EVALUATION OF POTHA GRASS (*Themeda cymbaria* (Roxb.) Hack.) FOR FODDER PRODUCTION AND QUALITY

By

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THESIS

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requirement for the degree of

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Faculty of Agriculture
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VELLANIKKARA, THRISSUR - 680 656
KERALA, INDIA

2007

DECLARATION

I, hereby declare that this thesis entitled **"Evaluation of Potha grass (*Themeda cymbaria* (Roxb.)Hack.) for fodder production and quality"** is a bonafide record of research work done by me during the course of research and that it has not been previously formed the basis for the award to me of any degree, diploma, fellowship or other similar title, of any other University or Society.

Vellanikkara
18-10-2007

A. Praveen

CERTIFICATE

Certified that this thesis, entitled **"Evaluation of Potha grass (*Themeda cymbaria* (Roxb.)Hack.) for fodder production and quality"** is a bonafide record of research work done independently by **Mr.A.Praveen** under my guidance and supervision and that it has not formed the basis for the award of any degree, diploma, fellowship or associateship to him.

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We, the undersigned members of the Advisory Committee of **Mr.A.Praveen** a candidate for the degree of **Master of Science in Agriculture** with major field in **Agronomy** agree that the thesis entitled **"Evaluation of Potha grass (*Themeda cymbaria* (Roxb.)Hack.) for fodder production and quality"** may be submitted by **Mr. A.Praveen** in partial fulfillment of the requirements for the degree.

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Introduction

1. INTRODUCTION

India is home for about 15 per cent of world's livestock population. According to 2003 livestock census, out of the 485 million heads of livestock in India, cattle and buffaloes constitute 283.1 million. However, the level of milk production is 100 million tonnes only (Balaraman, 2007). A major reason for the low productivity is malnutrition of milch animals. Most of the animals subsist on farm residues such as dry stalks and straws, which are very poor in nutrients. Although the National Commission on Agriculture (1976) recommended that 10 per cent of cultivated area should be under fodder crops, still it is hovering around 4.0 per cent only due to heavy pressure from food crops.

In a situation where no more area is available for cultivation, the best alternative is to increase the productivity of cultivated fodder crops. Most of the fodder crops grown in the country show their full potential only under irrigation. However, there are many areas in India, which cannot be brought under irrigation due to several constraints. In such circumstances, farmers have to depend upon rainfed fodder crops with good yield potential. It has been observed that the performance of most of the introduced tropical forage crops is low in rainfed situations. In such situations, however, native grasses may perform better. Several forage species endemic to western ghats are not fully explored and utilized. In fact, most of the fodder grasses, which we grow, are introduced from other parts of the tropics. There is a likelihood of loss of biodiversity, if cultivation of introduced fodder species is done in extensive areas. Attempts should be made to promote native fodder grasses with good yield potential.

Potha grass (*Themeda cymbaria* (Roxb.) Hack.) is one such promising native grass grown in parts of central Kerala. It is very common along the hill slopes, margins of the forests (sometimes inside the forests also), grass lands and banks of streams, and often associated with *Pennisetum polystachyon* and *Cymbopogan flexuosus* (Sreekumar and Nair, 1991). It is generally used for stabilizing earthen and stone pitched terrace walls. Potha grass is cut and fed to cattle in the region. The culms and leaves can be used for thatching and as mulch in cardamom nurseries (Thomas, 2003). It is a hardy grass and farmers get sizable quantity of herbage during summer without irrigation. The grass can tolerate drought to a great extent.

However, compared to many introduced grasses, only scanty information is available on the performance or quality of Potha grass. The present investigation was taken up to evaluate *Themeda cymbaria* for its fodder production potential by comparing it with Guinea grass. Guinea grass (*Panicum maximum*) is one of the major fodder grasses grown in Kerala for its high fodder production potential. The cultivar Makueni was selected for comparison because of its ability to withstand drought conditions.

The investigation was planned with the following main objectives.

1. To study the growth and phenology of *T.cymbaria.*
2. To evaluate the fodder production potential under irrigated and rainfed condition at different cutting regimes.
3. To assess the comparative nutritive value of *T.cymbaria* and Guinea grass cv. Makueni.

Review of Literature

2. REVIEW OF LITERATURE

Potha grass (*Themeda cymbaria* (Roxb.) Hack). is a popular grass in the parts of central Kerala, generally used for stabilizing earthen and stone pitched terrace walls. According to Thomas (2003), it is a hardy grass and can survive drought. It is reported to be a perennial, densely tufted, rhizomatous grass and laterally compressed at the base. Gamble (1928) recorded five species of Themeda in southern parts of India. They are *Themeda triandra* Forsk., *T.quadrivalvis* O.Ktz., *T.tremula* Hack., *T.laxa* Stapf *ex* Haines. and *T.cymbaria* (Roxb.) Hack. He noted *Themeda cymbaria* (*Anthistria cymbaria* Roxb.) in the western ghats from 1000-7000 ft. According to Sreekumar and Nair (1991), the culms of Potha grass grows to 60-250 cm high, the nodes on the stem are glabrous and the leaves linear – lanceolate and acuminate, of about 20-100 cm length and 4-10 mm wide. It produces a lax, drooping panicle of 15-80 cm long with loose cluster of spikelets. The grass is propagated through slips. Although it is extensively grown in the central part of Kerala and fed to cattle, not much information is available on its fodder value and cutting management.

Guinea grass (*Panicum maximum*) is widely distributed throughout the tropics and subtropics (Van Oudtshoorn, 1991). It is well adapted to agro climatic situations of Kerala. Because of its wide adaptations, quick growth, ease of establishment, palatability, herbage yield, good persistence and good response to fertilizers, it is selected for comparing Potha grass in the present study. The review pertaining to various aspects of the present study such as phenology, growth, fodder production and nutritive value and quality is presented in this Chapter. Similar works on other grasses are also included in the review wherever the literature is found to be insufficient on the grass under investigation.

2.1.1 Phenology

The structure of a plant community changes with the season. There are certain events in the life cycle of a plant, for instance, germination, flowering, fruit set and finally death. The timing of these phases in the life cycle are dependent on environmental conditions, especially temperature and day length.

Gonzalez and Torriente (1989) studied the developmental phases of panicle of Guinea grass cv. Likoni (*Panicum maximum* cv. Likoni) sown in October 1980 and observed ten developmental stages from full flag leaf emergence to empty panicle. According to Li Sheng *et al.* (1995), the seedling stage of Guinea grass ranges from 18th April to 1st May; tiller initiation on 24th May; heading on 11th August; and seed maturity from 6th September to 10th October.

In grasses, the interval between initiation and heading varies from 30 to 50 days according to the species and the environmental conditions. In *P. maximum*, the interval between initiation and heading was reported to be one month (Noirot and Ollitrault, 1992).

The expected dates for maximum flowering in *P. maximum* was 3 days after the flag leaf stage and the end of flowering was 7 to 9 days after the first opened spikelet (Javier, 1970; Warmke, 1951; Warmke, 1954). A vigorous fertile tiller can produce a new panicle every 12 days (Noirot, 1991).

Filho *et al.* (2002), evaluated vegetative and reproductive performance of 15 genotypes of Guinea grass hybrids. According to them, reproductive tiller number/ overall tiller number was from 26.3 per cent (H-38) to 86.0 per cent (H-22), panicle number / reproductive tiller from 1.2 (H-64, H-56, H-79, H-55) to 3.4 (H-22) and panicle length ranged from 20.1 cm (H-140) to 55.2 cm (H-64) and seeds from 705 (H-21) to 1,288(H-31) per gram.

Noirot and Ollitrault (1996) recorded the number of flower spikelets among four clones of *P. maximum*. Clones C1 and 64 produced on an average 312 and 393 flowered spikelets and the number was almost double in clone 2A4 (627 spikelets) and 267 (576 spikelets).

In *P. maximum*, inflorescence includes 18–56 primary branches, each one ending in a terminal spikelet. Boonman (1971) recorded such a process called inflorescence branching in *Panicum coloratum* and *Setaria sphacelata.* Within panicle, flowering is basipetal (Warmke, 1951; Javier, 1970). The spikelets are initiated at every order of branching and at the top of the main axis (Reinheimer *et al.*, 2005). It has bifloral spikelets in which the distal floret is hermaphroditic and the proximal one is male (Zuloaga, 1979; Morrone and Zuloaga, 1992). The proximal floret meristem (about 27.25 mm diametre) is 50 per cent smaller than the distal one (about 58.11 mm diametre). The spikelets of *T.cymbaria* are 4-5 mm long , callus hairs up to 3 mm long , white, involucral spikelets 5-6 mm long , glabrous, awns slender, up to 2cm long (Sreekumar and Nair,1991).

2.1.2 Growth

According to Watkins and Lewy-Van Severen (1951), the period of the lowest growth in grasses is from February to May, and the maximum growth is from June to November. This trend is very much similar for all forage grasses. Humphreys and Partridge (1995) reported that the deep dense and fibrous root system allows Guinea grass to survive quite long during drought periods, but its growth is best under well drained soils of good fertility in high rainfall regions.

Cutting frequency increased tiller density in *Panicum virgatum, Andropogon gerardii* and *Sorghastrum nutans* (Cuomo *et al.*, 1998). Purshotham and Siddaraju (2003) reported that the tiller number was significantly higher when Guinea grass was cut for fodder cum-seed purpose at later cuts than at first cut.

In an experiment conducted by Sumamal *et al.* (2000), significant increase in number of tillers/hill was observed with an increase in irrigation frequency. They also reported that maximum number of tillers / hill were at IW: CPE ratio of 1.0.

Ludlowu *et al.* (1974) reported that in grasses, higher leaf area index (LAI) values were observed with full sunlight and lower values with decrease in light.

According to Chatterjee and Das (1989), in grass legume mixed cropping sown 30 cm apart in alternate rows, the critical LAI of the grasses was 7.5 and that of legume was 3.

Chandini (1980) reported that in Guinea grass the leaf: stem ratio was from 2.35 to 2.59. According to Jank *et al*, (1994), the leaf: stem ratio of clipped herbage from 401-Guinea grass accessions ranged from 0.3 to 8.7, and leaf percentage ranged from 25 to 87 per cent.

Leaf: stem ratio decreased with stand age (Fleischer, 1987). This decrease was comparable to other C_4 perennial bunch grasses (Le Roux and Dannhauser, 2001). According to Gangaiah and Kumar (2004), the leaf / stem ratio was the highest when irrigation schedule was at 0.75 IW: CPE ratio.

2.2.1 Fodder Production

The rate of fodder production is a function of tiller production and leaf growth (Ryle, 1970; Selvi and Subramanian,1993). Plant height, tiller number and leaf number directly influences the yield of fodder. Barbbar (1985) reported that the green fodder yield per plant was positively correlated with number of tillers per plant, number of leaves per plant and stem weight per plant. Sotomayour-Rios *et al.* (1972) observed that tillering ability and forage volume showed the highest correlation with yield. Stand density, plant maturity, soil moisture, and soil fertility are the other factors positively correlated to Guinea grass yield.

According to Singh *et al.* (1995), measurement of leafiness has been used as indicator of yield and nutritive value. Leaf number and leaf area per tiller and per plant measured leafiness, and this characteristic was closely correlated with yield and digestibility. Malaviya (1999) further developed this theme by reporting that leaf length was the morphological characteristic most highly correlated with yield.

Crowder *et al.* (1970) reported that in Colombia well fertilized and irrigated Guinea grass could produce 40 – 50 t DM/ha. Jank *et al.* (1994), while studying

426 different accessions in Brazil, observed that the measured DM yield was from 6 to 53 Mg ha^{-1}. In India, annual yield of 226 t fresh herbage/ha in 12 cuts was reported for the sewage irrigated grass (Narayanan and Dabadghao, 1972). Reports from Thailand indicated fairly higher yields (20 t DM/ ha/ year) in the first two years of growth when the grass was well fertilized with NPK and irrigated during the dry season (Holm, 1972). However, lower yields were reported by Borget (1966) in French Guiana (14.4 t DM/ha) but, more realistic yields range mostly between 4 and 12 t DM/ha or between 15 and 50 t/ha fresh herbage. The yield depends on the cultivar, soil fertility, fertilizers applied, rainfall and management.

Irrigation increased yield considerably. Srivastava and Bhatnagar (1995) noted that in Uttar Pradesh hills a single irrigation of 50 mm during April- May boosted the yield of pastures by 45.32 per cent. The yield was improved by 101 per cent when the irrigation depth was 200 mm. Filho (1978) studied the effect of summer and winter irrigation in *Brachiaria decumbens*, and observed that average annual fresh matter yield was 18.8 kg per plant with irrigation and 14.7 kg per plant without irrigation.

In an experiment conducted by Segui *et al.* (1984) in Cuba, correlation between yield and irrigation was tested in 100 cultivars of Guinea grass. The grass was grown under two moisture regimes - irrigated and rainfed. No remarkable yield differences was found between irrigated and rainfed treatments.

Guinea grass when grown at College of Agriculture, Vellayani, Kerala, a sole crop produced 8.37 t of green fodder and 1.52 t/ha of dry fodder from a single cut (Krishnaraj, 1976). Pillai (1986) reported that Guinea grass produced 7.55.t/ha of dry fodder from three cuts. Chandini and Pillai (1980) reported that Guinea grass produced 8.74, 11.91 and 5.16 t/ha of green fodder from the first, second, third cuts, respectively. It was reported that Guinea grass cv. Makueni produced as much as 46 tonnes of fresh fodder and 15 t/ha of dry fodder in five cuts (Anon., 1983). Paterson (1936) observed that very early cutting reduced yields, According to him, frequent cutting impairs the vigor of the plant and results in small under stools. Watkins and Lewy-Van Severen (1951) showed that yields increase when the interval of cutting is increased. According to Nemoto *et al.* (1977), higher the cutting frequency, higher the forage yield. However, green fodder yield showed a diminishing trend with the progressive increase in the number of cuttings (Ramasamy *et al.*, 1993). Forage dry matter production increases as length of cutting interval increased (Van Man and Wiktorsson, 2003).

Guinea grass var. Makueni and Golden Timothy grass produced maximum dry matter and crude protein yields when they were harvested at 40 days intervals (Singh and Pradhan, 1995).

Green fodder yield was significantly higher in Guinea grass when cut for both fodder and seed purposes in third and fourth cuts as compared to first and second cuts. The increase in green fodder yield with fourth cut for fodder- cum-seed purpose was 22.8, 20.2 and 10.3 per cent higher than first, second and third cuts, respectively (Purshotham and Siddaraju, 2003). They also reported green fodder yield of 55-58.5 t/ha and a seed yield of 105-115 kg /ha with close row spacing of 30 or 45 cm and fourth cut for fodder-cum-seed purpose.

According to Louw (1938), considerable quantity of dry matter was produced by two months cutting intervals up to six months. Watkins and Lewy-Van Severen (1951) observed maximum green forage and dry matter yield per acre from Guinea grass when it was cut at every three months at 12 inches height.

Li Sheng *et al.* (1995) reported a herbage yield of 2800 kg/ha in Guinea grass when it was cut at jointing stage. Guinea grass regrows quickly, even in short grazing rotation (Gomide and Gomide, 2001).

In general, longer cutting intervals reduces the quality of herbage. When the grasses were cut at every 90 days, the forage was of poor quality indicated by its low protein and mineral content, and high lignin content (Vicente-Chandler *et al.*, 1959). On the other hand, when the forage was cut at every 40 days, the quality was excellent but yields were lower. Generally, a 60-day harvest interval would produce reasonably high yield and quality.

2.2.2 Nutritive value and quality

Crude protein, crude fibre, ash content, ether extract (EE), and nitrogen free extract (NFE) give an overall idea of nutrient composition of a grass. Minerals like phosphorous, potassium, calcium, and magnesium are also important in livestock nutrition.

Crude protein gives an approximate value of the protein content in the forages. The crude protein content of Guinea grass differs according to cultivar and growing conditions. In general, adequate fertilization and supplemental water increased forage production and its crude protein content (Hanson, *et al.*, 1978) Butterworth (1967) observed that the crude protein (CP) content of Guinea grass ranged from 4 to 14 per cent. (Chandini and Pillai, 1980) reported the crude protein content of Guinea grass to be 8.96 per cent

The crude protein contents of *Cynodon dactylon* and *Brachiaria decumbens* at flowering stage were reported to be 8.7 and 9.1 per cent (Grieve and Osburn, 1965). Krishnaraj (1976) observed that Guinea grass yielding 8.3 Mg of fresh weight yield could produce 195.5 kg/ha of crude protein. According to Eschie (1992), at the early stage of anthesis, the crude protein content of Guinea grass was 9.3 per cent.

According to Guyadeen (1949), the crude protein content of Guinea grass cv. Coloniao and Elephant grass (*Pennisetum purpureum*) were 7.34 and 6.77 per cent, respectively on moisture free basis at 12 week stage. The crude protein content of perennial grasses like *Cynodon dactylon, Brachiaria brizantha, Sporobolus indicus* and *Panicum maximum* were 116, 86, 79 and 69 g / kg dry matter respectively (Youssef and Brathwaite, 1987).

In Guinea grass, nitrogen application in general increases crude protein content (Little *et al.*, 1959; Vicente-Chandler *et al.*, 1959; Oakes, 1966; Kandaswamy *et al.*, 1973; and Chandramani *et al.*, 1975). Malkov *et al.*, (1978) observed that in irrigated pastures of Brazil, application of nitrogen improved the crude protein content of herbage.

Cutting frequency is likely to affect the nutritive content. According to Wilsie *et al.* (1940), protein content of Napier grass decreased as harvest interval was lengthened. According to Cameron and Lachance (1970), dry matter, protein and fibre digestion coefficients were higher for early cut and lower for late cut herbage. Almar *et al.* (1997) reported that the crude protein content of Italian rye grass decreased with delay in cutting. The forage quality, in terms of crude protein content, increases as the length of cutting intervals increases (Van Man and Wiktorsson, 2003).

Fibre content of forages is important for rumination. Grasses, in general, contain more crude fibre than legumes. The crude fibre (CF) content of Guinea grass ranges from 28 to 36 per cent (Chatterjee and Das, 1989). Sumamal *et al.* (2000), reported the crude fibre content of purple Guinea grass hay as 37.2 per cent. Vicente-Chandler *et al.* (1959) noticed increased forage fibre content by increasing nitrogen doses in Guinea grass and Napier grass.

Sreeramulu and Chande (1983) reported the ash yield of *Cynodon dactylon, Eleusine indica, Eragrostis superba, Rhynchelytrum repens, Sporobolus pyramidalis* and *Panicum maximum* as 14.6, 12.6, 6.6, 9.8, 9.2 and 11.5 per cent respectively. According to Ranjhan (1991), the ash content of *Cynodon dactylon, Echinochloa colonum* and *Panicum maximum* were 11.6, 8 and 16 per cent respectively. Lower ash content of 4.61 per cent on the Guinea grass leaf sheath at early anthesis was reported by Eschie (1992). According to Sumamal *et al.* (2000), ash content of purple Guinea grass hay was 14.3 per cent.

Guinea grass contains ether extract of 0.6 to 2.8 per cent and nitrogen free extract of 40 to 50 per cent (Chatterjee and Das, 1989). Sumamal *et al.* (2000)

reported that purple Guinea grass hay contained 1.06 and 37.1 per cent ether extract and nitrogen free extract respectively.

Phosphorus content of Guinea grass, Napier grass and Para grass were 0.15, 0.4, and 0.8 percent respectively according to Chatterjee and Das (1989). Eschie (1992) reported that the phosphorus content of Guinea grass leaf blade at early anthesis was 0.29 g kg^{-1} dry matter.

Thangamuthu *et al.* (1974) found that the application of phosphorus had no effect on the crude protein content but increased the phosphorus content of the forage. Rathore and Vijay (1977) noticed a decreasing trend in the phosphorus content of the grass due to nitrogen application.

Vicente-Chandler *et al.* (1959) observed that the phosphorus and potassium contents of three tropical grasses, Napier grass, Guinea grass and Para grass decreased markedly with length of harvest interval.

Bosworth *et al.* (1980) analyzed the potassium content of grasses and found that the contents were 3.1, 3.2, 2.7 and 2 per cent respectively in Texas Panicum, Crab grass, Crowfoot grass and Bermuda grass at flowering stage.

In a study conducted by Silva *et al.* (1982), calcium concentration of Guinea grass forage was 336 mg/kg in the dry season; and 436 mg/kg during the growing season.

A study conducted by Sreeramulu and Chande (1983), on *Cynodon dactylon, Dactyloctenium germinatum, Eleusine indica, Eragrostis superba, Rhynchelytrum repens, Sporobolus pyramidalis* and *Panicum maximum* revealed that the calcium content ranged from 0.2 to 0.9 per cent. The calcium content of Guinea grass herbage was from 0.52 and 0.69 per cent (Chatterjee and Das, 1989).

According to Bosworth *et al.* (1980), magnesium content of grasses like *Panicum texacum, Digitaria sanguinalis, Dactyloctenium aegyptium,* and *Cynodon dactylon* at flowering stage were 0.35, 0.33, 0.33 and 0.22 per cent respectively. The calcium and magnesium content of three tropical grasses like Napier grass, Guinea grass and Para grass decreased markedly with length of harvest interval (Vicente-Chandler *et al.*, 1959). Magnesium concentration of Guinea grass in Brazil varied from 142 mg/kg during the dry season to 159 mg/kg during the growing season. (Silva *et al.*, 1982).

According to Weber and Hagg (1984), phosphorus and calcium concentration increased with Guinea grass maturity, whereas potassium and magnesium concentration remained constant.

High oxalate content in the forages is harmful to animal health. Sen (1953) gave an account of the oxalic acid contents of various Indian feeding stuffs. According to him, the oxalate content of Guinea grass varies from 2.00 per cent in early cut fodders to 0.80 per cent in dead ripe fodders. Early cut Napier has 3.06 per cent, where as in dead ripe Napier, it was only 0.65 per cent.

Materials and Methods

3. MATERIALS AND METHODS

Field experiments were conducted during the year 2006-07 to evaluate Potha grass (*Themeda cymbaria* (Roxb.) Hack.) for fodder production and quality. Comparision was made with Potha grass and Guinea grass (*Panicum maximum*) cv. Makueni. The details of the materials used and methods adopted for the study are reported in this Chapter.

3.1 General details

Experiment site

The experiments were conducted at the Agronomy Research Farm of College of Horticulture, Kerala Agricultural University. Geographically, the area is situated at 10°31'N latitude and 76°13' E longitude and at an altitude of 40.3 m above mean sea level.

Soil

The soil of the experiment site was sandy clay loam in texture (Order: Ultisols). Physico-chemical properties of the soil are given in Table.1

Climate

The weather data recorded during the cropping period (August 2006 to September 2007) are given in Appendix I and graphically presented in Fig. 1 and Fig. 2.

Field operations

The selected area for the experiment was ploughed, stubbles removed, levelled and laid out in to plots as per the lay out plan.

Table 1. Physico-chemical properties of the soil

Particulars	Content	Method used
A. Mechanical composition		
Coarse sand (%)	27.20	Robinson international pipette method (Piper, 1942)
Fine sand (%)	23.70	
Silt (%)	22.20	
Clay (%)	26.90	
B. Chemical composition		
Organic C (%)	0.36	Walkley and Black method (Jackson, 1958)
Available N (kg ha^{-1})	213.45	Alkaline permanganate method (Subbiah & Asija, 1956)
Available P (kg ha^{-1})	20.83	Ascorbic acid reduced molybdophosphoric blue colour method (Watnabe and Olsen, 1965)
Available K (kg ha^{-1})	98.45	Neutral normal ammonium acetate extractant flame photometry (Jackson, 1958)

Fig.1. Weather Data during crop period (August 2006 to September 2007) at Vellanikkara, Thrissur.

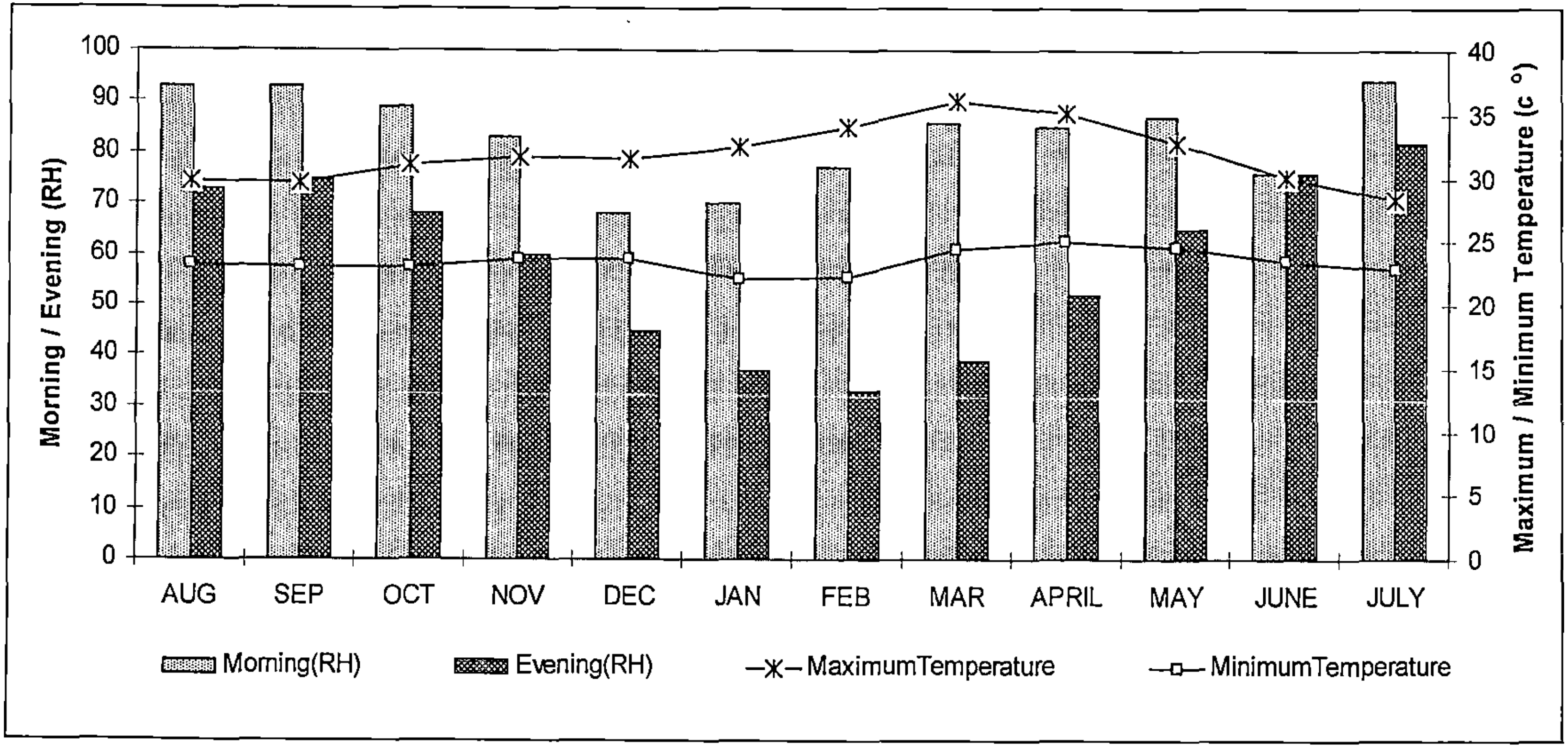
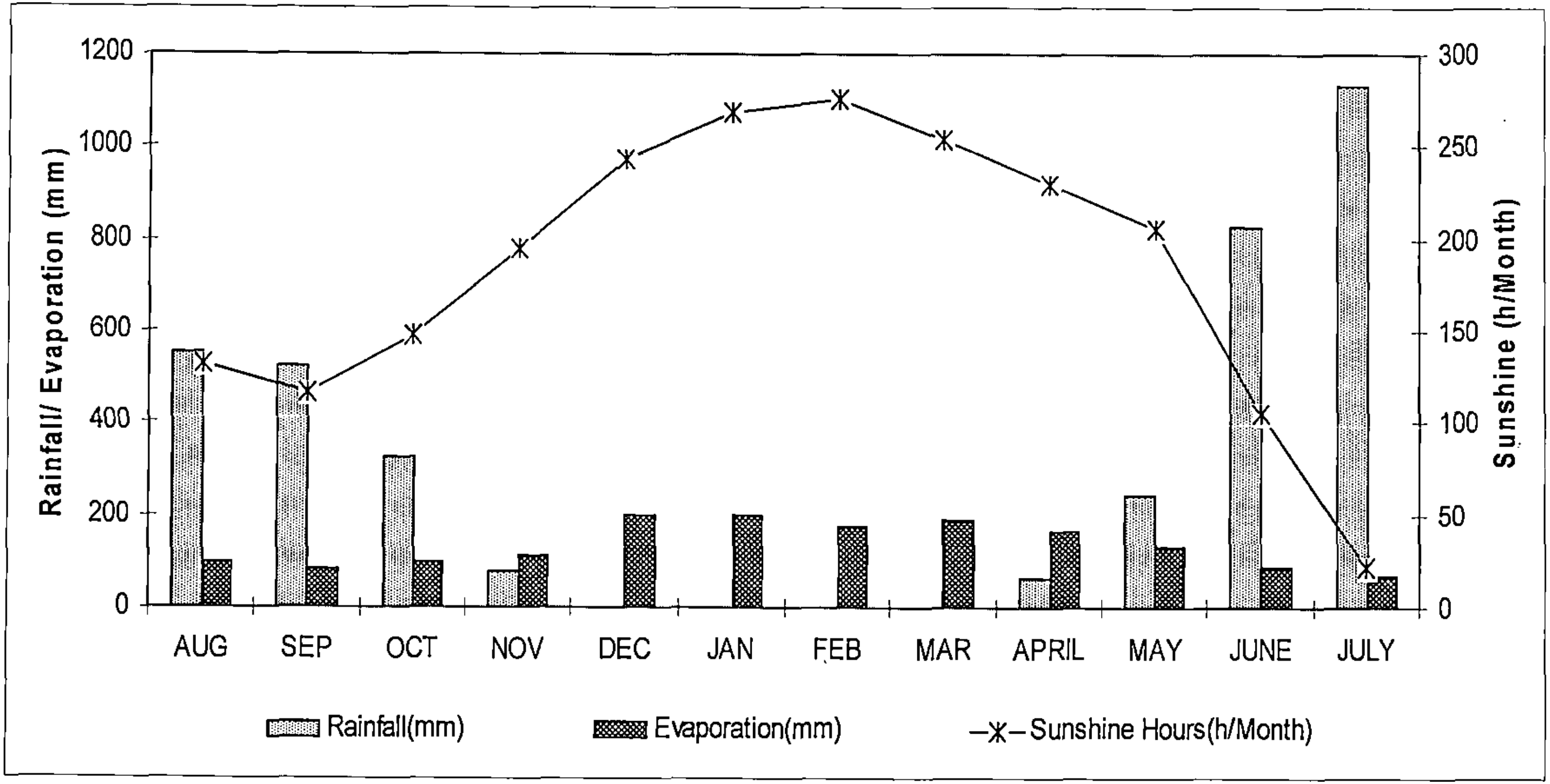


Fig.2. Weather Data during crop period (August 2006 to September 2007) at Vellanikkara, Thrissur.



Planting

Rooted slips of *Themeda cymberia* (Potha) and *Panicum maximum* cv. Makueni (Guinea grass) were planted during August (Experiment-1) and September (Experiment-2) 2006. Spacing followed was 60 cm x 30 cm, and two planted slips were planted.

Gap filling and one hand weeding were done 15 days after planting slips. Both grasses were given N: P: K fertilizers @ 200: 50: 50 kg/ha, as recommended for Guinea grass.

3.2 Experiment details

The investigation involved two experiments, the details which are given below.

Experiment 1: Phenology and growth analysis

Observed on the following major phenological stages were recorded

1. Vegetative growth
2. Flowering
3. Seed formation
4. Seed maturity
5. Senescence
6. Regeneration.

At maturity, the following observations were taken.

(i) Plant height

(ii) Number of tillers per plant

(iii) Number of spikelets per plant

(iv) Number of spikelets per panicle.

Growth analysis

At monthly intervals, observations on growth characters were taken. Three plants were uprooted randomly from each plot. Based on the observations, derived variables such as Relative Growth Rate (RGR), Net Assimilation Rate (NAR), Absolute Growth Rate (AGR), Leaf Weight Ratio (LWR), Specific Leaf Area (SLA), Leaf Area Ratio (LAR), Leaf Area Duration (LAD) as detailed by Gardner *et al.* (1985) and Dhopte and Livera (1989) were calculated. The following growth analysis characters were estimated.

(i) Plant height

Plant height in cm was recorded from the base of plant to the tip of the top most leaf during vegetative growth stage and from the base to the tip of inflorescence at maturity stage.

(ii) Number of leaves per plant

Numbers of leaves were counted at different stages of observation and the mean were worked out.

(iii) Leaf area per plant

Leaf area was measured by a leaf area meter. It is measured in cm^2.

(iv) Dry matter production

Pulled out plants were initially sun dried, then oven dried at $80^{\circ} \pm 5^{\circ}C$ and above ground weight was recorded. Mean weight of the plant was expressed in g.

(v) Stem and leaf weight of the plant

Stems, leaves and roots were separated from whole plants. Fresh weight and dry weight of different parts were recorded separately. Leaf: stem ratio was also worked out.

(vi) Derived growth variables

Different growth indices were worked out as shown below.

1. Leaf Area Ratio (LAR) = $\frac{(La_2 - La_1)}{(\ln La_2 - \ln La_1)} \times \frac{(\ln W_2 - \ln W_1)}{(W2 - W1)}$ $cm^2\ g^{-1}$

Where, La_1 and La_2 are total leaf area and W_1 and W_2 are the total dry weight.

2. Leaf Weight Ratio (LWR) = LW/ W

LW – Total leaf weight in g, W – Whole plant dry weight in g.

3. Specific Leaf Area (SLA) = La / LW ($cm^2\ g^{-1}$)

La - Leaf area in cm^2, LW - Leaf weight in g.

4. Leaf Area Duration (LAD) = $\frac{(La_2 - La_1)}{(\ln La_2 - \ln La_1)} \times (t_2 - t_1)$ dm^2 days

Where, La_1 and La_2 are total leaf area at time t_1 and t_2 days.

5. Absolute Growth Rate (AGR) = $\frac{(W_2 - W_1)}{(t_2 - t_1)}$ g day^{-1}

Where, W_1 and W_2 are the total dry weight at time t_1 and t_2 days.

6. Relative Growth Rate (RGR) = $\frac{(\ln W_2 - \ln W_1)}{(t_2 - t_1)}$ g g^{-1} day^{-1}

Where, W_1 and W_2 are total dry weight at time t_1 and t_2 days.

7. Net Assimilation Rate (NAR) = $\frac{(W_2 - W_1)\ (\ln La_2 - \ln La_1)}{(t_2 - t_1)\ (La_2 - La_1)}$ g m $^{-2}$ day $^{-1}$

Where La_1 and La_2 are total leaf area at time t_1 and t_2 and w_1 and w_2 are total dry weights during the same period.

Experiment 2: Fodder production potential

An experiment was conducted to compare the growth indices and fodder production potential of *Themeda cymbaria* and *Panicum maximum* cv. Makueni. The experiment was laid out in split plot design with four major treatments and three minor treatments in the crop museum area, where fixed plots of size 4 m x 3 m were already laid out. The slips were planted at a spacing of 60 cm x 30 cm. There were 6 rows spaced at 60 cm apart leaving borders of 50 cm on either sides. In each row, 10 hills at 30 cm spacing were accommodated. The net plot size was 2.4 m x 2.4 m and in this net area, there were 4 rows with 8 hills each. The field lay out is presented in Fig.3. Treatment details are as shown below.

Treatments:

Main plots:

1. Irrigated Guinea
2. Rainfed Guinea
3. Irrigated Potha
4. Rainfed Potha

Sub plots:

C_1 - Cutting at 30 days interval

C_2 - Cutting at 45 days interval

C_3 - Cutting at 60 days interval

Fig. 3. Layout of experiment

N

R_1 R_2 4 m

3 m

RPC_1	RGC_2	IPC_3	IGC_2	RGC_1	RGC_3	RGC_2
RPC_2	RGC_3	IPC_2	IGC_1	RPC_2	RPC_1	RPC_3
RPC_3	RGC_1	IPC_1	IGC_3	IPC_1	IPC_2	IPC_3
IPC_2	IPC_3	IPC_1		IGC_1	IGC_2	IGC_3
RPC_3	RPC_2	RPC_1	IPC_1	IGC_2	RPC_3	RGC_1
IGC_2	IGC_1	IGC_3	IPC_2	IGC_1	RPC_2	RGC_2
RGC_1	RGC_3	RGC_2	IPC_3	IGC_3	RPC_1	RGC_3

R_3 R_4

R_1, R_2, R_3, R_4 - Replications

IP - Irrigated Potha

RP - Rainfed Potha

IG - Irrigated Guinea

RG - Rainfed Guinea

C1 - Cutting at 30 day interval

C2 - Cutting at 45 day interval

C3 - Cutting at 60 day interval

Plate 1. General view of the experimental field

Plate 2. Potha grass (*Themeda cymbaria*)

(I) Biometric observations

At different cutting intervals, three plants were uprooted randomly from each plot and following observations on the following growth characters were taken.

(i) Plant height

Plant height in cm was recorded from the base of plant to the tip of the top most leaf during vegetative growth stage and from the base to the tip of inflorescence at maturity stage.

(ii) Number of leaves per plant

Number leaves were counted at different stages of observation and the means were worked out.

(iii) Leaf Area Index (LAI)

It refers to the ratio of leaf area (one side) to ground area.The leaf area noted from the uprooted plants were used to arrive at LAI.

(iv) Stem weight

Stem parts, leaves and roots were separated from the whole plant, oven dried and dry weight of separated stems was recorded in g.

(v) Leaf weight

Separated leaves from each plant were oven dried and the dry weight of the leaves was expressed in g.

(vi) Green fodder yield

The green fodder yield from each plot was recorded immediately after cutting at each interval. The yield of green fodder in kg ha^{-1} was recorded.

(viii) Dry fodder yield

The fodder from each cut was sun dried and weight of this sun-dried fodder was recorded. From this, the yield of dry fodder in kg ha^{-1} was calculated.

(II) Nutritive value and quality

Plant samples from all the treatments were collected at 90 days after planting and were analyzed to determine following parameters, nutritive value.

(i) Crude Protein

Plant nitrogen content was estimated by microkjeldhal digestion and distillation method (Jackson, 1958). This content was multiplied by 6.25 to obtain crude protein content of the sample.

(ii) Crude Fibre

The crude fibre content was estimated using the acid-alkali digestion method (Sadasivam and Manickam, 1996).

(iii) Ether Extract (Crude fat)

Crude fat was estimated by extracting the plant material with fat solvent, petroleum benzene. (A.O.A.C, 1975).

(v) Ash content

Ash content was determined by igniting a known quantity of plant sample at 500°C for one hour.

(iv) Nitrogen Free Extract (NFE)

Nitrogen free extract of the plant sample was obtained by subtracting crude protein, crude fibre, ether extract and ash content values from the original sample dry weight.

(vi) Phosphorus

Plant samples were digested in the diacid mixture and the phosphorus content was determined by Vanedomolybdo phosphoric yellow colour method (Jackson, 1958). The intensity of colour was read using Spectrophotometer at 420 nm.

(vii) Potassium

Potassium present in the diacid mixture was estimated using EEL Flame photometer (Jackson, 1958).

(viii) Calcium and Magnesium

By using diacid mixture, Ca and Mg present in plant sample were read by AAS (Atomic Absorption Spectrometer) (Jackson, 1958).

(ix) Oxalate content

Oxalate content in the sample was analysed colorimetrically as suggested by Marderosian *et al.* (1979). The dried plant material was powdered and 0.5 g of the sample was added to 10 ml of distilled water followed 10 ml citric acid reagent. The oxalates were extracted by shaking for 10 minutes at room temperature. The extract was filtered and the precipitate dissolved in 50 ml of 0.4 N hydrochloric acid by shaking for 10 minutes. The sample was filtered and 2 ml of the filtrate was added to 2 ml of diluted ferron reagent and absorbance was read at 540nm in a spectrophotometer. The oxalate content of the dried sample was calculated from the standard graph and expressed on fresh weight basis.

3.3 Data analysis

Analysis of variance was performed on the data collected using the statistical package 'MSTAT' (Freed, 1986).

Results

4. RESULTS

Field and laboratory experiments on various aspects of phenology, growth, fodder production potential and nutrient composition of Potha grass were conducted during the period 2006-07 at the College of Horticulture, Vellanikkara. Comparisons were made with Guinea grass cv. Makueni. The data collected was tabulated, analysed and the results obtained are presented below.

4.1 Exp. I. Phenology and growth

4.1.1 Phenology

Phenological characters of *Themeda cymbaria* and *Panicum maximum* were studied from a population maintained without defoliation during the year 2006-07 and observations are presented in Table 2.

Vegetative growth

Slips were planted on August 6, 2006. In the case of Guinea grass, vegetative growth period started from the time of planting. Vegetative growth continued, although flowering was observed from January. In the case of *Themeda cymbaria*, after establishment, vegetative growth started from the middle of August and continued until the end of experiment (July 2007).

Flowering

In *Themeda cymbaria,* flowering was not observed during the experiment period (August 2006 - July 2007). In *P.maximum*, flowering period started by the beginning of January and continued up to July 2007.

Seed formation and maturation

In *Panicum maximum*, seed formation started in the middle of February and continued till the end of the month. Seed maturation began in late February

Table 2. Phenological events of *Themeda cymbaria* and *Panicum maximum*

Character	Guinea grass cv. Makueni	Potha grass
Time of planting	Early August	Early August
Commencement of growth	Early August	Mid August
Flowering	Early January	----
Seed formation	Mid February	
Seed maturity	Late February	----
Senescence	No	No
Plant height at flowering (cm)	126-242	----
Number of tillers per plant	9-21	7-18
Number of spikelets per plant	8744-25296	----
Number of spikelets per panicle	2109	----

and extended up to middle of March. As there was no flowering, seed characters could not be observed in *Themeda cymbaria*.

Senescence

Senescence was not observed in both the grasses during the period of experiment. Flowering and vegetative growth went simultaneously in Guinea grass. However, in Potha grass vegetative growth continued until the end of experiment.

Vegetative and seed characters at maturity

Guinea grass showed the maximum height of 126 cm at initial stage of maturity; and 242 cm at the end of the experiment. On an average 12 panicles per plant were observed. A single panicle had 2109 mean number of spikelets and mean number of spikelets per plant ranged from 8744 to 25296. As *Themeda cymbaria* did not flower, such characters could not be observed.

4.1.2 Growth

Plant height

Plant height of *T.cymbaria* and *P.maximum* at different months are presented in Tables 3 and 4, and Fig.4. The grasses showed proportionate increase in height as the time progressed. During the summer period from February to April, plants showed retarded growth. However, rapid elongation of plants was observed during May to June. At all the stages of observation, *P.maximum* showed higher height than *T.cymbaria* and the maximum height was recorded at 330 days after planting.

Number of leaves

Number of leaves per plant of *T.cymbaria* and *P.maximum* at monthly intervals are given in Tables 3 and 4 and Fig.5. Leaf number showed a similar trend to that of plant height. Throughout the period, Guinea grass showed more number of leaves than Potha grass.

Leaf area per plant

Leaf area per plant of *T.cymbaria* and *P.maximum* were taken at monthly intervals and the data are presented in Tables 3 and 4 and Fig.6. Leaf area showed a gradual increase in both *T.cymbaria* and *P.maximum* through out the experimental period. However, decrease in leaf area was observed in *Themeda cymbaria* during February and March. Maximum leaf area was recorded during June-July in both the grasses. Between the two, higher leaf area was recorded in Guinea grass than Potha grass.

Dry matter production

Data pertaining to dry matter production of *T.cymbaria* and *P.maximum* are presented in Tables 3 and 4 and Fig.7. An increase in dry matter content of the plant was observed as growing period advances. In both grasses, higher dry matter production was obtained during rainy season as compared to summer season. Compared to Potha grass, Guinea grass showed higher dry matter production.

Stem weight

Data on stem weight of *T.cymbaria* and *P.maximum* are presented in Tables 3 and 4 and Fig.8. Stem weight could not be recorded until April (240 days) and March (180 days) in *T.cymbaria* and *P.maximum* respectively as they were not developed fully. However, stem weight was recorded at 270 days (May) in Potha and at 210 days (March) in Guinea grass. Guinea grass recorded higher stem weight compared to Potha grass.

Leaf weight

Data on leaf weight of the two grasses are presented in Tables 3 and 4 and Fig.9. At the initial stages, similar leaf weights were recorded for Potha and

Guinea grasses. However, at the later stages, they showed variation in weight and Guinea grass has recorded higher leaf weight than Potha grass. For both grasses, maximum leaf weight was observed during June - July.

Leaf Stem Ratio

Data on leaf: stem ratio of the taken species are presented in Tables 3 and 4 and Fig.10. Leaf: stem ratio was recorded during the last 3 to 5 months (March-July) as stem weight could not recorded in the initial stages. Maximum leaf: stem ratio was recorded during the initial stages in both grasses and then showed decreasing trend until the end of the experiment.

Net Assimilation Rate

The net assimilation rate of the fodder grasses evaluated at different months is presented in Tables 3 and 4 and Fig.11. NAR was high at the initial and final stages of experiment in both grasses. During summer, net assimilation rate declined but on receipt of pre-monsoon rains, NAR improved. Guinea grass showed higher NAR than Potha grass throughout the experiment.

Absolute Growth Rate

The absolute growth rate (AGR) of *T.cymbaria* and *P.maximum* at different months is presented in Tables 3 and 4 and Fig.12. AGR in both grasses increased gradually with time, although a decreasing trend was observed during summer period. However, with the onset of monsoon the growth rate was very high in May and June and then started showing declining trend. Between the grasses, Guinea grass has shown higher AGR than Potha grass in all its growing months.

Relative Growth Rate

Relative growth rate (RGR) of the two grasses are presented in Tables 3 and 4 and Fig.13. Initially RGR of both grasses was high and then started showing a declining trend, during the summer season (April). Guinea grass has shown more RGR than Potha grass at different monthly intervals.

Leaf Weight Ratio

The leaf weight ratio (LWR) of *T.cymbaria* and *P.maximum* at different months are presented in Tables 3 and 4 and Fig.14. The data reveals that both grasses were showing gradual increase in leaf weight ratio until April. The LWR was less in potha grass during February and March and in Guinea grass during January - February. With the onset of monsoon, the leaf weight ratio declined. Potha grass has recorded higher leaf weight ratio than Guinea grass.

Specific Leaf Area

The data on specific leaf area (SLA) of the two grasses are presented in Tables 3 and 4 and Fig.15. The specific leaf area of both grasses showed high values during the initial 30 days. After that, SLA declined until the end of experiment. Guinea grass has shown higher specific leaf area compared to Potha grass. However, less SLA was recorded for both grasses during summer period (March-April) than rainy season (June -July).

Leaf Area Ratio

The leaf area ratio of *T.cymbaria* and *P.maximum* at different months is presented in Tables 3 and 4 and Fig.16. A gradual increase in LAR was observed during the initial three months (Sep. – Nov.) and then showed decreasing trend up to the summer season (April). After the onset of monsoon, there was an increase in leaf area ratio up to the end of experiment in July. On an average, LAR was higher in Guinea grass than Potha grass.

Leaf Area Duration

The leaf area duration of *T.cymbaria* and *P.maximum* at different months are presented in Tables 3 and 4 and Fig.17. There was a gradual increase in LAD

Table.3 Growth analysis of *T.cymbaria* at monthly intervals

Growth Characters / *Months*	*SEP*	*OCT*	*NOV*	*DEC*	*JAN*	*FEB*	*MAR*	*APR*	*MAY*	*JUNE*	*JULY*
Days	**30**	**60**	**90**	**120**	**150**	**180**	**210**	**240**	**270**	**300**	**330**
Plant height (cm)	56	64	77	97	89	105	102	106	126	165	187
No. of leaves per plant	19	32	56	86	144	130	126	210	243	363	386
Leaf area per plant (cm^2)	1512	2479	3202	3642	4271	3854	3824	4671	7569	20141	22014
Dry matter per plant (g)	6	9	24	57	86	94	124	156	252	460	567
Stem weight per plant (g)	0	0	0	0	0	0	0	0	36	120	146
Leaf weight per plant (g)	6	9	24	57	86	94	124	156	216	340	421
Leaf : Stem ratio	0	0	0	0	0	0	0	0	6	2.8	2.9
Net Assimilation Rate ($g\ m^{-2}\ day^{-1}$)	1.45	8.45	2.04	3.25	1.19	4.24	2.89	1.42	1.05	3.98	2.05
Absolute Growth Rate ($g\ day^{-1}$)	0.30	0.16	0.56	1.10	0.50	1.76	0.86	0.66	6.20	5.10	1.60
Relative Growth Rate ($g\ g^{-1} day^{-1}$)	0.07	0.01	0.03	0.02	0.01	0.01	0.01	0.01	0.03	0.01	0.01
Leaf Weight Ratio	0.66	0.64	0.77	0.89	1.08	0.71	0.78	0.87	0.62	0.67	0.76
Specific Leaf Area ($cm^2 g^{-1}$)	252	275	133	63	49	41	30	29	35	59	52
Leaf Area Ratio ($cm^2\ g^{-1}$)	50.30	174	131	73.90	58.7	40.90	20.80	4.70	24.50	30.18	43.90
Leaf Area Duration (dm^2 days)	0.61	5.92	8.34	10.20	12.60	12.50	9.00	14.10	17.70	38.48	70.20

Table.4 Growth analysis of *P.maximum* at monthly intervals

Growth Characters \ *Months*	*SEP*	*OCT*	*NOV*	*DEC*	*JAN*	*FEB*	*MAR*	*APR*	*MAY*	*JUNE*	*JULY*
Days	**30**	**60**	**90**	**120**	**150**	**180**	**210**	**240**	**270**	**300**	**330**
Plant height (cm)	76	85	92	110	126	124	121	129	147	235	242
No. of leaves per plant	22	32	103	127	161	179	189	246	329	565	540
Leaf area per plant (cm^2)	2645	3874	3977	6199	7614	7894	8436	9875	19247	34019	32641
Dry matter per plant (g)	6	12	30	51	84	94	151	212	386	587	687
Stem weight per plant (g)	0	0	0	0	0	0	9	26	126	172	201
Leaf weight per plant (g)	6	12	30	51	84	94	142	186	260	415	486
Leaf : Stem ratio	0	0	0	0	0	0	15.7	7.15	2.00	2.40	2.41
Net Assimilation Rate ($g\ m^{-2}\ day^{-1}$)	8.94	1.03	8.41	2.43	3.72	4.29	4.74	2.05	4.29	5.17	4.60
Absolute Growth Rate ($g\ day^{-1}$)	0.30	0.33	0.43	1.20	2.63	0.30	0.36	1.96	6.00	13.4	1.96
Relative Growth Rate ($g\ g^{-1}day^{-1}$)	0.07	0.02	0.03	0.01	0.03	0.001	0.002	0.01	0.01	0.02	0.002
Leaf Weight Ratio	0.66	0.63	0.55	0.75	0.57	0.60	0.85	0.82	0.64	0.51	0.56
Specific Leaf Area (cm^2g^{-1})	440	322	132	121	90	83	59	53	74	81	67
Leaf Area Ratio ($cm^2\ g^{-1}$)	81.68	242.6	412	31.60	69.90	38.89	49.27	50.41	45.07	44.48	40.65
Leaf Area Duration (dm^2 days)	1.00	9.70	15.45	14.80	21.20	21.00	23.22	28.78	41.96	77.74	103.40

in both grasses as growing period continued. This increase was found to be the maximum during rainy season (June – July). During the summer season (March- April), leaf area duration was almost static. Compared to Guinea grass, Potha grass showed higher LAD.

4.2. Exp. II. Fodder production potential of *Themeda cymbaria*

Fodder production potential of *Themeda cymbaria* was compared with Guinea grass cv. Makueni under irrigated and rainfed conditions by harvesting the herbage at 30, 45 and 60 days intervals. Data on biometric and yield observations are presented in Table 5 to 28

Plant height

The plant height of *Themeda cymbaria and Panicum maximum* at cutting interval of 30 day over a period of eight months are presented in Table 5. Plant height of the grasses showed no significant difference under irrigated and rainfed conditions at 75th day cutting. In the later stages, Guinea grass showed more height than Potha grass. However, in most of the cases between irrigated and rainfed conditions there were no significant differences..

The results obtained with regard to plant height at 45 days cutting intervals during the growth period are presented in Table 6. Plant height of Potha and Guinea grass showed no significant difference under irrigated and rainfed condition at 75 and 210 day cutting. Irrigated and rainfed Potha did not show any significant difference at any of the stages, but there were significant differences between irrigated and rainfed Guinea grass at 255 and 300 days.

Data on plant height at 60 days cutting interval are presented in Table 7. Both the grasses did not show any significant difference under irrigated and rainfed conditions at 75 and 135-day cuttings, but remaining cuttings showed significant height differences under irrigated and rainfed grasses except cuttings at 195 days. In all the cases, Guinea grass had more plant height than Potha grass.

Table 5. Height of *T.cymbaria* and *P.maximum* at 30 days cutting interval

height (cm)	*Nov.*	*Dec.*	*Jan.*	*Feb.*	*Mar.*	*Apr.*	*May*	*June*
(Days)	**75**	**105**	**135**	**165**	**195**	**225**	**255**	**285**
Irrigated Potha	69.50	79.00	66.00	78.25	77.00	62.75	81.50	125.25
Rainfed Potha	66.75	67.50	64.75	55.75	55.75	58.25	75.50	120.50
Irrigated Guinea	81.25	88.00	111.80	97.00	77.00	78.00	136.25	189.50
Rainfed Guinea	73.50	83.25	70.25	77.25	70.25	72.00	97.00	187.50
CD (0.05)	NS	13.18	14.03	9.93	14.28	6.35	15.87	16.09

Table 6. Height of *T.cymbaria* and *P.maximum* at 45 days cutting interval

height (cm)	*Nov.*	*Dec.*	*Feb.*	*Mar.*	*May*	*June*
(Days)	**75**	**120**	**165**	**210**	**255**	**300**
Irrigated Potha	71.80	72.50	68.80	66.30	81.50	131.80
Rainfed Potha	66.80	82.80	72.00	60.00	78.80	126.00
Irrigated Guinea	75.80	91.80	117.00	67.80	166.00	215.50
Rainfed Guinea	79.00	88.00	90.00	71.00	136.00	192.50
CD (0.05)	NS	18.56	27.12	NS	15.82	17.59

Table 7. Height of *T.cymbaria* and *P.maximum* at 60 days cutting interval

height (cm)	*Nov.*	*Jan.*	*Mar.*	*May*	*July*
(Days)	**75**	**135**	**195**	**255**	**315**
Irrigated Potha	76.00	82.00	59.80	79.30	125.00
Rainfed Potha	69.50	73.30	58.50	80.50	132.00
Irrigated Guinea	69.30	102.00	78.30	130.00	186.00
Rainfed Guinea	77.50	81.00	67.50	150.00	210.00
CD (0.05)	NS	NS	10.70	12.73	15.95

Both grasses had less plant height during summer (Feb- April), and the plants started regaining height with the onset of monsoon during May – June. There was no significant difference between irrigated and rainfed Potha grass at any of the stages observed. However, there were significant difference for irrigation at 255 and 315 days cutting in the case of Guinea grass.

Plant heights observed 75 and 255 days after planting, where all the cutting intervals coincided (30, 45 and 60 days) are presented in Table 26. No significant differences were observed between Potha and Guinea grass under irrigated and rainfed condition at 75 day cutting. However, significant differences were observed at 255 days cutting, where Guinea grass and Potha grass showed higher plant height under irrigated condition. Between the cutting intervals, 45 days cutting interval showed higher plant heights than 30 and 60 days cutting intervals. Interaction between cutting intervals and the grasses under irrigated and rainfed condition showed no significant difference at 75th day. Significant difference was observed at 255th day cutting, with irrigated Guinea recorded the maximum height. There was no significant influence of irrigation on height of Potha grass. Grasses at 45 days cutting interval showed more height than other interactions. Interaction was significant in irrigated grasses at 60 day cutting showed the maximum height.

Number of leaves

The mean number of leaves per plant in *T.cymbaria* and *P.maximum* at different cutting intervals over eight month's period are given in Tables 8, 9 and 10. With 30 days cutting interval, significant differences were observed in the leaf number between the two grasses. In most cases, Guinea grass had more number of leaves than Potha grass. Under irrigated conditions, both grasses produced more number of leaves than rainfed conditions except 75, 105, 165, and 195-day cuttings, in which of irrigated Potha was on par with rainfed Potha.

With cutting interval of 45 days, also significant differences were observed in the leaf number between the two grasses. In all the cases, Guinea grass produced more leaf

Table 8. Number of leaves of *T.cymbaria* and *P.maximum* at 30 days cutting interval

Leaf no. per plant	*Nov.*	*Dec.*	*Jan.*	*Feb.*	*Mar.*	*Apr.*	*May*	*June*
(Days)	**75**	**105**	**135**	**165**	**195**	**225**	**255**	**285**
Irrigated Potha	18.50	78.00	67.00	55.50	47.00	54.25	125.00	179.25
Rainfed Potha	17.50	72.50	47.25	53.25	46.50	50.25	80.00	115.00
Irrigated Guinea	70.75	146.75	121.30	102.00	119.25	171.00	180.00	271.50
Rainfed Guinea	56.00	113.50	87.75	68.25	114.25	167.80	175.00	251.25
CD (0.05)	14.57	50.25	44.46	26.75	16.80	23.73	35.93	81.87

Table 9. Number of leaves of *T.cymbaria* and *P.maximum* at 45 days cutting interval

Leaf no. per plant	*Nov.*	*Dec.*	*Feb.*	*Mar.*	*May*	*June*
(Days)	**75**	**120**	**165**	**210**	**255**	**300**
Irrigated Potha	15.00	75.00	40.80	49.30	83.80	167.00
Rainfed Potha	16.30	70.00	38.60	61.80	82.80	135.50
Irrigated Guinea	74.00	143.00	186.00	136.00	231.00	415.50
Rainfed Guinea	54.80	132.00	107.00	98.00	210.00	346.80
CD (0.05)	24.96	61.74	66.42	27.37	32.2	115.26

Table 10. Number of leaves of *T.cymbaria* and *P.maximum* at 60 days cutting interval

Leaf no. per plant	*Nov.*	*Jan.*	*Mar.*	*May*	*July*
(Days)	**75**	**135**	**195**	**255**	**315**
Irrigated Potha	20.80	50.50	61.30	85.00	183.00
Rainfed Potha	15.80	70.50	53.50	78.50	174.00
Irrigated Guinea	59.80	105.00	131.00	179.00	326.00
Rainfed Guinea	66.50	114.00	109.00	156.00	300.00
CD (0.05)	21.16	21.03	25.8	25.57	90.64

number than Potha grass. In most of the cases, both grasses produced more leaves under irrigated conditions than rainfed conditions, except 75, 165, and 255-day cuttings, which showed on par results between irrigated and rainfed Potha. Number of leaves at 60-day cutting intervals also showed significant differences between the two grasses. Similar to 30 and 45-day cutting intervals, Guinea grass at 60 days cutting had more leaf number than Potha grass. The grasses produced more leaves under irrigated conditions than rainfed conditions.

The mean number of leaves per plant at initial stages (November) were very less. Number of leaves started showing a decreasing trend during summer (February -April). However, grasses grown under irrigated conditions recorded more number of leaves than under rainfed conditions. Among the different cutting intervals, 45-day cutting interval has shown more number of leaves than other cutting intervals. Number of leaves at 75 and 255 days coinciding 30, 45 and 60 days cutting intervals are presented in Table 26. The grasses showed significant differences under irrigated and rainfed conditions for both 75 and 255 days cutting. However, different cutting intervals showed no significant difference at 75th days cutting period and significant difference at 255th day in which 45 cutting interval showed more leaf number than other cutting intervals. Interaction was absent at 75th day but significant differences was observed for 255th day cutting period. Among interactions, irrigated Guinea at 45 cutting interval showed more leaf number than other interactions.

Leaf weight

The data on leaf weight of *Themeda cymbaria* and *Panicum maximum* with 30 days cutting interval is presented in Table11. Significant differences were observed on leaf weight of grasses under irrigated and rainfed condition in all its cutting period. Guinea grass showed more leaf weight than Potha grass under irrigated conditions. However, irrigated Potha grass at 75, 105, and 255 days cuttings were on par with rainfed Potha.

25-54 **Table 11. Leaf weight of *T.cymbaria* and *P.maximum* at 30 days cutting interval**

Leaf wt. in (g)/ plant	*Nov.*	*Dec.*	*Jan.*	*Feb.*	*Mar.*	*Apr.*	*May*	*June*
(*Days*)	**75**	**105**	**135**	**165**	**195**	**225**	**255**	**285**
Irrigated Potha	28.50	33.50	49.25	56.25	51.50	37.25	73.00	114.00
Rainfed Potha	27.00	30.50	42.75	50.00	47.00	38.75	69.50	98.50
Irrigated Guinea	50.00	51.25	80.25	103.00	82.75	66.75	97.25	165.00
Rainfed Guinea	59.50	45.00	70.25	79.00	77.50	62.75	83.50	141.75
CD (0.05)	19.24	14.21	19.01	14.95	12.44	6.14	9.83	20.05

Table 12. Leaf weight of *T.cymbaria* and *P.maximum* at 45 days cutting interval

Leaf wt. in (g)/ plant	*Nov.*	*Dec.*	*Feb.*	*Mar.*	*May*	*June*
(*Days*)	**75**	**120**	**165**	**210**	**255**	**300**
Irrigated Potha	27.80	34.30	54.00	48.80	88.50	125.50
Rainfed Potha	24.70	30.00	50.00	43.30	73.80	111.50
Irrigated Guinea	68.80	55.30	88.50	78.00	111.00	172.00
Rainfed Guinea	58.50	51.80	81.80	69.80	105.00	165.00
CD (0.05)	30.82	18.72	18.26	14.05	7.57	24.95

Table 13. Leaf weight of *T.cymbaria* and *P.maximum* at 60 days cutting interval

Leaf wt. in (g)/ plant	*Nov.*	*Jan.*	*Mar.*	*May*	*July*
(*Days*)	**75**	**135**	**195**	**255**	**315**
Irrigated Potha	29.00	36.80	39.00	83.00	111.00
Rainfed Potha	27.00	28.30	38.30	73.50	105.00
Irrigated Guinea	54.30	36.30	68.50	94.50	161.00
Rainfed Guinea	57.30	49.00	61.00	85.50	139.00
CD (0.05)	27.00	NS	7.96	7.79	17.45

The results with 45 days cutting intervals are presented in Table 12. Significant differences were observed between Potha and Guinea in all the cutting periods. In most of the cases, irrigated grasses showed on par results with rainfed grasses. The data on 60-day cutting interval are presented in Table 13. The grasses were significantly different under irrigated and rainfed conditions except January cutting which showed no significant difference. However, cuttings during 75 and 195 showed on par results between irrigated and rainfed conditions.

The leaf weights coinciding 75 and 255 days having 30, 45 and 60 days cutting intervals are presented in Table 26. The leaf weight of 75 and 255 days cutting showed significant differences between Guinea and Potha grass. Leaf weights were almost similar under rainfed and irrigated conditions at 75^{th} day cutting. Different cutting intervals at 75^{th} day cutting showed no significant differences. However, 255^{th} day cutting showed significant differences between cutting intervals in which 45-day cutting interval showed more leaf weight than other cutting intervals. Interaction was absent at 75^{th} day but significant at 255^{th} day. At 255^{th} day cutting irrigated guinea with 45 days, cutting interval showed more leaf weight than other combinations.

Stem weight

The stem weight of *T.cymbaria* and *P.maximum* at different cutting intervals is presented in Tables 14, 15 and 16. Potha grass did not show any distinguishable stem parts both under irrigated and rainfed conditions. However, Guinea grass recorded stem weight during January to June with 30 days cutting interval and March to June with 45 and 60 days cutting intervals. The stem weight was higher in irrigated plots.

At 75^{th} day cutting, as there were no apparent stems, stem weight could not be recorded. At 255^{th} day too, stem weight was not apparent in the case of Potha grass. However, it was recorded in case of Guinea grass.

Table 14. Stem weight of *T.cymbaria* and *P.maximum* at 30 days cutting interval

Stem wt. in (g)/plant	*Nov.*	*Dec.*	*Jan.*	*Feb.*	*Mar.*	*Apr.*	*May*	*June*
(*Days*)	**75**	**105**	**135**	**165**	**195**	**225**	**255**	**285**
Irrigated Potha	0	0	0	0	0	0	0	0
Rainfed Potha	0	0	0	0	0	0	0	0
Irrigated Guinea	0	0	14.3	19.4	19.2	21.3	55.4	161.6
Rainfed Guinea	0	0	0	16.7	15.0	20.1	47.4	142.4

Table 15. Stem weight of *T.cymbaria* and *P.maximum* at 45 days cutting interval

Stem wt. in (g)/plant	*Nov.*	*Dec.*	*Feb.*	*Mar.*	*May*	*June*
(*Days*)	**75**	**120**	**165**	**210**	**255**	**300**
Irrigated Potha	0	0	0	0	0	0
Rainfed Potha	0	0	0	0	0	0
Irrigated Guinea	0	0	0	18.2	51.3	184.1
Rainfed Guinea	0	0	0	17.7	42.6	166.6

Table 16. Stem weight of *T.cymbaria* and *P.maximum* at 60 days cutting interval

Stem wt. in (g)/plant	*Nov.*	*Jan.*	*Mar.*	*May*	*July*
(*Days*)	**75**	**135**	**195**	**255**	**315**
Irrigated Potha	0	0	0	0	0
Rainfed Potha	0	0	0	0	0
Irrigated Guinea	0	0	13.5	39.3	136.4
Rainfed Guinea	0	0	13.3	28.8	133.3

Leaf Area Index

The data on Leaf Area Index of *T.cymbaria* and *P.maximum* with 30 days cutting interval is presented in Table 17. There exists significant differences between Potha and Guinea grass at 105,165 and 285 days cuttings and no significant differences were recorded during the remaining periods of cutting. Guinea grass showed more leaf area than Potha grass. However, in most of the cases grasses under irrigated condition are found to be on par with rainfed grasses.

The data with 45 days cutting interval is presented in Table 18. Significant differences were observed between Guinea and Potha grass at 120, 210, and 300 days cuttings. Grasses under irrigated condition are found to be on par with rainfed grasses at 120 day cutting and remaining cuttings showed significant differences.

Leaf Area Index of 60 days cutting interval is presented in Table 19. The LAI of Potha and Guinea grasses were showing significant difference at initial cutting at 75 days and 195 days after planting and no significant differences for the remaining cutting period. Maximum LAI was observed in irrigated Guinea than Potha grass. However, at 75, 255 and 315 day cuttings, grasses under irrigated condition are found to be on par with rainfed grasses.

The Leaf Area Index coinciding 75^{th} and 255^{th} day cuttings having 30, 45 and 60 days cutting intervals are presented in Table 27. Significant differences were observed between Potha and Guinea grass under irrigated and rainfed conditions at 75^{th} and 255^{th} day cutting period. Cutting intervals, showed no significant effects at 75 days cutting but, significant results at 255^{th} day cutting. Between cutting intervals, higher LAI was recorded in 45 days cutting interval. Interactions were absent at 75 and 255 days cutting.

Table 17. Leaf Area Index of *T.cymbaria* and *P.maximum* at 30 days cutting interval

LAI	*Nov.*	*Dec.*	*Jan.*	*Feb.*	*Mar.*	*Apr.*	*May*	*June*
(Days)	**75**	**105**	**135**	**165**	**195**	**225**	**255**	**285**
Irrigated Potha	1.83	0.65	2.42	1.02	0.45	1.01	4.02	4.92
Rainfed Potha	1.36	0.56	1.52	0.94	0.32	0.61	4.11	4.18
Irrigated Guinea	2.13	1.61	1.63	2.2	0.93	1.24	4.15	5.59
Rainfed Guinea	1.69	1.18	1.46	1.52	0.50	1.00	3.39	6.38
CD (0.05)	NS	0.57	NS	0.43	NS	NS	NS	0.97

Table 18. Leaf Area Index of *T.cymbaria* and *P.maximum* at 45 days cutting interval

LAI	*Nov.*	*Dec.*	*Feb.*	*Mar.*	*May*	*June*
(Days)	**75**	**120**	**165**	**210**	**255**	**300**
Irrigated Potha	1.28	0.57	3.05	1.36	5.37	4.68
Rainfed Potha	0.85	0.68	1.58	1.86	4.17	3.15
Irrigated Guinea	1.79	1.40	1.92	2.41	5.43	6.51
Rainfed Guinea	1.62	1.05	1.30	2.07	4.27	5.84
CD (0.05)	NS	0.53	NS	0.62	NS	1.06

Table 19. Leaf Area Index of *T.cymbaria* and *P.maximum* at 60 days cutting interval

LAI	*Nov.*	*Jan.*	*Mar.*	*May*	*July*
(Days)	**75**	**135**	**195**	**255**	**315**
Irrigated Potha	0.97	0.69	0.78	4.05	6.53
Rainfed Potha	0.99	0.46	1.06	4.00	6.30
Irrigated Guinea	2.09	0.93	1.68	4.76	7.42
Rainfed Guinea	1.72	1.10	1.49	3.46	6.20
CD (0.05)	0.65	NS	0.44	NS	NS

Green fodder yield

Green fodder yield of *T.cymbaria* and *P.maximum* at 30 days cutting interval is presented in Table 20. Green fodder yield of the grasses under irrigated and rainfed conditions was found to be non-significant at 135 and 225 days after planting and significant differences were obtained for remaining cuttings. Between irrigated and rainfed conditions, the results were found to be on par during 105, 195 and 225 day cuttings.

The data with 45 days cutting intervals are presented in Table 21. It is found that there exist significant differences between Potha and Guinea grasses in all the cuttings. However, in most of the cases, grasses under irrigated condition are found to be on par with rainfed grasses. Guinea grass gave more green fodder yield than Potha grass.

The results with 60 days cutting interval are presented in Table 22. It showed significant differences between the treatments. At all the stages, irrigated Guinea recorded maximum yield. This was on par with rainfed Guinea at 75, 255 and 315-day cuttings. Among the different cutting intervals, cutting at 45 days interval produced higher green fodder yields followed by 60 and 30 days cuttings interval. The green fodder yield coinciding 75 and 255-day stages having 30, 45 and 60 days cutting intervals are presented in Table 27. Green fodder yield at 75 and 225-day cuttings showed significant differences between the major treatments. Between irrigated and rainfed conditions, maximum green fodder yield was in irrigated Guinea which was on par with rainfed Guinea. However, cutting at 75th day showed no significant difference and 225th day cutting showed significant differences. At 225th day, 45 days cutting interval produced more green fodder yield than other cutting intervals. The interaction with grasses under irrigated and rainfed conditions were found to be non-significant.

Table 20. Green fodder yield of *T.cymbaria* and *P.maximum* at 30 days cutting interval

***Green fodder* (t/ha)**	***Nov.***	***Dec.***	***Jan.***	***Feb.***	***Mar.***	***Apr.***	***May***	***June***
(Days)	**75**	**105**	**135**	**165**	**195**	**225**	**255**	**285**
Irrigated Potha	0.36	0.82	0.41	2.00	0.50	0.35	2.18	3.56
Rainfed Potha	0.17	0.66	0.29	0.64	0.30	0.25	0.83	2.17
Irrigated Guinea	1.51	3.04	0.43	2.35	2.54	0.58	5.72	14.32
Rainfed Guinea	0.75	2.69	0.28	0.89	0.62	0.20	5.83	13.88
CD (0.05)	0.92	1.05	NS	1.65	1.75	NS	3.96	5.38

Table 21. Green fodder yield of *T.cymbaria* and *P.maximum* at 45 days cutting interval

***Green fodder* (t/ha)**	***Nov.***	***Dec.***	***Feb.***	***Mar.***	***May***	***June***
(Days)	**75**	**120**	**165**	**210**	**255**	**300**
Irrigated Potha	0.25	0.93	1.03	0.81	2.60	8.50
Rainfed Potha	0.21	0.81	0.98	0.35	2.18	7.22
Irrigated Guinea	2.18	4.16	4.41	2.12	7.21	30.83
Rainfed Guinea	1.15	3.83	1.10	1.02	5.83	29.58
CD (0.05)	1.15	2.01	1.36	0.63	4.13	16.46

Table 22. Green fodder yield of *T.cymbaria* and *P.maximum* at 60 days cutting interval

***Green fodder* (t/ha)**	***Nov.***	***Jan.***	***Mar.***	***May***	***July***
(Days)	**75**	**135**	**195**	**255**	**315**
Irrigated Potha	0.31	2.91	1.12	3.12	7.50
Rainfed Potha	0.13	2.03	0.35	2.08	7.29
Irrigated Guinea	1.65	5.91	1.88	6.45	26.20
Rainfed Guinea	1.39	3.18	0.75	5.83	25.90
CD (0.05)	1.25	2.01	0.93	3.44	5.87

Dry fodder yield

Dry fodder yield of *T.cymbaria* and *P.maximum* with 30 days cutting interval is presented in Table 23. The dry fodder yield under irrigated and rainfed conditions was found to be non-significant at 135 and 225 days after planting and significant differences were observed for the remaining cutting periods between Potha and Guinea grass. However, in such cases too, irrigated grasses are found to be on par with rainfed grasses.

Data with 45 days cutting interval are presented in Table 24. Dry fodder yield is found to show significant differences between Guinea and Potha grass in all the cutting periods. Irrigated grasses are found to be on par with rainfed grasses during 75, 120, and 165 day cutting.

The data with 60 days cutting interval are presented in Table 25. It showed significant differences between Potha and Guinea grass under irrigated and rainfed condition, irrigated grasses are found to be on par with rainfed grasses during 75 days.

Among different cutting intervals, 45 days cutting interval recorded the highest dry fodder yield than others. Guinea grass is found to give higher yields than Potha grass in all the cutting intervals under irrigated and rainfed condition. In many cases, dry fodder yield is found to be higher under irrigated condition than rainfed condition.

Dry fodder yield coinciding 75 and 255 days having 30, 45 and 60 days cutting intervals are presented in Table 27. The dry fodder yield at 75^{th} day cutting showed significant differences between Potha and Guinea grasses under irrigated and rainfed conditions. Cutting intervals and their interactions showed no significant differences. At 255 day cutting, significant difference between Potha and Guinea grasses under irrigated and rainfed conditions could be seen. Dry fodder yield of Guinea grass was found to be higher than Potha grass at 255^{th} day. Different cutting intervals showed significant differences at 225 day cutting in which 45 days cutting interval produced more dry fodder yield. Among interactions, irrigated Guinea at 45 days cutting interval gave more dry fodder yield than other interactions. In general, both grasses gave higher green and dry fodder yield during rainy season (June-July) than summer period (February-May).

Table 23. Dry fodder yield of *T.cymbaria* and *P.maximum* at 30 days cutting interval

Dry fodder **(t/ha)**	***Nov.***	***Dec.***	***Jan.***	***Feb.***	***Mar.***	***Apr.***	***May***	***June***
(Days)	**75**	**105**	**135**	**165**	**195**	**225**	**255**	**285**
Irrigated Potha	0.08	0.21	0.22	0.50	0.11	0.02	0.56	0.93
Rainfed Potha	0.04	0.19	0.12	0.13	0.06	0.01	0.13	0.45
Irrigated Guinea	0.46	0.84	0.26	0.87	0.77	0.05	1.76	5.34
Rainfed Guinea	0.26	0.81	0.10	0.30	0.16	0.02	1.71	4.72
CD (0.05)	0.36	0.51	NS	0.45	0.52	NS	1.39	3.04

Table 24. Dry fodder yield of *T.cymbaria* and *P.maximum* at 45 days cutting interval

Dry fodder **(t/ha)**	***Nov.***	***Dec.***	***Feb.***	***Mar.***	***May***	***June***
(Days)	**75**	**120**	**165**	**210**	**255**	**300**
Irrigated Potha	0.05	0.93	0.21	0.19	0.62	2.86
Rainfed Potha	0.06	0.82	0.17	0.07	0.15	2.12
Irrigated Guinea	0.66	1.12	1.35	0.65	3.37	9.53
Rainfed Guinea	0.36	1.02	0.31	0.32	2.55	9.33
CD (0.05)	0.48	1.01	0.36	0.28	1.92	3.97

Table 25. Dry fodder yield of *T.cymbaria* and *P.maximum* at 60 days cutting interval

Dry fodder **(t/ha)**	***Nov.***	***Jan.***	***Mar.***	***May***	***July***
(Days)	**75**	**135**	**195**	**255**	**315**
Irrigated Potha	0.06	0.65	0.25	0.70	2.68
Rainfed Potha	0.03	0.33	0.06	0.39	2.21
Irrigated Guinea	0.52	1.82	0.58	2.98	7.80
Rainfed Guinea	0.43	0.85	0.19	2.31	7.17
CD (0.05)	0.47	0.59	0.26	1.27	2.26

Table 26. Fodder production potential of 30, 45 and 60 days cutting interval at 75 and 255 days after planting

Treatments	***Plant height* (cm)**		***Number of leaves Per plant***		***Leaf weight* (g)**	
Days	**75**	**255**	**75**	**255**	**75**	**255**
IP	72.75	80.10	18.19	97.90	27.75	81.00
RP	65.75	78.26	16.50	80.43	26.91	72.25
IG	79.33	137.80	70.00	196.66	61.73	106.00
RG	72.00	121.00	56.00	180.33	54.33	91.59
CD (0.05)	NS	11.26	15.02	17.04	22.88	4.81
C1	72.75	97.60	41.00	136.00	41.25	80.81
C2	70.81	115.00	42.00	172.00	44.93	94.68
C3	73.06	110.00	40.00	124.00	41.00	84.12
CD (0.05)	NS	4.53	NS	16.25	NS	3.29
IP X C1	66.50	81.50	18.00	125.00	28.50	73.00
IP X C2	61.75	78.80	15.00	167.00	27.75	88.50
IP X C3	69.00	80.30	20.00	78.00	27.00	83.00
RP X C1	69.75	75.50	18.00	82.00	27.00	69.00
RP X C2	66.75	81.50	16.00	83.00	24.75	73.75
RP X C3	76.50	79.50	15.00	85.00	29.00	73.50
IG X C1	73.25	136.00	70.00	171.00	50.00	97.25
IG X C2	75.75	166.00	74.00	230.00	59.50	111.25
IG X C3	69.25	130.00	66.00	179.00	68.50	94.50
RG X C1	81.50	97.00	54.00	175.00	59.50	83.50
RG X C2	79.00	136.00	59.00	210.00	58.75	105.25
RG X C3	77.50	150.00	56.00	156.00	57.25	85.50
CD (0.05)	NS	9.07	NS	32.56	NS	6.58

Table 27. Fodder production potential of 30, 45 and 60 days cutting interval at 75 and 255 days after planting

Treatments	*Leaf area index*		*Green fodder yield (t/ha)*		*Dry fodder yield (t/ha)*	
Days	**75**	**255**	**75**	**255**	**75**	**255**
IP	1.80	4.10	0.30	2.02	0.06	0.59
RP	1.03	4.48	0.17	1.72	0.04	0.53
IG	1.88	4.77	1.78	6.46	0.54	1.99
RG	1.07	3.71	1.16	5.83	0.34	1.97
CD (0.05)	0.92	3.04	0.90	3.04	0.54	1.09
C1	1.50	3.92	0.70	3.18	0.21	1.02
C2	1.39	4.81	0.95	4.45	0.27	1.90
C3	1.44	4.07	0.87	4.37	0.26	1.58
CD (0.05)	NS	0.88	NS	0.88	NS	0.4
IP X C1	0.83	4.02	0.17	2.18	0.05	0.46
IP X C2	1.28	5.37	0.21	2.60	0.05	0.62
IP X C3	0.97	4.05	0.12	3.12	0.03	0.70
RP X C1	1.36	4.15	0.36	0.83	0.08	0.15
RP X C2	0.85	4.17	0.25	2.18	0.05	1.05
RP X C3	0.99	4.00	0.31	2.08	0.06	0.39
IG X C1	2.13	4.11	1.51	5.72	0.46	1.76
IG X C2	1.79	5.43	2.18	7.21	0.65	3.39
IG X C3	1.72	4.76	1.65	6.45	0.52	2.93
RG X C1	1.69	3.39	0.75	5.83	0.26	1.71
RG X C2	1.62	4.27	1.15	5.83	0.35	2.55
RG X C3	2.09	3.46	1.38	5.83	0.43	2.31
CD (0.05)	NS	NS	NS	NS	NS	0.79

Total green and dry fodder yields

Total green and dry fodder yields of *T.cymbaria* and *P.maximum* at 30, 45 and 60 days cutting intervals over a period of eight months are presented in Table 28. For comparison of total green and dry fodder yields of *T.cymbaria* and *P.maximum*, green and dry fodder yields produced from each cutting were summed up and presented as total green and dry fodder yields for individual 30, 45 and 60 days cutting intervals. Significant differences were observed in total green and dry fodder yield between the grasses. Between the grasses, higher green and dry fodder yields were obtained in Guinea grass than Potha. Although total green and dry fodder yield was maximum in irrigated grasses they were was found to be on par with rainfed grasses. Maximum green (40 t/ha) and dry (12.51 t/ha) fodder yield was in irrigated Guinea plots. Different cutting intervals and their interaction were also showing significant differences in total green and dry fodder yields. Between different cutting intervals, fodder cut with 45 days cutting intervals produced higher green and dry fodder yields than other cutting intervals. Among different interactions, interaction between irrigated Guinea and 45 days cutting interval produced higher green and dry fodder yields.

4.2.2. Nutritive value and quality

Crude protein

The data on crude protein content of *Themeda cymbaria* and *Panicum maximum* are presented in Table 29. Crude protein content in *T.cymbaria* ranged from 7.55 per cent to 9.54 per cent and in *P.maximum*, it ranged from 6.93 to 7.08. Both the grasses are almost alike in crude protein content under irrigated and rainfed conditions. Cutting intervals did not affect the crude protein content. Interaction between grasses under irrigated and rainfed conditions at different cutting regimes also showed no significant differences.

Table 28. Effect of treatments on total Green and Dry fodder yield

Grasses	*Green fodder* (t/ha)	*Dry fodder* (t/ha)
IP	12.58	3.78
RP	9.80	2.44
IG	40.00	12.51
RG	36.10	10.29
CD (0.05)	7.54	4.07
C1	17.76	4.89
C2	29.60	10.93
C3	26.49	7.95
CD (0.05)	6.53	3.52
IP X C1	9.75	3.31
IP X C2	14.77	4.29
IP X C3	13.23	3.74
RP X C1	5.61	1.76
RP X C2	12.07	3.51
RP X C3	11.71	2.05
IG X C1	29.26	12.07
IG X C2	49.89	19.46
IG X C3	40.85	14.32
RG X C1	26.43	9.42
RG X C2	43.57	17.00
RG X C3	38.29	10.46
CD (0.05)	13.06	7.05

Plate 3. Early stages of Potha grass

Plate 4. Later stages of Potha grass

Crude fibre

The data on crude fibre content of *Themeda cymbaria* and *Panicum maximum* are presented in Table 29. Crude fibre content in *T.cymbaria* ranged from 31.44 per cent to 33.37 per cent and in *P.maximum,* it ranged from 22.75 to 23.04. Significant differences were noticed in crude fibre content between grasses grown under irrigated and rainfed conditions. Cutting intervals, did not affect the crude fibre content. Interaction effect was not significant.

Ether extract

Ether extract of *Themeda cymbaria* and *Panicum maximum* was analyzed and presented in Table 29. In *T.cymbaria*, it ranged from 2.08 per cent to 2.42 per cent and in *P.maximum*, it ranged from 2.13 to 2.20. Both Potha and Guinea grasses showed no significant differences in ether extract content in irrigated or rainfed situation. The cutting intervals of 30, 45 and 60 days also did not have any effects on ether extract content. Interaction effects between grasses and cutting intervals under irrigated and rainfed conditions were not significant.

Nitrogen free extract

Nitrogen free extract of *Themeda cymbaria* and *Panicum maximum* are presented in Table 29. Nitrogen free extract (NFE) in *T.cymbaria* ranged from 39.78 per cent to 42.03 per cent and in *P.maximum*, it ranged from 45.88 to 49.67. It showed no significant differences between grasses and cutting intervals under irrigated and rainfed conditions. Interaction effects were not significant.

Ash content

Ash content of *Themeda cymbaria* and *Panicum maximum* are presented in Table 29. Ash content in *T.cymbaria* ranged from 16.53 per cent to 17.54 per cent and in *P.maximum* it ranged from 13.86 to 15.50. There were no significant differences between Potha and Guinea grass under irrigated and rainfed conditions with respect to ash content. The cutting intervals also did not influence ash content. Interaction effect was not significant.

Phosphorous

Phosphorous content of *Themeda cymbaria* and *Panicum maximum* are presented in Table 30. Phosphorus content in *T.cymbaria* ranged from 0.11 per cent to 0.12 per cent and in *P.maximum* it ranged from 0.10 to 0.11.The data on phosphorus content did not differ between Potha and Guinea grass under irrigated and rainfed conditions. Different cutting intervals and their interaction with the grasses under irrigated and rainfed conditions also did not show any significant difference.

Potassium

The data on potassium content of *Themeda cymbaria* and *Panicum maximum* are presented in Table 30. Potassium content in *T.cymbaria* ranged from 2.07 per cent to 2.49 per cent and in *P.maximum* it ranged from 1.86 to 2.31. Potassium content of plant showed significant differences between Potha and Guinea grass under irrigated and rainfed conditions. However, interaction effect between the grasses and cutting intervals was not significant.

Calcium

The data on calcium content in *Themeda cymbaria* and *Panicum maximum* are presented in Table 30. Calcium content in *T.cymbaria* ranged from 0.16 per cent to 0.18 per cent and in *P.maximum* it ranged from 0.28 to 0.32. Significant differences were observed on calcium content between grasses at irrigated and rainfed conditions. However, interaction effect between the grasses and cutting intervals was not significant.

Magnesium

Data on magnesium content in *Themeda cymbaria* and *Panicum maximum* are presented in Table 30. Magnesium content in *T.cymbaria* ranged from 0.36 per cent to

0.37 per cent and in *P.maximum* it is 0.37. However, there exist no significant difference between the treatments or their interactions.

Oxalate content

Data regarding oxalate content of *Themeda cymbaria* and *Panicum maximum* are presented in Table 30. Oxalate content in *T.cymbaria* ranged from 0.34 per cent to 0.37 per cent and in *P.maximum* it ranged from 0.36 to 0.38. However, no significant differences were observed between the treatments and their interactions.

Table 29. Nutritive value of *Themeda cymbaria* and *Panicum maximum* at 90 days after planting

Grasses	*Crude protein* %	*Crude fibre* %	*Ether Extract* %	*Nitrogen Free Extract* %	*Ash* %
IP	9.54	33.37	2.42	39.78	17.54
RP	7.55	31.44	2.08	42.03	16.53
IG	6.93	23.04	2.20	45.88	15.50
RG	7.08	22.75	2.13	49.67	13.86
CD (0.05)	NS	3.42	NS	NS	NS
C1	8.82	28.39	2.18	44.55	15.60
C2	7.74	26.65	2.34	42.62	15.25
C3	6.77	27.90	2.10	45.10	16.72
CD (0.05)	NS	NS	NS	NS	NS
Interactions	NS	NS	NS	NS	NS

Table 30. Nutritive value of *Themeda cymbaria* and *Panicum maximum* at 90 days after planting

Grasses	*Phosphorus* %	*Potassium* %	*Calcium* %	*Magnesium* %	*Oxalate* %
IP	0.11	2.07	0.16	0.37	0.34
RP	0.12	1.86	0.18	0.36	0.37
IG	0.10	2.49	0.28	0.37	0.38
RG	0.11	2.31	0.32	0.37	0.36
CD (0.05)	NS	0.19	0.07	NS	NS
C1	0.11	2.15	0.26	0.37	0.34
C2	0.12	2.21	0.28	0.37	0.36
C3	0.10	2.17	0.26	0.36	0.38
CD (0.05)	NS	NS	NS	NS	NS
Interactions	NS	NS	NS	NS	NS

Discussion

5. DISCUSSION

Experiments were conducted to obtain basic information on the phenology, growth behaviour and fodder production potential of *Themeda cymbaria*, locally called Potha grass. For comparison, Guinea grass cv. Makueni was used. The results obtained from the experiment are discussed based on the available literature, in this Chapter.

5.1 Exp. I. Phenology and Growth

5.1.1 Phenology

Themeda cymbaria and *Panicum maximum* were planted during early August 2006. Generally, structure of a plant changes with time and also depends on environmental conditions. Both grasses established well and started showing proportionate increase in vegetative growth. Although phenological events such as flowering, seed formation, and seed maturity were absent in Potha grass these events took place by the beginning of January in Guinea grass (Table 2). Flowering in Guinea grass started during early January and extended up to the first week of February. Specifically, it shows one month duration for the completion of flowering. Noirot and Ollitrault (1992) recorded the interval between initiation and heading as one month in *P.maximum*. On the other hand, no such phenological events were observed in *Themeda cymbaria* during the experimental period. In *P.maximum* other phases such as seed formation and seed maturity took place during mid and late February and continued up to middle of March. A single plant of *P.maximum* produced 8744 to 25296 spikelets at initial and final stages of experiment with an average of 2019 spikelets per panicle.

Plant height at flowering varied from 126 cm to 242 cm and tiller number from 9 to 12 per plant in *P.maximum*. However, in *T.cymbaria*, 7 to 18 tillers per plant were observed. The plants showed more growth with the onset of monsoons where the shoot length, panicle length and tiller number increased. A favorable climate by the receipt of monsoons made the plants to produce more plant height and increased number of spikelets and seeds. Potha grass is usually grown by the farmers on bunds. Absence of flowering and fruit setting makes *T.cymbaria* an ideal grass for soil conservation.

5.1.2 Growth

Plant height at initial stages were 56cm and 76cm in *T.cymbaria* and *P.maximum* respectively (Tables 3 and 4). Later, they began to show a gradual increase in height until the end of experiment (Fig.4). During summer (February to April), grasses tend to show retarded and static growth due to high temperature and moisture stress. With the onset of monsoon in May, the grasses again showed increase in height due to elongation of leaf and stem. This increase was continued till the end of experiment in July. Maximum height observed in July was 187cm in *T.cymbaria* and 242 cm in *P.maximum*. Comparatively, *P.maximum* recorded more height than *T.cymbaria* at all growth stages. Rapid elongation of stem and inflorescence in Guinea grass is a reason for increased height than Potha grass. On the contrary, there was no apparent stem in Potha grass.

More number of leaves were produced by *P.maximum* than *T.cymbaria* from Tables 3 and 4, and Fig. 5. A gradual increase in leaf number could be observed in both the grasses. *T.cymbaria* showed decreased leaf number during February and March. Leaf number decreased due to leaf senescence during summer period. However, with the onset of monsoon a significant increase in leaf number was observed and this increase extended up to July in both the grasses because of rainfall. Leaf area per plant (Table 3 and 4; Fig. 6) showed a similar trend as that of leaf number. Throughout the period, *P.maximum* showed more leaf area than *T.cymbaria*.

A gradual increase in dry matter production of the plant was observed as growth progressed (Table 3 and 4; Fig.7). In both grasses, dry matter accumulation was found to be less during summer because of moisture stress. However, dry matter accumulation was higher during rainy season. Drastic increase in dry matter

Fig.4 Plant height of *T.cymbaria* and *P.maximum* at monthly intervals

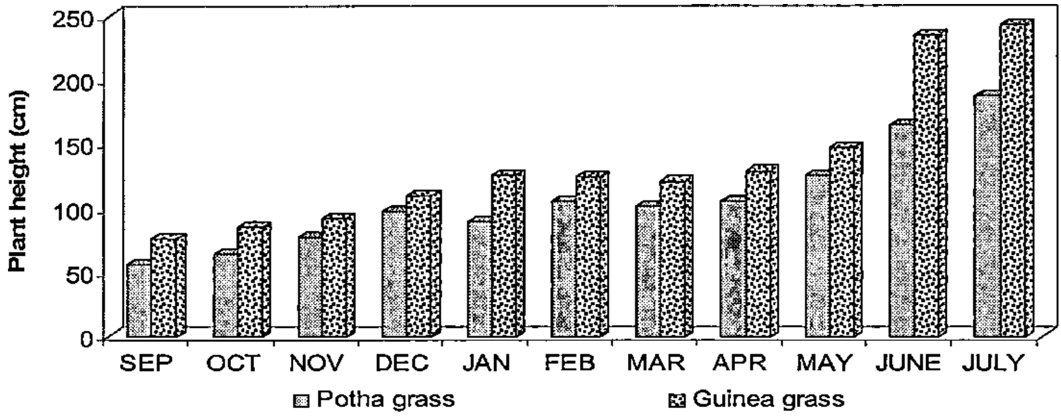


Fig.5 Total Number of leaves in *T.cymbaria* and *P.maximum* at monthly intervals

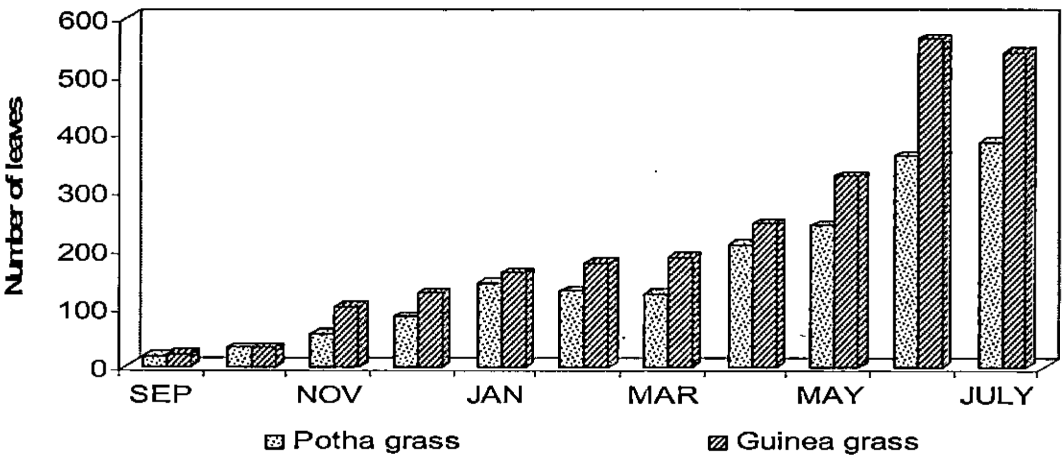


Fig.6 Total leaf area in *T.cymbaria* and *P.maximum* at monthly intervals

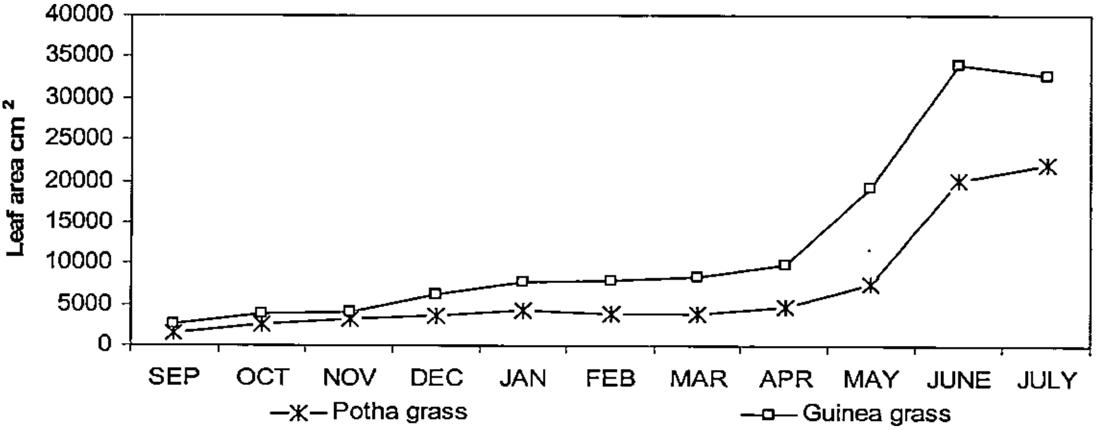


Fig.7 Total Dry matter production of plant in *T.cymbaria* and *P.maximum* at monthly intervals

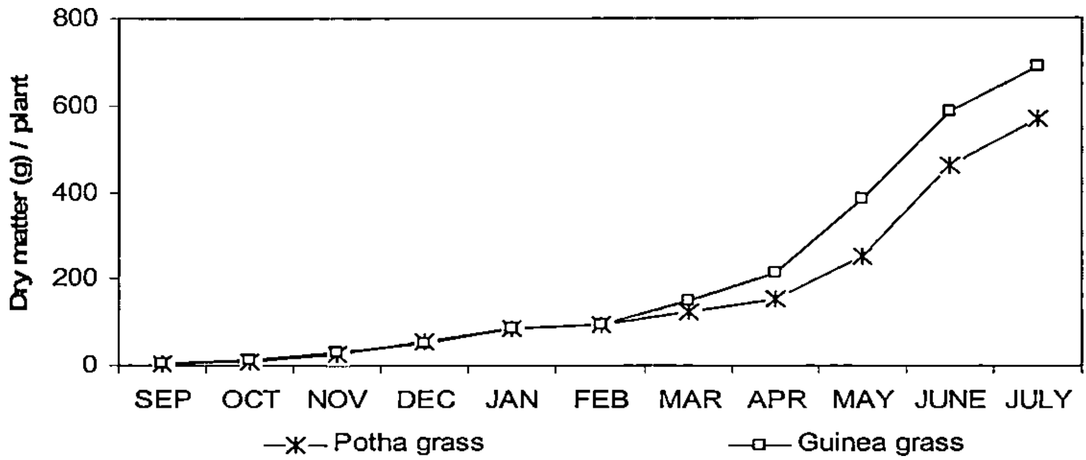


Fig.8 Total Stem weight in *T.cymbaria* and *P.maximum* at monthly intervals

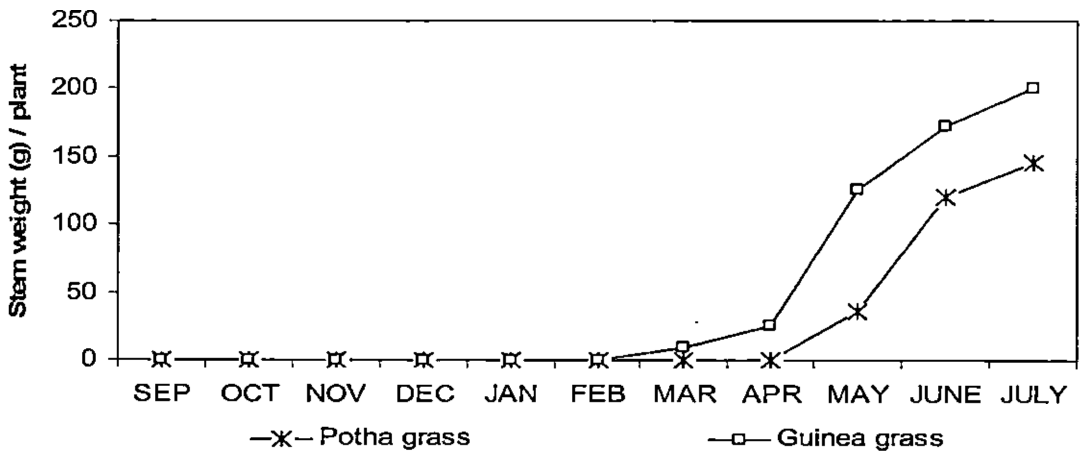
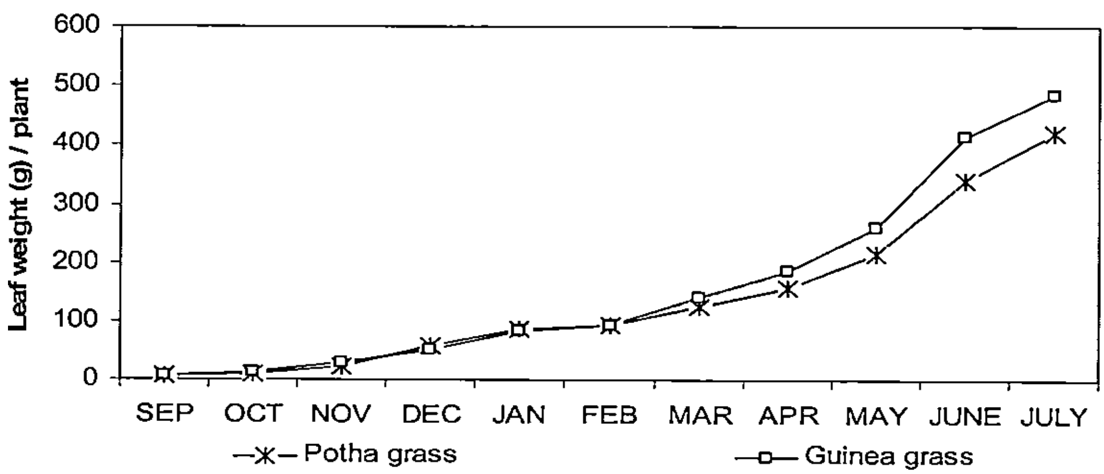


Fig.9 Total Leaf weight in *T.cymbaria* and *P.maximum* at monthly intervals



production was observed in Guinea grass after the onset of monsoon. Guinea grass showed higher dry matter production than Potha grass. Stem weight could not be recorded until April (240 day) and March (180 day) in *T.cymbaria* and *P.maximum* respectively as there were non-visible. Maximum stem weight of Guinea grass was recorded during rainy season. In the case of leaf weight, both grasses showed an increasing trend until the end of experiment. For both grasses, maximum leaf weight was observed during June-July due to more assimilation of dry matter.

The leaf: stem ratio could not be recorded up to May in *T.cymbaria* and April in *P.maximum*. This is due to the absence of stem growth during this period. Both grasses showed heigher leaf: stem ratio initially and then declined till the end of experiment. The leaf: stem ratio was found to be 2.8 to 6 in *T.cymbaria* and 2 to15 in *P.maximum*. Fleischer (1987) reported a decrease in leaf: stem ratio with stand age. Jank *et al.* (1994) recorded leaf: stem ratio ranging form 0.3 to 8.7 in Guinea grass.

Net assimilation rate (NAR) is a measure of the average photosynthetic efficiency of leaves. It is the net gain of assimilate or dry matter accumulation per unit leaf area per unit time. Gardner *et al.* (1985) suggested that as the plant grows and LAI increases, more and more leaves become shaded, causing a decrease in NAR as the growing season progresses. In the present experiment, Net assimilation rate was high at initial and final stages of experiment (Table 3 and 4) due to rapid accumulation of dry matter in these stages. During summer, both grasses showed decline in NAR due to senescence of leaves. By the receipt of rains, NAR improved due to vigorous growth of the plant.

Absolute growth rate (AGR) is a simple measure of rate of increase in dry weight of a plant per unit time. Results from Table 3 and 4 showed that AGR was increasing gradually with time, although a decreasing trend was observed during summer season because of less dry weight acquisition by the plant. However, with the onset of monsoon the growth rate was very high in May and June due to rapid increase in dry matter accumulation and then AGR showed declining trend. Guinea grass has higher AGR than Potha grass.

Fig.10 Leaf: Stem ratio in *T.cymbaria* and *P.maximum* at monthly intervals

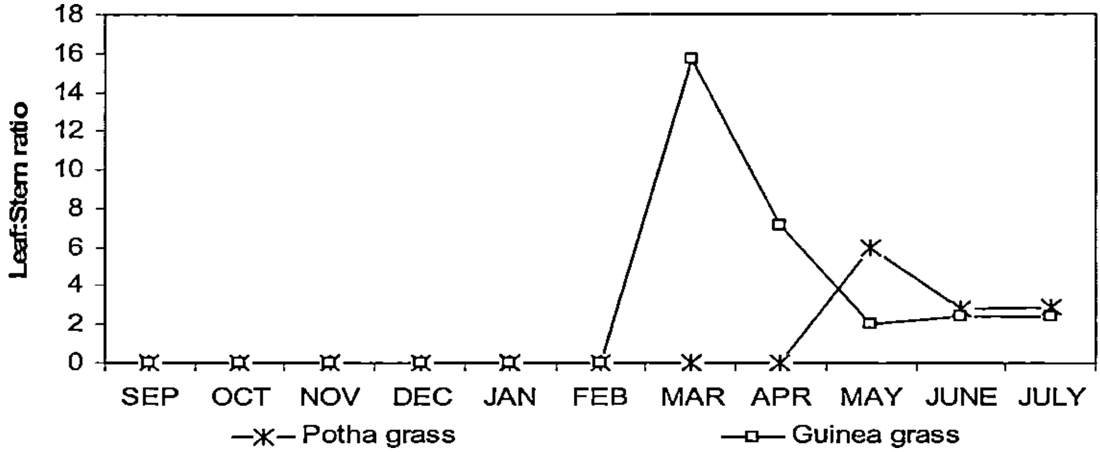


Fig.11 Net Assimilation Rate of *T.cymbaria* and *P.maximum* at monthly interval

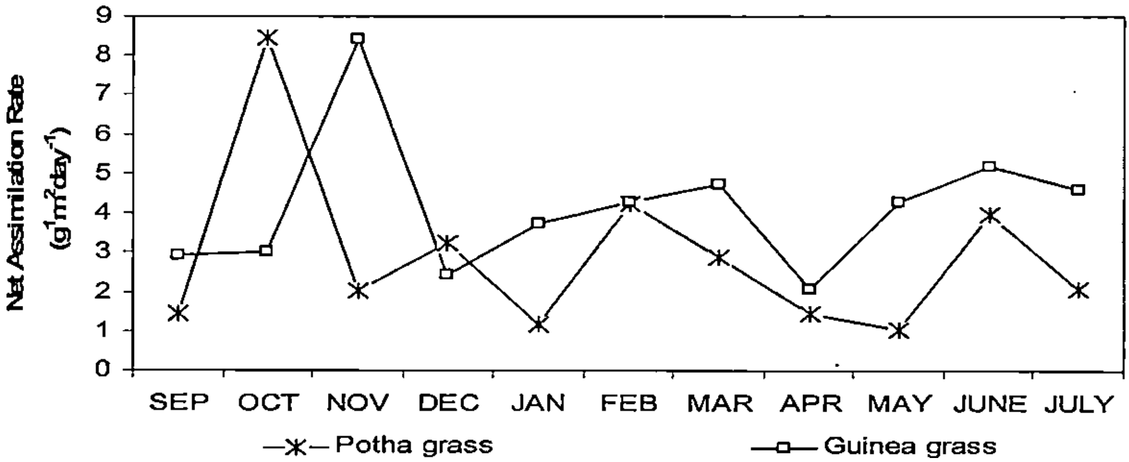
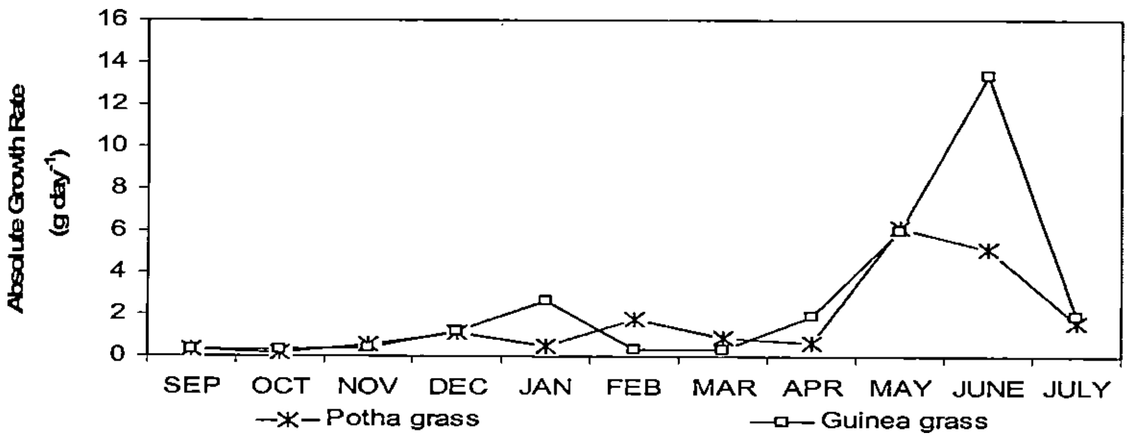


Fig.12 Absolute Growth Rate of *T.cymbaria* and *P.maximum* at monthly intervals



Relative growth rate (RGR) is the dry weight increase in a time interval in relation to its initial weight. From the RGR values presented in Table 3 and 4, it was inferred that both grasses showed high RGR values at initial stages and then started showing declining trend during summer and then again started showing higher RGR values in rainy season (Fig.13). According to Gardner *et al.* (1985) RGR of crop plants begins slowly just after germination, peaks rapidly soon afterwards and then falls off. However, in both grasses the rapid increase in total stem weight and plant dry weight during initial and final stages resulted in high RGR values. Guinea grass has shown more relative growth rate than Potha grass.

Leaf weight ratio (LWR) is the ratio of leaf weight per unit total plant dry weight. The leaf weight ratio increased up to summer season and then started declining with the onset of monsoon. Potha grass has higher leaf weight ratio than Guinea grass in all the stages, as the stem portion was negligible in Potha grass. Specific leaf area is the leaf area per unit leaf dry weight. Between the grasses, *P.maximum* is having high SLA (Table 3 and 4) because of more leaf area per unit leaf dry weight during its growth stages. Both grasses showed lesser SLA during summer period (March-April) than in the rainy season (June-July). Loss of leaf area due to senescence is a reason for this behavior.

Leaf area ratio (LAR) is a measure of relative leafiness of a plant. From Table 3 and 4 and Fig.16. It seems that the leaf area ratio of both grasses increased during the initial three months (September- November) and the succeeding months showed lesser leaf area ratio because relative leafiness decreased with the age of the grass. However, Leaf area duration (LAD) expresses the magnitude and persistence of leaf area during the period of plant growth. It takes into account both duration and extent of photosynthetic tissues of the plant canopy. As Gardner *et al.* (1985) stated, LAD is correlated to dry matter yield and gives an indication of plant productivity. Results of LAD presented in Table 3 and 4 and Fig.17. indicates that *P.maximum* showed higher productivity than *T.cymbaria*. There is a gradual increase in leaf area duration in both grasses as growing period progresses. However, during summer both grasses showed static LAD due to unfavorable weather.

Fig.13 Relative Growth Rate of *T.cymbaria* and *P.maximum* at monthly intervals

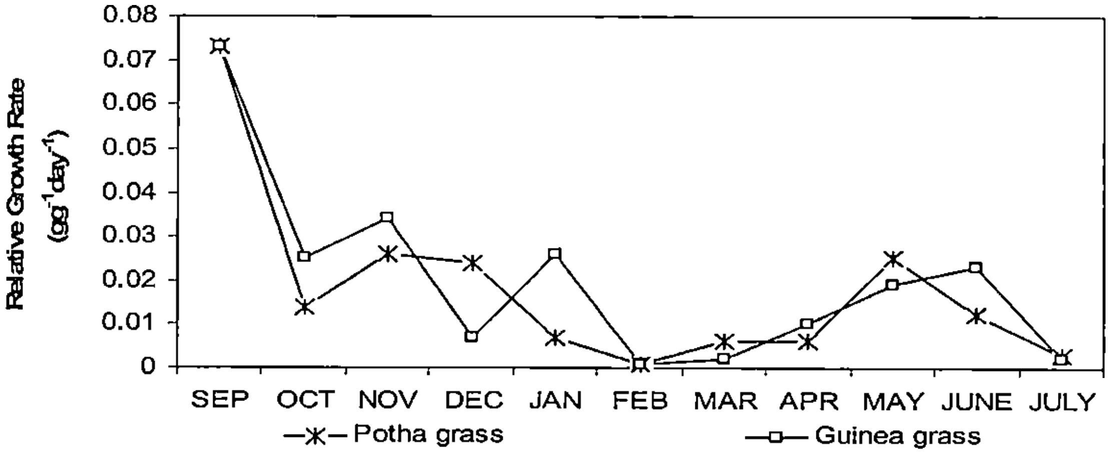


Fig.14 Leaf Weight Ratio of *T.cymbaria* and *P.maximum* at monthly intervals

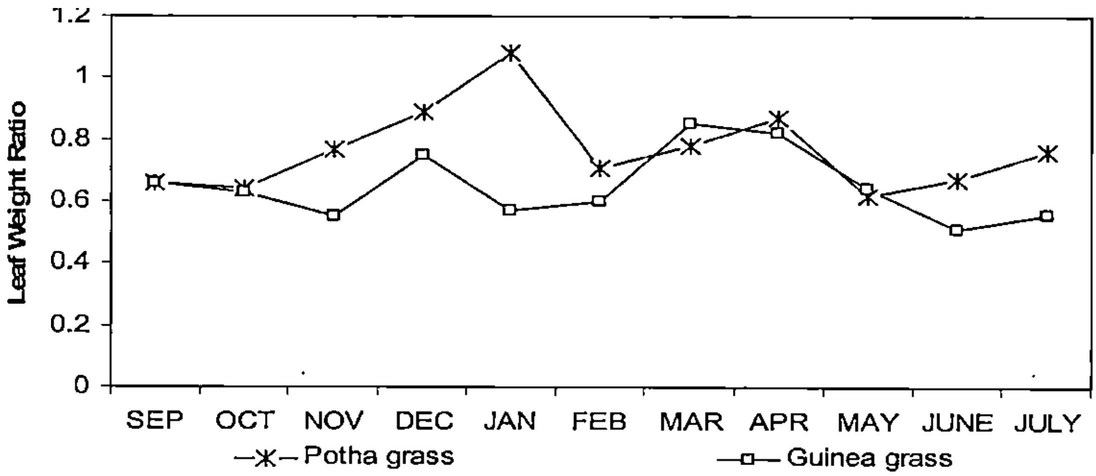


Fig.15 Specific Leaf Area of *T.cymbaria* and *P.maximum* at monthly intervals

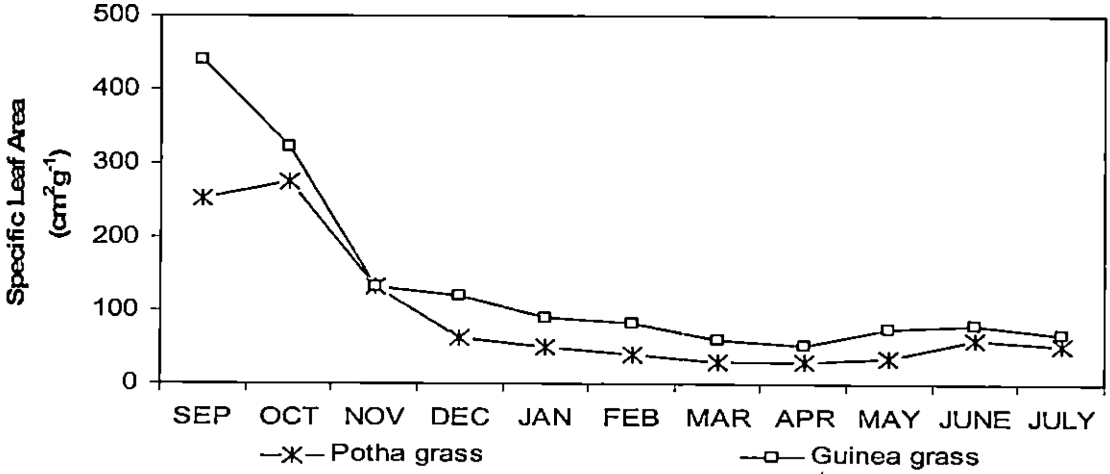


Fig.16 Leaf Area Ratio of *T.cymbaria* and *P.maximum* at monthly intervals

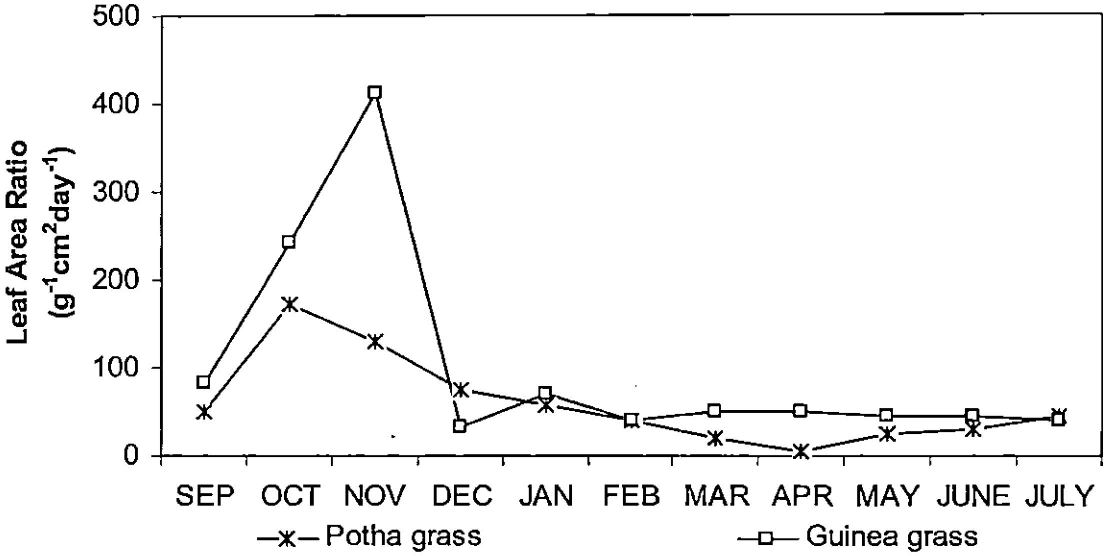
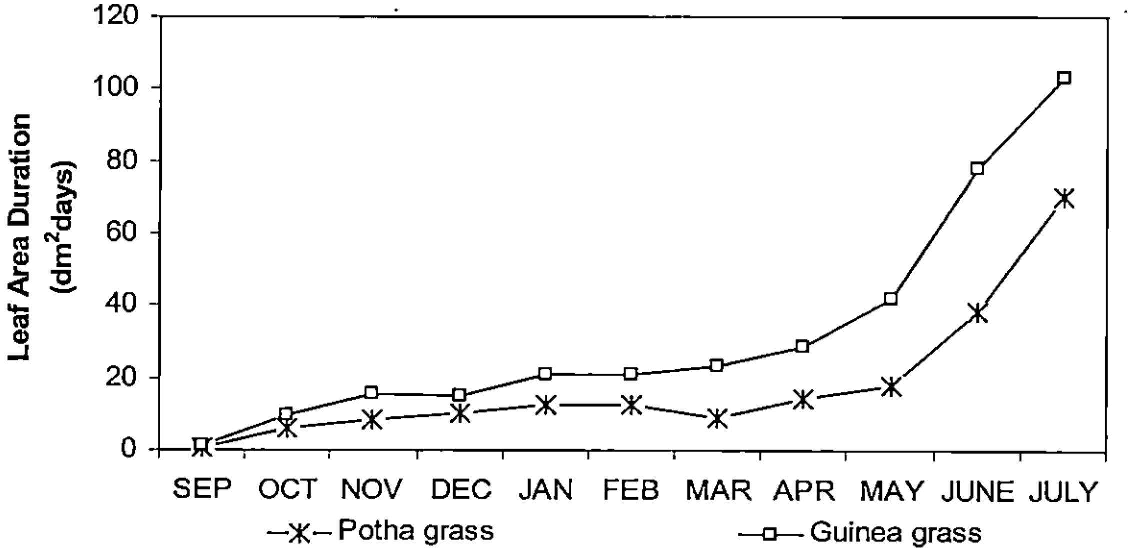


Fig.17 Leaf Area Duration of *T.cymbaria* and *P.maximum* at monthly intervals



5.2. Exp. II. Fodder production potential of *Themeda cymbaria*

5.2.1 Growth and yield

Heights of *Themeda cymbaria* and *Panicum maximum* at initial cuttings showed no significant difference among 30, 45 and 60 day cutting intervals under irrigated and rainfed conditions (Table 5, 6 and 7). During initial stages, irrigation could not show any significant effect on plant height. However, significant differences were observed during summer season. Irrigation in summer season provides sufficient moisture for the grasses, which grows fast. Moisture stress in rainfed situation affected cell division, cell enlargement and finally growth. Among cutting intervals, maximum plant height was recorded with 45 days cutting interval.

Irrigation and cutting intervals affected the number of leaves per plant (Table 8, 9 and 10). Among the cutting intervals, 45 days cutting interval showed higher number of leaves than others. However, the leaf number was found to decline in all the cutting intervals, during summer season. The reason behind this might be due to higher temperatures and moisture deficit during summer.

Leaf weight per plant also showed significant differences in all the cutting frequencies except 30 day cutting interval. As shown in Table 11, 12 and 13, initial cutting of 30 day cutting interval showed no significant difference under irrigated and rainfed conditions. Similar to leaf number, leaf weight also showed decreasing trend during summer.

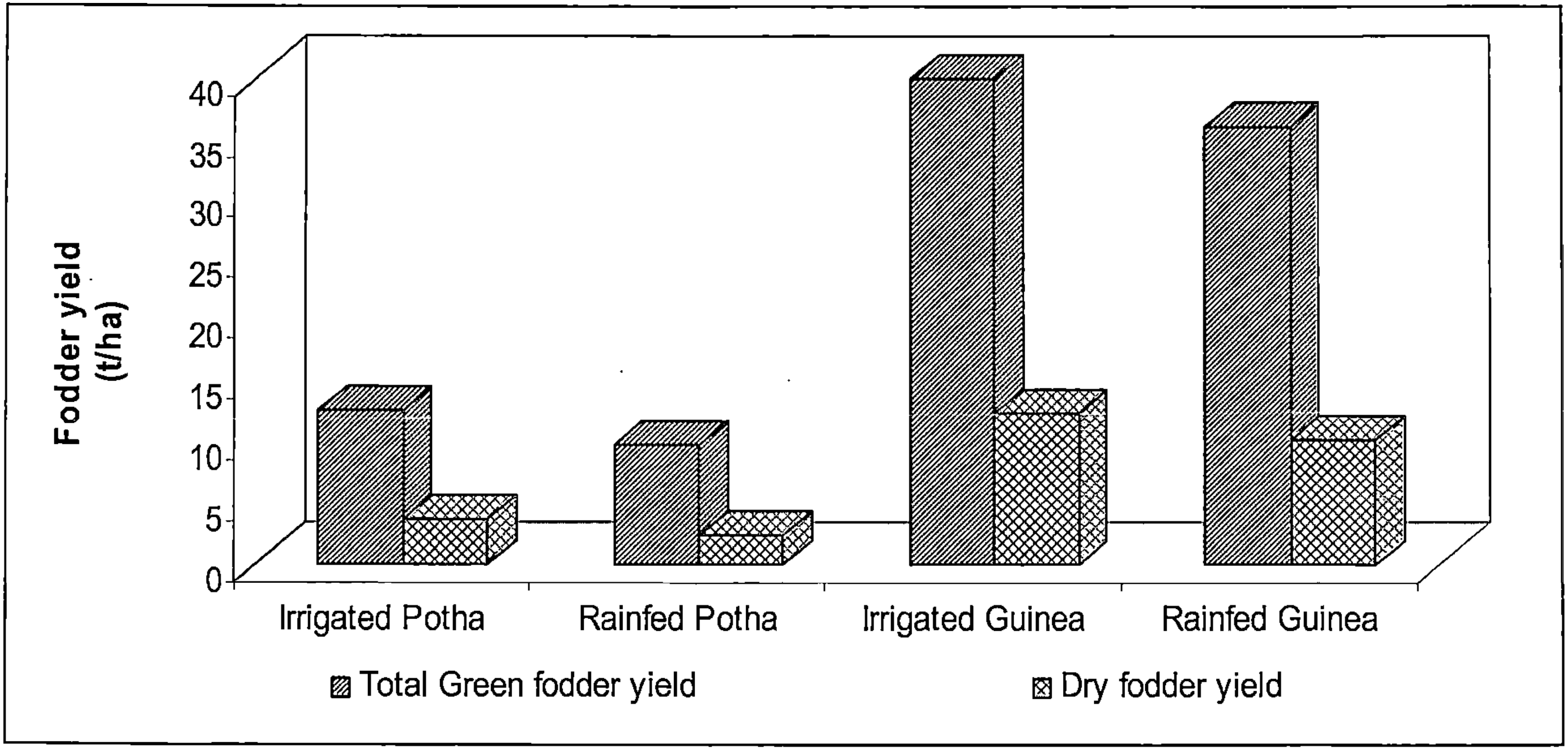
No stem weight could be recorded in *T.cymbaria* during the experimental period as there were no apparent stems. Stem weight was recorded in *P.maximum* during January in 30 day cutting interval and March in 45 and 60 days cutting intervals. Maximum stem weight was recorded in 45 days cutting interval which might be due to more dry matter accumulation in stem. Leaf area index (LAI) at 45 days cutting interval was found to be higher than other cutting intervals.

The yield data on green and dry fodder at the end of the experimental period of 10 months from planting indicate a clear yield advantage for Guinea grass than Potha grass. This could be expected as most of the growth characters such as plant height, number of leaves, leaf weight, stem weight and leaf area index showed higher values than Potha grass. It is generally agreed that the rate of fodder production is a function of tiller production and leaf growth (Ryle, 1970; Barbbar, 1985; Selvi and Subramanian, 1993). As Singh *et al.*, (1995) observed, leafiness measured by leaf number and leaf area per plant, is the most important parameter indicative of yield.

Between irrigated and rainfed grasses, although there were significant differences at some stages of cutting, total yield was not significantly different. The highest green fodder yield of 40 t/ha was recorded in irrigated Guinea grass closely followed with 36.1 t/ha from rainfed Guinea grass. However, in Potha grass, the respective figures were 12.5 t/ha and 9.8 t/ha. As the yield data were from the initial 10 month period of planting the impact of irrigation could not be conclusively assessed. Moreover, rainless period was just four months as shown by the weather data (Appendix I). During summer, there was clear advantage for the irrigated grasses. However, rainfed grasses performed well with the onset of monsoons. A Cuban report affirms the present result. Segui *et al.* (1984), tested correlation between yield and irrigation in Guinea grass with two moisture regimes of irrigated and rainfed conditions and found no remarkable yield differences.

Regarding the cutting intervals, 45 day cutting interval performed better compared to 30 and 60 day intervals. In 30 day cutting interval, the yield reduction could be attributed to short duration of growth between two intervals. Paterson (1936) showed that very early cutting reduced the yield since frequent cutting impairs the vigour of the plant. Watkins and Lewy-Van Severen (1951) showed that yield increase when the interval of cutting is increased. However, there is an optimum interval of cutting as is evident in the present experiment. As Ramasamy *et al.* (1993) observed green fodder yield shows a diminishing trend with the progressive increase in the number of cuttings.

Fig. 18 Total Green and Dry fodder yield



From yield point of view, the results show that Potha grass is not comparable with Guinea grass. However, there are some plus points in favour of Potha grass as a soil conservation grass. Guinea grass requires frequent cutting to retain its leafiness, otherwise it may show flowering and quality suffers. In the case of Potha grass, there was no flowering at all during the entire experimental period making it an ideal choice for soil conservation purposes. The grass can not spread to cultivated fields as a weed easily probably, this may be the reason why it is already a popular grass on bunds and stone walls in many parts of Kerala. Being a fodder grass with good quality Potha grass will be an ideal alternative as a soil conservation grass for livestock farmers, instead of the usually recommended non-edible Vetiver (*Vetiveria zizanioides*).

5.2.2 Nutrient value and quality

Nutrient composition of *T.cymbaria* and *P.maximum* was determined from samples taken at 90 days after planting. Crude protein gives an approximate value of the protein content in the forages. The results showed no significant differences in the crude protein content under irrigated and rainfed conditions. In the present experiment, crude protein content of Potha grass was in the range of 7.55 to 9.54 per cent and in Guinea grass, it is from 6.93 to 7.08. Chandini and Pillai (1980) reported that the crude protein content of Guinea grass was 8.96 per cent. Guyadeen (1949) observed CP content of 7.34 per cent in Guinea grass. The results show that Potha grass is comparable to Guinea grass in terms of crude protein content.

With regard to crude fibre content of plant also, significant differences could not be observed between grasses under irrigated and rainfed conditions. However, crude fibre content was high in Potha grass than Guinea grass. This might be due to higher accumulation of dry matter in plant under irrigated conditions. In the present experiment, CF content ranged from 22.75 – 23.04 per cent in *P.maximum* and 31.44 – 33.37 per cent in *T.cymbaria*. According to Chatterjee and Das (1989), CF content of Guinea grass was in the range of 28 to 36 per cent. Arora (1997) recorded crude fibre content of Guinea grass as 38.38 per cent.

Ether extract, nitrogen free extract and ash content in the grasses did not show any significant differences between irrigated and rainfed conditions. Ether extract gives an estimate of crude fat content in the feed. Nitrogen free extract represents the digestible carbohydrates present in the feed; Ash content gives total mineral content. Ether extract in Potha grass ranged from 2.08 to 2.42 and Guinea grass from 2.13 to 2.20. Nitrogen free extract in Potha grass ranged from 39.78 to 42.03 and Guinea grass ranged from 45.88 to 49.67. The ash content in Potha grass was from 16.53 to 17.54 and in Guinea grass from 13.86 to 15.50 per cent. In an experiment conducted by Ranjhan (1991) the ash content of *P.maximum* was 16 per cent. Arora (1997) gave NFE value of Guinea grass as 37.01 per cent, EE, 1.19 per cent and total ash content 15.54 per cent.

Phosphorous content of Potha grass and Guinea grass was almost similar under irrigated and rainfed conditions. However, potassium content differed significantly between Potha and Guinea grass. Potassium content was more in *P.maximum* (2.49 per cent) than *T.cymbaria* (2.3 per cent). Bosworth *et al.* (1980) reported the potassium content of Guinea grass as 3.1 per cent.

Calcium content significantly differed between grasses and it was found to be more in Guinea grass (0.28-0.32) than Potha grass (0.16-0.18) Magnesium and oxalate content showed no significant difference between grasses under irrigated and rainfed conditions.

The results on nutrient composition of the herbage in Potha grass and Guinea grass showed that there are hardly any differences between the two. Potha grass can replace Guinea grass in feeding with the same quality.

Summary

SUMMARY

Potha grass (*Themeda cymbaria* (Roxb.) Hack) is a fodder grass grown in parts of central Kerala. The present experiment was undertaken to have and understanding on the phenology, growth behavior and fodder production potential of *Themeda cymbaria* at the Agronomy Research Farm, College of Horticulture, Kerala Agricultural University, Vellanikkara during 2006-2007. The main objectives were to compare the phenology, growth characters and fodder production potential of *T.cymbaria* with *P.maximum* cv. Makueni.

Phenology

The phenological events were noted from the experiment during the year 2006-07. In the experiment, *P.maximum* started flowering during beginning of January and continued up to July 2007. In general, it took one month duration from flowering to seed maturity. A single panicle produced 2109 mean number of spikelets and mean number of spikelets per plant ranged from 8744 to 25296. However, no phenological events related to flowering were observed in *T.cymbaria* during the experiment.

Growth characterstics

Slips of *T.cymbaria* and *P. maximum* were planted at a spacing of 60 cm x 30 cm during August 2006. At monthly intervals, observations on growth characters were taken.

Growth was comparatively fast in *P.maximum* than *T.cymbaria*. Plant height, number of leaves, leaf area, leaf weight, stem weight and dry matter production per plant were high in *P.maximum* at all growth stages. *P.maximum* showed higher leaf: stem ratio than *T.cymbaria*. Similarly, growth indices like Leaf area ratio (LAR), Relative growth rate (RGR), Absolute growth rate (AGR) and Net assimilation rate (NAR) showed higher values in *P.maximum* than

T.cymbaria. However, leaf weight ratio was higher in *T.cymbaria* than in *P.maximum*. Relative growth rate (RGR) was higher in the early stages, declined in the middle stages and then again increased. In the cases of SLA and LAD, *P.maximum* showed higher values than *T.cymbaria*. SLA was higher in the early stages and declined until the end of experiment. Both grasses showed decline in growth during summer season. However, with the onset of monsoons both grasses performed well in their growth.

Fodder production potential

Fodder production potential of Potha grass was compared with Guinea grass cv. Makueni under irrigated and rainfed conditions, by harvesting the herbage at 30, 45 and 60 day intervals. Growth characters like plant height, number of leaves, leaf weight, stem weight and LAI were found to be higher in *P.maximum* than *T.cymbaria*. Growth of grasses was found to be on par between irrigated and rainfed conditions. Among cutting intervals, 45 days cutting interval showed higher growth than 30 and 60 days cutting interval. Initially, growth was not influenced by irrigation and cuttings. Later, they showed significant differences with time. Decline in growth was observed during summer season due to moisture stress, whereas, with the onset of monsoons, the grasses showed gradual increase in growth which had direct influence on yield. Between irrigated and rainfed grasses, although there were significant differences at some stages of cutting, total yield was not significantly different. The highest green fodder yield of 40 t/ha was recorded in irrigated Guinea grass, followed with 36.1 t/ha from rainfed Guinea grass. However, in Potha grass, the respective figures were 12.5 t/ha and 9.8 t/ha. Between cutting intervals, 45 day cutting interval produced more fodder yields than 30 and 60 day cutting. In general the fodder production potential of *P.maximum* was found to be much higher than that of *T.cymbaria*.

Although the results show that Potha grass is inferior to Guinea grass in terms of yield, it may be suitable as a soil conservation grass. Shy flowering behavior of Potha grass is an advantage in this respect. Growth during the dry period was also normal. Being a fodder grass with good quality it could be an alternative as a soil conservation grass for farmers, who also rear livestock, instead of the usually recommended non-edible vetiver (*Vetiveria zizanioides*). However, some more studies on the root spread and perennial behavior when maintained under cut-and-carry system are required.

Nutrient value and quality

Nutrient compositions like crude protein, Ether extract, NFE, Ash, phosphorus, magnesium and oxalate content of both the grasses showed no significant difference under irrigated and rainfed conditions at different cutting intervals. However, crude fibre, potassium and calcium contents were found to showed significant differences between the grasses. Potha grass showed higher crude fibre content than Guinea grass. Potassium and calcium contents were found to be higher in Guinea grass than Potha grass. From nutrient point of view, as there are not much differences between the grasses, Potha grass can replace Guinea grass in feeding with the same quality and quantity.

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EVALUATION OF POTHA GRASS (*Themeda cymbaria* (Roxb.) Hack.) FOR FODDER PRODUCTION AND QUALITY

By

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ABSTRACT OF THE THESIS

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ABSTRACT

Potha grass (*Themeda cymbaria* (Roxb.) Hack.) is a native fodder grass grown in parts of central Kerala. The present investigation was undertaken to have an understanding on the phenology, growth characteristics, fodder production potential and nutritive quality of *T.cymbaria*. Comparisons were made with Guinea grass (*Panicum maximum*) cv. Makueni. The experiments were conducted at the Agronomy Research Farm of College of Horticulture, Kerala Agricultural University Vellanikkara during 2006– 2007.

The phenological and growth characteristics were noted during the year 2006-07. *P.maximum* started flowering at the beginning of January and continued up to July 2007. It took one month from flowering to seed maturity. However, no phenological events related to flowering were observed in *T.cymbaria* during the experimental period.

Growth was comparatively fast in *P.maximum* than *T.cymbaria*. Plant height, number of leaves, leaf area, leaf weight, stem weight and dry matter production per plant were the highest in *P.maximum* during all the growth stages. Similarly, growth indices like leaf area ratio (LAR), specific leaf area (SLA), leaf area duration (LAD), relative growth rate (RGR), absolute growth rate (AGR) and net assimilation rate (NAR) showed higher values in *P.maximum* than *T.cymbaria*. However, the value of leaf weight ratio (LWR) was higher in *T.cymbaria* than *P.maximum*. Both grasses showed a decline in growth during summer season. However, with the onset of monsoon, both grasses performed well.

The fodder production potential of *T.cymbaria* was compared with Guinea grass cv. Makueni under irrigated and rainfed conditions by harvesting the herbage at 30, 45, and 60 days intervals. Growth characters like plant height, number of leaves,

leaf weight, stem weight and leaf area index (LAI) were found to be higher in *P.maximum* than *T.cymbaria*. The green and dry fodder yields at the end of the experimental period of 10 months from planting indicated a clear yield advantage for Guinea grass over Potha grass. Between irrigated and rainfed grasses, although there were yield differences at some stages of cutting, total yields showed no significant difference. The highest green and dry fodder yields were recorded in irrigated Guinea grass. Regarding cutting intervals, 45 days cutting interval performed better compared to 30 and 60 days intervals. From yield point of view, Poth grass may not be comparable with Guinea grass. However, Potha grass could be recommended as a soil conservation grass as it did not show any flowering and seed formation. Growth during the dry period was also normal. It could be an ideal alternative as a soil conservation grass for farmers who also rear livestock, instead of the usually recommended non-edible Vetiver (*Vetiveria zizanioides*).

Nutrient aspects like crude protein, ether extract, nitrogen free extract, ash, phosphorus, magnesium, and oxalate contents of both grasses were found to be similar under irrigated and rainfed conditions at different cutting intervals. However, crude fibre content was higher in Potha grass, while potassium and calcium contents were higher in Guinea grass. From nutrient point of view, there is hardly any difference between the two grasses. Potha grass can replace Guinea grass in feeding with the same quality.

APPENDIX

Monthly rainfall (mm), evaporation (mm), surface air temperature (°c), Relative humidity (%) and sunshine hours (h/day) at COH, Vellanikkara from August 2006 to July 2007
(Latitude 10°31'N, Longitude 76°13' and Altitude 40.29 MSL)

Months	*Rainfall* (mm)	*NRD*	*Evaporation* (mm)	*Surface air Temperature °C*		*Relative Humidity %*		*Sunshine Hours* (h/day)
				Maximum	*Minimum*	*Morning*	*Evening*	
AUG	550.6	15	98.3	29.8	23.1	93	73	131.8
SEP	522.2	17	82.4	29.6	23	93	75	116.4
OCT	323.7	11	95	31	23	89	68	147.3
NOV	79.5	5	111.6	31.7	23.7	83	60	195
DEC	0	0	197.3	31.5	23.6	68	45	242.6
JAN	0	0	196.1	32.5	22	70	37	268.5
FEB	0	0	173.3	34	22.2	77	33	275.5
MAR	0	0	188.5	36	24.4	86	39	254.4
APRIL	61	4	163	35.1	25	85	52	230
MAY	240.5	10	130.2	32.8	24.6	87	65	205.1
JUNE	826.5	23	88	30.1	23.5	76	76	105.5
JULY	1131.9	28	69	28.4	22.9	94	82	22.1