EFFECT OF ORGANIC MANURES ON GROWTH PERFORMANCES AND NUTRITIVE VALUE OF PAKCHONG FORAGE GENOTYPE

A THESIS

BY

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AGROTECHNOLOGY DISCIPLINE

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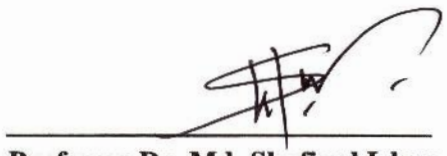

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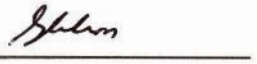

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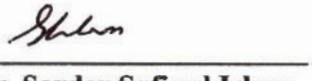

Professor Dr. Sarder Safiqul Islam

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May 2022

DEDICATED

TO

MY

BELOVED PARENTS

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ABSTRACT

The study was conducted to determine the effects of sheep manure nitrogen and urea nitrogen on the growth parameters and nutrient composition of Pakchong forage genotype. The experiment was conducted with five treatments e.g., T_0 control (no fertilizer and manure nitrogen), T_1 (100% urea nitrogen), T_2 (66.67% urea nitrogen and 33.33% sheep manure nitrogen), T_3 (66.67% sheep manure nitrogen and 33.33% urea nitrogen) and T_4 (100% sheep manure nitrogen) having 3 replications for each treatment. The forage was harvested at 2 cutting periods (60 and 90 days). The effects of urea nitrogen and sheep manure nitrogen were significant for root length ($p<0.05$) at 60 DAP. No significant ($p>0.05$) difference was observed among the other growth parameters like plant height, leaf number, tiller number, leaf width, leaf length, stem diameter and biomass of the forage at 60 DAP. Significant effect on stem diameter ($p<0.05$) and tiller number ($p<0.01$) were found at 90 DAP. Significantly varied DM ($p<0.01$), CF ($p<0.01$) and ash ($p<0.05$) were found at 60 DAP and their highest values were 12.07%, 33.1% and 16.55%, respectively. No significant ($p>0.05$) effect was found on the nutrient parameters e.g., DM, CF, CP, EE and ash at 90 DAP. The study also showed that DM, CF and ash content were increased with the advances of age of the genotype while vice versa in CP content. The highest value of CF and DM were obtained at 60 DAP with the combination of 66.67%sheep manure nitrogen and 33.33%urea nitrogen (T_3). The CP content of the genotype was 14.94% in T_2 and 11.86% in T_3 at 60 DAP and 90 DAP, respectively but definitely less than that of T_1 at both cutting periods. For most of the studied agronomic growth parameters, highest values were obtained with the combination of 66.67% urea nitrogen and 33.33% sheep manure nitrogen (T_2). With the combination of 66.67% urea nitrogen and 33.33% sheep manure nitrogen percentage of DM, CF and ash were obtained 11.42, 33.0 and 16.15, respectively.

Keywords: Pakchong, sheep manure, urea, nitrogen

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CHAPTER I

INTRODUCTION

Livestock is considered as a thrust sector for poverty reduction, income generation and meet up nutrient deficiency. Its contribution in national GDP is 1.60% in 2016-17 (Bangladesh Economic Review, 2017). In south-west Bangladesh, where land scarcity due to salinity and water logging is main constraint for crop production, livestock rearing is emerging as livelihood option for resource-poor people. In Bangladesh the arable land is mainly occupied by crops for staple food production and farmers do not grow any crop exclusively as fodder. As a result, fodder shortage is aggravating day by day and recently has emerged out as an acute problem for rearing of livestock in coastal region. The lands used as temporary pastures in the recent past have now been turned into crop field due to the expansion of irrigation facilities. The country has a quite large number of livestock populations, which are competing with the human for their feeds and forages.

In other hand, one of the most important impediments for low productivity of livestock is acute shortage of quality feeds and fodder (Tareque and Chowdhury, 2012). Here, the animal feeding is mainly based on crop residue and roadside grass. Several studies in the past clearly indicated about animal feeds and nutrient shortage in Bangladesh. From a recent study on the availability of feeds and forage, it is evident that the availability of nutrients is 73.11% DM, 18.49% DCP and 25.24% ME with the deficits of 26.89% DM, 81.51% DCP and 74.76% ME, respectively (Akbar and Khaleduzzaman, 2009). This apprises a huge amount of nutrient demand is not accomplished and in long run it can bring ominous situation for the population as this sub-sector has remarkable deliberations in ensuring food security, nutritional demand, poverty reduction, farmers' economical solvency etc.

The coastal area accounts for about 20% of the total land area (Islam *et al.* 2007). The region comparatively poor and out of 3.22 million rural farm household, 0.62 million are owner cum tenant and 1.8 million households are tenant (BBS, 2014). Livestock population in the region is comparatively high, but the productivity is quite low due to ill health attributing by scarcity of green fodder and diseases infestation. As per district statistics published by BBS, 2010, there are 4841 dairy farms in the south-south and southwest coastal region and total population of livestock are, Cattle & Buffalo 6.9 million, Goat 1.6 million and Sheep 1.2 million, respectively. Moreover, there is an urgent need for producing fodders to feed substantial number of livestock in this region.

CHAPTER II

REVIEW OF LITERATURE

2.1 Sheep manure as fertilizer

Sheep manure is a natural slow-release fertilizer. Nutrients in sheep manure fertilizer provide adequate nourishment for soil. It is high in both phosphorus and potassium, essential elements for optimal plant growth. These nutrients help plants to establish strong roots, defend against pests and grow into vibrant and productive plants. One of the important aspects of sheep farming business is having an effective waste management plan which reaps the benefits and reduces the risks caused by improper disposal of sheep manure wastes.

Moradi (2015) experimented on morphological properties of onion by using sheep manure levels (0 and 5 ton/ha), three triple superphosphate levels (0, 100 and 150 kg/ha) and three urea levels (0, 150 and 300 kg/ha) and found that the morphological properties significantly improved in sheep manure treatment, phosphorus treatment significantly improved the morphological properties of onion and urea treatments increased the fresh and dry weight, volume and bulb diameter of onion.

An experiment was conducted by Yang *et al* (2021) to observe the combined effects of sheep manure with chemical fertilizer on maize yield and found that the yield of sheep manure combined with chemical fertilizer is much higher than that of only sheep manure and no fertilizer and also found that among 15%, 30%, and 45% sheep manure with chemical fertilizer the crop highest crop yield was observed with the combination of 15% sheep manure nitrogen with chemical fertilizer. The experiment revealed that the combined application of chemical fertilizers with sheep manure can increased the partial productivity and the agronomic utilization rate of the nitrogen fertilizer and increase crop yields.

Chammaa *et al* (2012) studied to know the effect of phosphorus fertilizer and sheep manure on growth and nitrogen fixation in soybean and found a positive result on the seed yield. A research was conducted by Tahami *et al* (2010) to compare the effect of organic and chemical fertilizer on yield and essential oil percentage of basil and found that plant height, leaf yield, fresh and dry matter were high in compare with chemical fertilizer.

Rengsirikul *et al.* (2013) carried out a study on eight cultivars of Napier grass namely; Dwarf, Muaklek, Bana, Taiwan A148, Common, Wruk wona, Tifton and Kampheng San. They found that biomass yield varied significantly ($P < 0.05$) among cultivars and the tall cultivars yielded 46.3 - 58.4 t/ha/yr compared with 27.1 and 35.1 t/ha/yr for Dwarf and Muaklek, respectively.

2.2.3 Tiller Number and Leaf Number

Sirichaiwetchakul *et al.* (2016) conducted an experiment on arbuscular mycorrhizal fungi (AMF) to promote the yield and nutritive values Napier Pakchong 1 and found that tiller number was highly significant ($p<0.01$) by inoculation of AM fungi. At both cutting stages (60 DAP 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 research 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 (*Pennisetumpurpureum* × *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.

According to Hasan *et al.* (2010) on branching of plant there was no significant effect of nitrogen fertilizer from urea.

2.3 Nutritional parameters

2.3.1 Crude Protein (CP)

Haryani *et al.* (2018) conducted an experiment to evaluate the yield and nutritive values of six 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 metabolised energy % 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 research on seasonal fertilizer response of Napier grass and found that dry forage yield in optimum fertilizer level on sandy soil around 5 t ha^{-1} yr^{-1} in dry soil condition and 55 t ha^{-1} yr^{-1} in sandy clay loam soil with adequate moisture. Digestible nutrient and protein levels of 60-days forage were about 55 and 10% respectively.

Sirichaiwetchakul *et al.* (2016) conducted a study on yield and nutritive values of Napier Pakchong 1 by using arbuscular mycorrhizal fungi (AMF) and found that the addition of commercial AMF and urea fertilizer to Napier Pakchong 1 resulted in an increase in crude protein.

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 NyPa 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%.

2.3.2 Crude Fiber (CF)

Eltelib *et al.* (2006) studied on the effect of nitrogen and phosphorus 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.

Kidder (1945) experimented on composition and digestible nutrient of Napier grass leaves and found that at age of 6, 8, 10, 12, 14 weeks CF% were increasing gradually CF contents were respectively 28.8, 30.7, 32.0, 32.6, 33.9.

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 Glass (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.

Sarker *et al.* (2019) experimented to compare the feed potential of BLRI Napier3 (BN3) and Pakchong (PK) and found that acidic detergent fibre (ADF) (61.89%) was found. While on the other hand, neutral detergent fiber (NDF) (88.06%) in PK silage were not different from BN3 silage.

2.3.3 Dry Matter (DM), Ether Extract (EE) and ash content

A scientific study was conducted by Zewdu *et al.* (2002) on Napier grass (Pennisetum purpureum (L.) Schumach.) by using a 5 x 3 factorial experiment. The treatments were five fertilizer applications (0kg ha-1 N, 46kg ha-1 N and 92kg ha-1 N, 1t ha-1 and 2t ha-1 cattle manure) and three plant heights at cutting (0.5m, 1m and 1.5m). The average dry matter (DM) yield per cut was 8.21t 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.

To compare the potentiality between BLRI Napier-3 (BN-3) and Pakchong (PK) fodders, research was conducted by Sarker *et al.* (2019) and found that dry matter (DM) (24.71%) and total ash (8.35%) in PK silage were significantly higher.

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 Pennisetum 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 cutting period.

CHAPTER III

MATERIALS AND METHOD

3.1 Site of the experiment

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

3.2 Preparation of plot

Fifteen (15) plots having the same dimension of 2m×5m= $10m^2$ space for each plot was arranged for this experiment.

3.3 Layout of the experiment

Treatment	Replication		
	R_1	R_2	R_3
T_0	T_0R_1	T_0R_2	T_0R_3
T_1	T_1R_1	T_1R_2	T_1R_3
T_2	T_2R_1	T_2R_2	T_2R_3
T_3	T_3R_1	T_3R_2	T_3R_3
T_4	T_4R_1	T_4R_2	T_4R_3

T_0 = Control (No fertilizer and manure); T_1 = Urea Nitrogen (100% ≈ 62.5g as recommended dose) + Sheep manure Nitrogen (0); T_2 = Urea Nitrogen (66.67% ≈41.67g) + Sheep manure Nitrogen (33.33% ≈3.42kg); T_3 = Urea Nitrogen (33.33% ≈20.831g) + Sheep manure Nitrogen (66.67% ≈6.85kg); T_4 = Urea Nitrogen (0) + Sheep manure Nitrogen (100% ≈ 10.27kg).

Treatments

T_0 = Control (No fertilizer and manure);

T_1 = Urea Nitrogen (100% ≈ 62.5g as recommended dose), (Islam, 2020) +Sheep manure Nitrogen (0);

T_2 = Urea Nitrogen (66.67% ≈41.67g) +Sheep manure Nitrogen (33.33% ≈3.42kg);

T_3 = Urea Nitrogen (33.33% ≈20.831g) +Sheep manure Nitrogen (66.67% ≈6.85kg);

T_4 = Urea Nitrogen (0) + Sheep manure Nitrogen (100% ≈ 10.27kg).

3.4 Sheep manure analysis

Sheep manure was analysed using Kjeldahl Distillation unit, UK; Spectrophotometer TG, China and Flame photometer JENWAY, UK for content of Nitrogen, P and K, respectively. After reviewing analysis, the sheep manure consists of 0.28% N, 0.0050% P and 1.2536% K.

3.5 Adjustment of TSP and MoP fertilizer

The recommended value of TSP and MoP is 87.5kgh^{-1} and 37.5kgh^{-1}, respectively (Islam, 2020). When the TSP and MoP fertilizer were applied for Pakchong forage production, the amount of P and K were also adjusted with the amount of P and K of sheep manure.

3.6 Collection of cutting

Cutting of Pakchong forage genotype was collected from the germplasm centre of Dr. Purnendu Gain Field Laboratory of Agrotechnology Discipline, Khulna University, Khulna.

3.7 Collection of sheep manure

Sheep manure was collected from the project entitled "Improvement of Sheep Production in South-Western Costal Regions of Bangladesh through Proper Breeding and Feeding Techniques". Project No: LS20191163; GARE, BANBEIS, MOE implemented under Agrotechnology Discipline. Khulna University, Khulna.

3.8 Planting of cuttings

Cuttings were planted on 20th February 2021. There were four rows in each plot and each row contained eighteen cuttings where cutting to cutting distance was 30cm.

3.9 Irrigation and fertilizer application

Half of measured fertilizers (Urea, MoP and TSP and sheep manure) were applied six (6) days before cutting plantation and rest of fertilizers were applied 15 days after planting. Irrigation was applied according to the requirement.

3.10 Harvesting

The Pakchong was first harvested on 22nd of April, 60 days after planting (DAP) and second cutting was conducted on 22nd of May, 90 days after planting (DAP).

3.11 Collection of data

Agronomic data such as plant height, leaf number, leaf length, leaf width, tiller number, biomass, stem diameter and nodal distance & nutritional data e.g., percentage of dry matter, crude protein ash and ether extract were collected after harvesting of the forage cultivars at two times with 30 days intervals (60 and 90 DAP).

3.11.1 Agronomic data

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 leaf of the plant and mean value of plant height was recorded.

Leaf length

The leaf length was measured from the tip of the entire leaf down to the base of the leaf blade. Four leaves of five plants from each plot were selected randomly and after measuring each leaf length, their mean value was recorded.

Nodal distance

Distance between two nodes were measured with a measuring tape. Four tillers of five plants from each plot were selected randomly and nodal distance of each tiller was measured and their mean value was taken.

Tiller number and leaf number

Tiller number and leaf number were counted manually and mean tiller number of five plants from each plot was recorded.

Biomass

Randomly five plants were harvested from each plot and their mean shoot weight was recorded.

3.11.2 Proximate Analysis

3.11.2.1 Crude Protein Analysis:

Test Procedures:

Digestion

Digestion was completed by using DK 8 Heating Digester VELP SCIENTIFICA. 1g of sample was weighted with an accuracy of ±0.1mg. For each sample 2 catalyst and 12ml H_2SO_4 were added and then placed into digestion block. The temperature of the digestion

block was maintained at 420°C and sample was heated for 60 minutes until the fumes stopped. Then the sample was taken to cool at 50-60°C.

Distillation

Distillation process was conducted by using UDK 129 Distillation Unit VELP SCIENTIFICA. 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

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

3.11.2.2 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 fibre 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

3.11.2.3 Ether Extract Analysis

Test method procedure:

Ether extract analysis was conducted by using VELP SCIENTIFICASER 148 Solvent Extractor.

Sample: 3 g (F1) 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 10mg/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(F3) it after cooling a desiccator.

Calculation:

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

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

3.11.2.4 Dry matter

Test procedure

Envelopes were weighted (W1) and weight was recorded to 0.001g. After harvesting, fresh shoot weight (W2) 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(W3) is weighted.

Calculation:

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

Where,

W_1 = Weight of envelope in gram

W_2 = Weight of fresh sample in gram

W_3 = Weight of envelope and dried sample in gram

3.10.2.5 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

3.12 Statistical method and analysis:

Data were analyzed using the General Linear Model (GLM) procedure of SAS version 9.1, 1994 (SAS Institute, Inc.). DMRT was used to compare the treatment means with significance consider at $p<0.05$.

CHAPTER IV

RESULTS AND DISCUSSION

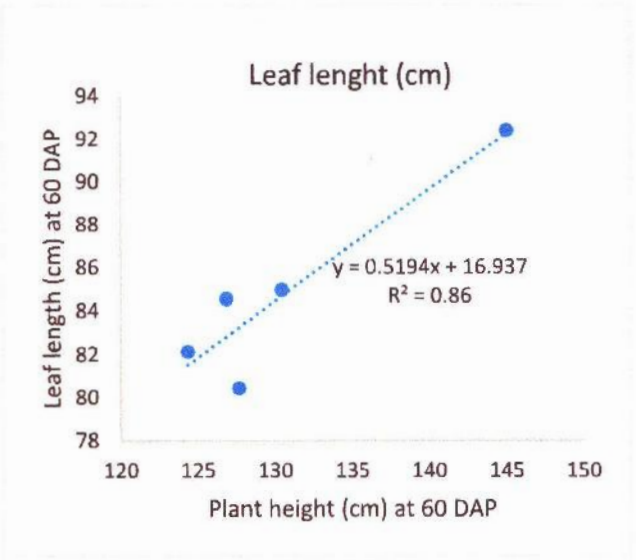
4.1 Agronomic growth parameters of Pakchong forage at 60 DAP

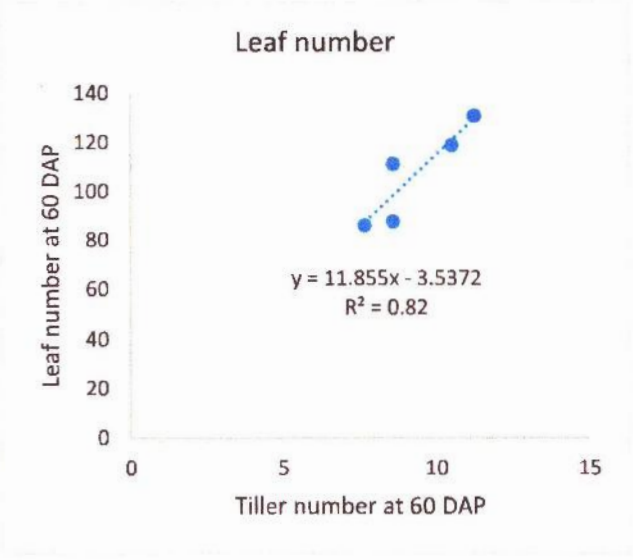
Combined effects of urea nitrogen and sheep manure nitrogen showed significant ($p<0.05$) effect on root length (Table 4.1.1). Highest root length (34.90cm) was obtained with the treatment of 66.67% sheep manure nitrogen and 33.33% urea nitrogen (T_3) at 60 DAP. There were no significant effects($p>0.05$) on plant height, leaf number, leaf length, leaf width, tiller number, stem diameter and biomass among different treatments. Sirichaiwetchaku *et al.* (2016) found that there was no significant effect of urea fertilizer on plant height of Napier Pakchong1. According to Hasan *et al* (2010), urea nitrogen fertilizer had significant effect on plant height and highest plant height (96.25 cm) was observed at 25 kg N/ha but had no significant effect on the branching of plant with cumulative N fertilizer on cowpea forage. In the present study highest value of plant height (145.00cm), leaf length (92.41cm), leaf width (4.13cm) and stem diameter (4.06cm) at 60 DAP (Table 4.1.1) were found with 66.67% urea nitrogen combined with 33.33% sheep manure nitrogen (T_2).

Table 4.1.1 Combined effects of urea nitrogen and sheep manure nitrogen on growth parameters of Pakchong genotype at 60 DAP (Mean±SE)

Parameter at 60 DAP	(Mean ± SE)					*P* value	Level of Sig	CV.
	T_0	T_1	T_2	T_3	T_4			
Plant height (cm)	124.33±4.1.3	126.83±3.3	145.00±3.4	130.42±4.1	127.67±9.4	0.16	NS	7.32
Root length (cm)	28.43^{a}±1.1	32.13^{a} ±6.7	31.36^{a} ±2.9	34.90^{a} ±3.4	18.63^{b}±2.6	0.02	*	16.67
Leaf length(cm)	82.14±5.8	84.55±1.6	92.41±1.9	84.97±2.9	80.44±4.6	0.3	NS	7.81
Leaf width(cm)	3.69±0.2	4.08±0.08	4.13±0.1	4.11±0.1	3.87±0.07	0.35	NS	7.32
Stem diameter(cm)	3.66±0.4	3.83±0.1	4.06±0.32	4.02±0.23	4.00±0.31	0.82	NS	14.86
Tiller number	7.66±0.1	8.58±0.6	8.58±1.0	10.50±0.5	11.25±1.4	0.11	NS	17.10
Leaf number	86.08±13.0	87.52±7.2	111.02±4.7	118.85±9.8	130.92±15.2	0.09	NS	18.89
Biomass (MT/ha)	9.48±1.72	13.02±4.9	13.46±3.59	17.53±6.44	15.59±4.15	0.72	NS	52.77

** Labled as $p<0.05$ and ** labled as $p<0.01$. NS = non-significant. T_0 = Control (No fertilizer and manure); T_1 = Urea Nitrogen (100% ≈ 62.5g as recommended dose) + Sheep manure Nitrogen (0); T_2 = Urea Nitrogen (66.67% ≈41.67g) + Sheep manure Nitrogen (33.33% ≈3.42kg); T_3 = Urea Nitrogen (33.33% ≈20.831g) + Sheep manure Nitrogen (66.67% ≈6.85kg); T_4 = Urea Nitrogen (0) + Sheep manure Nitrogen (100% ≈ 10.27kg).*





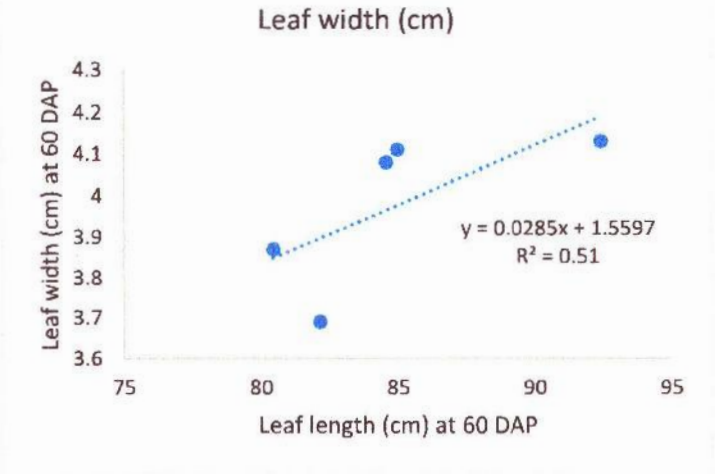


Figure 4.1.1: Relation between the plant height and leaf length, tiller number and leaf number and leaf length and leaf width of Pakchong forage at 60 DAP.

Regression coefficient between plant height and leaf length, tiller number and leaf number and leaf length and leaf width were stated in Figure 4.1.1. It is explained from the Figure 4.1.1 that there was highly positive correlation between plant height and leaf length (R^2 = 0.86), tiller number and leaf number (R^2 = 0.82) and leaf length and leaf width (R^2 = 0.51).

Table 4.1.2: Correlation matrix of growth parameters of Pakchong genotype at 60 DAP

Parameters at 60 DAP	1	2	3	4	5	6	7	8
1. Plant height(cm)	1							
2. Root length(cm)	0.15	1						
3. Tiller number	0.20	-0.30	1					
4. Leaf number	0.29	-0.08	0.80**	1				
5. Leaf length(cm)	0.82**	0.49	0.10	0.27	1			
6. Leaf width (cm)	0.47	0.44	0.25	0.35	0.77**	1		
7. Stem diameter (cm)	.52*	0.30	0.19	0.39	0.52*	0.56*	1	
8. Biomass (MT/ha)	0.35	0.14	0.26	0.23	0.30	0.19	0.32	1

** Labled as $p<0.05$ and ** labled as $p<0.01$. NS = Non - significant.*

The results of Pearson's correlation coefficients analysis among the growth parameters of Pakchong forage genotype at 60 DAP are presented in Table 4.1.2. Highly positive significant ($p<0.01$) association was found between plant height and leaf length (r = 0.82**), tiller number and leaf number (r = 0.80**) and leaf length and leaf width (r = 0.77**). There was positive significant ($p<0.05$) association between plant height and stem diameter (r = 0.52*), leaf length and stem diameter (r = 0.52*) and leaf width and stem diameter (r =0 .56*).

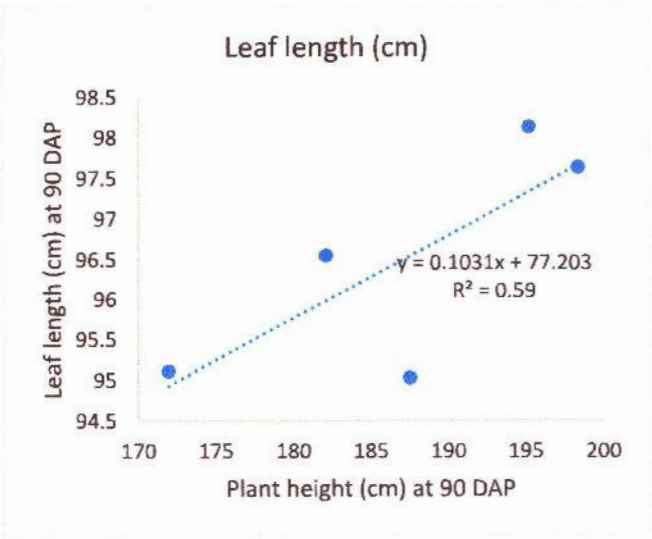
4.2 Agronomic growth parameters of Pakchong forage at 90 DAP

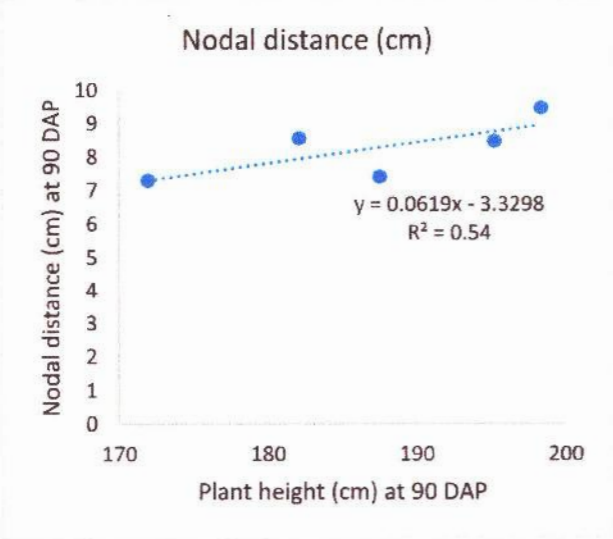
Tiller number was highly significant ($p<0.01$) with the combination of urea nitrogen and sheep manure nitrogen (Table 4.2.1). The highest number of tiller (10.41) was found with the combination of 66.67% sheep manure nitrogen along with 33.33% urea nitrogen (T_3) at 90 DAP. The stem diameter was significantly ($p<0.05$) varied ranging from 4.03cm to 4.82cm and the highest value was obtained with 66.67% sheep manure nitrogen along with 33.33% urea nitrogen (T_3) at 90 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 consistent with the findings of the present study. Wangchuk *et al* (2015) compared Pakchong-1, CO-3 and Giant Napier at 3 cutting intervals (40, 60 and 80 days) and found that CO-3 produced highest tiller number per plant and Pakchong-1 was taller, had bigger tillers and basal circumference compare to CO-3 and Giant Napier. At 90 DAP, highest plant height (198.33cm), root length (48.66cm), leaf length (98.63cm) and biomass (69.04MT/ha) were obtained with 66.67% urea nitrogen and 33.33% sheep manure nitrogen (T_2).

Table 4.2.1 Combined effects of urea nitrogen and sheep manure nitrogen on growth parameters of Pakchong genotype at 90 DAP (Mean±SE)

Parameter at 90 DAP	(Mean±SE)					*P* value	Level of Sig.	CV
	T_0	T_1	T_2	T_3	T_4			
Plant height(cm)	171.92±12.03	182.08±11.02	198.33±1.20	195.17±11.54	187.50±6.06	0.43	NS	9.43
Root length(cm)	37.33±2.5	40.33±5.55	48.66±8.76	40.66±1.45	37.35±3.17	0.51	NS	21.05
Leaf length(cm)	95.11±4.89	96.55±1.48	98.63±1.85	97.13±1.41	95.03±1.81	0.67	NS	3.28
Leaf width(cm)	4.72±0.22	4.85±0.14	4.61±0.15	4.87±0.11	4.82±0.20	0.78	NS	5.97
Stem diameter(cm)	4.03^{b}±0.08	4.80^{a}±0.21	4.53^{ab}±0.06	4.82^{a}±0.25	4.23^{b}±0.01	0.04	*	6.64
Tiller number	7.08^{c}±0.30	8.58^{bc}±0.72	8.67^{bc}±0.46	10.41^{a}±0.83	9.83^{ab}±0.74	0.01	**	10.38
Leaf number	91.92±8.16	103.08±7.34	104.33±0.96	117.33±15.35	97.17±6.05	0.44	NS	15.77
Nodal distance(cm)	7.31±0.89	8.56±0.31	9.46±0.34	8.46±1.79	7.41±1.01	0.61	NS	22.36
Biomass (MT/ha)	35.45±7.59	68.21±21.73	69.04±11.47	62.99±22.63	53.35±6.77	0.57	NS	47.59

** Labled as $p<0.05$ and ** labled as $p<0.01$. NS = Non - significant. T_0 = Control (No fertilizer and manure); T_1 = Urea Nitrogen (100 ≈ 62.5g as recommended dose) + Sheep manure Nitrogen (0); T_2 = Urea Nitrogen (66.67% ≈41.67g) + Sheep manure Nitrogen (33.33 ≈3.42kg); T_3 = Urea Nitrogen (33.33% ≈20.831g) + Sheep manure Nitrogen (66.67% ≈6.85kg); T_4 = Urea Nitrogen (0) + She manure Nitrogen (100% ≈ 10.27kg).*





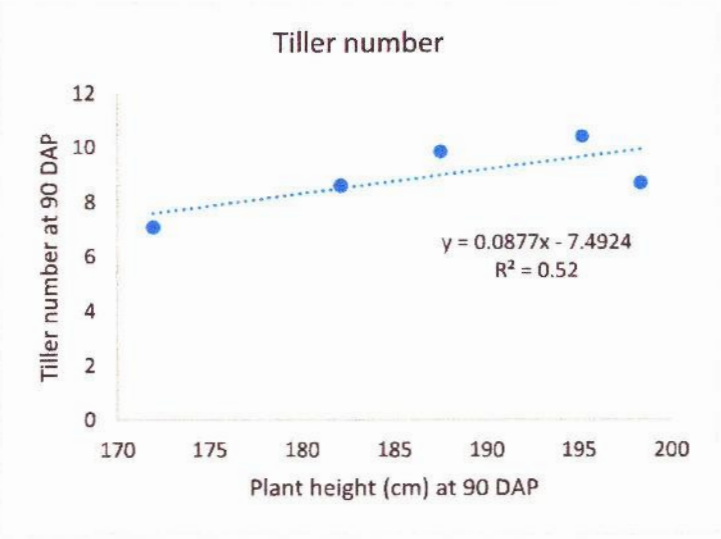


Figure 4.2.1: Relation between the plant height and leaf length, plant height and nodal distance and plant height and tiller number of Pakchong forage cultivar at 90 DAP.

Regression coefficient between plant height and leaf length, plant height and nodal distance and plant height and tiller number were stated in Figure 4.2.1. It is explained in the Figure 4.2.1 that leaf length ($R^2 = 0.59$), nodal distance ($R^2 = 0.54$) and tiller number ($R^2 = 0.52$) were positively correlated with plant height. It could be expressed that if plant height increased, the above-mentioned agronomic growth parameters would also be increased.

Table 4.2.2: Correlation matrix of growth parameters of Pakchong genotype at 90 DAP

Parameters at 90 DAP	1	2	3	4	5	6	7	8	9
1. Plant height(cm)	1								
2. Root length(cm)	0.27	1							
3. Tiller number	0.18	-0.06	1						
4. Leaf number	0.27	0.24	0.40	1					
5. Leaf length (cm)	0.4	-0.09	0.13	0.39	1				
6. Leaf width (cm)	0.19	0.13	0.35	0.39	0.56*	1			
7. Stem diameter (cm)	-0.24	-0.19	0.3	0.45	-0.04	0.34	1		
8. Biomass (MT/ha)	0.38	0.36	0.29	0.67**	0.03	0.05	0.27	1	
9. Nodal distance (cm)	0.68**	0.47	-0.21	0.29	0.14	-0.05	-0.23	0.53*	1

** Labled as $p<0.05$ and ** labled as $p<0.01$. NS = Non - significant.*

The results of Pearson's correlation coefficients analysis among the growth parameters of Pakchong genotype at 90 DAP are presented in Table 4.2.2. Highly significant ($p<0.01$) association was found between plant height and nodal distance (r = 0.68**) and biomass and leaf number (r = 67**). Significant ($p<0.05$) association was found between leaf length and leaf width (r =0.56*) and biomass and nodal distance (r =0 .53*).

4.3 Nutrient composition of Pakchong forage genotype at 60 DAP

Highly significant ($p<0.01$) dry matter (DM) and crude fiber (CF) of Pakchong forage varied between 10.50 to 12.07% and 28.07 to 33.1%, respectively (Figure 4.3.1) among the treatments at 60 DAP. The highest value of DM and CF was obtained with the treatment of 66.67% sheep manure nitrogen and 33.33% urea nitrogen (T_3). The ash content of Pakchong was significantly ($p<0.05$) varied among the treatments and highest value (16.55%) was obtained with 100% sheep manure nitrogen (T_4). No significant ($p>0.05$) effect was found on crude protein (CP) at 60 DAP, where the highest value of CP was 16.29% in the treatment of 100% urea nitrogen (T_1).

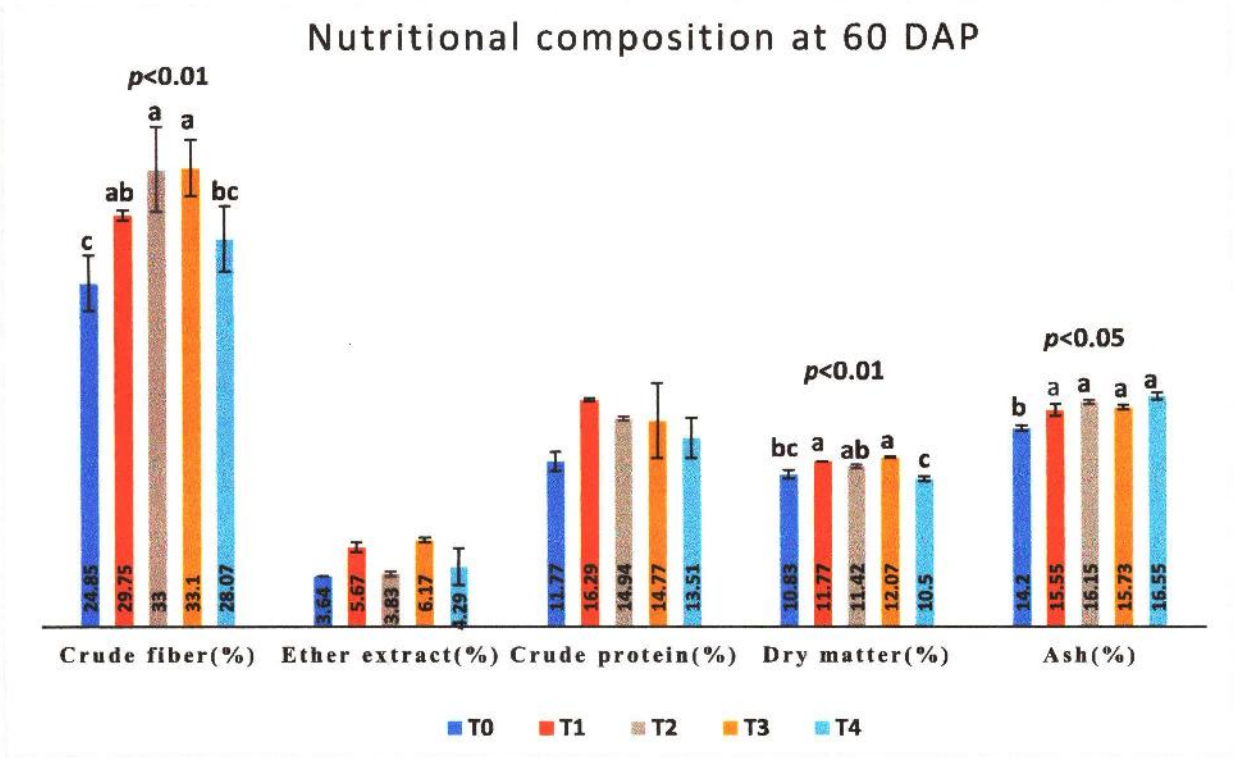


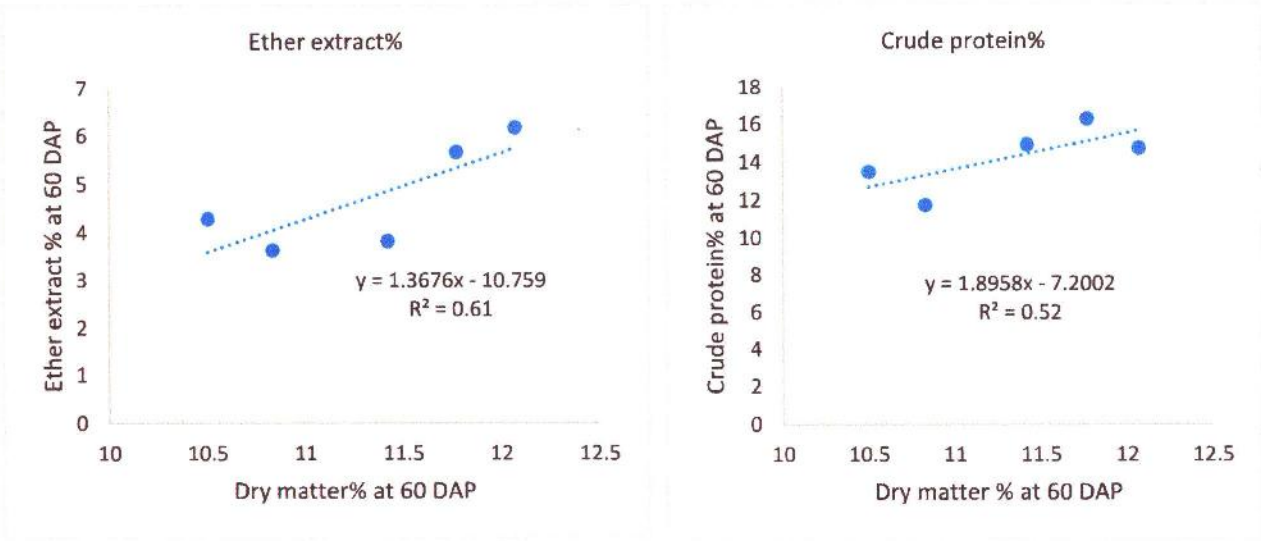
Figure 4.3.1: Crude fiber, ether extract, crude protein, dry matter and ash content of Pakchong forage at 60 DAP

Table 4.3.1: Correlation matrix of growth parameters and nutrient parameters at 60 DAP

	1	2	3	4	5	6	7	8	9	10	11	12	13
1. CF	1												
2. EE	-0.51	1											
3. DM	-0.36	0.63*	1										
4. Ash	-0.07	-0.40	-0.53	1									
5. CP	0.04	0.36	0.41	-0.24	1								
6. PH	-0.50	-0.10	-0.14	0.44	-0.40	1							
7. RL	0.22	-0.54	-0.18	0.04	-0.13	0.15	1						
8. TN	-0.26	-0.53	-0.51	0.37	-0.13	0.20	-0.31	1					
9. LN	-0.43	-0.31	-0.11	0.35	-0.17	0.29	-0.08	.80**	1				
10. LL	-0.30	-0.29	0.13	0.12	-0.15	.81**	0.49	0.10	0.28	1			
11. LW	-0.22	-0.32	0.05	0.02	0.20	0.47	0.44	0.25	0.35	.77**	1		
12. SD	0.01	-0.32	-0.08	0.19	-0.18	.52*	0.30	0.19	0.39	.52*	.56*	1	
13. BM	0.18	-0.54	-0.44	0.09	-0.13	0.35	0.14	0.27	0.23	0.31	0.19	0.32	1

** Labled as $p<0.05$ and ** labled as $p<0.01$. NS = Non - significant. CF = Crude Fiber, EE = Ether Extract, DM = Dry matte, CP = Crude Protein, PH = Plant Height, RL = Root Length, TN = Tiller Number, LN = Leaf Number, LL = Leaf Length, LW = Leaf width, SD = Stem Diameter and BM = Biomass.*

The results of Pearson's correlation coefficients analysis among the agronomic growth parameters and nutritional composition of Pakchong forage genotype at 60 DAP are presented in Table 4.3.1. Highly significant ($p<0.01$) association was found between leaf length and plant height (r = 0.81**), leaf number and tiller number (r = 0.80**) and leaf length and leaf width (r = 0.77**). Significant ($p<0.05$) association was found between dry matter and ether extract (r = 0.63*), plant height and stem diameter (r = 0.52*), stem diameter and leaf length (r = 0.52*) and stem diameter and leaf width (r = 0.56*).



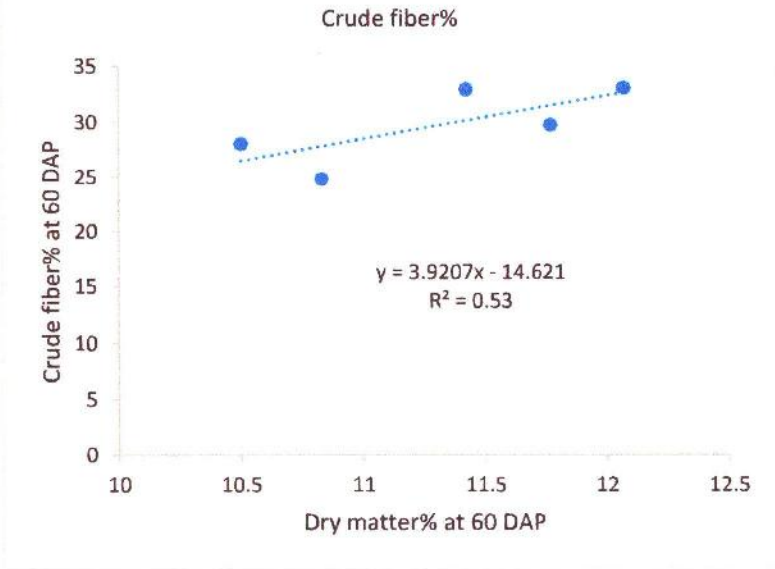


Figure 4.3.2: Relation between dry matter and ether extract, dry matter and crude fiber and dry matter and crude protein of Pakchong forage at 60 DAP.

Regression coefficient between dry matter and ether extract, dry matter and crude fiber and dry matter and crude protein were stated in Figure 4.3.2. It is explained from the Figure 4.3.2 that ether extract (R^2 = 0.61), crude fiber (R^2= 0.53) and crude protein (R^2 = 0.52) were positively correlated with dry matter. It could be expressed that if dry matter increased, the crude protein, crude fiber and ether extract would also be increased.

4.4 Nutrient composition of Pakchong forage at 90 DAP

Crude fiber (CF), crude protein (CP), ether extract (EE), dry fiber (DM) and ash contents of Pakchong at 90 DAP (Figure 4.4.1) were non-significant (p>0.05) with the application of different levels of urea nitrogen and sheep manure nitrogen. The highest value of CF (39.39%) and CP (13.87%) were found with 100% urea nitrogen application (T_1). With the application of 66.67% sheep manure nitrogen and 33.33% urea nitrogen, the highest value of EE (2.58%) and DM (14.98%) were obtained. With the maturation of the Pakchong forage genotype, the CF and DM contents were increased at 90 DAP (Figure 4.4.1) 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.

Crude protein (CP) content of the Pakchong genotype ranged from 10.16% to 13.87% (Figure 4.4.1) at 90 DAP had no significant (p>0.05) difference among the treatments. The CP content of the genotype was 11.86% in T_3 at 90 DAP but definitely less than that of T_1 in at 90 DAP of cutting period. CP percentage gradually decreased with maturation of the forage. 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 research by Center, Y. T. (2004) 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.

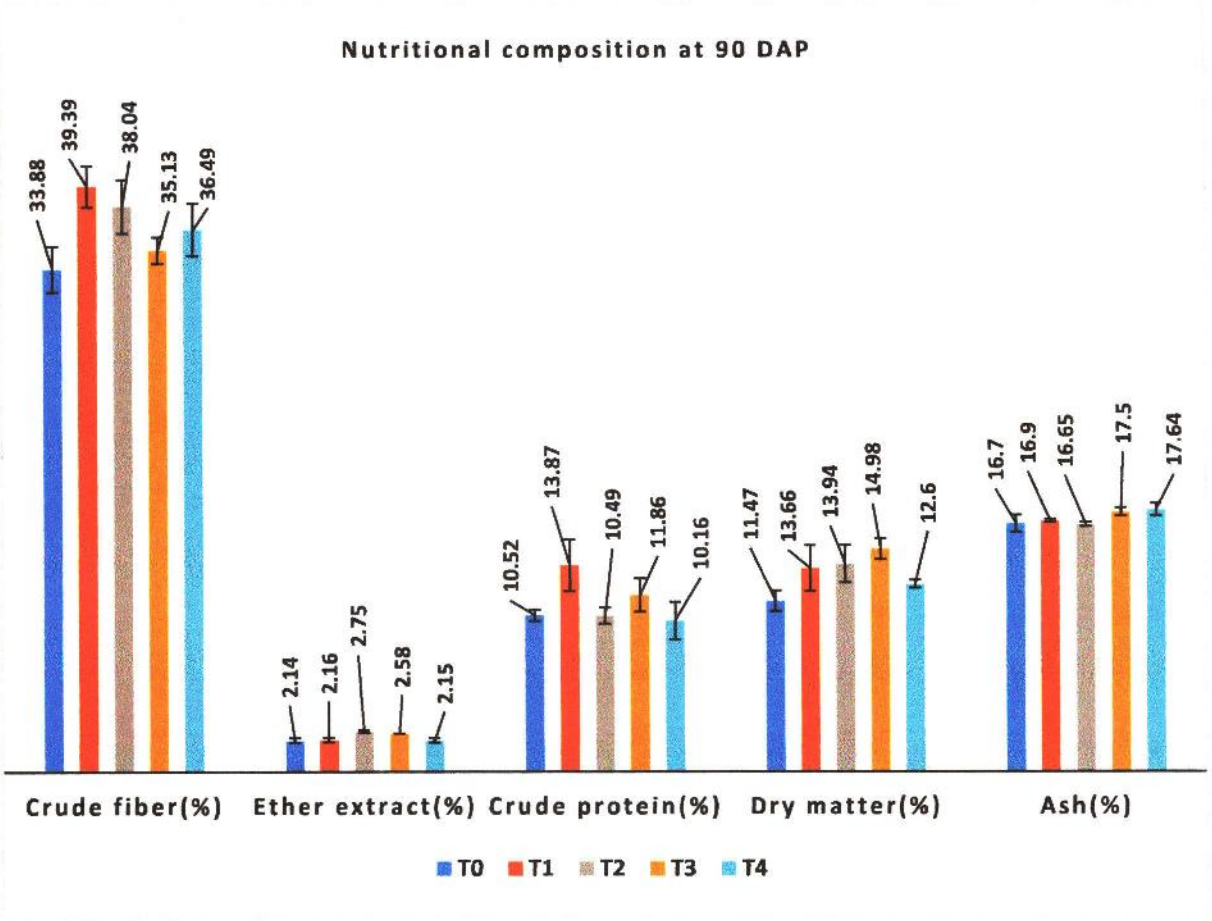


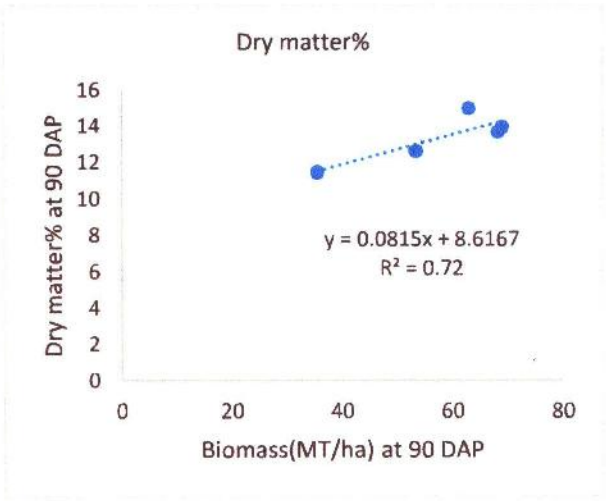
Figure 4.4.1: Crude fiber, ether extract, crude protein, dry matter and ash content of Pakchong forage at 90 DAP

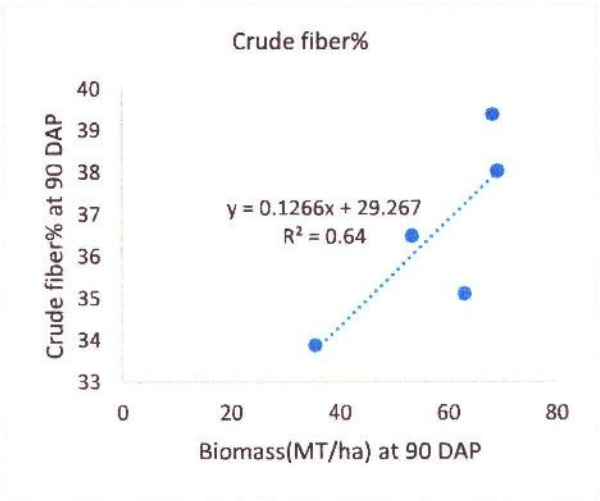
Table 4.4.1: Correlation matrix of growth parameters and nutrient parameters at 90 DAP

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. CF	1													
2. EE	0.25	1												
3. DM	0.20	-0.39	1											
4. Ash	0.06	-0.06	-0.26	1										
5. CP	-0.31	-0.34	0.10	0.11	1									
6. PH	-0.36	-0.23	-0.17	.66*	0.06	1								
7. RL	0.03	0.63	-0.05	0.20	-0.17	0.28	1							
8. TN	-0.25	-0.26	-0.03	0.13	0.18	0.19	-0.07	1						
9. LN	0.20	-0.17	0.26	0.60	0.39	0.27	0.24	0.41	1					
10. LL	0.19	-0.21	-0.34	0.60	-0.15	0.40	-0.09	0.13	0.40	1				
11. LW	0.27	0.03	-0.09	-0.16	-0.24	0.19	0.14	0.35	0.39	.56*	1			
12. SD	-0.05	-0.29	0.44	-.71*	0.40	-0.25	-0.20	0.30	0.45	-0.05	0.34	1		
13. BM	-0.35	-0.26	0.28	0.33	0.57	0.38	0.36	0.29	.67**	0.03	0.05	0.27	1	
14. ND	-0.21	-0.09	-0.03	0.57	-0.17	.68**	0.47	-0.21	0.30	0.14	-0.06	-0.23	.53*	1

** Labled as $p<0.05$ and ** labled as $p<0.01$. NS = Non - significant. CF = Crude Fiber, EE = Ether Extract, DM = Dry matte, CP = Crude Protein, PH = Plant Height, RL = Root Length, TN = Tiller Number, LN = Leaf Number, LL = Leaf Length, LW = Leaf width, SD = Stem Diameter and BM = Biomass.*

The results of Pearson's correlation coefficients analysis among the growth parameters and nutrient parameters of Pakchong forage genotype at 90 DAP are presented in Table 4.4. Highly significant ($p<0.01$) association was found between plant height and nodal distance (r = 0.68**) and biomass and leaf number (r = 0.67**). Significant ($p<0.05$) association was found between ash and plant height (r = 0.66*), leaf length and leaf width (r = 0.56*) and nodal distance and biomass (r = 0.53*).





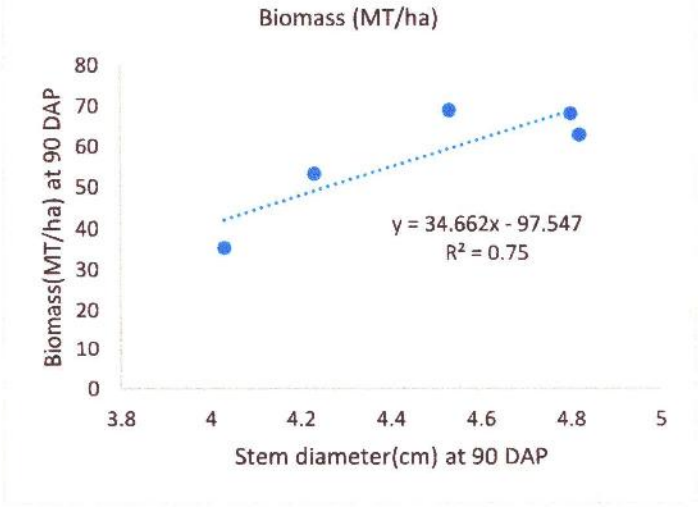


Figure 4.4.2: Relation between biomass and dry matter, biomass and crude fiber and biomass and stem diameter of Pakchong forage at 90 DAP.

Regression coefficient between biomass and dry matter, biomass and crude fiber and biomass and stem diameter stated in Figure 4.4.2. It is explained in Figure 4.4.2 that dry matter (R^2 = 0.72) is positively correlated with biomass, crude fiber (R^2 = 0.64) is highly positively correlated with biomass and biomass (R^2 = 0.75) is highly positively correlated with stem diameter.

CHAPTER V

SUMMARY AND CONCLUSION

5.1 Summary

Forages are the most valuable feed source for cattle because they supply the fiber required to optimize digestive function. Pakchong is one of the most popular forages in the tropics and sub-tropics and also in Bangladesh due to its high yielding performance and nutritional qualities with good adaptability. For this reason, farmers are highly interested for the cultivation of Pakchong. Inorganic fertilizers, unlike organic manure, are not economically effective in the cultivation of Pakchong. By taking the facts under consideration, the researcher conducted this study entitled "Effect of organic manures on growth performances and nutritive value of Pakchong forage genotype".

The findings of the study revealed that highest plant height, leaf length and leaf width were 145.00cm, 92.41cm and 4.13cm, respectively obtained with the combination of 66.67% urea nitrogen and 33.33% sheep manure nitrogen (T_2) at 60 DAP. Significantly ($p<0.05$) varied root length was found at 60 DAP, where the highest value (34.90cm) was obtained with the combination of 66.67% sheep manure nitrogen and 33.33% urea nitrogen (T_3). With the same combination highest biomass (17.53MT/ha) was also found at 60 DAP.

At 90 DAP highest plant height (198.33cm), root length (48.66cm), nodal distance (9.46cm) and biomass (69.04 MT/ha) were found by the application of 66.67% urea nitrogen and 33.33% sheep manure nitrogen (T_2). Significantly different tiller number($p<0.01$) and stem diameter ($p<0.05$) were found at 90 DAP and highest value of tiller number (10.41) and stem diameter (4.82cm), respectively were obtained with the combination of 66.67% sheep manure nitrogen and 33.33% urea nitrogen (T_3).

Significantly varied CF ($p<0.01$), DM ($p<0.01$) and ash ($p<0.05$) were found at 60 DAP with highest value 33.1%, 12.07% and 15.73%, respectively. Highest CP (16.29%) was obtained with 100% urea nitrogen (T_1)at 60 DAP. DM, CP, CF, EE and ash were not significantly ($p>0.05$) influenced at 90 DAP.

5.2 Conclusion

The present study clearly shows that highly significantly varied tiller number ($p<0.01$) and stem diameter ($p<0.05$) were found at the second cutting period (at 90 DAP), though they were not significantly influenced at the time of first cutting (at 60 DAP). Plant height and biomass of Pakchong genotype were not significant ($p>0.05$) at both cuttings but their cumulative rate had been observed with the advance of age. For most of the studied agronomic growth parameters, highest values were obtained with the combination of 66.67% urea nitrogen and 33.33% sheep manure nitrogen. Significantly influenced DM ($p<0.01$), CF ($p<0.01$) and ash ($p<0.05$) were found at 60 DAP and their highest values are 12.07%, 33.1% and 16.55%, respectively. With the combination of 66.67% urea nitrogen and 33.33% sheep manure nitrogen, percentage of DM, CF and ash were obtained 11.42, 33.0 and 16.15, respectively, which could be considered as very slight differences.

CHAPTER VI

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APPENDICES

Appendix: Photographic Presentation of the Study