EVALUATION OF NATURAL GRAMINACEOUS WEED FLORA IN SOUTH KERALA FOR FODDER PURPOSE

BY

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THESIS

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DECLARATION

I hereby declare that this thesis entitled "**Evaluation of natural graminaceous weed flora in Southern Kerala for fodder purpose**" is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title of any other University or society.

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CERTIFICATE

Certified that this thesis entitled "Evaluation of natural graminaceous weed flora in Southern Kerala for fodder purpose" is a record of research work done independently by Mrs. ANEESA. M.S. under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship or associateship to her.

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LIST OF ABBREVIATIONS

N	-	Nitrogen
P	-	Phosphorus
K	-	Potassium
Ca	-	Calcium
Mg	-	Magnesium
Cu	-	Copper
Zn	-	Zinc
Mn	-	Manganese
Pb	-	Lead
Ni	-	Nickel
Co	-	Cobalt
HCN	-	Hydrogen cyanide
%	-	Per cent
m	-	Metre
cm	-	Centimetre
kg ha^{-1}	-	Kilogram per hectare
kg m^{-2}	-	Kilogram per square metre
ppm	-	Parts per million
GFY	-	Green fodder yield
DFY	-	Dry fodder yield
Py	-	Protein yield
CD	-	Critical difference
SE	-	Standard error

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INTRODUCTION

1. INTRODUCTION

The cattle form an integral component of the agrarian economy of Kerala and they contribute about 10 per cent of the domestic products. The past two decades have witnessed a quantum jump in the rate of milk production in the State. This has obviously been due to cross breeding with exotic strains of cattle which has improved the genetic quality of the livestock. At present, more than 60 per cent of the cattle are cross bred which has resulted in a tangible increase in their productivity (George, 1994).

However, Kerala lags behind in the production of quality feeds and fodder in sufficient quantity. This has been attributed to be one of the major hurdles that stands in the way of attaining a sustainable position in milk production. In dairying, the cost of feed and fodder alone accounts for 60 to 65 per cent of the total expenses, of which more than 70 per cent is spent for the purchase of concentrate feeds. Paddy straw contributes to more than 50 per cent of the roughage requirement of cattle in Kerala. The nutritive value of paddy straw, especially protein is very negligible and as such this has to be augmented by expensive concentrate feeds. Use of green fodder would help to reduce the proportion of concentrates in animal ration and enable the cattle to maintain their normal health and productivity.

The per capita availability of cultivated land is very low, ie 0.13 ha in the State (KLD Board, 1994-'95) with the average holding size of 0.47 ha. Only 12 per cent of the dairy farmers in the State actually cultivate fodder and cultivated fodder accounts for only 3 per cent of the feed (Mariyappan, 1994). Majority of the rest of the farmers are thus compelled to depend on other sources for meeting the nutritional requirement of their cattle. The gap between the roughage availability and its demand is estimated to be 27.6 lakh tonnes per year in terms of dry matter and this is attributed to be due to non-availability of land exclusively for fodder cultivation in the State (Pillai and Nair, 1989).

In Kerala, about 9.58 lakh tonnes of dry roughage accounting to 28 per cent of dry matter intake of dairy cattle is obtained annually from the collected weeds from cultivated fields and roadside and way side grazing (Joseph and Von sury, 1987). Dabadghao and Sankaranarayanan (1973) conducted a detailed survey of the grass cover of India and reported that there are a large number of grass species which could be used well for cattle feeding in the country. Since time immemmorial, grasses and other weeds collected from cultivated and other lands have been used as cattle feed. These edible species are found to have wide acceptance among dairy farmers over the years. However, scientific information on the dry matter productivity and nutritional quality of these indigenous plant species is lacking.

Studies on the above aspects would provide an insight in to the usefulness of these species in the nutrition of bovines. The anti-nutritive factors, if any, associated with these plants as well as any hitherto not reported qualities would also be made to appear in the limelight. This could also definitely pave the way for conservation as well as domestication of the valuable grass weed flora which would otherwise become extinct due to excessive grazing, chemical weed control or burning. Possibilities for the amelioration of these natural grass flora may also be thought of. Hence the present study was undertaken with the following objectives.

1. To identify the most prominent grass weeds of Southern Kerala, which can be used as fodder.

2. To evaluate the dry matter productivity and nutritive composition of these grasses and to compare them with the most popular and well adapted fodder crop, guinea grass (Panicum maximum) of the State and,

3. To develop a quality index for each of these local grasses based on their quality characters and to identify the superior local grass based on this index.

REVIEW OF LITERATURE

2. REVIEW OF LITERATURE

An investigation was undertaken to evaluate the performance and nutrient composition of the predominent local grass weeds of Southern Kerala and to compare it with the standard fodder grass of the State, guinea grass (Panicum maximum).

Many of the grass weeds coming under different species are reported to have good fodder value. But authentic information with regard to their qualities is yet to be reported. The relevant literature available in this aspect are reviewed in this section.

2.1 Weeds used as fodder

Senaratna (1934) observed from his investigations on indegenous grasses of Peradeniya that grasses like Bothriochloa pertusa, Apluda mutica, Axonopus compressus, Brachiaria distachya, Cenchrus ciliaris, Cynodon dactylon, Cynodon plectostachyus, Dactyloctenium aegyptium, Digitaria adscentens, Echinochloa colonum, Ischaemum indicum, Ischaemum timorense had satisfactory pasture value and could give good fodder yields.

The suitability of grasses like Echinochloa colonum, Eleusine indica, Cynodon dactylon, Dactyloctenium aegyptium, Brachiaria spp, Axonopus compressus, Chloris gayana, Eragrostis sp for fodder purpose has also been reported by Bor (1960).

As per the reports of Fairbairn and Thomas (1959), 20 weed species were identified to have good nutritional value for fodder purpose.

According to Kurup (1984), the native species may be encouraged to produce more forage by correction of nutrient deficiencies in soil, by adoption of suitable utilization techniques or by combination of both these measures.

Pillai (1986) suggested that identification of local grasses and their popularisation as fodder would support the livestock at reduced feed cost and would help in increased milk production.

Joseph and Vonsury (1987) reported that weeds and grazing accounted to 28 per cent of the total dry matter intake of dairy cattle in Kerala.

2.2 Weed survey

Based on the survey conducted by Dabadghao and Sankaranarayanan (1973) it was observed that Cynodon dactylon, Panicum repens, Ischaemum indicum, Heteropogon contortus, Eleusine indica, Brachiaria ramosa, Rhynchelytrum repens and Paspalum scrobiculatum were the important grass weeds found in the cultivated fields of Kerala.

As per AICRP report (1987) on weed control, it was evident that Sacolepis interupta, Echinochloa crusgalli, Isachne miliaceae and Ischaemum sp were the prominent grass weeds found in Kuttanadu rice fields during Kharif season. In coconut

gardens of Kerala, Axonopus compressus, Dactyloctenium aegyptium and Ischaemum sp were the problem grass weeds. Cynodon dactylon and Panicum repens were seen in abundance in coconut -banana intercropping system. Axonopus compressus was the most predominent grass species of banana and coconut - cocoa mixed cropping systems. The survey also revealed that grasses like Axonopus compressus, Cynodon dactylon, Panicum repens, Chrysopogon aciculatus and Dactyloctenium aegyptium dominate along the road sides of the State.

Based on the detailed survey work in Tamil Nadu, Subramanian et al., (1991) reported that the major grass weeds of Tamil Nadu were Digitaria singuinallis, Echinochloa colonum, Panicum repens, Dactyloctenium aegyptium, Dinebra arabica and Cynodon dactylon and their intensity varied from 3 to 53 m^{-2}. They also reported the suitability of almost all grass weeds for fodder purpose.

2.3 Growth and yield attributes

Bogdan (1977) reported that well fertilized and irrigated guinea grass yields 40 to 50 t ha^{-1} of green fodder.

From a trial of 12 widely divergent varieties of Deenanath grass (Pennisetum pedicellatum), Babbar (1985) reported that the green fodder yield per plant was positively correlated with number of tillers per plant, number of leaves per plant and leaf and stem weight per plant.

2.4 Nutritive value of grasses

2.4.1 Protein content and protein yield

Crude protein in any feeding stuff includes the true protein containing a number of amino acids and non-protein nitrogenous compounds such as the amides. The proteins are mainly used for the production of lean meat and for replacing the physiological losses of protein from the body. The raw proteins required to supply the proteins in milk have also to be provided by the diet of the animal.

Guyadeen (1949) reported that the crude protein content of guinea grass cv. Coloniao (Panicum maximum var. 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 contents of Cynodon dactylon and Brachiaria decumbens at flowering stage were reported to be 8.7 and 9.1 per cent (Grieve et al., 1965).

Butterworth (1967) observed that the crude protein content of guinea grass ranged from 4 to 14 per cent.

Marten and Anderson (1975) studied 12 annual weeds for their crude protein content and observed that all of them have more than 14 per cent crude protein and 10 species had higher crude protein than oats.

Among different species of indigenous grasses studied, Cynodon dactylon was reported to have the highest crude protein content of 13.26 per cent (Dogra et al., 1979).

Chandini and Pillai (1980) reported that the crude protein content of guinea grass was 8.96 per cent.

Bosworth et al. (1980) studied the crude protein content of Panicum dichotomiflorum, Digitaria sanguinalis and Dactyloctenium aegyptium at flowering stage and observed that the contents were 9.1, 8.1 and 7.9 per cent, respectively.

Sreeramulu and Chande (1983) estimated the crude protein content of 20 common Tanzanian fodder grasses and reported that Cynodon dactylon, Panicum infestum, Pennisetum polystachyon, Dactyloctenium geminatum and Hyparrhenia rufa were found to be rich in crude protein coupled with low fibre values. They also reported that the crude protein content of Cynodon dactylon, Eleusine indica, Eragrostis superba, Dactyloctenium geminatum, Rhynchelytrum repens, Sporobolus pyramidalis and Panicum maximum were 19.1, 11.9, 11.3, 15.6, 11.3, 9.7 and 12.4 per cent respectively.

The crude protein content of Cynodon dactylon, Brachiaria brizantha, Sporobolus indicus and Panicum maximum were 116, 86, 79 and 69 g kg^{-1} DM, respectively (Youssef and Brathwaite, 1987).

Similarly Ranjhan (1991) reported variation in the crude protein content of Cynodon dactylon, Echinochloa colonum and Panicum maximum.

The crude protein content of guinea grass at early anthesis was found to be 9.3 per cent by Esechie (1992).

2.4.2 Crude fibre content

Crude fibre consisting of the cell wall and woody fibre of all plants is the least digestible part of the feed. The ability of the rumen bacteria and protozoa to digest a forage is greatly affected by its crude fibre content.

Guyadeen (1949) reported that the crude fibre content of guinea grass cv. Coloniao (Panicum maximum var. Coloniao) and elephant grass (Pennisetum purpureum) were 32.3 and 29.1 per cent on moisture free basis at 12 weeks age.

From the studies conducted by Sreeramulu and Chande (1983), it was observed that the grass species showed little variation among themselves on crude fibre content and the content ranged from 26 to 33 per cent in most of the species.

According to Pillai (1986), the crude fibre content of guinea grass and setaria grass at flowering were 32.48 and 33.48 per cent, respectively in open area.

The crude fibre content of grasses such as Cynodon dactylon, Echinochloa colonum, and Panicum maximum were 20.2, 40.5 and 38.1 per cent respectively (Ranjhan, 1991).

Eschie (1992) reported a crude fibre content of 35.1 per cent in guinea grass at early anthesis.

2.4.3 Total ash content

Ash content being the reliable estimate of mineral content of forage crops, has a prominent role in the nutritive value of any feed. Animals feeding on forage of high ash content are said to have higher intake of minerals.

Sreeramulu and Chande (1983) observed that the ash yield of Cynodon dactylon, Eleusine indica, Eragrostis superba, Rhynchelytrum repens, Sporobolus pyramidalis and Panicum maximum were 14.6, 12.6, 6.6, 9.8, 9.2 and 11.5 per cent, respectively.

Ranjhan (1991) reported that the ash content of grasses such as Cynodon dactylon, Echinochloa colonum and Panicum maximum were 11.6, 8 and 16 per cent respectively.

A lower ash content of 4.61 per cent on the guinea grass leaf sheath at early anthesis was reported by Eschie (1992).

2.4.4 Phosphorus content

The content of P in forage crops plays an important role in maintaining the animal in better health, fertility and production.

Andrew and Robins (1971) reported that the herbage for cattle should necessarily contain at least 0.15 per cent phosphorus.

According to ARC (1980), the P content of leaf and stem from Digitaria milanjiana and Digitaria eriantha ssp. pentzii were 0.3, 0.25 and 0.33, 0.23 per cent, respectively.

Bosworth et al. (1980) reported that the P content of grasses such as Panicum texanum, Digitaria sanguinalis, Dactyloctenium aegyptium and Cynodon dactylon at flowering stage were 0.17, 0.25, 0.18, 0.15 per cent, respectively.

Youssef and Brathwaite (1987) analaysed 106 tropical grasses and observed that the P content ranged from 1-3g kg^{-1} DM.

Fouseca et al. (1990) analysed the samples of young and mature Hyparrhenia rufa, Penninsetum purpureum, Panicum maximum, Axonopus scoparins, Cynodon ulemfuensis, Melinis minufiflora, Paspalum notatum and Brachiaria sp in South Costa Rica in wet and dry seasons and found that the average P content was 0.14 per cent of DM.

Ranjhan (1991) observed that the P content of Cynodon dactylon was 0.2 per cent.

Esechie (1992) reported that the P content of guinea grass leaf blade at early anthesis was 0.29 g kg^{-1} DM.

2.4.5 Potassium content

K plays an important role in animal nutrition. It is required for muscular activity, maintenance of the acid - base balance in the blood and for osmotic pressure of body fluid.

Deficiency symptoms are non-specific, but are associated with reduced feed consumption, growth rate and feed efficiency and stiffness and emaciation.

According to NRC (1975, 1978, 1984), the K requirements of sheep, dairy cattle and beef were estimated to be 5, 8 to 12 and 5.7 g kg^{-1} DM, respectively.

ARC (1980) reported that the K concentration of the leaf and stem from Digitaria milanjiana and Digitaria eriantha ssp pentzii were 2.68, 2.9 and 2.13, 2.64 per cent, respectively.

Bosworth et al. (1980) analysed the K 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, crow foot grass and bermuda grass at flowering stage.

According to Sreeramulu and Chande (1983), the K content of Cynodon dactylon, Dactyloctenium geminatum, Eleusine indica, Eragrostis superba, Rhynchelytrum repens, Sporobolus pyramidalis and Panicum repens were 2.76, 0.71, 5.14, 0.96, 0.98, 1.32 and 1.5 per cent, respectively.

Jayakumar et al. (1985) reported that the K content of Cynodon dactylon, Eleusine indica and Panicum repens were 1.72, 1.21 and 1.08 per cent, respectively. Similarly variations in K content of Brachiaria brizantha, Cynodon dactylon, Sporobolus indicus and Panicum maximum were reported by Youssef and Brathwaite (1987).

Fouseca et al. (1990) observed that the average K content of grasses such as Hyparrhenia rufa, Penninsetum purpureum, Panicum maximum, Axonopus scoparins, Cynodon ulemfuensis, Melinis minutiflora, Paspalum notatum and Brachiaria sp was 1.7 per cent.

2.4.6 Calcium content

In animal nutrition, Ca is required in highest quantity for bone growth, it is also needed in constant amount for various metabolic functions in the animal including formation and maintenance of skeletal structure, blood clotting and muscle tone and contraction.

The range for the requirement of sheep, dairy cattle and beef were 2.1 to 5.2, 4.3 to 6 and 1.8 to 5.3 g kg^{-1} DM, respectively (NRC, 1975, 1978, 1984).

According to ARC (1980), the Ca content of Digitaria milanjiana and Digitaria eriantha ssp. pentzii in the leaf and stem were 0.43, 0.19 and 0.51, 0.15 per cent, respectively.

Bosworth et al. (1980) reported variation in Ca content of texas panicum, crab grass, crow foot grass and bermuda grass at flowering stage.

Similar work on Cynodon dactylon, Dactyloctenium geminatum, Eleusine indica, Eragrostis superba, Rhynchelytrum repens, Sporobolus pyramidalis and Panicum maximum were conducted by Sreeramulu and Chande (1983) and they observed that the Ca content ranged from 0.2 to 0.9 per cent.

Fouseca et al. (1990) reported the average Ca content of grasses like Hyparrhenia rufa, Pennisetum purpureum, Panicum maximum, Axonopus scoparins, Cynodon ulemfuensis, Melinis minutiflora, Paspalum notatum and Brachiaria sp as 0.27 per cent.

2.4.7 Magnesium content

Like other nutrients, Mg is also having important role in animal nutrition. Mg is closely related to Ca and P in metabolism and maintenance. It is needed in several enzyme

systems and for muscle relaxation. A deficiency of this results in a disease commonly called grass tetany or grass staggers.

According to NRC (1975, 1978, 1984) the sheep, dairy cattle and beef requirements of Mg were 0.4 to 0.8, 2 and 0.5 to 2.5 g kg^{-1} DM, respectively.

ARC (1980) reported that the Mg concentration of leaf and stem from Digitaria milanjiana and Digitaria eriantha ssp pentzii was 0.41, 0.36 and 0.34, 0.2 per cent, respectively.

According to Bosworth et al. (1980), the Mg content of grasses like Panicum texanum, Digitaria sanguinalis, Dactyloctenium aegyptium and Cynodon dactylon at flowering stage were 0.35, 0.33, 0.33 and 0.22 per cent, respectively.

Poland and Schnabel (1980) reported from Jamaica that the Mg range in Brachiaria and pangola grasses were 0.20 to 0.25 and 0.16 to 0.23 per cent, respectively.

From their studies with 106 tropical grasses, Youssef and Brathwaite (1987) reported that the Mg content of these grasses ranged from 0.7 to 4.4 g kg^{-1} DM.

The average Mg contnet of grasses like Hyparrhenia rufa, Pennisetum purpureum, Panicum maximum, Axonopus scoparins, Cynodon ulemfuensis, Melinis minutiflora, Paspalum notatum and Brachiaria sp in South Costa Rica was 0.16 per cent. (Fouseca et al., 1990).

The Mg content of sun cured bermuda hay in late vegetative stage was observed to be 0.28 per cent by Ranjhan (1991).

According to Esechie (1992) the Mg content of guinea grass leaf blade at early anthesis was 0.72 g kg^{-1}.

2.4.8 Micro nutrients

A number of minerals are required by the animal body in smaller quantities and these trace elements are frequently involved in enzyme systems, rather than subserving a structural or regulatory function.

Fleming (1965) reported that the copper content of temperate grass species varied from 5 to 20 ppm.

Underwood (1977) attributed the normal pasture level of Cu as 7 to 14 ppm and he also specified that levels below 5 ppm was likely to cause deficiency symptoms.

Appreciable amounts of micro nutrients viz. Cu, Zn and Mn have been reported in the leaves and stem of Digitaria milanjiana and Digitaria eriantha ssp pentzii. (ARC, 1980).

Poland and Schnabel (1980) from Jamaica observed that the concentration of Cu, Fe, Mn and Zn ranged from 2.9 to 8.4, 98 to 144, 41 to 344 and 25 to 125 ppm, respectively in Digitaria decumbens and Brachiaria decumbens.

Youssef and Brathwaite (1987) analysed the micronutrient content in 106 tropical grasses and reported that the content of Cu, Fe, Mn and Zn ranged from 2.2 to 11.9, 90 to 1473, 63 to 983 and 11 to 59 mg kg^{-1} DM, respectively.

Fouseca et al. (1990) analysed the samples of young and mature Hyparrhenia rufa, Pennisetum purpureum, Panicum maximum, Axonopus scoparins, Cynodon ulemfuensis, Melinis minutifolora, Paspalum notatum and Brachiaria sp in South Costa Rica and found that the average Fe, Cu, Mn and Zn contents were 245, 6, 119 and 39 mg kg^{-1} DM, respetively.

From the work of Esechie (1992), it was revealed that the Cu, B, Zn, Mn and Fe contents of guinea grass were 5, 16, 21, 6.3 and 41 mg kg^{-1}, respectively at early anthesis.

2.4.9 Anti-quality components

a. Potassium : (Calcium + Magnesium) ratio

The K : (Ca + Mg) ratio of the fodder material is very important from the nutritional point of view.

Grunes et al. (1970) concluded from their studies that there was a good relationship between the K : (Ca + Mg) ratio and incidence of grass tetany (hypomagnesaemia) of cattle. They indicated that when the ratio was less than 2.2, there were very few occurrences of grass tetany.

Marten and Anderson (1975) analysed the K : (Ca + Mg) ratio for 12 annual weed species and reported that in all those species except yellow foxtail, the ratio was below the critical level of 2.2.

Experiments by Thill and George (1975) on K : (Ca + Mg) ratio of 9 cool season grasses also revealed that the ratio above 2.2 was dangerous to cattle and may result in the incidence of hypomagnesaemia or grass tetany.

Bosworth et al. (1980) from their experiments on grasses reported that the K : (Ca + Mg) ratio ranged from 1 to 2.89 in the species studied.

b. Calcium : Posphorus ratio

The Ca : P ratio is very important in animal nutrition. The feeding stuffs vary markedly in their Ca and P contents. The availability of Ca and P from feeding stuff is not necessarily indicated by their gross composition in a feed. The absorbability of these minerals in the animal system depends on the chemical composition in which they occur.

Marten and Anderson (1975) analysed Ca : P ratios of 12 annual weed species and reported that grass weeds were within safe limits with ragard to Ca : P ratio. A Ca : P ratio below 8:1 is safe for ruminants.

According to NAC (1976), plants which offer the most efficient utilisation of Ca and P will be those with a Ca: P ratio between 1:1 and 2:1 and when this ratio exceeds 7:1, metabolic disorders may arise. They also reported that grass weeds and cultivated grasses were all within a safe range.

Bosworth et al. (1980) reported that the Ca : P ratio of grasses such as Panicum texanum, Digitaria sanguinalis, Dactyloctenium aegyptium and Cynodon dactylon at flowering stage were between 1.7 to 4.6.

2.4.10 Anti-nutritional factors

Anti-nutritional factors are generated in natural feed stuffs by the normal metabolism of the species from which the material originates, and by different mechanisms, exerting effects contrary to the optimum nutrition of animals.

The grasses as a family are relatively free of toxins, with the exception of cyanogenic glycosides and nitrates which are accumulated by some species.

a. Tannin

The relevance of tannin in fodder quality as an anti quality factor has been reported by Joslyn and Goldstein (1964), Makkar (1993) and Kakkar et al. (1994).

b. Oxalate

According to Seawright et al. (1970), oxalate rich fodders generally do not affect ruminant animals unless present in exceptionally high concentrations.

Kakkar et al. (1994) found that some plant species contained soluble oxalates at a concentration more than 10 per cent. These include species of rumex, chinopodium, amaranthus and paddy straw. He also reported that feeding forages containing more than 10 per cent oxalate is hazardous to the animal. Fodder crops like guinea grass, bajra and napier grass also contain oxalate within safe limits.

c. Cyanogenic glycosides

The influence of cyanogenic glycoside on fodder quality was studied by Kakkar et al. (1994) and they reported that a minimum level of 0.2 per cent was sufficient to cause toxicity.

d. Heavy metals

Though the role of heavy metals in animal nutrition is not clear, excess amounts of them in forage was reported to cause toxicity in animals.

Underwood (1977) and AEC (1978) observed that a selenium concentration of about 0.5 ppm in forages would be toxic to the animal.

The occurrence of toxic levels of selenium in forages at the foot hills of Himalayas was reported by Ghosh et al. (1993).

MATERIALS AND METHODS

3. MATERIALS AND METHODS

An investigation was undertaken with the objective of identifying and evaluating the prominent local grass species of three southern districts of Kerala and to compare them quantitatively and qualitatively with the most popular fodder grass of Kerala viz. guinea grass (Panicum maximum).

The study was conducted in two stages. The first step involved a survey work on the local weed species of southern districts of the State namely Thiruvananthapuram, Kollam and Pathanamthitta and to identify the most prominent grass species among them. In the next step, these prominent species identified in the survey were tested in a micro plot trial along with guinea grass cv. Hamil.

3.1 Survey work

3.1.1 Experimental area

The survey work was conducted in the uplands of the southern districts of Kerala viz. Thiruvananthapuram, Kollam and Pathanamthitta. The details are given in Table 3.1.

3.1.2 Soil

Soil type of the area varied from red laterite to sandy loam.

Table 3.1 Location surveyed in the southern districts of Kerala

District	Taluk	Location
1. Thiruvananthapuram	Neyyattinkara	Vellayani
		Neyyattinkara
		Vizhinjham
		Kattakada
		Parassla
		Aryankode
	Thiruvananthapuram	Manakkadu
		Cheruvikkal
		Kuravankode
		Vellayambalam
		Malayankeezhu
		Ulloor
	Nedumangad	Karakulam
		Nedumangad
		Anad
		Palode
		Aruvikkara
		Vembayam
	Chirayinkil	Korani
		Chirayinkil
		Anjuthengu
		Vakkom
		Avamavamcjero
		Venjarammoodu

District	Taluk	Location
2. Kollam	Kollam	Kallambalam
		Chathannoor
		Kottiyam
		Thattamala
		Chavara
		Kundara
	Kottarakara	Kottarakara
		Puthoor
		Veliyam
		Ayoor
		Anchal
		Pooyappally
	Karunagapally	Ochira
		Karunagapally
		Puthiyakavu
		Thodiyoor
		Mynagapally
	Pathanapuram	Vilakkudy
		Thalavoor
		Pattazhi
		Piravanthoor
		Pathanapuram
	Kunnathoor	Sasthamkotta
		Kallada
		Kurumathoor
		Poruvazhi
		Soornad

District	Taluk	Location
3. Pathanamthitta	Adoor	Kalayapuram
		Adoor
		Pandalam
		Pathanamthitta
		Elamthitta
	Kozhencheri	Kozhancheri
		Ayroor
		Elanthoor
		Omalloor
		Chenurkara
		Thottapuzhasseri
	Thiruvalla	Nedumbram
		Kuttoor
		Thiruvalla
		Chathankary
		Kaviyoor
		Peringara
	Mallappally	Kallooppara
		Kottangal
		Aanikkad
		Kottanad
	Ranni	Chittar
		Konni
		Edamon
		Vadasserikkara
		Perinad
		Pazhavangadi

3.1.3 Season

The survey was conducted during the period from September to October 1994. Details were given in the Table 3.2.

Table 3.2 Period of survey in different districts

Area	Period of survey
Thiruvananthapuram	10.9.1994 - 20.9.1994
Kollam	21.9.1994 - 28.9.1994
Pathanamthitta	10.10.1994 - 19.10.1994

3.1.4 Methodology

The method suggested by Subramonian et al. (1991) was followed for the survey.

The routes were first selected so as to cover the different taluks of each district. A stop was made after every 10 km distance on selected routes and the location for recording weed observations was selected 4 to 5 fields away from the road, so that it represented the natural weed flora. Observations were recorded at random from 2 to 3 places of 1 m^2 area.

All plant species occuring within the sampling plot of 1 m^2 were listed under three categories namely grasses, sedges and dicots. In case of species that could not be identified on

the spot or when identification was in doubt, plant specimens were collected and pressed and these were later identified at College of Horticulture, Vellanikkara and Tropical Botanical Garden and Research Institute, Palode.

In addition, grass bundles were collected from the local markets to identify the common weed species used as forage. Ten grass bundles were collected from the important local markets of each district, separated into different species and the percentage weight of each species were worked out and the mean percentage weight for each district was calculated.

3.2 Field experiment

3.2.1 Experimental site

The experiment was conducted in the Instructional Farm attached to the College of Agriculture, Vellayani, situated at 8.5°N latitude and 76.9°E longitude and at an altitude of 29 m above mean sea level.

3.2.2 Soil

The soil of the experimental area was oxisol, Vellayani series having the following physico-chemical properties.

Table 3.3 Mechanical analysis of the soil of the experimental site

Sl. No.	Parameter	Content in soil (%)	Method used
1	2	3	4
1.	Coarse sand	35.40	Bouyoucos Hydrometer method (Bouyoucos, 1962)
2.	Fine sand	16.00	
3.	Silt	17.50	
4.	Clay	30.00	
5.	Textural class	Sandy clay loam	

Table 3.4 Chemical properties of the soil of the experimental site

Sl. No.	Parameter	Content	Method
1.	Available N	260.32 kg ha^{-1}	Alkaline $KMnO_4$ method (Subbiah and Asija, 1956)
2.	Available P_2O_5	45.29 kg ha^{-1}	Bray colorimetric method (Jackson, 1973)
3.	Available K_2O	125.25 kg ha^{-1}	Ammonium acetate method (Jackson, 1973)
4.	pH	5.5	pH meter with glass electrode (Jackson, 1973)

3.2.3 Season

The field experiment was conducted during the period, February to December, 1995.

3.2.4 Weather condition

Data on weather parameters were collected from the observatory attached to the College of Agriculture, Vellayani. The monthly mean values of the weather elements during the cropping period are presented in Appendix I and Fig. 1. Mean maximum and minimum temperature ranged from 28.85 to 32.74°C and 20.03°C to 24.89 respectively. The total rainfall received was 1382.4 mm. The mean relative humidity ranged from 71.48 to 86.27 per cent. Altogether the weather condition was satisfactory during the cropping period.

3.2.5 Cropping history of the field

The experimental area was lying fallow for the last one year.

3.3 Materials

3.3.1 Planting material

The planting material of the identified grass species were collected locally and planted in the field as per the technical programme along with guinea grass cv. Hamil.

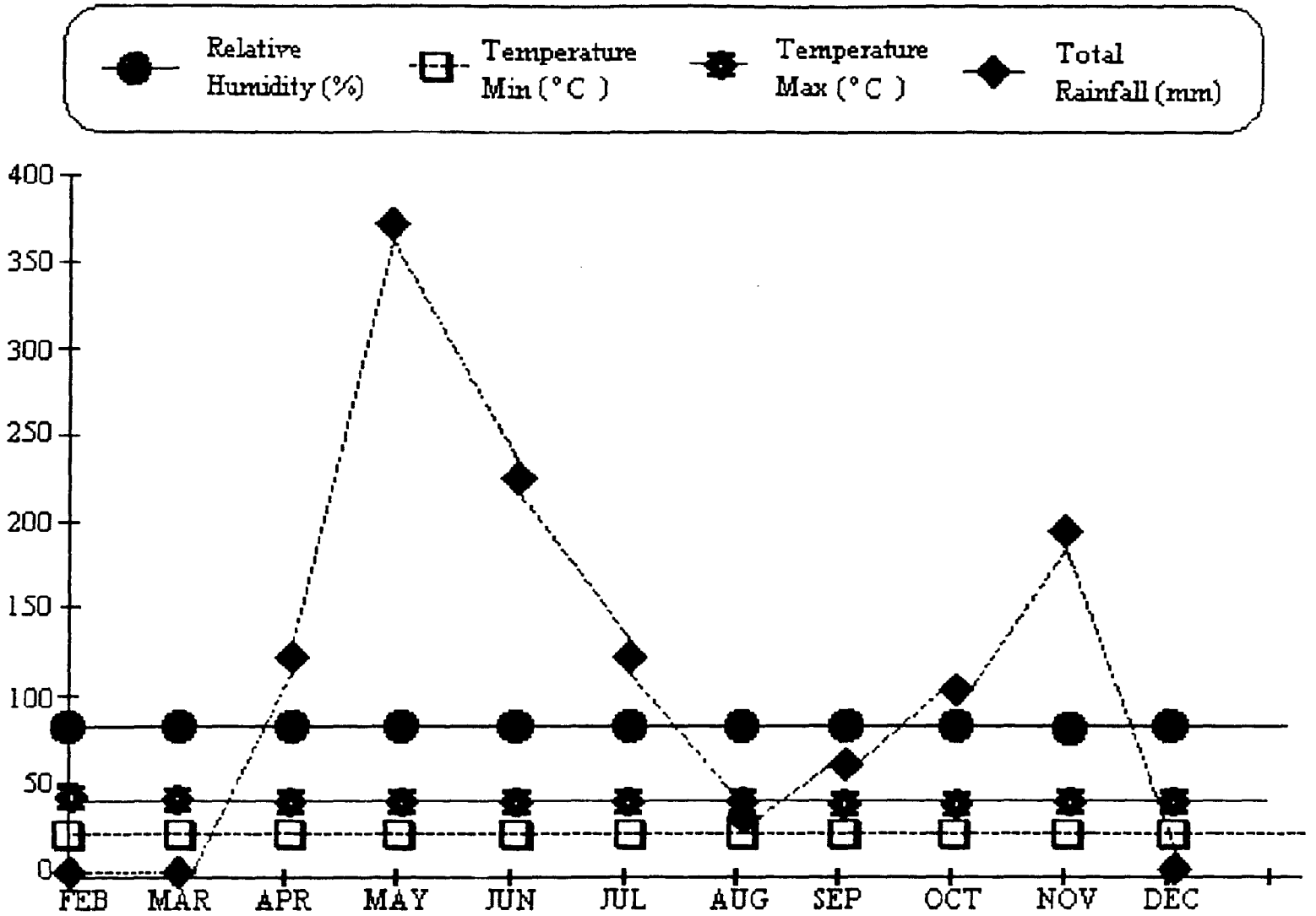


Fig. 1: Monthly mean values of weather parameters during the cropping season.

The plant parts of grass species used for planting is given in the Table 3.5.

Table 3.5 Plant parts of grass species used for planting

Sl. No.	Grass	Plant part used
1.	*Cynodon dactylon*	Rooted stem piece/runner
2.	*Digitaria ciliaris*	Rooted plant
3.	*Alloteropsis cimicina*	Rooted plant
4.	*Eleusine indica*	Rooted slips
5.	*Axonopus compressus*	Rooted slips
6.	*Panicum repens*	Rooted stem piece
7.	*Rhynchelytrum repens*	Rooted slips
8.	*Echinochloa colonum*	Rooted plant
9.	*Cyrtococcum trigonum*	Rooted bit of branches
10.	*Brachiaria ramosa*	Rooted bit of branches
11.	*Eragrostis tenella*	Rooted plant
12.	*Panicum javanicum*	Rooted bit of branches
13.	*Dactyloctenium aegyptium*	Rooted plant
14.	*Chloris barbata*	Rooted plant
15.	*Sporobolus indicus* var. diander	Rooted plant
16.	*Panicum maximum* cv. Hamil	Slips

3.3.2 Manures and Fertilizers

Farm yard manure analysing 0.5, 0.2, 0.5 per cent of N, P_2O_5 and K_2O was used. Chemical fertilizers like Urea (46 per cent N), Mussuriephos (22 per cent P_2O_5) and Muriate of potash (60 per cent K_2O) were also used.

Cynodon dactylon (L.) Pers.

Digitaria ciliaris (Retz.) Koeler.

Alloteropsis cimicina (Linn.) Stapf.

Elusine indica (L.) Gaertn.

3.4 Methods

3.4.1 Treatments

15 grass species identified as most prominent species in the survey along with guinea grass cv. Hamil constituted the treatments.

T_1 Cynodon dactylon (L.) Pers.

A perennial grass with long runners which strike roots at the nodes and extensive underground rhizomes. The leaves of Cynodon vary greatly in length from 3 to 20 cm. The flowering stems may be 15 to 50 cm long. It propagates vegetatively more than by seeds.

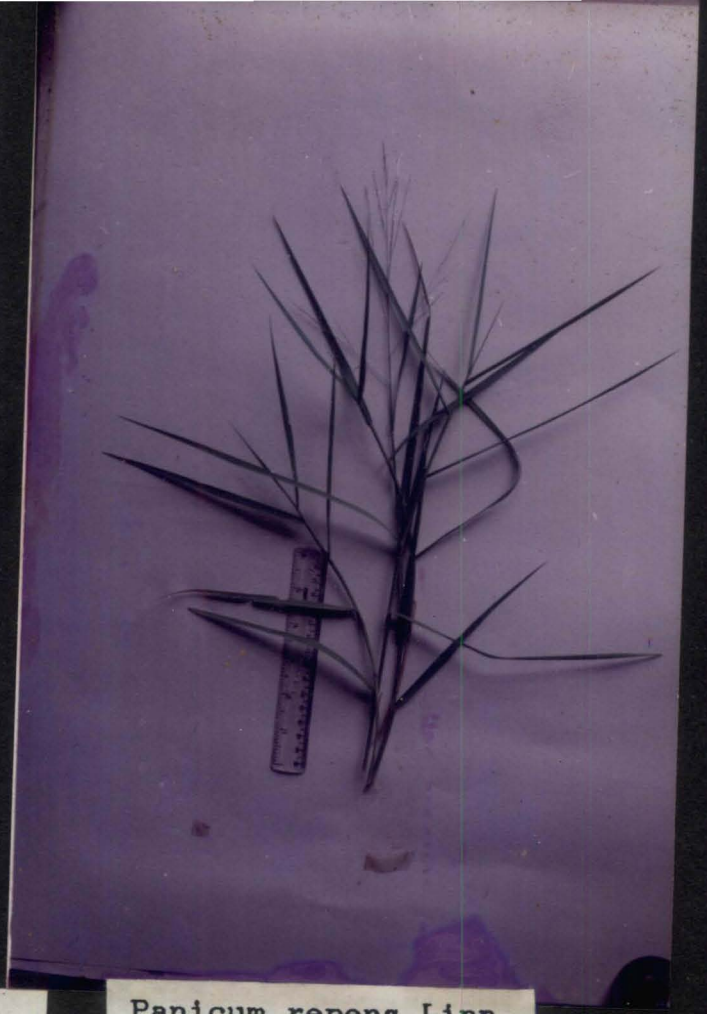
T_2 Digitaria ciliaris (Retz.) Koeler.

An annual grass. The culms are stout, 50 to 90 cm long when prostrate. The leaves are 5 to 15 cm long, 5 to 10 mm wide. The spike is 5 to 15 cm long, with 3 to 13 fingerlike segments in whorls at the top of the stem. Although it is annual it exhibits perennial growth.

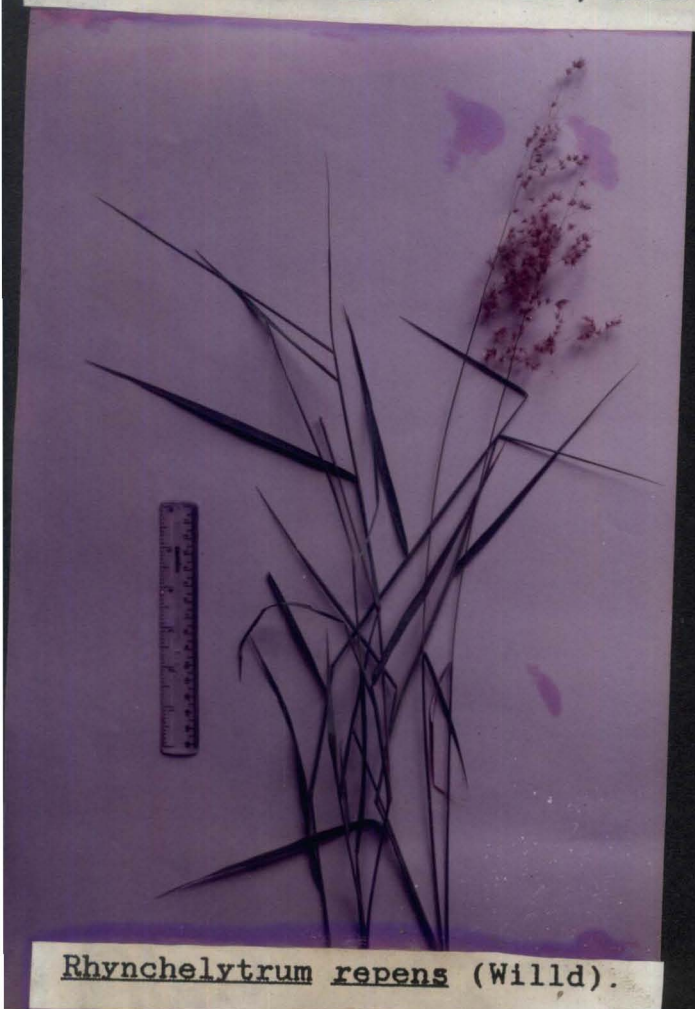
T_3 Alloteropsis cimicina (Linn.) Stapf.

An annual grass with ascending culms, upto 90 cm in height, arising from a geniculate base. Nodes hairy, leaves ovate, lanceolate spikes sub verticillate, whorled, 2 to 15 cm long.

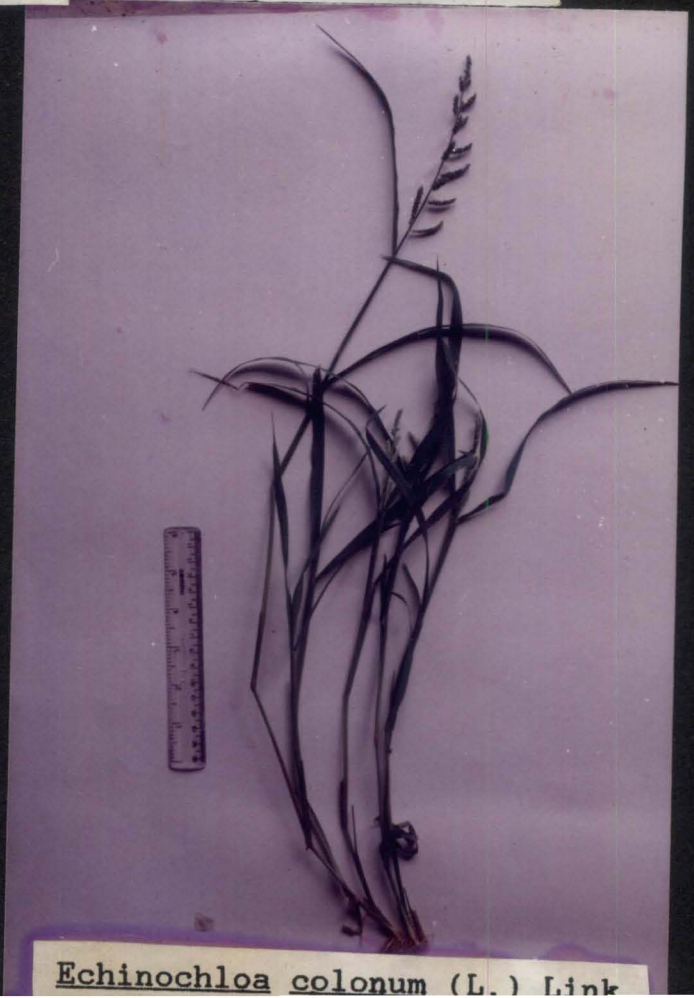
Axonopus compressus (Swartz.) Beauv.



Panicum repens Linn.



Rhynchelytrum repens (Willd).



Echinochloa colonum (L.) Link

T_4 Eleusine indica (L.) Gaertn.

Eleusine indica is a coarse tufted, annual grass which grows 30 to 60 cm height, with laterally flattened shoots. The inflorescence consists of 4 to 8 narrow finger like spikes, 4 to 15 cm long, arising from the top of the stem to form a spreading umbel. It reproduces by seeds and old roots.

T_5 Axonopus compressus (Swartz) Beauv.

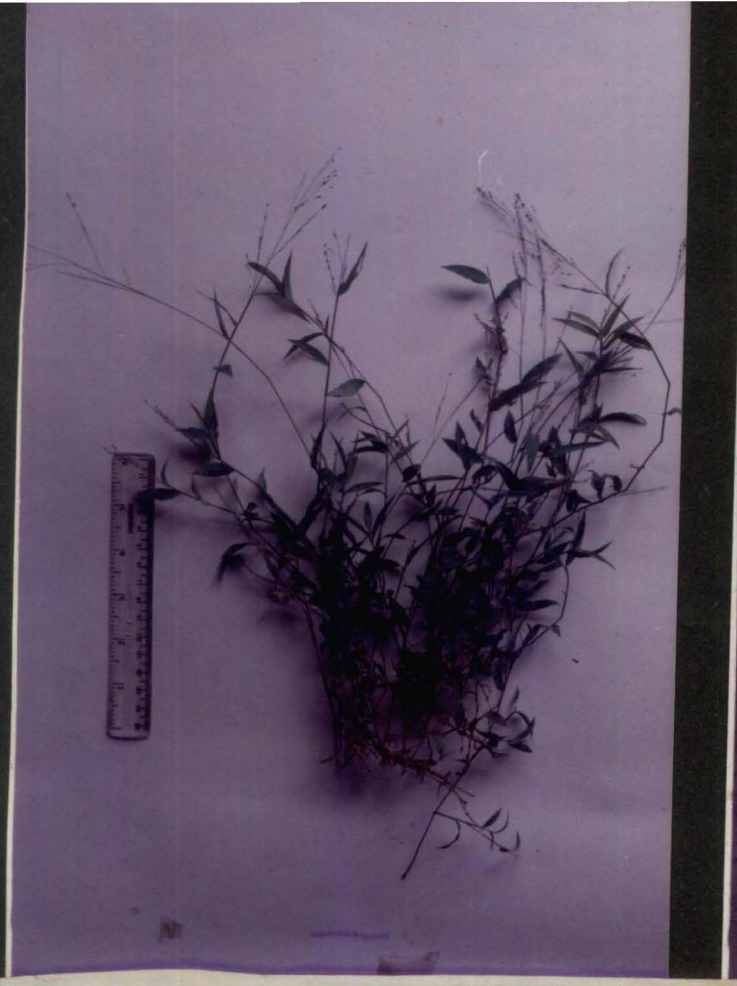
A stoloniferous perennial grass. The leaves are flat, lanceolate, 10 to 15 cm long and 2 to 15 mm wide. The culms are erect, 20-25 cm long. The inflorescence has 3 to 5 spikes, 5 to 7 cm long, erect and slightly digitate. The plant strikes roots from nodes of the stem when creeping along the ground. It propagates by vegetative parts as well as by seeds.

T_6 Panicum repens Linn.

Panicum repens is an aggressive perennial grass. It is a creeping perennial which propagates vegetatively through rhizomes. The leaves are 15 to 25 cm long and 1.5 cm wide. The panicles are 6 to 18 cm long, some what loose and open and erect or ascending.

T_7 Rhynchelytrum repens (Willd)

Is an annual or short lived perennial, about 30 cm to slightly less than 1 m height and rooting at the lower nodes. The panicle is coloured reddish by long silky hairs.



Cyrtococcum trigonum (Retz) A. Camus.

Brachiaria ramosa (L) Stapf.

Eragrostis tenella (Linn) P. Beauv.

Panicum javanicum Pair.

T_8 Echinochloa colonum (L.) Link.

It is a slender annual grass growing to a height of 60 to 90 cm. The stem is creeping below and erect above, with rooting at lower nodes. Propagates through seeds as well as vegetatively. Panicle erect, 5 to 13 cm high.

T_9 Cyrtococcum trigonum (Retz) A. camus.

Perennial grass with slender, geniculated culms ascending from a decumbent or creeping base. Leaves linear, lanceolate, glabrous or laxly hairy. Panicle contracted, branches short.

T_{10} Brachiaria ramosa (L) Stapf

Annual grass, stem decumbent and branched below, branches erect, leafy, leaves lanceolate, acuminate, thin, glabrous or pubescent. Spikes 2.5 to 5 cm, erecto-patent, rather distant, sometimes divided at the base.

T_{11} Eragrostis tenella (Linn) P Beauv.

A small elegant, slender and loosely tufted annual with narrow leaves. Panicle 5 to 20 cm long, contracted or spreading, excessively branched.

T_{12} Panicum javanicum Pair

Annual, stem 30 to 60 cm, decumbent and rooting below, nodes pubescent. Leaves 2.5 to 12.5 x 0.8 to 1.6 cm flat or

Dactyloctenium aegyptium Beauv.

Chloris barbata Sw.

Sporobolus indicus (L.) B.R.R. var. diander

Panicum maximum Jacq. cv Hamil.

undulate, very variable in breadth and form of base. Spikes 1.5 to 5 cm long.

T_{13} Dactyloctenium aegyptium Beauv.

An annual very variable grass with erect or creeping culms, 15 to 45 cm long, rooting and branching proliferously at nodes. Leaves distinchous, acute or acuminate, ciliate, sheaths compressed. Inflorescences of 2 to 6 digitate spikes.

T_{14} Chloris barbata Sw.

Annual grass, stem 30 to 90 cm, stout, erect from a geniculate or from a creeping, proliferously branched base, simple or branching above, nodes with often large tufts of leaves having compressed equitant sheaths. Leaves 6 to 8 cm long. Spikes 1.25 to 10 cm, sub erect. spickelets green or red to purple.

T_{15} Sporobolus indicus (L.) B.R.R var. diander (Retz)

A tall erect, sltender annual or perennial grass. culms 30 to 90 cm high, leaves densely tufted, 7.5 to 25 cm x 2.5 mm. Panicles pyramidal, 10 to 80 cm long.

T_{16} Panicum maximum Jacq. cv Hamil.

A tufted perennial, often with a shortly creeping rhizome, 60 to 200 cm high, stem branching, branches erect. Leaves long broadly linear or linear-lanceolate glabrous, Panicle large decompound, lower branches whorled.

3.4.2 Layout and Design

The experiment was laid out in Randomised Block Design with three replications. The layout plan is presented in Fig. 2.

3.4.3 Spacing and plot size

A spacing of 20 cm between rows and plants was followed in microplots of 1 x 1 m area accommodating 25 plants m^{-2}.

3.4.4 Details of cultivation

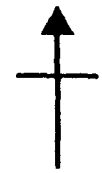
The experimental site was dug twice, weeds were removed and left as such for two weeks for complete destruction of the weeds. After that the field was dug again, clods broken and laid out into plots and blocks.

3.4.5 Organic manure and Fertilizer application

Farm yard manure at the rate of 1 kg $plot^{-1}$ was applied uniformly prior to planting. 22 g of Urea (1/2 N), 23 g of Mussurie phos (Full P) and 8 g of Muriate of potash (Full K) were applied as basal, based on the recommendation for guinea grass (200:50:50 kg N, P_2O_5 and K_2O ha^{-1}) in Package of Practices Recommendations 1993. Remaining 22 g of Urea was applied in 2 equal splits after the second and third cuts on 14.6.1995 and 15.8.1995.

3.4.6 Planting

Planting materials of different grasses were planted in the microplots at a spacing of 20 x 20 cm. on 5-2-1995.



T_9	T_{11}	T_{12}
T_8	T_{16}	T_{14}
T_6	T_{13}	T_9
T_2	T_{15}	T_1
T_1	T_4	T_{13}
T_{11}	T_{10}	T_6
T_5	T_{14}	T_2
T_{13}	T_5	T_4
T_7	T_{12}	T_8
T_{16}	T_2	T_7
T_3	T_6	T_5
T_{12}	T_7	T_{10}
T_4	T_9	T_{15}
T_{10}	T_8	T_3
T_{14}	T_3	T_{16}
T_{15}	T_1	T_{11}
BLOCK I	BLOCK II	BLOCK III

Treatments

T_1 *Cynodon dactylon*

T_2 *Digitaria ciliaris*

T_3 *Alloteropsis cimicina*

T_4 *Eleusine indica*

T_5 *Axonopus compressus*

T_6 *Panicum repens*

T_7 *Rhynchelytrum repens*

T_8 *Echinochloa colonum*

T_9 *Cyrtococcum trigonum*

T_{10} *Brachiaria ramosa*

T_{11} *Eragrostis tenella*

T_{12} *Panicum javanicum*

T_{13} *Dactyloctenium acgyptium*

T_{14} *Chloris barbata*

T_{15} *Sporobolus indicus var. diander*

T_{16} *Panicum maximum cv. Hamil*

Replication - 3

Design - Randomised Block Design

Fig. 2. Layout plan of the field experiment

3.5 After cultivation

Establishment of the planted slips was difficult. Gap filling was done twice within two weeks of planting for Cynodon dactylon, Alloteropsis cimicina, Echinochloa colonum, Cyrtococcum trigonum and Chloris barbata.

One weeding was given before each cut to prevent the growth of other weed species.

3.6 General performance of the crop

General performance of the crop was satisfactory. No plant protection measure was adopted.

3.7 Harvest

Five cuts were taken at an interval of 60 days on 15.4.1995, 17.6.1995, 15.8.1995, 15.10.1995 and 16.12.1995. A cutting height of 3 to 10 cm was given depending on the species.

3.8 Observations recorded

3.8.1 Survey

The following observations were recorded from each site using a G.I. wire frame of $1m^2$ area.

3.8.1.1 Weed species

Weed species associated with the important crops of the location were identified from different locations.

3.8.1.2 **Weed count**

The count of weeds belonging to each class viz. grasses, sedges and dicots was taken from 1 m^2 area.

3.8.1.3 **Relative weed intensity**

The weed intensity of each group was worked out using the following relationship.

$$\text{Weed intensity of each group} = \frac{\text{Count of each group} \times 100}{\text{Total weed count}}$$

3.8.2 **Field experiment**

3.8.2.1 **Growth characters**

For recording growth characters, five hills of grasses were selected randomly from each plot.

3.8.2.1 **a. Plant height**

The height was measured one day prior to each harvest and was recorded in cm from the base of the plant to the tip of the longest leaf.

b. Tiller count

The number of tillers per plant was counted on the same day and mean values worked out.

c. Leaf stem ratio

The plant samples were taken after harvest, separated into leaf and stem, dried at 80°C to a constant weight and the leaf stem ratio recorded.

d. Green fodder yield

Green fodder yield from each plot was recorded immediately after harvest and expressed as kg m^{-2}.

e. Dry fodder yield

500 g of the harvested samples was sun dried and then oven dried at 80°C to a constant weight. The dry fodder yield was worked out based on the percentage loss in driage and expressed in kg m^{-2}.

f. Propagation

The method of propagation and its persistence was observed for each species.

g. Acceptability by animal

Animal acceptability of each species was tested separately by feeding 500 g of each species to adult cows maintained by the Animal Husbandary department of the College of Agriculture, Vellayani.

h. Root parameters

The root parameters were recorded in uprooted plants after final harvest. For this the soil around the grasses were removed without any damage to the root system. The plants were carefully uprooted and the observations recorded.

a. Root length

Root length was measured from the plant base up to the tip of the longest root and expressed in cm.

b. Root spread

After uprooting, the root was kept as such on a flat surface and the maximum width measured and expressed as spread in cm.

3.9 Quality characters

The quality parameters were analysed using plant samples collected at harvest. Fresh samples were used for estimation of chlorophyll, HCN and oxalate. The oven dried sample used for the determination of dry fodder yield was ground in a Wiley mill and used for chemical analysis.

3.9.1 Chlorophyll

Chlorophyll content was estimated from the fully opened second leaf from the top at flowering using the method proposed by Arnon (1949).

3.9.2 Crude protein content

The total nitrogen content of the samples was determined by modified microkjeldahl method (Jackson, 1971) and the crude protein content was calculated by multiplying the nitrogen content by the factor 6.25 (Simpson et al. 1965) and expressed as percentage.

3.9.3 Crude protein yield

The crude protein yield expressed in kg m^{-2} was determined by multiplying the protein content with dry matter yield.

3.9.4 Crude fibre content

Crude fibre content was determined by the A.O.A.C. method (1975) and expressed as percentage.

3.9.5 Ash content

Ash content given as percentage was also estimated by A.O.A.C. method (1965).

3.9.6 Phosphorus content

Total phosphorus, was determined by Vanadomolybdate phosphoric acid yellow colour method (Jackson, 1973) and expressed as percentage.

3.9.7 Potassium content

Potassium content presented as percentage was estimated by using a Eel flame photometer.

5.9.8 Calcium, Magnesium and micro nutrient contents

One gram powdered sample was digested with tri-acid mixture (HNO_3 + H_2SO_4 + $HCl\ O_4$) (Jackson and Ulrich, 1959). The digest was filtered, made upto 100 ml and used for the estimation of Ca, Mg, Cu, Zn, and Mn and presented as percentages and ppm.

3.9.9 K: (Ca+Mg) ratio

The ratio was calculated from the values of K, Ca and Mg.

3.9.10 Ca:P ratio

The ratio was computed from the values of Ca and P.

3.9.11 Heavy metals

The triple acid digest was used for the estimation of heavy metals like Pb, Ni and Co by Atomic Absorption Spectrophotometer.

3.9.12 Antinutritional factors

a. HCN

HCN content was determined by method of Gilcheist et al (1967).

b. Tannin

The content of tannin as percentage in plant samples was estimated by Folin-Denis method (Schanderi, 1970).

c. Oxalate

From fresh plant samples, oxalate content was determined by the method suggested by Abaza et al. (1968) and presented as percentage.

3.9.13 Nutrient uptake

The uptake of N, P, K, Ca and Mg were worked out for each species based on their nutrient content and dry weights and expressed as kg m^{-2}.

3.10 Statistical analysis

The data generated from the field experiment was analysed statistically using the analysis of variance for Randomised Block Design (Cochran and Cox, 1965).

The quality index for each grass species was worked out using the quality parameters by the following method.

$$I = \sum_{i=1}^{k} Wi\ Xij$$

where $Wi = 1/Si^2$, Si^2 being the variance of the i^{th} variable and Xij is j^{th} observation with respect to i^{th} variable

$i = 1, 2 \ldots k$ where k is the number of characters.

$j = 1, 2 \ldots r$ where r is the number of replication.

RESULTS

4. RESULTS

A survey and field experiment were conducted to identify and evaluate the promising graminaceous weed flora of Southern Kerala.

4.1 Survey

The survey was conducted in the southern districts of Kerala, viz. Thiruvananthapuram, Kollam and Pathanamthitta to study the natural weed flora and to identify the prominent grass species of the locality. The observations recorded in the survey are furnished below.

4.1.1 Important weed species and their count

4.1.1.1 Weeds associated with cassava (*Manihot esculenta*)

The details of the weed species associated with cassava and their count are given in the tables 4.1 to 4.3.

a. Thiruvananthapuram district

Among grasses, the important species observed were *Axonopus compressus*, *Panicum javanicum*, *Cyrtococcum trigonum*, *Brachiaria ramosa*, *Dactyloctenium aegyptium*, *Sporobolus indicus*, *Cynodon dactylon*, *Panicum repens*, *Eleusine indica*, *Alloteropsis cimicina* and *Eragrostis tenella*.

Cyperus rotundus and Cyperus killinga were the predominent sedges observed in this district. Among dicots and others, Synedrella nodiflora, Borroria latifolia, Desmodium triflorum, Ageratum conyzoides, Clerodendron infortunatum and Sebastiana chamelia predominated. The weed count per unit area varied from 2 to 82 for grasses, 5 to 32 for sedges and 1 to 35 for dicots and others.

Among grasses, Axonopus compressus recorded the highest count of 82 m^{-2} followed by Panicum javanicum (52 m^{-2}) and Cyrtococcum trigonum (50 m^{-2}). Cyperus rotundus recorded the highest count of 32 m^{-2} among sedges. In dicots, Synedrella nodiflora and Borroria latifolia recorded 35 numbers m^{-2} followed by Desmodium triflorum (28 m^{-2}) and Ageratum conyzoides (26 m^{-2}).

b. Kollam district

The important grass species observed were Brachiaria ramosa, Axonopus compressus, Cyrtococcum trigonum, Dactyloctenium aegyptium, Panicum javanicum, Sporobolus indicus and Panicum repens. Cyperus rotundus and Cyperus killinga were the predominant sedges. Among dicots, Borroria latifolia, Synedrella nodiflora, Cleome viscosa, Ageratum conyzoides and Vernonia cinerea predominated.

The weed count per square metre varied from 2 to 90 for grasses, 2 to 47 for sedges and 2 to 52 for dicots.

Brachiaria ramosa recorded the highest weed count (90 m^{-2}) among grasses followed by Axonopus compressus (76 m^{-2}) and Cyrtococcum trigonum (58 m^{-2}). Among sedges Cyperus rotundus recorded the highest count of 47 m^{-2}. In dicots, Borroria latifolia recorded a weed count of 4 to 52 m^{-2} followed by Synedrella nodiflora (9 to 44 m^{-2}) and Cleome viscosa (5 to 32 m^{-2}).

c. Pathanamthitta district

Axonopus compressus, Panicum javanicum, Brachiaria ramosa, Echinochloa colonum, Digitaria ciliaris were the important grass species observed in Pathanamthitta district.

The sedges included the important species of Cyperus viz. Cyperus rotundus and Cyperus killinga. Among dicots and others, Borroria latifolia, Synedrella nodiflora and Ageratum conyzoides predominated.

The weed count per unit area varied from 2 to 55 for grasses, 2 to 14 for sedges and 2 to 22 for dicots and others.

In grasses, Axonopus compressus recorded the highest weed count ranging from 13 to 55 m^{-2}. Cyperus rotundus was dominant (14 m^{-2}) among sedges and in dicots, Synedrella nodiflora predominated (22 m^{-2}) followed by Ageratum conyzoides (20 m^{-2}).

Table 4.1 Important weed species, assoicated with cassava (*Manihot esculenta*) and their count in Thiruvananthapuram district

Grasses	Count/m^2 (Range)	Sedges	Count/m^2 (Range)	Dicots and others	Count/m^2 (Range)
Axonopus compressus	11 - 82	*Cyperus rotundus*	8 - 32	*Synedrella nodiflora*	10 - 35
Panicum javanicum	8 - 52	*Cyperus killinga*	5 - 15	*Borroria latifolia*	5 - 35
Cyrtococcum trigonum	10 - 50			*Desmodium triflorum*	5 - 28
Dactyloctenium aegyptium	8 - 42			*Ageratum conyzoides*	1 - 26
Brachiaria ramosa	8 - 42			*Sebastiana chamelia*	2 - 18
Sporobolus indicus	4 - 35			*Clerodendron infortunatum*	8 - 15
Panicum repens	5 - 20			*Cleome viscosa*	4 - 14
Cynodon dactylon	6 - 18			*Boerhaevia diffusa*	1 - 12
Eleusine indica	9 - 15			*Hyptis suaveolens*	3 - 10
Alloteropsis cimicina	5 - 12			*Cassia occidentalis*	5 - 10
Eragrostis tenella	8 - 12			*Justicia prostrata*	3 - 8
Aristida setacea	4 - 8			*Scoparia dulcis*	1 - 6
Digitaria ciliaris	2 - 8			*Acalypha indica*	2 - 4

Table 4.2 Important weed species associated with cassava (*Manihot esculenta*) and their count in Kollam district

Grasses	Count/m^2 (Range)	Sedges	Count/m^2 (Range)	Dicots and others	Count/m^2 (Range)
Brachiaria ramosa	12 - 90	*Cyperus rotundus*	4 - 47	*Borroria latifolia*	4 - 52
Axonopus compressus	26 - 76	*Cyperus killinga*	2 - 10	*Synedrella nodiflora*	9 - 44
Cyrtococcum trigonum	15 - 58			*Cleome viscosa*	5 - 32
Dactyloctenium aegyptium	2 - 55			*Ageratum conyzoides*	4 - 28
Chloris barbata	5 - 32			*Vernonia cinerea*	2 - 24
Cynodon dactylon	14 - 36			*Tridax procumbens*	2 - 18
Panicum javanicum	8 - 36			*Acalypha indica*	2 - 18
Sporobolus indicus	4 - 25			*Sida acuta*	8 - 16
Panicum repens	14 - 24			*Amaranthus viridis*	4 - 8
Eleusine indica	4 - 18			*Biyophytum sensitivum*	2 - 6
Eragrostis tenella	4 - 18				
Alluteropsis cimicina	2 - 16				
Digitaria ciliaris	2 - 7				

Table 4.3 Important weed species associated with cassava (*Manihot esculenta*) and their count in Pathanamthitta district

Grasses	Count/m^2 (Range)	Sedges	Count/m^2 (Range)	Dicots and others	Count/m^2 (Range)
Axonopus compressus	13 - 55	*Cyperus rotundus*	2 - 14	*Borroria latifolia*	4 - 18
Panicum javanicum	9 - 42	*Cyperus killinga*	4 - 8	*Synedrella nodiflora*	6 - 22
Brachiaria ramosa	4 - 28			*Ageratum conyzoides*	4 - 20
Echinochloa colonum	8 - 25			*Leucas aspera*	2 - 12
Digitaria ciliaris	8 - 20			*Amaranthus viridis*	2 - 10
Panicum repens	4 - 18			*Commelina jacobi*	2 - 7
Cynodon dactylon	6 - 20			*Mimosa pudica*	2 - 6
Alloteropsis cimicina	2 - 8			*Sebastiana chamelia*	2 - 5
Sporobolus indicus	4 - 8				

4.1.1.2 Weeds associated with coconut (*Cocos nucifera*)

The details of the weed species associated with coconut and their count are given in the tables 4.4. to 4.6.

a. Thiruvananthapuram district

The important species associated with coconut in Thiruvananthapuram district were *Axonopus compressus*, *Cyrtococcum trigonum*, *Panicum javanicum*, *Panicum repens*, *Brachiaria ramosa*, *Sporobolus indicus* etc. *Cyperus rotundus* was the predominent sedge and among dicots and others *Justicia diffusa*, *Borroria latifolia*, *Cleome viscosa*, *Synedrella nodiflora* and *Spermacoea stricta* were the important species. The weed count per unit area showed variation and the count varied from 2 to 122 for grasses, 5 to 15 for sedges and 2 to 21 for dicots and others.

The highest count of 122 m^{-2} was registered by the grass species *Axonopus compressus* followed by *Cyrtococcum trigonum* (120 m^{-2}). In dicots, *Justicia diffusa* recorded a maximum weed count of 21 m^{-2} followed by *Borroria latifolia* (20 m^{-2}) and *Cleome viscosa* (19 m^{-2}).

b. Kollam district

In Kollam district, grass species namely *Brachiaria ramosa*, *Axonopus compressus*, *Cyrtococcum trigonum*, *Dactyloctenium aegyptium*, *Cynodon dactylon*, *Panicum javanicum* and *Panicum repens* were more common.

Cyperus rotundus and Cyperus killinga were the prominent sedges. The important dicots observed were Sida acuta, Desmodium triflorum, Spermacoea stricta, Synedrella nodiflora etc. The grasses registered a weed count varying from 2 to 90 m^{-2} whereas, sedges and dicots had a count ranging from 4 to 18 and 1 to 42 m^{-2} respectively.

Axonopus compressus and Brachiaria ramosa dominated among grasses and recorded the highest count of 90 m^{-2} followed by Cyrtococcum trigonum (72 m^{-2}).

c. Pathanamthitta district

The important grass species associated with coconut in Pathanamthitta district were Axonopus compressus, Panicum javanicum, Cyrtococcum trigonum, Echinochloa colonum, Brachiaria ramosa and Panicum repens. Cyperus rotundus and Cyperus killinga were more common in sedges. In dicots and others, Borroria latifolia, Synedrella nodiflora, Desmodium triflorum and Clerodendron infortunatum predominated.

The weed count per unit area varied from 4 to 110 m^{-2} for grasses, 4 to 18 m^{-2} for sedges and 2 to 40 m^{-2} for dicots and others. Among grasses, the maximum count was recorded by Axonopus compressus (110 m^{-2}) followed by Panicum javanicum (62 m^{-2}) and Cyrtococcum trigonum (54 m^{-2}).

Table 4.4 Important weed species associated with cocount (*Cocos nucifera*) and their count in Thiruvananthapuram district

Grasses	Count/m^2 (Range)	Sedges	Count/m^2 (Range)	Dicots and others	Count/m^2 (Range)
Axonopus compressus	32 - 122	*Cyperus rotundus*	5 - 15	*Justicia diffusa*	12 - 21
Cyrtococcum trigonum	12 - 120			*Borroria latifolia*	5 - 20
Panicum repens	15 - 71			*Cleome viscosa*	4 - 19
Panicum javanicum	5 - 62			*Synedrella nodiflora*	3 - 18
Brachiaria ramosa	8 - 35			*Mimosa pudica*	4 - 16
Sporobolus indicus	8 - 34			*Eupatorium odoratum*	2 - 12
Dactyloctenium aegyptium	4 - 28			*Commelina benghalensis*	7 - 12
Aristida setacea	4 - 24			*Leucas aspera*	4 - 12
Rhynchelytrum repens	2 - 16			*Spermacoea stricta*	2 - 12
Eleusine indica	2 - 14			*Commelina jacobi*	4 - 10
Cynodon dactylon	4 - 12			*Hemidesmus indicus*	2 - 10
Eragrostis tenella	8 - 12			*Croton sparsiflorus*	2 - 8
				Andrographis echioides	2 - 4

Table 4.5 Important weed species associated with coconut (*Cocos nucifera*) and their count in Kollam district

Grasses	Count/m^2 (Range)	Sedges	Count/m^2 (Range)	Dicots and others	Count/m^2 (Range)
Axonopus compressus	30 - 90	*Cyperus rotundus*	8 - 12	*Sida acuta*	6 - 42
Brachiaria ramosa	14 - 90	*Cyperus killinga*	4 - 18	*Desmodium triflorum*	4 - 34
Cyrtococcum trigonum	15 - 72			*Spermacoea stricta*	4 - 31
Dactyloctenium aegyptium	8 - 70			*Synedrella nodiflora*	2 - 28
Cynodon dactylon	13 - 54			*Eupatorium odoratum*	5 - 26
Panicum javanicum	14 - 43			*Ageratum conyzoide*	4 - 24
Panicum repens	24 - 42			*Heptis suaviolense*	6 - 15
Eragrostis tenella	7 - 28			*Phyllanthus niruri*	2 - 15
Echinochloa colonum	4 - 28			*Emelia sonchifolia*	8 - 14
Sporobolus indicus	13 - 25			*Croton sparsiflorus*	5 - 14
Perotis latifolia	2 - 24			*Amaranthus viridis*	4 - 13
Eleusine indica	11 - 24			*Leucas aspera*	1 - 12
Digitaria ciliaris	7 - 20			*Acalypha indica*	4 - 10
Alloteropsis cimicina	5 - 12			*Biyophytum sensitivum*	2 - 10
				Clerodendron infortunatum	2 - 7
				Commelina jacobi	2 - 7
				Sebastiana chamelia	2 - 6

Table 4.6 Important weed species associated with coconut (Cocos nucifera) and their count in Pathanamthitta district

Grasses	Count/m^2 (Range)	Sedges	Count/m^2 (Range)	Dicots and others	Count/m^2 (Range)
Axonopus compressus	45 - 110	Cyperus rotundus	4 - 18	Borroria latifolia	4 - 40
Panicum javanicum	18 - 62	Cyperus killinga	4 - 12	Synedrella nodiflora	5 - 30
Cyrtococcum trigonum	10 - 54			Clerodendron infortunatum	8 - 12
Echinochloa colonum	15 - 19			Desmodium triflorum	8 - 16
Brachiaria ramosa	8 - 30			Amaranthus viridis	2 - 10
Panicum repens	10 - 38			Vernonia cinerea	4 - 8
Dactyloctenium aegyptium	6 - 32			Leucas aspera	4 - 8
Cynodon dactylon	8 - 20			Commelina jaicobi	2 - 8
Rhynchelytrum repens	4 - 18			Hydrocotyl asiatica	2 - 6
Digitaria ciliaris	6 - 15			Eupatorium odoratum	2 - 5
Alloteropsis cimicina	5 - 18				
Eragrostis ciliaris	4 - 14				
Eleusine indica	4 - 18				

4.1.1.3 Weeds associated with Rubber (Haevia brasiliensis)

Tables 4.7 to 4.9 represents the details and count of weed species associated with rubber.

In all the three districts surveyed, Cyrtococcum trigonum and Axonopus compressus were the predominent grass species, observed in rubber plantations. Among dicots and others, Elephantopus scaber, Clerodendron infortunatum, Eupatorium odoratum were more prevalent. In all the districts, the population of sedges were practically nil in rubber plantations.

4.1.1.4 Weeds associated with homesteads and other crops

The details of the weeds in homesteads and associated with other crops were furnished in the tables 4.10 to 4.12.

a. Thiruvananthapuram district

The important grass species observed were Axonopus compressus, Panicum javanicum, Sporobolus indicus, Cyrtococcum trigonum, Rhynchelytrum repens, Dactyloctenium aegyptium etc. Cyperus killinga and Cyperus rotundus were the predominant sedges. Leucas aspera, Synedrella nodiflora, Ageratum conyzoides, Spermacoea stricta, Commelina jacobi, Mimosa pudica, and Justicia prostata and Desmodium triflorum were the common dicots.

Table 4.7 Important weed species associated with rubber (*Haevia brasliensis*) and their count in Thiruvananthapuram district

Grasses	Count/m^2 (Range)	Sedges	Count/m^2 (Range)	Dicots and others	Count/m^2 (Range)
Cyrtococcum trigonum	26 - 120	Nil		*Elephantopus scaber*	2 - 39
Axonopus compressus	12 - 46			*Clerodendron infortunatum*	2 - 20
				Eupetorium odoratum	2 - 12
				Hemidesmus indicus	1 - 10
				Ixora sp	1 - 9
				Cureligo orchioides	4 - 6

Table 4.8 Important weed species associated with rubber (*Haevia brasiliensis*) and their count in Kollam district

Grasses	Count/m^2 (Range)	Sedges	Count/m^2 (Range)	Dicots and others	Count/m^2 (Range)
Cyrtococcum trigonum	10 - 95	Nil		*Clerodendron infortunatum*	2 - 12
Axonopus compressus	8 - 32			*Elephantopus scaber*	4 - 16
Oplismenus compositus	2 - 18			*Eupatorium odoratum*	1 - 8
				Melastoma sp.	1 - 6

Table 4.9 Important weed species associated with rubber (*Haevia brasiliensis*) and their count in Pathanamthitta district

Grasses	Count/m^2 (Range)	Sedges	Count/m^2 (Range)	Dicots and others	Count/m^2 (Range)
Cyrtococcum trigonum	51 - 116	Nil		*Elephantopus scaber*	4 - 35
Axonopus compressus	80 - 80			*Eupatorium odoratum*	1 - 14
Panicum javanicum	4 - 8			*Clerodendron infortunatum*	4 - 12
				Mimosa pudica	1 - 11
				Synedrella nodiflora	4 - 10
				Ixora sp.	2 - 8

The weed count per unit area varied from 2 to 56 m^{-2} for grasses, 8-18 m^{-2} for sedges and 1 to 42 m^{-2} for dicots and others. Axonopus compressus recorded the maximum weed count of 56 m^{-2} among grass followed by Panicum javanicum (48 m^{-2}). Among dicots, Synedrella nodiflora and Leucas aspera recorded the maximum weed count of 42 m^{-2}.

b. Kollam district

In Kollam district grass weeds predominated. The prominent among them were Axonopus compressus, Brachiaria ramosa, Panicum javanicum, Dactyloctenium aegyptium, Cynodon dactylon, Panicum repens, Digitaria ciliaris, Echinochloa colonum, Rhynchelytrum repens etc. As seen in other crop associations, in homesteads also Cyperus rotundus and Cyperus killinga were the predominent sedges. Synedrella nodiflora, Cleome viscosa, Ageratum conyzoides, Borroria latifolia, Desmodium triflorum, Sida acuta and Scoparia dulcis were the important dicots observed.

The weed count per square metre varied from 6 to 84 for grasses, 2 to 26 for sedges and 2 to 46 for dicots. Among grasses, Axonopus compressus recorded the highest count (84 m^{-2}) followed by Brachiaria ramosa (72 m^{-2}). In sedges, Cyperus rotundus had the maximum count of 26 m^{-2}. Synedrella nodiflora recorded the highest count (46 m^{-2}) among dicots.

c. Pathanamthitta district

The important grass species observed in this district were Axonopus compressus, Panicum javanicum, Cyrtococcum

Table 4.10 Important weed species associated with Homestead crops and their count in Thiruvananthapuram district

Grasses	Count/m^2 (Range)	Sedges	Count/m^2 (Range)	Dicots and others	Count/m^2 (Range)
Axonopus compressus	10 - 56	Cyperus rotundus	8 - 18	Synedrella nodiflora	6 - 42
Panicum javanicum	4 - 48	Cyperus killinga	8 - 15	Leucas aspera	5 - 42
Sporobolus indicus	5 - 32			Spermacoea stricta	4 - 38
Cyrtococcum trigonum	7 - 29			Ageratum conyzoides	8 - 32
Dactyloctenium aegyptium	8 - 26			Commelina jacobi	6 - 32
Rhynchelytrum repens	2 - 26			Cleome viscosa	4 - 31
Brachiaria ramosa	6 - 21			Borroria latifolia	4 - 31
Cynodon dactylon	6 - 20			Mimosa pudica	8 - 25
Panicum repens	4 - 28			Justicia prostata	4 - 24
Eleusine indica	9 - 12			Desmodium triflorum	16 - 22
Alloteropsis cimicina	3 - 12			Boerhaevia diffusa	2 - 18
Digitaria ciliaris	2 - 12			Phyllanthus niruri	2 - 18
				Vernonia cinerea	2 - 16
				Clerodendron infortunatum	4 - 16
				Eupatorium odoratun	5 - 16
				Acalypha indica	1 - 14
				Andrographis paniculata	2 - 12
				Croton sparsiflorus	4 - 12
				Biyophytum sensitivum	4 - 12
				Scoparia dulcis	5 - 12
				Justicia diffusa	4 - 12
				Cassia occidentalis	2 - 8
				Sebastiana chamelia	2 - 8

Table 4.11 Important weed species associated with homestead crops and their count in Kollam district

Grasses	Count/m^2 (Range)	Sedges	Count/m^2 (Range)	Dicots and others	Count/m^2 (Range)
Axonopus compressus	26 - 84	Cyperus rotundus	8 - 26	Synedrella nodiflora	4 - 46
Brachiaria ramosa	8 - 72	Cyperus killinga	2 - 10	Cleome viscosa	6 - 36
Dactyloctenium aegyptium	8 - 55			Ageratum conyzoides	4 - 36
Cynodon dactylon	18 - 48			Borroria latifolia	10 - 34
Panicum javanicum	12 - 42			Sida acuta	2 - 32
Panicum repens	20 - 38			Desmodium triflorum	4 - 32
Digitaria ciliaris	8 - 36			Scoparia dulcis	5 - 29
Echinochloa colonum	8 - 32			Sida rombifolia	2 - 28
Rhynchelytrum repens	6 - 25			Hyptis suaveolens	4 - 18
Eragrostis tenella	6 - 24			Spermacoea stricta	4 - 18
Alloteropsis cimicina	12 - 24			Commelina jacobi	2 - 16
Sporobolus indicus	6 - 24			Leucas aspera	2 - 11
Chloris barbata	8 - 12			Clerodendron infortunatum	4 - 12

Table 4.12 Important weed species associated with homestead crops and their count in Pathanamthitta district

Grasses	Count/m^2 (Range)	Sedges	Count/m^2 (Range)	Dicots and others	Count/m^2 (Range)
Axonopus compressus	13 - 75	*Cyperus rotundus*	5 - 35	*Borroria latifolia*	5 - 35
Panicum javanicum	18 - 48	*Cyperus killinga*	4 - 12	*Synedrella nodiflora*	8 - 32
Cyrtococcum trigonum	10 - 40			*Amaranthus viridis*	4 - 21
Echinochloa colonum	9 - 28			*Justicia prostata*	4 - 12
Cynodon dactylon	12 - 23			*Hydrocotyl asiatica*	6 - 12
Eleusine indica	4 - 15			*Leucas aspera*	3 - 12
Sporobolus diander	4 - 14			*Sida acuta*	4 - 12
Panicum repens	8 - 13			*Vernonia cinerea*	2 - 11
Chloris barbata	5 - 10			*Phyllanthus niruri*	2 - 10
Aristida setacea	2 - 8			*Cleome viscosa*	2 - 7
				Commelina benghalensis	2 - 6

trigonum, Echinochloa colonum, Cynodon dactylon and Eleusine indica. Sedges were alike in all districts surveyed and Cyperus rotundus and Cyperus killinga were the common species observed. Among dicots, the predominent species were Borroria latifolia, Synedrella nodiflora, Amaranthus viridis, Hydrocotyl asiatica and Justicia prostata.

The weed count per unit area varied from 2 to 75 m^{-2} for grasses, 4 to 35 m^{-2} for sedges and 2 to 35 m^{-2} for dicots. Among grasses, Axonopus compressus recorded the highest weed count of 75 m^{-2}.

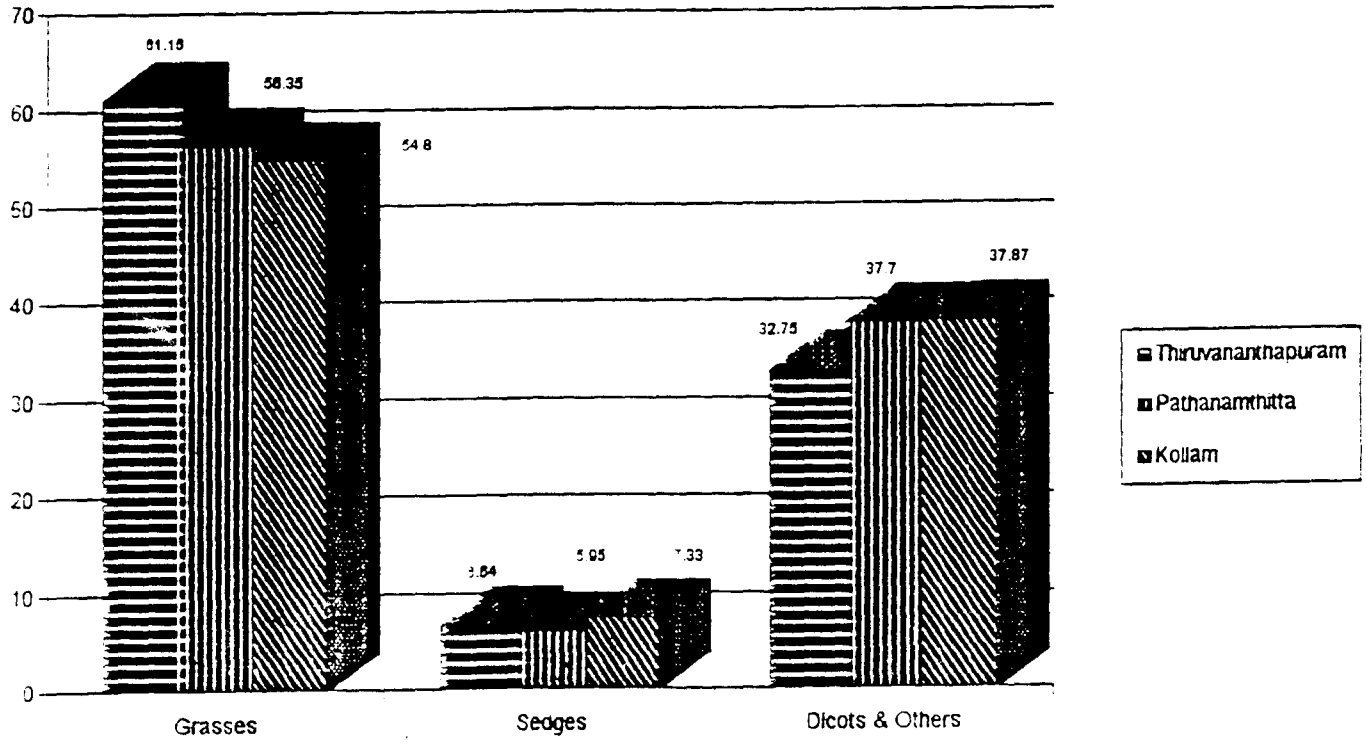
4.1.2 Relative weed density

The results revealed the predominance of grass species in the natural weed flora of all the districts surveyed (Table 4.13). The population of the sedges was the least. The relative weed density of grasses was the highest in Thiruvananthapuram district (61.16 per cent), followed by Pathanamthitta (56.35 per cent) and Kollam (54.80 per cent). The relative density of sedges were 7.33, 6.64 and 5.95 per cent for Kollam, Thiruvananthapuram and Pathanamthitta, respectively. Relative density of dicots and other species was maximum in Pathanamthitta and Kollam districts whereas, intensity was the lowest in Thiruvananthapuram district.

Table 4.13 Relative Density of weed speices in three districts of Kerala

Name of district	Relative weed density (%)		
	Grass	Sedge	Dicots and others
Thiruvananthapuram	61.16	6.64	32.75
Kollam	54.80	7.33	37.87
Pathanamthitta	56.35	5.95	87.70

Fig. 3: Relative Weed Intensity in different districts



4.1.3 Composition of grass bundles

Grass bundles collected from the local markets of the three districts were subjected to species wise separation and the results observed are presented in table (4.1.4). It was observed that in all the bundles grass species predominated and species like Panicum javanicum, Axonopus compressus, Brachiaria ramosa and Panicum repens were more common. The other common grass species identified include Cynodon dactylon, Echinochloa colonum, Eleusine indica, Dactyloctenium aegyptium, Cyrtococcum trigonum, Digitaria ciliaris and Alloteropsis cimicina. Sedges were not observed in this bundles and among dicots, species like Borroria latifolia, Amaranthus viridis, Ageratum conyzoides, Synedrella nodiflora were common. Though the number of other dicots was comparatively lesser, different species like Justicia prostrata, Vernonia cinerea, Commelina jacobi, Aerva lanata, Boerhaevia diffusa, Croton sparsiflorus were also observed.

4.2 Field experiment

Data collected from the field experiment were statistically analysed and the results are presented below.

4.2.1 Biometric observations

a. Height of the plant (cm)

The mean height of the plants are given in the table 4.2.1.

Table 4.14 Composition of grass bundles collected from local markets at Thiruvananthapuram, Kollam and Pathanamthitta districts

Species	Per cent composition		
	Thiruvananthapuram	Kollam	Pathanamthitta
Panicum javanicum	12.0	16.0	10.0
Axonopus compressus	10.0	11.0	13.0
Panicum repens	7.0	6.5	6.0
Brachiaria ramosa	6.0	8.0	10.0
Eleusine indica	4.0	4.8	5.1
Dactyloctenium aegyptium	3.0	2.8	4.0
Cyrtococcum trigonum	2.8	3.2	5.0
Cynodon dactylon	3.0	5.5	6.0
Sporobolus indicus	1.0	2.8	1.6
Digitaria ciliaris	2.8	2.2	1.5
Echinochloa colonum	2.0	4.0	2.8
Chloris barbata	2.1	2.5	2.4
Brachiaria distachyum	2.0	-	-
Alloteropsis cimicina	2.0	1	1.5
Borroria latifolia	6.0	5.8	6.0
Synedrella nodiflora	7.0	4.2	5.0
Amaranthus viridis	5.5	5.8	4.0
Ageratum conyzoides	5.1	4.5	5.2
Commelina jacobi	4.0	2.1	2.3
Aerva lanata	3.2	2.0	1.5
Vernonia cinerea	3.1	-	2.0
Boerhaevia diffusa	2.5	1.2	1.1
Justicia prostrata	2.0	-	1.2
Emilia sonchifolia	1.2	1.1	1.0
Croton sparsiflorus	-	1.0	-

The results revealed that the maximum plant height of 216.67 cm was recorded by Panicum maximum and the lowest plant height of 21.67 cm was registered by Cyrtococcum trigonum which was on par with Cynodon dactylon, Axonopus compressus and Eragrostis tenella.

b. Tiller number

Data on the mean tiller number per plant are presented in Table 4.2.1.

From the mean values it was observed that Rhynchelytrum repens was significantly superior to all other grasses in terms of tiller number. Digitaria ciliaris registered the lowest tiller number of 16 and was on par with Echinochloa colonum, Panicum maximum, Panicum repens, Eleusine indica, Cyrtococcum trigonum, Alloteropsis cimicina and Cynodon dactylon.

c. Leaf stem ratio

Data presented in table 4.2.1 showed significant difference in leaf stem ratio among the grass species. The highest leaf stem ratio of 1.84 was recorded by Panicum maximum followed by Panicum javanicum (1.21) which was on par with Axonopus compressus (1.2). Rhynchelytrum repens recorded the lowest leaf stem ratio of 0.52.

Table 4.2.1 Growth characters and yield of different grass species

Sl. No.	Treatments	Height (cm)	Tiller number	Leaf stem ratio	Grain fodder yield $kg\ m^{-2}$	Dry fodder yield $kg\ m^{-2}$
1.	*Cynodon dactylon*	23.57	26.67	0.73	1.97	0.51
2.	*Digitaria ciliaris*	65.00	16.00	0.80	4.78	1.56
3.	*Alloteropsis cimicina*	84.00	24.67	0.62	4.03	1.36
4.	*Eleusine indica*	90.66	24.00	0.70	8.12	2.36
5.	*Axonopus compressus*	34.30	31.30	1.20	6.55	2.10
6.	*Panicum repens*	105.00	19.67	1.09	8.80	2.73
7.	*Rhynchelytrum repens*	91.66	75.33	0.52	14.30	5.29
8.	*Echinochloa colonum*	75.00	16.33	1.07	2.08	0.77
9.	*Cyrtococcum trigonum*	21.67	24.67	0.69	0.98	0.35
10.	*Brachiaria ramosa*	65.00	51.33	0.81	10.67	4.07
11.	*Eragrostis tenella*	35.00	41.67	0.62	2.02	0.64
12.	*Panicum javanicum*	88.33	47.00	1.21	14.98	4.17
13.	*Dactyloctenium aegyptium*	61.67	33.00	0.88	4.75	1.62
14.	*Chloris barbata*	65.00	31.33	0.84	3.77	1.31
15.	*Sporobolus indicus*	80.00	56.33	1.08	5.89	1.77
16.	*Panicum maximum*	216.67	17.33	1.84	33.77	9.20
	F	51.88**	8.567**	158.79**	595.941**	619.28**
	SE	6.31	5.713	0.026	0.331	0.092
	CD	18.22	16.5	0.075	0.955	0.265

** Significant at 1% level

d. Green fodder yield (kg m^{-2})

The mean green fodder yield of the grasses pooled for five cuts are given in table 4.2.1.

Results clearly indicated that Panicum maximum recorded the highest green fodder yield of 33.77 kg m^{-2} which was significantly superior to all other grasses tried. This was followed by Rhynchelytrum repens and Panicum javanicum which were on par. Cyrtococcum trigonum recorded the lowest green fodder yield of 0.98 kg m^{-2}.

c. Dry fodder yield (kg m^{-2})

Mean values presented in table 4.2.1 revealed that the dry fodder yield varied among grasses.

Panicum maximum was found significantly superior to other grasses and registered a dry fodder yield of 9.2 kg m^{-2}. The lowest dry fodder yield of 0.35 kg m^{-2} was recorded by Cyrtococcum trigonum.

f. Propagation

The method of propagation of each grass species used in field trial was given in table 4.2.2 and it was observed that almost all species can be propagated through seeds and vegetative plant parts like rooted stem pieces and slips.

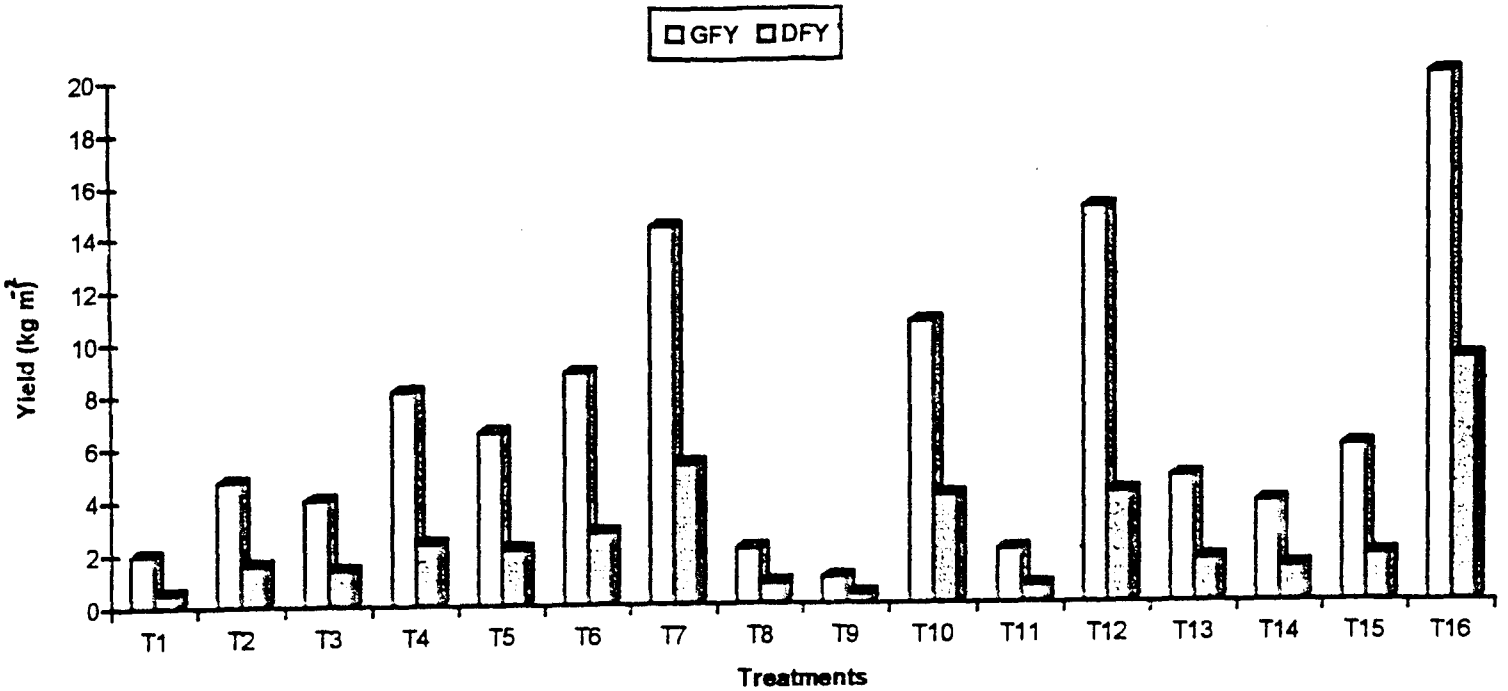


Fig. 4. Green Fodder and Dry Fodder Yield of different grass species (kg m^{-2})

Table 4.2.2 Method of propagation of the different grass species

Sl. No.	Species	Method
1.	*Cynodon dactylon*	Runners and slips
2.	*Digitaria ciliaris*	Rooted stem portions
3.	*Alloteropsis cimicina*	Rooted slips
4.	*Eleusine indica*	Seeds and rooted slips
5.	*Axonopus compressus*	Rooted stem piece
6.	*Panicum repens*	Seeds and underground stem
7.	*Rhynchelytrum repens*	Seeds and rooted slips
8.	*Echinochloa colonum*	Seeds and rooted slips
9.	*Cyrtococcum trigonum*	Rooted stem piece
10.	*Brachiaria ramosa*	Rooted stem piece
11.	*Eragrostis tenella*	Slips
12.	*Panicum javanicum*	Seeds and rooted stem piece
13.	*Dactyloctenium aegyptium*	Rooted slips
14.	*Chloris barbata*	Rooted slips
15.	*Sporobolus indicus*	Rooted slips
16.	*Panicum maximum*	Seeds and rooted slips

g. Acceptability by animal

Animal acceptability of the species in table 4.2.3 revealed that all the 15 species tried were acceptable to animals.

h. Root length at final harvest (cm)

The mean root length of the plants at final harvest are given in the table 4.2.4. It was evident that Panicum maximum produced the longest root (33.33 cm) followed by Panicum javanicum (27 cm). Grasses like Sporobolus indicus, Eleusine indica, Digitaria ciliaris, Rhynchelytrum repens, Echinochloa colonum and Alloteropsis cimicina were on par. Cyrtococcum trigonum recorded the lowest root length of 7.67 cm which was on par with Eragrostis tenella.

i. Root spread at final harvest (cm)

Mean values presented in table 4.2.4 revealed that the highest root spread of 16.83 cm was recorded by Panicum javanicum which was on par with Rhynchelytrum repens, Digitaria ciliaris and Panicum maximum. The lowest spread of 5.17 cm was recorded by Cyrtococcum trigonum.

Table 4.2.3 Acceptability of different grass species by animal

Sl. No.	Grass species	Acceptability	
		Yes	No
1.	*Cynodon dactylon*	Yes	
2.	*Digitaria ciliaris*	Yes	
3.	*Alloteropsis cimicina*	Yes	
4.	*Eleusine indica*	Yes	
5.	*Axonopus compressus*	Yes	
6.	*Panicum repens*	Yes	
7.	*Rhynchelytrum repens*	Yes	
8.	*Echinochloa colonum*	Yes	
9.	*Cyrtococcum trigonum*	Yes	
10.	*Brachiaria ramosa*	Yes	
11.	*Eragrostis tenella*	Yes	
12.	*Panicum javanicum*	Yes	
13.	*Dactyloctenium aegyptium*	Yes	
14.	*Chloris barbata*	Yes	
15.	*Sporobolus indicus*	Yes	
16.	*Panicum maximum*	Yes	

Table 4.2.4 Root observations in grass species

Sl. No.	Treatments	Root length (cm)	Root spread (cm)
1.	*Cynodon dactylon*	16.50	12.33
2.	*Digitaria ciliaris*	20.83	17.00
3.	*Alloteropsis cimicina*	19.33	11.17
4.	*Eleusine indica*	21.00	10.67
5.	*Axonopus compressus*	17.17	13.33
6.	*Panicum repens*	17.17	15.50
7.	*Rhynchelytrum repens*	20.67	17.17
8.	*Echinochloa colonum*	20.67	10.83
9.	*Cyrtococcum trigonum*	7.67	5.17
10.	*Brachiaria ramosa*	15.00	11.00
11.	*Eragrostis tenella*	10.33	9.67
12.	*Panicum javanicum*	27.00	18.63
13.	*Dactyloctenium aegyptium*	13.67	14.50
14.	*Chloris barbata*	14.67	14.50
15.	*Sporobolus indicus*	21.34	13.33
16.	*Panicum maximum*	33.33	16.83
	F	37.735**	25.277**
	SE	0.998	0.693
	CD	2.88	2.00

** Significant at 1% level

4.2.2 Quality parameters

a. Chlorophyll content (mg g^{-1})

Mean values of chlorophyll content are furnished in Table 4.2.5.

The chlorophyl content showed significant difference among grass species. Though Panicum maximum registered the highest value it was on par with Rhynchelytrum repens, Echinochloa colonum and Brachiaria ramosa. Cyrtococcum trigonum registered the lowest value.

b. Protein content and protein yield (% and kg m^{-2})

Table 4.2.5 gives the data on mean protein content and protein yield.

The results revealed that the protein content was highest in Dactyloctenium aegyptium which was on par with Panicum javanicum. The lowest value of 5.84 per cent was registered by Eragrostis tenella.

Protein yield also showed significant variation among species, Panicum maximum being significantly superior to all others. Eragrostis tenella recorded the lowest protein yield.

Table 4.2.5 Quality attributes of different grass species on drymatter basis

Sl. No.	Treatments	Chlorophyll mg g^{-1}	Protein content (%)	Protein yield kg m^{-2}	Crude fibre content (%)	Ash content (%)
1.	*Cynodon dactylon*	0.86	10.92	5.53	24.35	8.57
2.	*Digitaria ciliaris*	0.96	10.97	16.71	27.67	9.43
3.	*Alloteropsis cimicina*	1.41	9.31	12.63	27.5	10.23
4.	*Eleusine indica*	1.28	11.08	26.15	30.34	9.27
5.	*Axonopus compressus*	1.48	12.17	25.59	26.83	10.83
6.	*Panicum repens*	0.95	10.75	29.30	31.33	7.23
7.	*Rhynchelytrum repens*	1.69	11.65	61.69	31.0	10.8
8.	*Echinochloa colonum*	1.65	10.04	7.76	31.0	11.07
9.	*Cyrtococcum trigonum*	0.60	11.44	4.06	25.5	12.13
10.	*Brachiaria ramosa*	1.65	8.46	34.5	26.17	10.83
11.	*Eragrostis tenella*	0.78	5.84	3.76	15.83	9.57
12.	*Panicum javanicum*	1.4	13.96	58.34	18.83	12.67
13.	*Dactyloctenium aegyptium*	1.09	15.0	24.3	20.33	10.57
14.	*Chloris barbata*	1.04	13.13	17.19	20.67	12.5
15.	*Sporobolus indicus*	1.33	12.5	21.83	24.33	8.67
16.	*Panicum maximum*	1.78	10.69	98.40	23.17	9.70
	F	20.10**	13.214**	140.254**	30.011**	45.504**
	SE	0.079	0.843	3.033	0.849	0.228
	CD	0.23	1.721	6.192	2.45	0.657

** significant at 1% level

c. Crude fibre content (%)

Grass species varied significantly in crude fibre content (Table 4.2.5). The highest crude fibre content of 31.33 per cent was observed in Panicum repens which was on par with Rhynchelytrum repens (31 per cent), Echinochloa colonum (31 per cent) and Eleusine indica (30.34 per cent). The lowest content of 15.83 per cent was recorded in Eragrostis tenella.

d. Ash content (%)

Mean values of ash content furnished in table 4.2.5 revealed that Panicum javanicum, Chloris barbata, and Cyrtococcum trigonum were on par and significantly superior to all other species in terms of ash content. Panicum repens was significantly inferior and registrered an ash content of 7.23 per cent.

4.2.8 Nutrient content

a. Nitrogen, Phosphorus and Potassium content (%)

The mean values of N, P and K contents are presented in table 4.2.6.

The different grass species showed significant variation in their N, P and K contents. The N content was maximum (2.4 per cent) in Dactyloctenium aegyptium and was on par with Panicum javanicum and Chloris barbata. Eragrostis tenella recorded the lowest N content of 0.91 per cent.

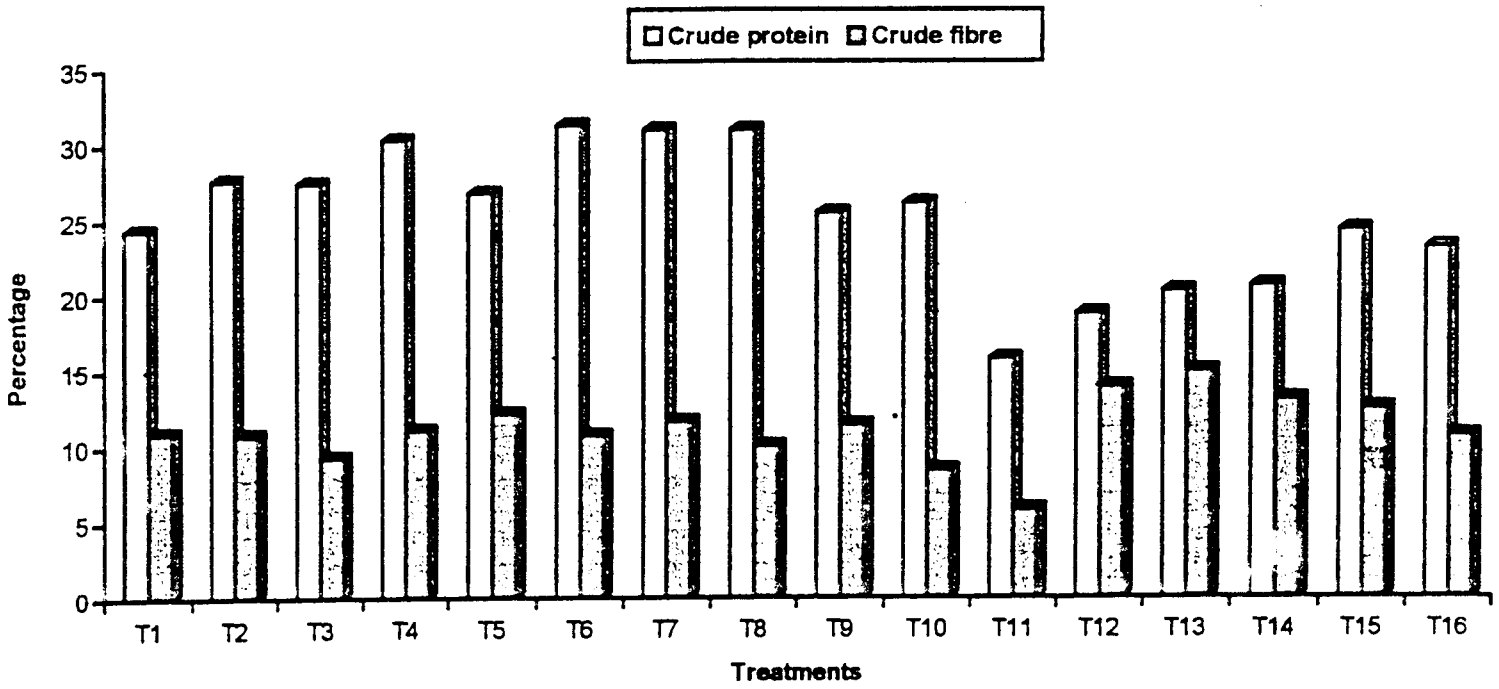


Fig. 5. Percentage crude protein and crude fibre content of different grass species

Chloris barbata ranked first in P content (0.46 per cent) and was noticed to be on par with Digitaria ciliaris and Echinochloa colonum. The lowest content of 0.157 per cent was registered by Panicum repens which was on par with Cynodon dactylon and Brachiaria ramosa.

In the case of K content Panicum javanicum and Dactyloctenium aegyptium were observed to be superior to all other grasses except Dactyloctenium aegyptium. Cynodon dactylon was found to be significantly inferior and the content was only 0.86 per cent.

b. Calcium and Magnesium content (%)

Chloris barbata was significantly superior to other grasses in terms of Ca content (Table 4.2.6) and it registered a content of 0.32 per cent. Sporobolus indicus recorded the lowest Ca content of 0.067 per cent which was on par with Eragrostis tenella, Axonopus compressus and Echinochloa colonum.

Grasses differ significantly in Mg content. The highest Mg content of 0.441 per cent was recorded by Echinochloa colonum and the lowest by Eragrostis tenella (0.152).

c. Copper, Zinc and Manganese content

The grasses differ significantly in Cu, Zn and Mn contents (Table 4.2.7). The highest Cu content of 37 ppm was recorded by Brachiaria ramosa followed by Eleusine indica.

Table 4.2.6 Content of major and secondary nutrients in different grass species

Sl. No.	Treatment	N (%)	P (%)	K (%)	Ca (%)	Mg (%)
1.	*Cynodon dactylon*	1.75	0.187	0.867	0.103	0.247
2.	*Digitaria ciliaris*	1.72	0.447	1.53	0.079	0.409
3.	*Alloteropsis cimicina*	1.49	0.37	1.25	0.128	0.278
4.	*Eleusine indica*	1.77	0.30	1.36	0.128	0.366
5.	*Axonopus compressus*	1.95	0.297	1.47	0.081	0.405
6.	*Panicum repens*	1.72	0.157	1.34	0.131	0.282
7.	*Rhynchelytrum repens*	1.86	0.337	1.89	0.113	0.219
8.	*Echinochloa colonum*	1.61	0.433	1.32	0.089	0.441
9.	*Cyrtococcum trigonum*	1.83	0.27	1.63	0.085	0.428
10.	*Brachiaria ramosa*	1.35	0.203	1.73	0.196	0.365
11.	*Eragrostis tenella*	0.91	0.257	1.25	0.069	0.152
12.	*Panicum javanicum*	2.23	0.353	2.53	0.172	0.393
13.	*Dactyloctenium aegyptium*	2.4	0.28	2.53	0.26	0.395
14.	*Chloris barbata*	2.1	0.46	2.01	0.329	0.281
15.	*Sporobolus indicus*	2.0	0.303	2.01	0.067	0.206
16.	*Panicum maximum*	1.71	0.247	1.87	0.103	0.343
	F	13.477**	27.146**	20.023**	55.149**	425.491**
	SE	0.135	0.017	0.103	0.010	0.004
	CD	0.276	0.05	0.298	0.029	0.012

** Significant at 1% level

Table 4.2.7 Content of micro nutrients in different grass species.

Sl. No.	Treatment	Cu ppm	Zn ppm	Mn ppm
1.	*Cynodon dactylon*	18.7	32	134
2.	*Digitaria ciliaris*	18.0	133	186
3.	*Alloteropsis cimicina*	12.0	120	200
4.	*Eleusine indica*	30.0	42	313
5.	*Axonopus compressus*	17.0	80	120
6.	*Panicum repens*	12.0	29	75
7.	*Rhynchelytrum repens*	23.0	62	173
8.	*Echinochloa colonum*	13.0	91	249
9.	*Cyrtococcum trigonum*	19.0	127	71
10.	*Brachiaria ramosa*	37.0	54	151
11.	*Eragrostis tenella*	14.0	40	78
12.	*Panicum javanicum*	21.0	62	72
13.	*Dactyloctenium aegyptium*	18.0	250	359
14.	*Chloris barbata*	18.0	70	96
15.	*Sporobolus indicus*	12.0	96	87
16.	*Panicum maximum*	15.0	51	245
	F	19.604**	276.11**	790.29**
	SE	1.533	3.271	3.205
	CD	4.428	9.44	9.255

** significant at 1% level

Alloteropsis cimicina registered the lowest value of 12 ppm which was on par with Sporobolus indicus, Panicum repens, Echinochloa colonum, Eragrostis tenella and Panicum maximum.

With respect to Zn content, the highest value of 250 ppm was recorded by Dactyloctenium aegyptium and the lowest value of 51 ppm by Panicum repens.

Mn content was the highest in Dactyloctenium aegyptium and the lowest in Cyrtococcum trigonum which was on par with Panicum javanicum, Panicum repens and Eragrostis tenella.

4.2.4 Antiquality components

a. Potassium : (Ca + Mg) ratio

The K : (Ca + Mg) ratio (Table 4.2.8) worked out from the contents of these nutrients showed significant variation among the grass species. Sporobolus indicus recorded the highest ratio of 7.39 which was significantly higher than others while, the lowest ratio of 2.49 was recorded by Cynodon dactylon which was on par with Echinochloa colonum, Eleusine indica and Axonopus compressus.

b. Calcium : Phosphorus ratio

From table 4.2.8, it could be observed that Brachiaria ramosa recorded the highest Ca : P ratio of 0.97 which was on par

Table 4.2.8 K : Ca + Mg ratio and Ca : P ratio of different grass species

Sl. No.	Treatment	K/Ca+Mg	Ca : P
1.	*Cynodon dactylon*	2.49	0.56
2.	*Digitaria ciliaris*	3.12	0.18
3.	*Alloteropsis cimicina*	3.28	0.28
4.	*Eleusine indica*	2.75	0.43
5.	*Axonopus compressus*	3.03	0.28
6.	*Panicum repens*	3.3	0.84
7.	*Rhynchelytrum repens*	5.71	0.36
8.	*Echinochloa colonum*	2.49	0.21
9.	*Cyrtococcum trigonum*	3.17	0.32
10.	*Brachiaria ramosa*	3.10	0.97
11.	*Eragrostis tenella*	5.64	0.27
12.	*Panicum javanicum*	4.6	0.47
13.	*Dactyloctenium aegyptium*	3.88	0.94
14.	*Chloris barbata*	3.31	0.72
15.	*Sporobolus indicus*	7.39	0.22
16.	*Panicum maximum*	4.21	0.42
	F	19.234**	44.770**
	SE	0.311	0.038
	CD	0.899	0.110

** significant at 1% level

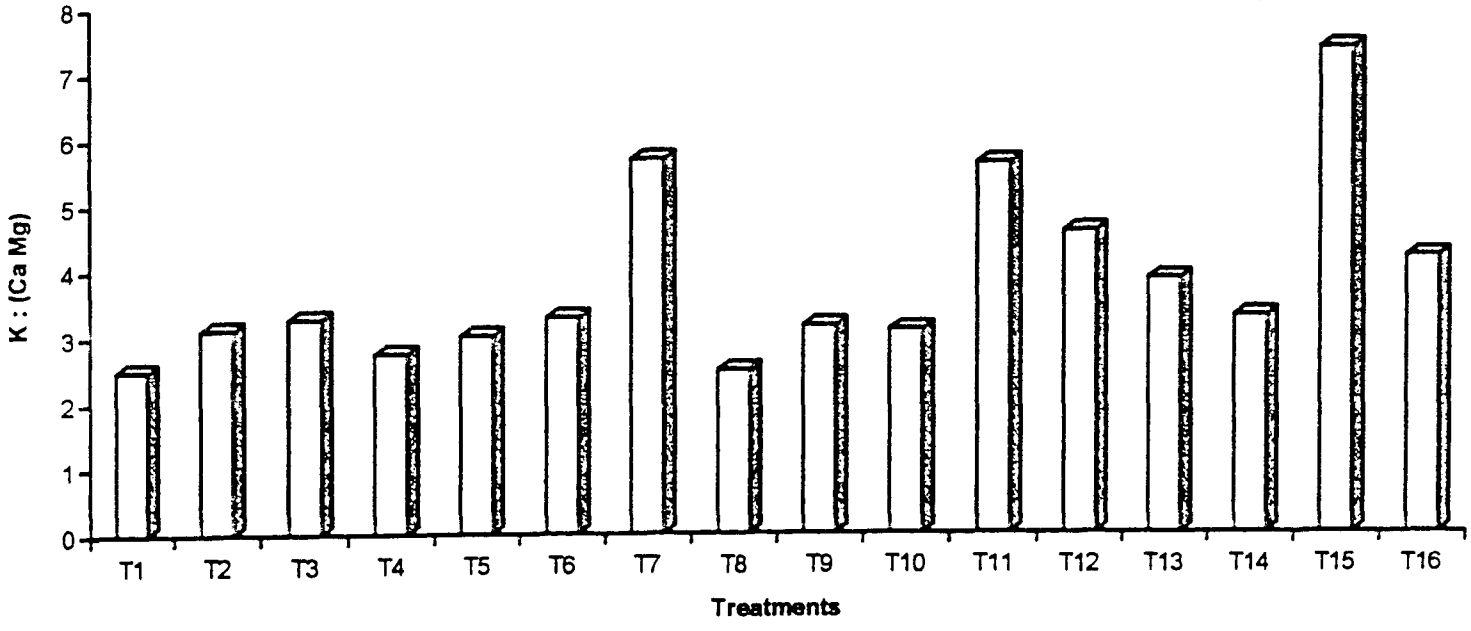


Fig. 6. K/(Ca + Mg) ratio of different grass species

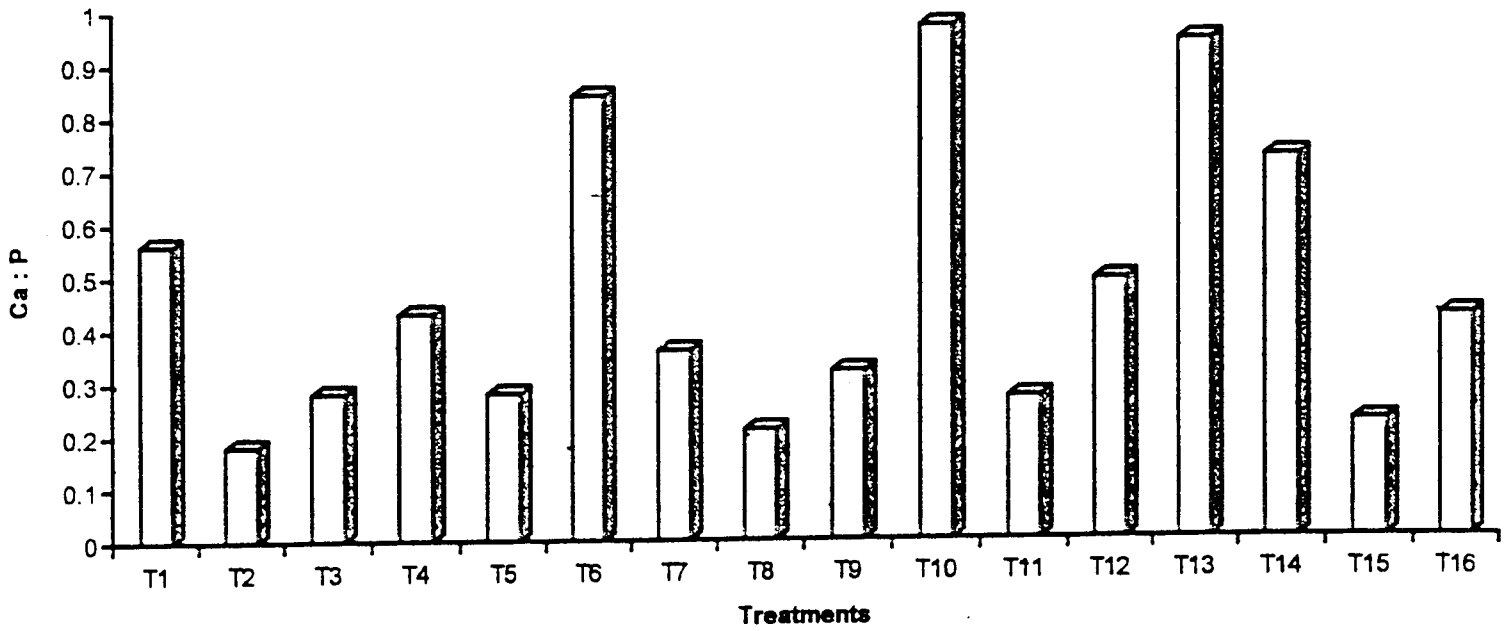


Fig . 7. Ca : P ratio of different grasses

with Dactyloctenium aegyptium, with a value of 0.94. The lowest value of 0.18 was recorded by Digitaria ciliaris.

4.2.5 Anti-nutritional factors

All the antinutritional factors studied except HCN and heavy metals showed significant variation among grass species. (Table 4.2.9). There was no HCN present in the different grass species studied. Also no detectable amount of heavy metals.

a. Tannin content (%)

Maximum tannin content of 1.45 per cent was recorded by Cyrtococcum trigonum and the lowest value of 0.23 per cent by Eleusine indica.

b. Oxalate content (%)

Oxalate content was the highest (0.165 per cent) in Cyrtococcum trigonum which was on par with Rhynchelytrum repens. The lowest value (0.038 per cent) was observed in Sporobolus indicus which was on par with Brachiaria ramosa, Cynodon dactylon and Panicum repens.

4.2.6 Nutrient uptake (kg m^{-2})

Panicum maximum registered the highest N, P and K uptake values of 15.74, 2.26 and 17.13 kg m^{-2} respectively (Table 4.2.10). Eragrostis tenella recorded the lowest N uptake of 0.59 kg m^{-2} whereas, Cynodon doctylon

Table 4.2.9 Anti nutritional factors of different grass species

Sl. No.	Treatment	Tannin (%)	Oxalate (%)	HCN	Heavy metal
1.	*Cynodon dactylon*	0.63	0.05	Nil	Nil
2.	*Digitaria ciliaris*	0.46	0.124		
3.	*Alloteropsis cimicina*	0.5	0.098		
4.	*Eleusine indica*	0.23	0.097		
5.	*Axonopus compressus*	0.8	0.087		
6.	*Panicum repens*	0.57	0.058		
7.	*Rhynchelytrum repens*	0.6	0.135		
8.	*Echinochloa colonum*	0.49	0.119		
9.	*Cyrtococcum trigonum*	1.46	0.165		
10.	*Brachiaria ramosa*	0.57	0.096		
11.	*Eragrostis tenella*	0.43	0.095		
12.	*Panicum javanicum*	0.43	0.11		
13.	*Dactyloctenium aegyptium*	0.47	0.069		
14.	*Chloris barbata*	0.33	0.058		
15.	*Sporobolus indicus*	0.40	0.038		
16.	*Panicum maximum*	0.33	0.07		
	F	43.13**	10.758**		
	SE	0.043	0.011		
	CD	0.123	0.032		

** Significnat at 1% level

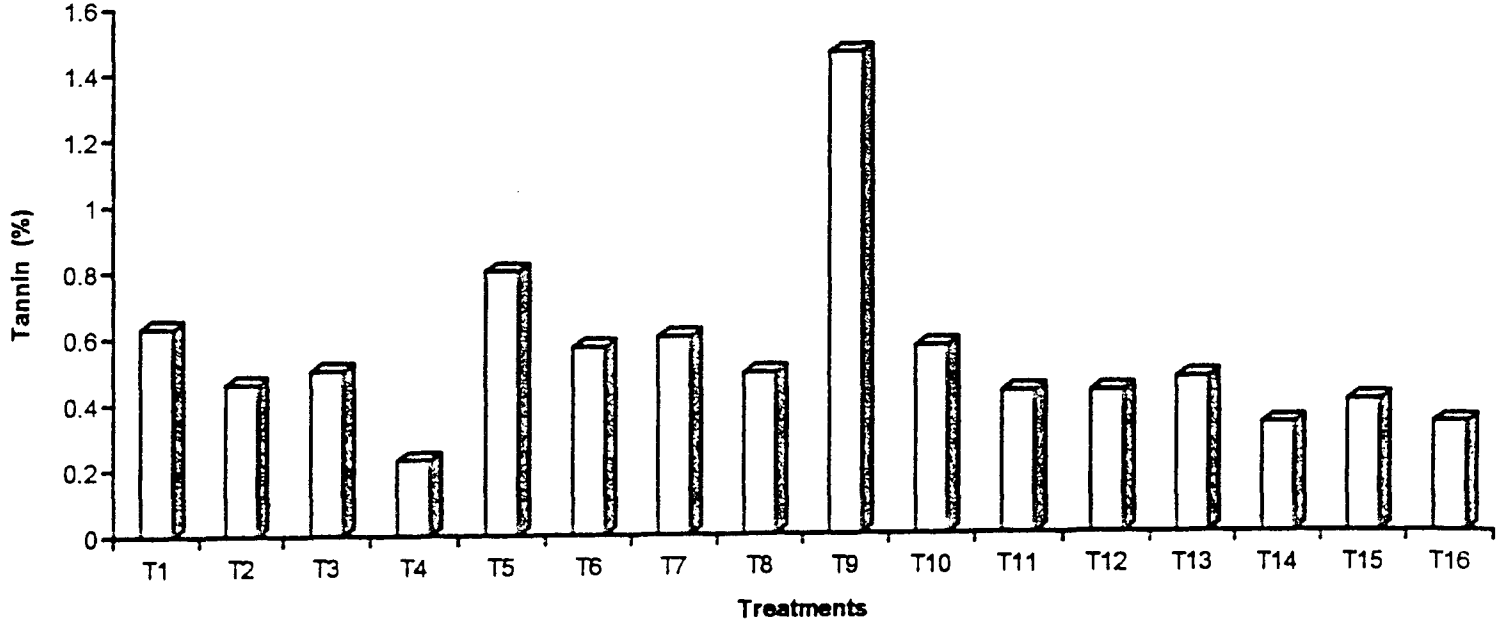


Fig. 6. Tannin content of different grasses

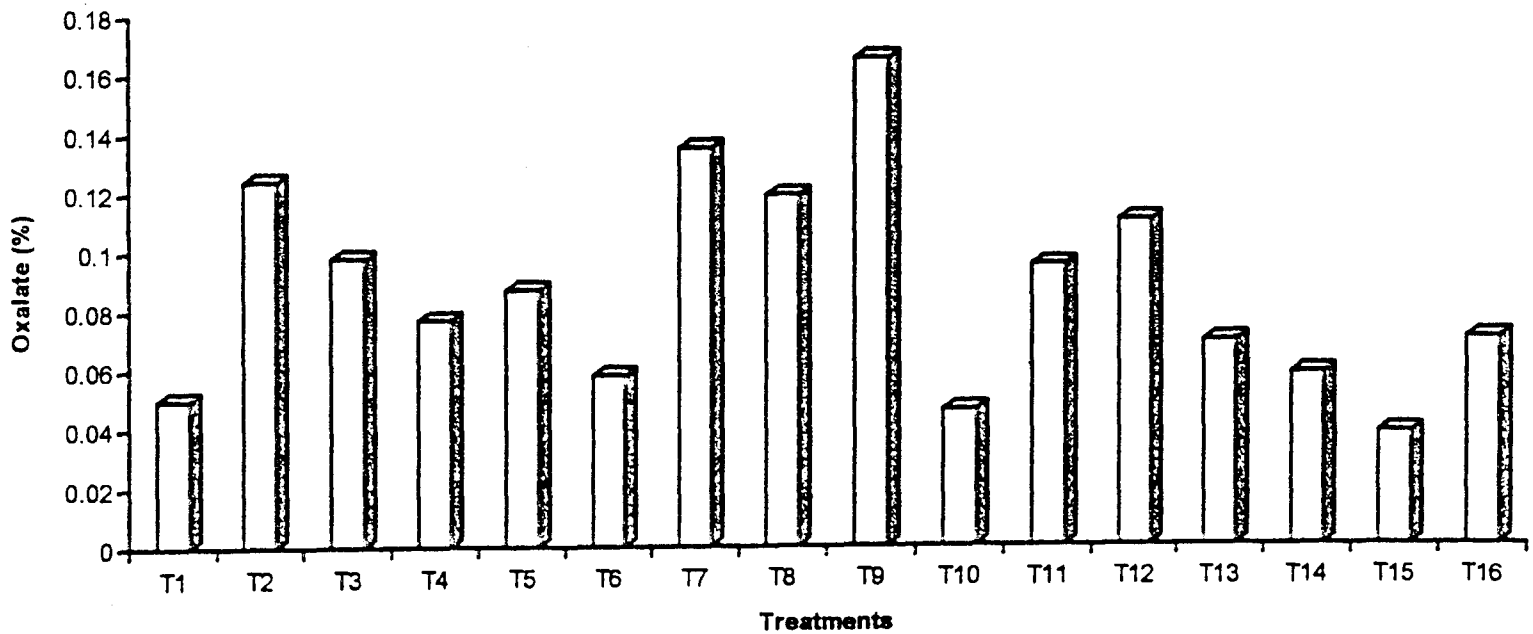


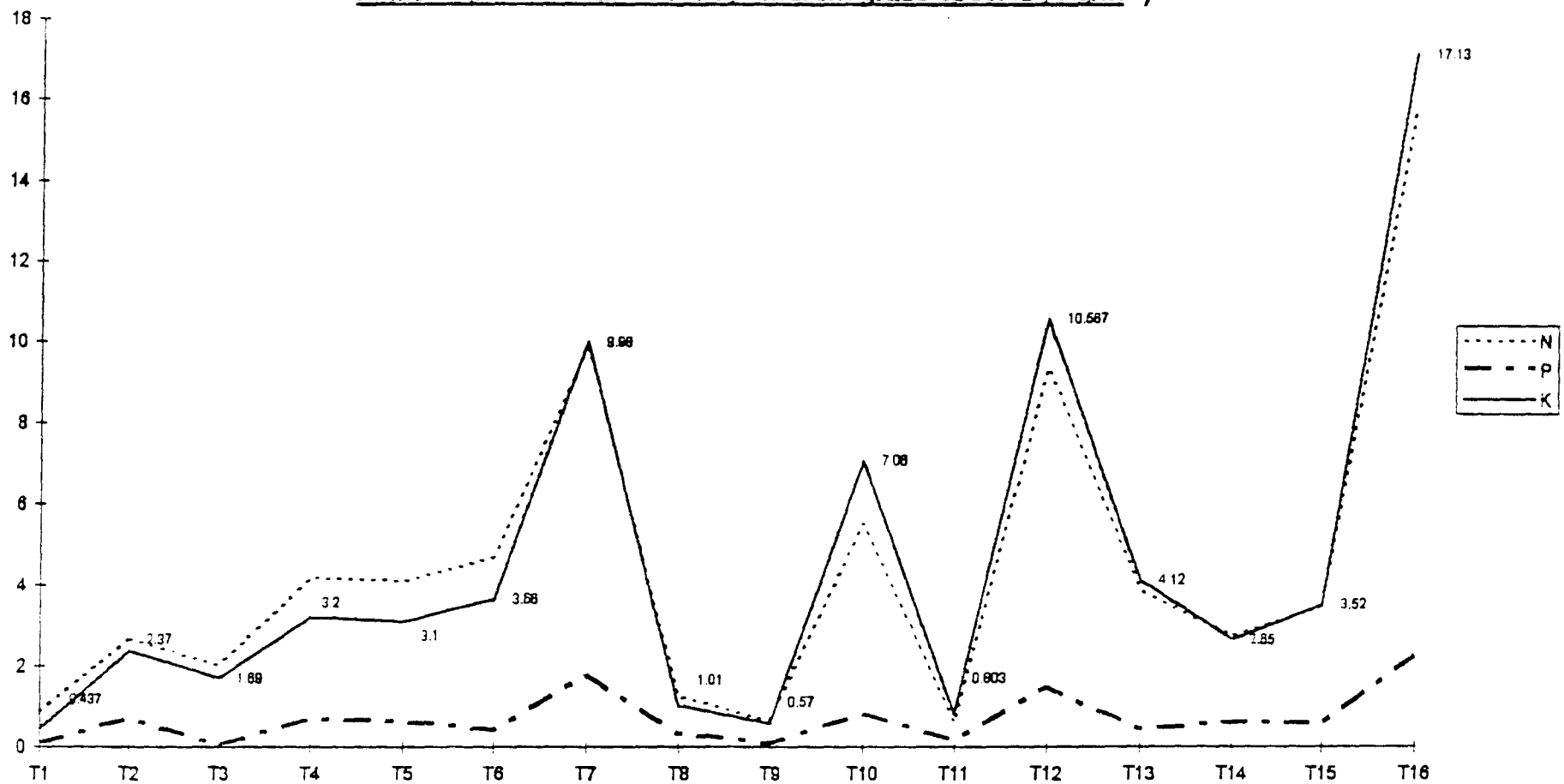
Fig. 9. Oxalate content of different grasses

Table 4.2.10 Nutrient uptake by different grass species

Sl. No.	Treatment	N	P	K	Ca	Mg
				(kg/m^2)		
1.	*Cynodon dactylon*	0.88	0.09	0.44	0.05	0.13
2.	*Digitaria ciliaris*	2.67	0.69	2.37	0.12	0.64
3.	*Alloteropsis cimicina*	2.02	0.50	1.69	0.14	0.38
4.	*Eleusine indica*	4.18	0.71	3.20	0.30	0.86
5.	*Axonopus compressus*	4.10	0.62	3.10	0.17	0.85
6.	*Panicum repens*	4.69	0.43	3.66	0.36	0.76
7.	*Rhynchelytrum repens*	9.87	1.77	9.98	0.59	1.16
8.	*Echinochloa colonum*	1.24	0.23	1.01	0.07	0.33
9.	*Cyrtococcum trigonum*	0.65	0.09	0.57	0.03	0.15
10.	*Brachiaria ramosa*	5.52	0.83	7.06	0.80	1.48
11.	*Eragrostis tenella*	0.59	0.16	0.80	0.04	0.10
12.	*Panicum javanicum*	9.34	1.467	10.57	0.72	1.64
13.	*Dactyloctenium aegyptium*	3.89	0.45	4.12	0.43	0.64
14.	*Chloris barbata*	2.75	0.60	2.65	0.43	0.37
15.	*Sporobolus indicus*	3.49	0.53	3.52	0.12	0.36
16.	*Panicum maximum*	15.74	2.26	17.13	0.94	3.17
	F	139.997**	140.33**	108.015**	61.268**	280.699**
	SE	0.4856	0.0515	0.4388	0.0376	0.0465
	CD	0.9916	0.1486	1.267	0.1086	0.1342

** Significant at 1% level

Fig.#6 : Uptake of N,P and K by different grass species (Kg/m^2)



and Cyrtococcum trigonum recorded the lowest P uptake of 0.09 kg m^{-2} which was on par with Eragrostis tenella. K uptake was the lowest for Cynodon dactylon (0.44 kg m^{-2}).

Panicum maximum also recorded maximum uptake of Ca and Mg. Cyrtococcum trigonum recorded the lowest uptake of Ca whereas, Eragrostis tenella recorded the lowest uptake of Mg.

4.3 Quality index of grasses

Based on the nutritional and anti-nutritional factors, a quality index was developed for the different species as described in the methodology in Chapter 2. The nutritional factors selected include Nitrogen, Phosphorus, Potassium, Calcium, Magnesium, Copper, Zinc, Manganese, Crude protein, Crude fibre, Ash and Chlorophyll contents, Green fodder, Dry fodder and Protein yields and Ca : P and P : (Ca + Mg) ratios. The antinutritional factors include oxlate and tannin contents. These indices are subjected to analysis of variance for comparison. Results are furnished in Table 4.3.1.

The results revealed that Brachiaria ramosa was superior in quality when compared with other grasses and it registered an index value of 8209.59. This was followed by Eleusine indica which recorded an index value of 6966.82. Panicum repens was observed to have the lowest index value of 2848.97. 5 grasses namely Eleusine indica, Rhynchelytrum repens,

Table 4.3.1 Quality index of different grass species

Sl. No.	Treatment	Quality index
1.	*Cynodon dactylon*	4243.81
2.	*Digitaria ciliaris*	4534.82
3.	*Alloteropsis cimicina*	3326.76
4.	*Eleusine indica*	6966.82
5.	*Axonopus compressus*	4203.11
6.	*Panicum repens*	2848.68
7.	*Rhynchelytrum repens*	5273.13
8.	*Echinochloa colonum*	3439.201
9.	*Cyrtococcum trigonum*	4512.77
10.	*Brachiaria ramosa*	8209.59
11.	*Eragrostis tenella*	3108.15
12.	*Panicum javanicum*	4715.57
13.	*Dactyloctenium aegyptium*	5233.98
14.	*Chloris barbata*	4213.68
15.	*Sporobolus indicus*	3115.57
16.	*Panicum maximum*	3647.02
	F	19.368**
	SE	327.01
	CD	944.33

** Significant at 1% level

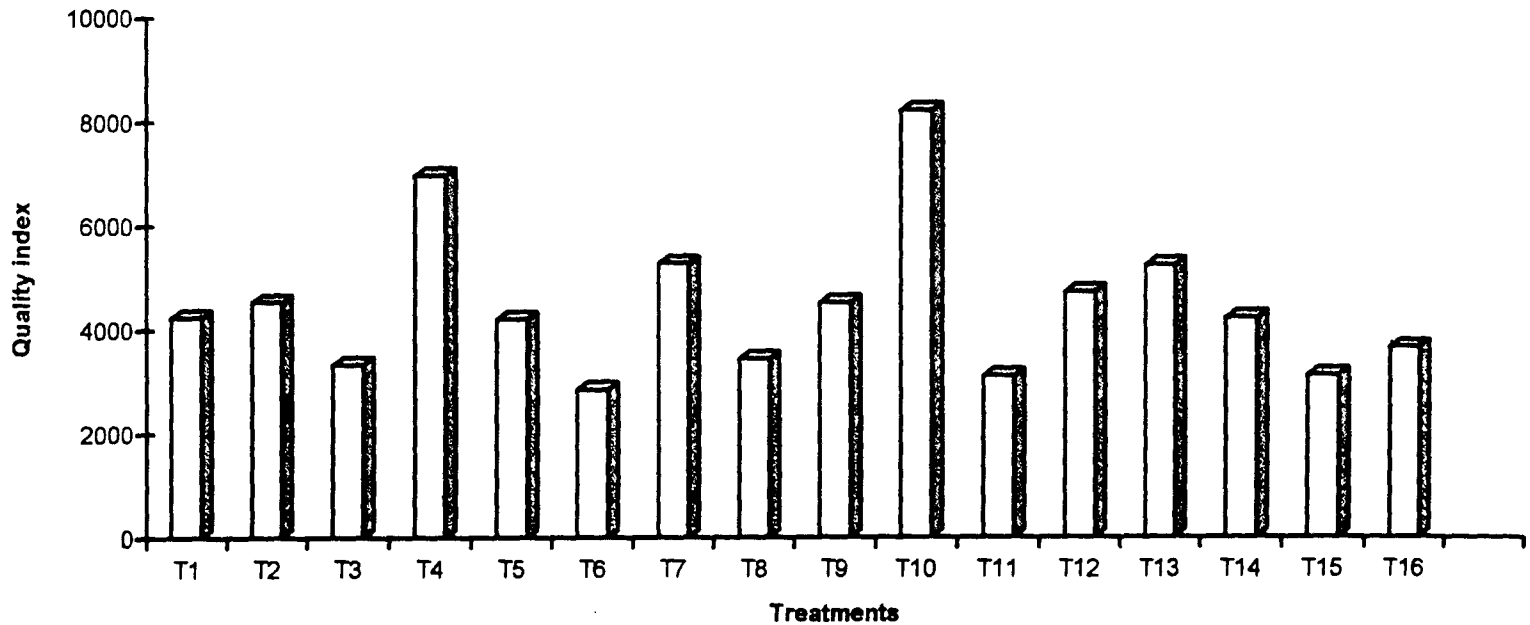


Fig. 11. Quality index of different grass species

Brachiaria ramosa, Panicum javanicum and Dactyloctenium aegyptium were found superior to guinea grass. The other species were found to be on par with guinea grass.

4.4 Correlation studies

Correlation of important parameters with green fodder yield, dry fodder yield and protein yield are given in the table 4.4.1 .

The results revealed that the plant height, leaf stem ratio, root characters, chlorophyll content and nutrient uptake values were showing significant positive correlation with green fodder yield, dry fodder yield and protein yield. Among all these parameters N, P and K uptake values recorded the highest correlation with yield. The ash and crude fibre contents were negatively correlated with green fodder yield.

Table 4.4.1 Correlation of different parameters with GFY, DFY and PY of different grass species

Sl. No.	Treatment	GFY	DEFY	PY
1.	Height of the plant	0.8738	0.8404	0.8150
2.	Tiller number	0.0850	0.1830	0.1368
3.	Leaf stem ratio	0.7022	0.6183	0.6758
4.	Root length	0.7690	0.7276	0.7534
5.	Root spread	0.5382	0.5463	0.5832
6.	Crude protein content	0.2941	0.2615	0.3938
7.	Ash content	-0.0204	0.00476	0.0469
8.	Crude fibre content	-0.0175	0.0434	-0.0285
9.	Chlorophyll content	0.5684	0.6221	0.5856
10.	N uptake	0.9873	0.9760	0.9927
11.	P uptake	0.9166	0.9392	0.9399
12.	K uptake	0.9555	0.9665	0.9699
13.	Ca uptake	0.8196	0.8593	0.8279
14.	GFY		0.9851	0.9869
15.	DFY			0.981

r (0.01) =0.36

DISCUSSION

5. DISCUSSION

The results of the present study conducted to identify and evaluate the promising natural graminaceous weed species for fodder purpose are discussed below.

5.1 Survey

The results of the survey conducted in the southern districts of Kerala indicated that grass species predominated among the weeds associated with cassava crop in all the districts. Further observations emphasised that most of these grasses were perennial in nature and species like Axonopus compressus, Panicum javanicum, Cyrtococcum trigonum, Brachiaria ramosa were the common species observed in all districts. These four perennial grasses have high persistence capacity due to their dual survival mechanisms of high seed production and vegetative method of propagation. Also they have higher competitive ability than other species which help in their survival and multiplication (Gupta and Lamba, 1978).

Cassava being a crop of 10 months duration, requires inter cultivation only during the early growth stages upto 2 to 3 months, before tuberization begins. Probably the last intercultivation given to cassava might have reduced the population of most of annual grasses and dicots. The increase in

the population of grass species can be mainly attributed due to their efficient survival mechanism which enable them to germinate and regenerate in the field even after the intercultivation operations have destroyed most of the previous ones. Thus grass species became more prominent in the tapioca plots surveyed where the plants are about 5 to 6 months old.

In the case of coconut plantations also, the grass weeds were found to be predominant than sedges and dicots in all the three districts surveyed. Weeds such as Axonopus compressus, Cyrtococcum trigonum, Panicum repens, Panicum javanicum, Brachiaria ramosa, Dactyloctenium aegyptium were the common species noticed in coconut plantations.

Coconut requires weeding and intercultivation during two times in a year whereby all the weeds including grasses, sedges and dicots present in the field are removed. But perennial grasses on account of their profuse seed production capacity and due to the presence of underground dormant propagules will regenerate during favourable conditions. These weeds also produce roots from their nodes which help them to spread rapidly within a short span of time. These favourable factors have contributed to the dominance of perennial grasses in coconut gardens The AICRP survey report on weed control (1987) also emphasised Axonopus compressus and Dactyloctenium aegyptium as the problem weeds of coconut gardens of Kerala.

In addition to grass species, the count of annual dicot species were also higher in coconut garden. The species which prefer light shade and moderate soil moisture like Synedrella nodiflora, Ageratum conyzoides, Emilia sonchifolia, Amaranthus viridis, Acalypha indica, Commelina sp, Leucas aspera can grow well under the partial shaded conditions available in coconut garden, which might have resulted in their increased count.

Observations on the weed species associated with rubber revealed that the weed population was comparatively poorer and the species present were mostly perennial in nature. The presence of cover crops and the development of sufficient foliage by the rubber plants might have reduced the occurrance of weed species in rubber plantations.

Among grass species, Axonopus compressus, Cyrtococcum trigonum were the important ones. Dabadghao and Sankaranarayanan (1973) also reported the predominance of perennial grasses like Cynodon dactylon, Imperata cylindrica, Heteropogon contortus and Sporobolus marginatus in the teak plantations of Kerala. In the case of dicots, perennials like Elephantopus scaber, Clerodendron infortunatum, Eupatorium odoratum etc. dominated.

In rubber plantations, regular intercultivation operations were absent and the fertilizer application is mostly limited to spot application. This might have again favoured the self regeneration of perennial weeds in the rubber plantations.

The results presented in tables 4.10 to 4.12 clearly showed the presence of annual and perennial grasses and dicots associated with the crops of the homestead in all the three districts, though perennial grasses predominate.

The important grass species were the same as that observed in cassava and coconut fields. In homesteads, different crop combinations received different management practices. Moreover, in homesteads no scientific plant geometry and fertilizer application methods were followed. The conditions prevailing in homestead is mostly identical to the partial shaded condition in coconut garden and in homesteads tree crops like jack, mango, tamarind and tuber crops like yams, colocasia etc. were present. Because of the varied growth pattern of a variety of crops and availability of waste water received from the house like bath water, cloth washings and kitchen washings, many weed species dominated in the homesteads. The high persistance rate observed in the case of perennials like Axonopus compressus, Brachiaria ramosa, Panicum javanicum, Cynodon dactylon, Clerodendron infortunatum, Eupatorium odoratum might have contributed to their increased count in the homesteads. The well distributed rains received during the previous south-west monsoon period (Appendix - I) ie, two months prior to survey work, coupled with the benefit of waste water obtained from the household might have encouraged the germination and establishment of annuals and perennials. Absence of regular cultivation

operations in turn also have facilitated self regeneration and growth of weed species in homesteads.

In homesteads and in all crop associations the predominant sedge observed was Cyperus rotundus. Cyperus rotundus being a deep rooted perennial, produces large number of tubers which can tolerate the adverse weather conditions, remain dormant for longer periods and can germinate during favourable seasons. These features might have enabled Cyperus rotundus to dominate in all the three districts surveyed. Similar observations of dominence by Cyperus rotundus were also reported from the survey work conducted by Subramanian et al. (1991) in Tamil Nadu.

The superiority of grass species in natural weed flora was also evident by analysing the grass bundles collected from the local markets at Thiruvananthapuram, Kollam and Pathanamthitta districts. In all these districts, perennial grass species on account of their effective regrowth with the onset of rains contributed the highest composition in grass bundles. This again supports the results of survey work which revealed the predominance of grass species among the natural weed flora and also these species are acceptable to animals which increased the market demand of grass species.

On comparison of the relative weed intensities of 3 districts, (Table 4.13), it was observed that the intensity was maximum for grass species and minimum for sedges, in all three districts.

Most of the grasses were perennial and are well adapted to withstand adverse conditions. Unlike other species, they propagate by seeds and by underground stem, rhizome and/or suckers. (Subramanian et al. 1991). This self regeneration capacity of grasses helps them to multiply faster within a short period of time. Moreover, the vegetative propagules and seeds can remain dormant during unfavourable weather conditions and they can putforth quick germination and resume vigorous growth when the conditions become favourable.

Since the survey was conducted after the south-west monsoon, the germination and regrowth of all seeds as well as dormant propagules of grasses were effected which led to the increased weed density of grass species in all the districts surveyed.

Similar reports on the increased intensities of grass weeds in the natural weed flora of cultivated lands of Kerala were made by Dabadghao and Sankaranarayanan (1973). Subramanian et al. (1991) also observed a higher intensity of grass weeds in Tamil Nadu.

5.2 Field experiment

5.2.1 Growth characters and yield

From the field experiment conducted it was observed that all the indigenous grass species tried, showed some delay in

establishment under field conditions whereas, their growth under the natural habitat was excellent. This attributed to the reluctance of these grass species to domestication and once they get established, then their growth was found to be good.

The results presented in table 4.2.1 revealed that the growth characters of grass species namely plant height and leaf stem ratio were significantly superior in the case of control, ie, Panicum maximum to the natural grass species tried. The tiller number was the highest for Rhynchelytrum repens. The increased plant height and leaf stem ratio of Panicum maximum has contributed to the increased green fodder and dry fodder yield of this grass. Among the indigenous species, Panicum javanicum recorded the highest green fodder yield which was on par with Rhynchelytrum repens. This increased yield is attributed to the high plant height and leaf stem ratio of Panicum javanicum and more plant height and tiller number of Rhynchelytrum repens. This became more evident after the correlation studies; where positive correlation values were noticed between yield and plant height and leaf stem ratio. Similar positive correlation between green fodder yield and number of tillers per plant and leaf stem ratio was reported by Babbar (1985) in Dinanath grass (Pennisetum pedicellatum).

The inherent genetic make up of the different grass species might have contributed to the variation in their growth

habit and consequently to herbage yield. In the case of dry fodder yield also, similar trend was observed. Variations in the dry matter content of four species of Digitaria grass have also been reported by Miller and Cowlishaw (1976).

5.2.2 Nutritive quality

Quality of any forage is determined by its chemical composition and nutritive value (Sood et al., 1975). It is always true that the chemical composition of a forage does not give a true measure of its nutritive value for the animal, but it can be utilised as a useful tool to estimate the quality of the forage.

a. Crude protein

Out of the 15 indigenous grass species tried, 11 species recorded higher crude protein content than guinea grass. Dactyloctenium aegyptium and Panicum javanicum were on par in crude protein content and significantly superior to all others. (Table 4.2.5). Crude protein, which is an index of grass quality was higher in majority of the indigenous species tried. This revealed that these grass species are suitable for providing the crude protein requirement for maintenance of high producing ruminants (Bosworth et al., 1980). The protein content of grasses tried in this experiment ranged from 10 to 15 per cent which is considered to be adequate for maintenance of a dry pregnant ruminant.

Similar variation in crude protein content among grasses has also been reported by Sreeramulu and Chande (1983), Youssef and Brathwaite (1987) and Esechie (1991).

Elliott and Topps (1963) opined that the protein content of tropical forages is directly correlated with their intake by animals. They recorded a significant reduction of intake when levels of crude protein in the forage fell below 5.5 per cent.

According to Youssef and Brathwaite (1987) a level of 100 g CP kg^{-1} DM would satisfy the maintenance requirements of beef and dairy cattle and sheep and goats to produce some beef, milk and mutton respectively. In the present study 81.25 per cent of the grass species tried had a crude protein concentration above the required level whereas, only 18.75 per cent had a level below optimum.

Regarding the protein yield, the highest value of 98.4 kg m^{-2} was registered by Panicum maximum though it had a comparatively lower protein content than most of the indigenous species. Protein yield being the product of protein content and dry matter yield, the increase in dry matter production of Panicum maximum had contributed to the higher protein yield of this grass. Among the indigenous species, the highest crude protein yield was registered by Rhynchelytrum repens and Panicum javanicum owing to their high dry matter production and higher

protein content. The relationship between protein yield with dry matter production and protein content was more evident in this experiment by their significant positive correlation values of 0.981 and 0.394. Increased protein yield due to high drymatter production was also observed from the studies on guinea grass by Pillai (1986).

b. Crude fibre content

Crude fibre content of all the grass species studied also showed variation and it was observed that grasses such as Panicum repens, Rhynchelytrum repens, Echinochloa colonum and Eleusine indica had higher crude fibre content than the other grass species. The lowest content was registered by Eragrostis tenella and Panicum javanicum. It has been reported that increase in crude fibre content exerts a negative effect in the digestibility of crude protein and it reduces its fodder value. (Glover and French, 1957 and Elliott and Fokkema, 1960). Though species having high fibre values are not well relished by cattle, it was also observed that all the species tried in this experiment were accepted by cattle as is evident from the acceptability test (Table 4.2.3).

In this trial though Dactyloctenium aegyptium and Panicum javanicum had the highest crude protein content, Panicum javanicum had the least crude fibre denoting the superiority of this species in animal nutrition over Dactyloctenium aegyptium.

Similar variations in crude fibre content of different grass species have also been reported by Miller and Cowlishaw (1976) and Sreeramulu and Chande (1983).

c. Ash content

Ash content is an inherent genetic character and variation in the ash content among different grass species of the tropical region has been reported by Sreeramulu and Chande (1983). The results of the present study is in agreement with their findings. Ash content is a fair estimate of the mineral contents of forage species and plants with high ash content are reported to have high mineral content also.

On perusal of the results in table 4.2.5, it was evident that grasses Panicum javanicum and Chloris barbata had higher ash content than others while, Panicum repens recorded the least content of minerals. The N, P, K and Ca content of different grasses presented in Table 4.2.6 showed that the two grasses having higher ash content viz. Panicum javanicum and Chloris barbata are having relatively higher content of mineral nutrients than other grasses. This again is a more reliable criteria for assessing the quality of grasses.

d. Chlorophyll content

Chlorophyll content (Table 4.2.5) showed variation among grasses. Panicum maximum registered the highest content and on

par with Rhynchelytrum repens, Echinochloa colonum and Brachiaria ramosa.

Content of chlorophyll in any plant is highly influenced by its genetic make up and it shows variation among species. The significant positive correlation values (0.5684 and 0.6221) observed between chlorophyll content and green fodder and dry fodder yields clearly gives an insight into the role of this pigment in photosynthesis and thereby on yield.

e. Nutrient content

Critical review of results in Table 4.2.6 showed that the nutrient content differed significantly among the grasses. Dactyloctenium aegyptium, Chloris barbata and Panicum javanicum recorded the highest N, P, and K contents respectively. Since all grass species were given the uniform management practices like fertilizer and manure application, weed control etc., the differences in their nutrient content may be attributed to their genetic character. Similar difference in mineral content of grasses were reported by Jayakumar et al. (1985), Youssef and Brathwaite (1987) and Esechie (1992).

Of the 15 indigenous species tried, 8 species in N content, 12 species in P content and 4 species in K content were found significantly superior to guinea grass. Similarly 8 species in Ca and Mg, 10 species in Cu, 11 species in Zn and 3 species in Mn were found to be superior to guinea.

This is attributed to the ability of weed plants to extract and accumulate high concentrations of nutrients in their tissues, in many cases, much higher than that found in common crop plants. (Gupta and Lamba, 1978). Even under the same level of fertilization, the domesticated guinea grass was found to be inferior to some of the natural weed species in terms of nutrient content.

The variation in N content of the grasses is reflected in the variation of crude protein content which is already discussed.

Phosphorus is needed for maintaining the animal in better health, fertility and production. The P values of the grasses ranged from 0.16 to 0.46 per cent whereas, the P requirement of sheep, dairy cattle and beef are 1.6 to 3.7, 3.1 to 4 and 1.8 to 4.7 g kg^{-1} DM respectively (NRC, 1975, 1978 and 1984).

The phosphorus contents of majority of the grasses tried in this experiment (including guinea grass) were above the minimum requirement level of 1.6 kg $^{-1}$ DM, and as such these local grasses would be able to satisfy the P requirement of the domesticated ruminants which depend upon the weed flora.

The grass species tried in this experiment registered a potassium content ranging from 0.867 to 2.53 per cent (Table 4.2.6). The K requirement of sheep, dairy cattle and beef

cattle are 5, 8 to 12 and 5 to 7 g kg^{-1} DM respectively (NRC, 1975, 1978 and 1984), which clearly indicate that all the grass species tried here are able to satisfy the maintenance requirement of the different classes of livestock which feed on these grass weeds. Grasses have the capacity to absorb more K^+ from soil (Chaterjee and Das, 1989) and hence the deficiency of this nutrient is not commonly manifested in the natural flora. In this study also the K content of different species is above the normal level (Table 4.2.6).

The results depicted in Table 4.2.6 revealed that the calcium content of the grasses was within the range of 0.067 to 0.329 per cent whereas, the content of Magnesium was 0.152 to 0.441 per cent. Comparing this with the animal requirement suggested by NRC (1975, 1978 and 1984), it was observed that the requirement of Ca for sheep, dairy cattle and beef cattle are 2.1 to 5.2, 4.3 to 6 and 1.8 to 5.3 g kg^{-1} DM, respectively. In the present study, the calcium content was comparatively low and this may be due to the less prefernece of Ca^{2+} by grasses and high acidity of the soil (Table 3.4). On the contrary, the magnesium content was sufficiently higher to satisfy the requirement of sheep, dairy and beef cattle, ie. 0.4 to 0.8, 2 and 0.5 to 2.5 kg^{-1} DM, respectively. Leachability of Mg^{2+} is less when compared to Ca^{2+}. More over pasture crops have high preference to Mg^{2+} ions (Tisdale et al. 1990).

Chatterjee and Das (1989) observed an increased magnesium concentration in forages due to increased nitrogen

application. In this study also nitrogen was applied @ 200 kg ha^{-1} which might have increased the magnesium concentration in grasses. Similar variation among species in calcium and magnesium contents have also been reported by ARC (1980), Youssef and Brathwaite (1987) and Esechie (1992).

The micronutrients such as copper, zinc and manganese are essential in animal nutrition. Supplementation of these nutrients through feeds and forages will help to overcome the deficiency diseases.

Copper is needed for haemoglobin formation as well as in several enzymes. The content of copper in the grass species ranged from 12 to 37 ppm which is over and above the requirement for sheep, dairy and beef cattle ie 5, 10 and 4-10 mg kg^{-1} DM, respectively (NRC 1975, 1978 and 1984).

Thus all the indigenous grasses could satisfy the copper requirement in the three groups of animals. The deficiency of this element in animal diet can lead to bone changes and fragility, anaemea and defective pigmentation (Butterworth, 1985). It also causes fibrosis of the myocardium and diarrhoea.

The element zinc which is a part of various enzyme systems involved in vital processes like digestion and cellular metabolism of animals, is required at the rate of 35 to 50, 40

and 20 to 40 ppm, respectively for sheep, dairy cattle and beef cattle (NRC 1975, 1978 and 1984). This element is present in sufficiently high quantities in majority of the grasses tried.

According to Butterworth (1985), the micronutrient manganese is essential for the growth and reproduction of animals and it also acts as a co-factor for the enzymes involved in the bio-synthesis of glycoproteins. All the grass species studied in this experiment had adequate level of Mn ranging from 71 to 359 ppm whereas, the animal requirement as suggested by NRC (1976) was only between 1 to 20 ppm.

Since the local grasses tried in this experiment contain these trace elements at satisfactory levels, feeding domesticated cattle with these grasses may help to overcome the possible deficiency diseases if any, occurring to these cattle. Youssef and Brathwaite (1987) and Esechie (1992) also reported similar variations in copper and manganese contents of grasses.

f. Anti-quality components

K : (Ca+Mg) ratio

The different grass species tried had higher values for K : (Ca + Mg) ratio than the reported critical value of 2.2 for the incidence of grass tetany (hypomagnasaemia) in cattle. The wider ratio observed in this study may be attributed to the lower Ca and Mg content of the grasses corresponding to high K content.

Because of the high rainfall received in the region where the study was conducted, Ca and Mg ions might have been leached away resulting in extremely acidic soil conditions. This acidic condition limits the further uptake of Ca and Mg ions from the soil by these grasses. More over, the response of grasses to these divalent ions are less, compared to that of legumes. The addition of potassium @ 50 kg ha^{-1} also might have enhanced the K content in the species (Table 4.2.6), there by making the ratio wider and rendering the grasses unsuitable from the animal nutritionalists point of view. The high K absorbing capacity of grasses through diffusion is also a major factor which helps in increasing the K content. Abraham (1978) also observed similar results in Dinanath grass under similar soil and climatic conditions.

Ca : P ratio

Though the availability of Ca and P from feeding stuff is not generally indicated by their gross composition, plants which offer the most efficient utilisation of Ca and P will be those with a Ca:P ratio of 1:1 to 2:1 (National Academy of Sciences, 1976) and when the ratio exceeds 7:1, metabolic disorders may arise. In all the species tried here, the ratio, though lesser than the limits prescribed for efficient utilisation of Ca and P, it is much below the critic level which cause metablic disorders in animals. This is in line with the findings of Bosworth et al. (1980).

The ratio of the different grasses as obtained in this experiment ranged from 0.18 to 0.97 mainly due to their very low Ca content when compared with their P contents.

The observations on K : Ca+Mg ratio and Ca:P ratio clearly revealed the reduced uptake of Ca and Mg ions from the soil by the grass species. Since acidic pH resulted from the excessive leaching of these ions was attributed as the main cause, proper liming of the soil will help in a long way to improve the pH and to bring down the ratios to a safer level. In addition, including Ca feeds in animal diet will also help in ameliorating these ratios in animal system.

g. Anti-nutritional factors

The results of chemical analysis on anti-nutritional factors clearly revealed that all the grass species tried in this experiment had low contents of anti-nutritional factors. The tannin content of the species ranged from 0.23 to 1.46 per cent. The increase in tannin could decrease the availability of protein to animals. The oxalate content ranged from 0.038 to 0.165 per cent and an oxalate content of 10 per cent and above can cause oxalate poisoning in sheep and cattle (Kakkar et al. 1994). Similarly for HCN, though the minimum toxic level reported was 0.2 per cent, it could not be detected in any of the grass species tried in this experiment. Also the content of heavy metals was much below the detectable range. Though the role of

heavy metals is not clearly understood, higher concentration can unfavourably affect the animal health.

The contents of all these anti-nutritional factors in different grass species were much below the limits specified. This indicates that the different indigenous species have good quality and so can be recommended for safe feeding to animals.

h. Nutrient uptake

Results presented in table 4.2.10 revealed that guinea grass recorded significantly higher uptake of major nutrients and Ca and Mg, when compared with all the other indigenous species tried. The higher drymatter yield of Panicum maximum is the main factor that contributed to the increased nutrient uptake, though the nutrient content was comparatively lesser than the indigenous species. Among the indigenous grasses, Rhynchelytrum repens and Panicum javanicum recorded significantly higher uptake than other species. The better root proliferation noticed in these grasses such as root length and root spread (Table 4.2.4) might have enhanced the foraging ability of these grasses which inturn enhanced better absorption of water and nutrients resulting in higher fodder yield. The higher dry matter yield along with comparatively better nutrient content values contributed to the enhanced nutrient uptake by the two indigenous species. This observation was again supported by the high positive correlation values recorded in the case of dry fodder yield and nutrient

uptake (Table 4.4.1) ranging from 0.8593 for Ca to 0.976 for N. Similar increase in nutrient uptake due to enhanced dry matter production was also reported by Pillai (1986) in guinea grass.

i Quality index

The quality index developed on the basis of nutritional and anti-nutritional factors of different grasses revealed that Brachiaria ramosa was superior to all other species in terms of quality and this was followed by Eleusine indica. The medium nutrient content of Brachiaria ramosa and Eleusine indica along with the low contents of anti-nutritional factors enhanced the quality of these grasses. Out of 15 indigenous species tried, five species were found to be superior to the common cultivated grass guinea grass in terms of quality though they had lesser yield than the cultivated fodder. This emphasises the suitability of these species for feeding livestock to meet the minimum standards prescribed for animal feeding. It is also evident that these natural species currently occupy very important place in animal feeding and thus contributing enormously to animal management as evident from the composition of grass bundles collected from local markets. Animal feeding with these species rich in mineral nutrients will definitely help to maintain the animals healthy and protect them from developing deficiency diseases. Panicum repens on account of its high crude fibre and low mineral content was observed to have the least quality.

Developing an index considering all positive and negative qualities of a grass gives an over all idea of its suitability in animal feeding and from this study, Brachiaria ramosa and Eleusine indica were observed to be the best which recorded a quality index of 8209.59 and 6966.82, respectively. Similar differences among forage species based on nutritive value index had also been reported by Grieve and Osborn (1965).

SUMMARY

SUMMARY

An investigation was undertaken for the identification and evaluation of promising natural graminaceous weed species for fodder purpose in the southern districts of Kerala. The experiment was conducted in two parts. In the first part, a survey was conducted to identify the prominent grass weeds of the southern districts of Kerala, viz. Thiruvananthapuram, Kollam and Pathanamthitta districts. Quantitative and qualitative comparison of 15 selected grasses from these species with the standard fodder grass of the region viz. guinea grass cv. Hamil constituted the second part of the study.

A. Survey

The survey was conducted during the period from September to October 1994 and the results of the survey are summarised below.

1. In all the districts surveyed, perennial grasses predominated among the weed species found associated with the prominent cultivated crops viz. cassava and coconut.

2. In rubber plantations, perennial grasses and perennial dicots were more common though the weed population was comparatively less.

3. In homesteads, owing to its peculiarities, diversity was observed among weed species.

4. The population of sedges was comparatively less in all crop associations and it was almost nil in rubber plantations.

5. When the intensity of different weed species were compared, the grass species registered the highest intensity in all the districts and there was not much variation among districts in terms of weed intensity.

6. The prominent grass species identified were, Panicum javanicum, Axonopus compressus, Cyrtococcum trigonum, Brachiaria ramosa, Panicum repens, Cynodon dactylon, Dactyloctenium aegyptium, Eleusine indica, Echinochloa colonum, Chloris barbata, Digitaria ciliaris, Alloteropsis cimicina, Rhynchelytrum repens, Sporobolus indicus and Eragrostis tenella.

B. Field experiment

The field experiment in microplots was laid out in a randomised block design with three replications. The treatment constituted 15 grass species identified by the survey along with the control, guinea grass cv. Hamil. The data generated from the experiment were statistically analysed, presented and discussed in the foregoing chapters. The results of the experiment are summarised below.

1. Panicum maximum (control) registered the maximum plant height of 216.67 cm. Among the indigenous species, Panicum repens recorded the maximum height (105 cm) followed by Rhynchelytrum repens (91.60 cm).

2. Maximum number of tillers was produced by Rhynchelytrum repens (75.33) followed by Sporobous indicus (56.33).

3. The highest leaf stem ratio of 1.84 was recorded by Panicum maximum and among indigenous species, Panicum javanicum (1.21) was found superior to others.

4. Both green and dry fodder yields (33.77 and 9.28 kg m^{-2}) were maximum for Panicum maximum. Among the indigenous species, highest green fodder yield was recorded by Panicum javanicum (14.98 kg m^{-2}) where as Rhynchelytrum repens gave the highest dry fodder yield (5.29 kg m^{-2}).

5. Propagation through seeds and vegetative plant parts was the common feature of all the species tried.

6. The 15 species tried were found to be readily acceptable to animals.

7. The highest root length was recorded by Panicum maximum (33.33 cm) whereas Panicum javanicum registered maximum root spread (18.63 cm).

8. Panicum maximum registered the highest chlorophyll content (1.78 mg g^{-1}) which was followed by Rhynchelytrum repens (1.69 mg g^{-1}), Echinochloa colonum (1.65 mg g^{-1}) and Brachiaria ramosa (1.65 mg g^{-1}).

9. The protein content of grass species ranged from 15 to 5.84 and Dactyloctenium aegyptium recorded the highest content (15%) Panicum maximum gave the highest protein yield (98.4 kg m^{-2}).

10. Lowest crude fibre percentage was recorded in Eragrostis tenella (15.83%) and it was highest in Panicum repens (31.33%).

11. Regarding ash content, Panicum javanicum (12.67%) was observed to be superior to others.

12. Maximum phosphorus content was recorded by Chloris barbata (0.46%) followed by Digitaria ciliaris (0.447%) and Echinochloa colonum (0.433%). The lowest content was registered by Panicum repens (0.157%).

13. Panicum javanicum and Dactyloctenium aegyptium gave the highest potassium content (2.53%).

14. In calcium content, Chloris barbata (0.329%) was significantly superior to other grasses, whereas, it was minimum in Sporobolus indicus (0.069%).

15. Magnesium content also showed variation among species and Echinochloa colonum registered the highest content (0.441%).

16. Brachiaria ramosa recorded maximum copper content (37 ppm) followed by Eleusine indica (30 ppm). Dactyloctenium aegyptium was superior in zinc (250 ppm) and manganese (359 ppm) contents.

17. All the 15 grass species recorded a higher K: (Ca+Mg) ratio than the reported critical value of 2.2. The maximum value of 5.71 was recorded by Rhynchelytrum repens.

18. Ca:P ratio was within safe limits and maximum value was recorded in Brachiaria ramosa (0.97) followed by Dactyloctenium aegyptium (0.94).

19. Cyrtococcum trigonum (0.165%) followed by Rhynchelytrum repens (0.135%) recorded maximum oxalate content though the values were well below the toxicity levels.

20. Tannin contents of all the grasses were observed to be within the safe limits.

21. HCN or heavy metals were not detected in the 16 species tried.

22. Panicum maximum registered the highest uptake values for N, P, K, Ca and Mg.

23. The quality index developed for these grasses revealed that five out of 15 species tried were superior to guinea grass in quality and Brachiaria ramosa followed by Eleusine indica were the best among all the grasses.

24. Plant height, leaf stem ratio, root characters, chlorophyll content and nutrient uptake showed high positive correlation with green and dry fodder yields and protein yield.

Future line of work

In the present study, the survey was conducted only in the garden lands of Southern Kerala. An elaborate survey all over the State including uplands and low lands for the identification of the prominent species for fodder purpose would be more useful and meaningful.

Moreover, an elaborate study on the chemical composition of these grasses along with the digestibility trials in animals will help to gather additional information which will be more useful in animal feeding especially when the availability of green matter from cultivated fodder grasses is low in this state.

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APPENDIX - I

Weather data during the cropping period (February 1995 - December 1995)

Month	Temperature (°C)		Rainfall (mm)	Relative humidity (%)
	Maximum	Minimum		
February	31.98	23.14	-	72.54
March	32.74	23.73	5.00	71.48
April	32.44	24.89	137.40	76.50
May	31.52	24.84	365.20	78.32
June	30.15	24.43	228.60	84.08
July	28.85	23.91	143.70	82.16
August	29.16	24.06	58 80	83.68
September	29.50	24.05	83.50	86.27
October	30.52	24.05	113.90	79.10
November	30.41	23.40	246.30	81.19
December	31.50	20.03	-	81.32

EVALUATION OF NATURAL GRAMINACEOUS WEED FLORA IN SOUTH KERALA FOR FODDER PURPOSE

BY

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ABSTRACT OF THE THESIS
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ABSTRACT

An investigation was undertaken in the Southern districts of Kerala for the identification and evaluation of promising natural graminaceous weed species for fodder purpose. The experiment was conducted in two steps. In the first part, a survey was conducted to identify the prominent grass weeds of Thiruvananthapuram, Kollam and Pathanamthitta districts. In the three districts surveyed, perennial grasses predominated among the weed species. The prominent grass species identified were Panicum javanicum, Axonopus compressus, Cyrtococcum trigonum, Brachiaria ramosa, Panicum repens, Cynodon dactylon, Dactyloctenium aegyptium, Eleusine indica, Echinochloa colonum, Chloris barbata, Rhynchelytrum repens, Sporobolus indicus and Eragrostis tenella.

Qualitative and quantitative comparison of the selected 15 grass species with guinea grass cv. Hamil constituted the second part of the study. This was conducted at the Instructional Farm attached to the College of Agriculture, Vellayani in micro plots of 1 m^2 area and was laid out in Randomised Block Design with three replications.

Guinea grass was found to be superior to the indigenous species in terms of growth characters and green and dry fodder yields. Among the indigenous species, highest green fodder yield

was recorded by Panicum javanicum and dry fodder yield by Rhynchelytrum repens. The protein content of grass species varied from 5.84 to 15.00 per cent and Dactyloctenium aegyptium recorded the highest protein content. Guinea grass gave the highest protein yield owing to high dry matter production. Variation in crude fibre, ash, nitrogen, phosphorus, potassium, calcium, magnesium, copper, zinc and manganese contents was also observed among grasses. In the case of K : (Ca + Mg) ratio, all the 15 grass species recorded higher values than the reported critical value of 2.2. Ca : P ratio was within the safe limits.

In all the species studied, the anti-nutritional factors like tannin and oxalate were well below the toxicity levels. Content of HCN and heavy metals could not be detected in any of the species tried. Nutrient uptake also showed variation and guinea grass recorded the maximum.

The quality index developed on the basis of nutritional and anti-nutritional factors of different grasses revealed that out of 15 indigenous grass species tried, five were found superior to guinea grass in quality. Brachiaria ramosa and Eleusine indica were observed to be the best.