SEED PRODUCTION POTENTIAL OF GUINEA GRASS (*Panicum maximum* Jacq.) cv RIVERS DALE UNDER DIFFERENT MANAGEMENT TECHNIQUES

By

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THESIS

Submitted in partial fulfilment of the requirement for the degree

Master of Science in Agriculture

Faculty of Agriculture
Kerala Agricultural University

Department of Agronomy
COLLEGE OF HORTICULTURE
Vellanikkara - Thrissur

1993

DECLARATION

I hereby declare that the thesis, entitled **Seed production potential of Guinea grass (panicum maximum Jacq.) cv Riversdale under different management techniques** 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 any other similar title, of any other University or Society.

Vellanikkara,
27-9-1993

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CERTIFICATE

Certified that the thesis entitled **Seed production potential of Guinea grass (panicum maximum Jacq.) cv Riversdale under different management techniques** is a bonafide record of research work done independently by Sri. Krishnan, K. under my guidance and supervision and that it has not previously formed the basis for the award of any degree, diploma, fellowship or associateship to him.

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ACKNOWLEDGEMENT

It is a matter of grate privilege and pleasure to record my deep sense of gratitude and heart-felt thanks to Dr. E. Tajuddin, Professor and Head, Department of Agronomy and chairman of advisory committee for his personal attention, keen interest, constant inspiration and valuable guidance during the course of this work and preparation of the thesis. My sincere heart-felt gratitude ever remains with him.

I extend my sincere thanks to Sri. P. Girijavallabhan, Co-ordinator, Kerala Livestock Development Board and co-chairman of advisory committee for his timely help and valuable suggestions at every stage of this investigation.

My gratefulness and obligation go to Dr. G. Raghavan Pillai, Professor of Agronomy, College of Agriculture, Vellayani and member of advisory committee who was even ready to extent his help and assistance at different periods of this study.

My profound gratitude is due to Dr. Sudhakara, Associate Professor of College of Forestry, Vellanikkara and member of advisory committee for his timely help and valuable suggestions at every stage of this investigation and preparation of the thesis inspite of his busy schedule.

I am extremely grateful to Sri. V.K.G. Unnithan, Associate Professor, Department of Agriculture Statistics, College of Horticulture for his sincere help and guidance in the formulation of data for statistical analysis which contributed much towards the completion of the work.

I extend my sincere thanks to Sri. K.P. Dhamu, Associate Professor (Senior), Department of Statistics, Tamilnadu Agricultural University for his whole hearted support and co-operation extended to me in the statistical analysis and interpretation of the data.

I take this opportunity to extend my sincere thanks to Dr. Neelakantan Potty, Professor of Agronomy, Dr. M. Abdul Salam, Associate Professor of Agronomy, Dr. P.K. Asokan, Associate Professor, College of Forestry and Dr. M.A.Hassan, Associate Professor, Department of Soil Science and Agriculture Chemistry, College of Horticulture for their help and valuable suggestions which contributed much in completing the work.

I am also thankful to Sri. Purushothaman Nair, Associate Professor, Water Management Research Centre, Vellanikkara for his sincere help, guidance and inspiring suggestions, during the entire period of research. I am extremely glad to record here that I could really enjoy his company as my roommate in the hostel.

I am very much indebted and grateful to all the staff members of Department of Agronomy for their sincere and wholehearted co-operation throughout.

It is with immense pleasure that I thank the staff members of the farm unit of Kerala Livestock Development Board, and in particular Sri. K.J. Chacko and Smt. M.N. Suseela, Seed Testing Laboratory who have put in a helping hand in this tenure.

Assistance and co-operation rendered by the labourers in conducting the field equipment are gratefully acknowledged.

My profound sense of gratitude is due to Sri. H. Mariappan, Co-ordinator and Sri. Cyril Pereiro, Manager (F.D) for their help and support rendered at various stages of the study.

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I am very much indebted and grateful to the Managing Director and members of the Board of Kerala Livestock Development for my deputation for the M.Sc. (Ag) programme and the facilities provided for the conduct of experiment at farm unit, K.L.D. Board, Dhoni, Palakkad.

It is with a great pleasure, I thank M/s Blaise Computer Consultancy, Mannuthy for their prompt and neat execution of the typing work.

I wish to record my appreciation of the co-operation and encouragement given by my wife and relatives during my studies.

Last but least, I bow my head before Almighty whose blessings enable me to complete this venture successfully.

KRISHNAN, K.

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To my wife

Introduction

INTRODUCTION

Livestock rearing, an important occupation of the farmers plays a vital role in Indian Agriculture. However, the low productivity of livestock is a matter of concern, which is mainly due to the poor fodder and feed resources. Nutritious, balanced and adequate feeding of animals is a major requirement for the livestock production in the country.

The forages are the main stay of animal production. The dry and green fodder requirements in the year 1985 was estimated to be 780 and 932 mt respectively, against the estimated availability of 441 and 250 mt respectively. Overall, the present availability of animal feeds and fodder is estimated to be 40 per cent of the requirement (ICAR, 1989). Kerala has a cattle wealth of 35.3 lakhs adult units and the dry matter availability is estimated to be 40 lakhs tonnes as against the requirement of 67.6 lakh tonnes per year. The gap between the availability and requirement thus estimated to be 27.6 lakhs tonnes (Anon., 1989). In Dairy production, the expenditure towards feed constitute about 60-65 per cent of the total cost of milk production (Von Sury, 1987 and ICAR, 1989). The country has about 4 per cent of the cultivated area under cultivated forages. About 25 per cent of the country's land area offers varied degree of grazing resources to the animals. These constitute mainly natural grasslands including barren and uncultivated lands, permanent pastures, grazing lands and cultivable wastes and degraded forests. The opportunities for increasing this area for cultivated forages are remote because of preferential need for human food. However, possibility exists for improved land productivity through appropriate management practices (ICAR, 1989).

Primary factor which is coming in the way of popularisation of the fodder crops is the non-availability of good quality seed of high yielding varieties. Efforts have to be intensified in developing suitable techniques for forage seed production. More widespread use of improved varieties of forages depends on the continuous availability of seed planting materials which is true to type, free from weeds, inexpensive to obtain and which will successfully establish good pastures when planted.

Many of the tropical forage plants are relatively wild plants which have not been domesticated and rigorously selected for good seed production characteristics. Too often plant breeders and agronomists have concentrated on improving vegetative growth and nutritive value and hence given little attention to the ease of seed production which will determine how widely the new tropical variety is used by the farmer. However in the last three decades great progress has been made in improving the crop husbandry of tropical forages to give higher seed yield and better seed quality. Loch (1991) reported that herbage seed production in the tropics has shorter history and is at an earlier and less sophisticated stage of development than in temperate areas. Most of the tropical forage crops were developed within the last 30 years and new to agriculture and retain wild characteristics that interfere with commercial seed production. Almost all are perennials and comprise wide variety of growth habits. Australia has the largest history of production in the tropics and produces the greatest diversity of herbage seeds particularly legumes. Other major producing countries include Brazil, Thailand, India, Kenya and Zimbabwe. The available technology for tropical herbage seed production is now being advanced through research in Australia and several other countries developing better understanding of the flowering behaviour of such cultivar is important, since this helps to determine where to grow seed crops and how to manage them for maximum seed production.

Guinea grass (*Panicum maximum* Jacq.) is a native of tropical Africa extending to the subtropics of South Africa. Guinea grass is a very variable species and large number of distinct types occur naturally in Africa and about a dozen botanical varieties have been named. In India however where it was first introduced in 1793, it became one of the important fodder grass. Panicum maximum can be established either by seed or vegetatively by tuft splits (Bogdan, 1977).

Guinea grass is one of the most promising perennial fodder crop (pasture grass) popularised among farmers. Preliminary studies conducted by Kerala Livestock Development Board (Indo-swiss Project) have indicated that the cultivar Riversdale is a promising variety of guinea grass suited to the soil and climatic conditions of Kerala (Anon., 1984). It is a high yielding variety with high degree of tolerance to drought conditions.

Guinea grass cv Riversdale was selected as a pure and uniform line of the widespread and widely used "common" guinea grass which was the most widely planted grass in the west tropics of northern Australia. But as it had been introduced before 1900, its samples had become somewhat eviable and were often contaminated with a weedy unpalatable form of coarse guinea. To provide an evenline, for modern seed production techniques, a selection programme by the Queensland Department of Primary Industries resulted in the release of cv Riversdale by the Queensland Herbage Plant Liaison Committee in 1975 (Cameron, 1987).

Eventhough advancement has been made in the genetic improvement of livestock in Kerala, not much care has been taken for the development of feeds and fodder resources for the livestock. Many reasons are attributed to this. One of the reasons is the production and availability of good quality seeds in proper time. The principal agency for production and distribution of seeds of fodder crops in Kerala is the Kerala Livestock Development Board. Even this agency is not in a position to cater the needs of this state yet. The technical information on the Agronomy of forage seed production under the agroclimatic conditions of the state is also very rare or scarce. With this background, the present study was taken up with the following objectives.

To find out the optimum time of cutting to obtain maximum production of seed,

to find out the optimum time of seed collection, and

to find out optimum level of nitrogen, phosphorus and potassium to get maximum seed yield.

Review of Literature

REVIEW OF LITERATURE

Scientific efforts have been made in the past to evaluate production potential of fodder crops. Too often plant breeders and agronomists have concentrated on improving vegetative growth and nutritive value of forage crops. Very little attention has been given to the task of seed production which will determine how widely the new tropical variety is used by the farmers. However, in the last three decades great progress has been made in improving the crop husbandry of tropical forages to give higher seed yields and better seed quality (Humpbreys, 1979).

An investigation was conducted to find out the seed production potential of most promising forage crop, Guinea grass cv Riversdale under different management technique involving cutting management, stages of seed collection and varying levels of N, P, K.

Seed production studies on Guinea grass (*Panicum maximum* Jacq) is meagre and limited. A brief review of work done on this grass and on other pasture species to evaluate the fodder and seed production potential is presented.

2.1. Herbage yields

Crowder *et al.* (1970) reported that in Colombia well fertilized and irrigated *Panicum maximum* can produce 40-50 t

DM/ha. In India a yield of 226 t fresh herbage/ha/year in 12 cuts was recorded for the sewage irrigated grass (Narayanan and Dabadghao, 1972). In Puerto Rico 46.72 t DM/ha were recorded for a crop given about 900 kg N/ha and in other trials over 35 t/ha (Little et al., 1959; Vicente-Chandler et al., 1959). Fairly high yields were also obtained in Thailand 20 t DM/ha/year in the first two years of growth when the grass was well fertilized with NPK and irrigated during the dry season (Holm, 1972). Lower yields were obtained by Borget (1966) in French Guiana, 14.4 t DM/ha, but more realistic yields range mostly between 4 and 12 t DM/ha or between 15 and 50 t fresh herbage and can sometimes be still lower. The yields depend on the cultivar, soil fertility, the fertilizers applied, the rainfall and management.

Guinea grass when grown at College of Agriculture, Vellayani as a sole crop, could produce 8.37 t of green fodder and 1.52 t/ha of dry fodder from a single cut (Krishnaraj, 1976). Chandini and Raghavan Pillai (1980) reported that guinea grass produced 8.74, 11.191 and 5.16 t/ha of green fodder from the Ist, 2nd and 3rd cuts respectively. Guinea grass cv Makueni when grown in the same condition could produce as much as 46 tonnes of fresh fodder (15 t/ha of dry fodder) in 5 cuts (Anon., 1983).

Raghavan Pillai (1986) reported that guinea grass produced 7.55 t/ha of dry fodder from three cuts.

2.2. Leaf/stem ratio

Leaf/stem ratio indicates the general succulency of herbage. A ratio above (1.00) indicates more succulence. Thangamuthu _et al_. (1974) recorded lack of response of nitrogen on leaf stem ratio of grasses. Leaf stem ratio of guinea grass was reported to range from 2.35 to 2.59 according to Chandini (1980).

2.3. Protein content

Gomide _et al_. (1969) reported that crude protein content of guinea grass decreased with advancement of age. According to Krishnaraj (1976) guinea grass yielding 8.3 t of fresh fodder could produce 195.5 kg/ha of crude protein. In a similar study Chandini and Raghavan Pillai (1980) obtained 277.5 kg/ha of crude protein from a crop yielding 25.8 t/ha of fresh fodder in three cuts.

2.4. Effect of establishment methods on seed yield

Seed yield of guinea grass varied with the method of establishment. Sarroca _et al_. (1980) observed that guinea grass cv Likoni planted at a spacing of 60 cm and 100 cm apart gave a seed yield of 93 kg and 141.8 kg respectively. Lawrance (1980) found that the optimum row spacing of highest seed production was 120 cm for *Elymus angustus* cv Altai.

Sarroca and Concepcion (1981) found that guine grass sown at a distance of 100 cm between plants gave 11 and 26 per cent more yield than those given by 30 and 60 cm spacing respectively.

The effect of row spacing, sowing rate on seed yield in *Lolium perenne* was investigated for four years under dryland conditions at Ankara, Turkey by Acikoz and Karagoz (1989). They observed that sowing rates 10, 20, 30 kg/ha did not affect seed yield or their characteristics. Row spacing significantly affected seed yield.

Hare *et al.* (1989) reported that *Bromus willdenowii* (*B. catharticus*) cv Grass land yielded 36 per cent more yield in drilled plots than yield from broad cast sown plots.

In a field trial at Sopetran Antioguia, Colombia, *Panicum maximum* CIAT 673 and *Andropogon gayanus* CIAT 6053 recorded a seed yield of 0.25 t and 0.29 t of classified seed/ha respectively (Osorio *et al.*, 1991).

Hare (1992) studied the effect of time of establishment on seed production of Grassland Rou' Tallfescue (*Festuca arundinacea*). The crop recorded a seed yield of 2.91-3.69 t/ha when sown during October-February and decreasing to 0.94 t/ha after April sowing. Early sowing gave higher seed yields by allowing more time for tiller production before winter.

2.5. Effect of defoliation on seed yield

The effect of defoliation on plant growth and reproduction are not well understood. Defoliation is always characterised by its frequency and severity, and by its timing in relation to development stage or environmental conditions (Humphreys, 1979).

Effect of cutting frequency on seed production of Buffel grass cv Biloda and Formidable was studied by Gomez *et al*. (1978) and found that maximum seed yield/cut was obtained in October-November for both cultivars. Hebblethwaite and Clemence (1981) reported that autumn defoliation of *Lolium perenne* in two years had no significant effect on seed yield.

Burning increased the seed yield of *Andropogon gayanus* (CIAT, 1982). Burning or cutting without or with removal of aftermath gave similar yield which tended to decrease with increasing stand age.

Monteiro <u>et</u> <u>al</u>. (1984) observed that when Guinea grass (<u>Panicum</u> <u>maximum</u>) sown on 28th October (1976) was cut on 31st January, 14th February, 28th February and 14th March 1977 and harvested for seed from 10 to 20th May, ie. 35 days after initial panicle emergence found that apart from panicle length all seed yield components were affected by cutting date. Yield of pure viable seed was highest at 44 kg//ha when cutting took place in 14th February.

Ward <u>et</u> <u>al</u>. (1984) reported that seed yield of Tallfescue was reduced by defoliation later than 1st December and further reduction resulted from defoliation made after 15th March. Seed quality declined with defoliation made after 1st April.

Management of the post harvest residues of seed crops of <u>Brachiaria</u> <u>decumbens</u> cv Basilisk at Mt Gatton, South eastern Queensland was studied by Stur and Humphreys (1985). They found that cutting and burning with moderate fuel load gave similar seed yields but a higher fuel load decreased seed yield. Fire duration decreased tiller and inflorescence density and seed yield.

Sangakkara (1990) has reported that defoliation and increasing nitrogen rates in Panicum maximum increased the number of tillers/plant and the percentage of effective tillers. The defoliation and nitrogen treatments has no significant effect on number of tillers/receme or 1000 seed weight. Two defoliations 4 and 8 weeks after establishment in combinations with 150-200 N kg/ha produced an approximately two fold increase in yield.

Lombardo and Tuttobene (1988) opined that forage cut reduced the number of seeds/panicle and spikelets/panicle particularly if the reproductive apex was damaged or removed, based on the study on the effects of cuttings of Festuca and Dactylis glomerata for forages. Reduction of productive potential after first year indicated that only plants in their first year should be used for seed production.

Thompson and Clark (1989) observed that stubble removal of Poa pratensis cv Nugget after seed harvest and application of 0-1 kg N/ha and 50 kg P/ha has increased seed yield. Stubble cutting increased panicle density and harvest index and reduced panicle weight, shoot height and hay yield.

In a study by Reis and Garcia (1989) on the effect of cutting on seed production in *Brachiaria decumbens*, observed that cutting once did not affect number of inflorescences/ unit area whereas cutting two or three times gave a significant reduction. Cutting had no significant effect on number of spikelet/racemes or number of spikes in flower.

Springer and Taliaferro (1989) reported that harvest frequencies in *Cyanadon dactylon* had a significant inverse effect on forage DM yield associated with seed crop each year.

In a field study by Garcia *et al*. (1989), Molasses grass (*Mellinis minutiflora* subjected to five intervals of cutting and seed was harvested 20, 25, 30 and 35 dates after floral initiation. Seed yield was highest when swards were cut in January and seed was harvested 35 days after floral initiation and was lowest with cutting in March and seed harvesting 20 days after floral initiation. Yields were low with 2 cuts.

In a similar study with *Brachiaria decumbens*, Garcia *et al*. (1989) found that the number of inflorescence/m^2, branches/inflorescence and pure seed yield were greater with application of N 112 kg/ha and with two cuts. The percentage of pure seed was greater with two cuts than without cutting.

Peres *et al*. (1990) found that in *Panicum maximum* cv Likoni the total seed yield ranged from 40 kg without cutting to 749 kg/ha with cutting at 25 cm in the first year and from 40 kg (cutting to 35 cm) to 84 kg (cutting to 50 cm) in the second year. The total number of reproductive stem was greatest without cutting in both years.

Buffel grass *Cenchrus ciliaris* cv Gayandah were subjected to different cutting time and seeds were collected at different intervals in a field study by Garcia *et al*. (1990). Seed yield/plot was highest without cutting at each harvesting date.

2.6. Effect of fertilizer on grass seed crop

Fertilizer practice which gives good vegetative growth of tropical pastures, will usually give high seed yields if the progress of the crop to maturity is not interrupted by drought or frost. The use of high levels of fertilizer is usually economical for pasture seed crops. Literature on the influence of various fertilizers on seed production of tropical pasture crops are few and limited.

2.6.1. Influence of nitrogen on seed production

Nitrogen availability is a dominant factor controlling the rates of the various processes which result in seed production. Positive responses to nitrogen have now been recorded in many tropical grass seed crops (Black 1957).

An experiment by Boonman (1972) on the effect of nitrogen and row width on seed crops of *Setaria sphacelata* illustrated the dependence of optimum density upon fertility level as exemplified by nitrogen supply. 90 cm row spacing gave highest seed yield at low nitrogen level (no fertilizer during first year and 65 kg N/ha/crop subsequently). At medium nitrogen supply (130 kg N/ha/crop) 30 cm spacing was optimal. At high levels of N supply no additional seed was produced in close spaced treatments and less seed was harvested at wide spacing (90 cm).

Chadhokar and Humphreys (1973) studied the influence of time and level of urea application on seed production of Paspalum and opined that response to nitrogen was much less in the year of establishment and higher in the succeeding years.

In a field study Bilbao *et al*. (1979) applied different levels of nitrogen at 0, 10 and 20 days after cutting of

Cenchrus ciliaris L. cv Bioloela and seeds were harvested 45 and 65 days after cutting respectively. Number of panicles per hectare were similar when N was applied immediately after cutting. The number of seeds/panicle increased significantly with increase in lateness of N application. Panicle production/ha increased with N rate but later had no effect on panicle length. Nitrogen rate had no significant effect on percentage of panicles.

Febles *et al*. (1982) reported that seed yield of common guinea grass (*Panicum maximum*) was not significantly increased by application of 50 or 100 kg N/ha 40 days after cutting when compared with untreated control. Highest pure seed yield of 150 kg/ha were obtained with application of 100 kg N/ha every 20 days after cutting. In the second year, seed production was highest with application of 200 kg N/ha in August-October.

In a field trial Gaborcik (1983) applied different levels of nitrogen after taking a cut of *Dactylis glomerata* and found that rates of N 120-150 kg/ha were economically efficient if subsequent herbage yields were included. Nitrogen use efficiency was highest at 60 kg/ha.

Janqueira *et al*. (1985) studied the effect of nitrogen application on seed production of *Andropogon gayanus* var.

bisquamulatus cv planaltina and found positive response to time of nitrogen application and nitrogen rates were not significant. Number of vegetative tillers increased linearly with increasing N. Reproductive and vegetative tiller numbers decreased linearly with time.

Rates of N fertilizer were investigated in Phleum pratense grown for seed by Torskene (1986) and found that autumn application had no significant effect. Nitrogen upto 60 kg/ha applied in spring was recommended for practical seed growing.

Seed yield in Tallfescue varies with seasons at different rates of nitrogen application (Hare and Rolston, 1990).

Dwivedi et al. (1991) reported varietal response of setaria to fertilizer on seed yield and its attributes. Dry matter crude protein and seed yields were highest in cv Nand. Yields increased upto 80 kg N/ha.

In irrigated field trial Tallfescue (Festuca arundinacea) gave highest seed yield of 333 kg/ha with 80 kg N in autumn and no nitrogen in spring. Highest herbage yield of 5.98 t/ha was obtained with 80 kg N in autumn + 40 kg in spring. Plant height and seed weight/panicle were not increased by N application (Gokkus and Serin, 1991).

2.6.1.1. Influence of nitrogen on seed yield attributes

Nitrogen fertilizer increased some yield components and decreased others in all detailed studies of tropical pasture response. The timing and level of fertilizer application and the cultivar used determine which components are increased. In a study by Cameron and Humphreys (1976) seed yield of Paspalum plicatulum averaged 60, 301 and 361 kg/ha when fertilized with 0, 100 and 400 kg N/ha respectively. Nitrogen application increased tiller density, tiller fertility and the raceme number on the individual inflorescence and decreased percent tiller survival. Raceme length and individual seed weight and seed density per unit raceme length were not varied significantly.

2.6.1.2. Response to nitrogen as affected by age of stand

First year stands are less responsive to nitrogen application than older stands. This was demonstrated for Setaria anceps and Chloris gayana by Boonman (1972 a, b) who found no increase in optimum nitrogen level after second year. Chadhokar and Humphreys (1973) found much less response to nitrogen in first year than the succeeding year in Paspalum plicatulum seed yield.

2.6.1.3. Effect of nitrogen on seed quality

It is not possible to predict safely the effect of high nitrogen application on seed quality. Boonman (1972 a, b) has noted a negative association for Setaria anceps and Chloris gayana but positive effects have been recorded by Bahnisch (1975). Cameron and Mullay (1969) for Cenchrus ciliaris and Grof (1969) for Brachiaria mutica found seed quality not consistently related to nitrogen level.

2.6.2. Effect of phosphorus on seed yield

Phosphorus deficiency is common and is almost universally associated with delayed flowering. On red-yellow podzolic soils in South eastern Queensland improved phosphorus supply of 80 kg P/ha plus 20 kg P/ha as annual maintenance increased the inflorescence density of Desmodium uncinatum which resulted in a 35 per cent rise in seed yield (Nicolls et al., 1973). Inflorescence density in Stylosanthes humilis was also positively related to phosphorus addition (Shelton and Humphreys, 1971). This increased seed yield by 20 per cent under conditions where phosphorus addition increased yield of plant tops by 54 per cent. The importance of phosphorus nutrition is often stressed more for the early phases of growth than for the later development stages. Stylosanthes humilis showed remarkable capacity to transfer phosphorus from leaf and other tissues to meet the requirements of the developing seed (Robinson and Jones, 1972). Very little informations are available on the effects of fertilizer on grass seed production. Ayerza (1980) reported that buffel grass cv Texas 4464 given 0, 40, 80 or 120 kg P_2O_5/ha gave seed yields of 82.5, 91.0, 173.1 and 257.5 k/ha on a high phosphate soil.

2.6.3. Effect of potassium on seed yield

Potassium being a mobile nutrient is easily lost from the soil profile, and frequent application is needed. Removal of plant residues from the field after seed harvest will quickly induce potassium deficiency especially in the case of *Setaria anceps*. This practice requires high levels of potassium fertilizer application. Setaria has a high requirement for potassium, the critical concentration in plant tops lying over one percent. It is important that phosphorus, sulphur and potassium remain in balance if a seed crop receives high nitrogen usage (Humphreys, 1979).

Effect of NPK on seed yield

Kern and Baryla (1983) studied the effect of different mineral fertilizer application rates on seed yield of

Cocksfoot grass. Seed yields were highest (750 kg/ha) with 200 kg N + 100 kg P_2O_5.

In a field trial at Jaboticabal in 1981-82 Paspalum notatum was given 5 g N, 50 g P_2O_5, 15 g K_2O, 200 g dolomite lime and 10 g horse manure/m^2 alone and in all possible combinations. Seeds were harvested in December, 1981 and April, 1982. Seed quality and quantity were found affected by mineral nutrition (Dematte et al., 1987).

Satjipanon et al. (1989) in a field experiment at Chiang-Yern Animal Nutrition station, Thailand in a Brachiaria ruziziensis pasture given 0-48 kg N/ha, 0-24 kg P/ha and 0-15 kg K/ha were cut 70 days after sowing and seed was harvested at 160 days after sowing. Fertilizer application showed no effect on seed quality. Maximum seed yield of 531 kg/ha was obtained with application of 16 and 20 kg N and P respectively.

Mahler and Elsign (1989) evaluated the effect of N, P, S and B fertilization of Kentucky blue grass and they found excellent relationship between percentage of maximum seed production and the sum of inorganic soil N and applied fertilizer N. Application of 30 kg P_2O_5 increased seed yield by 10.0-51.6 per cent compared with control. Application of 15 kg SO_4-S increased seed yield by 12.6-

107.3 per cent. Boron application had no effect on seed yield.

2.7. Seed production components

2.7.1. Varietal responses to seed yield

The responsiveness of the seed crop to seed yield differ with varieties. Patil and Singh (1963) reported that percentage of seed set in *Cenchrus setegerus* varied from 8 to 61 according to line. Characteristic such as high seed density, grain filling and maturation are closely dependent up on current photosynthesis.

Hacker and Jones (1971) found that one line of *Setaria anceps* (CPI 32930) showed a quadratic response to nitrogen and in other line, better introduction CPI 33452 continued to respond linearly to higher levels.

Boonman and Vanwijk (1973) found considerable variation in the seed production of clones of *Setaria anceps*. Viable seeds formed per head varied from 17.9 in three selected lines to 9.8 for the average of 18 clones.

2.7.2. Effect of tiller age on seed yield

Chadhokar and Humphreys (1973a) illustrated the effect of first year crop of *Paspalum plicatulum* cv Rodd's Bay grown at a density of 67 plants/m^2. In this particular crop floral initiation occurred about 93 days after seedling emergence. The main tillering activity occurred early and 50 days after seedling emergence. Ninety three per cent of the tillers had appeared accounting for 95 per cent of the subsequent seed yield. In this well grown crop, the survival of tillers to seed maturation varied from 100 per cent for the main apex to only 40 per cent for the class of tillers which appeared 41-50 days after seedling emergence, but there was less variation in the fertility of the surviving tillers.

2.7.3. Time of flower initiation in relation to seed production

Nascimento Junior and Kneebone (1979) studied the effect of flower initiation on some components of seed yield. About 20 stems were labelled at weekly intervals at boot stage and harvested individually. Seed production parameters included stem length, panicle length, number of seeds and of floret/panicle and seed set percentages. There were significant difference between date of labelling and all characteristics studied with exception of number of florets and seeds per panicle. The highest seed set was observed in mid season. Number of floret/panicle remained fairly constant throughout the sampling period.

2.7.4. Effect of seedling emergence and plant density on seed yield

Hopkinson and English (1982) reported that variation in rate of seedling emergence and final density was shown to affect seed yield far more strongly than duration of anthesis and seed set.

2.7.5. Effect of nitrogen fertilizer and date of harvest on seed yield components

Mecelis and Oliveira (1984) studied the effect of nitrogen fertilizer and date of harvest on Brachiaria humidicola and they observed that N application significantly increased DM production, total number of tillers/m^2, number of fertile tillers/m^2, number of branches/inflorescence, length of each branch, number of caryopsis/branch, seed weight, pure seed production and germination. There was a significant interaction between harvest date and N application for seed weight, seed production and germination. Seed production was positively correlated with total tiller number, percentage of fertile tillers and number of caryopsis/branch. Only 18.1-24.7 per cent of the spikelet contributed to pure seed production in the best harvest. There was an increment of 3.4 g of pure seed per each 1 g of N applied.

2.7.6. Floret fertility and seed yield

Gangi (1984) investigated the rate and date of N application at different growth stages on potential and actual seed yield and floret fertility in *Lolium perenne*. Nitrogen application increased seed yield potential by increasing the number of fertile tillers/unit area and the number of florets/spikelet. Rate and date of N application had no significant effect on reproduction. Percentage floret fertility declined during development from 61 to 20-32. Floret fertility was slightly lower at the tip than in the middle or the bottom of the ear. Cv Linn. showed a higher floret filling than cv pennfire.

2.7.7. Effect of development phases of panicles on production and quality of seeds

Gonzalez and Torriente (1989) studied the developmental phases of panicle of guinea grass cv Likoni and the effect on production and quality of seed. *Pamicum maximum* cv. Likoni sown in October 1980 and harvested for seed at different period with ten developmental phases from full flag leaf emergence to empty panicle. For the seed harvest at March-April the highest yield of total seed/panicle (384 mg) and fertile seed/ panicle (213 mg) were obtained 15 days after full flag leaf appearance. Corresponding figures for

July-August were 463 mg, 108 mg and 23 days and for October-November 317 mg, 127 mg 13 days.

2.7.8. Effect of seed harvesting time on seed yield

Judging the correct harvesting time has peculiar difficulty for tropical pattern seed crops. The uncertainties of weather during harvesting, poor synchronization of flowering and rapid seed shattering concern all seed producers. Studies made on the effect of harvest date on seed production is reviewed here under.

Oliveira and Mastrocola (1980) reported that optimum harvest date was considered to be between the 4th and 6th week after beginning of flowering to combine the higher seed yield with high viability and percentage purity.

Gonçalvez *et al*. (1980) observed that seed collections on 14th February, 24th February, 25th April, 5th May were considered the best and produced highest amount of viable seed/unit area in *Brachiaria decumbens* field sown in 1976 and harvested in 1977 at 10 days interval.

In a field trial Bilbao and Matias (1980) obtained 263.5 kg and 138.3 kg/ha during two consecutive years 8 weeks after last cut. The best date for seed harvest was in November and worst in March for *Chlorisgayana* cv callide.

Judging seed harvest time of Green panic and Kazungula setaria in relation to the characteristic of head borne on the tillers developed at different times was studied by Nishihira and Nishimura (1982). In green panic most fertile tillers developed before 2nd July while in Setaria anceps cv Kazungula they developed before July. Head length and seed weight depend on heading time than tillering date in the case of green panic but for Kazungula setaria, heading time and tillering dates were affected head length and seed weight/head.

Breazu (1984) observed that seed moisture content decreased from the 20th days after completion of the flowering from 45-50 per cent of Dactylis glomerata and Phleum pratense to 55-60 per cent Lolium perenne were cut at 25-30 days after flowering when seed moisture content level reached 45-33 per cent.

In a field trial Luiz and Murant (1984) observed that seed shedding in Phalaris tuberosa began 19-22 days after anthesis and mean daily loss and 3.5 per cent. At 40 days after anthesis 25 per cent of seeds were retained. Maximum germination percentage and 1000 seed weight occurred 34 days after anthesis optimum production found at 19-22 days after anthesis.

The interval from 17.5 to 24.5 days was considered the optimum period for harvesting for *Paspalum guenoarum* Arest. cv. Azulao (Pinto and Nabinger, 1984).

Janqueira *et al*. (1985) studied the effect nitrogen fertilizer and harvest on *Setaria sphacelata* seed production and they reported the optimum harvest date was 29-36 days from the beginning of flowering.

Tuttobene and Cavallaro (1988) opined that seed shedding in *Dactylis glomerata* cv Dora and *Festuca arundinacea* cv Festal began quite early and preceded peak seed production (25 days after anthesis). Highest seed shedding occurred at 35 days after anthesis in *Festuca arundinacea* and 45 days after anthesis in *Dactylis glomerata* and amounted to 18 and 41 per cent of maximum seed production respectively.

2.7.7. Physiological maturity of grass seed

Physiological maturity of seeds of *Andropogon gayanus* var bisquamulatus was studied by Conde *et al*. (1984). The crop was cut 7 times 20-21 days after inflorescence emergence and seed yield measured. Yield increased from 169.1 kg at 20 days to 339.3 kg at 38 days and then decreased to 21.4 kg at 56 days. Production of pure viable seed was highest at 32 and 38 days with 105 kg and 99.5 kg/ha respectively. Germination increased from 22 per cent at 20 days to 60 per cent at 32 days and decreased to 31 per cent at 56 days.

Boonman (1971) elucidated that seed yield of eight tropical grass varieties at Kitale, Kenya was best correlated with rate of head emergence in six week to harvest.

Germination of grass seeds

In most tropical grasses post harvest seed maturation is needed and in the first month after harvesting the germination can be poor. The best germination is usually observed in 6 to 12 month old seeds and then it declines first slowly and then faster. Compared to other grasses *Panicum maximum* germinate slowly (Bogdan, 1977).

Materials and Methods

MATERIALS AND METHODS

The present study was conducted to investigate the seed production potential of Guinea grass (Panicum maximum Jacq) cv Riversdale under different management techniques such as time of cutting before leaving the crop for seed, time of seed collection and optimum level of nitrogen, phosphorus and potassium fertilizers to obtain maximum yield of seed.

3.1. Experimental site

Field experiment was conducted at the Farm unit of Kerala Livestock Development Board, Dhoni, Palakkad.

3.2. Soil

Soil of experimental site was gravely clay loam.

Table 1. Physiochemical properties of soil

Mechanical composition

Constituents	Content	Method
Gravel (%)	12.00	Hydrometer method (Piper, 1942)
Coarse sand (%)	46.80	
Fine sand (%)	16.20	
Silt (%)	20.80	
Clay (%)	16.20	

(Contd....)

Chemical properties

Constituents	Content	Method
Organic carbon (%)	1.14	Walkley and Black method, (Piper,1942)
Available nitrogen (kg/ha)	370	Alkaline permanganate method (Subbiah and Asija, 1956)
Available phosphorus(kg/ha) (Bray Extract)	46.4	Cholorostannous reduced molybdophosphoric blue colour method (Jackson, 1958)
Exchangable potassium (kg/ha) (Neutral normal ammonium acetate extract)	436.8	Flame Photometric method (Jackson, 1958)
pH (1:2.5 soil water ratio)	5.5	pH meter (Jackson, 1958)

3.3. Season and climate

The experiment was initiated during the month of May 1992 and continued upto December 23rd, 1992. During this period the crop received a total rainfall of 2196 mm with 111 rainy days. Meteorological parameters like rainfall, maximum and minimum temperatures, number of rainy days were obtained from the meteorological observatory of Kerala Livestock Development Board farm unit, Dhoni, Palakkad. Average weekly values of the meteorological parameters were worked out and data presented in Appendix I and Fig.3a & 3b.

Fig.3a Weather data during crop period .

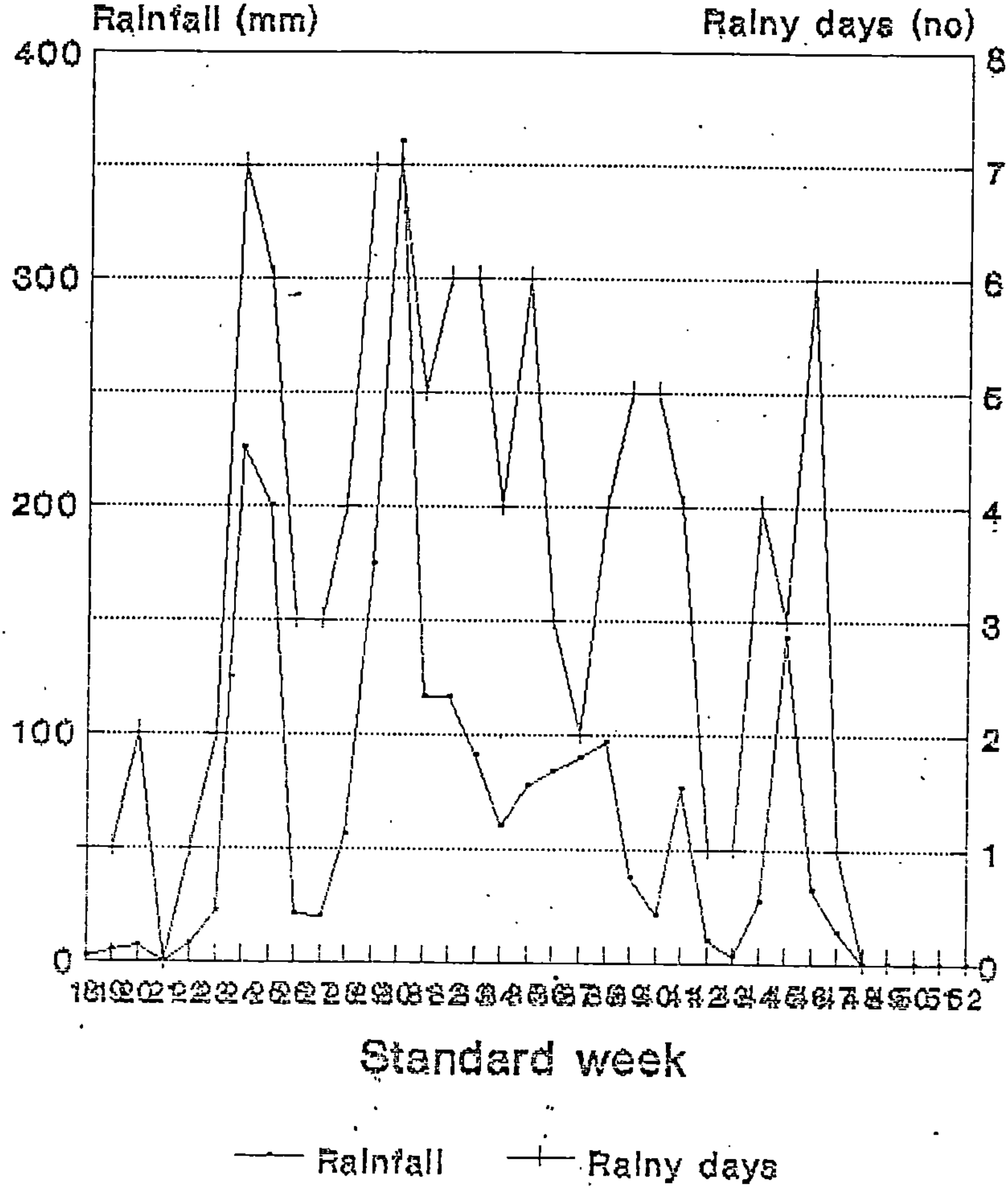
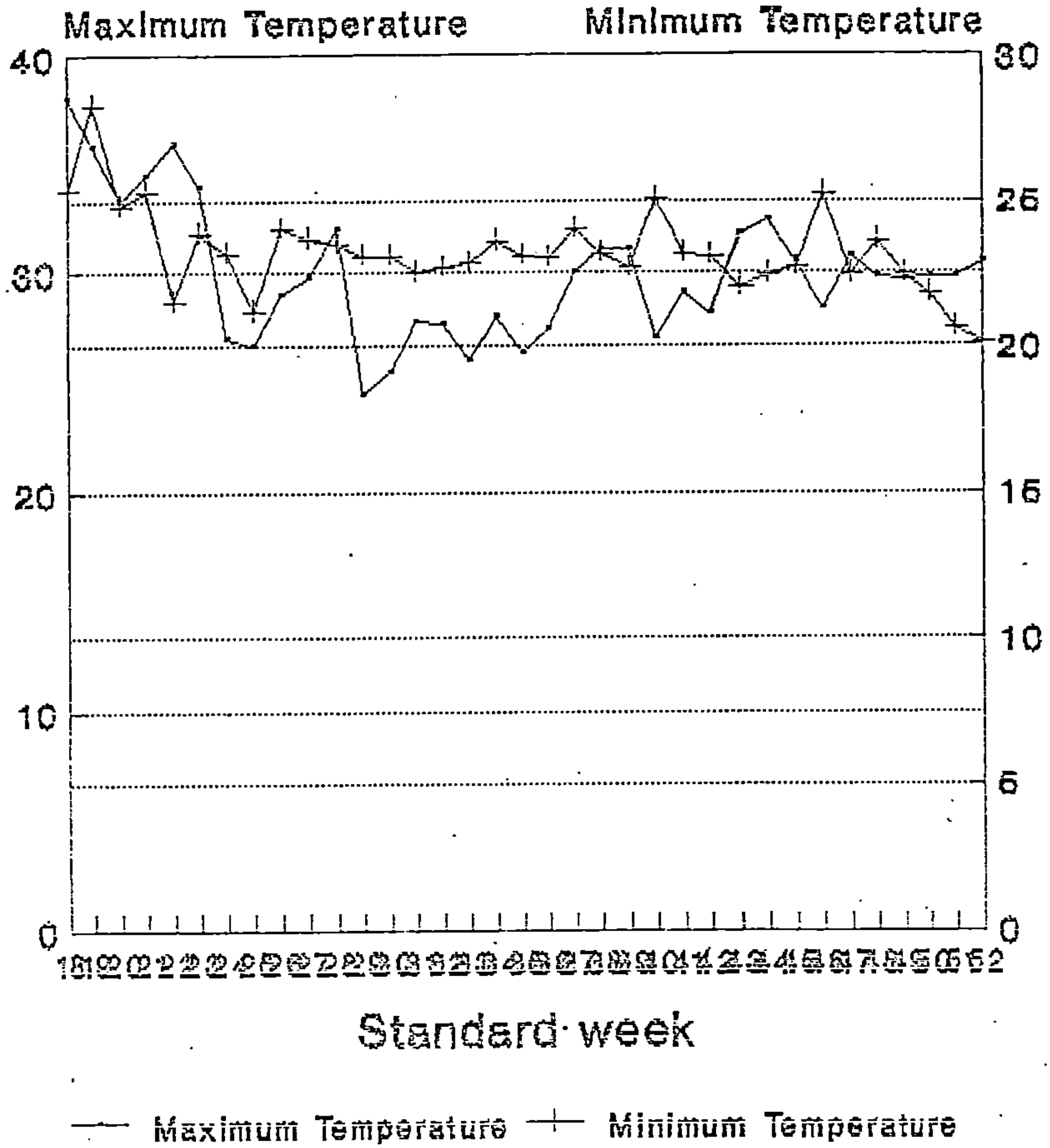


Fig.3b Weather data during crop period .



3.4. Crop history

The experimental area was cultivated with hybrid maize/fodder Jowar (Sorghum sp.) during the previous year with large quantity of organic manure. After jowar crop the land was under fallow for four months. During May 1992, the land was ploughed and prepared for laying out the experimental plots.

3.5. Crop and variety

Guinea grass (*Panicum maximum* Jacq) cv Riversdale received from KLD Board, Dhoni unit was used for the study. Nursery was established by sowing seeds during May 1992. Healthy seedlings from the nursery were transplanted 45 days after sowing in the experimental plots.

3.6. Fertilizers

Nitrogen, phosphorus and potassium were supplied through urea (45.6% N), Mussorie phosphate (24% P_2O_5) and muriate of potash (60% K_2O) respectively.

3.7. Experimental details

The study involved two experiments. The details are given below.

3.7.1. Experiment I

This was conducted to find out the optimum time of cutting and maturity stage of seed harvesting after emergence of panicle.

3.7.1.1. Cutting treatments

C_1 - Seed and crop residue cuts only. No fodder cut before leaving the crop for seed.

C_2 - One fodder cut and two subsequent seed and residue cut.

C_3 - Two fodder cuts and one seed and residue cut.

Fodder cuts were made 50 days after transplanting at a height of 15 cm above the ground level. Seed and residue cuts were made only after tagged panicles were removed as per schedule and when the panicle starts shedding seeds. For seed collection only earheads were cut and removed. Crop residue is cut at 15 cm above ground level.

3.7.1.2. Earhead collection intervals after panicle emergence

Treatment	Earhead collection intervals (days)
S_1	10
S_2	15
S_3	20
S_4	25
S_5	30

Fig. 1 PLAN OF LAY OUT EXPERIMENT I

T_6	T_2	T_8	T_{14}	T_7	T_7	T_3	T_8	T_{12}	T_{14}	T_8	T_4	T_9	T_{13}	T_5
T_4	T_{10}	T_{12}	T_5	T_{15}	T_5	T_{11}	T_{13}	T_6	T_1	T_6	T_{12}	T_{14}	T_7	T_2
T_1	T_9	T_7	T_{11}	T_3	T_2	T_{10}	T_9	T_{15}	T_{14}	T_3	T_{11}	T_{10}	T_1	T_{15}

REPLICATION 1 REPLICATION 2 REPLICATION 3

Plot size Gross _ 6m × 3.6m
Net _ 4.8 × 2.4m

Index
Bunds and Boarders
Drainage channel

3.7.1.3. Treatment combinations

T_1	C_1S_1	T_6	C_2S_1	T_{11}	C_3S_1
T_2	C_1S_2	T_7	C_2S_2	T_{12}	C_3S_2
T_3	C_1S_3	T_8	C_2S_3	T_{13}	C_3S_3
T_4	C_1S_4	T_9	C_2S_4	T_{14}	C_3S_4
T_5	C_1S_5	T_{10}	C_2S_5	T_{15}	C_3S_5

3.7.1.4. Design and layout

Number of replications	3
Number of treatments	15
Total number of plots	45

<u>Plot size</u>

Gross plot size	6m x 3.6 m
Net plot size	4.8 m x 2.4 m

Border row - One row of plants were left as border row all around the plot.

Details of layout are given in Fig. 1

3.7.2. <u>Experiment II</u>

This experiment was conducted to find out the optimum level of nitrogen, phosphorus and potassium to obtain maximum seed yield.

3.7.2.1. Treatments

Nutrients	Levels (kg/ha)		
Nitrogen	(N_o)	(N_1)	(N_2
	0	100	200
Phosphorus	(P_0)	(P_1)	(P_2)
	0	40	80
Potassium	(K_0)	(K_1)	(K_2)
	0	30	60

3.7.2.2. Treatment combinations

Replication I
(NPK confounded)

	Block I	Block II	Block III
T_1	$N_0P_0K_0$	$N_0P_0K_1$	$N_0P_0K_2$
T_2	$N_0P_2K_1$	$N_0P_2K_2$	$N_0P_2K_0$
T_3	$N_0P_1K_2$	$N_0P_1K_0$	$N_0P_1K_1$
T_4	$N_1P_1K_1$	$N_1P_1K_2$	$N_1P_1K_0$
T_5	$N_1P_0K_2$	$N_1P_0K_0$	$N_1P_1K_1$
T_6	$N_1P_2K_0$	$N_1P_2K_1$	$N_1P_2K_2$
T_7	$N_2P_1K_0$	$N_2P_1K_1$	$N_2P_1K_2$
T_8	$N_2P_0K_1$	$N_2P_0K_2$	$N_2P_0K_0$
T_9	$N_2P_2K_2$	$N_2P_2K_2$	$N_2P_2K_1$

Replication II

(NPK^2 confounded)

	Block I	Block II	Block III
T_1	$N_0P_0K_0$	$N_0P_0K_1$	$N_0P_0K_2$
T_2	$N_1P_0K_1$	$N_0P_1K_2$	$N_0P_1K_0$
T_3	$N_0P_1K_1$	$N_0P_2K_0$	$N_0P_0K_1$
T_4	$N_2P_2K_1$	$N_1P_0K_2$	$N_1P_0K_0$
T_5	$N_2P_0K_2$	$N_1P_1K_0$	$N_1P_1K_1$
T_6	$N_1P_1K_2$	$N_1P_2K_1$	$N_1P_2K_2$
T_7	$N_0P_2K_2$	$N_2P_2K_2$	$N_2P_2K_0$
T_8	$N_1P_2K_0$	$N_2P_0K_0$	$N_2P_0K_1$
T_9	$N_2P_1K_0$	$N_2P_1K_1$	$N_2P_1K_2$

3.7.2.3. Design and layout

Number of replication	2
Number of block per replication	3
Number of plots per block	9
Total number of plots	54

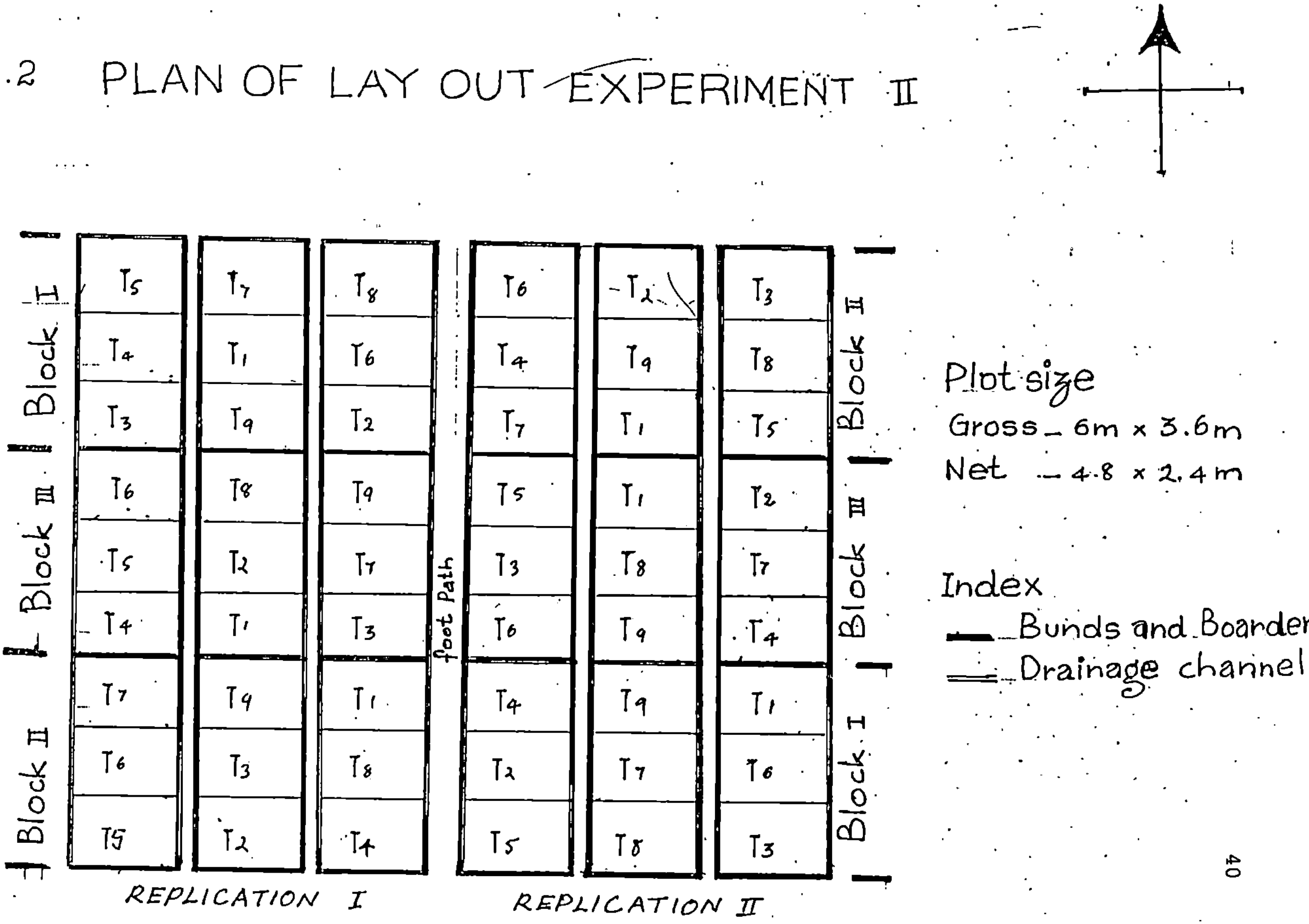
<u>Plot size</u>

Gross plot size	6 m x 3.6 m
Net plot size	4.8 x 2.4 m

Border row - One row of plants were left all around the plot.

Details of layout are given in Fig. 2.

Fig. 2 PLAN OF LAY OUT EXPERIMENT II



3.7.3. Details of cultivation

The experimental area was ploughed, harrowed and leveled. Stubbles were removed and clods crushed manually and fine seed bed was prepared. Plots were formed with bunds and channels around each plot to prevent loss of fertilizer through surface flow.

3.7.4. Fertilizer application

3.7.4.1. Experiment I

Basal doze of 80 kg phosphorus and 60 kg potassium/ha was applied for all plots while preparing plots. However, with regard to nitrogen 100 kg/ha was applied basally if the crop were to be left for seed cut or 50 kg N/ha were to be left for fodder weight. Consequently in the case of C_1 treatments 100 kg N/ha was applied at each of the two seed cuts, in the case of C_2 treatment 50 kg N/ha was applied for the first fodder cut and 100 kg N/ha was applied for each of the two subsequent seed cuts. In the case of C_3 treatments 50 kg N/ha was applied for each of the two fodder cuts and 100 kg N/ha for the final seed cut.

3.7.4.2. Experiment II

Phosphorus and potassium were applied basally as per treatment schedule at the time of field preparation. All the plots were given a basal dose of 50 kg N also for good establishment and fodder harvest.

Forage cuts were made 50 days after transplanting. After the forage cut crops were left for two subsequent seed cuts. At each time nitrogen was applied as per the treatments to the plots.

3.7.5. Method of planting

Forty five days old healthy seedlings were uprooted from the nursery. The tip of seedlings were cut off to obtain 25 to 30 cm length and then planted at a spacing of 60 cm x 60 cm on June 15, 1992.

3.7.6. Gap filling

Gap filling was done uniformly in all plots on seventh day after planting to ensure uniform stand.

3.7.7. Weeding

Two weedings were done first weeding 30 days after transplanting and second weeding after first fodder/residue harvest.

3.7.8. Harvesting

Fodder/crop residue were cut by sickle 20 cm above the ground. Seed collection was made by harvesting the earheads only.

3.7.9. Tagging of panicle

In order to collect the seeds at different maturity stages in the experiment I, emergence of panicle was closely watched. This was essential since the emergence of panicle was not uniform. Details of the stage of panicle are shown in Plate 5. They were tagged immediately after opening by fixing stickers on the leaf below the boot leaf. Stickers contain details of date of tagging and the date on which the panicle had to be harvested as per date of collection.

3.7.10. Processing of seed

3.7.10.1. Experiment I

The tagged panicles were collected as per the treatments at different time intervals in cloth bags and dried in the sun/artificial seed drier. This was necessitated due to rainy weather and because the sky was overcast during most of the time. After drying, the earheads were threshed and seeds separated by winnowing and sieving.

After the collection of the tagged panicles as per the treatments the remaining ear heads were harvested from the net area. In the case of S_1, S_2 and S_3 the remaining ear heads were harvested when most of the panicles shed about 25 per cent of the spikelet. In the case of other treatments S_4 and S_5 ear heads were harvested immediately after the collection of tagged panicles.

The earheads were sweated, threshed and seeds cleaned by winnowing and using sieves.

3.7.10.2. Experiment II

Earheads were harvested when the panicles shed about 25 per cent of the spikelets. It was used as a thumb rule for judging the harvest peakness of guinea grass. The harvested ear heads were sweated, threshed and seeds separated by sieving and winnowing. Seeds were dried in the sun and artificial seed drier.

3.7.11. Germination test

Hundred pure seeds each in two replication was placed in aluminium trays. Germination paper (Brown kraft paper Indian make) was used as substratum. The trays were placed in a germination room where the humidity was maintained at 90-95 per cent. Daily watering was done and continued up to 21 days. Counting of seedlings was carried out weekly.

Germinated seedlings were counted and removed each time and continued upto three weeks. Germination was expressed as percentage of total seeds (ISTA, 1985).

3.7.12. Topographical Tetrazolium Test (TTC)
(Biochemical test for viability)

The object of biochemical tests are to make a quick estimate of viability of seed samples in general and those showing dormancy in particular. 2, 3, 5 triphenyl tetrazolium chloride (colourless solution) was used as an indicator (ISTA, 1985).

Hundred seeds were drawn randomly and presoaked in water for 15 hrs. Presoaked seeds were cut along the embryo and added 0.25% tetrazolium chloride solution and placed in an incubator at 40°C for 8 hours.

Each seed is examined and evaluated as viable or non viable on the basis of staining patterns. Red coloured living seeds were distinguished from colourless dead ones. Red coloured seeds were recorded and reported in percentage as viable.

3.7.13. Determination of moisture percentage

High constant temperature oven method was used for determination of seed moisture content (ISTA, 1985) 4 to 5gm of seed sample was taken for test in 50 mm diameter petridish with lid. Petridish with lid were weighed. After filling with seed they were again weighed and placed in an oven maintained at a temperature of 130-133°C. The seed samples were dried for a period of one hour. Then cooled in a desiccator and subsequently weighed.

Moisture content of seeds was expressed in percentage by means of the following formula.

$$(M_2-M_3) \times \frac{100}{M_3-M_1}$$

where

M_1 - is the weight in grams of the petridish and lid

M_2 - is the weight in grams of the petridish with lid and seed before drying

M_3 - is the weight in grams of the petridish with lid and seed after drying.

3.7.14. <u>Growth characters</u>

For recording growth characters four hills of guinea grass were selected randomly.

3.7.14.1. Height of grass

The height of plants was recorded at 30 days interval after transplanting and the day prior to each harvest. The height was measured in centimeter from the base of the plant to the tip of the tallest leaf in all the observation hills and the means worked out.

3.7.14.2. Tiller count

Number of tillers in each hill was counted at 30 days interval after transplanting and the day prior to each harvest and the means were worked out.

3.7.14.3. Leafiness

The samples of either fodder or residue cut were separated into leaf and stem and weighed separately. The percentage of leaf component was calculated and expressed as leafiness.

3.7.15. Fresh fodder yield

Fresh fodder yields from the net area were recorded immediately after harvest. Total fresh fodder yield/ha was calculated.

3.7.16. Total dry matter yield

Fresh weight and dry weight of grass were recorded and moisture percentage was estimated on fresh weight basis. Samples from each cut were oven dried to a constant weight at 80°C. The dry matter was computed for each treatment and the mean dry matter yield of fodder was worked out.

3.7.17. Protein yield

Crude protein was calculated by multiplying the nitrogen content by the factor 6.25 (Simpson et al., 1965). Crude protein yield was calculated by multiplying the crude protein content by dry matter yield.

3.7.18. Seed yield

Dried clean seed obtained from the net area of each plot was weighed and recorded and the per hectare yield was worked out.

3.7.19. Pure seed yield

The clean dried seed is a mixture of pure seed and chaff. Sample drawn from the clean seed is weighed and the chaff blown off in a seed blower to obtain pure seed. From the weight of seed sample and pure seed, percentage of pure seed was computed. Pure seed was calculated by multiplying pure seed content by seed yield and worked out the per hectare pure seed yield.

3.7.20. Seed weight per panicle

Tagged panicles were collected and the number was counted. Panicles were dried and threshed. Seeds were separated, dried, cleaned and pure seed obtained by blowing. Pure seed weight per panicle was computed dividing quantity of seed by number of panicle.

3.7.21. Seed weight per plant

Total tagged panicles from four random hills were collected. Panicles were dried and threshed. Seeds were separated, dried cleaned and total quantity of seed was recorded. Seed weight per hill was computed by dividing total quantity of seed received from hills with number of hills.

3.7.22. Thousand seed weight

Thousand seeds were drawn from the pure seed sample and weighed in a 0.1 mgm precision Mettler electronic balance and the weight was recorded as per ISTA (1985).

3.7.23. Pure seed yield

Seed yield per plot was computed from the quantity of seed collected from four random hills in which panicles were tagged as per treatment schedule. As the tagging was continued as and when the panicle emerged and stretched for long time, net plot could not be harvested at a time and hence the yield computed. This was necessary because the panicle emergence was not uniform.

Tagging of panicle

	C_1	C_2	C_3
First seed harvest	12 days 21/8 - 1/9	4 days 3/9 - 6/9	7 days 5/11 - 11/11
Second seed harvest	7 days 5/11 - 11/11	7 days 17/11 - 23/11	Nil

Economics

Economics of fodder and seed production was worked out based on the total cost of cultivation and the gross returns from sale proceeds of seed and fodder involved in the various cutting treatments C_1, C_2 and C_3. The cost of cultivation involved in various cutting treatments as worked out based on the number of workers engaged and the labour charge prevailed during that period. The existing prices followed for the sale of fodder and seeds by the Kerala Livestock Development Board, Dhoni Palakkad was taken into account while calculating the gross net returns.

Statistical analysis

The data collected were analysed statistically by applying the technique of analysis of variance (Panse and Sukhatme, 1967) and significance was tested by F test.

Results

RESULTS

During the course of investigation observation on various characters for growth, fodder yield, seed production components and seed yield were recorded to study the seed production potential of Guinea grass (Panicum maximum Jacq.) cv Riversdale. The data were subjected to statistical analysis and the results are presented in this chapter.

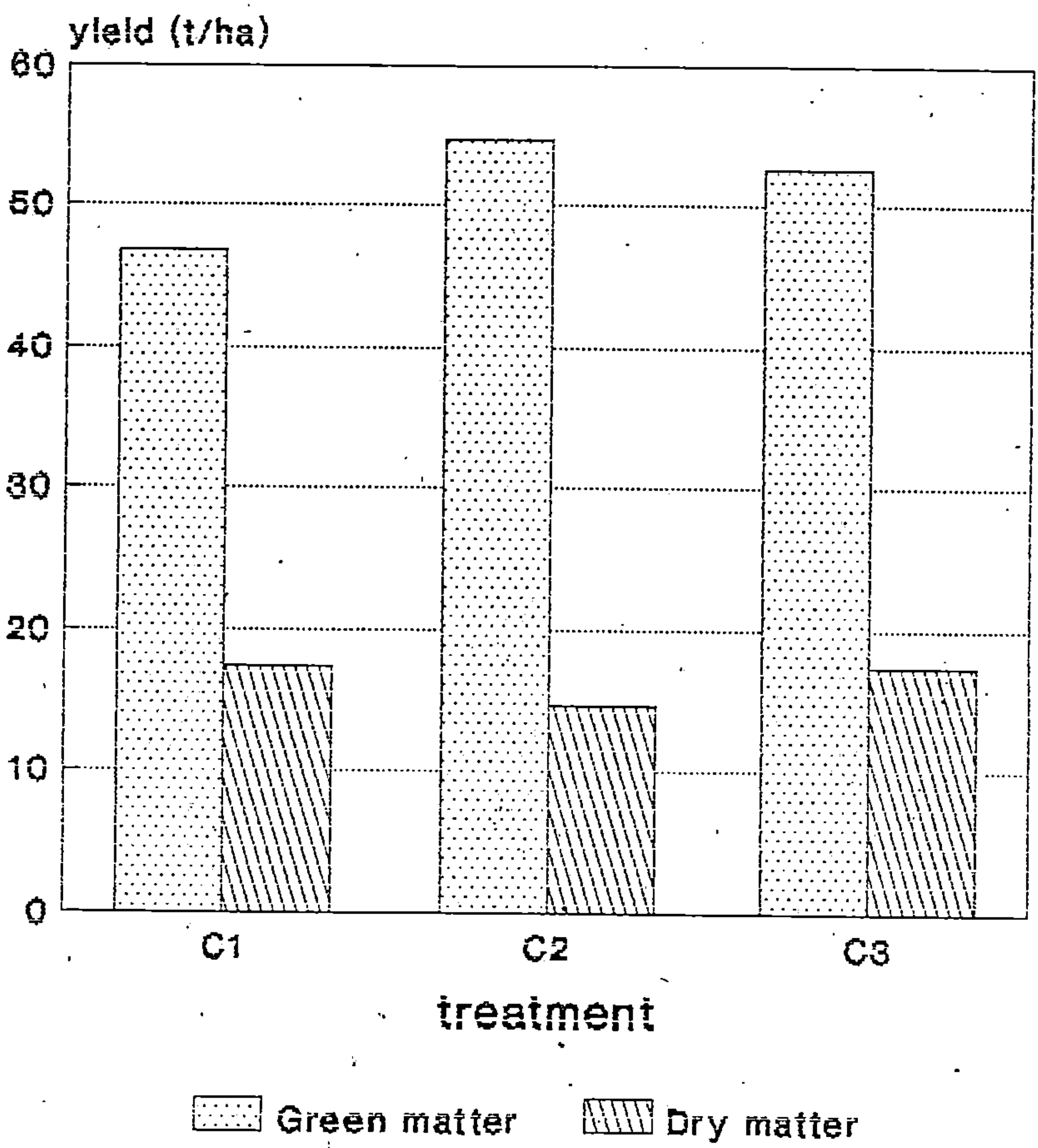
Experiment I

4.1. Growth and Fodder yield

The data pertaining to the growth and fodder yield characters as affected by various cutting treatments are given in Table 2a, 2b, 2c, 2d and 2e.

Height of the plant was not significantly influenced by the different cutting treatments either at 30 or 60/50 days after transplanting. Similarly number of tillers per hill was also not significantly influenced. Green yield as well as dry matter yield of first residue/fodder cut were significantly influenced by the different cutting treatments. Largest green as well as dry matter yield was recorded in the case of C_1 cutting treatment and lowest in the case of C_2 and C_3 cutting treatments. The difference in green yield between C_1 cutting treatment on the one hand and

FIG.4 Cumulative green and dry matter yield (t/ha) as affected by various cutting treatment.



of C_1 treatment whereas dry matter was significantly less. There was not much difference in leafiness among these three treatments comparisons.

When growth and fodder yield characters in second residue cut of C_1 treatment and C_2 treatment and first residue cut of C_3 cutting treatments are compared, they were more or less at par. Plant height, tiller per hill, leafiness, green and dry matter yield in general was not affected by cutting treatments.

When the cumulative green/dry matter yield of individual cutting treatment (Table 2e) were compared (C_1, C_2, C_3), it was found that largest green yield was obtained in the C_2 cutting treatment and lowest in the case of C_1 cutting treatment. There was not much difference in the green yield between C_2 and C_3 cutting treatments. When the dry matter is taken into consideration largest was in the case of C_1 and C_3 cutting treatments and lowest in the case of C_2 cutting treatment. Highest protein yield (1.75 t/ha) obtained from the C_3 cutting treatment and lowest in the case of C_2 cutting treatment (1.07 t/ha) and C_1 cutting treatment being intermediate (1.15 t/ha). The chemical composition and protein yield are given in tables 3a and 3b.

Table 2a. Growth and fodder character as affected by C_1 treatment (two seed harvest)

	First seed and residue cut							Second seed and residue cut					
	Plant height 30 DAT (cm)	Tiller/ hill 30 DAT (nos.)	Plant height 60 DAT (cm)	Tiller/ hill 60 DAT (nos.)	Green yield 108 DAT (t/ha)	DM yield 108 DAT (t/ha)	Leafi-ness (%)	Plant height 30 DAR (cm)	Tiller/ hill 30 DAR (nos.)	Plant height 71 DAR (cm)	Green yield 71 DAR (t/ha)	DM yield 71 DAR (t/ha)	Leafi-ness (%)
S_1	59.56	13.23	85.03	42.63	28.63	9.33	24.00	162.80	47.93	184.86	19.40	8.40	29.33
S_2	63.23	19.96	85.23	46.73	28.63	9.46	24.00	171.80	52.63	188.43	21.40	8.96	24.50
S_3	63.23	16.83	83.56	37.16	26.03	8.43	34.66	167.53	38.53	185.70	20.83	9.00	26.83
S_4	49.63	11.55	74.46	31.80	24.56	7.96	33.83	167.86	44.10	183.53	18.80	7.20	34.40
S_5	62.16	18.00	84.70	45.56	25.46	8.20	29.66	104.26	50.10	191.43	20.26	9.50	26.83
Grand Mean	59.58	15.91	82.59	40.77	26.66	8.67	29.23	166.85	46.65	185.30	20.13	8.61	28.38
SE	5.035	3.815	4.984	7.190	1.580	0.018	3.029	1.841	4.885	2.329	0.765	0.096	4.456
CD	NS	NS	NS	NS	NS	0.059*	NS	NS	NS	NS	NS	0.459**	NS
CV	0.146	0.416	0.104	0.305	0.102	0.036	0.179	0.019	0.181	0.021	0.065	0.019	0.272

DAT - Days After Transplanting

DAR - Days After first Residue cut

** Highly significant at 0.01

* Significant at 0.05

Table 2b. Growth and fodder character as affected by C_2 treatment (one fodder cut + two seed harvest)

	First fodder cut							First seed and residue cut					Second seed and residue cut						
	Plant height 30 DAT (cm)	Tillers/ hill 30 DAT (nos.)	Plant height 50 DAT (cm)	Tillers/ hill 50 DAT (nos.)	Green yield 50 DAT (t/ha)	DM yield 50 DAT (t/ha)	Leafiness (%)	Plant height 30DAF1 (cm)	Tillers/ hill 30DAF1 (nos.)	Green yield 60 DAF1 (t/ha)	DM yield 60 DAF1 (t/ha)	Leafiness (%)	Plant height 40 DAR (cm)	Tillers/ hill 40 DAR (nos.)	Plant height 80 DAR (cm)	Veg. tillers 80 DAR (nos.)	Green yield 80 DAR (t/ha)	DM yield 80 DAR (t/ha)	Leafiness (%)
S_1	59.00	14.40	75.33	29.80	9.16	1.20	50.00	148.80	58.33	33.26	6.22	31.33	157.20	41.63	173.03	27.26	16.16	7.40	23.00
S_2	71.66	22.96	90.13	41.73	9.63	1.36	50.00	146.46	64.80	32.70	6.30	31.83	164.00	53.66	177.10	24.53	16.80	7.93	28.50
S_3	54.20	12.50	69.40	32.86	7.17	0.98	50.00	152.40	58.06	28.93	6.40	37.50	167.93	43.43	174.53	26.53	17.66	7.20	27.33
S_4	57.63	17.73	75.06	35.33	7.08	0.92	50.00	145.46	56.96	26.90	6.33	28.50	162.53	40.53	173.63	18.43	13.60	5.80	22.50
S_5	64.63	19.96	81.13	35.80	10.29	1.40	45.00	146.20	66.46	28.00	6.40	26.83	143.76	41.43	170.43	31.33	15.63	7.23	28.33
Grand Mean	61.42	17.51	78.21	35.10	8.66	1.17	49.00	147.56	60.92	29.45	6.83	31.19	159.08	44.13	173.74	25.61	15.97	7.212	25.93
SE	2.374	4.203	3.032	4.831	0.903	0.2568	8.684	2.902	6.486	1.180	0.258	0.882	6.791	4.599	3.576	7.736	1.522	0.618	2.881
CD	7.942**	NS	14.386*	NS	NS	NS	NS	NS	NS	3.619*	NS	NS	NS	NS	NS	NS	NS	NS	NS
CV	0.066	0.415	0.067	0.238	0.180	0.380	0.250	0.034	0.184	-	0.070	0.049	0.073	0.180	0.035	0.523	0.165	0.148	0.192

DAT - Days After Transplanting
DAF1 - Days Afater first Fodder cut
DAR - Days After first Residue cut

** Highly significant at 0.01
* Significant at 0.05

Table 2c. Growth and fodder character as affected by C_3 treatment (two fodder cut + one seed harvest)

	First fodder cut							Second fodder cut					First seed and residue cut					
	Plant height 30 DAT (cm)	Tillers/ hill 30 DAT (nos.)	Plant height 50 DAT (cm)	Tillers/ hill 50 DAT (nos.)	Green yield 50 DAT (t/ha)	DM yield 50 DAT (t/ha)	Leafi-ness (%)	Plant height 30DAF1 (cm)	Tillers/ hill 30DAF1 (nos.)	Green yield 50 DAF1 (t/ha)	DM yield 50 DAF1 (t/ha)	Leafi-ness (%)	Plant height 40DAF2 (cm)	Tillers/ hill 40DAF2 (nos.)	Plant height 78DAF2 (cm)	Green yield 78 DAF2 (t/ha)	DM yield 78 DAF2 (t/ha)	Leafi-ness (%)
S_1	61.96	11.83	74.80	27.96	7.19	1.03	50.00	146.90	47.80	23.10	6.76	31.66	165.53	41.36	184.83	19.96	8.70	29.0
S_2	60.73	13.06	80.46	27.06	9.13	1.22	50.00	142.83	50.40	25.46	8.00	29.33	160.86	37.93	181.20	19.40	8.73	24.50
S_3	60.73	17.46	78.80	33.23	7.12	1.28	50.00	148.63	46.30	23.16	6.80	27.03	161.80	49.43	184.76	20.23	8.63	28.36
S_4	65.80	17.30	82.56	34.86	8.06	1.12	50.00	149.90	54.06	25.83	8.06	26.33	163.10	48.80	183.76	20.56	9.00	33.83
S_5	53.73	14.63	68.96	30.36	8.44	1.21	50.00	146.96	45.46	25.23	7.30	28.50	163.83	45.00	185.60	19.66	8.73	25.50
Grand mean	60.59	14.85	77.11	30.69	7.98	1.17	50.00	147.04	48.80	24.55	7.38	28.57	162.96	44.50	184.02	19.96	8.75	28.22
SE	4.685	1.704	3.651	3.204	0.986	12.255	12.254	1.880	3.515	1.580	0.110	0.674	2.271	4.398	1.742	0.181	0.031	4.156
CD	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	*	NS	NS	NS	NS	NS	NS
CV	0.133	0.198	0.082	0.180	0.210	3.207	3.207	0.022	0.124	0.114	0.025	0.040	0.024	0.171	1.640	0.059	0.062	0.254

DAT - Days After Transplanting
DAR - Days After first Residue cut
DAF1 - Days After first Fooder cut
DAF2 - Days After second Fooder cut

** - Highly siginificant at 0.01
* - Siginificant at 0.05

Table 2d. Green and drymatter yield (t/ha) as affected by various cutting treatments C_1, C_2 and C_3.

		First fodder cut		Second fodder cut		First residue cut		Second residue cut	
		Green	Dry matter	Green	Dry matter	Green	Dry matter	Green	Dry matter
C_1	GM	-	-	-	-	26.66	8.76	20.13	8.61
	CD	-	-	-	-	NS	*	NS	**
	SEM	-	-	-	-	1.5805	0.01825	0.76515	0.09687
	CV	-	-	-	-	0.10266	0.03643	0.06580	0.01947
C_2	GM	8.66	1.17	-	-	29.95	6.33	15.97	7.21
	CD	NS	NS	-	-	*	NS	NS	NS
	SEM	0.90367	0.25819	-	-	0.10988	0.25819	1.52282	0.618058
	CV	0.18054	0.38049	-	-	-	0.07063	0.16512	0.14840
C_3	GM	7.98	1.17	24.55	7.38	19.96	8.75	-	-
	CD	NS	NS	NS	NS	NS	NS	-	-
	SEM	0.98632	12.25564	1.58009	0.11028	0.68157	0.3162	-	-
	CV	0.21075	3.20784	0.11143	0.02586	0.05912	0.062525	-	-

* Significant at 0.05 ** Highly significant at 0.01

Table 2e. Cumulative and dry matter yield (t/ha) as affected by various cutting treatment

Cutting treatment	C1		C2		C3	
No. of cuts	Greeen	drymatter	Greeen	drymatter	Greeen	drymatter
First fodder cut	-	-	8.66	1.17	7.98	1.17
Second fodder cut	-	-	-	-	24.55	7.38
First residue cut	26.66	8.76	29.95	6.33	19.96	8.75
Second residue cut	20.13	8.61	15.97	7.21	-	-
Total	46.79	17.37	54.58	14.71	52.49	17.30

able 3a. Chemical Composition of fodder samples (composite)

Type of Fodder	Crude Protein (%)	Crude Fibre (%)	Acid Insolube Ash (%)
odder samples taken during fooder cut	13.98	27.00	2.00
oder samples taken during residue cut	6.62	35.00	1.75

able 3b. Protein yield as effected by different cutting treatement (t/ha)

	C_1		C_2		C_3	
	Drymatter yield	Crude protein	Drymatter yield	Crude protein	Drymatter yield	Crude protein
irst Fodder	-	-	1.2	0.17	1.1	0.15
econd Fodder	-	-	-	-	7.4	1.03
irst Residue	8.7	0.58	6.3	0.42	8.7	0.57
econd Residue	8.6	0.57	7.2	0.48	-	-
	17.3	1.15	14.7	1.07	17.2	1.75

4.2. Seed yield components

4.2.1. Panicle per hill

The number of panicles per hill as influenced by different cutting treatment and intervals of harvest of panicles after emergence are shown in table 4. In the case of C_1 cutting treatment which involved two seed cuts only, the number of panicle per hill observed in the first seed cutting was significantly high compared to the second seed cut, the difference being of the order of 3.2 times. In the case of C_2 cutting treatment which involved one fodder cut and two subsequent seed cuts, number of panicles per hill was significantly high in the first seed cut compared to the second seed cut the difference being of the order of 3.6 times. In general the number of panicle per hill was more in C_2 treatment during the first and second treatment respectively. Number of panicles obtained in the C_3 cutting treatment was almost at par with that of the second seed cut of either C_1 or C_2 cutting treatment.

4.2.2. Panicle length

The length of panicle as influenced by different cutting treatments and intervals of panicle harvest are shown in table 5. Panicle length was significantly more in first seed cut compared to second seed cut in both C_1 and C_2 treatments. In the case of C_1 treatment the difference in able 4. Number of panicles (nos.) per hill as influenced by different cutting treatment and interval of panicle harvest.

utting treatment		C1		C2		C3
requency of eed harvest		No of panicle/hill First	Second	No of panicle/hill First	Second	No of panicle/hill First
	S1	26.03	9.59	31.43	9.83	14.50
	S2	32.50	10.36	37.36	10.03	12.13
	S3	21.86	8.10	36.10	6.60	13.10
ntervals of anicle arvest	S4	23.46	6.86	35.26	14.20	15.03
	S5	25.63	5.10	28.60	6.10	9.43
	GM	25.89	7.984	33.75	9.352	12.838
	SE	3.46753	1.94923	3.15189	2.15283	2.56857
	CD	NS	NS	NS	NS	NS
	CV	0.23188	0.04612	0.16173	0.39866	0.34684

Table 5. Pancile length (cm) as influenced by different cutting treatments and intervals of panicle harvest

Cutting treatment		C1		C2		C3
requency of eed harvest		Length of panicle First	Second	Length of panicle First	Second	Length of panicle First
ntervals of anicle rvest	S1	32.53	24.20	32.60	28.76	22.76
	S2	32.63	25.10	32.36	26.43	23.66
	S3	32.86	23.33	31.36	26.36	21.83
	S4	31.53	25.10	31.70	27.76	24.10
	S5	31.00	23.36	31.20	24.60	22.20
	Grand Mean	31.99	24.21	31.884	26.78	24.91
	SE	3.85198	0.74157	0.67886	0.92165	0.97279
	CD	NS	NS	NS	NS	NS
	CV	0.04612	0.55272	0.03691	0.05950	0.07353

panicle length between first and second seed cut was of the order of 1.3 times and in the case of C_2 cut this difference was 1.2 times. The panicle length in the case of C_3 cutting treatment was more or less similar to that of the second seed cut of either C_1 C_2 treatment. Panicle length also was not influenced by any of the stage of seed harvest.

4.2.3. Pure seed per panicle

The data pertaining to the pure seed per panicle as influenced by different cutting treatment intervals of panicle harvest are shown in Table 6. Invariably the weight of pure seeds per panicle was more in the first seed cut of both C_1 and C_2 cutting treatment. The difference between the first and second seed cut were of the order of 3.9 times in C_1 cutting treatment and 5.8 times in the C_2 treatment.

The weight of pure seed per panicle in the case of C_3 cutting was more or less similar to that of second seed cut in either C_1 or C_2 cutting treatment. Weight of pure seed per panicle was not significantly influenced by stages of harvest of the panicle in the first seed cut of C_1 cutting treatment.

However significant difference was observed due to the stages of harvest of panicle during the second seed cut of

Table 6. Pure seed per panicle(gms) as influenced by different cutting treatment and intervals of panicle harvest.

Cutting treatment		C1		C2		C3
Frequency of seed harvest		Pure seed/panicle(gms) First	Second	Pure seed/panicle(gms) First	Second	Pure seed/pancile (gms) First
Intervals of panicle harvest	S1	0.530	0.233	0.466	0.273	0.190
	S2	0.560	0.213	0.546	0.123	0.143
	S3	0.420	0.066	0.656	0.023	0.046
	S4	0.450	0.040	0.236	0.033	0.023
	S5	0.240	0.020	0.246	0.000	0.023
	Grand Mean	0.440	0.114	0.518	0.090	0.08[illegible]
	SE	0.09393	0.17013	0.08083	0.03207	0.02923
	CD	NS	0.01**	0.05*	0.01**	0.05*
	CV	0.367555	2.56984	0.38355	0.84207	0.60344

** Highly significant at 0.01
* Significant at 0.05

percentage was observed. In the case of C_3 cutting treatment no definite trend in germination could be observed due to harvest of panicle at different days after emergence.

4.2.6. Viability of seeds (Using TTC)

Topographical Tetrazolium Chloride test

Viability of seeds as influenced by the different cutting treatments and intervals of panicle harvest are shown in table 9. In general viability of seeds was not significantly influenced by the cutting treatments as well as stages of harvest of panicle.

4.2.7. Moisture percentage

Moisture percentage of seeds as influenced by the cutting treatments and intervals of panicle harvest are shown in table 10. The moisture percentage of seeds could not be determined in the case C_2 and C_3 cutting treatments and also in the second seed cut of C_1 cutting treatment. Moisture percentage was not significantly influenced.

4.3. **Seed yield per hectare**

The data pertaining to the seed yield per hectare as affected by the different cutting treatments and stages of panicle harvest are shown in table and the cumulative seed yield as affected by different cutting treatment and intervals of panicle harvest are shown in table 11.

The seed yield per hectare extrapolated from the weight of seeds of panicles tagged in four random hills per plot showed significant variations due to stages of harvest in the cutting treatment. Even though difference in yield due to stages of harvest were not significant for first seed harvest in C_1 cutting treatment. There was general decrease in seed yield with latter stages of panicle harvest. This may be explained on the basis of high degree of variability in the data. In general the seed yield decreased rapidly with late stages of harvest.

When different cutting treatments were taken into consideration the seed yield obtained due to C_3 cutting treatment was significantly lower compared to C_1 and C_2 treatment. Maximum seed yield was obtained due to C_1 cutting treatment this being about 8.6 times more compared to that of C_3 treatment and 1.3 times more compared to C_2 cutting treatment. Other interesting feature is that seed yield in C_3 was more or less equal to that of second seed harvest of either C_1 or C_2 cutting treatment.

Economics

The C_1 treatment with only two consecutive seed harvest recorded the highest cost benefit ratio with net return of

Table 7. Thousand seed weight(gms) as affected by different cutting treatment and intervals of panicle harvest.

Cutting treatment		C1		C2		C3
Frequency of seed harvest		1000 seed weight First	Second	1000 seed weight First	Second	1000 seed weight First
Intervals of panicle harvest	S1	0.991	0.914	0.917	1.108	0.993
	S2	0.971	1.051	0.665	1.159	1.066
	S3	1.077	1.042	0.922	0.976	1.061
	S4	1.072	1.020	0.924	0.873	0.925
	S5	0.969	0.931	0.927	0.779	1.005
	Grand Mean	1.016	1.003	0.871	0.979	1.010
	SE	0.54726	0.02517	0.44595	0.03905	0.03530
	CD	NS	NS	NS	** 0.01	NS
	CV	0.09328	0.04343	3.82073	0.06905	0.06052

** Highly significant at 0.01
* Significant at 0.05

Table 8. Germination of seed (%) as influenced by different cutting treatment and intervals of panicle harvest

Cutting treatment		C1		C2		C3
Frequency of seed harvest		Germination (%)		Germination (%)		Germination (%)
		First	Second	First	Second	First
Intervals of panicle harvest	S1	12.00	11.83	4.00	49.66	21.53
	S2	16.16	18.33	3.66	38.50	23.14
	S3	16.83	48.83	14.33	17.50	40.48
	S4	22.16	39.66	15.50	0.00	28.06
	S5	7.83	27.66	27.00	0.00	39.77
	Grand Mean	15.09	29.26	12.89	21.13	30.07
	SE	0.07508	4.54849	4.23690	9.88187	3.90399
	CD	NS	NS	NS	0.05*	0.05*
	CV	0.92625	0.26881	0.56887	0.80900	0.22009

* Significant at 0.05

Table 9. Viability of seed (%) as influenced by different cutting treatment and intervals of panicle harvest

Cutting treatment		C1		C2		C3
Frequency of seed harvest		Viability of seed(%) First	Second	Viability of seed (%) First	Second	Viability of seed (%) First
Intervals of panicle harvest	S1	60.00	66.00	46.86	68.00	49.73
	S2	38.66	54.66	18.83	65.33	53.98
	S3	69.33	64.00	49.33	65.33	53.99
	S4	65.33	41.83	55.33	46.66	44.59
	S5	54.66	61.33	70.66	45.33	49.99
	Grand Mean	57.59	57.59	48.16	58.13	50.35
	SE	8.58940	5.71936	9.34344	6.34670	3.45892
	CD	NS	NS	*	NS	NS
	CV	0.25828	0.17198	0.33598	0.18611	0.11896

* Significant at 0.05

Table 10. Moisture percentage of seed as influenced by the different cutting treatments and intervals of panicle harvest.

Cutting treatment		C1		C2		C3
Frequency of seed harvest		Moisture content First	Second	Moisture content First	Second	Moisture content First
Intervals of panicle harvest	S1	10.26				
	S2	10.23				
	S3	10.73				
	S4	10.90				
	S5	12.16		Available seed was not enough to determine moisture content		
	Grand Mean	10.85				
	SE	0.188244				
	CD	NS				
	CV	0.03002				

Table 11. Cumulative seed yield (kg/ha) as affected by different cutting treatments and intervals of panicle harvest.

Cutting treatment	C1			C2			C3
Frequency of seed harvest	Seed yield (kg/ha) First	Second	Cumulative	Seed yield (kg/ha) First	Second	Cumulative	Seed yield (kg/ha) First
Intervals of panicle harvest S1	173.66	58.51	232.17	120.20	49.85	170.05	39.81
S2	180.61	44.69	225.30	168.29	25.25	193.54	37.08
S3	140.30	17.48	157.86	145.63	3.14	148.78	8.95
S4	123.46	9.44	132.90	62.28	1.15	63.44	5.62
S5	73.07	5.06	78.13	63.46	0.32	63.78	5.09
Grand Mean	138.24	27.04	165.27	111.97	15.94	127.92	19.31
SE	25.8384	6.2276	29.9776	3.65	9.777	12.9783	8.4454
CD	NS	19.6225**	94.4509*	43.0194*	NS	40.8929**	26.6100*
CV	32.3744	39.8668	31.4196	21.1280	106.1700	17.5726	75.75

** Highly significant at 0.01
* Significant at 0.05

Table 12. Economics of fooder and seed production as affected by different cutting treatments

Treatements	Cost of cultivation (Rs/ha)	Gross Return (Rs/ha)	Net Returen (Rs/ha)	B.C ratio
C_1	13,062	29,827	16,765	2.2
C_2	14,175	27,138	12,963	1.9
C_3	12,362	15,384	3,022	1.2

Price of Green fodder - Rs 0.30/kg for first quality fodder (Fodder cut).

- Rs 0.15/kg for second quality fodder (Residue cut).

Price of Seeds - 138/kg

Labour charge - Rs 25/woman/day and Rs 30/man/day

Cost of Fertilizer - Rs 6.2/kg of N, Rs. 10.5/kg of P_2OS, Rs 10.3/kg of K_2O

Rs 16765/ha and the lowest recorded for the C_3 treatment with two fodder cut and one seed harvest recording a net return of Rs 3022/ha. The C_2 cutting treatment with one fodder and two subsequent seed harvest was intermediate and accounted a net return of Rs 12963/ha (Table 12).

Experiment II

4.4. Growth and Fodder Characters

The data pertaining to the growth and fodder characters as affected by different levels of N, P and K fertilizers and their interaction effects are given in Tables 13a, 13b and 13c.

4.4.1. Plant height/tiller numbers/Green, dry matter yield 30 days after transplanting and during first fodder cut

The plant height and tiller number per hill at 30 days after transplanting and at the time of first fodder cut (50 das after transplanting) and also green and dry matter yield at first fodder cut were not affected by any of the P and K fertilizer treatment. They were also not affected by nitrogen fertilizer treatment because the nitrogen fertilizer treatment was applied only after first fodder cut.

4.4.2. Plant height tiller number/30 days after the first fodder cut

The plant height was significantly affected due to nitrogen fertilizer application, the maximum increase of about 1.1 times obtained at 100 kg N/ha itself. The higher dose of 200 kg N/ha did not show any additional influence. However P and K fertilizers did not show any influence on plant height. The plant height at the time of first seed cut was not influenced by any of the fertilizer treatment.

The number of tillers per hill at 30 days after first fodder cut was also significantly influenced by nitrogen fertilizers applied 100 kg N/ha, the increase being about 1.23 times. The higher dose of 200 kg N/ha even though raised the number of tillers, the increase was not significant. However, P and K fertilizers did not influence the tiller production.

4.4.3. Green and dry matter yield after first seed cut

The green yield as well as the dry matter yield obtained after the first seed cut was not influenced by any of the fertilizer treatment.

4.4.4. Plant height/tiller number/green, dry matter yield during second seed harvest

The plant height at the time of second seed harvest was shown to be significantly different due to nitrogen fertilizer application. However, the difference was not consistent. P and K fertilizers did not have any influence on plant height. In general the green yield and the dry matter yield after the second seed cut was also not influenced by fertilizer applications. The leafiness also was not influenced generally by fertilizer treatments.

4.4.5. Interaction effect on growth and fodder yield characters

The interaction effects of NxP, NxK, PxK on the growth and fodder yield characters are given in table 13b. None of the characters were influenced by these interaction effects during any of the growth stages. Similarly 3 factor interaction effect NxPxK did not show any influence on growth and fodder yield characters (Table 13c).

4.5. Seed production characters

Seed production characters as affected by different levels of N, P and K fertilizers and their interactions are shown in tables 14a, 14b and 14c.

4.5.1. Number of panicles per hill

Nitrogen fertilizer significantly increased number of panicles per hill during the first and second seed harvest. There was 1.36 times increase in the number of panicles due to the application of 100 kg N/ha compared to control and 1.51 times increase due to 200 kg N/ha compared to control. P and K fertilizers did not have any influence. During the second seed harvest 100 kg N/ha significantly influenced number of panicle per hill compared to control (1.5 times). However the higher level of 200 kg N/ha did not have any added influence. Effect of P and K were similar to that of the first seed harvest.

4.5.2. Panicle length

The panicle length at first seed harvest was reduced by nitrogen fertilizer treatment, the decrease being significant at higher level of nitrogen. However P and K fertilizer did not have any influence. Panicle length at second seed harvest was not influenced by any of the fertilizer treatment.

4.5.3. Weight of seed per panicle

Even though non significant, weight of seeds per panicle at both first and second harvest decreased with increased levels of nitrogen fertilizer. P and K fertilizers did not have any influence.

4.5.4. Seed yield

Application of 100 kg N/ha significantly increased the seed yield during the first and second seed harvest. During the first seed harvest this increase was 1.16 times and during the second year it was 1.23 times. P and K fertilizers did not have any influence on the seed yield.

The pure seed yield showed a declining trend with nitrogen application during the first and second seed harvest. However the difference were not significant. P and K fertilizers did not have any influence.

4.5.5. Thousand seed weight

A general declining trend was observed in the case of thousand seed weight during both first and second seed harvests due to the application of nitrogen fertilizers. However, the differences were not significant. P and K fertilizers did not have any influence.

4.5.6. Seed moisture content/germination/viability

In general fertilizers did not have any influence on seed moisture content, germination percentage and viable seeds by indirect test of viability during the first and second seed harvest.

There was no significant two factor interaction effect of N, P and K fertilizers on seed yield characters. In general three factor interaction effect also was not significant.

Table 13a. Growth and fodder chracter as affected by different levels of N,P and K fertilizers

	Plant height 30 DAT (cm)	Plant height 50 DAT (cm)	Plant height 30 DAF1 (cm)	Plant height 60 DAF1 (cm)	Plant height 40 DAR (cm)	Tillers per hill 30 DAT (nos)	Tillers per hill 50 DAT (nos)	Tillers per hill 30 DAF1 (nos)	Green yield 50 DAT (kg/ha)	Dry matter yield 50 DAT (hg/ha)	Green yield 60 DAF1 (kg/ha)	Dry matter yield 48 DAT (kg/ha)	Green yield 48 DAR (hg/ha)	Dry matter yield 48 DAT (kg/ha)	Lefiness 60 DAF1 (%)	Lefiness 48 DAR (%)
N_0	64.46	98.98	131.96	149.48	172.50	22.58	34.47	52.11	10.68	1.80	25.83	7.71	25.15	6.42	40.58	41.88
N_1	61.61	94.78	141.40	143.74	167.59	20.16	32.97	64.02	11.55	1.94	26.03	7.38	22.37	6.35	36.33	41.47
N_2	67.22	97.10	140.11	144.10	165.96	24.96	35.31	68.54	10.92	1.71	26.94	7.59	22.36	5.80	32.86	37.27
SE	2.057	2.526	1.230	1.803	0.968	1.380	1.803	1.893	0.603	0.096	0.543	0.509	0.439	0.208	1.152	1.529
CD	NS	NS	3.142**	NS	2.685**	NS	NS	5.248**	NS	NS	NS	NS	1.218**	NS	3.193**	NS
P_0	63.06	96.03	138.95	145.47	168.50	21.45	32.63	59.41	11.25	1.79	26.27	7.161	23.32	6.21	37.16	40.27
P_1	63.27	97.68	137.48	146.51	169.30	21.17	36.97	64.05	10.61	1.73	26.22	7.13	23.52	6.32	34.75	39.58
P_2	66.47	97.16	137.04	145.33	168.25	25.07	35.15	61.21	11.28	1.92	26.32	8.39	23.03	6.03	37.80	39.58
SE	2.057	2.526	1.230	1.803	0.968	1.380	1.803	1.893	0.603	0.096	0.543	0.509	0.439	0.208	1.152	1.529
CD	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Contd.....

K_0	64.36	94.60	136.51	148.18	168.18	22.20	32.52	62.26	10.23	1.78	25.84	7.14	23.02	6.06	38.22	40.69
K_1	64.50	97.45	137.74	144.39	169.85	23.46	36.18	63.84	10.61	1.84	27.08	7.91	23.23	6.19	34.88	40.88
K_2	64.44	98.82	139.22	144.75	168.01	22.04	34.05	58.57	11.28	1.82	25.88	7.64	23.62	6.31	36.66	39.05
SE	2.057	2.526	1.230	1.803	0.968	1.380	1.803	1.893	0.603	0.096	0.543	0.509	0.439	0.208	1.152	1.529
CD	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

DAT - Days After Transplanting
DAF1 - Days After first Fodder cut
DAR - Days After First Residue cut

** - High siginificant at 0.01
* - Siginificant at 0.05

contd.....

NxK																
N_0P_0	61.93	94.50	130	152.31	172.73	22.46	31.63	50.59	9.13	1.88	25.6	7.86	25.25	6.40	43.33	45.08
N_0P_1	66.91	101.98	132.46	149.26	173.75	22.88	36.35	54.31	11.05	1.71	26.18	7.95	24.30	6.31	38.75	39.25
N_0P_2	64.55	100.48	132.63	146.86	141.01	22.40	35.43	31.43	11.86	1.80	25.73	7.33	25.90	6.55	39.66	41.33
N_1P_0	64.02	93.83	140.78	145.68	167.60	20.98	31.45	65.96	10.88	1.75	26.37	6.51	22.28	6.03	38.25	38.41
N_1P_1	58.31	95.28	140.11	142.95	167.90	19.80	35.90	65.96	11.71	2.08	26.25	7.75	22.70	6.38	35.08	45.83
N_1P_0	62.51	95.25	143.30	142.73	167.28	19.70	31.58	60.15	12.06	2.00	25.03	7.90	22.13	6.63	35.66	40.16
N_2P_2	67.13	95.48	137.95	146.68	164.23	23.15	34.50	70.23	10.70	1.73	25.60	7.04	21.55	5.76	33.08	38.58
N_2P_1	68.28	95.10	140.65	140.96	167.91	27.70	36.30	71.25	10.93	1.73	28.33	8.03	22.70	5.88	30.83	37.58
N_2P_2	66.26	100.73	141.75	144.65	165.73	24.03	35.15	64.15	11.13	1.68	26.90	7.70	22.85	5.76	34.66	35.66
SE	3.564	4.375	2.132	3.124	1.678	2.340	3.122	3.279	1.045	0.166	0.941	0.881	0.761	0.360	1.995	1.649
CD	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Contd....

PxK																
P_0K_0	63.30	98.23	135.85	146.98	167.05	22.13	35.06	60.14	10.78	1.78	25.88	6.73	21.98	5.76	38.00	44.16
P_0K_1	62.20	95.51	139.48	147.13	169.80	22.48	33.70	59.71	11.93	1.90	26.91	8.93	23.56	6.20	35.00	39.00
P_0K_2	63.68	94.35	141.51	142.31	168.65	19.73	29.15	58.40	11.05	1.70	26.01	5.81	24.43	6.68	38.500	37.66
P_1K_0	62.35	90.00	135.90	149.20	170.40	19.73	28.28	63.50	11.18	1.80	26.03	6.58	24.58	6.66	34.66	39.16
P_1K_1	63.05	97.20	134.85	142.51	168.15	21.31	35.75	69.20	9.96	1.61	25.86	6.78	22.50	6.15	34.33	42.83
P_1K_2	64.43	105.76	141.71	147.81	169.35	22.48	40.90	59.845	10.70	1.80	26.76	8.05	23.43	6.15	35.25	40.33
P_2K_0	67.44	95.50	137.78	148.36	167.11	24.73	34.23	63.15	8.75	1.78	25.61	8.11	22.51	5.76	42.00	38.75
P_2K_1	68.26	99.65	138.90	143.53	171.61	26.58	39.90	62.61	11.80	2.01	28.48	8.01	23.56	6.23	35.33	40.83
P_2K_2	65.21	96.35	134.45	144.11	166.03	23.91	32.11	67.88	13.31	1.98	24.88	9.06	23.01	6.11	36.25	39.16
SE	3.564	4.375	2.132	3.124	1.678	2.390	3.122	3.279	1.045	0.663	0.941	0.881	0.761	0.360	1.995	1.649
CD	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

DAT-Days After Transplanting   DAF1-Days After first Fodder cut   DAR-Days After First Residue cut

Table 13c. Growth and fodder character as affected by the interaction of NxPxK fertilizers

	Plant height 30 DAT (cm)	Plant height 50 DAT (cm)	Plant height 30 DAF1 (cm)	Plant height 60 DAF1 (cm)	Plant height 40 DAR (cm)	Tillers per hill 30 DAT (nos)	Tillers per hill 50 DAT (nos)	Tillers per hill 30 DAF1 (nos)	Green yield 50 DAT (kg/ha)	Dry matter yield 50 DAT (hg/ha)	Green yield 60 DAF1 (kg/ha)	Dry matter yield 48 DAT (kg/ha)	Green yield 48 DAR (hg/ha)	Dry matter yield 48 DAT (kg/ha)	Lefiness 60 DAF1 (%)	Lefiness 48 DAR (%)
$N_0P_0K_0$	57.75	85.90	128.75	151.75	169.25	22.55	28.50	39.22	11.75	1.90	24.30	6.35	23.85	5.65	42.75	42.25
$N_0P_0K_1$	65.50	107.75	133.00	152.00	173.50	24.25	28.50	39.22	11.75	1.90	24.30	6.35	23.85	5.65	42.75	42.25
$N_0P_0K_2$	74.40	104.65	138.00	152.80	177.75	21.15	29.0	58.40	12.25	1.75	26.00	6.15	28.25	8.25	37.25	38.75
$N_0P_1K_0$	66.50	104.30	130.50	156.55	178.90	22.30	34.15	58.55	11.00	1.80	26.45	8.50	26.90	6.45	40.50	46.00
$N_0P_1K_1$	68.00	99.15	134.00	147.75	169.25	20.00	35.75	61.65	8.64	1.35	25.60	5.35	23.00	5.70	38.25	40.25
$N_0P_1K_2$	58.00	102.15	138.90	149.90	175.75	23.15	43.90	51.40	9.95	1.60	28.60	8.15	26.00	5.75	37.15	44.25
$N_0P_2K_0$	61.55	93.30	133.15	148.654	170.05	22.55	32.25	54.00	5.14	1.95	26.05	8.25	25.00	7.10	46.75	46.75
$N_0P_2K_1$	67.25	99.05	130.40	148.05	178.50	24.40	34.57	40.80	12.15	1.90	25.15	8.39	25.60	6.80	30.50	40.00
$N_0P_2K_2$	61.25	94.65	121.00	137.80	159.55	22.90	33.40	44.50	13.40	2.05	22.60	7.70	23.45	5.65	44.00	41.00

Contd...

$N_1P_0K_0$	68.90	108.15	142.15	146.30	167.00	20.55	30.15	64.30	10.05	1.55	26.90	8.19	19.55	5.40	36.75	44.75
$N_1P_0K_1$	55.30	87.15	143.05	141.90	166.25	19.05	30.90	59.25	10.80	1.80	26.05	7.70	23.00	6.40	34.25	45.50
$N_1P_0K_2$	53.25	78.50	143.30	130.40	168.80	14.15	25.65	53.15	11.35	1.90	23.45	5.85	21.25	6.05	36.50	40.00
$N_1P_1K_0$	53.30	83.05	138.80	146.05	171.15	17.00	25.30	69.55	12.20	1.95	27.35	5.80	25.15	7.45	37.50	36.25
$N_1P_1K_1$	56.00	98.55	135.15	142.55	167.65	19.80	40.50	65.15	11.65	1.85	26.00	7.40	22.55	6.95	39.50	46.00
$N_1P_1K_2$	71.55	111.00	142.00	149.40	163.65	22.90	36.80	61.90	11.45	2.15	25.20	8.15	22.15	6.25	37.00	38.25
$N_1P_2K_0$	65.87	90.30	141.40	144.30	164.65	25.40	38.90	64.05	10.40	1.75	24.75	5.55	22.15	5.25	40.50	34.25
$N_1P_2K_1$	63.65	100.15	142.15	144.40	169.80	20.55	36.30	73.50	13.30	2.60	28.2	8.15	22.55	5.80	31.50	46.00
$N_1P_2K_2$	62.75	96.65	144.6	148.40	169.40	22.058	32.30	65.40	13.40	1.95	26.45	9.70	23.00	7.60	33.50	42.25
$N_2P_0K_0$	63.25	100.65	136.65	142.90	164.90	23.30	46.55	76.9	11.05	1.90	26.45	5.65	22.55	6.25	34.30	45.25
$N_2P_0K_1$	65.80	91.65	142.40	147.50	169.65	24.15	31.40	59.40	12.65	2.00	26.90	9.00	23.40	5.75	31.25	34.00
$N_2P_0K_2$	63.40	99.90	143.25	143.65	159.40	23.90	32.80	63.65	9.55	1.45	28.60	5.45	23.80	5.75	41.75	34.25
$N_2P_1K_0$	67.25	82.90	138.40	145.00	161.15	19.90	25.40	62.40	10.35	1.65	24.30	5.45	21.70	6.10	26.00	35.25
$N_2P_1K_1$	65.15	93.90	135.40	137.25	167.55	24.15	31.00	80.80	10.20	1.65	26.00	7.60	22.15	5.80	25.25	42.25
$N_2P_1K_2$	63.75	104.15	144.25	144.15	168.65	21.40	42.00	65.05	10.70	1.65	26.50	7.85	22.15	6.45	31.00	38.50
$N_2P_2K_0$	70.90	102.90	138.80	152.15	166.65	26.25	31.55	71.40	10.70	1.65	26.05	10.05	20.40	4.95	38.75	35.25
$N_2P_2K_1$	73.90	99.75	144.15	138.15	166.55	34.80	46.50	73.55	9.95	1.55	32.10	7.50	22.55	6.10	36.00	36.50
$N_2P_2K_2$	71.65	98.15	137.75	146.15	169.15	26.80	30.65	63.75	13.15	1.95	25.60	9.80	22.60	5.10	31.25	34.25
CD	NS	NS	NS	NS	* 0.05	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

DAT-Days After Transplanting   DAF1-Days After first Fodder cut   DAR-Days After First Residue cut   * - Siginificant at 0.05

Table 14a. Seed production characters as affected by the interaction of NxPxK fertilizers

	Panicle/hill 60DAFI (cm)	Panicle/hill 48DAR (nos.)	Seed/panicle 60DAFI (gms)	Seed/panicle 48DAR (gms)	Panicle length 60 DAFI (cm)	Panicle length 48 DAR (cm)	First Seed: Total yield 60 DAFI (kg/ha)	First Seed: Pure seed 60 DAFI (kg/ha)	Second Seed: Total yield 48 DAR (kg/ha)	Second Seed: Pure seed 48 DAR (kg/ha)	1000 seed wt. 60 DAFI (gms)	1000 seed wt. 48 DAR (gms)	Seed moisture 60 DAFI (%)	Seed moisture 48 DAR (%)	Seed quality 60 DAFI: Germination (%)	Seed quality 60 DAFI: viability (TTC) (%)	Seed quality 48 DAR: Germination (%)	Seed quality 48 DAR: viability (TTC) (%)
$N_0P_0K_0$	31.65	7.50	0.10	0.350	29.65	25.05	104.05	79.75	76.40	51.45	0.989	0.999	12.00	12.65	21.50	58.0	23.00	50.00
$N_0P_0K_1$	31.15	13.25	0.11	0.230	27.90	28.75	127.65	91.2	68.15	43.75	0.971	1.012	11.60	11.10	17.25	66.00	14.50	70.00
$N_0P_0K_2$	30.05	10.15	0.16	0.300	33.65	28.65	120.15	100.90	94.65	63.00	0.960	1.037	12.20	11.40	30.75	72.00	29.25	72.00
$N_0P_1K_0$	33.25	10.90	0.13	0.300	32.30	27.55	104.05	73.75	70.30	41.20	1.027	1.040	12.05	11.30	12.25	88.00	21.25	50.00
$N_0P_1K_1$	35.80	11.65	0.15	0.265	27.65	29.90	131.20	104.55	85.10	54.80	0.942	0.996	12.20	12.10	20.25	62.00	31.50	50.00
$N_0P_1K_2$	36.15	12.40	0.12	0.335	29.40	27.15	147.70	114.40	99.40	65.85	0.967	0.984	11.70	11.85	29.00	60.00	27.25	52.00
$N_0P_2K_0$	32.90	10.65	0.12	0.230	29.80	27.60	117.10	487.55	66.25	40.20	0.976	0.989	12.05	11.40	19.50	57.00	31.00	70.00
$N_0P_2K_1$	30.50	10.80	0.15	0.385	28.75	26.90	99.05	74.10	116.75	76.90	1.026	1.048	11.85	11.35	11.75	52.00	24.25	64.00
$N_0P_2K_2$	27.90	8.90	0.11	0.470	29.50	29.15	91.35	69.05	92.45	58.00	1.037	1.016	11.10	12.30	14.75	76.00	27.00	44.00

contd......

$N_1P_0K_0$	45.15	17.55	0.11	0.345	26.25	26.65	132.40	110.10	119.35	70.14	0.932	0.941	11.70	11.55	11.75	64.00	22.75	58.00
$N_1P_0K_1$	50.80	16.50	0.10	0.250	26.90	28.40	137.30	113.55	80.25	53.50	0.936	0.989	11.95	12.05	26.75	46.00	16.50	50.00
$N_1P_0K_2$	33.80	16.50	0.16	0.350	27.55	26.15	116.35	99.95	147.55	91.20	1.015	0.979	11.75	11.55	13.25	70.00	25.25	54.00
$N_1P_1K_0$	36.90	9.90	0.12	0.300	29.25	30.05	139.40	119.35	54.70	33.30	0.952	0.969	11.85	11.15	28.50	60.00	25.75	50.00
$N_1P_1K_1$	46.45	15.60	0.09	0.220	28.80	28.05	151.95	118.60	129.35	81.00	0.956	0.996	11.50	11.35	25.50	65.00	32.75	60.00
$N_1P_1K_2$	43.90	14.55	0.13	0.255	28.05	26.05	129.25	101.90	87.65	49.00	0.963	0.991	11.60	12.05	10.75	70.00	18.50	60.00
$N_1P_3K_0$	43.90	18.30	0.15	0.375	27.40	28.15	130.15	104.60	118.05	60.45	0.992	0.990	11.85	12.20	18.25	56.00	16.25	44.00
$N_1P_3K_1$	43.65	15.30	0.09	0.270	28.75	27.65	115.60	101.40	115.90	72.70	0.981	0.976	12.05	11.35	12.25	68.00	26.75	60.00
$N_1P_3K_2$	47.30	17.75	0.13	0.280	33.50	28.80	154.75	129.15	95.05	61.45	0.919	1.001	12.00	11.40	8.25	46.00	19.50	68.00
$N_2P_0K_0$	52.00	11.65	0.09	0.220	26.30	30.30	135.9	107.00	75.50	46.75	0.934	0.982	1.90	12.20	24.5	64.00	265	62.00
$N_2P_0K_0$	45.00	14.65	0.1	0.350	26.75	27.90	127.05	93.95	126.30	80.25	0.998	1.009	11.55	11.45	19.0	74.00	26.25	66.00
$N_2P_0K_2$	44.15	16.90	0.10	0.120	27.65	27.30	149.85	102.75	84.60	44.30	0.971	0.946	12.05	12.30	15.75	56.00	10.75	58.00
$N_2P_1K_0$	44.05	18.65	0.12	0.260	26.55	29.15	133.70	95.55	130.20	80.35	0.975	1.003	11.85	11.15	29.25	64.00	35.00	72.00
$N_2P_1K_1$	48.65	14.15	0.08	0.270	28.25	28.40	130.00	100.3	106.35	65.5	0.951	0.974	11.85	11.40	18.0	74.00	24.00	62.00
$N_2P_1K_2$	50.30	9.65	0.09	0.230	29.30	27.90	120.30	96.70	84.20	51.6	0.896	0.941	12.2	11.55	16.5	56.00	19.00	50.00
$N_2P_2K_0$	50.80	12.15	0.09	0.255	25.90	27.05	140.95	104.40	66.40	42.00	0967	0.973	1.60	11.3	10.25	80.00	42.75	58.00
$N_2P_2K_1$	51.15	14.65	0.09	0.225	26.15	28.05	130.00	104.50	67.70	33.05	0.896	0.958	12.25	12.75	14.50	74.00	26.25	74.00
$N_2P_2K_2$	49.65	21.05	0.15	0.280	27.15	26.65	135.05	96.10	113.75	76.35	0.977	0.974	11.60	11.85	15.25	71.00	28.50	52.00
CD	NS	NS	NS	NS	NS	NS	NS	NS	*	*	NS	NS	NS	NS	NS	NS	NS	NS

DAT-Days After Transplanting   DAF1-Days After first Fodder cut   DAR-Days After First Residue cut   * - Siginificant at 0.05

Table 14b. Seed production character as affected by different levels of N,P and K fertilizers

	Panicle/hill 60DAF1 (cm)	Panicle/hill 48DAR (nos.)	Seed/panicle 60DAF1 (gms)	Seed/panicle 48DAR (gms)	Panicle length 60 DAF1 (cm)	Panicle length 48 DAR (cm)	First Seed: Total yield 60 DAF1 (kg/ha)	First Seed: Pure seed 60 DAF1 (kg/ha)	Second Seed: Total yield 48 DAR (kg/ha)	Second Seed: Pure seed 48 DAR (kg/ha)	1000 seed wt. 60 DAF1 (gms)	1000 seed wt. 48 DAR (gms)	Seed moisture 60 DAF1 (%)	Seed moisture 48 DAR (%)	Seed quality 60 DAF1: Germination (%)	Seed quality 60 DAF1: viability (TTC) (%)	Seed quality 48 DAR: Germination (%)	Seed quality 48 DAR: viability (TTC) (%)
N_0	32.15	10.69	0.125	0.318	29.84	27.86	115.88	132.86	85.49	55.01	0.988	1.013	11.86	11.71	20.22	65.88	25.44	58.66
N_1	43.67	15.78	0.115	0.294	28.49	27.77	134.13	110.96	105.32	63.63	0.960	0.562	11.80	11.62	17.22	60.55	22.66	57.77
N_2	48.53	14.80	0.099	0.251	27.11	28.08	133.65	100.14	95.00	58.35	0.951	0.972	11.87	11.77	18.11	68.11	26.55	61.55
SE	1.68	0.868	0.707	0.018	0.503	0.432	3.671	25.942	5.350	3.897	0.070	31.884	0.079	0.115	1.623	3.572	2.039	3.028
CD	4.870	2.435	NS	NS	1.394**	NS	10.178**	NS	14.829*	NS	NS	NS	NS	NS	NS	NS	NS	NS
P_0	40.42	13.85	0.113	0.285	28.07	27.68	127.92	99.91	96.97	61.03	0.967	0.562	11.85	11.80	20.11	63.33	21.63	60.38
P_1	41.85	13.05	0.110	0.271	28.84	28.24	131.95	102.79	94.14	58.07	0.958	0.988	11.86	11.54	21.11	66.55	26.11	57.77
P_2	42.08	14.39	0.117	0.308	28.54	27.78	123.78	141.26	94.70	57.90	0.974	0.992	11.81	11.76	13.86	64.44	26.91	59.33
SE	1.686	0.868	0.007	0.018	0.503	0.432	3.671	25.942	5.350	3.897	0.070	31.884	0.079	0.115	1.623	3.572	2.039	3.028
CD	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	4.499**	NS	NS	NS

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K_0	41.29	13.03	0.113	0.293	28.16	27.95	126.48	142.45	86.35	51.76	0.971	0.987	11.87	11.65	19.5	65.66	27.13	57.77
K_1	42.71	14.06	0.105	0.274	27.77	28.22	127.76	100.29	99.58	62.38	0.962	0.995	11.86	11.65	18.36	64.55	24.75	62.66
K_2	40.36	14.21	0.123	0.297	29.53	27.53	129.42	101.21	94.92	62.86	0.967	0.562	11.80	11.80	17.49	64.11	22.77	57.55
SE	1.686	0.868	0.007	0.018	0.503	0.432	3.671	25.942	5.350	3.897	0.070	34.884	0.079	0.115	1.623	3.572	2.039	3.028
CD	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

DAF1 - Days After first Fodder cut
DAR - Days After first Residue cut

** - Highly siginificant at 0.01
* - Siginificant at 0.05

Table 14c Seed production characters as affected by the interacation of NxP NxK and PxK fertilizer

	Panicle/hill 60DAF1 (cm)	Panicle/hill 48DAR (nos.)	Seed/panicle 60DAF1 (gms)	Seed/panicle 48DAR (gms)	Panicle length 60 DAF1 (cm)	Panicle length 48 DAR (cm)	First Seed: Total yield 60 DAF1 (kg/ha)	First Seed: Pure seed 60 DAF1 (kg/ha)	Second Seed: Total yield 48 DAR (kg/ha)	Second Seed: Pure seed 48 DAR (kg/ha)	1000 seed wt. 60 DAF1 (gms)	1000 seed wt. 48 DAR (gms)	Seed moisture 60 DAF1 (%)	Seed moisture 48 DAR (%)	Seed quality 60 DAF1: Germination (%)	Seed quality 60 DAF1: viability (TTC) (%)	Seed quality 48 DAR: Germination (%)	Seed quality 48 DAR: viability (TTC) (%)
NxP																		
N_0P_0	30.95	10.30	0.122	0.293	30.40	27.48	117.48	90.62	79.73	52.73	0.973	1.016	11.93	11.71	24.83	65.33	22.25	64.00
N_0P_1	35.07	11.65	0.132	0.300	27.78	28.20	127.65	97.57	84.93	53.95	0.978	1.007	11.98	11.75	20.5	70.33	26.66	52.66
N_0P_2	30.43	10.12	0.123	0.362	29.35	27.88	102.5	210.4	91.82	58.37	1.013	1.018	11.66	11.68	15.33	61.66	26.41	59.33
N_1P_0	43.25	16.85	0.122	0.315	26.90	27.07	128.68	107.87	115.72	71.61	0.961	1.666	11.80	11.71	17.16	60.60	21.5	56.66
N_1P_1	42.47	13.35	0.107	0.258	28.70	28.05	140.20	113.28	90.57	54.43	0.956	0.985	11.65	11.51	21.58	65.00	25.66	59.33
N_1P_2	45.72	17.12	0.118	0.308	29.88	28.20	133.50	111.72	109.67	64.87	0.964	0.989	11.96	11.65	12.91	56.66	20.83	57.33
N_2P_0	47.05	14.40	0.097	0.247	26.90	28.50	137.60	101.23	95.47	50.77	0.968	0.977	11.83	11.98	19.75	64.66	21.16	62.00
N_2P_1	48.00	14.15	0.092	0.253	28.03	28.48	128.00	97.52	106.92	65.82	0.940	0.973	11.96	11.36	21.25	64.66	26.00	61.33
N_2P_2	50.53	15.95	0.110	1.253	26.40	27.25	135.33	101.67	82.62	50.47	0.946	0.968	11.81	11.96	13.33	75.00	32.50	61.33
SE	2.921	1.504	0.012	0.321	0.871	0.748	6.359	9.934	4.266	6.750	0.012	55.224	0.137	0.199	2.811	6.188	3.532	5.246
CD	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

(Contd...)

NxK																		
N_0K_0	32.60	9.68	0.115	0.293	30.58	26.73	108.60	213.68	70.98	44.28	0.997	1.009	12.03	11.78	17.75	67.66	25.08	58.60
N_0K_1	32.48	11.90	0.135	0.293	28.10	28.52	119.30	90.12	90.00	58.48	0.980	1.018	11.88	11.51	16.41	60.00	23.41	61.33
N_0K_2	31.37	10.48	0.127	0.368	30.85	28.32	119.73	94.78	95.50	62.28	0.988	1.012	11.66	11.85	26.5	69.33	27.83	56.00
N_1K_0	41.98	15.25	0.123	0.340	27.63	28.28	133.98	111.35	97.37	54.63	0.958	0.967	11.80	11.63	19.41	60.00	21.58	50.66
N_1K_1	47.36	15.80	0.092	0.247	28.15	28.03	134.95	111.18	108.50	69.07	0.958	0.987	11.83	11.58	21.50	59.66	25.33	59.33
N_1K_2	41.67	16.27	0.132	0.295	29.70	27.00	133.45	110.33	110.08	67.22	0.966	1.666	11.78	11.66	10.75	62.00	21.08	63.33
N_2K_0	49.28	14.15	0.100	0.245	26.25	28.83	136.85	102.32	90.70	56.37	0.958	0.986	11.78	11.55	21.33	69.33	34.75	64.00
N_2K_1	48.27	14.48	0.088	0.282	27.05	28.12	129.07	99.58	110.12	59.60	0.948	0.980	11.88	11.86	17.16	74.00	25.50	67.33
N_2K_2	48.03	15.87	0.110	0.227	28.03	27.28	135.07	98.52	94.18	59.03	0.948	0.957	11.95	11.90	15.83	61.00	19.41	53.33
SE	2.921	1.504	0.012	0.032	0.871	0.748	6.359	44.934	19.266	6.075	0.012	55.224	0.137	0.199	2.811	6.188	3.532	5.246
CD	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	0.5*	NS	NS	NS
PxK																		
P_0K_0	42.93	12.23	0.098	0.305	27.40	27.33	124.32	98.95	90.42	56.11	0.952	0.974	11.86	12.13	11.16	62.00	24.00	56.66
P_0K_1	42.31	14.80	0.103	0.277	27.18	28.35	130.67	99.57	91.57	59.17	0.968	1.003	11.70	11.53	21.00	62.00	19.08	64.66
P_0K_2	36.00	14.52	0.138	0.273	29.62	27.37	128.78	101.20	108.93	67.83	0.982	1.667	12.00	11.75	21.50	66.00	21.75	61.33

Contd......

P_1K_0	38.40	13.15	0.122	0.287	29.37	28.92	125.72	96.22	85.07	51.62	0.954	1.004	11.91	11.20	23.33	70.66	27.33	59.33
P_1K_1	43.70	13.80	0.103	0.257	28.23	28.78	137.72	107.82	106.93	67.00	0.949	0.988	11.85	11.61	21.25	67.00	29.41	57.33
P_1K_2	43.45	12.20	0.105	0.273	28.92	27.03	132.42	104.33	90.42	55.48	0.942	0.972	11.83	11.81	18.75	62.00	21.58	56.66
P_2K_0	32.53	13.70	0.118	0.287	27.70	27.60	129.40	232.18	83.87	47.55	0.978	0.984	11.83	11.63	16.00	64.33	30.00	57.33
P_2K_1	42.10	13.58	0.108	0.293	27.88	27.53	114.88	93.50	100.12	60.88	0.968	0.994	12.05	11.81	12.83	64.66	27.75	66.00
P_2K_2	41.61	15.90	0.125	0.343	30.05	28.20	127.05	98.10	100.42	65.77	0.978	0.997	11.56	11.85	12.75	64.23	25.00	54.66
SE	2.921	1.504	0.012	0.032	0.871	0.748	6.359	44.934	9.266	6.750	0.012	55.224	0.137	0.199	2.811	6.288	3.532	5.246
CD	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

DAT-Days After Transplanting   * - Siginificant at 0.05

DAF1-Days After first Fodder cut

DAR-Days After First Residue cut

Discussion

DISCUSSION

The study on the seed production potential of Guinea grass (Panicum maximum Jacq.) cv Riversdale under different management techniques was conducted at farm unit of Kerala Livestock Development Board, Dhoni, Palakkad during the period from May 1992 to May 1993. The main objectives of the study were to find out, the optimum time of cutting to obtain maximum production of seed, to find out the optimum time of seed collection and to find out the optimum level of nitrogen, phosphorus and potassium to get maximum yield.

Growth and fodder yield characters, plant height, tiller number, leafiness, green yield, dry matter yield and the seed yield parameters like number of panicles per hill, length of panicle, weight of seed per panicle, thousand seed weight, seed yield per hectare, germination, viable seeds, moisture percentage of seed were measured and recorded.

The data obtained were analysed statistically. The results from this study are discussed below.

5.1. Growth and fodder yield

The height of the plant and the number of tillers per hill at 30 or 60/50 days after transplanting were not significantly influenced by the different cutting treatment.

This is because that the treatments had not been applied till then.

The significantly higher green as well as dry matter yield of the first residue/fodder cut may be because, in the case of C_1 treatment fodder cut was made 108 days after transplanting and in the case of C_2 and C_3 cutting treatment, 50 days after transplanting. Krishnaraj (1976) has reported that guinea grass produced 8.37 t/ha green fodder and 1.52 t/ha dry fodder in a single cut. Approximately 7.4 times increase in the dry matter yield compared to 3 times increase in green yield between C_1 cutting treatment on the one hand and C_2 and C_3 cutting treatment on the other hand noticed here may be because there is greater accumulation of dry matter as the fodder matures. This shows that leaving the crop for seed and subsequent residue cut will result in reduced fodder quality compared to having a fodder cut 50 days after transplanting and then leaving the crop for seed cut. The result on the leafiness of residue/fodder cut also proved the above contention.

The green and dry matter yield in the case of second fodder cut of C_3 treatment was significantly superior to first fodder cut of C_2 or C_3 cutting treatment. This may be due to increase in number of tillers noticed during the second fodder cut. Chandini and Raghavan Pillai (1980) has reported that guinea grass produced 8.74, 11.91 and 5.16 t/ha of green fodder from the 1st, 2nd and 3rd cut respectively. This showed that yield potential of second fodder cut is significantly superior to the first fodder cut.

When the first residue cut of C_1 and C_2 cutting treatment are compared the green yield of C_2 treatment is significantly more compared to the C_1 treatment whereas the dry matter is significantly less. There was not much difference in the leafiness between these two treatments. The C_2 cutting treatment was subjected to one fodder cut which resulted an increase in tiller number thereby increasing the green yield and in the case of C_1 treatment the possibility of increasing tiller number ceased because of the crop turned to reproductive phase. The lower dry matter in the first residue cut of C_2 cutting treatment compared to that of C_1 may be because of lesser duration for dry matter accumulation.

5.2. Height and tillers of plants

The results on plant height and tiller per hill 30 days after first residue cut of C_1 cutting treatment and 30 days after first fodder cut of C_2 and C_3 treatment do not show any general trend.

When the green, dry matter yield and leafiness of second residue cut of C_1 cutting treatment and first residue cut of C_2 are compared, green yield was significantly more in first residue cut of C_2 cutting treatment (1.5 times), the dry matter yield was significantly less (0.7 times) and the leafiness was significantly more (1.1 lower). This showed that dry matter accumulation is more in second residue cut of C_1 cutting treatment resulting in the reduced fodder quality compared to the first residue cut of C_2 treatment. Another reason may be that the crop was harvested 71 days after the first residue cut of C_1 cutting treatment compared to 61 days after first fodder cut in C_2 cutting treatment, ie. the crop in C_1 cutting treatment is older compared to the C_2 cutting treatment. Over maturity, leads to accumulation of more crude fibre which reduces the quality of fodder (Butterworth, 1967).

When second residue cut of C_1 and C_2 cutting treatments and first residue cut of C_3 cutting treatments are compared, the plant height and number of tillers per hills 30 days after the previous cut (residue/fodder) were more or less similar. This shows that the rejuvenating ability of the plant is decided more by the age of the plant than by the number of cuts (1st or 2nd cut),type of cut (residue/fodder) to which it has been subjected. When green/dry matter yield and leafiness were compared among the second residue cut of C_1 and C_2 cutting treatment and first residue cut of C_3 cutting treatment they were found to be significantly less in the second residue cut of C_2 cutting treatment. This may be because the soil might have been exhausted with one fodder cut followed by two seed cuts.

When the first residue cut of C_1 cutting treatment is compared to the second residue out of C_1 or C_2 cutting treatment and first residue cut of C_3 cutting treatment it was found that the green yield was significantly more and dry matter is on par in the second residue cut of C_1 or C_2 cutting treatment and first residue cut of C_3 cutting treatment. The biomas production in C_1 treatment was higher compared to other two treatments because of the long duration of the crop growth 108 days at which the first residue cut occurred and in the case of second residue cut of C_1 or C_2 and first residue cut of C_3 cutting treatment the period of regrowth is only about 75 days. The second residue cut of C_1 or C_2 and first residue cut of C_3 falls during the dry period of the season and will account for higher dry matter percentage than the first residue cut which falls during the wet season and when the dry matter percentage will be much less.

When cumulative green/dry matter yield of individual cutting treatment were compared (Table 2e), it was found that largest green yield was obtained in C_2 cutting treatment and lowest in the C_1 cutting treatment. There was not much difference in the green yield between C_2 and C_3 cutting treatment. This may be because the first fodder cut and first residue cut in C_2 cutting treatment and the fodder cuts in C_3 cutting treatment falls in wet season, whereas in the case of C_1 cutting treatment only the first residue cut falls in the wet season. The last cuts of all treatments happened to be in the period of less rainfall and the yields were on par. When we consider these two factors the cumulative green yield will be more in the C_2 cutting treatment compared to C_1 and C_3 treatments. The lowest cumulative dry matter yield in C_2 cutting treatment may be because of the significantly lower dry matter yield obtained during the first residue cut and second residue cut in the C_2 treatment. This is because the rejuvenating ability of the plant is decided more by the age of the plant than by the number of cuts and type of cuts. Borget (1966) has reported that more realistic yields range mostly between 4 and 12 t dry matter/ha or between 15 and 50 t/ha fresh fodder. Makueni guinea grass produced 46 t of fresh fodder and 15 t of dry fodder per hectare in 5 cuts (Anon., 1983). Raghavan Pillai (1986) has reported that guinea grass produced 7.55 t/ha of dry fodder from three cuts. The present study also showed that the cumulative green and dry matter yield is more compared to that of any previous study. This may be because our study involved both fodder and residue cuts whereas the reports cited are based on fodder cuts only. The crude protein per cent was more than twice in fodder cut compared to that in dry residue cut indicating superior nutritive value of the fodder cut. However, the total crude protein content behaved more or less like the dry matter yield indicating positive correlation in between the dry matter yield and protein yield. The crude fibre per cent was more in dry residue cut than in dry fodder cut. These results point out that superior quality fodder will be obtained due to the first two fodder cuts in the C_3 cutting treatment followed by that first fodder cut in C_2 cutting treatment and lowest quality fodder will be obtained in the case of dry residue cuts of the different cutting treatment. On over all basis it can be inferred that in the farmers primary emphasis on fodder yield and seed yield is only subsidiary C_3 cutting treatment can best be recommended. On the other hand if the primary emphasis is on seed yield and fodder yield is only subsidiary C_1 cutting treatment can be recommended. If both fodder yield and seed yield are equally important C_2 cutting treatment can be recommended.

5.3. Seed Yield Components

5.3.1. Panicle per hill

Significantly more number of panicle per hill in the first seed cut of C_2 treatment compared to that of C_1 may be because of the large number of tillers obtained as a result of first fodder cut. In C_2 cutting treatment higher panicle density could be observed after a forage cut 50 days after transplanting. This is because the number of tillers produced especially fertile tillers were more after a forage cut. However, the present study is in contradiction to that of Peres et al. (1990) who observed the total number of reproductive stem was greatest without cutting. Ward et al. (1984) also found that seed yield of Tallfescue was reduced by defoliation.

It is worth noting that number of panicles per hill due to C_3 cutting treatment was lowest compared to first and second seed harvest in either C_1 or C_2 cutting. Naturally, number of panicle per hill was not influenced by any of the stages of harvest in any of the cutting treatments.

5.3.2 Panicle length

Panicle length was significantly more in the first seed cut compared to second seed cut in both C_1 and C_2

treatments. The panicle length in the C_3 cutting treatment was more or less similar to that of the second seed cut of either C_1 or C_2 treatment. Thompson and Clark (1989) has seen that stubble cutting has reduced the panicle weight and Montero et al. (1984) observed that the panicle length was affected by cutting date. Patil and Singh (1963) have opined that seed production components are closely depend upon current photosynthesis. In the present study the panicle length was more in the case of first seed cut compared to second seed cut in both C_1 and C_2. It can be concluded that panicle length is affected by different cutting treatments.

5.3.3. Pure seed per panicle

Pure seed per panicle was more in the first seed cut of both C_1 and C_2 cutting treatments. The weight of pure seed per panicle in the case of C_3 cutting treatment was more or less similar to that of second seed cut from either C_1 or C_2 treatment. Montero et al. (1984) had observed that all seed yield components were affected by cutting date. Defoliation has reduced the seed yield in Tallfescue (Ward et al., 1984). Lombardo and Tuttobene (1988) opined that forage cut reduced the number of seeds per panicle. From this study it could be observed that pure seed per panicle is affected by different cutting treatments.

Weight of pure seed per panicle were not significantly influenced by stages of harvest in the first seed cut of C_1 cutting treatment, the reason being that the seed shedding was not severe during the seed maturation period due to the wet and overcast weather condition, which lead to slow maturation of seed. Significant difference was observed due to the stages of harvest of panicle during the second seed cut of C_1 and C_2 cutting treatment. Invariably weight of pure seed per panicle decreased in all the cases as the harvest of panicle was delayed. Weight of pure seed per panicle was maximum at the first two stages of harvest ie 10 days and 15 days after panicle emergence and rapid decrease in pure seed per panicle in later stages of harvest ie. 20, 25, 30 days after panicle emergence in all the cutting treatments. Gonzalez and Torrente (1989) obtained the highest yield of total seed per panicle (384 mg) and fertile seed per panicle (213 mg) 15 days after full flag leaf emergence. From the present study the highest pure seed per panicle recorded was for 10 days after panicle emergence.

5.3.4. Thousand seed weight

In general thousand seed weight was not much influenced by the cutting treatments as well as the stages of harvest of panicle. Sangakkara (1990) has reported that defoliation has no significant effect on thousand seed weight in

Panicum maximum. Patil and Singh (1963) have remarked that characteristics such as high seed density grain filling and maturation are closely dependent on current photosynthesis. Hebblethwaite and Clemence (1981) have observed that thousand seed weight has no effect on seed yield in *Lolium perenne*

5.3.5. Germination

Germination percentage was not significantly influenced in either first or second seed cut due to stages of harvest of panicle in the C_1 cutting treatment and first seed cut in C_2 cutting treatment. In the case of second seed cut of C_2 treatment zero germination due to harvest of panicle at 25 and 30 days after panicle initiation was noticed due to non availability of seeds for germination studies. Similarly in the case of harvest of panicle at 20 days after panicle emergence seeds for germination studies were available only in one replication. Hence low mean germination percentage was noticed in this study. No definite trend in the case of C_3 cutting treatment could be observed due to harvest of panicle at different days after emergence.

In most tropical grasses post harvest seed maturation is needed. The best germination is usually observed in 6 to 12 month old seeds and then it declines first slowly and then faster (Bogdon, 1977). Because of this reason no consistent results on germination percentage could be obtained.

5.3.6. Moisture percentage

Moisture percentage of seeds collected at different stages of harvest could not be determined in the case of C_2 and C_3 cutting treatments and also in the second seed harvest of C_1 cutting treatment. Moisture percentages was not significantly influenced in the case of first seed cut of C_1 treatment, the reason being the seeds of all stages of harvest of panicle were subjected to uniform drying method. 4 to 5 gm of such seeds are required to test the moisture content of seed according to ISTA rules.

5.4. Pure seed yield per hectare

The pure seed per hectare extrapolated from the weight of seed of panicles was tagged at different stages of harvest. Tagging of flowers in each stage was continued for few days during the peak flowering period ie. about 4 to 8 days. This was necessitated because of non-uniformity of panicle emergence. The pure seed yield/ha showed significant variations due to different stages of harvest in the cutting treatments. It is worth noting that in the case of C_1 cutting treatment drastic reduction in seed yield was observed only at 30 days after panicle emergence. In the case of first seed cut of C_2 cutting treatment also drastic reduction in seed yield was observed 25 days after panicle emergence onwards. On the contrary in the case of second seed harvest of C_1 and C_2 and first seed harvest of C_3 treatment not only the yield were low but also drastic reduction was observed from 20 days from panicle emergence and the seed yield was less.

Weather plays an important role in the maturation of seeds. A good weather forecasting will help to maximise recoverable seed yield (Humphreys, 1979). In the case of C_1 treatment, difference in yield due to stages of harvest were non significant for first seed harvest but there was general decrease in yield with later stages of harvest. Higher seed yield recorded in all the stages of seed harvest in the first seed harvest in C_1 treatment because of the retention of seed in panicle due to wet and overcast weather (Table 11). Drastic reduction in yield in the second seed harvest of C_1 and C_2 and first seed harvest of C_3 cutting treatment was because of the dry and clear sunny weather prevailed during the period (December). Gaveria et al. (1989) reported highest seed yield harvested at 35 days after floral initiation and lowest yield 20 days after floral initiation, optimum harvest date was considered to be between 4th and 6th week after beginning of flowering for highest seed yield of Brachiaria decumbens (Oliveira and Mastrocola, 1980). Pinto and Nabinger (1984) considered the interval from 17.5 to 24.5 days for harvesting of Paspalum queroarum Areth. Janqueira et al. (1985) found optimum harvest data in Setaria sphacelata to be 29-36 days from beginning of flowering.

When cumulative seed yield of different cutting treatments are considered the seed yield obtained due to C_3 cutting treatment with two fodder cut and are seed cut was significantly lower compared to C_1 and C_2 treatment. Maximum seed was obtained due to C_1 cutting treatment with two seed cuts, this being 8.6 times more compared to C_3 cutting treatment and 1.3 times compared to C_2 cutting treatment. From this it is understood that leaving the crop for seed during the early stages of growth will result in good seed yield and leaving the crop in the late stages of growth will give only less seed and these are governed by weather conditions also (Wet and overcast weather/dry and clear sunny weather conditions). Second seed cut of C_1 and C_2 and first seed cut of C_3 accounted very less seed yield in which harvests were carried out in dry and clear sunny days during December.

Febles et al. (1982) reported higher pure seed yield of 150 kg/ha in common guinea grass (Panicum maximum). An yield of

194 kg/ha was harvested from _Panicum maximum_ cv Gatton panic (Hopkinson and English (1982). Oliveira and Mastrocola (1980) reported highest average seed yield of 103.35 kg/ha in _Brachiaria decumbens_ in the first year. Total seed yield ranged from 40 kg to 74.9 kg/ha in _Panicum maximum_ (Peres _et al_., 1990).

5.5. Economics

The cost benefit ratio worked out also shows that highest returns can be obtained by resorting to the C_1 cutting treatment and lowest returns due to C_3 cutting treatment. However a livestock farmer cannot afford to feed his cattle with low quality fodder throughout the year. If he can meet both the requirement of his livestock and seed demand of his farm and is left with surplus quantity of seed for sale that can be the best management. In this sense C_2 cutting treatment best serves the purpose. However the main emphasis of this study was to find out the best cutting management to obtain maximum seed production and hence C_1 cutting treatment can be the best recommended for a commercial seed farmer.

EXPERIMENT II

The experiment has shown that nitrogen fertilizer has significantly affected the plant height and number of tillers 30 days after the first fodder cut. Similarly plant height was significantly affected 40 days after first seed cut. Black (1957) recorded positive responses to nitrogen in many tropical grass seed crops. The green yield significantly reduced at the second seed harvest ie. 48 days after the first residue by fertilizer application. Leafiness showed declining trend with increase in fertilizer application. Janqueira et al. (1985) opined that number of vegetative tillers increased linearly with increasing does of nitrogen. Reproductive and vegetative tiller numbers decreased linearly with time.

In general fertilizer application did not affect the fodder yield. The non significant effect of nitrogen on growth and yield characters during the first fodder cut may be because a general dose of 50 kg N/ha was applied to achieve the initial establishment of the crop, ie. fertilizer treatment was not applied at this time.

Generally speaking different levels of nitrogen did not have much influence on the growth and yield characters of the crop during the first and second seed cut. Only in certain cases like 30 days after first fodder cut plant height and number of tillers were significantly increased by increasing levels of fertilizer. However the green yield of residue cut decreased with increased levels of nitrogen during the second seed cut. However dry matter yield was not affected by the nitrogen fertilizer during any of the cutting stages. The P and K fertilizers also did not affect the growth and fodder yield characters of the crop during any of the cutting stages. The interaction effect of N, P and K on the growth and fodder yield characters were not significant. This shows that fertilizer in general did not have any effect on the growth and fodder yield characters of the crop during any of the cutting stages. This may be because of the high inherent fertility status of the soil (Table 1). Chemical analysis has shown that, the soil of the experiment site is fairly rich in nutrient status with the available nitrogen 350 kg/ha available phosphorus 46.4 kg/ha and exchangeable potassium 436.8 kg/ha.

It was generally found that application of fertilizer to a soil already rich in nutrient status will fail to give any positive response. In some cases it may even be deleterious. The present study also the green yield of the residue after the second seed cut has shown decreasing trend with increasing nitrogen fertilizer. The leafiness has also decreased at the time of first residue harvest of the crop with the increasing levels of nitrogen. The interaction effect of the different fertilizers was also found to be non significant. This again shows that soil was fairly rich in nutrient status. Crowder et al. (1970) reported that well fertilized and irrigated Panicum maximum can produce 40-50 t dry matter/ha in Columbia and in India a yield of 226 t fresh herbage/ha per year in 12 cuts was recorded for sewage irrigated grass (Narayanan and Dabadghavo, 1972). In Puertorico 46.72 t dry matter/ha were recorded (Little et al. 1959; Vicente Chandler, 1959) for a crop given about 900 kg N/ha. Fairly high yields were also obtained in Thailand, 20 t dry matter/ha/year when fertilized with NPK and irrigated during the dry season (Holm, 1972).

The results reported are based on the experiments with irrigation and application high level of fertilizers. These reports are in contradiction with the observations of the present study where it is conducted in a fairly rich soil and seed production studies were included.

5.6. Seed yield characters

Nitrogen fertilizer significantly increased the number of panicles per hill during the first and second seed cut. This may be because increased number of tillers per hill was observed due to nitrogen application. This may be the reason for increased seed yield due to nitrogen application during the first and second seed cut. Bilbao et al. (1979) observed that panicle production per hectare increased with nitrogen rate. Highest pure seed yield of 150 kg/ha were given with application of 100 kg N/ha and the seed production was highest with application of 200 kg N/ha in the second year in *Cenchrus ciliaris*. Janqueira et al. (1985) opined that the number of vegetative tillers increased linearly with increasing nitrogen in *Andropogon gayanus*.

However, the seeds per panicle and length of panicle and number of seeds per panicle and thousand seed weight showed a general declining trend with increasing nitrogen application eventhough the effects were non significant. This may be because of the increased number of panicle per hill and consequent competition between source and sink.

Seed moisture content and germination percentage and number of viable seeds (determined by indirect test) also were not affected by the nitrogen application.

P and K fertilizers did not affect any of the seed yield characteristics in general. This may be because of the high nutrient status of the soil. This may also be the reason for non significant interaction effect among N, P and K fertilizers.

Positive responses to nitrogen have now been recorded in many tropical grass seed organs (Black, 1957). Boonman (1972a) recorded highest seed yield at low nitrogen level at 90 cm spacing in Setaria sphacelata. Chadhokar and Humphrey (1973) observed that response to nitrogen was much less in Paspalum plicatulum during the year of establishment.

The important conclusions from the discussions are the following.

1. Maximum seed yield was obtained from the crop that is transplanted and left without cutting till flowering during the first season. This management is best recommended for a commercial seed grower.

2. A livestock farmer can maximise returns from their land through multiple use of their crops for both seed and forage a cutting management with one fodder harvest in the beginning of the season and subsequent seed harvest best serves the purpose.

3. The ideal stage of harvest of seed crop to obtain maximum seed yield is considered to be 10 to 15 days after panicle emergence. Seed yield decreases with delayed harvest (20, 25, 30 days after emergence of panicle). The problem aggravate during the dry season.

The study showed that the seed quality was on par in all stages of harvest. Studies are needed to determine whether seed harvest can be further advanced to an earlier stage after panicle initiation.

4. Nitrogen, phosphorus and potassium fertilizer application upto 200, 80, 60 kg/ha respectively was not effective in increasing either the fodder or seed yield probably due to the high inherent fertility status of the soil of experimental site.

5.7. Future Line of Work

In sites where the fertility status of the soil is generally high we may not get response to the application of fertilizers on fodder and seed yield. The present site belonging to the farm unit of Kerala Livestock Development Board it was successively put under fodder maize/sorghum for the past 5 years with heavy load of cowdung application and 50, 80, 60 kg/ha respectively of N, P_2O_5, K_2O applied for each crop. However, farmers field may not be so much rich in nutrient status and therefore there is every scope to conduct research in such situations. The study shows that harvesting of panicle within 15 days after emergence has recorded highest seed yield. Further studies are required to know the effect of harvesting panicles earlier than the present study.

Summary

SUMMARY

Field experiments were conducted at the Farm unit of Kerala Livestock Development Board, Dhoni, Palakkad on a gravely clay-loam soil during May 1992 to May 1993. The objective of the experiment was to investigate the seed production potential of Guinea grass (Panicum maximum Jacq) CV Riversdale under different management techniques. Two experiments were laid out. Experiment I was laid out in randomised block design with fifteen combinations of three types of cutting management and five stages of seed collection treatments. Experiment II was laid out in partially confounded factorial design with two replication and three blockes in each replication. The experimental treatments were twenty seven combinations of three levels each of nitrogen, (N_0, N_{100}, N_{200}kg/ha) Phosphorus (P_0, P_{40}, P_{80}kg/ha) and Potassium (K_0, K_{30}, K_{60}kg/ha)

The important findings are summarised below.

1. Different cutting treatments did not affect growth attributes either at 30 or 60/50 days after transplanting.

2. Different cutting treatments influenced the green and dry matter yields during the first residue/fodder cut. First residue harvest recorded highest green and dry matter yield compared to the first fodder cut.

3. Different cutting treatments significantly influenced the height of the plant and number of tillers per hill 30 days after first residual fodder cut. Larger tiller number and green yield was obtained during the first residue cut in the treatment in which one fodder cut was taken.

4. Green and dry matter yield in the second fodder cut was significantly superior to first fodder cut.

5. Various cutting treatments did not show much difference in the leafiness of fodder crop.

6. Growth and fodder yield characters in the second residue cut were more or less at par in all the cutting treatments. Plant height, tiller number per hill, leafiness, green and dry matter yield in general was not affected by the cutting treatments.

7. Highest cumulative green yield was recorded in the cutting treatment with one fodder cut and two residue cut and lowest in the case of cutting treatment with two residue cut. But the cumulative dry matter yield was highest in the case of cutting treatment with two residue harvest and lowest in the case of cutting treatment with one fodder cut and two residue harvest.

8. Number of panicles per hill was influenced by different cutting treatment during the first and second seed harvest. In general the number of panicle per hill was higher in the first seed harvest than the second seed harvest in all the cutting treatment. Number of panicle per hill was highest in the first harvest of the treatment in which one fodder cut was taken and left for seed.

9. Length of panicle was significantly more in the first seed cut than the second seed cut. Panicle length in the last seed cut were more or less similar in all the different cutting treatments.

10. Panicle length was not influenced by the different stages of harvest (10, 15, 20, 25 and 30 days after panicle emergence).

11. Weight of pure seed per panicle was more in the first seed cut than in the second. The weight of pure seed per panicle in the last seed harvest was more or less similar to that of second seed cut in all the cutting treatments.

12. The different stages of earhead harvest (10, 15, 20, 25 and 30 days after panicle emergence) did not significantly influence the weight of pure seed per

panicle in the first seed harvest of the treatment in which the crop is left for seed after transplanting without any fodder cut.

13. Significant difference was observed due to the stages of harvest of panicle during the last seed harvest of all treatments.

14. Weight of the pure seed per panicle was maximum at the first two stages ie. 10 days and 15 days after panicle emergence and rapid decrease was observed in pure seed per panicle in later stages of harvest ie, 20, 25, 30 days after panicle emergence in all the cutting treatments.

15. Thousand seed weight was not much influenced by the cutting treatments as well as the stages of harvest.

16. Germination percentage was not significantly influenced in either first or second seed cut due to the stages of harvest of panicle.

17. Count of viable seeds as determined by Topographical Tetrazolium Chloride test, was not significantly influenced by the cutting treatments as well as the stages of harvest of panicles.

18. Highest cumulative seed yield was obtained from the cutting treatment with two consecutive seed cuts and no

fodder cut and lowest seed yield in the cutting treatment with two consecutive fodder cut and one seed cut.

19. Seed yield decreased in general with stages of harvest of panicles. Seed yield decreased rapidly with later stages of harvest.

20. Growth characters like plant height, tiller number per hill at 30 days after transplanting and at the time of first fodder cut 50 days after transplanting was not affected by any of the P and K fertiliser treatment.

21. Application of 100 kg nitrogen fertilizer significantly affected plant height and tiller number per hill 30 days after first fodder cut. Higher dose of nitrogen fertility 200 Kg N/ha did not show additional influence. P and K fertilizers did not show any influence on plant height and tiller number.

22. The green and dry matter obtained after the first seed cut was not influenced by any of the fertilizer treatment.

23. The difference in plant height during second seed harvest was not consistent due to nitrogen fertilizer application. P and K fertilizer did not have any influence on plant height. The green yield, dry matter

yield and leafiness after second seed cut was not influenced by fertilizer application.

24. Two factor interaction effects involving N, P and K did not show any influence on the growth and fodder yield characters.

25. Nitrogen fertilizer application significantly increased number of panicles per hill during the first and second seed harvest. P and K fertilizer did not have any influence on number of panicles per hill.

26. While higher level of nitrogen decreased the panicle length, P and K did not have any influence.

27. Weight of pure seed per panicle decreased with increased level of nitrogen fertilizer. But P and K did not have any influence.

28. Application of 100 kg N/ha significantly increased the seed yield during the first and second seed harvest. P and K fertilizers did not have any influence on seed yield.

29. Nitrogen fertilizer application showed declining trend in thousand seed weight. P and K fertilizer did not have any influence.

30. Interaction effect of N, P and K fertilizers on growth and seed yield characters, number of panicle per hill, panicle length, weight of seed per panicle, seed yield, thousand seed weight, seed moisture, germination, viable seed count were not significant.

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* Originals not seen

Appendices

Appendix 1. Weather data during crop period (18 to 52 standard meteorological week)

Standard week	Period	Rainfall (mm)	Temperature°C Minimum	Maximum	Rainy days (No.)
18	May 1-7	2.0	38.0	25.4	1
19	8-14	4.7	35.8	28.3	1
20	15-21	7.1	33.3	24.8	2
21	22-28	-	34.5	25.3	-
22	29-4 June	8.2	36.0	21.5	1
23	June 5-11	22.5	34.0	23.8	2
24	12-18	225.2	27.0	23.2	7
25	19-25	199.7	26.7	21.2	6
26	26-2 July	20.8	29.0	24.0	3
27	July 3-9	20.5	29.8	23.7	3
28	10-16	55.7	32.0	23.5	4
29	17-23	174.7	24.5	23.1	7
30	24-30	360.9	25.5	23.1	7
31	31-6 Aug	115.7	27.8	22.5	5
32	Aug 7-13	116.4	27.7	22.7	6
33	14-20	90.5	26.1	22.8	6
34	21-27	59.5	28.0	23.6	4
35	28-3 Sept	77.4	26.4	23.1	6
36	Sept 4-10	83.7	27.5	23.0	3
37	11-17	90.0	30.0	24.0	2
38	18-24	96.8	31.1	23.2	4
39	25-1 Oct	37.3	31.0	22.7	5
40	Oct 2-8	20.8	27.0	25.1	5
41	9-15	76.7	29.1	23.2	4
42	16-22	10.0	28.1	23.1	1
43	23-29	2.5	31.8	22.0	1
44	30-5 Nov	27.7	32.4	22.4	4
45	Nov 6-12	142.6	30.5	22.7	3
46	13-19	32.7	28.4	25.2	6
47	20-26	13.7	30.8	22.4	1
48	27-3 Dec	-	29.8	23.6	-
49	Dec 4-10	-	29.7	22.4	-
50	11-17	-	29.8	21.8	-
51	18-24	-	29.8	20.6	-
52	25-31	-	30.5	20.1	-

Plate 1. Nursery performance of guinea grass 45 days after sowing

Plate 2. Performance of dual purpose management for fodder and seed.

Plate 3. Phasic development of guinea grass for seed and fodder

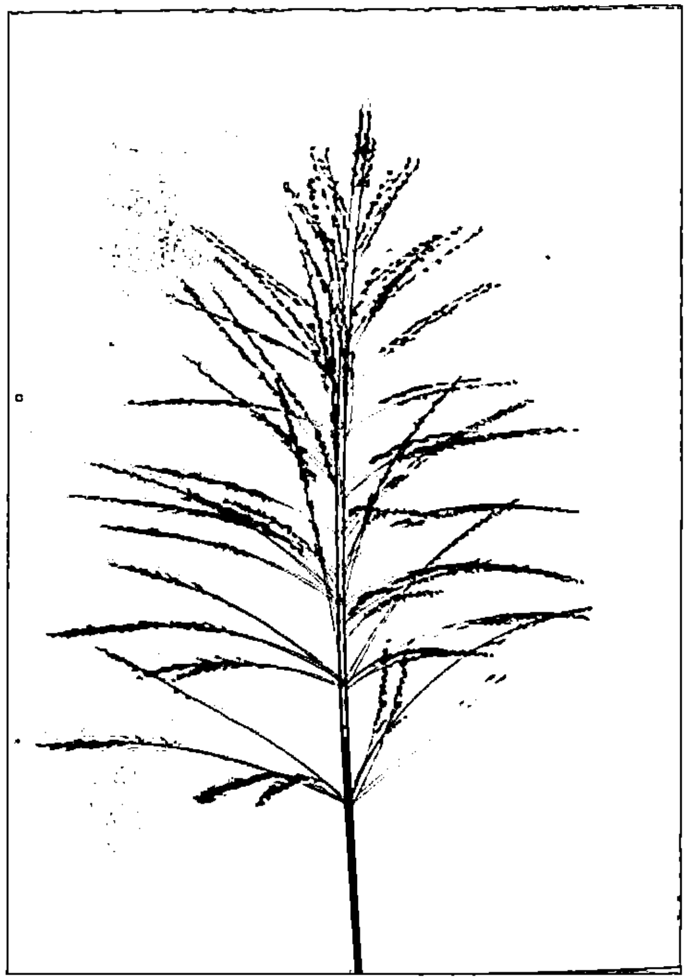
Phase 4. Guinea grass in full bloom

Plate 5. Technique of tagging open panicle with stickers

Plate 6. Development stages of inflorescence in guinea grass

Plate 7. Open panicle of guinea grass

Plate 8. Vigorous emergence of seedlings



SEED PRODUCTION POTENTIAL OF GUINEA GRASS (*Panicum maximum* Jacq.) cv RIVERS DALE UNDER DIFFERENT MANAGEMENT TECHNIQUES

By

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ABSTRACT OF THESIS

Submitted in partial fulfilment of the requirement for the degree

Master of Science in Agriculture

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1993

ABSTRACT

Two field experiments were conducted at farm unit of Kerala Livestock Development Board, Dhoni, Palakkad on a gravely clay-loam during May 1992 to May 1993. The objective of the experiments was to investigate the seed production potential of Guinea grass (Panicum maximum Jacq.) cv Riversdale under different management techniques. First experiment was laid out in randomised block design with fifteen combinations of three types of cutting management (C1-two seed harvest only, C2-one fodder cut and two subsequent seed harvest, C3-two fodder cut and one seed harvest) and five stages of seed harvest (10, 15, 20 25 and 30 days after panicle emergence) replicated thrice. Second experiment was laid out in partially confounded factorial design with twenty seven combination of different levels of N, P and K (No, N100, N200, P0, P40, P80, K0, K30, K60 kg/ha.). The data collected from the experiment were statistically analysed. The abstract of the study is presented below:

Highest seed yield 167 kg/ha. was obtained from the Guinea grass cv Riversdale when transplanted at a spacing of 60x60 cm, fertilized with 100kg N, 80kg P205 and 60kg K20 and left without cutting till flowering during the first season and one subsequent seed harvest in the second season.

The crop residue received after seed harvest was poor in quality containing higher percentage of crude fibre. A livestock farmer cannot afford to feed his cattle with low quality fodder through out the year. If he can meet both requirement of his livestock and his own demand of seed and the surplus quantity of seed for sale that could be the best management. A cutting management with one fodder cut in the beginning of the season and subsequent seed harvest serves best the purpose with a seed yield of 127 kg/ha. The ideal stage of harvest of seed crop to obtain maximum seed yield is considered to be 10 to 15 days after panicle emergence. The seed yield decreases with delayed harvest (20, 25, 30 days after emergence of panicle). The problem aggravates during the dry seasons. The study showed that the seed quality was on par in all stages of harvest. N, P and K fertilizer application upto 200, 80, 60 kg/ha respectively was not effective in increasing either the fodder or seed yield probably due to the high inherent fertility status of the soil of experimental site.