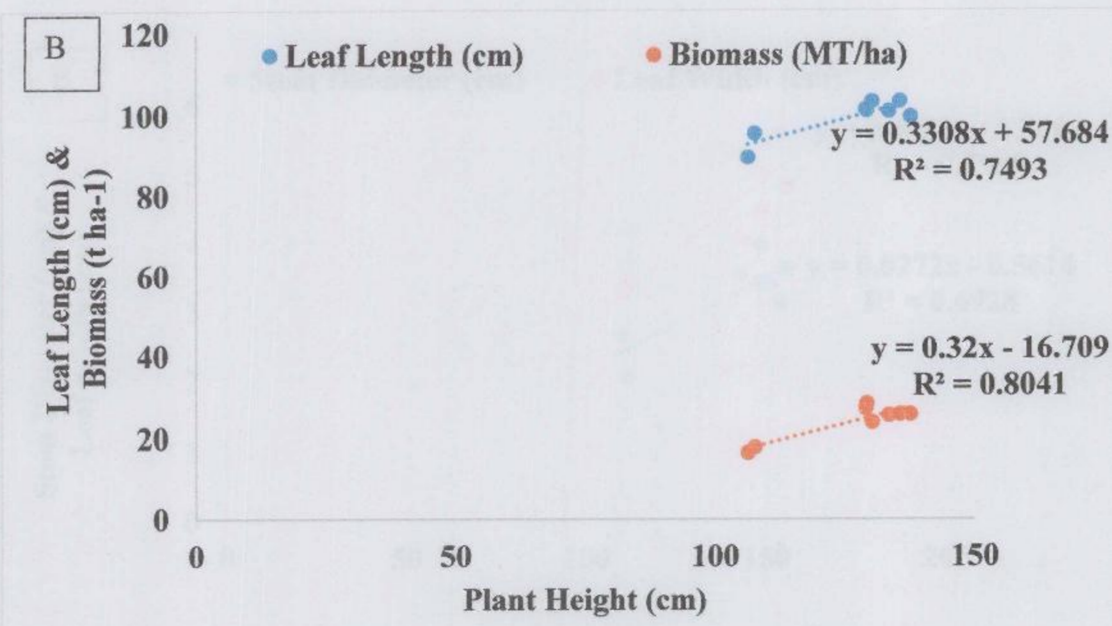


Figure 20: Relationship between plant height (cm) and leaf length (cm), biomass (t ha^{-1}) of BLRI Napier-4 (A) and Red Napier grass (B) at 160 DAP.

Regression coefficient between plant height (cm) and leaf length (cm), biomass (t ha^{-1}) of BLRI Napier-4 and Red napier grass at 160 DAP were stated in Figure 6. It is explained that there was highly positive relationship between plant height and leaf length (R^2 = 0.9148), plant height and biomass (R^2 = 0.775) at BLRI Napier-4 and also was highly positive relationship between plant height and leaf length (R^2 = 0.7493), plant height and biomass (R^2 = 0.98041) at Red Napier grass.

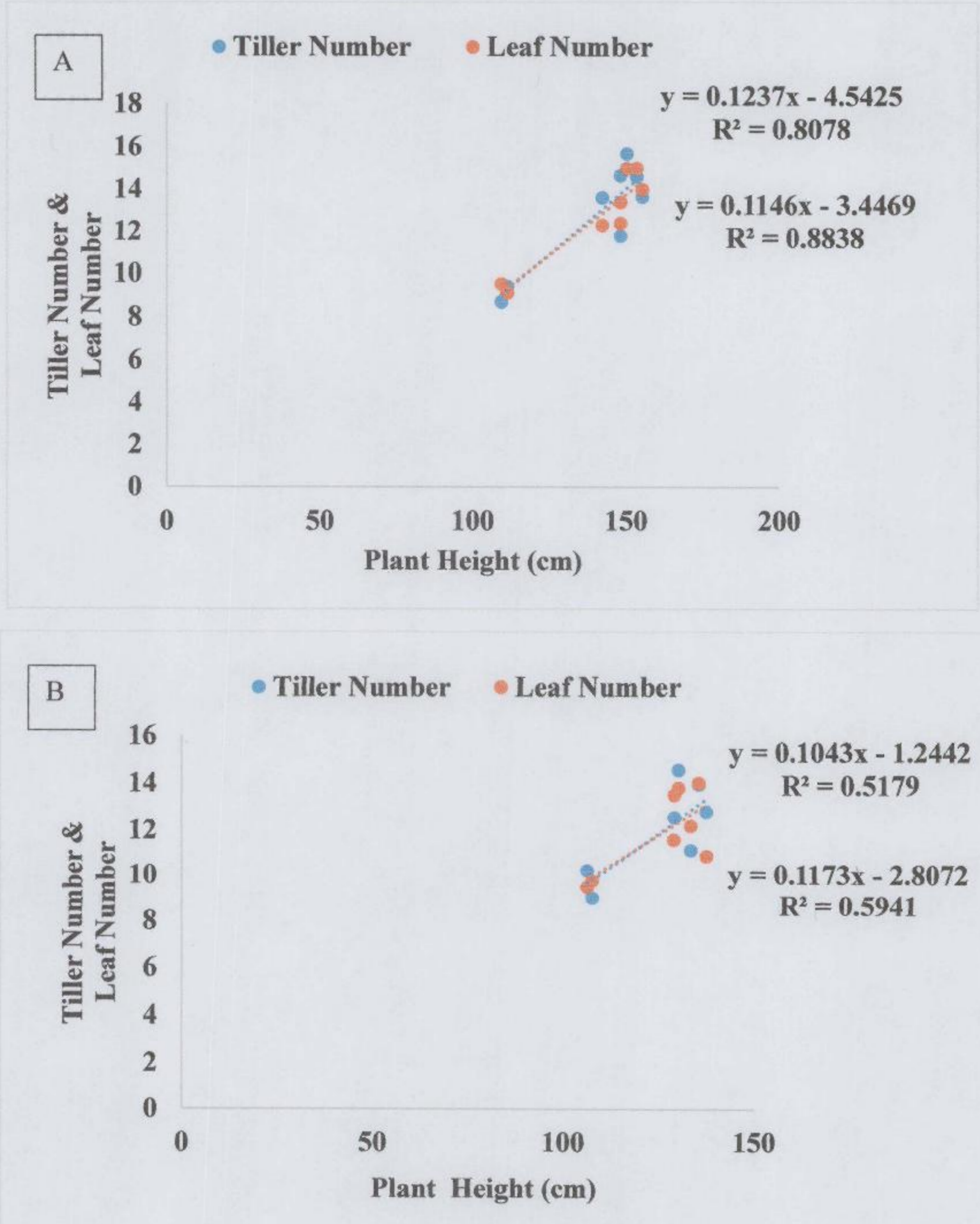


Figure 22: Relationship between Plant Height (cm) and Leaf Number, Tiller Number of BLRI Napier-4 (A) and Red Napier grass (B) at 160 DAP.

Regression coefficient between plant height (cm) and leaf number, tiller number of BLRI Napier-4 and Red Napier grass at 160 DAP were stated in Figure 22. It is explained that there was highly positive relationship between plant height and leaf number ($R^2 = 0.8838$), plant height and tiller number ($R^2 = 0.8078$) at BLRI Napier-4 and also was highly positive relationship between plant height and leaf number ($R^2 = 0.5179$), plant height and tiller number ($R^2 = 0.5941$) at Red Napier grass.

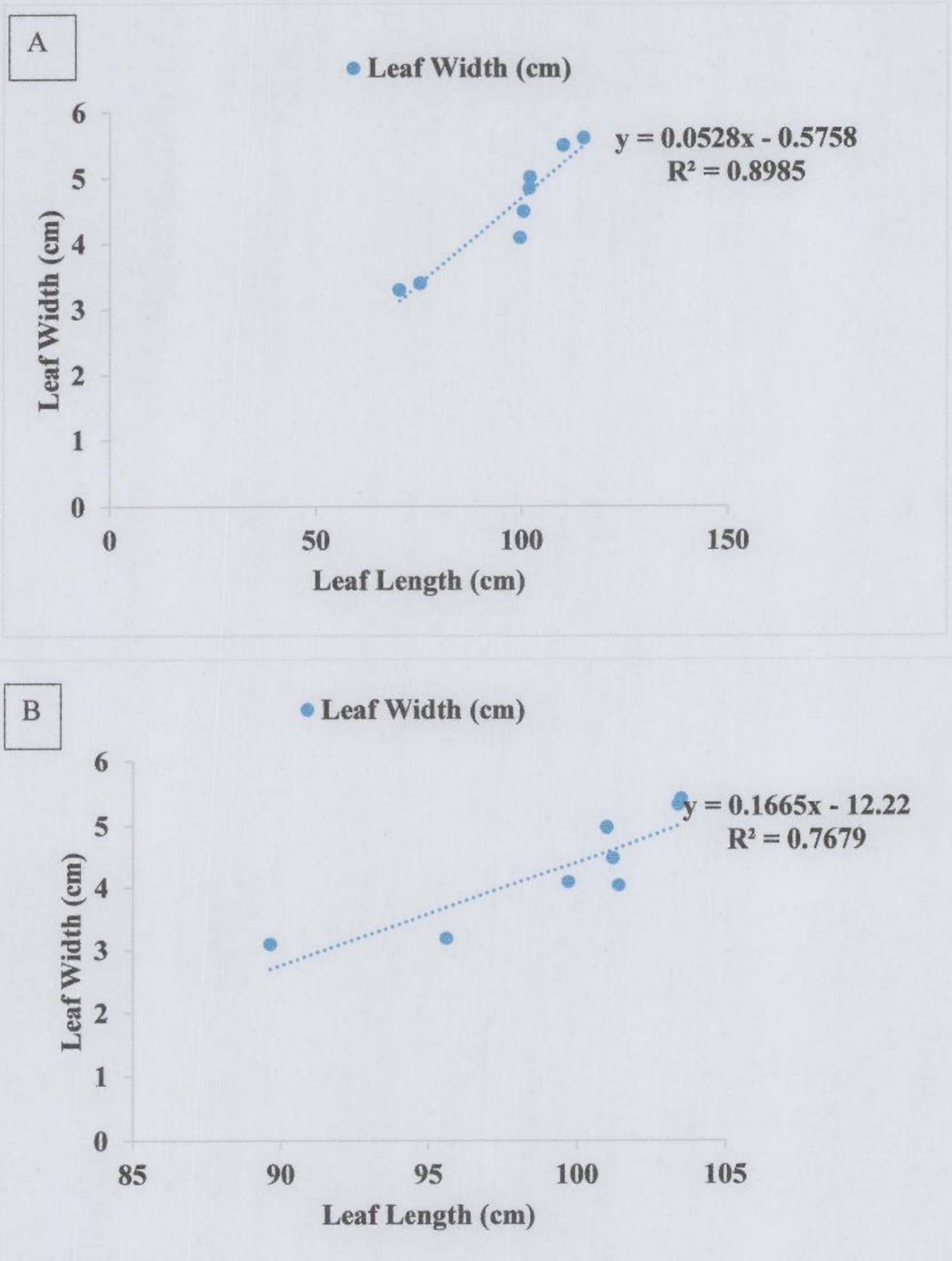


Figure 23: Relationship between Leaf length (cm) and Leaf width (cm) of BLRI Napier-4 (A) and Red Napier grass (B) at 160 DAP.

Regression coefficient between leaf length (cm) and leaf width (cm) of BLRI Napier-4 and Red napier grass at 160 DAP were stated in Figure 23. It is explained that there was highly positive relationship between leaf length and leaf width ($R^2 = 0.8985$), at BLRI Napier-4 and also was highly positive relationship between leaf length and leaf width ($R^2 = 0.7679$) at Red Napier grass.

4.3. Nutritional Composition of forage at 130 DAP.

In this study, the effects of different sources of organic manure on nutritional parameters of stem of two types of Napier grass, BLRI Napier-4 and Red Napier. Highly significant ($p<0.028$) fat % at stem of Napier cultivers forage varied between 0.13 to 1.78% respectively (table.6) among the treatments at 130 DAP. The highest value of fat% was obtained at T_1V_2 (1.78). In this study showed significant differences ($P<0.05$) in fat (%), while moisture, DM (%), CF (%), ash (%) and CF (%) did not exhibit significant difference ($p>0.05$) among the treatments at 60 days after planting. No significant ($p>0.05$) effect was found on crude protein (CP) at 130 DAP, where the highest value of CP was 4.6% at T_3V_2. The effects of organic fertilizers on morphological characteristics of two napier cultivars at 130 DAP are presented in Table 6 respectively.

Table 6. Proximate composition at Stem of BLRI Napier-4 and Red Napier grass genotype at 130 DAP.

Treatment	Variety	(Mean ± SE) Parameters at 130 DAP					
		Moisture (%)	Dry Matter (%)	Crude Protein (%)	Ash (%)	Fat (%)	Crude Fiber (%)
T_0	V_1	92.90±1.48	7.10±1.47	2.35±0.73	16.08±3.81	0.13^{b} ±0.09	25.50±0.71
	V_2	88.19±0.85	11.81±0.84	3.14±0.01	18.31±2.13	0.18^{b} ±0.12	25.50±0.71
T_1	V_1	91.56±4.43	8.45±4.43	2.71±0.12	17.73±0.45	0.60^{b} ±0.42	27.75±1.06
	V_2	94.37±2.42	5.63±2.42	2.66±0.57	15.88±0.45	1.78^{a} ±0.21	27.50±0.71
T_2	V_1	90.41±2.99	9.59±2.998	2.84±0.93	18.14±0.64	0.84^{ab}±0.26	27.80±1.31
	V_2	93.21±1.68	6.74±1.76	3.49±0.97	18.51±0.17	1.08^{ab} ±0.2	27.85±0.21
T_3	V_1	92.89±0.49	7.11±0.49	3.54±0.42	18.85±1.42	0.50^{b} ±0.24	27.45±0.64
	V_2	92.51±1.75	7.50±1.75	4.6±0.14	18.26±2.11	0.67^{b} ±0.00	27.60±0.57
P Value		0.15	0.15	0.62	0.48	0.03	0.98
CV		2.75	31.70	25.72	9.66	74.36	4.14

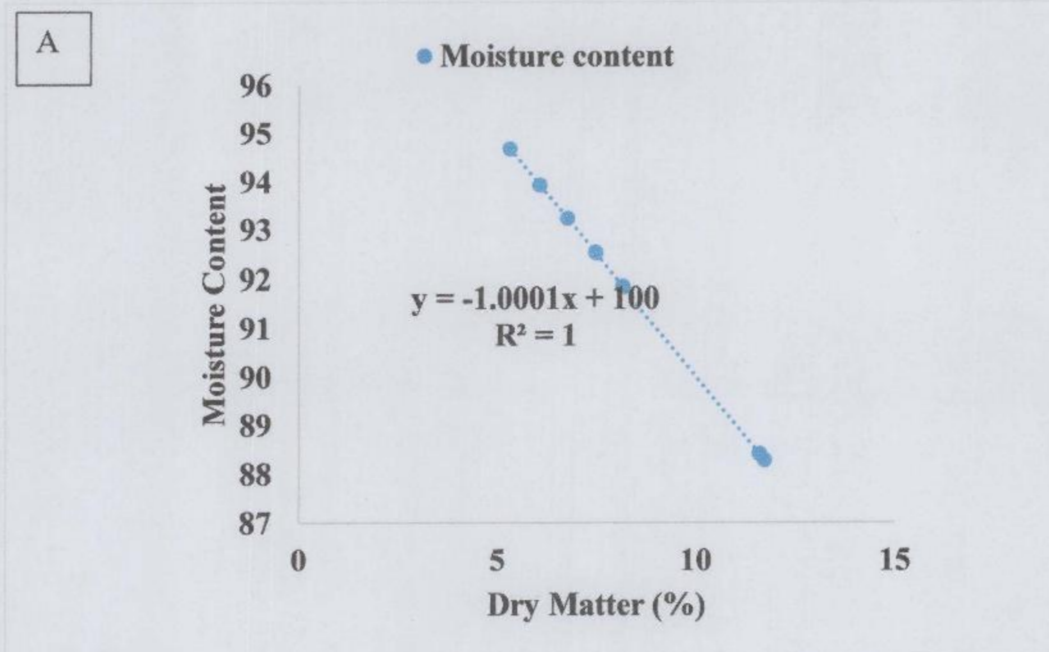
***Labled as $p<0.05$ and *** labled as $p<0.01$. NS = non-significant; CV= Coefficient of Variance, Means with different superscripts in a column differ significantly. (T_0= Control), (T_1= Cow Dung), (T_2= Poultry Manure), (T_3= Sheep Manure). (V_1= BLRI Napier-4, V_2= Red Napier)*

Table 7. Correlation matrix of Nutritional parameters of BLRI Napier-4 and Red Napier grass genotype at 130 DAP

Parameters at 130 DAP	Moisture (%)	Dry Matter (%)	Crude Protein (%)	Ash (%)	Fat (%)	Crude Fiber(%)
Moisture (%)	1.00					
Dry Matter (%)	-1.00	1.00				
Crude Protein (%)	0.04	-0.04	1.00			
Ash (%)	-0.43	0.43	0.64**	1.00		
Fat (%)	0.57**	-0.57	-0.02	-0.30	1.00	
Crude Fiber(%)	0.42	-0.42	0.34	0.32	0.64**	1.00

** indicates $p<0.05$; *** indicates $p<0.01$ and ab indicates $p>0.05$ (non significant)

The results of Pearson's correlation coefficients analys is among the nutritional parameters of BLRI Napier-4 and Red napier grass genotype at 130 DAPare presented in Table 7. Significant ($p<0.05$) association was found between moisture (%) and Fat (%), and between CP (%) and Ash (%) and also found between Fat (%) and CF (%).



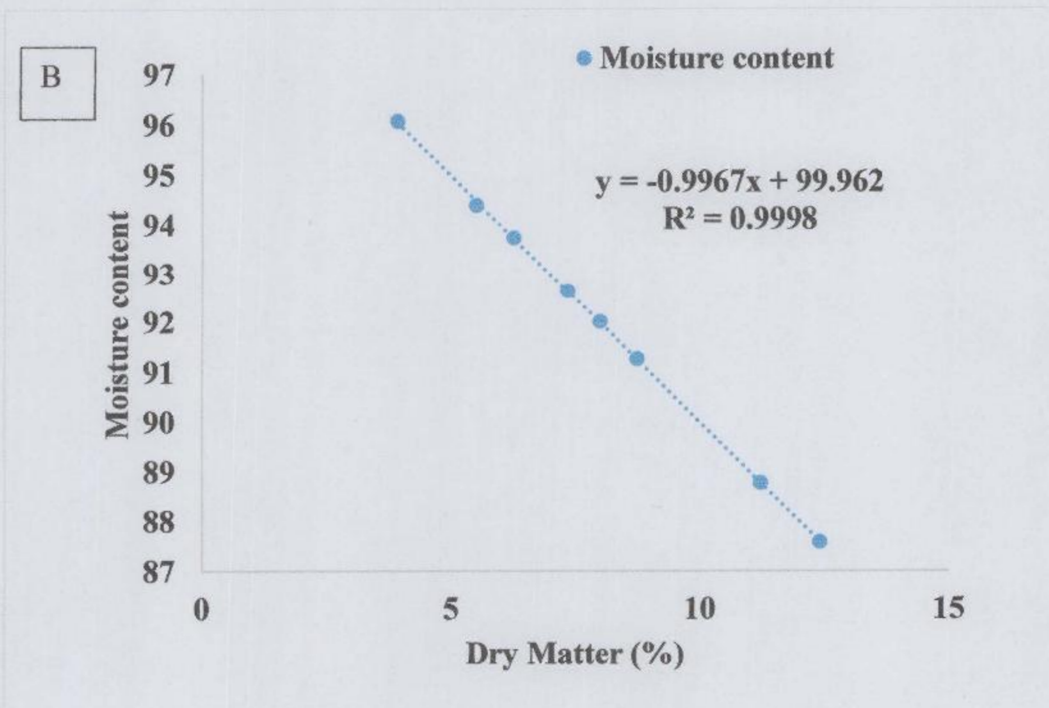


Figure 24: Relationship between dry matter (%) and moisture content of BLRI Napier-4 (A) and Red Napier grass (B) at 130 DAP.

Regression coefficient between dry matter and moisture, dry matter and crude protein were stated in Figure 24. It is explained that at BLRI Napier-4 moisture content ($R^2 = 1$) and at Red Napier moisture content ($R^2 = 0.9998$) were highly positive correlated with dry matter. It could be expressed that if dry matter increased, the moisture would also be increased.

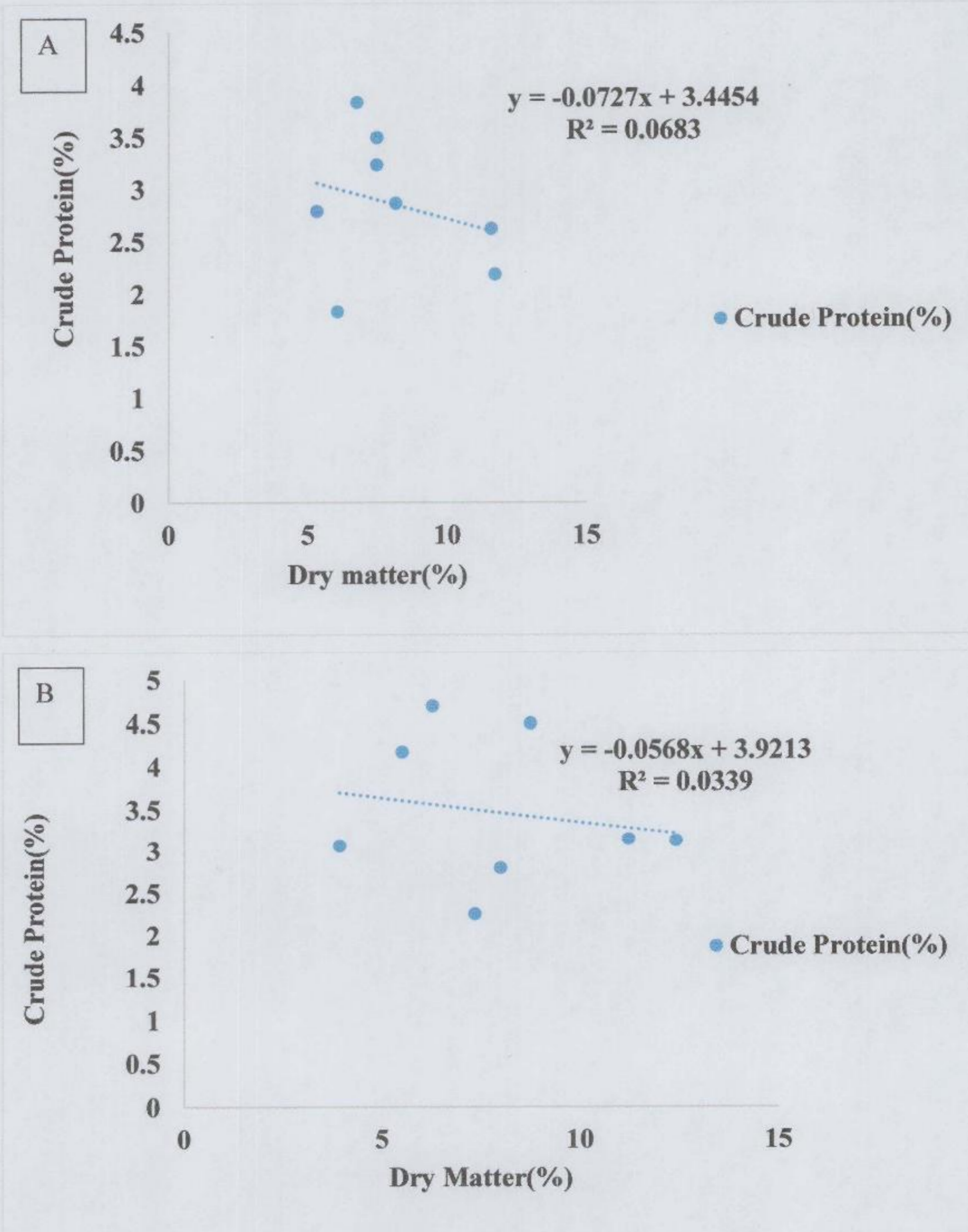
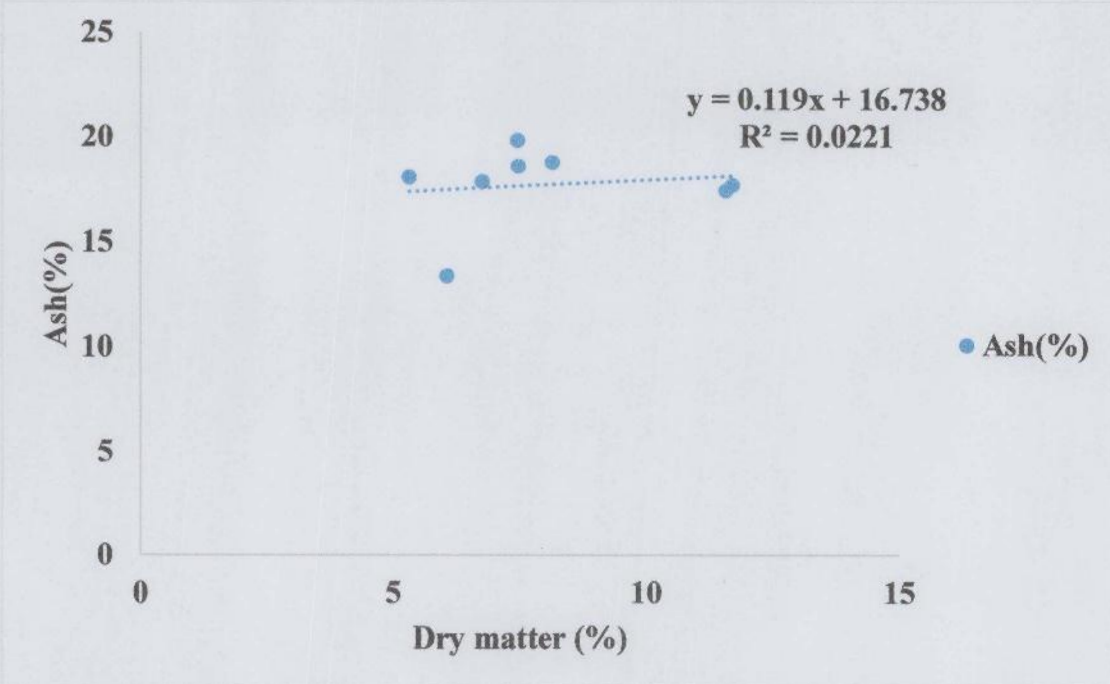


Figure 25: Relationship between Dry Matter (%) and Crude Protein (%) of BLRI Napier-4 (A) and Red Napier grass (B) at 130 DAP.

Regression coefficient between dry matter and crude protein were stated in Figure 25. It is explained that at crude protein at BLRI Napier-4 (R^2= 0.0683) and Red Napier grass (R^2 = 0.0339) were positively correlated with dry matter. It could be expressed that if dry matter increased, the crude protein would also be increased.



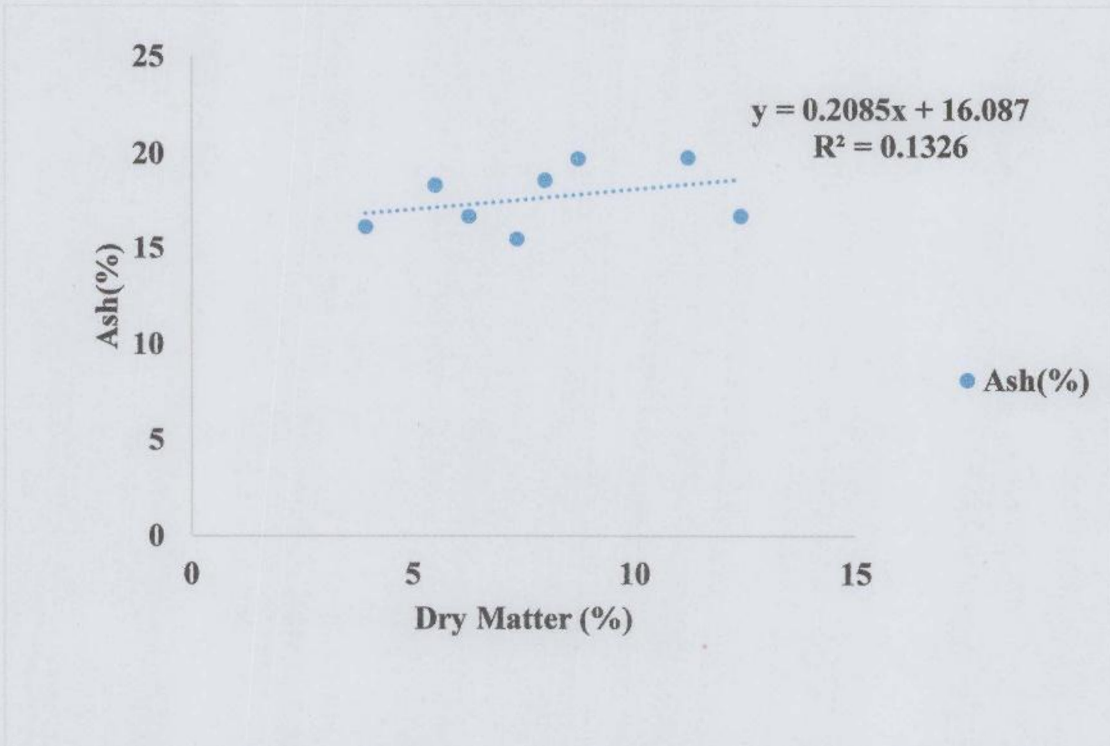


Figure 26: Relationship between Dry Matter (%) and Ash (%) of BLRI Napier-4 (A) and Red Napier grass (B) at 130 DAP.

Regression coefficient between dry matter and ash (%) were stated in Figure 12. It is explained from the Figure 12. that at BLRI Napier-4 ash (%) ($R^2 = 0.0221$) and at Red Napier ash (%) ($R^2 = 0.1326$) were positive correlated with dry matter. It could be expressed that if dry matter increased, the ash (%) would also be increased.

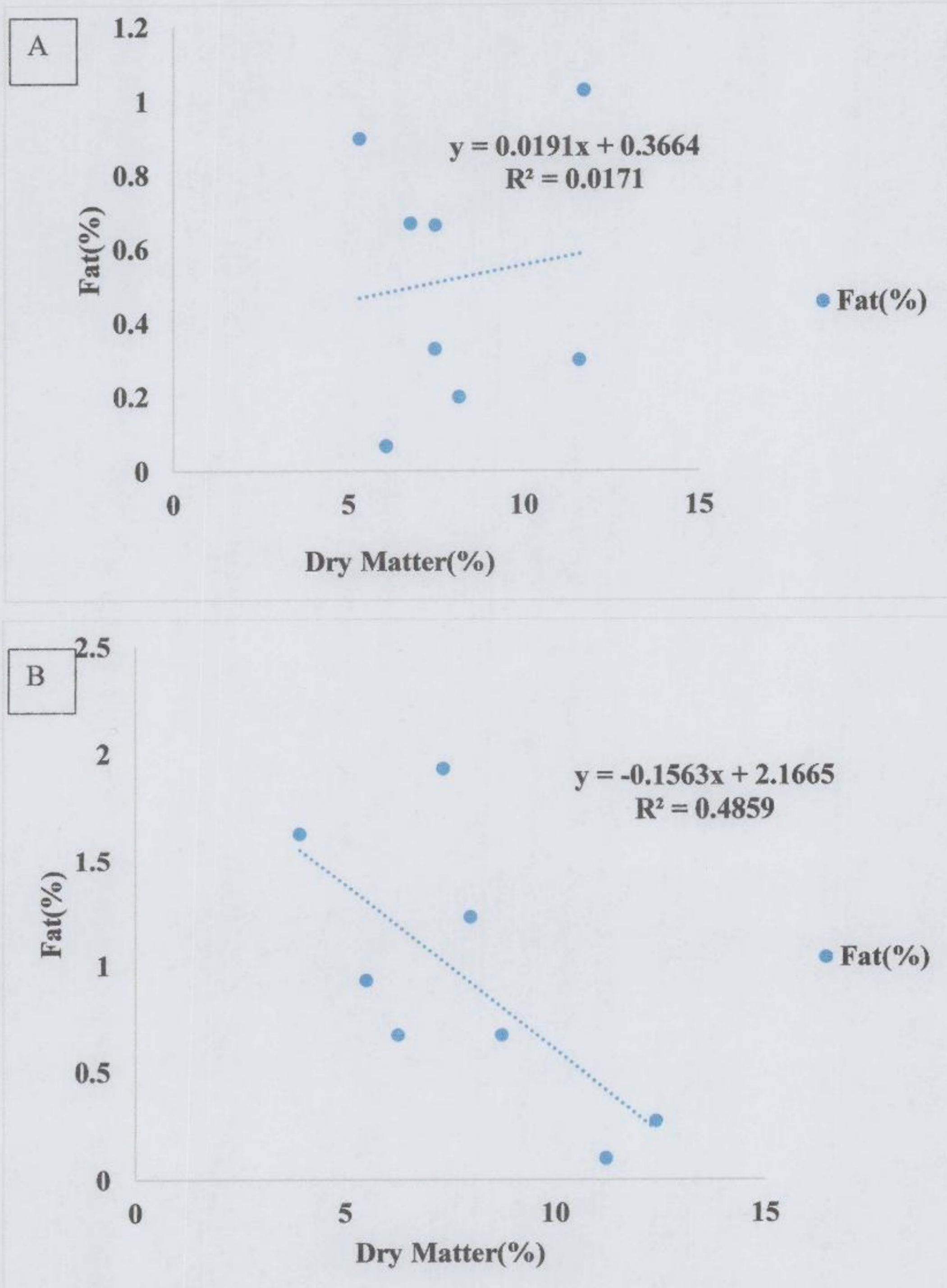
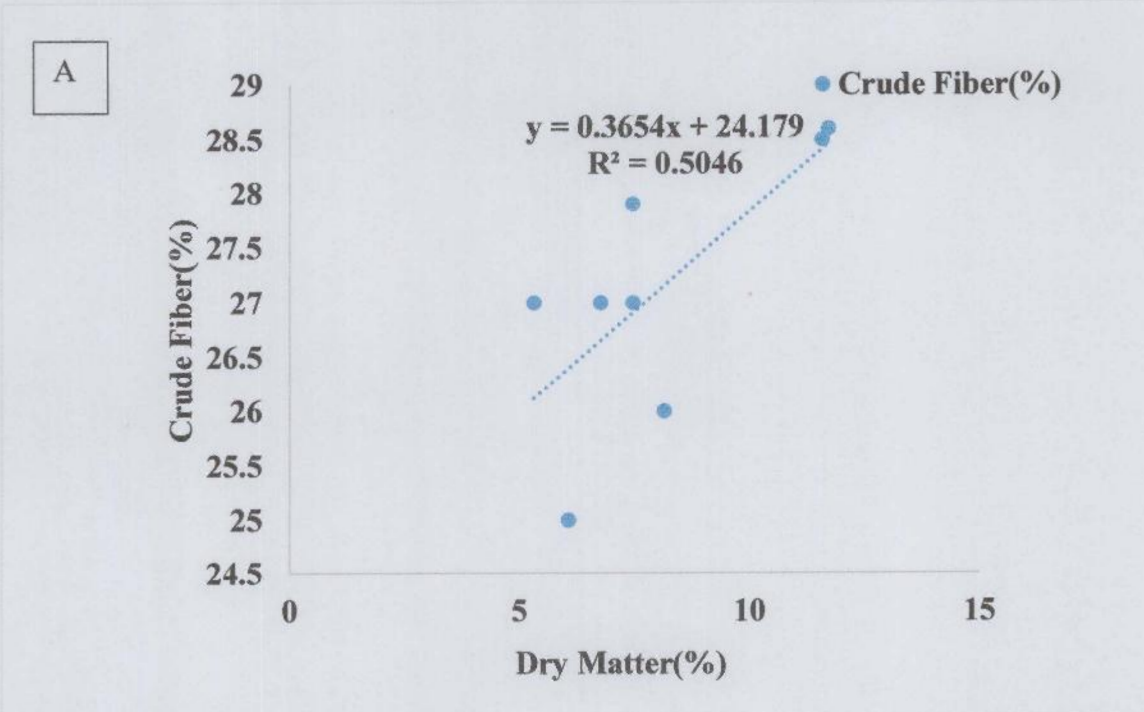


Figure 27: Relationship between Dry Matter (%) and Fat (%) of BLRI Napier-4 (A) and Red Napier grass (B) at 130 DAP.

Regression coefficient between dry matter and fat (%) were stated in Figure 27. It is explained that at BLRI Napier-4 fat (%) (R^2 = 0.0171) and at Red Napier fat (%) (R^2= 0.4859) had positive relationship with dry matter. It could be expressed that if dry matter increased, the fat (%) would also be increased.



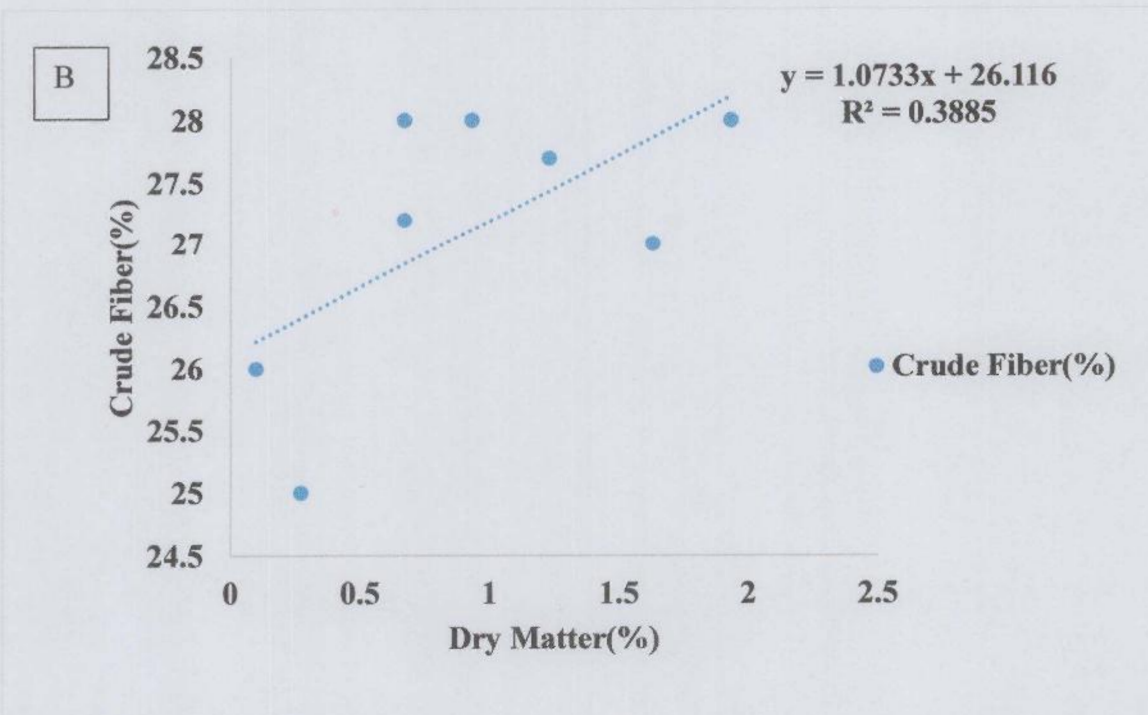


Figure 28: Relationship between dry matter (%) and crude fiber (%) of BLRI Napier-4 (A) and Red Napier grass (B) at 130 DAP

Regression coefficient between dry matter and crude fiber (%) were stated in Figure 27. It is explained that at BLRI Napier-4 CF (%) (R^2 = 0.5046) and at Red Napier CF (%) (R^2= 0.3885) were positive correlated with dry matter. It could be expressed that if dry matter increased, the CF (%) would also be increased.

Table 8. Correlation matrix with nutritional and agronomic at 130 DAP.

Parameters at 130 DAP	Moisture	Dry Matter	Crude Protein	Ash	Fat	Crude Fiber	Tiller Number	Plant Height (cm)	Stem Diameter (cm))	Leaf Number	Leaf Length (cm)	Leaf Width (cm)	Biomas t ha^{-1}
Moisture	1.00												
Dry Matter	-1.00	1.00											
Crude Protein	0.21	-0.21	1.00										
Ash	-0.25	0.25	0.47	1.00									
Fat	0.41	-0.41	-0.07	-0.20	1.00								
Crude Fiber	0.00	-0.01	0.16	0.34	0.50	1.00							
Titter Number	0.14	-0.14	-0.25	0.08	0.45	0.58	1.00						
Plant Height(cm)	0.37	-0.37	0.28	0.15	0.54	0.79^{***}	0.60	1.00					
Stem Diameter(cm)	-0.04	0.04	-0.01	0.29	0.03	0.50	0.62	0.59^{*}	1.00				
Leaf Number	0.28	-0.28	0.03	-0.11	0.47	0.58	0.76^{**}	0.75^{**}	0.31	1.00			
Leaf Length(cm)	0.52^{*}	-0.52	0.21	-0.17	0.75^{***}	0.67^{*}	0.51	0.77^{**}	0.16	0.75^{**}	1.00		
Leaf Width(cm)	0.45	-0.45	-0.01	-0.08	0.52	0.64	0.83^{***}	0.82^{***}	0.55^{*}	0.88^{***}	0.78^{**}	1.00	
Biomas t ha^{-1}	0.19	-0.19	0.20	0.13	0.20	0.70^{**}	0.63	0.88^{***}	0.69^{**}	0.78^{**}	0.59	0.83^{***}	1.00

** indicates $p<0.05$;*** indicates $p<0.01$ and ab indicates $p>0.05$ (non significant)

The results of Pearson's correlation coefficients analysis among the agronomic growth parameters and nutritional composition of BLRI Napier-4 and Red Napier forage genotype at 130 DAP are presented in Table 13. Highly significant ($p<0.01$) association was found between fat (%) and leaf length (r = 0.75***), CF% and plant height (r = 0.79***), tiller number and leaf width (r = 0.83***), plant height and leaf width (r = 0.82***), biomass (r = 0.88**), leaf number and leaf width (r = 0.88***), leaf width and biomass (r = 0.83***). Significant ($p<0.05$) association was found between CF% and biomass (r = 0.70**), tiller number and leaf number (r = 0.75**), plant height and leaf number (r = 0.75**), leaf length (r = 0.77**). Between leaf number and leaf length (r =0.75**) and biomass (r= 0.78**), leaf length and leaf width (r = 0.78**).

4.4. Nutritional composition of forage at 160 DAP

In Table 9, highest fat % was found in the interaction effect of T_0V_2 (1.66) and lowest was in T_0V_1 (0.27). Effect of manure application and cultivars had a highly significant effect (p<0.011) on fat% of forage cultivars. Highest CF% was found in the interaction effect of T_3V_1 (33.85) and lowest was in T_0V_2 (27.50) which had a highly significant effect (p<0.02) on CF% of forage cultivars. Moisture, dry matter (DM), crude protein (CP) and ash contents at stem of napier cultivars at 160 DAP were non-significant (p>0.05) with the application of different manure application. Highest moisture was found in the interaction effect of T_0V_1 (89.28) and lowest was in T_3V_2 (84.38). The interaction of manure application and cultivars had no significant effect (p<0.28) on moisture of forage cultivars. Highest DM% was found in the interaction effect of T_3V_2 (15.62) and lowest was in T_0V_1 (10.72). Which had no significant effect (p<0.28) on DM% of forage cultivars. Highest ash% was found in the interaction effect of T_0V_2 (22.23) and lowest was in T_2V_1 (15.02). The interaction of manure application and cultivars had no significant effect (p<0.92) on ash% of forage cultivars.
Kozloskiet *et al.* (2005) also noticed that young shoots of Napier grass have high moisture content that decreased with age. Manyawu *et al.* (2003) found that the DM increased in a progressively linear manner, with the age of napier grass. This was similar with the previous findings of Haryani *et al.* (2018) who found that the dry matter of Napier grass increases with the increment of the cutting interval. Dry matter yield generally increases with increasing fertilizer rate and cutting interval (Carvalho *et al.,* 2000). Present study agreed with this findings.
Highest CP% was found in the interaction effect of T_3V_1 (5.85) and lowest was in T_3V_2 (0.66). The interaction of manure application and cultivars had no significant effect (p<0.28) on CP% of forage cultivars. CP % gradually decreased with maturation of the forage cultivers. Ullah *et al.* (2010) found that crude protein content of Elephant grass decreased with longer harvesting intervals which strongly agrees with the present study. Manyawu *et al.* (2003) also found the same gradual reduction of CP level. A comprehensive study by Center was found that CP, CF, and EE yield of Zamboo grass increased with increasing fertilizer dose in the first cut, while in the second cut all other nutrient components except CF decreased.

According to Lounglawan *et al.* (2014), a young plant is characterized by their high protein content, ether extract, and ash, while the maturing plant have high of crude fiber content. Ahmed *et al.* (2021) also found the same pattern of nutritional composition change of forage cultivars for DM. It is consistent with the findings of the present study.

The effects of organic fertilizers on morphological characteristics of two napier cultivars at 130 DAP are presented in table 9 respectively.

Table 9. Proximate composition at Stem of BLRI Napier-4 and Red Napier grass genotype at 160 DAP.

Treatment	Variety	Parameters at 160 DAP (Mean ± SE) Moisture (%)	Dry Matter %)	Crude Protein (%)	Ash (%)	Fat (%)	Crude Fiber (%)
T_0	V_1	89.28±1.90	10.72±1.90	0.97±1.10	18.61±5.11	0.27^a ±0.08	27.90^a ±0.14
	V_2	88.07±1.51	11.94±1.51	2.96±1:3	22.28±3.15	1.66^a ±0.48	27.50^a ±0.71
T_1	V_1	88.33±1.57	11.67±0.90	4.08±2.77	17.77±4.62	1.25^a ±0.35	31.20^a ±0.42
	V_2	88.97±1.40	17.48±7.50	4.63±3.70	19.49±3.99	0.58^a ±0.11	31.90^a ±0.28
T_2	V_1	87.80±0.49	12.21±0.49	5.29±4.99	15.02±0.25	0.33^a ±0.00	33.85^a ±0.77
	V_2	87.26±1.18	12.45±1.61	4.31±5.23	16.29±2.21	1.11^a ±0.78	30.60^a ±0.57
T_3	V_1	88.98±1.82	11.02±1.81	5.85±1.10	18.61±4.89	0.93^a ±0.07	30.50^a ±0.71
	V_2	84.38±3.62	15.62±3.62	0.66±0.06	18.43±5.20	0.58^a ±0.1	30.00^a ±1.41
P Value		0.284	0.284	0.453	0.923	0.011	0.017
CV		2.30	16.80	82.20	19.65	63.70	6.70

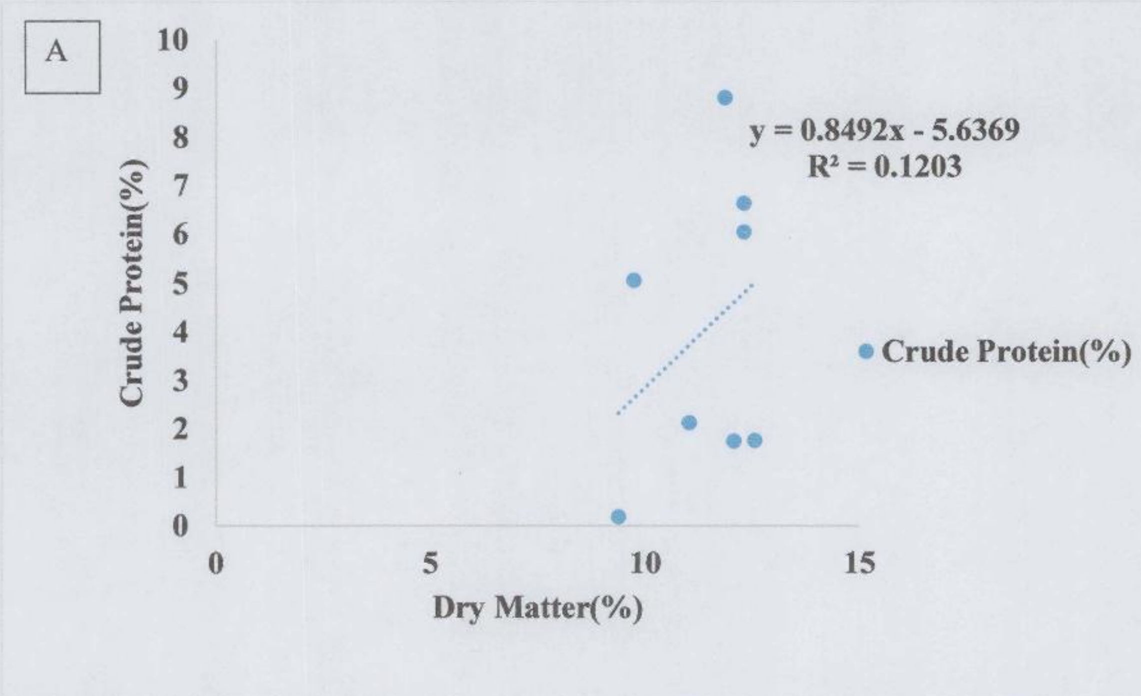
***Labled as $p<0.05$ and *** labled as $p<0.01$. NS = non-significant; CV= Coefficient of Variance {(Standard deviatiom ÷ Mean Value)×100 }, Means with different superscripts in a column differ significantly. (T_0= Control), (T_1= Cow Dung), (T_2= Poultry Manure), (T_3= Sheep Manure). (V_1= BLRI Napier-4, V_2= Red Napier)*

Table 10 . Correlation matrix of Nutritional parameters of BLRI Napier-4 and Red Napier grass genotype at 160 DAP

Parameters at 160 DAP	Moisture (%)	Dry Matter (%)	Crude Protein (%)	Ash (%)	Fat (%)	Crude Fiber(%)
Moisture (%)	1.00					
Dry Matter (%)	-0.29	1.00				
Crude Protein(%)	0.85***	-0.39	1.00			
Ash (%)	0.14	0.16	-0.34	1.00		
Fat (%)	0.24	-0.50	-0.11	0.60**	1.00	
Crude Fiber(%)	0.17	0.15	0.51**	-0.81	-0.80	1.00

** indicates $p<0.05$; ***indicates $p<0.01$ and ab indicates $p>0.05$ (non significant)

The results of Pearson's correlation coefficients analysis among the nutritional parameters of BLRI Napier-4 and Red Napier grass genotype at 160 DAP are presented in Table 10. Highly Significant ($p<0.01$) association was found between moisture (%) and CP (%) and between CP (%) and CF (%). Significant ($p<0.05$) association was found between ash (%) and Fat (%).



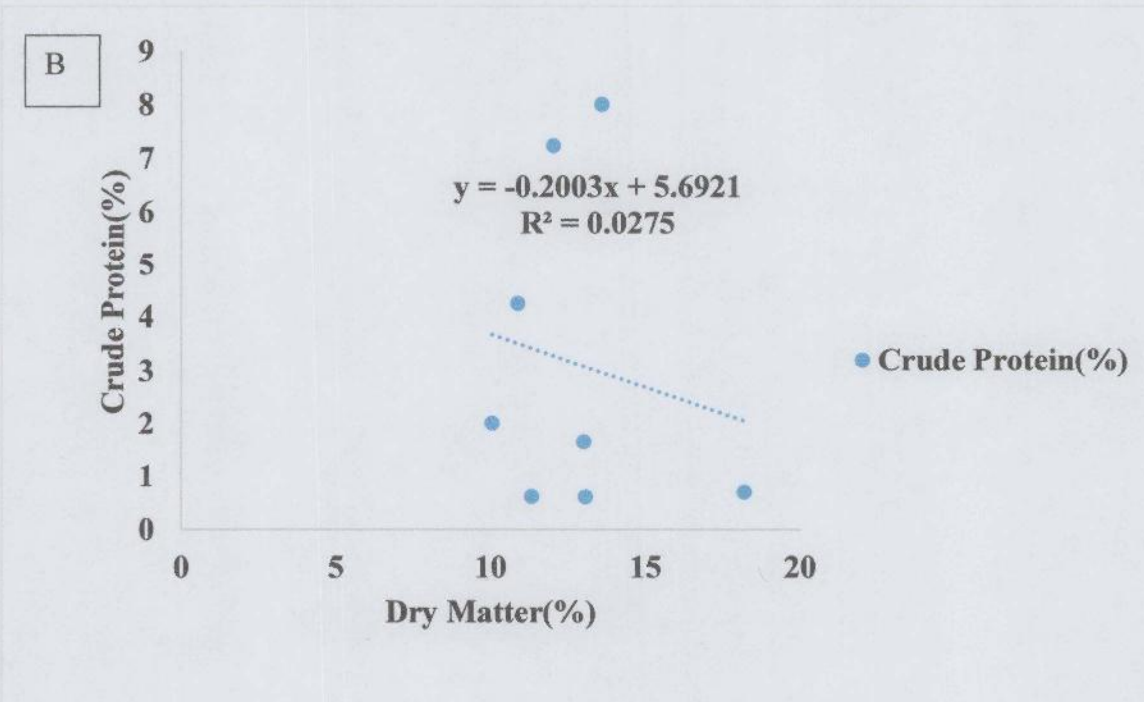


Figure 29: Relationship between Dry Matter (%) and Crude Protein (%) of BLRI Napier-4 (A) and Red Napier grass (B) at 160 DAP

Regression coefficient between dry matter (%) and crude fiber (%) were stated in Figure 29. It is explained that at BLRI Napier-4 CF (%) ($R^2 = 0.1203$) and at Red Napier CF (%) ($R^2= 0.0275$) were positive correlated with dry matter. It could be expressed that if dry matter increased, the CF (%) would also be increased.

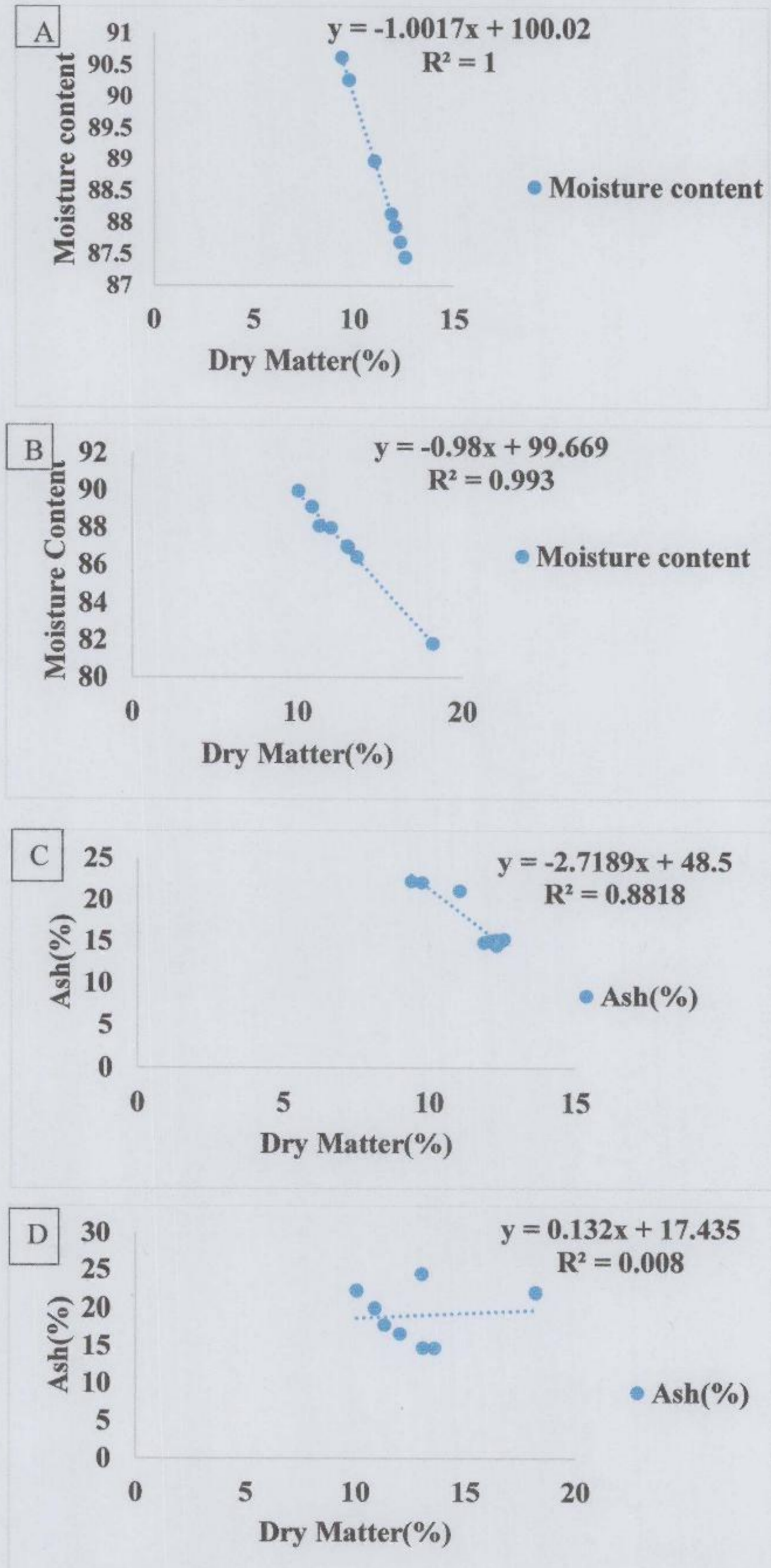
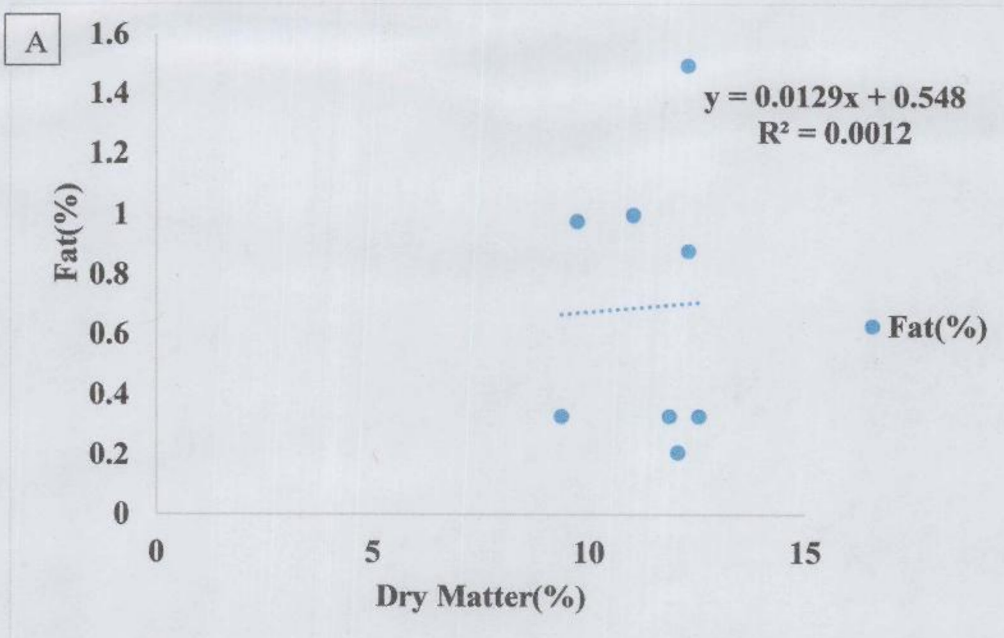
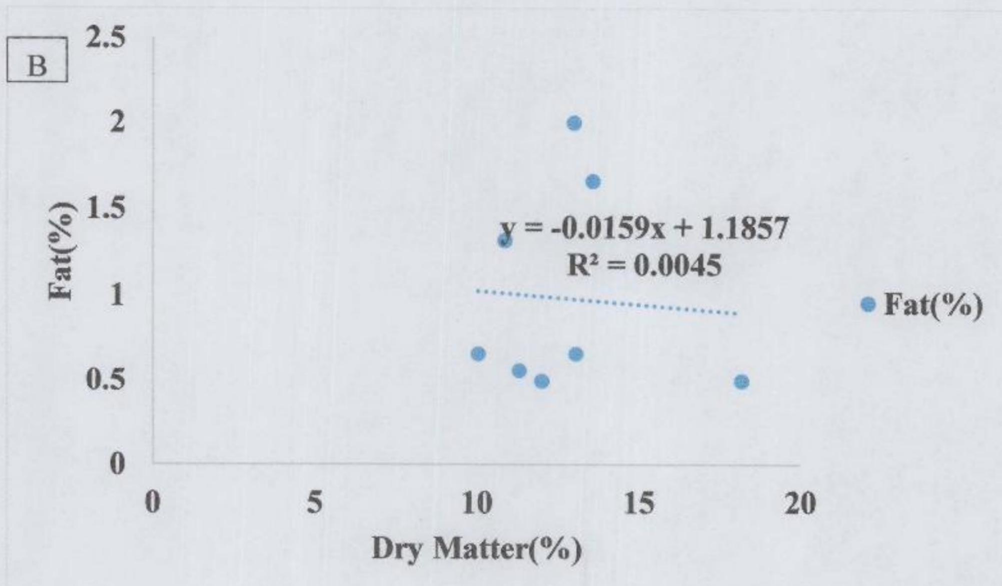
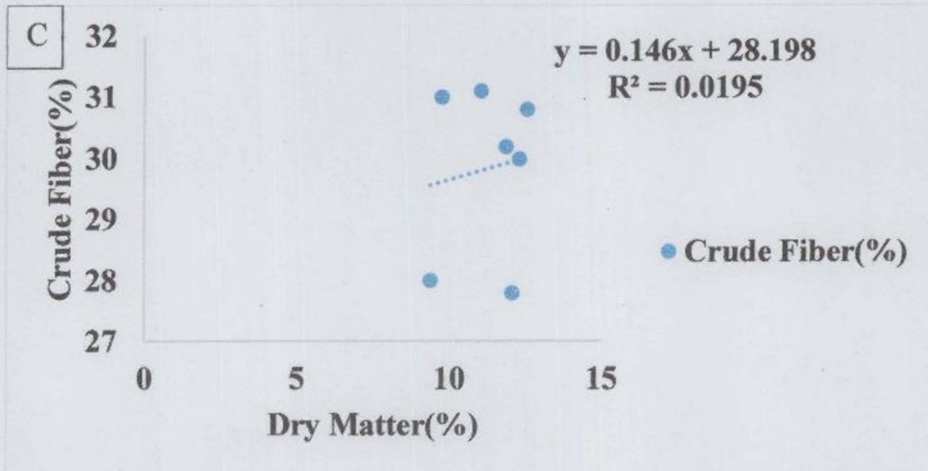


Figure 30. Relationship between dry matter (%) (A) and moisture content (B), dry matter (%) (C) and ash (%) (D) of BLRI Napier-4 and Red Napier grass at 160 DAP.

Regression coefficient between dry matter and moisture, dry matter and crude protein were stated in Figure 30. It is explained that at BLRI Napier-4 moisture content ($R^2 = 1$) and at Red Napier moisture content ($R^2 = 0.993$) were highly positive correlated with dry matter. At BLRI Napier-4 ash (%) ($R^2 = 0.8818$) and at Red Napier ash (%) ($R^2 = 0.008$) were positive correlated with dry matter. It could be expressed that if dry matter increased, the moisture and the ash (%) would also be increased.







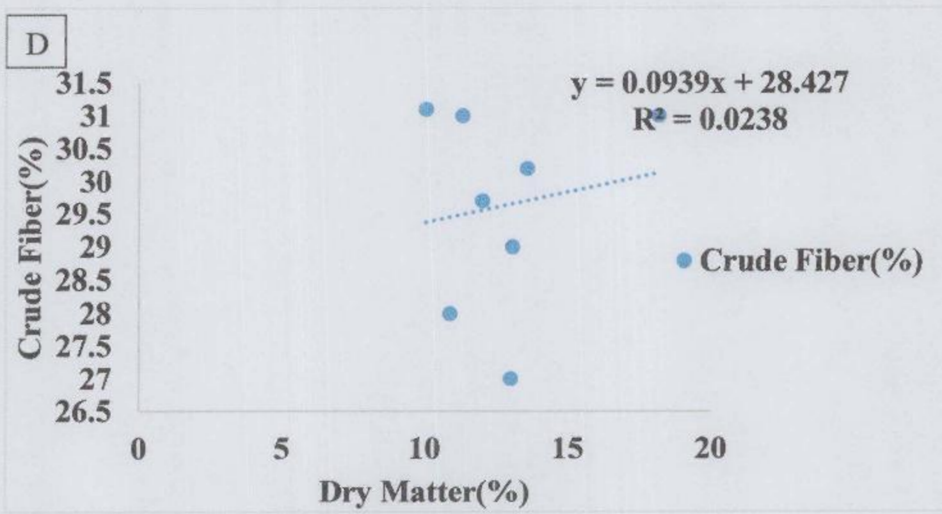


Figure 31. Relationship between dry matter (%) (A) and fat (%) (B), dry matter (%) (C) and crude fiber (%) (D) of BLRI Napier-4 and Red Napier grass at 160 DAP

Regression coefficient between dry matter and fat (%) were stated in Figure 31. It is explained that at BLRI Napier-4 fat (%) (R^2 = 0.0012) and at Red Napier fat (%) (R^2= 0.0045) were positive correlated with dry matter. Regression coefficient between dry matter and crude fiber (%) were stated at BLRI Napier-4 CF (%) (R^2 = 0.0195) and at Red Napier CF (%) (R^2= 0.0238) were positive correlated with dry matter. It could be expressed that if dry matter increased, Ash (%) and CF (%) would also be increased.

Table 11. Correlation matrix with nutritional and agronomic at 160 DAP

Parameters at 160 DAP	Moisture	Dry Matter	Crude Protein	Ash	Fat	Crude Fiber	Tiller Number	Plant Height (cm)	Stem Diameter (cm)	Leaf Number	Leaf Length (cm)	Leaf Width (cm)	Biomass t ha^{-1}
Moisture	1.00												
Dry Matter	-1.00	1.00											
Crude Protein	0.07	-0.05	1.00										
Ash	0.13	-0.13	-0.47	1.00									
Fat	-0.05	0.06	0.25	0.21	1.00								
Crude Fiber	-0.12	0.11	0.16	-0.11	-0.24	1.00							
Tiller Number	0.15	-0.15	0.45*	-0.27	0.01	0.73**	1.00						
Plant Height (cm)	-0.01	0.00	0.34	-0.28	-0.11	0.84***	0.84***	1.00					
Stem Diameter (cm)	0.12	-0.11	0.48*	-0.44	-0.18	0.63*	0.62*	0.84***	1.00				
Leaf Number	-0.01	0.02	0.33	-0.21	0.02	0.70**	0.91***	0.84***	0.62*	1.00			
Leaf Length (cm)	-0.18	0.18	0.31	-0.06	0.32	0.70**	0.81***	0.76**	0.46	0.84***	1.00		
Leaf Width (cm)	-0.10	0.10	0.22	-0.11	-0.09	0.76**	0.87***	0.81***	0.54*	0.95***	0.79**	1.00	
Biomass t ha^{-1}	0.00	0.00	0.33	-0.43	0.01	0.60	0.76**	0.89***	0.80***	0.79**	0.65*	0.72**	1.00

** indicates $p<0.05$; *** indicates $p<0.01$ and ab indicates $p>0.05$ (non significant)

The results of Pearson's correlation coefficients analysis among the agronomic growth parameters and nutritional composition of BLRI Napier-4 and Red Napier forage genotype at 160 DAP(3rd cutting) are presented in Table 11. Highly significant ($p<0.01$) association was found between CF(%) and plant height (r = 0.84***), among tiller number and plant height (r = 0.84***), leaf number (r = 0.91***), leaf length (r = 0.81***), leaf width (r = 0.87***), among plant height and stem diameter (r = 0.84***), leaf number (r = 0.84***), leaf width (r = 0.81***), biomass (r = 0.89***), between stem diameter and biomass (r = 0.80***), among leaf number and leaf length (r = 0.84***), leaf width (r = 0.95***). Significant ($p<0.05$) association was found between CF% and tiller number (r = 0.73**), leaf number (r = 0.70**), leaf length (r = 0.70**) and leaf width (r = 0.76**), Tiller number and biomass (r = 0.76**), leaf number and biomass (r = 0.79**), plant height and leaf length (r = 0.76**). leaf length and leaf width (r = 0.79**), leaf width and biomass (r = 0.72**). According to Lounglawan *et al.* (2014), a young plant is characterized by their high protein content, ether extract, and ash, while the maturing plant have high of crude fiber content.

CHAPTER V

Summary and Conclusion

5.1. Summary

Dairy farming in Bangladesh faces a significant challenge due to the scarcity of green fodder, as the absence of well-defined pasture areas compels ruminants to primarily rely on crop residues, agro-industrial by-products, naturally grown leaves, native grasses, aquatic plants, and fallows for sustenance. Napier grass (*Pennisetum purpureum*) propagated easily and grows very fast. For this reason, farmers are highly interested for the cultivation Napier cultivars (BLRI Napier-4 and Red Napier). Organic manures are easily available, nutritious and cost effective, so farmer can easily effort organic manure. Considering the relevant facts, the researcher conducted a study titled "Effect of Organic Manure on Production Performance and Nutritive Values of Napier Cultivars in Coastal Soil''

The findings of the study revealed that highest tiller number, plant height, stem diameter, leaf number, leaf length, leaf width and biomass were in the interaction of T_1V_1 (13.66), T_1V_1 (127.78 cm), T_1V_1 (3.28 cm), T_1V_1 (13.45), T_1V_2 (87.68 cm), T_1V_1 (3.68 cm), and T_1V_1 (28.30 t ha^{-1}) at 130 DAP. Highest tiller number, plant height, stem diameter, leaf number, leaf length and leaf width respectively obtained with 100% cow dung (T_1) at both cultivars at 130 DAP. Highest biomass obtained at BLRI Napier-4 from cow dung (T_1) at 130 DAP. Except leaf number and leaf width, tiller number, plant height, stem diameter, leaf length and biomass had significant effect ($p<0.05$) compared with control (T_0) at 130 DAP.

At 160 DAP, this study found that highest tiller number, plant height, stem diameter, leaf number, leaf length, leaf width and biomass were in the interaction of T_1V_1 (15.14), T_1V_1 (151.96 cm), T_2V_1 (3.77 cm), T_1V_1 (15.00), T_1V_2 (103.45 cm), T_1V_1 (5.56 cm), T_1V_1 (42.86 t ha^{-1}). Highest tiller number, plant height, leaf number, leaf length and width and biomass respectively obtained with 100% cow dung (T_1) at both cultivars at 160 DAP. Highest biomass obtained at BLRI Napier-4 from cow dung (T_1). Plant height and stem diameter had significant effect ($p<0.05$) compared with control (T_0). And leaf length and biomass had highly significant effect ($p<0.01$) compared with control (T_0).

Highest moisture, DM%, CP%, ash%, fat% and CF% were found in the interaction of T_1V_2(94.37%), T_0V_2 (11.81), T_3V_2 (4.6), T_3V_1 (18.85), T_1V_2 (1.78) and T_2V_2 (27.85%) at

130 DAP. Highest DM%, fat% and CF% were found in the interaction of T_1V_2 (17.48%), T_0V_2 (1.66%) and T_2V_1 (33.85%) at 160 DAP. Fat% and CF% were significantly (p>0.05) influenced at 160 DAP.

5.2. Conclusion

This research provides highest biomass obtained in the interaction of T_1V_1 (42.86 t ha^{-1}) at 160 DAP. Highest stem diameter was obtained in the interaction of T_2V_1 (3.77 cm) at 160 DAP. The treatment and the varietal effect had significant effect ($p<0.05$) on plant height and stem diameter. The treatment and the varietal effect had highly significant effect ($p<0.01$) on plant length and biomass. Highest tiller number, leaf number, leaf length and width respectively obtained with 100% cow dung (T_1) at both cultivars at 160 DAP. Fat (%) and CF (%) demonstrated significance differences ($p<0.05$) except moisture, DM (%), CP (%) and ash (%) among the treatments at 160 DAP. This research showed that highest biomass production (42.86 t ha^{-1}) was found in BLRI Napier-4 at 160 DAP with 100% cow dung and the highest value of CF (%) and fat (%) were obtained at 160 DAP with application of 100% poultry manure at stem of BLRI Napier-4 in coastal soil.

CHAPTER VI

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CHAPTER VI

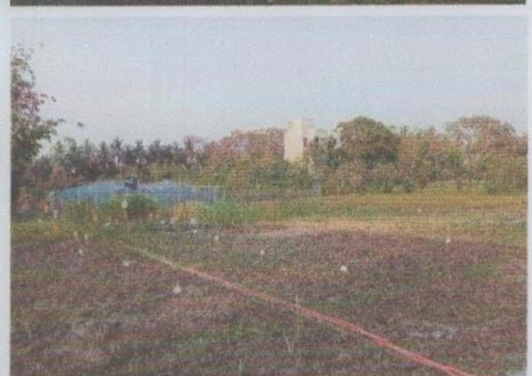
Appendix

Appendix-1: Photographic Presentation of the Research







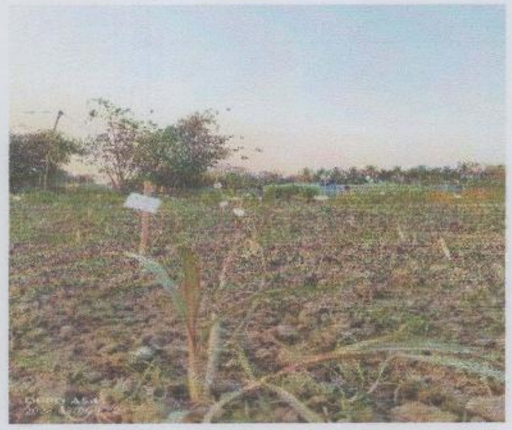



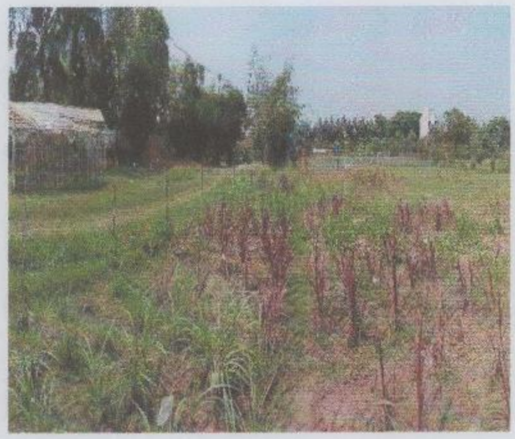












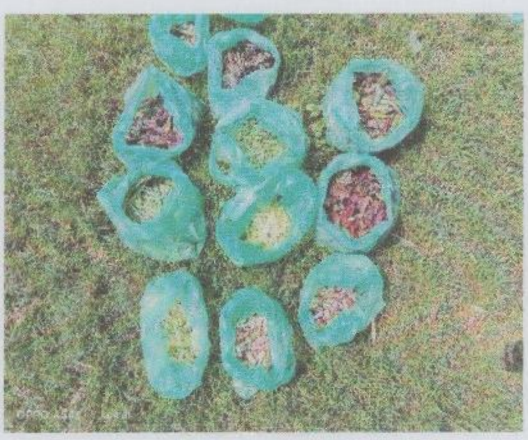
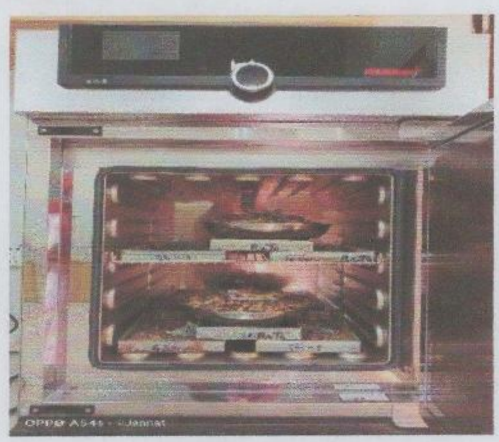




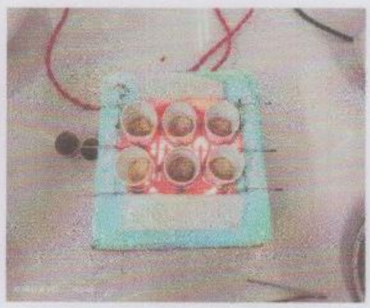








OPPO A54s · Jannat


JF
JF



For Cow dung,

50% manure was applied at 1st application = (6.42÷2) kg

=3.21. kg (per plot)

In 6 plot required = 19.26 kg

25 % manure was applied at 2nd application= (6.42÷4) kg

=1.605 kg (per plot)

In 6 plot required = 9.63 kg

25 % manure was applied at 2nd application = (6.42÷4) kg

=1.605 kg (per plot)

In 6 plots required = 9.63 kg

In Poultry Manure,

2.62 g N found in 100 g Poultry Manure

1 g N N found in = $\frac{100}{2.62}$ g Poultry Manure

For 27 g N we required = $\frac{100\times27}{2.62}$ g Poultry Manure

= 1030 g

= 1.03 kg

We can say that, 1.03 kg Poultry Manure is required for a 6 m^2 plots.

Total poultry manure is required for 6 plots = (1.03×6) = 6.18 kg

For Poultry Manure,

50% poultry manure was applied at 1st application = (6.18÷2) kg

=3.09 kg (per plot)

In 6 plot required = 18.54 kg

25 % poultry manure was applied at 2nd application= (6.18÷4) kg

=1.545 kg (per plot)

In 6 plot required = 9.27 kg

25 % poultry manure was applied at 2nd application= (6.18÷4) kg

=1.545 kg (per plot)

In 6 plots required = 9.27 kg