# SEEDLING PROGENY ANALYSIS IN SELECTED CLONES OF GUINEA GRASS (*Panicum maximum Jacq.*)

By

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**THESIS**

SUBMITTED IN PARTIAL FULFILMENT OF
THE REQUIREMENT FOR THE DEGREE OF
MASTER OF SCIENCE IN AGRICULTURE
(PLANT BREEDING & GENETICS)
FACULTY OF AGRICULTURE
KERALA AGRICULTURAL UNIVERSITY

DEPARTMENT OF PLANT BREEDING & GENETICS
COLLEGE OF AGRICULTURE
VELLAYANI, THIRUVANANTHAPURAM
1997

To

Beloved mom

Dear Dad and

Caring brothers

Venkat & Prabha

## DECLARATION

I hereby declare that this thesis entitled **"Seedling progeny analysis in selected clones of guinea grass (*Panicum maximum Jacq.*)"** 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 of any degree, diploma, associateship, fellowship or other similar title of any other University or Society.

Vellayani,
5-8-1997.

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**CERTIFICATE**

Certified that this thesis entitled **"Seedling progeny analysis in selected clones of guinea grass (*Panicum maximum Jacq.*)"** is a record of research work done independently by **Sri. R. Babu,** under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship or associateship to him.

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# *ACKNOWLEDGEMENT*

*I am much previleged to place my deep sense of gratitude to my mentor, philosopher and guide Dr. D.I. Suma Bai for her ingenious advice, constant incitement and motherly care bestowed throughout the course of research.*

*I am greatly indebted to Dr. R. Gopimony, Professor and Head, Department of Plant Breeding and Genetics who suggested this problem and helped in sustaining the interest through his insightful discourses on the subject.*

*I declare solemnly my heartfelt thanks to Dr. P. Saraswathi, Professor and Head, Department of Agricultural Statistics for her invaluable guidance, unquantifiable help in the interpretation of results and great amiability without which this thesis would not have materialised.*

*I am thankful to Dr. D. Wilson, Assistant Professor, Department of Plant Breeding and Genetics for his expert advice and constructive criticism during the course of research.*

*I am grateful to Shri C.E. Ajith Kumar, Junior Programmer for the help rendered in statistical analysis.*

*I am thankful to Dr. C. Gokulabalan, Associate Professor, Department of Plant Pathology, who provided access to computers to fecilitate data entry.*

*I feel exhilarating to have associated with my comrades Balagopal, Prashant and Sreekumar for their caring and gladdening attitude throughout the course of my discourse.*

*I am also thankful to my friends Moosa, Suresh, Santhosh, Roy, Dovelyn, Sophia, Gayatri, Jubina, Rani, Shaju, Selvin and Samuel for all their encouragement and cooperation.*

*I owe a lot to my well wishers Jose, Mohan and Ganesan.*

*I am sincerely grateful to Indian Council of Agricultural Research for granting Junior Research Fellowship.*

*The unrelenting service of Bharathi Communication Centre, Nagercoil is gratefully acknowledged.*

**R. BABU**

CONTENTS

# LIST OF TABLES

## LIST OF FIGURES

# INTRODUCTION

# INTRODUCTION

India accounts for 15 per cent of total world's livestock population with only two per cent of world's geographical area (Hazra, 1995). It has been estimated that the production of green fodder is less than one-third of the total requirements in India. Against the projected need of 990 million tonnes of green fodder and 830 million tonnes of dry fodder in India, the present availability is only 370 and 550 million tonnes respectively. While research and developmental efforts in the past years have resulted in increasing the yield and production of important cereal crops, endeavour for increasing the production of fodder crops has not been intensive. Besides, the area available for the cultivation of fodder crops is also very much limited.

In Kerala, the availability of roughage is only 4.2 million tonnes against the requirement of 6.2 million tonnes needed for feeding 3.4 million adult cattle showing a deficit of 41 per cent (Shamsudeen et al., 1985). The area under cultivated fodder crops in Kerala is only 0.1 per cent of the net area sown (Anonymous, 1991). Because of the preferential need for human food, the opportunity for increasing area under cultivated forages are remote. Hence the only possibility is to enhance the productivity through identification and development of superior fodder varieties. Since the non availability of nutritive and high yielding grass varieties is mainly responsible for the low productivity of our cattle population, genetic improvement of those crops for both increased production and superior quality is imperative.

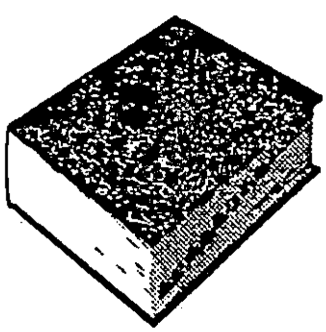
Guinea grass, a native of tropical Africa is the most important and popular fodder grass grown in Kerala. It is suited for Kerala conditions due to its hardy nature and tolerance to drought and partial shade. This highly nutritious and productive perennial fodder grass is well relished by all kinds of livestock in Kerala. It can be grown as rainfed crop since it can survive four month's summer and remain productive for more than three years.

Eventhough guinea grass is capable of producing viable seeds, the crop is propagated mainly through vegetative means as it is easily established if slips are transplanted during the onset of monsoon. Considering the convenience of handling the planting material, seed propagation is gaining popularity in guinea grass.

Recently through mutation breeding Kerala Agricultural University has released two high yielding mutant clones of guinea grass namely 'Haritha' and 'Marathakom'. Since these are mutants their popularisation is restricted through vegetative slips. Eventhough guinea grass is known to be of facultative apomictic in nature, the true breeding nature of high yielding clones cannot be taken for granted and hence the need to counduct a systematic study before embarking on large scale seed production is imminent. The present study is initiated with the following objectives.

i. to ascertain the seedling progeny behaviour of selected high yielding guinea grass clones compared to their vegetative progenies in fodder yield and other yield attributing traits.

ii. to estimate genetic parameters like variability, heritability, genetic advance and correlation.



# REVIEW OF LITERATURE

# REVIEW OF LITERATURE

Guinea grass (Panicum maximum Jacq.) is a perennial tetraploid and facultatively apomictic fodder crop native to tropical Africa. It was introduced in India in 1793 and its cultivation spread in South India as early as 1870 (Bor, 1960). Now it is the most adapted and popular fodder grass in Kerala. Burton et.al., (1973) has reported 0.6 percent seed setting through sexual reproduction in this facultative apomictic species. But Dutt and Pugh (1940), Whyte (1958) and Purseglove (1975) have reported cross pollination upto an extent of five percent under natural conditions in guinea grass. The estimation of genetic variability, heritability, genetic advance, correlation co-efficients and discriminant function analysis help in the selection of superior genotypes from genetically diverse population. A comparative study on the variability that exist in the populations raised through sexual and asexual means aid in the popularisation of high yielding mutant clones through large scale seed production. A brief account of work done on these aspects which forms the basis for a critical evaluation and planning of future strategies in guinea grass crop improvement is given below.

## 2.1. Variability

Burton et al. (1973) studied 158 accessions of guinea grass and reported variation in plant height and fresh plant weight.

Jose et al. (1978) studied bulk samples of 38 guinea grass populations and reported significant difference for tiller number, plant height, panicle length and days to flowering.

Tyagi et al. (1980) studied 30 strains of fodder pearl millet and reported maximum GCV value for green fodder yield (14.71%). This was followed by number of leaves (11.77%), leaf breadth (11.18%), dry matter yield and stem girth (9.94%), number of tillers (7.80%), plant height (5.57%) and leaf length (4.67%).

In fodder ragi, Dhanakodi (1980) reported maximum genotypic variance for fodder yield. The lowest phenotypic as well as genotypic variables were reported for leaf-stem ratio. The highest phenotypic coefficient of variation (91.59%) was observed for plant height followed by fodder yield (36.03%), leaf-stem ratio (21.24%) and tiller number (19.53%). Fodder yield recorded the highest genotypic coefficient of variation (30.43%). The GCV values were high for plant height (22.5%), leaf-stem ratio (16.56%) and tiller number (14.06%).

Mathur and Patil (1982) reported GCV estimates of 7.66%, 26.08% and 6.76% respectively for plant height, number of tillers per plant and dry matter yield per plant in fodder sorghum.

Prakash (1983) reported high genotypic coefficient of variation for plant height, forage yield per plant and dry matter yield per plant in fodder bajra.

Mohan and Dua (1984) in their studies on fodder pearl millet under single and double cut systems reported GCV values ranging from 9.71 to 21.23 per cent for plant height, 4.34 to 20.87 per cent for tiller number, 16.56 to 17.82 per cent for green fodder yield and 13.46 to 23.66 per cent for dry matter yield.

Kunjir and Patil (1986) reported high genotypic and phenotypic variability for tiller number in fodder bajra.

Sreenivasan et al. (1986) estimated variability in 24 varieties of guinea grass and reported maximum genotypic coefficient of variation for dry fodder yield (74.58%) followed by green fodder yield (71.29%) and leaf area index (63.61%). The crude fibre content recorded the lowest GCV value (7.52%). The highest phenotypic coefficient of variation was recorded for dry fodder yield (72.15%).

High genotypic variance for plant height in fodder sorghum was reported by Kaushik (1987).

High genetic variability for plant height and dry fodder yield in fodder sorghum was reported by Kulkarni and Shinde (1987).

Joseph (1988) reported maximum phenotypic coefficient of variation (33.15%) for dry matter yield in guinea grass. The lowest PCV value was recorded for tiller count (4.88%). Dry matter yield recorded the maximum GCV (24.03%) and the weight of leaves recorded the minimum GCV (2.10%).

Thejasee Bhai (1988) in her studies with guinea grass reported highest GCV for green fodder yield per hill followed by number of panicles per plot, leaf/stem ratio on fresh weight basis, green fodder yield per plot, tiller number per hill, dry matter yield per plot and plant height.

Maiti et al. (1989) evaluated ninety pearlmillet germplasm collections and reported that large phenotypic variability was found between genotypes for plant height, leaf number, leaf width and stem thickness.

Amirthadevarathinam et al. (1990) studied 30 genotypes of fodder sorghum and reported large genotypic variability for plant height, plant stand, total soluble solids and leaf length. Highest genotypic coefficient of variation was observed for fodder yield (49.65%) followed by total soluble solids (43.23%).

Based on the evaluation work on $M_2V_1$ guinea grass clones, Santipriya (1991) reported significant difference among the families and progenies. High phenotypic coefficients of variation were reported for inflorescence count (241.16%) leaf area (41.32%), leaf-stem ratio (39.33%) and root length (38.4%). High genotypic coefficients of variation were reported for inflorescence count (212.27%), leaf area (37.78%), root length (33.61%) and leaf-stem ratio (29.54%).

Thirumeni and Vijendra Das (1993) evaluated 15 genotypes of fodder pearlmillet and reported high genotypic and phenotypic coefficient of variation for leaf area per clump and dry matter yield.

Shajan (1993) evaluated 30 guinea grass clones and reported high GCV estimates for number of panicles per hill (89.50%), weight of seeds per hill (56.10%) and leaf-stem ratio (45.22%) and leaf-stem ratio (48.10%) recorded high PCV value.

Based on three yield evaluation trials conducted at the college of Agriculture, Vellayani using 12 clones of guinea grass, Sreekumar et al. (1994) reported that the clone MC-16 which had higher green fodder yield and better fodder quality was released as 'Marthakom'.

Dhanakodi (1994) studied fifty genotypes of fodder ragi and reported high GCV values for fodder yield (30.43%) and plant height (22.15%) followed by leaf-stem ratio (16.56%), leaf number (16.37%) and internodal length (15.32%).

Ramasamy et al. (1994) evaluated forty diverse genotypes of fodder ragi and reported high genotypic and phenotypic coefficient of variation for green fodder yield per plant. Days to 50% flowering recorded the lowest phenotypic and genotypic coefficient of variation.

Vijendra Das (1994) studied 22 genotypes of napier grass and reported high GCV estimates for the characters number of tillers per plant (40.9%), leaf area (35.4%) and leaf length (36.4%). Number of tillers per plant (43.3%), leaf length (36.4%) and leaf area (36.2%) recorded high PCV values.

Amirthadevarathinam and Dorairaj (1994) evaluated 53 genotypes of napier grass and reported that GCV was the highest in leaf weight (80.69%) followed by green fodder yield, ste m weight, crude protein content, dry matter yield and leaves per tiller.

Suthamathi and Dorairaj (1995) studied variability in twenty eight genotypes of fodder pearlmillet and reported that stem weight (28.9%), green fodder yield per plant (23.64), leaf weight (23.21%), number of tillers per plant (22.45%) and number of leaves per plant (22.03%) showed high genotypic coefficient of variation.

In fodder maize Sreekumar and Suma Bai (1995) reported that plant height (195.30%) and plant population (58.65%) recorded high genotypic coefficient of variation. The phenotypic coefficient of variation was maximum for plant height (291.76%) and minimum for leaf stem ratio (0.03%).

**2.2. Heritability and genetic advance**

In fodder bajra, Tyagi et al. (1980) reported high heritability values for fodder yield (66.48%), plant height (65.05%) and stem girth (56.09%). The dry fodder yield (22.01%) and leaf breadth (25.56%) recorded low estimate of heritability. Genetic advance as percentage of mean was reported to be low for all the characters and medium for green fodder yield.

Sidhu and Mehindiratta (1980) reported high heritability estimates for leaf length and plant height in fodder sorghum.

Sood and Ahluwalia (1980) reported heritability estimates exceeding 30 per cent for plant height and dry matter yield per plant in fodder sorghum.

Kumar (1982) reported high heritability and expected genetic advance for green and dry matter yield per plant, leaf weight and stem weight in fodder pearl millet.

In fodder Sorghum Mathur and Patil (1982) observed high heritability estimates for leaf number(188.88%) followed by dry matter yield (70.52%), plant height (54.70%) and number of tillers per plant (49.22%). The genetic advance was high for number of leaves per plant (165.28%).

In fodder Sorghum Singh (1982) reported high heritability estimates for plant height, leaf number, leaf yield and forage yield. Genetic advance was reported to be high for leaf yield per plant.

High heritability was reported for plant height in finger millet by Shankar (1982).

Prakash (1983) reported that plant height, forage yield per plant and dry matter yield per plant had high broad sense heritability values in pearl millet.

In fodder bajra Mohan and Dua (1984) reported high heritability value for leaf breadth (63.66%) followed by plant height (52.69%) and leaf length (44.68%). Green fodder yield (21.16%) recorded the lowest value of heritability. Genetic advance was reported to be high for plant height (37.75%) followed by leaf number (24.88%) and green fodder yield (17.11%).

Kunjir and Patil (1986) based on their studies on pearl millet reported high heritability estimates for tiller number (64.80%) and plant height (56.09%) and the genetic advance for these characters was also high indicating additive gene action.

Joseph (1988) in guinea grass reported high estimates of heritability for crude protein content (56.98%), dry matter yield (55.56%) and green fodder yield (51.81%). Moderate heritability estimates of 43.67% per cent, 39.37 per cent and 36.59 per cent were recorded for tiller count, leaf-stem ratio and crude fibre content respectively. Low estimate of heritability was recorded for width of leves (13.95%) and plant height (11.7%). High genetic advance of 21.51 per cent for inflorescence count was recorded.

Thejasee Bhai (1988) reported high heritability estimates for number of panicles per plant (82.45%) followed by leaf-stem ratio on dry weight basis (66.32%), leaf-stem ratio on fresh weight basis (59.98%) and plant height (54.65%) in guinea grass. Green fodder yield per hill recorded the highest estimate of genetic advance (184.59%).

Amirthadevarathinam et al. (1990) evaluated 30 genotypes of fodder sorghum and reported high heritability estimates for the characters plant height (98.07%), leaf length (97.40%), total soluble salts (96.85%) and grain yield (93.60%). The genetic advance of these characters were 29.31 per cent, 4.61 per cent 91.77 per cent and 59.28 per cent respectively.

Sant ipriya (1991) in guinea grass reported high estimate of heritability for plant height (77.59%) followed by inflorescence count (77.48%), leaf area (66.88%) and leaf-stem ratio (56.43%). The inflorescence count (384.91%), leaf area (56.91%) and leaf-stem ratio (45.72%) recorded high genetic advance values. The genetic advance was low for green fodder yield.

Thirumeni and Vijendra Das (1993) evaluated 15 gnotypes of fodder pearl millet and reported high estimates of heritbility for plant height, leaf area per clump, green fodder yield, dry matter yield and leaf-stem ratio. Low estimate of heritability was noticed for number of tillers per clump. High heritability coupled with high genetic advance estimates were observed for leaf-stem ratio, dry fodder yield, leaf area per clump, green fodder yield, crude protein and calcium content.

Patil et al. (1993) evaluated 45 genotypes of fodder sorghum and reported that green forage yield per plant, plant height and number of leaves for plant recorded high estimates of heritability and genetic advance.

Dhanakodi (1994) evaluated 50 genotypes of fodder ragi and reported high heritability estimates for days to flowering (99.08%), leaf number (79.67%), leaf length (73.94%) and fodder yield (71.31%). The corresponding values of genetic advance as percentage of mean were 286.68 per cent, 66.69 per cent and 98.79 per cent respectively.

Ramasamy et al. (1994) evaluated 40 diverse genotypes of fodder ragi and reported high heritability values for days to 50% flowering (96.07%), green fodder yield per plant (84.58%), plant height (72.89%) and number of tillers per plant (72.79%). The corresponding values of genetic advance as percentage of mean were 28.56 per cent, 74.27 per cent, 25.63 per cent and 47.47 per cent respectively.

Vijendra Das (1994) evaluated 32 genotypes of napier grass and reported high heritability values for leaf length (81.5%), green fodder yield (79.9%), number of tillers per plant (79.6%), plant height (79.5%) and stem girth (77.3%). The genetic advance was high for all the characters studied. Number of tillers per plant recorded the

(9.59%). low heritability estimate. The genetic advance was high for plant height (23.55%). Dry fodder yield recorded low genetic advance (0.38%).

## 2.3. Correlation studies

Tyagi et al. (1980) in fodder bajra reported that dry matter yield recorded significant positive association with fodder yield both at genotypic and phenotypic levels. They have also observed negative correlation between fodder yield and days to flower. Plant height showed significant positive association with number of leaves and leaf length. Positive significant correlation was observed between stem girth and leaf breadth and also between stem girth and number of tillers. Leaf breadth had positive significant association with number of tillers.

Sidhu and Mehindiratta (1980) in fodder sorghum reported that leaf number, stem thickness, leaf length and leaf width were positively correlated with green fodder yield at phenotypic level.

Dhanakodi (1980) in fodder ragi reported significant positive correlation between green fodder yield and plant height and also between days to flower and internodal length. Non significant negative correlation between leaf-stem ratio and plant height and positive correlation between tiller number and leaf-stem ratio were also reported.

In fodder sorghum Mathur and Patil (1982) reported positive and significant phenotypic correlation between dry matter yield and plant height and also between number of leaves per plant and number of tillers per plant.

In fodder sorghum Vaidyanathan (1982) reported positive phenotypic correlation between height and green fodder yield and negative correlation between leaf-stem ratio and fodder yield.

Achutha Kumar (1982) in fodder maize reported that forage yield was significantly and positively correlated with leaf length, leaf number, leaf breadth and plant height.

Mangath (1986) in fodder pearl millet reported that fodder yield was positively correlated with plant height, stem thickness, internode number, leaf width and days to flower.

In fodder maize Paramathma and Balasubramanian (1986) reported that plant height, stem girth, leaf breadh and leaf number had highly significant positive association with green fodder yield.

In guinea grass, Sreenivasan et al. (1986) reported positive association of characters such as dry weight, leaf area index, plant height, length of panicle, days to 50% flowering, girth of internode and crude fibre content with green fodder yield. The association was found negative in the case of crude protein and number of tillers with green fodder yield.

Patel and Shelke (1988) in fodder maize reported positive significant association of forage yield with plant height, leaf area per plant, stem girth and internode number per plant.

Joseph (1988) in guinea grass reported that green fodder yield had positive significant correlation with dry matter yield and positive non significant phenotypic correlation with leaf breadth, inflorescence count and tiller count and negative non significant correlation with leaf-stem ratio and protein percentage. Protein percentage showed positive non significant correlation with dry fodder yield.

Thejasee Bhai (1988) in guinea grass reported that genotypic correlation co-efficients were slightly higher than the phenotypic correlation co-efficients. Plant height was positively correlated with leaf area index, leaf-stem ratio, number of tillers per hill and dry matter yield at the genotypic level. Phenotypic correlation of number of panicles per hill with dry matter yield was reported to be positive but not significant.

Girija and Natarajarathinam (1989) reported that green matter yield was found to be correlated with dry matter accumulation in fodder sorghum.

Sood and Ahluwalia (1989) reported significant positive association of green fodder yield with dry matter yield, stem girth, leaves per plant, days to 50%

flowering and leaf breadth in singlecut fodder sorghum. Plant height showed a significant negative association with green fodder yield while leaf length exhibited significant and positive association with green fodder yield only in second cut in double cut forage sorghum.

In fodder ragi Dhanakodi and Chandrasekaran (1989) reported positive correlation of plant height, leaf number, leaf length, leaf width, days to flowering and internodal length with green fodder yield. Negative significant correlation between fodder yield and tiller number and non significant negative correlation between fodder yield and leaf-stem ratio were also reported.

Chalapathi (1990) in fodder maize reported positive and significant genotypic correlation of plant height with green fodder yield.

Amirthadevarathinam et al (1990) evaluated 30 genotypes of fodder sorghum and reported that plant height and total soluble salts showed high positive correlation with fodder yield.

Kaushik and Grewal (1991) evaluated 54 genotypes of fodder sorghum and reported positive correlation between plant height and stem weight.

Pradhan et al (1993) in bajra-napier hybrid reported that number of tillers per hill was positively associated with green fodder yield and dry fodder yield.

Ramasamy et al (1993) in bajra-napier hybrid reported that regrowth rate and tiller number were not significantly associated with yield.

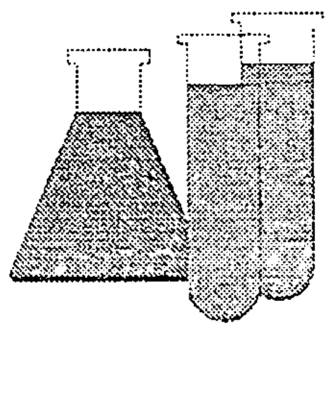
In guineagrass, Shajan (1993) reported high positive genotypic correlation and significant positive phenotypic correlation of green fodder yield with dry fodder yield, plant height, leaf length and leaf area index.

Sukachain and Sidhu (1993) reported that in guinea grass seed yield was positively correlated with branch number per panicle, panicle number per plant, panicle length, branch length, 100 seed weight and days to flowering. Panicle number per plant had the highest direct effect on seed yield per plant followed by branch number per panicle, days to flowering and 100 seed weight.

## 2.4. Selection index (Discriminant function)

Shant ipriya (1991) reported that plant height, tiller number, leaf area, leaf-stem ratio and green matter yield were the most important yield contributing parameters in guinea grass. She also suggested that the selection index formulated based on the above characters was useful for population improvement.

Shajan (1993) in guinea grass reported that selection index based on plant height, leaf area index, number of tillers per hill leaf-stem ratio, number of panicles per hill and weight of seeds per hill was useful in the improvement of fodder yield through selection.



# MATERIALS AND METHODS

# MATERIALS AND METHODS

The present investigation was carried out in the Department of Plant Breeding and Genetics, College of Agriculture, Vellayani, Thiruvananthapuram during July 1996 to May 1997.

## 3.1. Materials

The experimental material consisted of ten high yielding guinea grass clones from the test materials available with the All India Co-ordinated Research Project on Forage Crops and two high yielding mutant clones released by Kerala Agricultural University.

## 3.2. Methods

### Experiment I. Varietal evaluation

A field experiment was conducted during July to October 1996 with ten clones in a randomized block design with three replications. Two hundred and forty plants were maintained in a plot size of 12 $m^2$ with a spacing of 50 x 10 cm. The crop was raised as per the technical programme of AICRP on Forage Crops. Ten plants were selected at random from each plot and the data on the following characters were recorded and a selection index with respect to important characters was constructed to identify three superior clones.

**Table 1. Details of guinea grass evaluated**

| Sl.No. | Name | Source |
|---|---|---|
| 1. | JHGG 96-3 | IGFRI, Jhansi |
| 2. | JHGG 96-4 | IGFRI, Jhansi |
| 3. | JHGG 96-2 | IGFRI, Jhansi |
| 4. | Riversdale | Dhoni farm, Aralam |
| 5. | JHGG 96-1 | IGFRI, Jhansi |
| 6. | PGG 255 | IGFRI, Jhansi |
| 7. | PGG 310 | IGFRI, Jhansi |
| 8. | PGG 101 | IGFRI, Jhansi |
| 9. | PGG 518 | IGFRI, Jhansi |
| 10. | PGG 9 | IGFRI, Jhansi |

**IGFRI - Indian Grassland and Fodder Research Institute**

**Experiment II. Progeny mean analysis**

Based on the discriminant function analysis the top ranking three cones viz. JHGG 96-4, JHGG 96-3 and Riversdale along with two mutant clones viz. Haritha and Marathakom were subjected to progeny mean analysis through compact family block design with five replications using seeds and slips separately during January to May 1997. Ten progeny rows were maintained within each clone adopting a spacing of 50x10cm. Five plants were selected at random from each progeny row and the data on the following characters were recorded and subjected to statistical analysis for the comparison of variability with respect to the two types of planting materials viz. seeds and slips.

**3.2.1. Plant height**

The height was measured in centimeters from the base of the plant to the tip of the longest leaf.

**3.2.2. Tiller number per hill**

The total number of tillers per hill was counted from a random sample of ten hills per plot and mean was recorded.

### 3.2.3. Leaf number per hill

The total number of leaves from a random sample of ten hills per plot was counted at harvest and the mean was recorded.

### 3.2.4. Leaf-stem ratio

Ten hills selected at random from each plot were harvested and each hill was seperated into leaf and stem. Weight of leaf and stem was recorded seperately for each hill and leaf-stem ratio was worked out.

### 3.2.5. Leaf area index (LAI)

Leaf area was estimated by using leaf area meter. The leaf area index was computed following the formula suggested by William (1946)

$$LAI = \frac{\text{Total leaf area of the hill}}{\text{Ground area occupied}}$$

### 3.2.6. Internode number per hill

The total number of internodes per hill was counted from a random sample of ten hills per plot the and mean was recorded.

### 3.2.7. Length of internode

The internodal length was recorded in centimeters at the time of harvest from a random sample of ten hills per plot and the mean was recorded.

### 3.2.8. Green fodder yield

The green fodder yield per plot was recorded at harvest and estimated in tonnes per hectare.

### 3.2.9. Dry fodder yield

At harvest random sample was taken from each plot, weighed, dried to a constant weight and the dry matter percentage was computed. Based on this estimate the total dry matter yield was computed and expressed in tonnes per hectare.

### 3.2.10. Crude protein content

Dried plant samples collected at the time of harvest were subjected to nitrogen analysis by the modified micro-kjeldahl method (Jackson, 1967). The crude protein was calculated by multiplying the nitrogen percentage with a factor 6.25 (Simpson et al, 1965).

**3.2.11. Crude fibre content**

Dried plant samples collected at the time of harvest were utilised for the estimation of fibre content by acid and alkali digestion method (Sadasivam and Manickam, 1992).

**3.3. Statistical analysis**

The data collected were subjected to the following statistical analyses.

**3.3.1. Analysis of variance and covariance**

Analysis of variance and covariance were done.

i. to test varietal effect with respect to various traits

ii. to estimate variance components and other parameters like correlation coefficients, heritability, genetic advance etc (Singh and Choudhary, 1979).

Table 2 presents the analysis of variance / covariance. From this table other genetic parameters were estimated as follows.

**Table 2. Analysis of variance / covariance**

| Source | df | Observed mean square xx | Expected mean square xx | Observed mean sum of products xy | Expected mean sum of products xy | Observed mean square yy | Expected mean square yy |
|---|---|---|---|---|---|---|---|
| Block | (r-1) | Bxx | | Bxy | | Byy | |
| Genotype | (v-1) | Gxx | $\sigma^2 ex + r\sigma^2 gx$ | Gxy | $\sigma exy + r\sigma gxy$ | Gyy | $\sigma^2 ex + r\sigma^2 gx$ |
| Error | (v-1) (r-1) | Exx | $\sigma ex^2$ | Exy | $\sigma exy$ | Eyy | $\sigma^2 ey$ |
| Total | (rv-1) | Txx | | Txy | | Tyy | |

Hence We have the following estimate

| | | | | | |
|---|---|---|---|---|---|
| g (x) | = | (Gxx - Exx) / r | $\sigma^2 ex$ | = | Exx |
| g(y) | = | (Gyy - Eyy) / r | $\sigma^2 ey$ | = | Eyy |
| g(xy) | = | (Gxy - Exy) / r | $\sigma e(xy)$ | = | Exy |

| Variance | X | Y |
|---|---|---|
| Environmental variance ($\sigma^2 e$) | $= \sigma^2 ex = Exx$ | $\sigma^2 ey = Eyy$ |
| Genotypic variance ($\sigma^2 g$) | $= \sigma^2 gx = \frac{Gxx - Exx}{r}$ | $\sigma^2 gy = \frac{Gyy - Eyy}{r}$ |
| Phenotypic variance ($\sigma^2 p$) | $= \sigma^2 px = \sigma^2 gx + \sigma^2 ex$ | $\sigma^2 py = \sigma^2 gy + \sigma^2 ey$ |

### 3.3.2. Coefficient of variation

Phenotypic and genotypic coefficients of variation (PCV and GCV) were estimated as

$$GCV = \frac{\sigma gx}{\bar{x}} \times 100$$

$$PCV = \frac{\sigma px}{\bar{x}} \times 100$$

where $\sigma gx$ = genotypic standard deviation

$\sigma px$ = phenotypic standard deviation

### 3.3.3. Heritability (Broad sense)

$$h = \frac{\sigma^2 gx}{\sigma^2 px} \times 100$$

where $h^2$ is the heritability expressed in percentage (Jain, 1982).

**3.3.4. Genetic advance as percentage of mean**

$$GA = \frac{kh^2 \sigma p \times 100}{\bar{x}}$$ (Miller et al., 1958)

where k = selection differential = 2.06 at 5 per cent selection

**3.3.5. Correlation**

Genotypic correlation ($r_g$ xy) $= \frac{\sigma gxy}{\sigma gx \times \sigma gy}$

Phenotypic correlation ($r_p$xy) $= \frac{\sigma pxy}{\sigma px \times \sigma py}$

Environmental correlation ($r_e$xy) $= \frac{\sigma exy}{\sigma ex \times \sigma ey}$

**3.3.6. Selection index**

The selection index developed by Smith (1937) using discriminant function of Fisher (1936) was used to discriminate the genotypes based on nine characters viz. plant height, tiller number per hill, leaf number per hill, internode number per hill, internode length, leaf area index, leaf-stem ratio, green fodder yield and dry fodder yield. The selection index is described by the function

$I = b_1 x_1 + b_2 x_2 + \ldots + b_9 x_9$ and the merit of a plant is described by the function.

$$H = a_1 G_1 + a_2 G_2 + .... + a_9 G_9$$

where $X_1$, $X_2$ ...., $X_9$ are the phenotypic values and $G_1$, $G_2$ ....., $G_9$ are the genotypic worth of the plant with respect to characters $X_1$, $X_2$ ...., $X_9$.

The b coefficients are determined such that the correlation between H and I is maximum. It is also assumed that the economic weight assigned to each character is equal to unity

ie. $a_1, a_2 ...., a_9 = 1$

The expected genetic advance was also estimated at a given intensity of selection.

**Experiment II. Progeny mean analysis**

**3.3.8. Analysis of variance**

Analysis of variance was done as per the design for the following objectives (panse and Sukhatme, 1957).

i. for the comparison among the different families

ii. for the comparison among progenies within families, and

iii. to estimate the variance components

## TABLE 3 ANALYSIS OF VARIANCE (FBD)

For each family the following ANOVA is done

| Source | df | MS | F |
|---|---|---|---|
| Between replication | r-1 | MSB | |
| Between progenies | p-1 | MSP | |
| Error | (r-1) (p-1) | MSE | |

If the error variances are found to be homogenous then the following ANOVA is done

| Source | df | MS | F |
|---|---|---|---|
| Between replication | r-1 | MSB | |
| Between families | f-1 | MSP | |
| Error (1) | (r-1) (f-1) | $MSE_1$ | |
| Between progenies within families | f (p-1) | | |
| Error (2) pooled | f (p-1) (r-1) | $MSE_2$ | |

The genetic variance existing between progenies is worked out as

$$\sigma^2 g(x) = \frac{MSP - MSE}{r}$$

$$\sigma^2 p(x) = \sigma^2 g(x) + \sigma^2 e\,(x)$$

where
$\sigma^2 p(x)$ = phenotypic variance
$\sigma^2 g(x)$ = genotypic variance
$\sigma^2 e(x)$ = environmental variance

# RESULTS

# RESULTS

## 4.1. Experiment I. Varietal evaluation

The data collected from experiment I were statistically analysed and the results are presented below:

### 4.1.1. Analysis of variance

Analysis of variance of eleven characters revealed the significance of seven characters viz. tiller number per hill, internode number per hill, leaf number per hill, leaf area index, leaf-stem ratio, green fodder yield and dry fodder yield. The characters viz. plant height, internode length, crude protein content and crude fibre content did not exhibit significant difference. The mean value of all the eleven characters along with their standard error and critical difference are presented in Table 4.

### 4.1.2. Variability

Plant height ranged from 102.77 (PGG 101) to 111.83 cm (JHGG 96-4).

Tiller number per hill ranged from 14.00 to 21.03. The variety JHGG 96-2 recorded the maximum tiller number per hill (21.03) and was on par with the varieties PGG 9 and JHGG 96-4.

The maximum leaf number of 93.63 per hill was recorded by JHGG 96-2 and the minimum of 63.03 by PGG 255. The varities PGG 9 and JHGG 96-4 were found to be on par with JHGG 96-2.

The maximum internode number of 79.90 per hill was recorded by JHGG 96-2 and was found to be on par with the varieties PGG9 and JHGG 96-4. The minimum internode number of 53.17 per hill was registered by the variety PGG 255.

Internode length ranged from 17.07 (PGG 101) to 18.73 cm (PGG 310).

The maximum leaf area index was recorded by the variety JHGG 96-4 (5.43) and none of the varieties was found to be on par with this variety.

Leaf-stem ratio ranged from 1.76 to 2.55. The maximum value was recorded by the variety JHGG 96-4 and was found to be on par with the varieties JHGG 96-3 and JHGG 96-2.

The variety JHGG 96-2 recorded the maximum green fodder yield (31.20 t/ha) and it was on par with the variety JHGG 96-4. The minimum value was recorded by the variety PGG 101 (19.67 t/ha).

## Table 4. Mean value of eleven characters in guinea grass

| S.No. | Clones | Plant height (cm) | Tiller number per hill | Leaf number per hill | Internode number per hill | Indernode length (cm) | Leaf area index | Leaf stem ratio | Green fodder yield (t/ha) | Dry fodder yield (t/ha) | Crude protein content (%) | Crude fibre content (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | JHGG 96-2 | 109.36 | 21.03 | 93.63 | 79.90 | 18.20 | 4.73 | 2.48 | 31.20 | 9.97 | 9.23 | 29.80 |
| 2 | PGG 518 | 111.27 | 16.23 | 73.47 | 61.90 | 18.50 | 3.00 | 1.89 | 21.40 | 6.93 | 9.27 | 29.99 |
| 3 | Riversdale | 106.27 | 16.00 | 68.77 | 60.73 | 17.63 | 4.50 | 2.11 | 25.07 | 7.93 | 9.08 | 29.64 |
| 4 | JHGG 96-1 | 107.27 | 15.70 | 67.57 | 59.00 | 17.53 | 4.30 | 2.05 | 23.77 | 7.57 | 9.10 | 28.84 |
| 5 | PGG 310 | 111.03 | 15.43 | 66.60 | 58.70 | 18.73 | 2.93 | 1.83 | 22.93 | 7.50 | 9.23 | 30.06 |
| 6 | PGG 9 | 111.07 | 20.63 | 88.97 | 78.37 | 18.70 | 2.80 | 1.93 | 21.60 | 7.03 | 9.17 | 29.64 |
| 7 | JHGG 96-4 | 111.83 | 19.60 | 90.30 | 74.43 | 18.03 | 5.43 | 2.55 | 29.80 | 9.57 | 9.10 | 29.69 |
| 8 | PGG 255 | 103.77 | 14.00 | 63.30 | 53.17 | 17.40 | 3.33 | 2.06 | 21.27 | 6.80 | 9.19 | 29.55 |
| 9 | PGG 101 | 102.77 | 16.07 | 72.17 | 61.17 | 17.07 | 2.80 | 1.76 | 19.67 | 6.33 | 9.04 | 29.36 |
| 10 | JHGG 96-3 | 108.13 | 16.07 | 72.30 | 61.00 | 18.00 | 4.57 | 2.37 | 24.40 | 7.80 | 9.09 | 30.02 |
| | $F_{9,18}$ | 1.91 | 2.472* | 3.128* | 2.471* | 1.430 | 28.083** | 5.315** | 4.328* | 4.175* | 0.707 | 0.733 |
| | SE | 2.391 | 1.538 | 6.243 | 5.860 | 0.475 | 0.183 | 0.119 | 1.800 | 0.575 | 0.093 | 0.426 |
| | CD | 7.105 | 4.571 | 18.550 | 17.410 | 1.409 | 0.543 | 0.354 | 5.350 | 1.709 | 0.275 | 1.265 |

* Significant at 5 % level
** Significant at 1 % level

Dry fodder yield per hectare was maximum for the variety JHGG 96-2 (9.97 t/ha) and was on par with the variety JHGG 96-4. The minimum value was recorded by the variety PGG 101 (19.67 t/ha).

Crude protein content ranged from 9.04 (PGG 101) to 9.27% (PGG 518). Curde fibre content ranged from 28.84 (JHGG 96-1) to 30.02% (JHGG 96-3).

### 4.1.3. Genetic parameters

Genetic parameters were estimated for all the eleven characters. Table 5 and Figure 1 indicate phenotypic and genotypic variances and coefficient of variation. Heritability and genetic advance are presented in Table 6 and Figure 2

#### 4.1.3.a. Phenotypic and genotypic co-efficient of variation

Maximum phenotypic coefficient of variation was recorded for leaf area index (26.13) followed by internode number per hill (19.11), tiller number per hill (19.05), green fodder yield (18.78), leaf number per hill (18.68), dry fodder yield (18.46), leaf-stem ratio (15.35), internode length (4.89), plant height (4.36) and crude firbre content (1.70). Crude protein content recorded the minimum value (1.66).

**Table 5. Components of variation of eleven characters in guinea grass**

| Sl.No. | Characters | Genotypic variance $\sigma^2 g$ | Phenotypic variance $\sigma^2 p$ | Environmental variance $\sigma^2 e$ | Genotypic co-efficient of variation GCV | Phenotypic co-efficient of variation PCV |
|---|---|---|---|---|---|---|
| 1 | Plant height (Cm) | 5.2 | 22.36 | 17.16 | 2.11 | 4.36 |
| 2 | Tiller number per hill | 3.48 | 10.58 | 7.10 | 10.93 | 19.05 |
| 3 | Leaf number per hill | 82.95 | 199.87 | 116.92 | 12.03 | 18.68 |
| 4 | Internode number per hill | 50.51 | 153.51 | 103.00 | 10.96 | 19.11 |
| 5 | Internode length (cm) | 0.09 | 0.77 | 0.68 | 1.73 | 4.89 |
| 6 | Leaf area index | 0.90 | 1.01 | 0.11 | 22.79 | 26.13 |
| 7 | Leaf-stem ratio | 0.06 | 0.10 | 0.04 | 11.79 | 15.35 |
| 8 | Green fodder yield (t/ha) | 10.79 | 20.51 | 9.72 | 13.62 | 18.78 |
| 9 | Dry fodder yield (t/ha) | 1.05 | 2.04 | 0.99 | 13.24 | 18.46 |
| 10 | Crude protein content (%) | Ne | 0.02 | 0.02 | Ne | 1.66 |
| 11 | Crude fibre content (%) | Ne | 0.50 | 0.50 | Ne | 1.70 |

Ne - Not estimable

## Fig.1. Genotypic coefficient of variation for 11 characters

$X_1$ - Plant height

$X_2$ - Tiller number per hill

$X_3$ - Leaf number per hill

$X_4$ - Internode number per hill

$X_5$ - Internode length

$X_6$ - Leaf area index

$X_7$ - Leaf - stem ratio

$X_8$ - Green fodder yield

$X_9$ - Dry fodder yield

$X_{10}$ - Crude protein content

$X_{11}$ - Crude fibre content

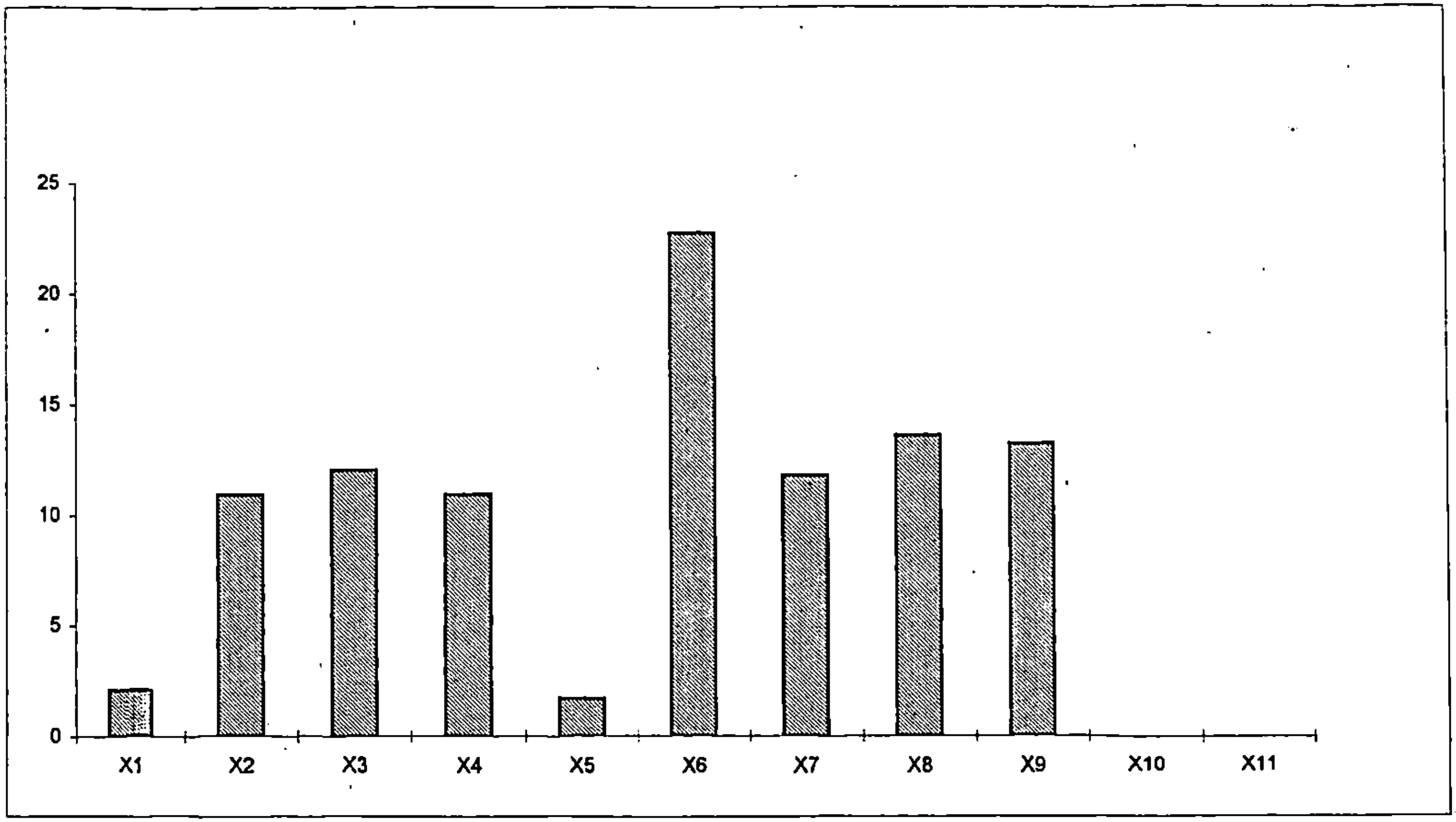



**Fig.1. Genotypic coefficient of variation for 11 characters**

Maximum genotypic co-efficient of variation was recorded for leaf area index (24.79) followed by green fodder yield (13.62), dry fodder yield (13.24), leaf number per hill (12.03), leaf-stem ratio (11.79), internode number per hill (10.96) and tiller number per hill (10.93). Plant height recorded the minimum value (2.11).

#### 4.1.4. Heritability and genetic advance

High heritability estimate was observed for leaf area index (90.02%). Medium estimates were obtained for leaf-stem ratio (58.99%), green fodder yield (52.59%), dry fodder yield (51.42%), leaf number per hill (41.50%) tiller number per hill (32.91%) and internode number per hill (32.91). Plant height (23.27%) and internodal length (12.53%) recorded low heritability estimates.

The genetic advance as percentage of mean was maximum for leaf number per hill (12.09%) and minimum for internodal length (0.23%). Internode number per hill (8.40%), green fodder yield (4.91%), plant height (2.27%), tiller number per hill (2.21%), leaf area index (1.86%), dry fodder yield (1.51%), leaf-stem ratio (0.39%) recorded low estimates of genetic advance. Leaf number per hill and internode number per hill had comparatively higher values for both heritability and genetic advance.

**Table 6. Heritability and genetic advance (as percentage of mean) of eleven characters in guinea grass**

| S.No. | Characters | Heritability (broad sense) (%) | Genetic advance at 5% intensity of selection |
|---|---|---|---|
| 1 | Plant height (Cm) | 23.27 | 2.27 |
| 2 | Tiller number per hill | 32.91 | 2.21 |
| 3 | Leaf number per hill | 41.50 | 12.09 |
| 4 | Internode number per hill | 32.91 | 8.40 |
| 5 | Internode length (cm) | 12.53 | 0.23 |
| 6 | Leaf area index | 90.02 | 1.86 |
| 7 | Leaf-stem ratio | 58.99 | 0.39 |
| 8 | Green fodder yield (t/ha) | 52.59 | 4.91 |
| 9 | Dry fodder yield (t/ha) | 51.42 | 1.51 |
| 10 | Crude protein content (%) | Ne | Ne |
| 11 | Crude fibre content (%) | Ne | Ne |

Ne - Not estimable

**Fig.2. Heritability and genetic advance for 11 characters**

| | | |
|---|---|---|
| $X_1$ | - | Plant height |
| $X_2$ | - | Tiller number per hill |
| $X_3$ | - | Leaf number per hill |
| $X_4$ | - | Internode number per hill |
| $X_5$ | - | Internode length |
| $X_6$ | - | Leaf area index |
| $X_7$ | - | Leaf - stem ratio |
| $X_8$ | - | Green fodder yield |
| $X_9$ | - | Dry fodder yield |
| $X_{10}$ | - | Crude protein content |
| $X_{11}$ | - | Crude fibre content |

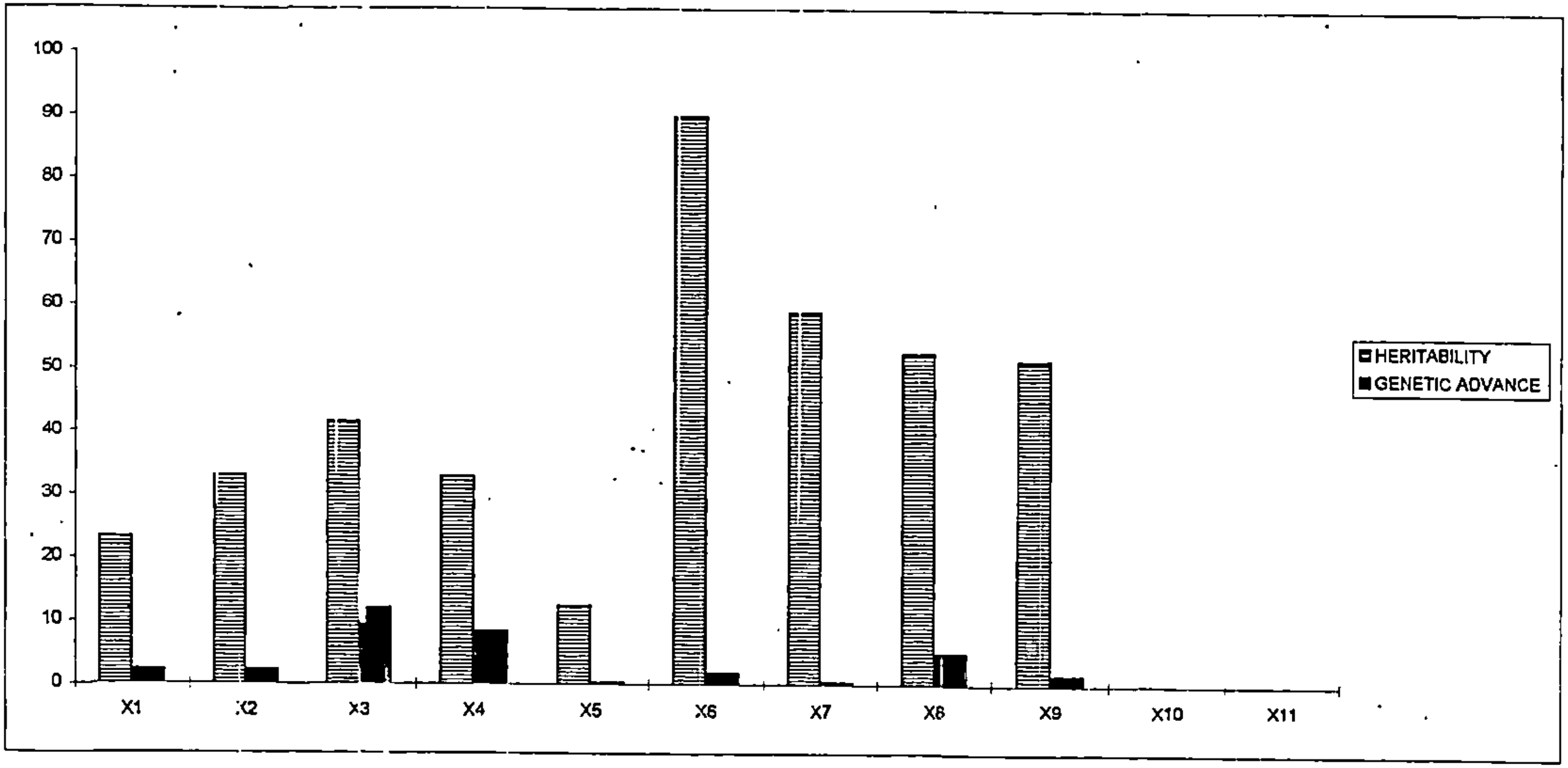



Fig.2. Heritability and genetic advance for 11 characters

### 4.1.5. Correlation

Phenotypic and genotypic correlations between yield and other ten characters and their *inter se* associations were worked out. The results on correlation have been split up under the following categories.

#### 4.1.5.a. Correlation between green fodder yield and other components

The estimate of correlation co-efficients between green fodder yield and other components are given in Table 7 and Figure 3.

All the genotypic correlations between green fodder yield and other characters were positive except for crude protein content and crude fibre content for which correlation co-efficients could not be estimated. Dry fodder yield had the highest positive genotypic correlation with green fodder yield (0.9999) followed by leaf area index (0.9131), leaf-stem ratio (0.8979), leaf number per hill (0.5796), tiller number per hill (0.5288) internode number per hill (0.5223) and plant height (0.4650). Internodal length had the lowest positive influence on green fodder yield (0.0441). Crude protein and fibre content were not correlated with green fodder yield at genotypic level.

At the phenotypic level also dry matter yield had the highest significant positive correlation with green fodder yield (0.9965) followed by leaf-stem ratio (0.8805), leaf area index (0.8003), leaf number per hill (0.7101), tiller number per hill (0.6920),

Table 7. Phenotypic and genotypic correlation coefficients of green fodder yield with other characters in guinea grass

| S.No. | Characters | Co-efficient of G | Correlation P |
|---|---|---|---|
| 1 | Plant height | 0.4650 | 0.3556 |
| 2 | Tiller number per hill | 0.5288 | 0.6920* |
| 3 | Leaf number per hill | 0.5800 | 0.7101* |
| 4 | Internode number per hill | 0.5223 | 0.6874* |
| 5 | Internode length | 0.0400 | 0.2562 |
| 6 | Leaf area index | 0.9131** | *0.8003* |
| 7 | Leaf-stem ratio | 0.8979** | 0.8805** |
| 8 | Dry fodder yield | 0.9999** | 0.9965** |
| 9 | Crude protein content | Ne | 0.0373 |
| 10 | Crude fibre content | Ne | 0.0813 |

** Significant at 5% level
* Significant at 1% level
Ne - Not estimable

**Fig.3. Correlation diagram showing genotypic correlation between green fodder yield and other characters.**

$X_1$ - Plant height

$X_2$ - Tiller number per hill

$X_3$ - Leaf number per hill

$X_4$ - Internode number per hill

$X_5$ - Internode length

$X_6$ - Leaf area index

$X_7$ - Leaf - stem ratio

$X_8$ - Dry fodder yield

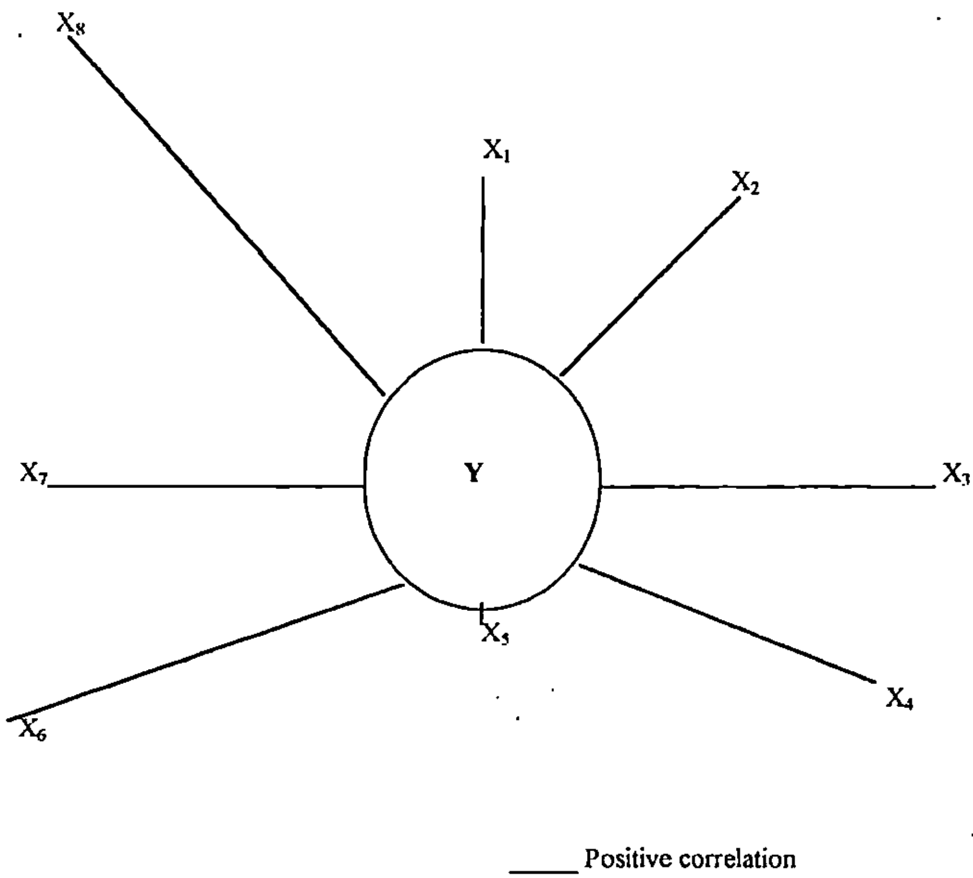



**Fig.3. Correlation diagram showing genotypic correlation between green fodder yield and other characters.**

internode number per hill (0.6874), plant height (0.3556) and internode length (0.2562). Crude fibre (0.0813) and protein content (0.0373) had the lowest phenotypic correlations with green fodder yield respectively.

### 4.1.5.b. Correlation between pair of chracters other than those with green fodder yield

Table 8 displays the correlation among eleven characters in all possible combinations.

At the genotypic level plant height had high positive correlation with internodal length (1.0000) followed by internode number per hill, tiller number per hill and leaf number per hill.

Plant height had high positive and significant phenotypic correlation with internodal length (0.8713).

Tiller number per hill had high positive and significant genotypic correlation with internode number per hill (1.0000) followed by leaf number per hill (0.9896) and internode length (0.7165).

Tiller number per hill had positive and non significant phenotypic correlations with leaf-stem ratio (0.5207 internode length (0.3758), leaf area index (0.3440), crude fibre content (0.1349) and crude protein content (0.1349). Leaf number per hill had high positive and significant genotypic correlation with internode number per hill (0.9921), tiller number per hill (0.9896) and internode length (0.6730).

Leaf number per hill had high positive and significant phenotypic correlation with tiller number per hill (0.9824) internode number per hill (0.9831), plant height (0.8696), dry fodder yield (0.7260) and green fodder yield (0.7101).

Internode number per hill had high positive and significant genotypic correlation with tiller number per hill (1.0000), leaf number per hill (0.9921), plant height (0.9046) and non significant correlation with dry fodder yield (0.5529) and green fodder yield (0.5223).

Internode number per hill had high positive and significant phenotypic correlation with tiller number per hill (0.9995), leaf number per hill (0.9831), dry fodder yield (0.7020) and green fodder yield (0.6874).

Internode length had high positive and significant genotypic correlation with plant height (1.0000), internode number per hill (0.7388), leaf number per hill (0.673) and tiller number per hill (0.7165). Negative genotypic correlations were recorded for internodal length with leaf area index (-0.3640) and leaf-stem ratio (-0.2578). Internode length had high positive and significant phenotypic correlation with plant height and negative non significant correlation with leaf area index (-0.0440).

Leaf area index recorded high positive and significant genotypic correlation with leaf-stem ratio (0.9646), green fodder yield (0.9131) and dry fodder yield (0.8925).

Leaf area index registered high positive and significant phenotypic correlation with leaf-stem ratio (0.8634), green fodder yield (0.8003) and dry fodder yield (0.7748). Crude protein content had non significant negative correlation with leaf area index.

Leaf-stem ratio had high positive and significant genotypic correlation with leaf area index (0.9646), green fodder yield (0.8979) and dry fodder yield (0.8861).

Leaf-stem ratio had high positive and significant phenotypic correlation with leaf area index (0.8634), green fodder yield (0.8805) and dry fodder yield (0.8681). Crude protein recorded non significant negative correlation with leaf-stem ratio (-0.0212).

Green fodder yield had highest positive genotypic correlation with dry fodder yield (0.9999). Crude protein and fibre content were not related with green fodder yield.

**Table 8. Phenotypic and genotypic correlation co-efficients of eleven characters in guinea grass**

| Characters | Plant height | Tiller number per hill | Leaf Number per hill | Internode number per hill | Indernode length | Leaf area index | Leaf stem ratio | Green fodder yield | Dry fodder yield | Crude protein content | Crude fibre content |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Plant height | - | 0.9032** | 0.8696** | 0.9046** | 1.0000** | 0.1999 | 0.2523 | 0.4650 | 0.5554 | Ne | Ne |
| Tiller number per hill | 0.4057 | - | 0.9896** | 1.0000** | 0.7165* | 0.3018 | 0.4427 | 0.5288 | 0.5582 | Ne | Ne |
| Leaf number per hill | 0.3834 | 0.9824** | - | 0.9921** | 0.6730* | 0.3542 | 0.5433 | 0.5796 | 0.6059 | Ne | Ne |
| Internode number per hill | 0.4076 | 0.9995** | 0.9831** | - | 0.7388* | 0.2876 | 0.4362 | 0.5223 | 0.5529 | Ne | Ne |
| Internode length | 0.8713** | 0.3578 | 0.3048 | 0.3578 | - | -0.3640 | -0.2578 | 0.0441 | 0.1710 | Ne | Ne |
| Leaf area index | 0.1065 | 0.3440 | 0.3874 | 0.3372 | -0.0440 | - | 0.9646** | 1.9131** | 0.8925** | Ne | Ne |
| Leaf-stem ratio | 0.2578 | 0.5207 | 0.5589 | 0.5160 | 0.1656 | 0.8634** | - | 0.8979** | 0.8861** | Ne | Ne |
| Green fodder yield | 0.3556 | 0.6920* | 0.7101* | 0.6874* | 0.2562 | 0.8003* | 0.8805** | - | 0.9999** | Ne | Ne |
| Dry fodder yield | 0.3629 | 0.7065* | 0.7260* | 0.7020* | 0.2634 | 0.7748* | 0.8681** | 0.9965** | - | Ne | Ne |
| Crude protein content | 0.0697 | 0.0957 | 0.0732 | 0.0950 | 0.2583 | -0.1178 | -0.0212 | 0.3730 | 0.0470 | - | Ne |
| Crude fibre content | 0.1781 | 0.1349 | 0.1366 | 0.1420 | 0.4222 | 0.0047 | 0.6530 | 0.0813 | 0.0967 | 0.6701* | - |

* Siginificant at 5% level

** Siginificant at 1% level

Ne - Not estimable

Upper diagonal values - Genotypic correlation co-efficients

Lower diagonal values - phenotypic correlation co-efficients

Green fodder yield recorded high positive and significant phenotypic correlation with dry fodder yield (0.9965), leaf-stem ratio (0.8805), leaf area index (0.8003), leaf number per hill (0.7101), tiller number per hill (0.6920) and internode number per hill (0.6874).

Dry fodder yield had high positive and significant genotypic corelation with green fodder yield (0.9999), leaf area index (0.8925) and leaf-stem ratio (0.8861).

Dry fodder yield recorded high positive and significant phenotypic correlation with green fodder yield (0.9965), leaf-stem ratio (0.8681), leaf area index (0.7748), leaf number per hill (0.7260), tiller number per hill (0.7065) and internode number per hill (0.7020).

At genotypic level, crude protein and fibre content were found to be not related with the remaining characters. However, at phenotypic level, crude protein exhibited non significant negative correlation with leaf area index (-0.1178) and leaf-stem ratio (-0.0212). Crude fibre content recorded high positive significant phenotypic correlation with crude protein content.

#### 4.1.6. Selection index (discriminant function)

Selection index is used to discriminate the varieties based on major components of yield, viz. plant height ($X_1$), tiller number per hill ($X_2$), leaf number per hill ($X_3$), internode number per hill ($X_4$), internodal length ($X_5$), leaf area index ($X_6$), leaf-stem ratio ($X_7$), green

Table 9. Selection index (Scores) for ten different varieties of guinea grass

| S.No. | Varieties | Selection Index |
|---|---|---|
| 1 | JHGG 96 - 3 | 36713.60 |
| 2 | JHGG 96 - 4 | 34172.65 |
| 3 | JHGG 96 - 2 | 24498.02 |
| 4 | Riversdale | 14476.46 |
| 5 | JHGG 96 - 1 | 10964.44 |
| 6 | PGG 255 | 9986.81 |
| 7 | PGG 310 | 9638.28 |
| 8 | PGG 101 | 9362.54 |
| 9 | PGG 518 | 9259.70 |
| 10 | PGG 9 | 5898.99 |

fodder yield ($X_8$) and dry fodder yield ($X_9$). The selection indices prepared on these characters are presented in Table 9.

The highest index was recorded by the clone JHGG 96-3 (36713.60) followed by JHGG 96-4 (34172.65), JHGG 96-2 (24498.02) and Riversdale (14476.46).

## 4.2. Experiment II. Comparison of variability between sexual and asexual populations through progeny mean analysis using seeds and slips.

The data collected on various characters viz. plant height, tiller number per hill, leaf number per hill, internode number per hill, internode length, leaf-stem ratio, leaf area index, green fodder yield, dry fodder yield, crude protein content and crude fibre content with respect to two types of planting materials viz., slips and seeds were subjected to progeny mean analysis in two separate compact family block designs.

### 4.2.1. Pooled Anova

Pooled Anova of various characters for five families viz. Riversdale, JHGG 96-3, Haritha, Marthakom and JHGG 96-4 in compact family block design using slips as well as seeds are given in appendix II and III. All the families exhibited significant differences for all the characters studied. The mean values for the asexual and sexual progenies of various characters are furnished in Tables 10 to 20.

### 4.2.2. Plant height

The family and progeny wise differences in plant height with respect to two types of planting materials viz. Slips and seeds are depicted in Table 10. The average plant height ranged from 85.6 cm (Riversdale) to 106.7 cm (JHGG 96-4) in asexual population and 91.0 cm (Riversdale) to 109.7 cm (JHGG 96-4) in sexual pupulation.

In the asexual population, four out of the five families did not exhbiit significant difference among the progenies while Riverdale did. In the sexual population, none of the families exhibited significant difference among the progenies.

### 4.2.3. Tiller number per hill

The average tiller number per hill ranged from 14.0 (Riversdale) to 15.8 (JHGG 96-4) in asexual population and 14.0 (Riversdale) to 16.2 (JHGG 96-4) in sexual population.

The families JHGG 96-3 and Marathakom exhibited significant difference among the progenies both in sexual and asexual populations. Within JHGG 96-3, the highest mean value was recorded by progeny 2 (16.9) and the lowest by progenies 8 and 9 (13.8) in asexual population while in sexual population, the highest mean value was recorded by progeny 1 (16.3) and the lowest by progeny 9 (11.0).

## Table 10. Family and progeny wise differences in plant height (cm)

### SLIPS

| Families | Progenies 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Family mean | $F_{9,36}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Riversdale | 81.8 | 85.5 | 82.9 | 81.7 | 83.2 | 85.9 | 87.7 | 88.9 | 89.5 | 88.6 | 85.6 | 2.50* |
| JHGG 96 - 3 | 104.8 | 104.0 | 102.6 | 104.4 | 106.1 | 101.9 | 105.9 | 105.8 | 103.2 | 105.8 | 104.5 | 1.43 |
| Haritha | 104.0 | 105.6 | 103.2 | 106.9 | 106.8 | 106.6 | 106.1 | 101.3 | 104.8 | 103.9 | 104.9 | 1.97 |
| Marathakom | 101.6 | 104.2 | 106.4 | 98.9 | 102.9 | 102.7 | 103.8 | 104.6 | 105.0 | 108.3 | 103.8 | 1.28 |
| JHGG 96 - 4 | 106.0 | 106.1 | 105.7 | 108.4 | 106.4 | 107.6 | 104.8 | 107.6 | 106.7 | 108.1 | 106.7 | 0.39 |

CD (Family) = 3.62

### SEEDS

| Families | Progenies 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Family mean | $F_{9,36}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Riversdale | 92.2 | 92.0 | 91.3 | 92.6 | 93.8 | 91.2 | 89.2 | 89.1 | 88.6 | 89.8 | 91.0 | 0.33 |
| JHGG 96 - 3 | 104.8 | 103.9 | 103.1 | 105.5 | 102.9 | 102.6 | 106.2 | 104.3 | 106.7 | 108.7 | 104.9 | 1.20 |
| Haritha | 105.3 | 106.6 | 106.3 | 105.3 | 107.3 | 106.6 | 102.5 | 104.5 | 105.6 | 100.8 | 105.1 | 1.69 |
| Marathakom | 110.6 | 108.9 | 106.8 | 103.1 | 104.3 | 105.4 | 109.3 | 109.8 | 106.7 | 105.9 | 107.1 | 1.15 |
| JHGG 96-4 | 108.1 | 111.6 | 113.6 | 113.7 | 110.7 | 107.5 | 107.2 | 110.9 | 107.5 | 106.4 | 109.7 | 1.33 |

CD (Family) = 3.19

* Significant at 5% level

## Table 11. Family and progeny wise differences in tiller number per hill

### SLIPS

| Families | Progenies 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Family mean | $F_{9,36}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Riversdale | 13.3 | 13.7 | 13.5 | 13.9 | 14.6 | 13.8 | 14.5 | 15.1 | 13.9 | 13.7 | 14.0 | 2.06 |
| JHGG 96 - 3 | 16.1 | 16.9 | 14.8 | 15.5 | 15.6 | 15.1 | 15.5 | 13.8 | 13.8 | 15.8 | 15.3 | 4.22** |
| Haritha | 13.8 | 13.8 | 14.3 | 16.1 | 12.9 | 12.1 | 13.3 | 14.4 | 14.6 | 14.9 | 14.0 | 2.05 |
| Marathakom | 15.4 | 15.8 | 15.6 | 16.5 | 14.8 | 13.4 | 14.3 | 15.8 | 16.5 | 14.5 | 15.3 | 2.31* |
| JHGG 96 - 4 | 17.2 | 15.6 | 16.3 | 15.4 | 16.1 | 14.4 | 15.5 | 16.5 | 15.4 | 15.9 | 15.8 | 0.86 |

CD (Family) = 1.13

### SEEDS

| Families | Progenies 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Family mean | $F_{9,36}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Riversdale | 13.2 | 14.0 | 13.3 | 14.2 | 14.4 | 13.6 | 14.5 | 15.3 | 14.5 | 13.3 | 14.0 | 1.35 |
| JHGG 96 - 3 | 16.3 | 16.0 | 15.1 | 16.2 | 12.3 | 15.4 | 15.8 | 15.6 | 11.0 | 15.8 | 14.9 | 3.38** |
| Haritha | 14.0 | 14.1 | 12.3 | 13.3 | 12.7 | 14.0 | 14.4 | 13.7 | 14.0 | 14.3 | 13.7 | 0.72 |
| Marathakom | 15.0 | 16.7 | 17.0 | 16.0 | 16.0 | 14.0 | 14.0 | 13.7 | 16.6 | 15.9 | 15.5 | 3.94** |
| JHGG 96-4 | 16.1 | 16.4 | 15.6 | 16.7 | 16.5 | 14.8 | 16.9 | 15.7 | 16.6 | 16.1 | 16.2 | 0.38 |

CD (Family) = 1.32

* Significant at 5% level
** Significant at 1% level

### 4.2.4. Leaf Number Per Hill

The highest and lowest average leaf number per hill were recorded by JHGG 96-4 (78.5, 77.8) and Haritha (59.9, 59.0) respectively in both asexual and sexual populations.

Among the clonal progenies, the families JHGG 96-3, Haritha and Marathakom exhibited significant difference among the progenies. Among the seedling progenies, the families JHGG 96-3 and Marathakom alone showed significant difference among the progenies. Within Marathakom, the highest mean value was recorded by progeny 3 (81.8) and the lowest by progeny 8 (65.9) in sexual population.

### 4.2.5. Internode number per hill

The average internode number per hill ranged from 50.5 (Haritha) to 67.4 (Marathakom) in asexual population and 49.9 (Haritha) to 68.3 (Marathakom) in sexual population.

None of the families in asexual population exhibited significant difference among the progenies. In the sexual population, significant difference among the progenies was recorded for the family Haritha alone. The lowest and highest mean values were recorded by progeny 3(44.9) and progeny 7(53.0) respetively.

**Table 12. Family and progeny wise differences in leaf number per hill**

**SLIPS**

| Families | Progenies 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Family mean | $F_{9,36}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Riversdale | 58.4 | 60.5 | 59.8 | 61.2 | 64.0 | 60.9 | 63.7 | 66.5 | 62.5 | 63.2 | 62.1 | 1.98 |
| JHGG 96 - 3 | 74.2 | 77.7 | 68.2 | 71.4 | 73.1 | 69.5 | 71.1 | 63.3 | 63.2 | 72.5 | 63.3 | 4.41** |
| Haritha | 59.5 | 59.6 | 61.5 | 69.1 | 55.8 | 50.4 | 56.9 | 62.8 | 58.9 | 64.4 | 59.9 | 2.27* |
| Marathakom | 72.4 | 74.2 | 73.3 | 77.6 | 69.6 | 63.1 | 67.4 | 74.1 | 77.3 | 68.3 | 71.7 | 2.29* |
| JHGG 96 - 4 | 82.7 | 75.2 | 84.5 | 80.2 | 81.0 | 71.0 | 75.9 | 81.1 | 75.5 | 77.9 | 78.5 | 1.05 |

CD (Family) = 4.78

**SEEDS**

| Families | Progenies 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Family mean | $F_{9,36}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Riversdale | 59.7 | 64.4 | 61.3 | 66.3 | 62.9 | 66.6 | 69.5 | 63.0 | 66.6 | 65.6 | 64.6 | 1.03 |
| JHGG 96 - 3 | 75.3 | 73.9 | 69.6 | 74.6 | 56.3 | 70.9 | 72.8 | 72.1 | 48.7 | 72.6 | 68.7 | 3.92** |
| Haritha | 60.3 | 60.7 | 53.1 | 54.8 | 56.8 | 61.0 | 61.6 | 58.9 | 60.1 | 62.7 | 59.0 | 0.85 |
| Marathakom | 72.2 | 80.4 | 81.8 | 76.7 | 76.7 | 67.3 | 67.3 | 65.9 | 79.7 | 76.4 | 74.4 | 3.94** |
| JHGG 96-4 | 77.2 | 78.9 | 74.7 | 80 | 78.7 | 70.3 | 77.9 | 72.3 | 84.1 | 83.7 | 77.8 | 0.73 |

* Significant at 5% level

CD (Family) = 5.98

**Table 13. Family and progeny wise differences in internode number per hill**

**SLIPS**

| Families | Progenies 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Family mean | $F_{9,36}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Riversdale | 50.4 | 52.2 | 51.6 | 51.4 | 53.9 | 51.3 | 54.8 | 57.5 | 52.9 | 48.5 | 52.5 | 1.21 |
| JHGG 96 - 3 | 61.3 | 63.9 | 56.2 | 54.8 | 56.3 | 54.3 | 55.8 | 49.5 | 47.4 | 58.7 | 55.8 | 0.42 |
| Haritha | 49.8 | 50.0 | 51.4 | 57.8 | 46.7 | 43.7 | 47.7 | 51.7 | 52.7 | 53.9 | 50.5 | 2.05 |
| Marathakom | 68.1 | 69.7 | 68.6 | 72.7 | 65.1 | 59.7 | 63.1 | 69.3 | 72.6 | 65.9 | 67.4 | 0.47 |
| JHGG 96 - 4 | 67.1 | 62.5 | 64.3 | 60.1 | 62.9 | 56.2 | 60.3 | 64.5 | 59.5 | 62.1 | 61.9 | 2.11 |

CD (Family) = 4.61

**SEEDS**

| Families | Progenies 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Family mean | $F_{9,36}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Riversdale | 46.2 | 51.8 | 49.2 | 52.7 | 53.4 | 50.5 | 53.5 | 56.6 | 52.1 | 57.8 | 51.4 | 1.51 |
| JHGG 96 - 3 | 62.0 | 62.9 | 60.7 | 61.9 | 44.8 | 55.5 | 56.5 | 56.0 | 39.4 | 56.8 | 55.6 | 1.75 |
| Haritha | 52.5 | 50.3 | 44.9 | 47.1 | 48.2 | 51.9 | 53.0 | 50.7 | 49.5 | 50.3 | 49.9 | 2.39* |
| Marathakom | 66.1 | 73.6 | 74.9 | 70.3 | 70.3 | 61.7 | 62.0 | 60.7 | 73.2 | 70.0 | 68.3 | 1.02 |
| JHGG 96-4 | 62.8 | 64.1 | 60.7 | 65.4 | 64.2 | 57.2 | 66.1 | 61.3 | 64.4 | 62.9 | 62.9 | 1.30 |

* Significant at 5% level

CD (Family) = 5.33

### 4.2.6. Internode length

The average internode length ranged from 16.3 cm (Riversdale) to 21.6 cm (JHGG 96-4) in asexual population and 15.9 cm (Riversdale) to 21.5 cm (JHGG 96-4) in sexual population. The families Haritha, Marathakom and JHGG 96-3 exhibited significant difference among the progenies in asexual population. Among the sexual population, significant difference among the progenies was observed for the families Marathakom and JHGG 96-3. Within Marathakom, the highest mean value was recorded by the progeny 4(21.6 cm) and the lowest by progeny 5 (18.6 cm).

### 4.2.7. Leaf-stem ratio

The average leaf-stem ratio ranged from 1.29 (Riversdale) to 2.32 (JHGG 96-4) in asexual population and 1.29 (Riversdale) to 2.18 (JHGG 96.4) in sexual population.

None of the families exhibited significant difference among the progenies in both asexual and sexual population.

### 4.2.8. Leaf area index

The average leaf area index ranged from 3.5 (Riversdale) to 5.3 (JHGG 96-4) in asexual population and 3.4 (Riversdale) to 5.3 (JHGG 96-4) in sexual population.

**Table 14. Family and progeny wise differences in leaf-stem ratio**

**SLIPS**

| Families | Progenies 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Family mean | $F_{9,36}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Riversdale | 1.2 | 1.29 | 1.38 | 1.32 | 1.33 | 1.33 | 1.24 | 1.29 | 1.28 | 1.29 | 1.29 | 2.02 |
| JHGG 96 - 3 | 1.5 | 1.54 | 1.58 | 1.66 | 1.61 | 1.70 | 1.63 | 1.56 | 1.64 | 1.66 | 1.6 | 1.85 |
| Haritha | 2.0 | 1.78 | 1.85 | 1.93 | 1.87 | 1.82 | 2.01 | 2.05 | 2.07 | 2.02 | 1.94 | 1.65 |
| Marathakom | 2.2 | 2.10 | 2.21 | 2.00 | 2.09 | 2.20 | 2.16 | 2.06 | 2.20 | 2.09 | 2.13 | 1.72 |
| JHGG 96 - 4 | 2.4 | 2.38 | 2.31 | 2.26 | 2.24 | 2.35 | 2.27 | 2.25 | 2.32 | 2.36 | 2.32 | 0.83 |

CD (Family) = 0.093

**SEEDS**

| Families | Progenies 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Family mean | $F_{9,36}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Riversdale | 1.23 | 1.30 | 1.37 | 1.33 | 1.25 | 1.33 | 1.34 | 1.15 | 1.28 | 1.29 | 1.29 | 1.38 |
| JHGG 96 - 3 | 1.50 | 1.54 | 1.47 | 1.56 | 1.68 | 1.62 | 1.63 | 1.58 | 1.60 | 1.66 | 1.58 | 0.72 |
| Haritha | 1.82 | 1.74 | 1.92 | 1.75 | 1.81 | 1.57 | 2.02 | 2.05 | 1.97 | 2.16 | 1.9 | 1.28 |
| Marathakom | 2.12 | 2.12 | 2.08 | 1.56 | 1.66 | 2.14 | 2.19 | 2.06 | 1.92 | 1.76 | 1.96 | 1.69 |
| JHGG 96-4 | 2.34 | 2.39 | 2.32 | 2.22 | 2.34 | 1.90 | 2.11 | 2.11 | 1.87 | 2.15 | 2.18 | 1.05 |

CD (Family) = 0.202

## Table 15. Family and progeny wise differences in internode length (cm)

### SLIPS

| Families | 1 | 2 | 3 | 4 | Progenies 5 | 6 | 7 | 8 | 9 | 10 | Family mean | $F_{9,36}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Riversdale | 17.6 | 16.8 | 15.7 | 18.1 | 16.5 | 15.3 | 16.4 | 15.8 | 15.6 | 15.5 | 16.3 | 2.00 |
| JHGG 96 - 3 | 20.1 | 19.5 | 20.4 | 20.6 | 19.4 | 20.0 | 19.5 | 20.7 | 20.3 | 20.1 | 20.1 | 7.27** |
| Haritha | 20.3 | 20.6 | 21.5 | 19.6 | 21.4 | 19.8 | 19.7 | 19.2 | 19.6 | 20.6 | 20.2 | 3.04** |
| Marathakom | 20.7 | 20.1 | 20.5 | 20.8 | 19.2 | 20.1 | 19.7 | 21 | 20.3 | 19.8 | 20.2 | 2.33* |
| JHGG 96 - 4 | 22.2 | 21.2 | 20.9 | 20.9 | 22.7 | 21 | 22.9 | 20.6 | 22.4 | 21.4 | 21.6 | 0.89 |

CD (Family) = 0.74

### SEEDS

| Families | 1 | 2 | 3 | 4 | Progenies 5 | 6 | 7 | 8 | 9 | 10 | Family mean | $F_{9,36}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Riversdale | 17.2 | 15.6 | 15.7 | 17.4 | 16.9 | 15.7 | 16.8 | 16.1 | 14.0 | 13.4 | 15.9 | 0.66 |
| JHGG 96 - 3 | 20.9 | 20.0 | 21.2 | 21.6 | 18.6 | 20.2 | 18.9 | 20.8 | 19.1 | 19.7 | 20.1 | 4.37** |
| Haritha | 20.6 | 20.1 | 20.6 | 18.9 | 20.5 | 20.0 | 19.5 | 20.2 | 17.5 | 20.5 | 19.8 | 2.08 |
| Marathakom | 20.8 | 20.4 | 20.6 | 20.1 | 18.2 | 20.8 | 19.6 | 21.2 | 20.1 | 20.6 | 20.3 | 3.93** |
| JHGG 96-4 | 22.6 | 21.5 | 21.7 | 21.3 | 21.9 | 20.8 | 21.9 | 18.8 | 22.3 | 21.5 | 21.5 | 0.43 |

CD (Family) = 0.99

* Significant at 5% level
** Significant at 1% level

## Table 16. Family and progeny wise differences in leaf area index

### SLIPS

| Families | Progenies 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Family mean | $F_{9,36}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Riversdale | 3.8 | 3.4 | 3.6 | 3.4 | 3.5 | 3.4 | 3.6 | 3.5 | 3.4 | 3.6 | 3.5 | 0.78 |
| JHGG 96 - 3 | 4.2 | 4.2 | 3.9 | 4.3 | 4.0 | 4.1 | 4.1 | 3.8 | 4.0 | 3.8 | 4.0 | 1.64 |
| Haritha | 4.7 | 4.3 | 4.1 | 4.6 | 4.3 | 4.2 | 4.2 | 4.5 | 4.7 | 4.4 | 4.4 | 1.39 |
| Marathakom | 5.0 | 4.7 | 5.1 | 4.5 | 4.6 | 5.1 | 4.7 | 4.5 | 4.2 | 4.7 | 4.7 | 2.46* |
| JHGG 96 - 4 | 5.3 | 5.1 | 5.0 | 5.5 | 5.8 | 4.3 | 4.8 | 5.2 | 5.0 | 5.3 | 5.3 | 1.37 |

CD (Family) = 0.243

### SEEDS

| Families | Progenies 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Family mean | $F_{9,36}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Riversdale | 3.9 | 3.5 | 3.2 | 3.3 | 3.4 | 3.4 | 3.3 | 3.8 | 3.6 | 2.9 | 3.4 | 3.49** |
| JHGG 96 - 3 | 4.2 | 4.2 | 4.2 | 3.5 | 4.0 | 3.9 | 4.1 | 3.8 | 3.9 | 3.9 | 3.9 | 1.84 |
| Haritha | 4.4 | 4.2 | 4.1 | 4.4 | 4.2 | 4.1 | 4.4 | 4.4 | 4.0 | 4.3 | 4.3 | 0.77 |
| Marathakom | 5.0 | 4.8 | 5.2 | 4.7 | 4.8 | 4.5 | 4.6 | 4.2 | 4.3 | 4.6 | 4.7 | 1.63 |
| JHGG 96-4 | 5.1 | 5.1 | 5.3 | 5.0 | 5.9 | 5.1 | 5.4 | 5.4 | 4.4 | 5.6 | 5.3 | 3.27** |

CD (Family) = 0.315

* Significant at 5% level

Significant difference among the progenies was not found except for the family Marathakom in asexual population. Among the sexual population, both Riversdale and JHGG 96-4 exhibited significant difference among the progenies.

#### 4.2.9. Green fodder yield

The average green fodder yield ranged from 30.3 t/ha (Haritha) to 38.3 t/ha (JHGG 96-4) in a seuxal population and 29.3 t/ha (Haritha) to 38.6 t/ha (JHGG 96-4) in sexual population. The families Riversdale, JHGG 96-3 and Marathakom exhibited significant difference among the progenies both in sexual and asexual population. Within Marathakom, the highest average green fodder yield was recorded by progeny 4 (36.3 t/ha) and the lowest by progeny 6 (28.1 t/ha) in asexual population. In asexual population, the highest mean value was recorded by progeny 3 (35.7 t/ha) and the lowest by progeny 8 (28.8 t/ha).

#### 4.2.10. Dry fodder yield

The average dry fodder yield ranged from 9.2 t/ha (Haritha) to 11.1 t/ha (JHGG 96.4) in asexual population and 9.1 t/ha (Hritha) to 11.6 t/ha (JHGG 96.4) in sexual population.

The families JHGG 96-3 and Haritha exhibited significant difference among the progenies both in sexual and asexual population.

**Table 17. Family and progeny wise differences in green fodder yield (t/ha)**

**SLIPS**

| Families | Progenies 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Family mean | $F_{9,36}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Riversdale | 29.2 | 30.2 | 29.9 | 30.6 | 32.0 | 31.7 | 33.3 | 34.8 | 31.7 | 31.5 | 31.5 | 3.62** |
| JHGG 96 - 3 | 35.3 | 39.2 | 34.0 | 34.4 | 35.7 | 33.2 | 34.0 | 30.3 | 30.2 | 34.3 | 34.1 | 3.21** |
| Haritha | 29.3 | 28.9 | 29.9 | 33.7 | 27.9 | 26.7 | 39.2 | 31.6 | 32.4 | 33.0 | 30.3 | 1.81 |
| Marathakom | 32.3 | 31.6 | 34.3 | 36.3 | 31.4 | 28.1 | 33.1 | 34.6 | 30.5 | 29.6 | 32.2 | 3.19** |
| JHGG 96 - 4 | 41.3 | 37.0 | 39.1 | 36.9 | 38.7 | 33.5 | 36.6 | 41.3 | 38.4 | 39.8 | 38.3 | 1.49 |

CD (Family) = 2.63

**SEEDS**

| Families | Progenies 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Family mean | $F_{9,36}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Riversdale | 29.1 | 30.8 | 29.3 | 31.9 | 31.6 | 30.3 | 33.3 | 36.6 | 34.8 | 31.9 | 32.0 | 3.41** |
| JHGG 96 - 3 | 35.9 | 35.3 | 34.8 | 37.5 | 28.2 | 35.5 | 36.6 | 35.9 | 25.5 | 37.2 | 34.2 | 3.15** |
| Haritha | 29.9 | 29.3 | 25.8 | 26.7 | 29.0 | 30.9 | 31.5 | 30.4 | 26.9 | 31.7 | 29.3 | 1.15 |
| Marathakom | 31.6 | 35.2 | 35.7 | 35.1 | 35.2 | 30.8 | 30.8 | 28.8 | 34.8 | 33.4 | 33.2 | 3.43** |
| JHGG 96-4 | 38.1 | 39.5 | 37.4 | 40.0 | 39.5 | 35.5 | 40.7 | 37.7 | 39.4 | 38.7 | 38.6 | 0.38 |

* Significant at 5% level

CD (Family) = 3.23

**Fig.4. Mean green fodder yield (t/ha) [slips Vs seeds]**

| | | |
|---|---|---|
| $X_1$ | - | Riversdale |
| $X_2$ | - | JHGG 96 - 3 |
| $X_3$ | - | Haritha |
| $X_4$ | - | Marathakom |
| $X_5$ | - | JHGG 96 - 4 |

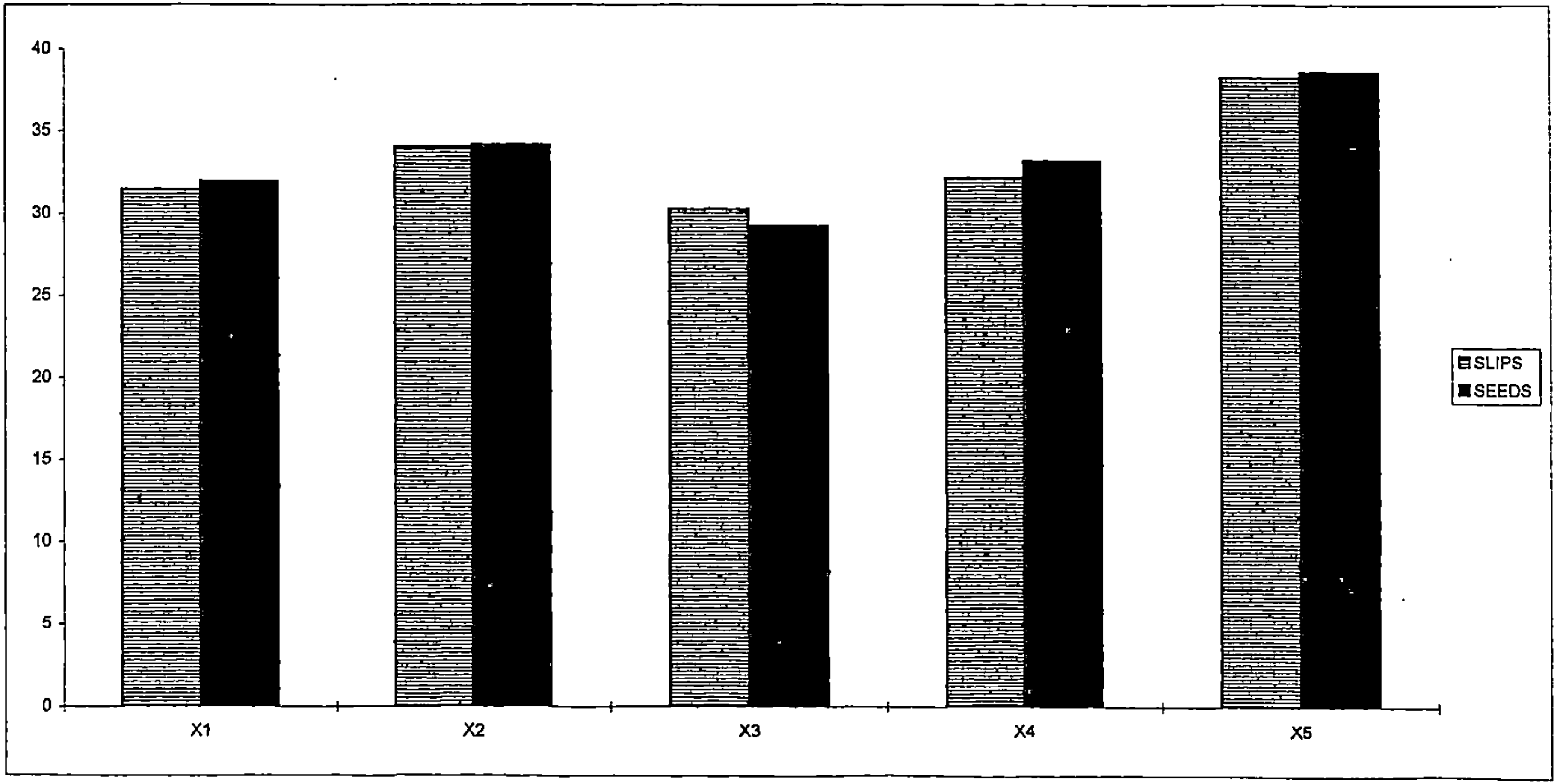



**Fig.4. Mean green fodder yield (seeds Vs slips)**

## Table 18. Family and progeny wise differences in dry fodder yield (t/ha)

### SLIPS

| Families | Progenies 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Family mean | $F_{9,36}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Riversdale | 9.3 | 9.7 | 8.9 | 9.8 | 9.6 | 9.5 | 10.1 | 10.1 | 9.2 | 9.2 | 9.5 | 1.84 |
| JHGG 96 - 3 | 10.7 | 11.3 | 10.2 | 7.1 | 11.0 | 10.6 | 10.9 | 9.7 | 8.5 | 9.6 | 10.4 | 7.59** |
| Haritha | 8.8 | 8.6 | 9.0 | 10.1 | 8.4 | 8.1 | 8.7 | 10.1 | 10.4 | 9.2 | 9.2 | 2.42* |
| Marathakom | 9.7 | 10.1 | 10.3 | 10.9 | 10.4 | 9.4 | 9.0 | 10.6 | 11.1 | 8.5 | 9.9 | 0.49 |
| JHGG 96 - 4 | 12.4 | 11.1 | 11.7 | 10.8 | 10.9 | 9.4 | 10.3 | 11.6 | 10.7 | 12.7 | 11.1 | 0.71 |

CD (Family) = 0.75

### SEEDS

| Families | Progenies 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Family mean | $F_{9,36}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Riversdale | 9.3 | 9.9 | 9.4 | 9.6 | 9.5 | 9.2 | 9.9 | 11.4 | 10.8 | 9.3 | 9.8 | 3.42** |
| JHGG 96 - 3 | 10.8 | 10.6 | 10.4 | 11.9 | 9.0 | 10.8 | 11.3 | 11.4 | 7.4 | 10.8 | 10.4 | 3.39** |
| Haritha | 8.9 | 8.8 | 7.7 | 8.0 | 9.6 | 10.1 | 9.7 | 8.6 | 10.1 | 9.8 | 9.1 | 2.02 |
| Marathakom | 9.5 | 10.5 | 10.7 | 10.5 | 10.9 | 10.0 | 9.9 | 9.3 | 11.1 | 10.8 | 10.3 | 2.36* |
| JHGG 96-4 | 12.2 | 12.6 | 11.9 | 11.8 | 11.8 | 10.7 | 12.2 | 11.3 | 11.0 | 10.8 | 11.6 | 0.77 |

CD (Family) = 0.99

* Significant at 5% level

** Significant at 1% level

**Fig.5. Mean dry fodder yield (t/ha) [slips Vs seeds]**

| | | |
|---|---|---|
| $X_1$ | - | Riversdale |
| $X_2$ | - | JHGG 96 - 3 |
| $X_3$ | - | Haritha |
| $X_4$ | - | Marathakom |
| $X_5$ | - | JHGG 96 - 4 |

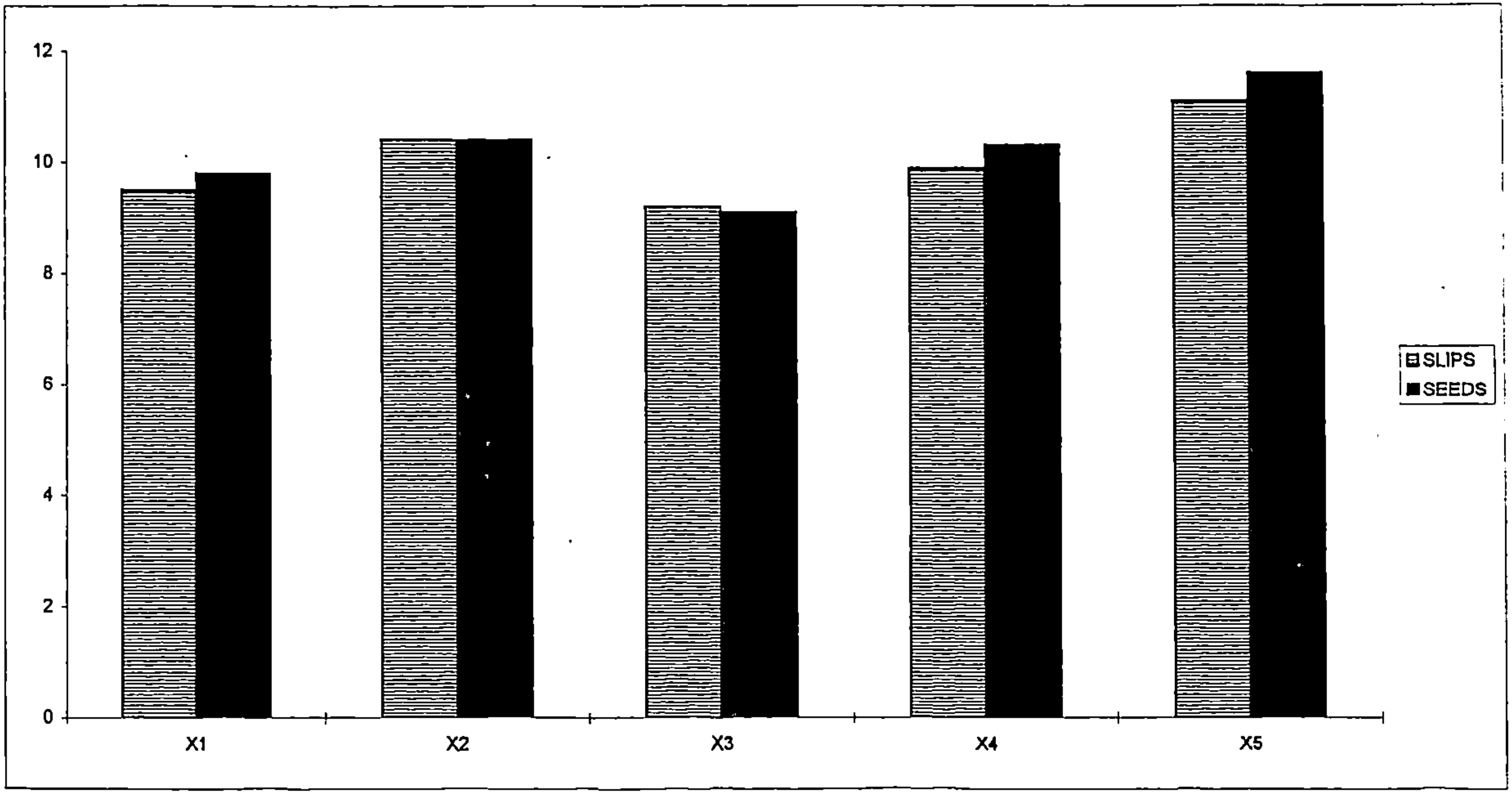



**Fig.5. Mean dry fodder yield (seeds Vs slips)**

### 4.2.11. Crude Protein Content

The average crude protein content ranged from 8.91% (JHGG 96-3) to 9.49% (Marathakom) in asexual population and 8.71 % (JHGG 96-3) to 9.44% (Marathakom) in sexual population.

Among the asexual population JHGG 96-3 and JHGG 96-4 exhibited significant difference among the progenies while the families Riversdale and Haritha exhibited the same in sexual population.

### 4.2.12. Crude fibre content

The average crude fibre content ranged from 28.0% (JHGG 96-3) to 31.5 (JHGG 96-4) in asexual population and 28.1% (JHGG 96-3) to 30.77% (JHGG 96-4) in sexual population. While none of the families exhibited significant difference among the progenies in asexual population, Riversdale and Haritha exhibited significant difference among the progenies in sexual population.

### 4.2.13. Bartlett's Chi-square value

Table 21 shows the Bartlett's chi-square value for various characters with respect to two types of planting materials viz. slips and seeds. Chi-square values for all the characters studied except internode length were found to be significant.

**Table 19. Family and progeny wise differences in crude protein content (%)**

**SLIPS**

| Families | Progenies 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Family mean | $F_{9,36}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Riversdale | 9.28 | 9.09 | 9.28 | 9.31 | 9.35 | 9.07 | 9.24 | 9.15 | 9.19 | 9.06 | 9.20 | 0.43 |
| JHGG 96 - 3 | 8.41 | 9.22 | 8.84 | 8.84 | 9.04 | 9.22 | 8.48 | 8.96 | 8.41 | 9.71 | 8.91 | 2.88* |
| Haritha | 9.57 | 9.42 | 9.09 | 9.69 | 9.42 | 9.16 | 9.05 | 9.31 | 8.99 | 9.33 | 9.31 | 2.07 |
| Marathakom | 9.60 | 9.72 | 9.75 | 9.54 | 9.58 | 9.01 | 9.58 | 9.31 | 9.68 | 9.10 | 9.49 | 0.74 |
| JHGG 96 - 4 | 8.84 | 9.69 | 9.07 | 9.09 | 8.99 | 8.33 | 8.96 | 8.52 | 9.19 | 9.33 | 9.00 | 3.20** |

CD (Family) = 0.21

**SEEDS**

| Families | Progenies 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Family mean | $F_{9,36}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Riversdale | 9.23 | 7.72 | 9.29 | 9.34 | 9.29 | 9.13 | 9.17 | 8.57 | 9.07 | 9.23 | 9.01 | 2.68* |
| JHGG 96 - 3 | 8.08 | 9.23 | 8.31 | 3.08 | 9.07 | 9.29 | 8.21 | 8.93 | 8.42 | 9.50 | 8.71 | 1.28 |
| Haritha | 9.44 | 8.93 | 8.07 | 9.54 | 9.17 | 9.17 | 9.05 | 9.43 | 8.92 | 9.09 | 9.08 | 3.00** |
| Marathakom | 9.34 | 9.70 | 8.83 | 9.62 | 9.70 | 8.77 | 9.47 | 9.51 | 10.07 | 9.38 | 9.44 | 1.2 |
| JHGG 96-4 | 8.79 | 8.61 | 9.03 | 9.17 | 8.90 | 8.47 | 7.32 | 9.42 | 7.34 | 9.34 | 8.64 | 1.24 |

* Significant at 5% level

CD (Family) = 0.35

### Table 20. Family and progeny wise differences in crude fibre content (%)

**SLIPS**

| Families | Progenies 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Family mean | $F_{9,36}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Riversdale | 31.35 | 31.15 | 29.39 | 28.97 | 31.14 | 30.29 | 27.38 | 30.80 | 32.33 | 31.59 | 30.44 | 1.43 |
| JHGG 96 - 3 | 27.96 | 28.21 | 29.25 | 30.25 | 25.63 | 27.95 | 29.28 | 28.72 | 26.95 | 25.84 | 28.00 | 1.08 |
| Haritha | 29.85 | 28.15 | 30.42 | 30.01 | 31.33 | 28.15 | 30.80 | 32.31 | 29.22 | 30.80 | 30.11 | 1.72 |
| Marathakom | 30.85 | 31.91 | 31.24 | 32.19 | 31.22 | 21.12 | 30.72 | 31.79 | 31.89 | 41.15 | 31.41 | 0.34 |
| JHGG 96 - 4 | 31.35 | 32.57 | 32.16 | 30.85 | 31.03 | 31.89 | 31.58 | 29.61 | 32.12 | 31.8 | 31.50 | 0.59 |

CD (Family) = 1.62

**SEEDS**

| Families | Progenies 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Family mean | $F_{9,36}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Riversdale | 30.17 | 30.20 | 29.83 | 24.19 | 30.71 | 31.77 | 25.91 | 31.57 | 32.16 | 32.21 | 29.87 | 3.94** |
| JHGG 96 - 3 | 28.49 | 28.21 | 29.74 | 29.99 | 26.64 | 24.99 | 27.92 | 29.09 | 29.19 | 26.74 | 28.10 | 0.63 |
| Haritha | 31.08 | 25.68 | 30.49 | 29.84 | 31.55 | 25.62 | 30.93 | 31.50 | 29.32 | 30.76 | 29.68 | 2.53* |
| Marathakom | 29.57 | 31.79 | 30.24 | 29.14 | 32.19 | 31.74 | 28.73 | 32.23 | 29.62 | 32.18 | 30.74 | 1.49 |
| JHGG 96 - 4 | 31.01 | 31.87 | 31.90 | 27.78 | 30.33 | 30.59 | 31.77 | 29.64 | 31.69 | 31.11 | 30.77 | 0.93 |

CD (Family) = 1.30

* Significant at 5% level
** Significant at 1% level

## Table 21. Bartlett's chi-square value

| S.No. | Characters | Slips | Seeds |
|---|---|---|---|
| 1 | Plant height | 18.7 | 19.53 |
| 2 | Tiller number per hill | 27.57 | 19.51 |
| 3 | Leaf number per hill | 31.19 | 20.50 |
| 4 | Internode number per hill | 29.23 | 17.91 |
| 5 | Internode length | 3.69$^{ns}$ | 1.29$^{ns}$ |
| 6 | Leaf area index | 13.39 | 12.09 |
| 7 | Leaf-stem ratio | 307.19 | 267.54 |
| 8 | Green fodder yield | 22.93 | 23.48 |
| 9 | Dry fodder yield | 22.73 | 24.59 |
| 10 | Crude protein content | 22.87 | 47.06 |
| 11 | Crude fibre content | 11.16 | 12.59 |

**4.2.14. Test of significance for variance and mean [Slips Vs Seeds]**

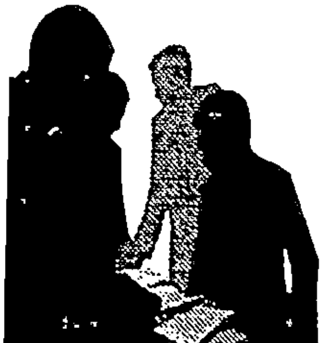
The significance of difference in variability of clonal and seedling progeny is shown in the Table 22. This difference was found to be significant in one out of the eleven characters studied in the family Martahakom and three out of the eleven in Haritha. JHGG 96-3 and JHGG 96-4 exhibited significant difference with respect to eight and four characters respectively. In Riversdale, the difference was found to be significant with respect to seven characters.

Among the uniform pupulations, the clonal and seedling progeny means of all the characters in the five families were found to be on par with each other.

### Table 22. Test of Significance for variance and mean (Slips Vs Seeds)

| Characters | Variance | | | | | Mean | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Riversdale | JHGG 96-3 | Haritha | Marathakom | JHGG 96-4 | Riversdale | JHGG 96-3 | Haritha | Marathakom | JHGG 96-4 |
| Plant height | 2.52* | 2.01* | 1.41 | 1.02 | 1.65 | Ne | Ne | 0.06 | 0.64 | 0.63 |
| Tiller number per hill | 2.31* | 4.22** | 1.13 | 1.11 | 1.59 | Ne | Ne | 0.12 | 0.10 | 0.19 |
| Leaf number per hill | 2.84* | 4.24** | 1.01 | 1.05 | 1.68 | Ne | Ne | 0.12 | 0.4 | 0.07 |
| Internode number per hill | 2.16* | 4.16** | 1.23 | 1.06 | 1.53 | Ne | Ne | 0.09 | 0.15 | 0.13 |
| Internode length | 1.68* | 1.21 | 1.28 | 1.06 | 2.42** | 0.23 | 0.00 | 0.24 | 0.05 | Ne |
| Leaf area index | 1.25 | 2.50* | 4.00** | 15.00** | 8.00** | 0.00 | Ne | Ne | Ne | Ne |
| Leaf-stem ratio | 1.09 | 1.44 | 1.28 | 1.58 | 1.00 | 0.3 | 0.31 | 0.25 | 0.00 | 0.00 |
| Green fodder yield | 2.23* | 2.41* | 1.32 | 1.1 | 1.58 | Ne | Ne | 0.24 | 0.28 | 0.06 |
| Dry fodder yield | 1.97* | 4.98** | 1.39 | 1.13 | 1.97* | Ne | Ne | 0.08 | 0.44 | Ne |
| Crude protein content | 3.73** | 3.89** | 2.20* | 1.39 | 9.78** | Ne | Ne | Ne | 0.09 | Ne |
| Crude fibre content | 1.24 | 1.73 | 1.91* | 1.74 | 1.43 | 0.26 | 0.03 | Ne | 0.38 | 0.35 |

* Significant at 5% level
** Significant at 1% level
Ne - Not estimable



DISCUSSION

# DISCUSSION

Variability, heritability, genetic advance, association of characters and selection index are some of the major parameters which help in the evaluation of the extent of genetic variability and association present in a population. The success of crop improvement programme depends on the existence and exploitation of genetic variability present in a given population. Considering the convenience in handling the planting material, seed propagation is fast becoming popular in guinea grass. However true breeding nature of guinea grass clones cannot be taken for granted since it is a facultative apomict. Hence ascertaining the seedling progeny behaviour of high yielding guinea grass clones compared to their vegetative progenies in fodder yield and other yield attributing traits would be *sine qua non* before embarking on large scale seed production.

The present investigation was initiated with the two fold objective of estimating genetic variability and ascertaining the seedling progeny behaviour. The experiment I estimated genetic variability and identified three superior high yielding guinea grass clones from the test materials available with All India Co-ordinated Research Project on Forage Crops. The two high yielding mutant clones namely Haritha and Marathakom along with three identified high yielding clones were utilised in experiment II. The results obtained from progeny mean analysis using seeds as well slips and comparison of variability with respect to two types of planting materials through statistical analysis are discussed below.

## 5.1. Varietal evaluation

### 5.1.1. Variability

Guinea grass is a facultative apomict with only five per cent cross pollination. The continuous vegetative propagation adopted in this crop has further reduced the extent of variability.

In the present study, the analysis of variance revealed significant difference among the clones with respect to tiller number per hill, internode number per hill, leaf number per hill, leaf area index, leaf-stem ratio, green fodder yield and dry fodder yield. The characters viz. plant height, internode length, crude protein content and crude fibre content did not exhibit significant difference. Sreenivasan et al (1986) in guinea grass had estimated only medium genotypic and phenotypic coefficient of vriation for plant height. The characters that did not reveal significant difference are seen keeping a high degree of genetic homogeneity among the different clones. Similar trend of significant differences were reported by Dhanakodi (1994) among 50 genotypes of fodder ragi for leaf number, tiller number, leaf-stem ratio and fodder yield. However, Suthamathi and Dorairaj (1995) reported significant differences for all the 18 characters studied in fodder bajra. Joseph (1988) reported insignificant difference among six genotypes of guinea grass for plant height in conformity with the results obtained in the present study.

The crop improvement programme in general is the exploitation of the genetic variability available in a population. The total variability present could be partitioned into heritable and non heritable components with the aid of genetic parameters like genotypic coefficient of variation. (GVC), phenotypic coefficient of variation (PVC), heritability ($h^2$) and genetic advance (GA) which serve as useful guidelines for selection.

Coefficient of variation is another means of expressing the amount of variability. In the present study phenotypic and genotypic coefficients of variation were highest for leaf area index which indicate that the varieties under study showed the highest genetic variability for leaf area index. Similar trend was reported by Thejasee Bhai (1988) in guinea grass.

In the present study the PCV was in general high for all the characters compared to GCV. Wide difference was observed between the estimates of PCV and GCV for characters such as plant height, internode length, crude protein content and crude fibre content indicating that they are influenced more by environment than by the genetic make up. Relatively little difference between GCV and PCV was observed for the characters leaf area index, leaf, stem, ratio, green fodder yield and dry fodder yield indicating that variations observed in these characters are more influenced by genetic causes than environment.

In general the estimates of GCV and PCV reported were low for all the characters in the present study. Similar trend of low GCV and PCV values for all the characters in guinea grass was reported by Joseph (1988) in guinea grass. Tyagi et.al., (1980) in Pearl millet had reported similar findings with respect to green fodder yield. However, Sreenivasan (1986) in guinea grass and Suresh (1997) in fodder bajra had reported high value of GCV for green fodder yield. Low estimate of GCV and PCV values obtained for leaf-stem ratio in the present study is in conformity with the results obtained by Sreenivasan (1986) in guinea grass. For dry matter yield low estimate of GCV value was recorded by Tyagi et.al., (1980) in pearlmillet. However, Sreenivasan (1986) in guinea grass reported high estimates of GCV for this character.

In the present study, plant height and internodal length registered very low GCV and PCV values while GCV values of crude protein content and crude fibre content were not estimable. Similar trend of very low GCV and PCV values for these characters were reported by Joseph (1988). Tyagi et.al., (1980) in Pearlmillet had also observed similar findings. Contrary to this Sreenivasan (1986) in guinea grass reported high GCV values for plant height. Low estimates of GCV was recorded for both crude fibre and protein content by Sreenivasan (1986) in guinea grass which is in agreement with the present study.

### 5.1.2. Heritability and genetic advance

Heritability is an index of transmissibility of characters from one generation to other and it provides a measure of the value of selection for different attributes in various types of progenies. According to Burton (1952) genotypic coefficient of variation alongwith heritability will give a clear idea about the amount of genetic advance as expected by selection.

In the present study, highest heritability estimate was reported for leaf area index. This indicates highly heritable nature and minimum influence of environment in phenotypic expression of this character. Suresh (1997) had reported high heritability value for leaf area index in fodder bajra which is in consonance with the results of this study.

Moderate heritability estimates were observed for leaf stem ratio, green fodder yield, dry fodder yield, leaf number per hill, tiller number per hill and internode number per hill. Mathur and Patil (1982) in fodder sorghum for tiller number, Suresh (1997) in fodder bajra for tiller number per plant, green fodder yield and dry fodder yield, Joseph (1988) in guinea grass for tiller count had reported same trends. Low heritability estimates were observed for plant height and internodal length. Heritability values were not estimable for crude protein content and crude fibre content. This indicates that environment plays a major role in the expression of these characters. Contrary to this, Suresh (1997) estimated high heritability values for crude protein and moderte heritability for crude fibre content and plant height in fodder bajra.

Heritability estimates alongwith genetic advance provides a clear picture on the extent of improvement that can be achieved. According to Panse (1957), the characters with high heritability and genetic advance were controlled by additive gene action and therefore amenable to genetic improvement through selection.

In the present study the genetic advance expressed as percentage of mean of the population was low for all the characters. Similar trend was reported by Joseph (1988) in guinea grass. Among the eleven characters studied, leaf number per hill recorded maximum genetic advance followed by internode number per hill and green fodder yield.

Leaf area index and leaf - stem ratio had high heritability coupled with low genetic gain. This indicates non additive gene action which greatly limits the scope for improvement of these characters through selection (Panse, 1957). Similar results were obtained by Suresh (1997) in fodder bajra for leaf area index and leaf stem ratio.

Green fodder yield and dry fodder yield had moderate heritability and low genetic advance which again limits the scope for improvement of the crop based on these traits through selection. The results obtained by Suresh (1997) in fodder bajra for dry fodder yield is in confirmity with the results of present study.

### 5.1.3. Correlation

Correlation measures the mutual relationship between two or more characters. Correlation coefficient is used to findout the degree and direction of relationship between two or more characters. Correlation analysis provides information about yield components and thus helps in the selection of surperior genotypes from diverse genetic population. The component characters always show inter relationship. The association between two characters which can be directly observed is termed as phenotypic correlation. It includes both genotypic and environmental effects. The inherent or heritable association between two characters is known as genotypic correlation, the main cause of which is pleiotropy, which refers to manifold effects of a gene (Falconer, 1960). This type of correlation is more stable and is of paramount importance for a plant breeder to bring about genetic improvement in one character by selecting the other character of a pair that is genetically correlated. Hence correlation between green fodder yield and other ten characters and their inter correlations were estimated.

#### 5.1.3.a. Correlation between green fodder yield and other chaacters

Green fodder yield reported high positive genotypic correlation with dry matter yield, leaf area index, leaf-stem ratio, leaf number per hill, tiller number per hill, internode number per hill and plant height. Tyagi et al. (1980) in fodder bajra, Sreenivasan et al. (1986) in guineagrass, Girija and Natarajarathinam (1989) in fodder sorghum and Sood and Ahluwalia (1989) in fodder sorghum reported positive genotypic correlation between dry matter yield and green fodder yield in conformily with the results of present study.

The positive significant genotypic correlation between green fodder yield and leaf number per hill obtained in this study was in agreement with the results of Dhanakodi and Chandrasekaran (1989) and Ramaswamy et al. (1994) in ragi, Amirthadevarathinam et al. (1980) in fodder Sorghum and Chalapathi (1990) in fodder maize.

Crude protein and fibre content were found to be not related with green fodder yield indicating their independent nature. However Joseph (1988) in guinea grass estimated negative genotypic correlation between green fodder yield and crude protein content.

Internodal length had the lowest positive influence on green fodder yield which was inconformity with the results of Dhanakodi and Chandrasekaran (1989) in ragi.

At the phenotypic level, dry matter yield, leaf-stem ratio, leaf area, index, leaf number per hill, tiller number per hill, internode number per hill had significant positive correlation with green fodder yield. Similar trend was reported by Mathur and Patil (1982) in fodder sorghum for dry matter yield. Sreenivasan (1986) in guinea grass reported similar findings for plant height. Contrary to the results of the present study, Sreenivasan (1986) observed negative correlation of green fodder yield with tiller number per plant in guinea grass. The phenotypic correlations were higher than the genotypic correlations for tiller number per hill, leaf number per hill, internode number per hill, leaf-stem ratio, crude protein and fibre content indicating that the apparent association of these characters with green fodder yield is not only due to genes but also due to favourable environment.

It is evident from the results that green fodder yield can be improved by exercising selection for the characters dry fodder yield, tiller number per hill, leaf number per hill, internode number per hill, leaf area index, leaf-stem ratio and plant height. However priority should be given to dry matter yield, leaf-stem ratio, leaf area index, leaf number per hill and tiller number per hill as they have comparitively higher correlation with green fodder yield both at genotypic and phenotypic level.

**5.13.6. Inter-se correlation between other characters**

Plant height had high positive genotypic correlation with tiller number per hill, leaf number per hill, internode number per hill and internodal length. So selection for plants having high plant height simultaneously will improve the above mentioned characters. Amirthadevarathinam et.al., (1990) in fodder sorghum and Dhanakodi and Chandrasekaran (1989) in ragi reported high positive genotypic correlation between plant height and number of leaves per plant in conformity with the present study. Contrary to this, Chalapathi (1990) in fodder maize reported negative correlation between plant height and number of leaves per plant. Tiller number per hill recorded positive and significant correlation with plant height, internode number per hill, leaf number per hill and internodal length. Sreenivasan (1986) and Joseph (1988) in guinea grass reported weak positive association of tiller counts with plant height.

Internode number per hill reported positive and significant correlation with intrnodal length. Hence improvement of one character will result in the simultaneous improvement of other.

Internodal length recorded negative genotypic correlation with leaf area index and leaf-stem ratio. Dhanakodi and Chandrasekaran (1989) in ragi reported negative genotypic correlation between internodal length and leaf-stem ratio in agreement with present study. An increase in internodal length would be accompanied by an increase in weight of the stem and thus narrowing the leaf-stem ratio. Hence negative association between internodal length and leaf-stem ratio is logical.

Leaf area index had positive and significant correlation with green fodder yield, dry fodder yield and leaf-stem ratio indicating that improvement of leaf area index will simultaneously improve leaf-stem ratio, green fodder yield and dry fodder yield. Leaf area index recorded nonsignificant negative correlation with internodal length. The positive association of leaf area index with plant height was in agreement with the results of Thejasee Bhai (1988) in guinea grass and Suresh (1997) in fodder bajra.

Leaf-stem ratio recorded high positive and significant correlation with leaf area index, green fodder yield and dry fodder yield indicating the scope for simultaneous improvement of these characters. However Sreenivasan (1986) Joseph (1988) in guinea grass had reported negative correlation between leaf-stem ratio and dry matter yield.

Green fodder yield exhibited positive association with all other characters except crude protein and fibre content. Crude protein and fibre content did not show correlation with any other characters at genotypic level indicating their relative independence. However at phenotypic level both the characters exhibited weak positive association with majority of the characters which indicates the relative influence of the environmental effects on the expression of these traits. Crude protein content recorded non significant negative correlation with leaf area index and leaf-stem ratio which is in agreement with the results of Joseph (1988) in guinea grass. Crude fibre content recorded positive and significant correlation with crude protein content. Contrary to this, Sreenivasan et al. (1986) in guinea grass reported negative association between crude protein and fibre content.

Dry fodder yield recorded positive genotypic correlation with the characters except crude protein and fibre content. This suggests the possibility of simultaneous improvement of these characters in a selection programme involving any one of these traits. Similar to the above findings, Suresh (1997) reported positive association of all the characters with dry matter yield in fodder bajra.

**4.1.6. Selection index**

Selection index refers to a linear combination of characters associated with yield which helps in discriminating the desirable genotypes from the undesirable ones, based on the combination of various characters. In the present study a selection index was formulated to identify three top ranking clones taking into account yield and other yield attributing traits such as plant height, leaf number per hill, tiller number per hill, internode number per hill, internodal length, leaf area index and leaf-stem ratio. Santipriya (1991) in guinea grass formulated a selection index based on plant height, leaf area index and green matter yield in agreement with the present study.

Similarly Shajan (1993) in guinea grass formulated a selection index by including plant height and leaf area index in consonance with the present study. In the present study highest index was recorded by the clone JHGG 96-3 followed by JHGG 96-4 and JHGG 96-2. Since JHGG 96-2 produced inadequate seeds to raise progeny rows, the next ranking clone Riveradale alongwith top two clones was selected and included in the experiment II.

### 5.2. Progeny mean analysis using seeds and slips and comparison of variability with respect to two types of planting materials

In Panicum maximum most biotypes are tetraploids and facultative apomicts (Savidhan, 1982). The term apomixis signifies all forms of asexual reproduction in higher plants that replace or act as substitutes for the sexual method. Agamospermy, in particular represents asexual reproduction via seed formation. As apomixis is a vegetative reproduction by seed the apomictic offspring will be uniform and identical to the mother plant. When apomixis is the only form of seed formation as it is in obligate apomicts, this holds true for the whole offspring. The facultative apomicts combine apomictic and sexual reproduction, resulting in a progeny of maternal types and deviating ones.

In facultative apomicts the uniformity of the offspring depends on the degree of apomictic reproduction in the parent plant. In the present study the variability that exist in seedling progeny as compared to their vegetative progeny with regard to important yield attributing traits has been comprehensively analysed. Such a comparative analysis would aid in the understanding of extent of segregation among the seedling progenies. Determining the significance or otherwise of such an extent of segregation is a prerequisite before embarking on large scale seed production.

The pooled analysis of variance on eleven characters of five families viz. Riversdale, JHGG 96-3, Haritha, Marathakom and JHGG 96-4 revealed significant difference for all the characters in both vegetative and seedling progenies. This shows the existence of high variability for all the characters studied in five families of guinea grass. Similar trend was reported by Santipriya (1991) in her progeny mean studies in guinea grass.

The variability, if any, among the progenies within a family in asexual population could be attributed to the environment. This is because the parental clones are expected to be highly homogenous in the absence of mutation or clonal degeneration. The variability that exist among the seedling progenies could be attributed to genotype, environment and genotype X environment interactions.

None of the families exhibited significant difference among the progenies in plant height in sexual population indicating that these five clones do not segregate for plant height when propagated through seeds. However, Santipriya (1991) reported significant difference among progenies within families FR-600, Mackueni, MC-2 and MC-16 in guinea grass for plant height.

The families JHGG 96-3 and Marathakom exhibited significant difference among the progenies both in sexual and asexual populations for tiller number per hill. Similar trend was reported for the family MC-23 in sexual population by Santipriya (1991) in guinea grass.

Test of significance for variance revealed significant variability with respect to two types of planting materials in the families Riversdale and JHGG 96-3. Among the remaining three families viz. Haritha, Marathakom and JHGG 96-4 which did not register significant variability, the average number of tillers per hill was found to be on par with each other for vegetative and seedling progenies. Thus it is inferred that these three clones do not segregate for tiller number per hill when propagated through seeds.

In the seedling progeny, JHGG 96-3 and Marathakom revealed significant difference among their progenies indicating the presense of variability within these families for leaf and internode number per hill. The variability was found to be significant with regard to two types of planting materials in the families Riversdale and JHGG 96-3. The rest of the families did not exhibit significant difference and their average leaf and internode number per hill was on par with each other for vegetative and seedling progenies. It indicated that these three families viz. Haritha, Marathakom and JHGG 96-4 did not segregate for leaf and internode number per hill when propagated through seeds.

Marathakom and JHGG 96-3 exhibited significant difference among their progenies in the sexual population for internodal length while the rest of the families did not, indicating the presence and absence of variability, respectively, in these families. None of the families except JHGG 96-4 in seedling progeny revealed significant difference as compared to their vegetative progeny which indicates the non segregating nature of the clones for internodal length.

None of the families revealed significant difference among the progenies in both sexual and asexual population for leaf-stem ratio indicating the highly homogenous nature of the progenies within each family. Similar trend for leaf-stem ratio was reported by Santipriya (1991) in guinea grass with six families. The variability was found to be significant between seedling and vegetative progeny in all the families except Riversdale indicating the possible segregating nature of the clones for leaf-stem ratio.

Riversdale and JHGG 96-4 exhibited significant variability among their progenies in sexual population while the rest of the families did not. Santipriya (1991) in her studies on guinea grass with six families reported significant variability among the progenies of the clones FR-600, MC-2 and MC-16 for leaf area index. The variability was found to be significant in none of the families in the comparison between seedling and vegetative progeny which is an indication of the non segregating nature of the clones for leaf area index.

Significant varriability was found among the progenies in sexual population within. Riversdale, JHGG 96-3 and Marathakom for green fodder yield. Similar trend was reported by Santipriya (1991) in guinea grass for green fodder yield in the clones, FR 600, MC-2, MC16 and MC23. Haritha, Marthakom and JHGG 96-4 did not reveal significant variability between vegetative and seedling progeny which confirms the true breeding nature of these clones for green fodder yield. Riversdale and JHGG 96-3 were found to be segregating for this character.

Considerable variability existed among the progenies within Haritha and JHGG 96-3 for dry fodder yield. Haritha and Marathakom were found to be breeding true for this character which is indicated by the insignificant variability in the comparison between vegetative and seedling progeny. The rest of the families JHGG 96-4, Riversdale and JHGG 96-3 were found to be segregating for dry fodder yield.

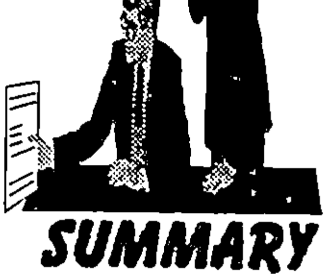
Riversdale and Haritha exhibited significant variability among their progenies for crude fibre content. All the families except Haritha were found to be breeding true for this character and the mean of the vegetative and seedling progeny of these families was on par. The family Haritha was found to be segregting for crude fibre content.

Thus, the difference in variability of vegetative and seedling progeny was found to be insignificant in ten out of the eleven characters studied in Marathakom. This suggests that the apomictic mechanism is intact in this clone and also explains the true breeding nature. The average values of all the characters in vegetative and seedling progeny were on par with each other which again corroborates the non segregating nature of this clone. Such an apomixis would remain stable over number of generations as the theoritical studies done to date, based on a variety of genetic as well as phenotypic models are consistent in indicating that apomixis has an automatic selective advantage over sexuality and will eventually become fixed in plant populations in the absence of opposing selective forces (Mandal, Ganguli and Banergee, 1991).

The automatic selective advantage of asexual individuals arises because all the offspring of an apomictic parent carry the full genetic complement of their maternal parent. Sexual out crossed offspring in contrast, carry only half the genetic complement of their mothers. If both sexual and apomictic parents produce equal numbers of offspring, then the asexual maternal parent will have double the genetic representation of the sexual in the offspring. The same situation applies in the next generation. All the genes of the asexual mother will be present in her grand children while only a quarter of the genes of the sexual mother will reach her grand children. Eac'ıgene of , sexual outcrossing individual suffers a 50 per cent hazard per generation compared to the asexual alternative. The disadvantage of sexual compared to asexual reproduction has been referred to as the 'cost of meiosis' (Williams 1975).

The difference in variability between vegetative and seedling progeny was found to be significant for crude protein content, crude fibre content and leaf-stem ratio in Haritha. JHGG 96-4, Riversdale and JHGG 96-3 differed with respect to four, seven and eight out of the eleven characters studied respectively. This indicates relatively higher degree of sexual reproduction in these clones.

Any attempt to study the inheritance of the percentage sexual reproducion in these clones would be a welcome area of research. Such a study would greatly fecilitate the recommendation of large scale seed production in these clones to alleviate the problem of non availability of planting materials to a considerable extent.



# SUMMARY

## SUMMARY

The present study was conducted at the Department of Plant Breeding and Genetics, College of Agriculture, Vellayani during July 1996 to May 1997 to ascertain seedling progeny behaviour in selected clones of guinea grass. The experimental material consisted of ten high yielding guinea grass clones from the test materials available with the All India Coordinated Research Project on Forage Crops and two high yielding mutant clones viz. Haritha and Marathakom released by Kerala Agricultural University.

A field experiment was conducted during July to October 1996 with ten clones in a randomized block design with three replications to evaluate the clones and assess variability based on the chracters viz. plant height, tiller number per hill, leaf number per hill, length of internode, green fodder yield, dry fodder yield, crude protein content and crude fibre content. A selection index was formulated with respect to important yield attributing traits and three superior clones viz. JHGG 96-4, JHGG 96-3 and Riversdale were identified for seedling progeny analysis. Haritha and Marathakom along with these three superior clones were subjected to progeny mean analysis through compact family block design with five replications using seeds and slips separately. Ten progeny rows were maintained within each clone adopting a spacing of 50 x 10 cm. Data collected on various traits were subjected to statistical analysis for the comparison of variability with respect to the two types of planting materials viz. seeds and slips.

**Salient findings of variability study**

Analysis of variance showed significant difference among the clones with respect to tiller number per hill, internode number per hill, leaf number per hill, leaf area index, leaf-stem ratio, green fodder yield and dry fodder yield. The characters viz. plant height, internode length, crude protein content and crude fibre content did not exhibit discernible difference indicating relative homogeneity of these traits among the different clones.

The estimates of genotypic and phenotypic coefficient of variation were in general low for all the characters. Relatively little difference between GCV and PCV was observed for the chracters leaf area index, leaf-stem ratio, green fodder yield and dry fodder yield indicating that variations observed in these traits are more influenced by genetic causes than environment.

High heritability coupled with low genetic gain was reported for leaf area index indicating non additive gene action which limits the scope for improvement of this trait through selection. Genetic advance was maximum for leaf number per hill followed by internode number per hill and green fodder yield.

Correlation values of green fodder yield with all other characters were positive both at genotypic and phenotypic level. Dry fodder yield had the highest positive correlation followed by leaf area index, leaf-stem ratio, leaf number hill and tiller number per hill indicating that yield can be increased indirectly by improving these components.

A selection index was constructed to identify three superior clones for further utilization in progeny mean analysis study. Highest index was recorded by the clone JHGG 96-3 followed by JHGG 96-4, JHGG 96-2 and Riversdale.

**Salient findings of comparative progeny mean analysis**

The pooled analysis of variance on eleven characters of five families viz. Riversdale, JHGG 96-3, Haritha, Marathakom and JHGG 96-4 revealed significant difference for all the characters in both vegetative and seedling progenies. This shows the existence of variability for all the characters in five families of guinea grass.

The variability detected among the progenies within a family in asexual population could be attributed to the environment while in seedling progeny variability could be attributed to genotype, environment and genotype x environment interactions.

None of the families exhibited significant difference among the progenies in plant height in sexual population indicating their non segregating nature for plant height.

Haritha, Marathakom and JHGG 96-4 recorded insignificant variability between vegetative and seedling progeny for tiller number per hill.

Significant variability with regard to vegetative and seedling progeny was recorded for leaf and internode number per hill in Riversdale and JHGG 96-3. None of the families except JHGG 96-4 in seedling progeny revealed significant variability as compared to their vegetative progeny for internodal length.

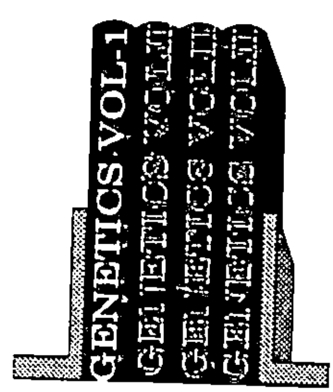
The variability was found to be significant between seedling and vegetative progeny in all the families except Riversdale for leaf-stem ratio.

None of the families recorded significant variability for leaf area index between vegetative and seedling progeny.

Haritha, Marathakom and JHGG 96-4 didnot reveal significant variability between sexual and asexual populations for green fodder yield. Haritha and Marathakom were also found to record insignificant variability for dry fodder yield between two types of progenies.

Marathakom alone recorded insignificant variability between sexual and asexual populations for crude protein content while Haritha revealed significant variability for crude fibre content.

The insignificant variability between two types of planting materials confirms the predominance of apomixis and significant variability could be due to the prevalence of sexual reproduction. Marathakom recorded insginificant difference in variability between vegetative and seedling progeny for ten out of the eleven characters studied indicating its true breeding nature and suitability to large scale seed production. The difference in variability between vegetative and seedling progeny was found to be significant for crude protein content, crude fibre content and leaf-stem ratio in Haritha. JHGG 96-4, Riversdale and JHGG 96-3 differed with respect to four, seven and eight characters respectively, which indicates relatively higher degree of sexual reproduction. Further studies on the inheritance of percentage sexual reproduction in these clones would be desirable for large scale seed production.

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## APPENDIX - I

**Analysis of variance for eleven characters in guinea grass**

| S.No. | Character | Mean sum of square | | | $F_{9, 18}$ |
|---|---|---|---|---|---|
| | | Replication df=2 | Treatment df = 9 | Error df = 18 | |
| 1 | Plant height | 3.67 | 32.76 | 17.15 | 1.91 |
| 2 | Tiller number per hill | 1.16 | 17.55 | 7.09 | 2.47* |
| 3 | Leaf number per hill | 17.31 | 365.76 | 116.92 | 3.13* |
| 4 | Internode number per hill | 18.09 | 254.54 | 102.99 | 2.47* |
| 5 | Internode length | 0.0063 | 0.97 | 0.68 | 1.43 |
| 6 | Leaf area index | 0.0029 | 2.82 | 0.100 | 28.08** |
| 7 | Leaf-stem ratio | 0.0137 | 0.23 | 0.04 | 5.31* |
| 8 | Green fodder yield | 4.11 | 42.09 | 9.72 | 4.33* |
| 9 | Dry fodder yield | 0.46 | 4.15 | 0.99 | 4.18* |
| 10 | Crude protein content | 0.01 | 0.0182 | 0.0257 | 0.71 |
| 11 | Crude fibre content | 0.49 | 0.40 | 0.544 | 0.73 |

* Significant at 5 % level
** Significant at 1 % level

## APPENDIX - II

**Pooled Anova of various characters for five families in CFBD using seeds**

| S.No. | Character | Mean sum of square | | | $F_{4,16}$ |
|---|---|---|---|---|---|
| | | Replication df=4 | Family df = 4 | Error df = 16 | |
| 1 | Plant height | 93.38 | 2655.13 | 28.29 | 93.83** |
| 2 | Tiller number per hill | 12.68 | 51.27 | 4.88 | 10.51** |
| 3 | Leaf number per hill | 283.03 | 2819.56 | 99.38 | 28.37** |
| 4 | Internode number per hill | 195.92 | 3053.11 | 78.98 | 38.66** |
| 5 | Internode length | 2.35 | 224.34 | 2.73 | 82.33** |
| 6 | Leaf area index | 0.126 | 5.99 | 0.114 | 52.60** |
| 7 | Leaf-stem ratio | 0.46 | 23.39 | 0.28 | 84.62** |
| 8 | Green fodder yield | 54.40 | 595.51 | 29.02 | 20.52** |
| 9 | Dry fodder yield | 23.51 | 170.93 | 43.71 | 15.64** |
| 10 | Crude protein content | 0.635 | 3.07 | 0.35 | 8.79** |
| 11 | Crude fibre content | 5.88 | 35.48 | 4.73 | 7.50** |

** Significant at 1% level

# APPENDIX - III

## Pooled Anova of various characters for five families in CFBD using slips

| S.No. | Character | Mean sum of square | | | $F_{4,16}$ |
|---|---|---|---|---|---|
| | | Replication df=2 | Family df = 4 | Error df = 16 | |
| 1 | Plant height | 82.56 | 3825.50 | 36.48 | 104.85** |
| 2 | Tiller number per hill | 2.34 | 33.65 | 3.55 | 9.48** |
| 3 | Leaf number per hill | 51.63 | 2863.91 | 63.56 | 44.98** |
| 4 | Internode number per hill | 30.56 | 2434.99 | 58.99 | 41.28** |
| 5 | Internode length | 4.79 | 195.67 | 1.52 | 129.44** |
| 6 | Leaf area index | 0.025 | 8.41 | 0.024 | 349.05** |
| 7 | Leaf-stem ratio | 0.421 | 21.43 | 0.164 | 131.04** |
| 8 | Green fodder yield | 12.99 | 487.56 | 19.29 | 25.27** |
| 9 | Dry fodder yield | 1.20 | 30.56 | 1.55 | 19.63** |
| 10 | Crude protein content | 0.34 | 1.61 | 0.122 | 18.12** |
| 11 | Crude fibre content | 12.36 | 59.89 | 7.29 | 8.21** |

** Significant at 1% level

# SEEDLING PROGENY ANALYSIS IN SELECTED CLONES OF GUINEA GRASS (*Panicum maximum Jacq.*)

By

R. BABU

## ABSTRACT

SUBMITTED IN PARTIAL FULFILMENT OF
THE REQUIREMENT FOR THE DEGREE OF
MASTER OF SCIENCE IN AGRICULTURE
(PLANT BREEDING & GENETICS)
FACULTY OF AGRICULTURE
KERALA AGRICULTURAL UNIVERSITY

DEPARTMENT OF PLANT BREEDING & GENETICS
COLLEGE OF AGRICULTURE
VELLAYANI, THIRUVANANTHAPURAM
1997

## ABSTRACT

A study was carried out at the Department of Plant Breeding and Genetics, College of Agriculture, Vellayani during July 1996 to May 1997 with the objective of ascertaining the seedling progeny behaviour in selected clones of guinea grass. A field experiment was conducted utilizing ten guinea grass clones available with All India Co-ordinated Research Project on Forage Crops to assess variability and identify three superior clones. Analysis of variance revealed significant difference for seven out of the eleven characters studied. The estimates of genotypic and phenotypic coefficient of variation were in general low for all the characters. Leaf area index recorded high heritability coupled with low genetic gain indicating non additive gene action. Correlation values of green fodder yield with all other characters were positive both at genotypic and phenotypic level. A selection index was formulated and three high yielding clones viz JHGG 96-3, JHGG 96-4 and Riversdale were selected and then subjected to progeny mean analysis along with two high yielding mutant clones viz Haritha and Marathakom in a compact family block design using seeds and slips. Marathakom recorded insignificant difference in variability with respect to two types of planting materials for ten out of the eleven characters studied, thus confirming the predominance of apomictic mode of reproduction and suitability to large scale seed production. Significant difference in variability was discernible in the remaining clones for more than one character indicating prevalence of sexual reproduction in these clones. Further studies on inheritance of

percentage sexual reproduction in these clones would be desirable before embarking on large scale seed production.