GENETIC VARIABILITY IN GUINEA GRASS

(*Panicum maximum* Jacq.)

BY

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THESIS

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DECLARATION

I hereby declare that this thesis entitled Genetic variability in 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 to me of any degree, diploma, associateship, fellowship, or other similar title, of any other University or Society.

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C E R T I F I C A T E

Certified that this thesis, entitled Genetic variability in guinea grass (*Panicum maximum* Jacq.) is a record of research work done independently by Sri. Shajan V.R. 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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INTRODUCTION

INTRODUCTION

Agriculture and dairing are the most important occupation of majority of the population in India. Eventhough India has a large live stock population of over 343 million, the production of milk and their live stock products is the lowest in the world. The analysis of this situation reveals that one of the main reasons for the low productivity of our live stock is malnutrition, under nutrition or both. Patil and Singh (1990) reported that in India there is a shortage of 388 million tonnes of greenfodder.

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. The present fodder production is only 1.4% of the total requirement (Pillai and Nair, 1989). This large deficit can be overcome by developing and identifying superior varieties. 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 live stock in Kerala. Since there is high population pressure on land there is only limited scope for increasing the area under fodder crops. So the only way to increase production is to develop superior clones and grow them in marginal lands.

Eventhough varietal testing has been carried out for identifying high yielding guinea grass varieties under AICRP (forage crops), no systematic effort has been made for screening large germ plasm for analysing the variability, correlations, path analysis and formulation of selection index, which may give valuable basic genetic information necessary for the genetic improvement of this crop. Hence the present research programme was undertaken with the objective of estimating the genetic variability, correlations, cause effect relationship and formulation of selection index for identifying superior guinea grass clones.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

1.1. Variability

Variability present in a population is due to genotype, environment and genotype environment interaction. Polygenic characters are highly influenced by environment. So it is important to identify whether the variability is due to the genotype or due to the environment. This can be obtained by estimating the genotypic and phenotypic coefficient of variation (GCV and PCV) and heritability. A brief review of work done in guinea grass and other fodder crops are summarised here.

i) Guinea grass

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

Pillai *et al.* (1974) evaluated 30 clones of guinea grass and reported significant difference in leaf stem ratio for FR 553 (1.78) green and dry matter yield for FR 600 (68.50 and 13.32 kg respectively).

Sidak *et al.* (1977) studied 192 clones of guinea grass and reported that annual dry matter yield ranged from 1.88 kg to 2.41 kg per plant and crude protein content from 13.9 to 17.2 per cent.

Jose et al. (1978) studied bulk samples of 28 guinea grass population and reported significant difference for tiller number, plant height, panicle length and days to flowering.

Sreenivasan (1983) estimated variability in 24 varieties of guinea grass and reported significant difference for mean values for all the characters he studied. He also observed maximum genotypic coefficient of variation (GCV) for dry fodder yield (74.58 per cent), followed by green fodder yield (71.29 per cent) and leaf area index (63.61 per cent). He has noticed high GCV estimates for plant height (31.93 per cent), panicle length (28.88 per cent), leaf stem ratio (27.75 per cent) and number of tillers (21.83 per cent). In his studies the crude fibre content exhibited the least GCV estimate (7.52 per cent) followed by crude protein content (8.93 per cent). The highest phenotypic coefficient of variation (PCV) was recorded for dry fodder yield (72.15 per cent). The PCV values recorded for plant height was 34.14 per cent, for number of tillers 30.49 per cent, for length of panicle 30.03 per cent and leaf stem ratio 27.79 per cent. Among the quality characters crude protein content and crude fibre content recorded phenotypic coefficient of variation values of 11.10 per cent and 8.73 per cent respectively.

Sally (1988) reported significant difference for all the characters studied in six varieties of guinea grass. In her study dry matter yield showed maximum phenotypic coefficient of variation (33.15 per cent). A low PCV value was recorded for the characters Leaf stem ratio (21.21 per cent), infloresence count (18.59 per cent), green fodder yield (16.99 per cent), crude protein content (9.15 per cent), height of plant (6.76 per cent) and width of leaves (5.76 per cent). The tiller count recorded the lowest PCV value of 4.88 per cent. The maximum GCV was recorded by dry matter yield (24.03 per cent). All the other characters such as infloresence count (13.13 per cent), leaf stem ratio (13.31 per cent), green fodder yield (11.68 per cent), crude protein content (6.91 per cent), tiller count (2.23 per cent) and height of plant (2.33 per cent) recorded a lower GCV value. The lowest GCV value was recorded for weight of leaves (2.1 per cent).

Thejasee Bhai (1988) studied variability in 15 guinea grass clones under partially shaded condition and reported that there was significant difference for the characters under study. The maximum phenotypic variance was reported for green fodder yield per hill and minimum for leaf stem ratio on fresh weight basis. Maximum genotypic variance was observed for green fodder yield per hill followed by plant height and dry matter yield per hill. Low values were reported for number of panicles per plot and number of tillers per hill. Leaf stem ratio on fresh weight basis recorded the minimum genotypic variance. The estimates of the coefficient of variation for the above traits revealed that green fodder yield per hill showed maximum phenotypic coefficient of variation (35.8 per cent). This was followed by leaf area index (28.72 per cent), number of panicles per plot (25.86 per cent), green fodder yield per plot (25.53 per cent), leaf stem ratio on dry weight basis (23.93 per cent) and leaf stem ratio on fresh weight basis (22.09 per cent). The highest genotypic coefficient of variation was observed for green fodder yield per hill (26.22 per cent), followed by number of panicles per plot (23.49 per cent) and leaf area index (22.93 per cent). Leaf stem ratio on dry weight basis (19.54 per cent) and leaf stem ratio on fresh weight basis (16.70 per cent) showed moderately high genotypic coefficient of variation.

Santhipriya (1991) studied six varieties of guinea grass and reported highest phenotypic variability for green fodder yield (275651.23) followed by dry matter yield (22308.40), leaf area (511.11) and height of grass (418.23). The lowest was reported for leaf stem ratio (0.69). Genotypic variance was higher for green fodder yield (21752.53) followed by dry matter yield (4701.47), leaf area (341.73) and height of grass (324.49) and lowest for leaf stem ratio (0.39) followed by inflorescence count (3.89).

The phenotypic coefficient of variations were high for the characters, inflorescence count (241.16 per cent), leaf area

(41.32 per cent), leaf stem ratio (39.33 per cent) and root length (38.4 per cent). High genotypic coefficient of variations were reported for inflorescence count (212.27 per cent), leaf area (33.78 per cent), root length (33.61 per cent) and leaf stem ratio (29.54 per cent).

ii) Sorghum

Genetic variability was studied in a collection of seventy divergent varieties of fodder sorghum (*Sorghum vulgare*) by Swarup and Chaugale (1962a) who reported high phenotypic variability for plant height, length and weight of panicle and HCN content. A number of characters such as plant height (53.11 per cent), leaf number (56.27 per cent) and green fodder yield (95.88 per cent) recorded high GCV.

Sindagi *et al*. (1970) estimated variability in F_2 progenies of intervarietal crosses of sorghum and reported maximum GCV value for green fodder yield (65.40 per cent).

Arora *et al*. (1975) reported variability in protein content from 4.81 to 7.44 per cent in forage sorghum.

Rana et al. (1976) recorded genotypic coefficient of variation of 15.0 per cent for plant height and 30.0 per cent for green fodder yield in forage sorghum.

Lodhi et al. (1977) studied variability between hybrids and varieties in forage sorghum and reported considerable amount of variability with respect to plant height, number of tillers per plant, leaf stem ratio and green fodder yield per plant.

Kaushik (1987) in fodder sorghum reported high genotypic variance for plant height.

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

iii) Bajra

Gupta and Gupta (1971) reported high genetic variability for the characters stem thickness, plant height and leaf size and medium for leaf number and green fodder yield.

Gupta and Nanda (1971) studied 176 lines of Bajra including Indian varieties and inbreds, African varieties and American inbreds and reported that Indian varieties were variable for leaf number, stem thickness and plant height. The African varieties were most variable for yield, leaf size, leaf number and stem thickness. The American inbreds recorded maximum variability for plant height.

Sangha and Singh (1973) stuided six bajra (Pennisetum typhoides) varieties and observed that fodder yield had maximum phenotypic (14.14 per cent) as well as genotypic (18.72 per cent) coefficient of variation. The PCV and GCV values were 12.77 and 12.22 per cent respectively for tiller number. The least estimates of PCV (4.08 per cent) and GCV (3.85 per cent) were observed for ear length.

Tygai et al. (1980) studied 30 strains fo Pearl millet (Pennisetum typhoides) and reported maximum GCV value for green fodder yield (14.71 per cent). This was followed by number of leaves (11.77 per cent), leaf breadh (11.18 per cent), dry matter yield and stem girth (9.94 per cent), number of tillers (7.8 per cent), plant height (5.57 per cent) and leaf length (4.67 per cent).

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

Kunjir and Patil (1986) studied variability in pearl millet and reported high genotypic and phenotypic variability for tiller number

iv) Ragi

A comparison of coefficients of phenotypic and genotypic variation in ragi was made by Kempanna and Thirumalachar (1968) who reported that the tiller number per plant was very much under the influence of environment.

Patnaik (1968) noted high phenotypic variation for number of tillers and high genotypic variation for plant height in finger millet.

Kempanna *et al.* (1971) observed genotypic coefficient of variation exceeding 30 per cent for number of productive tillers and less than 15 per cent for plant height in fodder ragi.

Mahudeswaran and Murugesan (1973) estimated variability in *Eleusine coracana* and reported maximum GCV value for straw yield (29.2 per cent) and minimum for plant height (13.7 per cent).

Patnaik and Jana (1973) studied 18 fodder ragi varieties and reported genotypic coefficient of variation of less than 15 per cent for plant height, number of tillers and number of panicles.

In fodder ragi, Appadurai *et al.* (1977) reported genotypic coefficient of variation of 9.8 per cent for plant height, 27.1 per cent for number of productive tillers and 44.1 per cent for straw weight.

Goud and Lakshmi (1977) reported wide range of phenotypic variation for most of the yield components in finger millet.

Mishra *et al.* (1978) in fodder ragi reported genotypic coefficients of variation values less than 13 per cent for plant height and number of effective tillers.

Agalodia *et al.* (1979) reported genotypic coefficient of variation less than 15 per cent for plant height.

In ragi, Dhanakodi (1980) reported maximum genotypic variance for fodder yield. The lowest phenotypic as well as genotypic variances were reported for leaf stem ratio. The highest phenotypic coefficient of variation (91.59 per cent) was observed for plant height. Fodder yield, leaf stem ratio and tiller number recorded high phenotypic coefficient of variation (36.03 per cent, 21.24 per cent and 19.53 per cent respectively). Fodder yield registered the highest genotypic coefficient of variation (30.43 per cent). The GCV values were high for plant height, leaf stem ratio, and tiller number (22.15 per cent, 16.56 per cent and 14.06 per cent respectively).

v) Oats

Phul *et al.* (1972) studied 40 genotype of oats (*Avena sativa*) for fodder characters and reported maximum values of GCV for fodder yield (17.99 per cent) and tiller number (17.01 per cent). They have also reported GCV values of 6.24 per cent for plant height, 6.89 per cent for leaf length, 8.76 per cent for leaf breadth and 5.35 per cent for number of leaves.

Nair and Gupta (1977) studied 32 diverse fodder oats and reported high GCV estimate of 33.68 per cent for green weight of leaves followed by weight of straw (27.28 per cent) and leaf stem ratio (18.95 per cent). Among quality characters the maximum GCV was recorded for percentage ash content (13.33 per cent). This was followed by crude protein content (10.16 per cent). Low values of GCV were observed for plant height (8.64 per cent) and dry matter yield (8.74 per cent).

Tyagi et al. (1977) conducted variability studies in fodder oats and reported high GCV value for dry matter yield (29.56 per cent). This was followed by plant height (28.94 per cent). In thier study, the number of tillers per plant recorded a GCV estimate of 25.81 per cent and green fodder yield 23.43 per cent. Low GCV values were estimated for leaf tem ratio (15.75 per cent) and number of leaves (12.16 per cent). The lowest GCV value was recorded for leaf breadth (5.2 per cent).

Rahaman and Roquib (1987) in fodder oats reported high genotypic coefficient of variation for green fodder yield, plant height and tiller number per plant.

vi) Other fodder crops

In little millet, Yadav and Srivastava (1976) reported that genotypic coefficient of variation was highest for straw yield.

Subramaniam (1979) reported high genotypic variance for plant height in little millet (Panicum miliare). The maximum Phenotypic and genotypic coefficient of variation was noticed for panicle number (25.31 per cent and 24.63 per cent respectively).

Gupta et al. (1974) studied forage yield of marval grass (Dichanthium annulatum) and reported highest phenotypic coefficient of variation for forage yield (78.44 per cent) followed by number of tillers (64.5 per cent).

In foxtail millet, Cill and Randhawa (1975) reported maximum genotypic coefficient of variation for plant height and minimum for number of inflorescence.

Nagarajan and Prasad (1980) estimated variability in 50 genotypes of Setaria italica and reported higher genotypic coefficient of variation for straw yield (46.13 per cent). The GCV estimated for number of branches was 19.91 per cent and for plant height 14.59 per cent.

Aranjo *et al*. (1983) studied 67 accessions of tall Fescue (*Festuca arundinacea*) and reported significant difference for annual dry matter yield and plant height.

Surprenaul and Michand (1988) in timothy grass reported significant variation for plant height and dry matter yield.

2. Heritability and genetic advance

i) Guinea grass

Machado *et al*. (1988) studied 24 hybrid plants and reported high heritability for dry matter yield, plant height and leaf percentage and moderate heritability for crude protein.

Sally (1988) reported comparatively higher estimate of heritability for crude protein content (56.98 per cent) followed by inflorescence count (56.16 per cent), dry matter yield (55.56 per cent) and green fodder yield (51.81 per cent). Moderate heritability estimates of 43.67 per cent, 39.37 per cent and 36.59 per cent were recorded for tiller counts, leaf stem ratio and crude fibre contents, respectively. Comparatively lower estimate of heritability was recorded for width of leaves (13.95 per cent) and plant height (11.7 per cent). She has also reported higher genetic advances for inflorescence count (21.51 per cent) followed by green fodder yield

(17.30 per cent) and leaf stem ratio (17.23 per cent). Crude protein content recorded a genetic advance of 10.74 per cent while the characters tiller count, crude fibre content, plant height and width of leaves showed very low estimates of genetic advance which ranged from 4.39 per cent to 1.63 per cent.

Thejasse Bhai (1988) reported hgiher heritbility estiamtes for number of panicles per plant (82.45 per cent) followed by leaf stem ratio on dry weight basis (66.32 per cent), Leaf stem ratio on fresh weight basis (59.98 per cent) and plant height (54.65 per cent). Green fodder yield per hill and leaf area index recorded moderately high heritability. Low values of heritability were recorded for chlorophyll 'a' (17.47 per cent) and chlorophyll 'b' (17.66 per cent). She has reported high genetic advance for green fodder yield per hill (84.59 per cent) and moderate genetic advance for plant height (17.83 per cent), dry matter yield per hill (9.49 per cent), green fodder yield per plot (7.1 per cent) and number of panicles per plot (6.76 per cent). Other characters showed a lower estimate of genetic advance in her study.

Santhipriya (1991) reported higher estimate of heritability for height of grass (77.59 per cent) followed by inflorescence count (77.48 per cent), leaf area (66.88 per cent) and leaf stem ratio (56.43 per cent). The low value of heritability was reported for green fodder yield (7.89 percent) and and matter yield (21.07 per cent). She has also reported high genetic advance for inflorescence count (384.91) followed by leaf area (56.91) and leaf stem ratio (45.72). The genetic advance were low for green fodder yield (5.84) and dry matter yield (15.68).

ii) Sorghum

Swarup and Chaugale (1962a) studied seventy divergent varieties of sorghum and reported higher heritability values for plant height (98.36 per cent), leaf number (98.18 per cent) and green fodder yield (84.83 per cent). The genetic advances recorded were 108.53 per cent for plant height, 114.88 per cent for leaf number and 81.31 per cent for fodder yield per plant.

Sindagi *et al*. (1970) studied parents, F_1s and F_2 s of two intervarietal crosses of fodder sorghum and reported high heritability and genetic advance for plant height (82.14 per cent and 37.62 per cent respectively) and green fodder yield (heritability 86.05 per cent and gentic advance 72.47 per cent). The number of leaves recorded a heritability estimate of 59.03 per cent and genetic advance of 26.81 per cent.

Sainy and Paroda (1975) reported low estimates of heritability (below 30 per cent) for the characters leaf weight, stem weight and green fodder yield and medium heritability (30 to 40 per cent) for number of tillers in 6 x 6 diallel cross involving six type of sorghum.

In forage sorghum, Jhorar and Paroda (1976) estimated higher heritability values for leaf area (93.32 per cent), number of tillers per plant (88.63 per cent), plant height (87.93 per cent) green fodder yield (87.50 per cent) and dry matter yield (86.93 per cent).

Rana et al. (1976) in forage sorghum estimated higher heritability for green fodder yield (64.5 per cent) and plant height (62.7 per cent).

Sidhu and Mehindiratta (1980) estimated high heritability for leaf length and plant height in forage sorghum.

Sood and Ahluwalia (1980) reported heritability estimates exceeding 30 per cent for plant height, number of leaves per plant, leaf length, green fodder yield per plant and dry matter yeild per plant in forage sorghum.

In forage sorghum, Mathur and Patil (1982) estimated higher heritability estimates for leaf number (88.88 per cent) followed by dry matter yield (70.52 per cent), plant height (54.70 per cent) and number of tillers per plant (49.22 per cent). The genetic advance was high for number of leaves per plant (165.28 per cent).

Singhania et al. (1977) in forage sorghum estimated high heritability for dry matter content and low heritability for yield, crude protein content and leaf stem ratio.

In Jowar, 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.

iii. Bajra

Gupta and Gupta (1971) in pearl millet reported higher heritability values for leaf number (97.91 per cent), leaf size (72.74 per cent), plant height (62.78 per cent) green fodder yield (61.10 per cent) and stem thickness (30.17 per cent).

Gupta and Nanda (1971) studied 176 lines of bajra germplasm consisting of Indian and African varieties and Indian and American inbreds. Indian varieties recorded higher heritability for leaf number (87.60 per cent) and stem thickness (55.95 per cent) while Indian inbreds recorded high heritability for plant height (61.72 per cent) and leaf size (53.11 per cent). In African varieties heritability was higher for leaf number (72.68 per cent), green fodder yield (61.28 per cent) and stem thickness (60.00 per cent). In American inbreds, higher heritability was estimated for plant height (93.24 per cent) and green foddeer yield (63.12 per cent).

Sangha and Singh (1973) studied six bajra varieties and reported that fodder yield had maximum heritability (93 per cent) followed by number of tillers (92 per cent). Genetic advance as per centage of mean were 37.18 per cent and 24.08 per cent respectively for the above characters.

Tyagi et al. (1980) estimated higher heritability for green fodder yield (66.48 per cent), plant height (65.05 per cent) and stem girth (56.90 per cent). The dry fodder yield (22.01 per cent) and leaf breadth (25.56 per cent) showed a lower estimate of heritability. Genetic advance as per centage of mean was reported to be low for all the characters and medium for green fodder yield in pearl millet.

In Bajra, Terinder Kumar (1982) reported high heritability and expected genetic advance for green and dry matter yield per plant, leaf weight and stem weight.

Mohan and Dua (1984) in pearl millet estimated higher heritability for leaf breadth (63.66 per cent) followed by plant height (52.69 per cent) and leaf length (44.88 per cent). The lowest value was estimated for green fodder yield (21.16 per cent). Genetic advance was reported to be higher for plant height (37.75 per cent) followed by leaf number (24.88 per cent) and green fodder yield (17.11 per cent).

Kungiar and Patil (1986) observed high heritability estimates for tiller number (64.80 per cent)and plant height (56.09 per cent) in pearl millet. The genetic advance for these characters was also found to be very high indicating additive gene action.

iv) Ragi

Kempanna and Thirumalachar (1968) reported medium heritability (32.28 per cent) for number of tillers per plant in ragi.

Patnaik (1968) reported high heritability for plant height (68.4 per cent) but low value for number of tillers (15 per cent) in finger millet.

Patnaik and Jana (1973) studied 18 ragi varieties and reported a heritabilty value of 37.69 per cent for plant height and 27.82 per cent for number of tillers. Genetic advance as percentage of mean was 93.65 per cent and 13.29 per cent for plant height and number of tillers respectively.

Mahudeswaran and Murugesan (1973) estimated high hereitability for plant height (90.3 per cent) and straw yield (67.6 per cent). They have reported genetic advance of 33.9 per cent for straw yield and 19.5 per cent for plant height.

Appadurai et al. (1977) estimated high heritability for number of leaves in main stem (80 per cent) and stem weight (72.5 per cent) in ragi. But plant height showed a lower value (37.2 per cent). Genetic advance as percentage of mean was high for straw weight (77.4 per cent). NUmber of leaves on main stem (30.7 per cent) and plant height (12.4 per cent) showed lower values.

v) Oats

Phul et al. (1972) studied 40 genotypes of oats and reported maximum heritability for tiller number (57.21 per cent). Heritability for other characters was 51.01 per cent for fodder yield, 45.51 per cent for plant height and 37.50 per cent for leaf breadth. Lower values of heritability were reported for number of leaves (25 per cent) and leaf length (23.67 per cent). The genetic advance as per centage of mean was also high for forage yield (26.46 per cent) and tiller number (26.56 per cent). Other characters showed lower estimate of genetic advance.

Nair and Gupta (1977) analysed 15 characters of 32 varieties of fodder oats and reported higher heritability for leaf stem ratio (98.69 per cent), number of leaves (96.03 per cent), number of tillers (95.29 per cent),leaf area (94.77 per cent), plant height (92.87 per cent), green weight of leaves (91.06 per cent) and total green yield (90.74 per cent). Total green yield (88.56 per cent) recorded the maximum genetic advance. The crude protain per centage (2.12 per cent) and leaf stem ratio (1.0 per cent) showed comparatively lower values.

Tyagi et al. (1977) estimated heritability in fodder oats and reported that heritability estimates in general, were high for all the traits. Plant height (90 per cent), leaf breadth (90.91 per cent), leaf stem ratio (99.78 per cent) and green fodder yield (91.38 per cent) showed heritability estimates above 90 per cent. High heritability estimates accompanied by high genetic advance was observed for green fodder yield, dry matter yield and leaf stem ratio, indicating that the above traits were predominently governed by additive gene effects.

Choubey and Gupta (1986) reported that expected genetic advance and heritability were high for height and yield of green foliage in fodder oats.

Rahaman and Roquib (1987) reported that heritability estimate was moderate for stem girth, plant height, leaf number, leaf length and low for green fodder yield in fodder oats.

vi) Other fodder crop

In barley, Sethi and Singh (1978) reported high heritability and genetic advance for dry matter production, leaf area and plant height.

In forage barley, Singh and Patil (1983) estimated higher heritability for dry matter yield (72.04 per cent), followed by plant height (58.61 per cent) and green forage yield (55.10 per cent). The leaf stem ratio had lowest heritability (12.15 per cent). The genetic advance as percentage of mean was also higher for dry matter yield (55.82 per cent) and green forage yield (44.62 per cent). Plant height (14.99 per cent) and leaf stem ratio (12.15 per cent) recorded lower genetic advances.

Singh and Prasad (1974) in *Pennisetum pedicellatum* reported high estimate of heritability for tiller number (81.46 per cent) and lower values for green fodder yield (28.17 per cent) and dry matter yield (15.38 per cent).

Yadav *et al.* (1976) in pasture grass (*Dichanthium annulatum*) reported that the heritability and expected genetic advance were 27.9 per cent and 90.5 per cent for leaf number and 13.2 and 87.5 per cent for tiller number.

Sleper *et al.* (1977) estimated high broad sense heritability for number of tillers per plant (69.0 per cent), yield per tiller and yield per plant (66.0 per cent) in tall fescu (*Festuca arundinaceae*).

Salach and Goral (1979) estimated higher heritability values for plant height (75.5 per cent), number of vegetative tillers (61.85 per cent) and lower value for dry matter yield (20.61 per cent) in timothy grass (*Phleum pratense*)

Nagarajan and Prasad (1980) reported higher heritability for plant height (91.67 per cent), number of branches (69.65 per cent) and medium heritability for straw yield (35.8 per cent) in Foxtail millet. The straw yield recorded high genetic advance as percentage of mean (82.14 pr cent). while the number of braches (34.2 per cent) and plant height (28.79 per cent) recorded medium values.

Kauzuba *et al.* (1981) estimated heritability values exceeding 60 per cent for plant height and length and breadth of 3rd leaf in *Phleum Phleum pratense*.

Vogel *et al*. (1981) estimated narrow sense heritability of 43 per cent for forage yield and protein in Indian grass.

AchuthaKumar (1982) reported high estimate of heritability and genetic advance for leaf weight and forage yield in maize.

Manoharan (1978) estimated high heritability and expected genetic adavance for straw yield in proso millet.

Riley and Vogel (1983) in *Andropogan halli* cv. goldstike reported heritability value of 28 per cent for yield and 33 per cent for dry matter yield.

Asay and Hansen (1984) reported broad sense heritability of 40 per cent for forage yield in quack grass x blue bunch wheat grass hybrid.

Bugge (1984) estimated a heritability of 48 per cent for dry matter yield per plant in *Lolium multiflorum.*

3. Correlation studies

i) *Guinea grass*

Sotomayor-Rios *et al*. (1972) reported that the tillering ability and forage volume had the highest phenotypic correlation with yield. They have also reported significant negative phenotypic correlation with rooting at nodes and fodder yield.

Sreenivasan (1983) in guinea grass reported that green fodder yield had high positive genotypic correlation and significant positive phenotypic correlation with plant height, leaf area index, leaf stem ratio and dry fodder yield. High negative genotypic correlation and significant negative phenotypic correlation was observed for the character protein percentage with green fodder yield. Number of tillers showed significant negative phenotypic and high negative genotypic correlation with green fodder yield. He observed that plant height had significant positive phenotypic correlations with number of tillers per hill, leaf stem ratio and dry weight. Protein percentage had significant negative phenotypic correlations with plant height and dry fodder yield. He has also reported that leaf area index showed significant positive phenotypic correlation with leaf stem ratio.

Kondo et al. (1984) reported that date of 1st panicle emergence was negatively correlated with crude protein content and positively correlated with lignin content.

Sewi et al. (1988) reported that plant height in Panicum maximum was positively and significanlty correlated with dry matter yield at the phenotypic level. Tillering ability was reported to be positively and significantly correlated with green matter yield.

Sally (1988) observed that green fodder yield had positive significant phenotypic correlation with dry matter yield and positive non-significant phenotypic correlations with leaf breadth, inflorescence count and tiller count and negative non-significant correlations with leaf stem ratio and protein percentage. Phenotypic correlations of plant height was positive but non-significant with tiller count and inflorescence count, while it was negative and non-significant with dry fodder yield. Phenotypic correlations of leaf breadth was positive and non-significant with the tiller count and dry fodder yield, whereas it was negative and non-significant with leaf stem ratio and inflorescence count. A non-significant negative correlation was observed for the character tiller count with inflorescence count. Protein percentage showed positive non-significant correlation with dry fodder yield.

Thejasee Bhai (1988) reported that the genotypic correlation coefficients were slightly higher than the phenotypic correlation coefficients. Genotypic correlaitons of plant height was positive with leaf area index, leaf stem ratio, number of tillers per hill and dry matter yield and negative with plant height and number of panicles per hill. Phenotypic correlations of greeen fodder yield was highly significant and positive with leaf area index, number of tillers per hill, and dry matter yield wereas it was positive and non-significant with plant height and leaf stem ratio and negative and non-significant with number of panicles per hill. Phenotypic correlation of number of panicles per hill with dry matter yield was reported to be positive but non-significant.

ii) Sorghum

Rohewal et al. (1964) reported significant positive phenotypic correlation of fodder yield with stem diameter and height. The correlation with internode number was also positive but not significant.

Wakankar et al. (1970) observed that fodder yield had positive phenotypic correlation with plant height and leaf area.

Naphade (1972) reported that the yield of fodder had significant positive correlation with leaf number and plant height. Plant height and leaf area showed positive but non-significant correlations with fodder yield.

Hussain and Khan (1973) reported positive and significant phenotypic correlation of fodder yield with tiller number, plant height and leaf number.

Patel et al. (1973) in forage sorghum observed that fodder yield had positive phenotypic correlaiton with plant height, stalk diameter and total leaf area.

Chauhan and Singh (1975) reported that fodder yield had positive phenotypic correlation with plant height and leaf number.

Sood (1975) observed a negative correlation between plant height and fodder yield in forage sorghum.

Paroda _et al_. (1975) observed that plant height, leaf length, leaf breadth, days to flower and stem girth were significantly and positively correlated with green fodder yield, both at genotypic and phenotypic level.

Jhorar and Paroda (1976) reported negative phenotypic correlation of plant height with tiller number.

Singhania _et al_. (1977) reported that plant height, fifth leaf area and stem diameter had positive phenotypic correlation with forage yield. The above characters showed positive association among themselves.

In forage sorghum, Vasudeva Rao and Ahluwalia (1977) reported that green fodder yield and dry fodder yield had significant positive phenotypic correlation with plant height and leaf stem ratio.

Gopalan and Balasubramanian (1978) conducted correlation studies in 23 lines of fodder sorghum and reported that number of leaves, length and breadth of leaf and thickness of stems had positive phenotypic correlation with green fodder yield.

Ross et al. (1979) reported positive phenotypic correlation between fodder yield and plant height.

In sorghum, Vaithialingam (1979) reported positive phenotypic correlation of plant height, fourth leaf area and dry fodder yield with green fodder yield.

In forage sorghum, Sidhu and Mehindiratta (1980) reported significant positive phenotypic correlation of leaf number, stem thickness, leaf length and leaf width with green fodder yield.

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

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

Girija and Nataraja Rathanam (1989) reported that green matter yield was found to be correlated with girth and dry matter accumulation.

iii) Bajra

Gupta and Athwal (1966) in Pennisetum typhoides reported positive phenotypic correlation of leaf size, leaf number, leaf length and tillering with green fodder yield.

Gupta and Nanda (1971) studied 30 Indian varieties, 70 Indian inbreds, 25 African and 51 American inbreds of bajra and reported that green fodder yield was dependent only on leaf size and number in Indian inbreds, leaf number, plant heights and tiller number in African varieties and plant height alone in American inbreds.

Sangha and Singh (1973) reported that green fodder yield had significant positive phenotypic correlation with number of tillers.

Phul et al. (1974) in pearl millet reported positive and significant phenotypic correlation between plant height and tiller number.

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

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

iv) Ragi

Patnaik (1968) in finger millet reported negative correlation of plant height with number of tillers.

Narasimha Rao and Pardhasaradhi (1968) reported positive correlation of plant height with tiller number.

Mahudeswaran and Murugesan (1973) studied 20 varieties of ragi and reported that in general genotypic correlations were slightly higher than phenotypic correlations. They observed that plant height was positively and significantly correlated with straw yield.

Appadurai et al. (1977) in Eleusine coracana reported that straw yield was positively and significantly correlated with plant height, while number of leaves per culm showed a negative and significant correlation with straw yield.

Goud and Lakshmi (1977) observed negative correlation between plant height and tiller number.

Dhanakodi (1980) reported significant positive correlations between green fodder yield and plant height, leaf number, leaf length leaf width, day to flower and internodel length. Non-significant negative correlation between leaf stem ratio and plant height and positive correlation between tiller number and leaf stem ratio was also reported.

Dhanakodi and Chandrasekharan (1989) reported positive significant correlation between fodder yield and plant height, leaf number, leaf length, leaf width, days to flowering and internodal length. Negative significant correlation between fodder yield and tiller number and non-significant negative correlation between fodder yield and leaf stem ratio was also reported.

v) Oats

In fodder oats Mehra *et al.* (1971) observed significant positive correlation of leaf area with fodder yield.

Nair and Gupta (1977) recorded high positive correlation of number of tillers, leaf area and number of leaves with green weight of stem and leaves.

Solanki (1977) observed that plant height, number of tillers per plant, number of leaves per plant and leaf breadth had positive significant phenotypic correlation with green as well as dry fodder yield.

Rao *et al.* (1978) observed positive association between plant height and fodder yield.

Murtaza *et al.* (1979) reported that both at the genotypic and phenotypic levels, the number of tillers per plant had positive and significant association with green fodder yield. A positive significant association between green and dry matter yield was also noted. They have also reported negative significant association between number of tillers per plant and plant height.

Singh *et al.* (1980) reported that plant height at flowering was positively and significantly correlated with green fodder yield.

A highly positive and significant association of number of tillers per plant with dry matter yield and green forage yield was also observed.

Choubey and Gupta (1986) in forage oats reported that yield had high significant positive correlation with plant height, leaf length and stem diameter.

Bahl et al. (1988) reported positive association among dry matter yield per plant, green fodder yield per plant, dry matter yield per day and green fodder yield per day. Green fodder yield per plant was positively associated with stem thickness and leaves per plant. Dry matter yield per day and green fodder yield per day were positively correlated with number of leaves per plant.

vi) Other fodder crops

In barley, Sethi and Singh (1978) reported that tillers per plant and plant height had significant positive correlations with green fodder yield.

Bainiwal et al. (1983) reported a close association between green fodder and dry fodder yield in forage barely. Plant height showed a positive association with green fodder yield in their studies.

Singh and Patil (1983) reported that dry matter yield and plant height had a high significant positive correlation with green fodder yield. It was also noted that tillers per metre row also had positive correlation with green fodder yield in barley.

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

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

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

Positive correlation of green fodder yield with dry matter yield and crude fibre content was observed by Maggiore et al. (1980) in fodder maize.

Sotomayor Rios et al. (1972) reported that dry matter yield was positively correlated with green fodder yield in *Digitaria* sp.

In marvalgrass, Gupta *et al*. (1974) noted significant positive correlation of plant height, number of tillers, basal area and crown area with forage yield.

Ramaswamy (1974) in *Cenchrus sp*. reported that number of tillers, length and breadth of leaves and height of the clones were positively correlated with green fodder yield.

In *Cenchrus ciliaris*, Yadav, *et al*. (1974) observed that plant height, leaf breadth and fodder yield were positively and significantly correlated with each other both genotypically and phenotypically. Tiller number was positively correlated with yield and number of leaves.

Gopalan and Ramaswamy (1979) in *Cenchrus ciliaris* observed that number of tillers, length and breadth of leaf, length and thickness of internode and height were positively correlated with fodder yield.

In *Cenchrus ciliaris*, Jatasra and Thakral (1986) reported that plant height and number of tillers per plant were positively correlated and leaf stem ratio was negatively correlated with green fodder yield.

In foxtail millet, Cill and Randhawa (1975) reported significant negative association of tiller number and plant height.

Fujimato and Susuki. (1975) in Italian rye grass reported high genotypic correlation between dry weight and plant height and also between tiller number and fresh weight.

Schitea (1983) in Italian rye grass reported significant positive correlation of green matter yield and dry matter yield with plant height. Significant positive correlation between green matter yield and crude protein content was also reported.

In tall Fescue, Nelsen et al. (1977) observed that number of tillers per plant had negative correlation with yield per tiller.

In tall fescue, Jones et al. (1979) noted that low rate of tiller production was correlated with forage yield.

Wai-koon et al. (1977) in smooth brome grass reported that yield was significantly and positively correlated with tiller density.

Tan et al. (1979) in smooth brome grass observed that both tiller density and height were significantly and positively correlated with green fodder yield.

Vogel (1983) in brome grass reported that forage yield was negatively correlated with crude protein content.

In Rhodes grass, Booman (1978) recorded negative correlation between leaf stem ratio and herbage yield.

In proso millet, Saxena et al. (1978) recorded positive correlations of high tillering and seedling vigour with fodder yield.

Sen and Hamid (1986) in proso millet reported that straw weight was positively correlated with plant height and negatively correlated with tillers per plant.

Titov et al. (1978) in *Festuca pratense* observed that height of plant and length of blade had a positive correlation with forage yield.

Salach and Goral (1979) in timothy grass observed negative correlation of tillering with plant height.

Clyde and Hill (1983) in timothy grass reported that correlation between forage yield and percentage dry matter yield was non-significant and positive. They have also observed negative correlation between protein and forage yield.

Subramaniam (1979) in little millet observed that panicle number and straw yield showed negative correlation with plant height both at the genotypic and phenotypic levels. Tiller number recorded positive and significant genotypic and phenotypic correlation with panicle number and straw yield.

Hacker and Bray (1981) in Pasture grass (*Setaria sphacelata*) reported that dry matter yield was genetically correlated with the number of inflorescence and number of days to flowering.

Vogel *et al.* (1981) in Indian grass reported significant positive correlation between forage yield and plant height, leafiness and vigour.

Riley and Vogel (1983) in *Andropogaon hallii* cv. Gold strike reported a negative correlation between yield and crude protein content.

4. Path Analysis

i) *Guinea grass*

Sreenivasan (1983) reported that plant height exerted maximum direct contribution towards fodder yield followed by girth of internode and number of days to 50 per cent flowering. Girth of internode and length of panicle showed indirect contribution towards fodder yield.

Thejasee Bhai (1988) reported that the maximum direct effect on green fodder yield per plot was exerted through green fodder yield per hill, leaf stem ratio on fresh weight basis, number of tillers per hill and plant height. Leaf area index exhibited negative direct effect and positive indirect effects through green fodder yield per hill and leaf stem ratio on fresh weight basis and green fodder yield per plot. She has suggested that green fodder yield per hill, leaf stem ratio on fresh weight basis and leaf area index are to be given importance in selection programmes for the improvement of fodder yield.

ii) Sorghum

Naphade (1972) done path analysis in sorghum and reported that the number of leaves per plant was the most important component of fodder yield followed by plant height and leaf area.

Path analysis conducted by Patel et al. (1973) revealed that stalk diameter had large positive direct influence on fodder yield followed by plant height. Leaf area influenced the fodder yield indirectly through plant height and stalk diameter.

Paroda et al. (1975) reported that stem girth had positive direct effect on green fodder yield but exerted negative direct effect on dry matter yield. Leaf breadth showed high positive effect on both green and dry matter yield. Direct effect of leaf length was high on dry matter yield. Plant height exerted negative direct effect on both green and dry fodder yield.

Gopalan and Balasubramanian (1978) reported that leaf length and breadth showed high positive direct effect on green fodder yield.

Mathur and Patil (1982) in forage sorghum reported that number of tillers per plant had positive direct effect and plant height and number of leaves had negative direct effect on dry fodder yield.

iii) Bajra

Sankaran and Kalippa (1974) reported that plant height exerted the maximum direct effect on straw yield.

Tyagi et al. (1980) reported that dry matter yield, leaf length and number of tillers had direct effects on green fodder yield. They have also reported that plant height, green fodder yield, stem girth and number of leaves exerted direct effect on dry matter yield.

In pearl millet, Mangath (1986) reported that internode number had the maximum direct effect on yield.

iv) Oats

In fodder oats, Nair and Gupta (1976) reported that number of tillers, leaf area and number of leaves had major roles in the accumulation of dry matter yield through green weight.

Solanki (1977) reported that plant height, number of tillers per plant, number of leaves per plant and leaf breadth were important component characters for green as well as dry fodder yield.

Dhumale and Mishra (1979) reported that plant height had high positive direct effect on green forage yield.

Murtaza et al. (1979) reported positive direct effect of number of tillers and plant height on green fodder yield. Plant height showed high negative indirect effect towards green fodder yield through number of tillers, leaf length and leaf breadth.

Singh et al. (1980) reported that plant height had a positive direct effect and number of tillers per plant had a negative direct effect on green fodder yield.

In forage oats, Choubey and Gupta (1986) reported that height and leaf width had high positive direct effects on forage yield.

iv) Other fodder crops

Achuthakumar (1982) reported that leaf length and cob weight had maximum contribution to forage yield in maize.

Patel and Shelke (1984) reported that leaf area per plant, internode number per plant, stem cirumference and percentage nitrogen content in the plant all had significant positive direct effect on yield in forage maize.

Paramathma and Balasubramanian (1988) in forage maize reported that stem girth and leaf breadth had positive direct effect on yield. Plant height influenced the yield mostly through stem girth and leaf breadth.

In fodder ragi, Dhanakodi (1980) reported positive direct effects of days to flowering, number of tillers and leaf number towards fodder yield. The plant height, leaf breadth and length of internode exerted positive direct effect through days to flowering.

Ramaswamy (1974) done path analysis in *Cenchrus ciliaris* and *Cenhrus setigerus* and reported that the number of tillers had the maximum direct effect on yield followed by length of leaf, thickness of internode, length of internode and height of clone.

Gopalan and Ramaswamy (1979) in Cenchrus ciliaris reported that number of tillers, length and breadth of leaf and height of clone showed high positive direct effects on fodder yield.

Singh and Prasad (1974) in Pennisetum pedicellatum reported direct effects of leaf length and plant height on yield but tiller number and stem girth had only indirect effects.

Sleper et al. (1977) in tall fescue reported that both tillers per plant and yield per tiller had large positive direct effects on total yield per plant.

Tan et al (1979) in smooth brome grass reported that tiller density followed by leaf area and tiller dry weight exerted the greatest direct influence on yield.

Descriminant function analysis

Santhipriya (1991) in guniea grass reported that height, tiller number, leaf area, leaf stem ratio and green matter yield were the most important yield contributing parameters in guinea grass and suggested that the selection index formulated based on the above charactrs are useful for population improvement.

Swarup and Changale (1962b) in sorghum reported that selection based on the index formulated by including the character plant height, stalk diameter and leaf number are useful for the improvement of fodder yield.

Singh and Singh (1974) in fodder sroghum reported that selection index developed by including leaf length, stem girth, stem length, number of internodes and fodder yield were very effective for the improvement of fodder yield through selection.

Vaidyanathan (1973) in blue panic grass reported that selection based on index formulated by including traits such as leaf width, number of tiller and plant height will be very effective for improving the green fodder yield.

MATERIALS AND METHODS

MATERIALS AND METHODS

A field experiment was conducted at the Instructional Farm, College of Agriculture, Vellayani during June to December 1990. The details of the materials used and the methods adopted in the experiment are presented.

I Materials

Thirty guinea grass clones maintained at the Department of Plant Breeding, College of Agriculture, Vellayani were used for the study. They are:

1. MS 4600	11. PGG 92	21. FR 42
2. MS 4675	12. PGG 112	22. FR 426
3. MS 4681	13. PGG 123	23. FR 428
4. MS 4685	14. PGG 132	24. FR 429
5. MS 4691	15. PGG 147	25. FR 443
6. MS 4732	16. MC 14	26. FR 550
7. MS 4733	17. MC 16	27. FR 552
8. PGG 9	18. GG 2	28. FR 553
9. PGG 14	19. Haritha	29. FR 559
10. PGG 26	20. Mackuenii	30. FR 600

II A. Methods

The experiment was laid out in a randomized block design with two replications. Slips were planted in plot size of 3 x 1.5 m with a spacing of 50 x 30 cm.

The management practices were given according to package of practices recommendations of Kerala Agricultural University (1989).

The following observations were recorded from three harvests at 45 days interval.

1. Plant height

The height was recorded from a random sample of ten hills per plot and mean values were estimated. The height was measured in centimetres from the base of the plant to the tip of the tallest leaf.

2. Leaf length

The length of middle leaf was measured in centimetres from a random sample of ten hills per plot and mean values were estimated.

3. Leaf breadth

The breadth of middle leaf was measured in centimetres from a random sample of ten hills per plot and means were estimated.

4. Leaf Area Index (L.A.I)

Leaf area was estimated by using leaf area meter - Li-COR; model 3100 Area meter. The leaf area index was computed following the formula suggested by William (1946).

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

5. Number of tillers per hill

The total number of tillers per hill were recorded from a random sample of ten hills per plot and mean values were estimated.

6. Leaf stem ratio

One plant selected at random from each plot was harvested and seperated into leaf and stem. Weight of leaf and stem were recorded and leaf stem ratio was worked out.

7. Number of panicles per hill

The total Number of panicles per hill were recorded from a random sample of ten hills per plot and the means were estimated.

8. Weight of seeds per hill

A hill per plot was selected randomly and seeds were collected from all the inflorescence at the time of maturity as decided by the complete emergence of panicle. The panicles were sun dried for 2 days. Seeds were collected and weight of seeds was recorded in grams.

9. Protein percentage

Dried plant samples collected from the third harvest was utilized for the estimation of the nitrogen content by the modified microjeldhal method (Jackson, 1967). The crude protein was calculated by multiplying the nitrogen content by the factor 6.25 and expressed as percentage (Simpson et al. 1965)

10. Green fodder yield

The weight of green fodder per plot was recorded in kilograms by cutting the hills at 10 to 15 cm above the ground level. Mean values of three harvests was taken.

11. Dry fodder yield

The random sample used for estimating the leaf stem ratio was sun dried and subsequently dried in a hot air over at 80° C for 48 hours to constant weight. Dry matter percentage was computed for each treatment. Based on this estimate the total dry matter yield per plot was worked out corresponding to its green fodder yield per plot. Mean values of three harvests was taken.

12. Reaction to pest and disease

Observation on pest and disease were not recorded, since there was no serious pest and disease incidence.

B. Statistical analysis

The data recorded from three harvests with respect to the above said characters were subjected to the following statistical analysis.

1. Analysis of variance and co-variance

Analysis of variance and co-variance was done to test whether there was any significant difference among the genotypes, with respect to the various characters under study and to estimate the components of variance and co-variance.

Table 1.

Source	Degrees of freedom	Mean sum of square X_1	Mean sum of square X_2	Mean sum of products
Block	(r-1)	MS_{Bx_1}	MS_{Bx_2}	$MS_{PBx_1x_2}$
Treatments	(v-1)	MS_{Vx_1}	MS_{vx_2}	$MS_{PVx_1x_2}$
Error	(r-1) (v-1)	MS_{Ex_1}	MS_{Ex_2}	MS_{PEx_1x2}
Total	rv-1			

Where r - number of replication

v - number of treatments

2. Variance

The phenotypic variation for a character is attributed to the sum of genotypic and environmental effects.

$V_{(P)} = V\ (G+E)$

$= V\ (G) + V\ (E) + 2\ cov.\ (GE)$

If the genotypes are grown independently over the environment then this COV (GE) = 0. So that

$V_{(P)} = V\ (G) + V\ (E)$ or

$\sigma_p^2 = \sigma_g^2 + \sigma_e^2$

Where σ_P^2 is the phenotypic variance

σ_g^2 is the genotypic variance

σ_e^2 is the environmental variance

The estimation of σ_p^2, σ_g^2 and σ_e^2 was done as per the method suggested by Johnson et al. 1955.

Genotypic variance ($\hat{\sigma}_g^2$) = $\dfrac{MS_{Vx_i} - MS_{Ex_i}}{r}$

Error (Environmental) variance ($\hat{\sigma}_e^2$) = MS_{Ex_i} and

$\hat{\sigma}_p^2 = \sigma_g^2 + \sigma_e^2$

3. Coefficient of variation

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

$$PCV = \frac{\sigma_p \times 100}{\bar{x}}$$

$$GCV = \frac{\sigma_g \times 100}{\bar{x}}$$

Where σ_p, σ_g and $\bar{x}$ are respectively the phenotypic and genotypic standard deviation and $\bar{x}$, the general mean (Burton, 1952).

4. Heritability

Heritability H^2 (broad sense) is the fraction of the genotypic variance to the phenotypic variance.

$$\hat{H}^2 = \frac{\sigma_g^2 \times 100}{\sigma_p^2}$$

Where H^2 is the heritability coefficient expressed in percentage.

5. Genetic advance

The expected genetic advance (GA) under selection was computed as per the method given by Allard (1960) and expressed as percentag of mean values.

$$\hat{GA} = KH^2 \sigma_p$$

where K is the selection differential and equal to

2.06 if 5% selection is adopted in large samples.

character σg_{ij} is estimated as

$$\hat{\sigma g}_{ij} = \frac{MS_{Pv} - MS_{PE}}{r}$$

where MS_{pv} – mean sum of product for treatment

MS_{PE} – mean sum of product for error

r = No. of replications

Error (Environmental) covariance σe_{ij} is

$$\hat{\sigma e}_{ij} = MS_{PE} \text{ and}$$

$$\hat{\sigma P}_{ij} = \hat{\sigma g}_{ij} + \hat{\sigma e}_{ij}$$

where σP_{ij} is the phenotypic co-variance.

7. Correlation coefficient

Correlation coefficients is a measure of the magnitude of association between two variables (Jain, 1982).

$$r_{p_{ij}} = \frac{\sigma P_{ij}}{\sigma P_i \, \sigma p_j}$$

$$r_{g_{ij}} = \frac{\sigma g_{ij}}{\sigma g_i \, \sigma g_j}$$

and

$$r_{e_{ij}} = \frac{\sigma e_{ij}}{\sigma e_i \, \sigma e_j}$$

where r_{pij}, r_{gij}, r_{eij} are the phenotypic, genotypic and environmental correlation coefficients.

6. Co-variance

Genotypic covariance with respect to the i^{th} and j^{th} character σg_{ij} is estimated as

$$\hat{\sigma} g_{ij} = \frac{MS_{Pv} - MS_{PE}}{r}$$

where MS_{pv} - mean sum of product for treatment

MS_{PE} - mean sum of product for error

r = No. of replications

Error (Environmental) covariance σe_{ij} is

$$\hat{\sigma} e_{ij} = MS_{PE} \text{ and}$$
$$\hat{\sigma} p_{ij} = \hat{\sigma} g_{ij} + \hat{\sigma} e_{ij}$$

where σp_{ij} is the phenotypic co-variance.

7. Correlation coefficient

Correlation coefficients is a measure of the magnitude of association between two variables (Jain, 1982).

$$r_{p_{ij}} = \frac{\sigma p_{ij}}{\sigma p_i \, \sigma p_j}$$

$$r_{g_{ij}} = \frac{\sigma g_{ij}}{\sigma g_i \, \sigma g_j}$$

and

$$r_{e_{ij}} = \frac{\sigma e_{ij}}{\sigma e_i \, \sigma e_j}$$

where r_{pij}, r_{gij}, r_{eij} are the phenotypic, genotypic and environmental correlation coefficients.

8. Path coefficient analysis

Path analysis was introduced by Wright (1921) to refer to a type of casual analysis. A path coefficient is a standardised regression coefficient and it gives the changes in the dependent variable for given changes in the appropriate independent variable, with all of the remaining variables controlled or held constant. A path coefficient P_i measures the proportion of the change in the dependent variable Y for which the independent variable x_j is directly responsible; the sign of P_i indicates the sign of the direct casual relationship.

$r(x_i, x_j)\, p_i$ meassures the indirect effect of x_i via x_j on Y. P_i are estimated from the solution of the simultaneous system of equation $\underset{\sim}{R}xx\ \underline{P}_i = R_{\underline{xy}}$

Where $\underset{\sim}{R}xx$ in the matrix of inter correlation between variabales X_i and x_j, i, j = 1, 2, ... K.

$\underline{p_i}$ is the vector of path coefficients and $R_{\underline{xy}}$ is the vector of correlation between the independent and dependent variables. The residual is estimated as $\left(1 - \sum_{l=1}^{K} P_i\, r(x_i, Y)\right)^{1/2}$

9. Selection index

Selection indices were worked out through the application of discriminant function proposed by Smith (1936). The characters used for the construction of selection indices were green fodder yield, plant height, leaf area index, number of tillers per hill, leaf stem ratio, number of panicles per hill and weight of seeds per hill.

Let. $\underset{\sim}{Pij}$ and $\underset{\sim}{Gij}$ be the variance/co-variance matices of order $n \times n$

A discriminant function

$$I = b_1x_1 + b_2x_2 + \ldots\ldots\ldots\ldots + b_nx_n$$

was constructed such that

$$\underset{\sim}{Pij}\ \underline{b} = \underset{\sim}{Gij}\ \underline{a}$$

where $\underline{b}$ is the vector of coefficients in I and $\underline{a}$ is the vector of economic weights assigned to the genotypic values of individual characters and

$$\underline{\hat{b}} = \underset{\sim}{Pij}^{-1}\ Gij\ \underline{a}$$

Here it is assumed that all the characters are economically equally important ie.

$$a_1 = a_2 = a_3 = a_n = 1$$

The mathematical discription of I is known as selection index giving

$$I = \hat{b}_1\ x_1 + \hat{b}_2\ x_2 + \ldots\ldots\ldots\ldots + \hat{b}_n X_n$$

The index values were determined, where x_1, x_2 ....x_n stands for the phenotypic performance of the individual with respect to each character.

On the basis of the selection indices, the individuals were arranged in order of merit and then the best 20% were identified and recommended as superior clones for further breeding programme.

The expected genetic gain through selection may be given by the formula

$$\Delta G = \frac{K \, \underline{a} \, \underset{\sim}{G}_{ij} \, \underline{b}}{(\underline{b} \, \underset{\sim}{P}_{ij} \, b')^{\frac{1}{2}}}$$

Where K is the selection differential.

RESULTS

RESULTS

The data on the observations were statistically analysed and the results are presented below.

I. Mean performance of the clones

Mean values of eleven characters in thirty clones of guinea grass are presented in Table 2 and graphically represented in figures 1 to 11. The analysis of variance for eleven characters are presented in Table 3. The anova revealed highly significant difference for all the characters except dry fodder yield.

1. Plant height

The plant height ranged from 76.5cm (MS 4685) to 121.9 cm (FR 42). FR 42 was on par with eleven clones viz. Mackuenii (120.5cm), PGG 122, FR 550 (both 116.9 cm), PGG 123 (115.4cm), MC 14 (114.5 cm), PGG 132 (113.6cm), PGG 92 (113.5 cm), FR 428 (112.1 cm), GG 2 (110.2 cm), FR 553 (109.9 cm) and FR 559 (109.8 cm).

2. Leaf length

The maximum leaf length was recorded for the clone MC 16 (61.1 cm) and minimum for MS 4600 (25.4 cm). The clone MC 16 was statistically on par with FR 550 (59.4 cm), FR 559 (58.4 cm) and Mackuenii (57.0 cm).

Table 2 Mean value of eleven characters in thirty clones of Guinea grass

Sl. No.	Clone	Plant height (cm)	Leaf length (cm)	Leaf breadth (cm)	Leaf area index	Number of tillers per hill	Leaf stem ratio	Number of panicles per hill	Weight of seeds per hill (g)	Protein percent-age	Green fodder yield (Kg)	Dry fodder yield (Kg)
1.	MS 4600	87.7	25.4	1.3	3.1	31.1	0.40	35.6	2.8	7.7	13.45	4.47
2.	MS 4675	88.3	27.0	1.2	2.3	32.6	0.31	42.8	2.3	9.4	18.55	6.62
3.	MS 4681	86.5	25.6	1.2	3.9	26.0	0.41	39.7	3.2	9.5	18.31	5.42
4.	MS 4685	76.5	25.5	0.8	3.8	37.8	0.41	38.9	3.6	7.9	12.64	4.14
5.	MS 4691	90.3	49.1	2.1	3.0	17.6	0.71	1.0	0.4	8.0	20.67	5.55
6.	MS 4732	86.3	26.1	1.2	4.1	33.2	0.49	39.3	2.2	6.1	14.75	4.90
7.	MS 4733	95.0	32.9	1.4	3.8	33.1	0.41	42.5	2.3	6.4	21.00	6.58
8.	PGG 9	107.5	42.0	1.8	2.1	17.9	0.53	17.9	3.0	7.7	18.36	6.59
9.	PGG 14	106.6	50.2	1.8	2.2	17.6	0.35	15.9	3.4	7.7	16.54	5.69
10.	PGG 26	105.9	49.0	1.8	3.4	18.6	0.55	16.7	2.7	7.4	18.67	5.82
11.	PGG 92	113.5	52.8	1.9	2.9	23.9	0.37	17.6	3.8	6.2	26.61	8.32
12.	PGG 112	116.9	51.5	1.8	2.6	18.4	0.37	18.3	4.3	7.9	20.91	6.59
13.	PGG 123	115.4	51.8	1.8	3.0	17.4	0.44	17.0	3.4	6.1	22.50	6.82
14.	PGG 132	113.6	47.8	1.9	3.2	18.2	0.41	20.6	4.5	7.5	21.20	6.72
15.	PGG 147	108.2	48.8	1.7	2.5	17.0	0.41	15.7	2.6	7.8	19.70	6.98
16.	MC 14	114.5	53.2	1.6	4.5	25.4	1.00	5.1	1.2	6.3	27.14	7.08
17.	MC 16	89.5	61.1	1.8	3.9	18.2	0.88	3.6	1.2	6.4	24.76	7.07
18.	GG 2	110.2	50.6	1.8	2.7	18.5	0.51	16.2	3.1	9.1	16.93	5.25
19.	Haritha	102.0	52.9	1.9	3.7	18.9	0.52	9.0	2.4	9.9	17.79	5.32
20.	Mackuenii	120.5	57.0	1.7	4.7	28.6	1.36	4.8	1.5	7.6	24.66	6.39
21.	FR 42	121.9	55.7	1.7	4.4	26.4	0.75	3.9	1.4	6.4	25.45	7.38
22.	FR 426	98.3	52.0	1.8	4.2	21.6	0.78	3.6	0.7	7.7	19.17	5.65
23.	FR 428	112.1	54.2	2.1	2.7	18.0	0.72	4.0	0.8	6.1	19.04	5.65
24.	FR 429	101.6	50.5	1.7	4.1	20.4	0.82	4.2	0.7	7.6	22.31	6.01
25.	FR 443	103.9	53.3	1.7	2.3	21.2	0.81	6.0	1.1	7.8	20.22	6.10
26.	FR 550	116.9	59.4	1.7	4.6	25.9	0.85	4.4	1.3	6.7	22.97	6.15
27.	FR 552	100.1	53.7	1.7	3.7	24.3	0.69	4.7	1.1	9.5	23.40	5.92
28.	FR 553	109.9	54.0	2.3	2.7	16.4	1.60	1.7	0.5	6.6	20.55	5.70
29.	FR 559	109.8	58.4	1.9	5.4	20.5	0.92	4.1	0.9	6.5	26.70	7.37
30.	FR 600	101.7	53.4	1.8	3.0	19.2	1.06	3.8	0.7	8.4	14.55	4.59
	CD	13.24	4.47	0.24	1.13	5.26	0.223	6.05	0.96	0.51	7.926	NS

Fig:1 Mean plant height of Thirty clones of guinea grass

X1.	MS 4600	X11.	PGG 92	X21.	FR 42
X2.	MS 4675	X12.	PGG 112	X22.	FR 426
X3.	MS 4681	X13.	PGG 123	X23.	FR 428
X4.	MS 4685	X14.	PGG 132	X24.	FR 429
X5.	MS 4691	X15.	PGG 147	X25.	FR 443
X6.	MS 4732	X16.	MC 14	X26.	FR 550
X7.	MS 4733	X17.	MC 16	X27.	FR 552
X8.	PGG 9	X18.	GG2	X28.	FR 553
X9.	PGG 14	X19.	Haritha	X29.	FR 559
X10.	PGG 26	X20.	Mackuenii	X30.	FR 600

Fig : 1 MEAN PLANT HEIGHT OF THIRTY

CLONES OF GUINEA GRASS

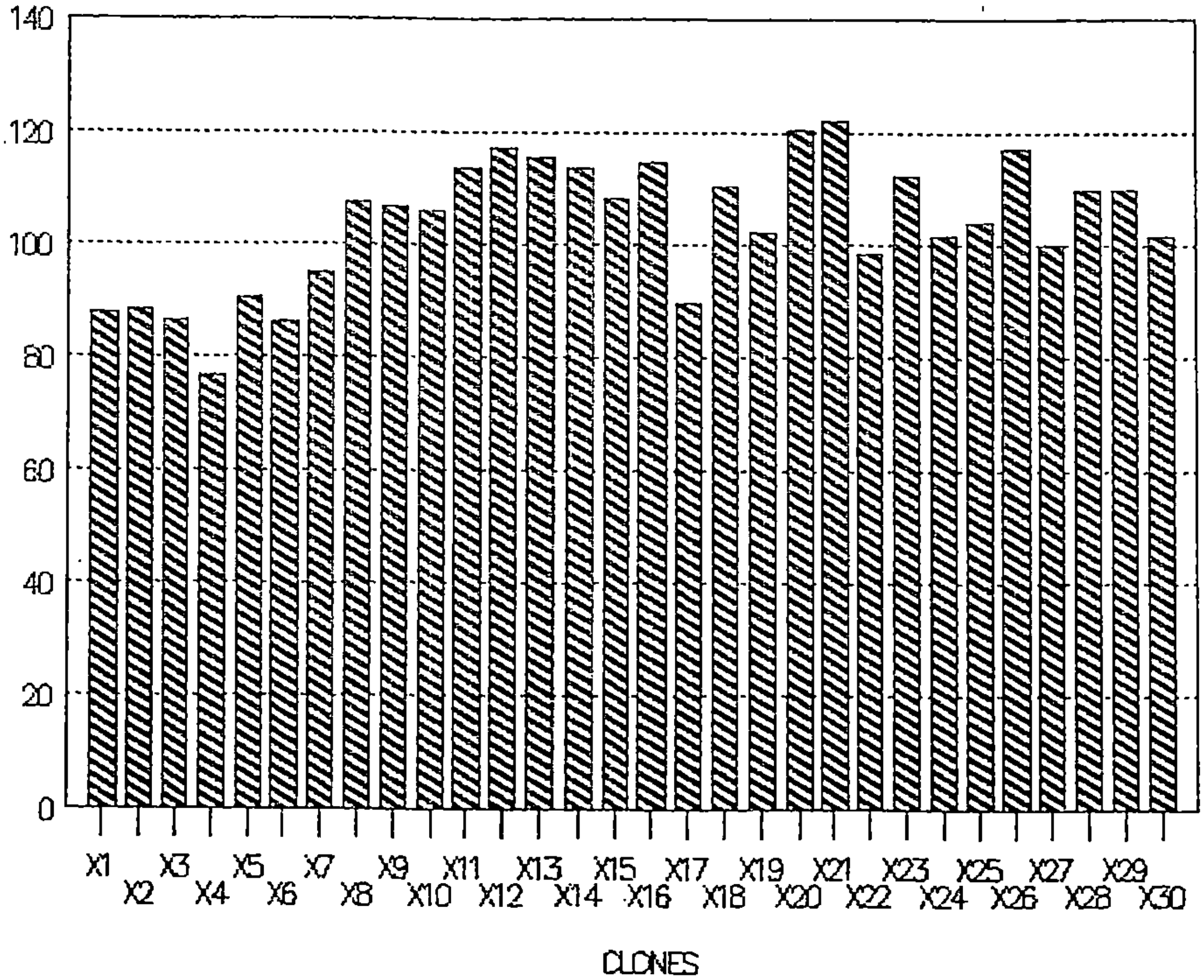


Fig. 2 Mean leaf length of thirty clones of guinea grass

X1. MS 4600	X11. PGG 92	X21. FR 42
X2. MS 4675	X12. PGG 112	X22. FR 426
X3. MS 4681	X13. PGG 123	X23. FR 428
X4. MS 4685	X14. PGG 132	X24. FR 429
X5. MS 4691	X15. PGG 147	X25. FR 443
X6. MS 4732	X16. MC 14	X26. FR 550
X7. MS 4733	X17. MC 16	X27. FR 552
X8. PGG 9	X18. GG2	X28. FR 553
X9. PGG 14	X19. Haritha	X29. FR 559
X10. PGG 26	X20. Mackuenii	X30. FR 600

Fig : 2 MEAN LEAF LENGTH OF THIRTY

CLONES OF GUINEA GRASS

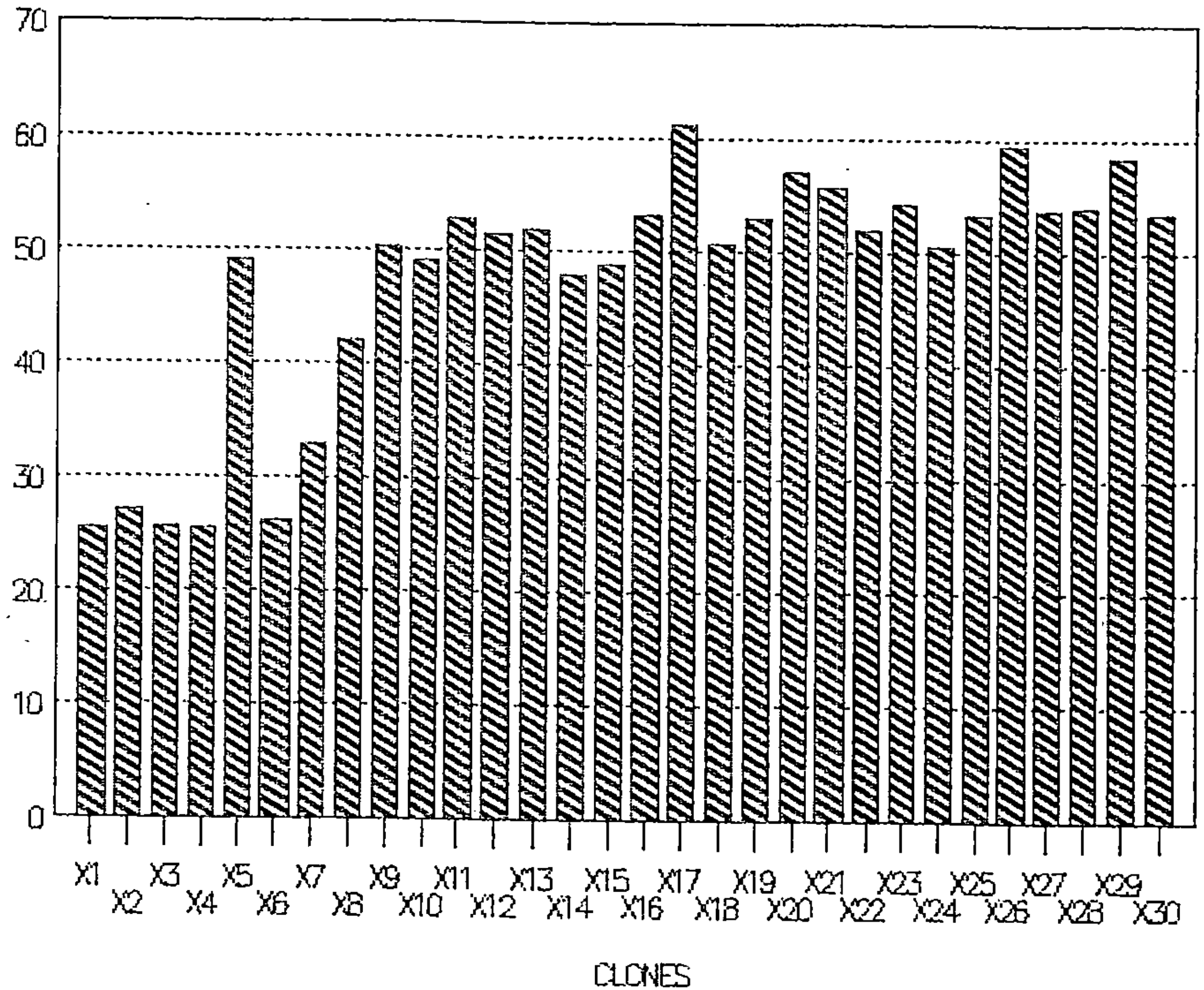


Fig. 3 Mean leaf breadth of thirty clones of guinea grass

X1. MS 4600	X11. PGG 92	X21. FR 42
X2. MS 4675	X12. PGG 112	X22. FR 426
X3. MS 4681	X13. PGG 123	X23. FR 428
X4. MS 4685	X14. PGG 132	X24. FR 429
X5. MS 4691	X15. PGG 147	X25. FR 443
X6. MS 4732	X16. MC 14	X26. FR 550
X7. MS 4733	X17. MC 16	X27. FR 552
X8. PGG 9	X18. GG2	X28. FR 553
X9. PGG 14	X19. Haritha	X29. FR 559
X10. PGG 26	X20. Mackuenii	X30. FR 600

Fig : 3 MEAN LEAF BREADTH OF THIRTY

CLONES OF GUINEA GRASS

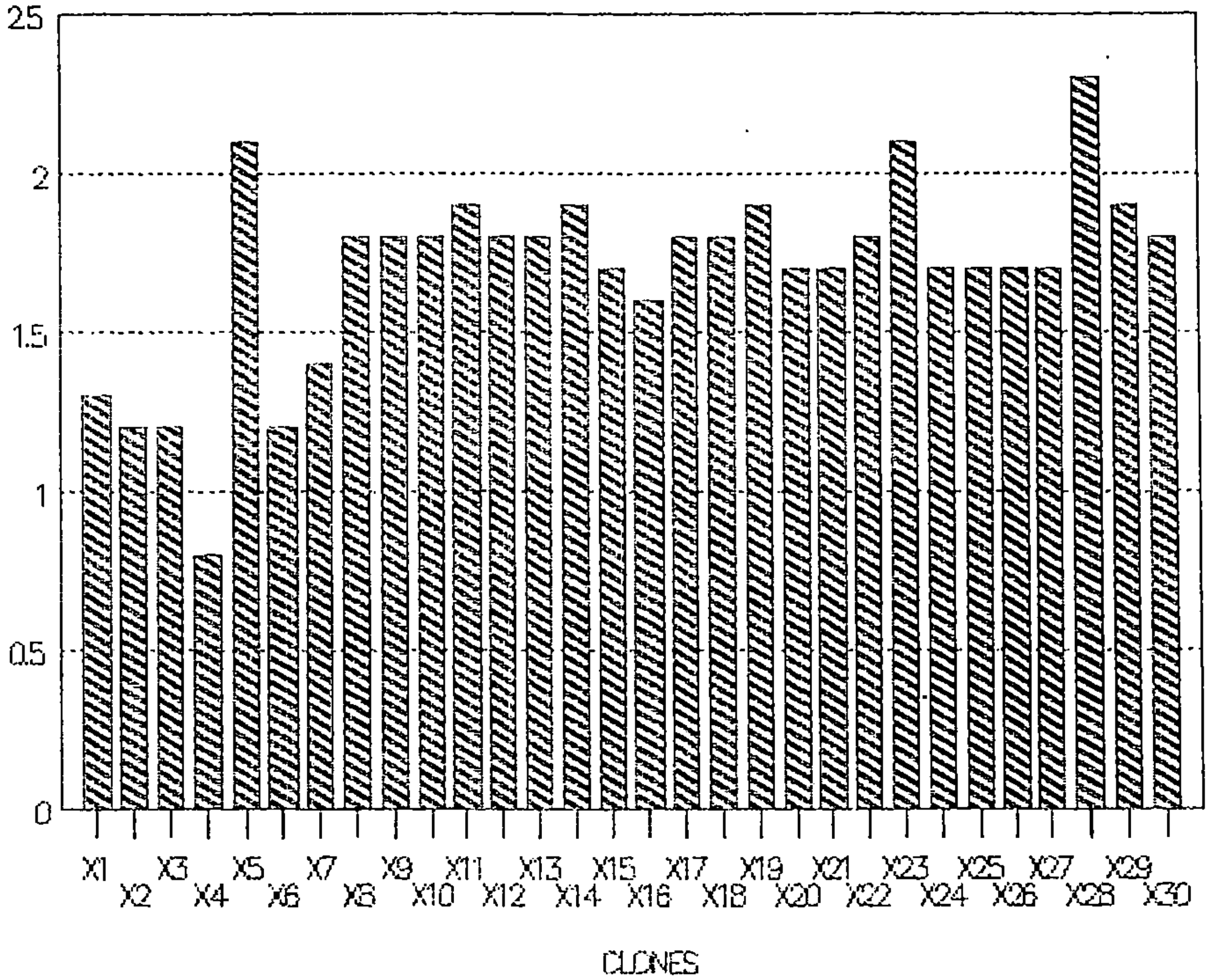


Fig.4 Mean leaf area index of thirty clones of guinea grass

X1.	MS 4600	X11.	PGG 92	X21.	FR 42
X2.	MS 4675	X12.	PGG 112	X22.	FR 426
X3.	MS 4681	X13.	PGG 123	X23.	FR 428
X4.	MS 4685	X14.	PGG 132	X24.	FR 429
X5.	MS 4691	X15.	PGG 147	X25.	FR 443
X6.	MS 4732	X16.	MC 14	X26.	FR 550
X7.	MS 4733	X17.	MC 16	X27.	FR 552
X8.	PGG 9	X18.	GG2	X28.	FR 553
X9.	PGG 14	X19.	Haritha	X29.	FR 559
X10.	PGG 26	X20.	Mackuenii	X30.	FR 600

Table 3 Analysis of variance for eleven characters in guinea grass

Sl. No.	Character	Mean sum of square			F value
		Replication df=1	Treatment df=29	Error df=1	
1.	Plant height	43.06	274.42	41.89	6.55**
2.	Leaf length	1.70	244.08	4.79	50.97**
3.	Leaf breadth	0.01	0.19	0.01	19.00**
4.	Leaf area index	0.01	1.44	0.31	4.69**
5.	Number of tillers per hill	11.26	70.83	6.62	10.70**
6.	Leaf stem ratio	0.01	0.19	0.01	19.00**
7.	Number of panicles per hill	40.25	383.38	8.75	43.82**
8.	Weight of seeds per hill	0.62	2.99	0.22	13.50**
9.	Protein percentage	0.03	2.54	0.06	40.33**
10.	Green fodder yield	22.18	30.24	15.02	2.01*
11.	Dry fodder yield	0.01	1.69	1.29	1.31NS

** Significant at 1% level of probability
* Significant at 5% level of probability
NS Not significant

Fig : 4 MEAN LEAF AREA INDEX OF THIRTY

CLONES OF GUINEA GRASS

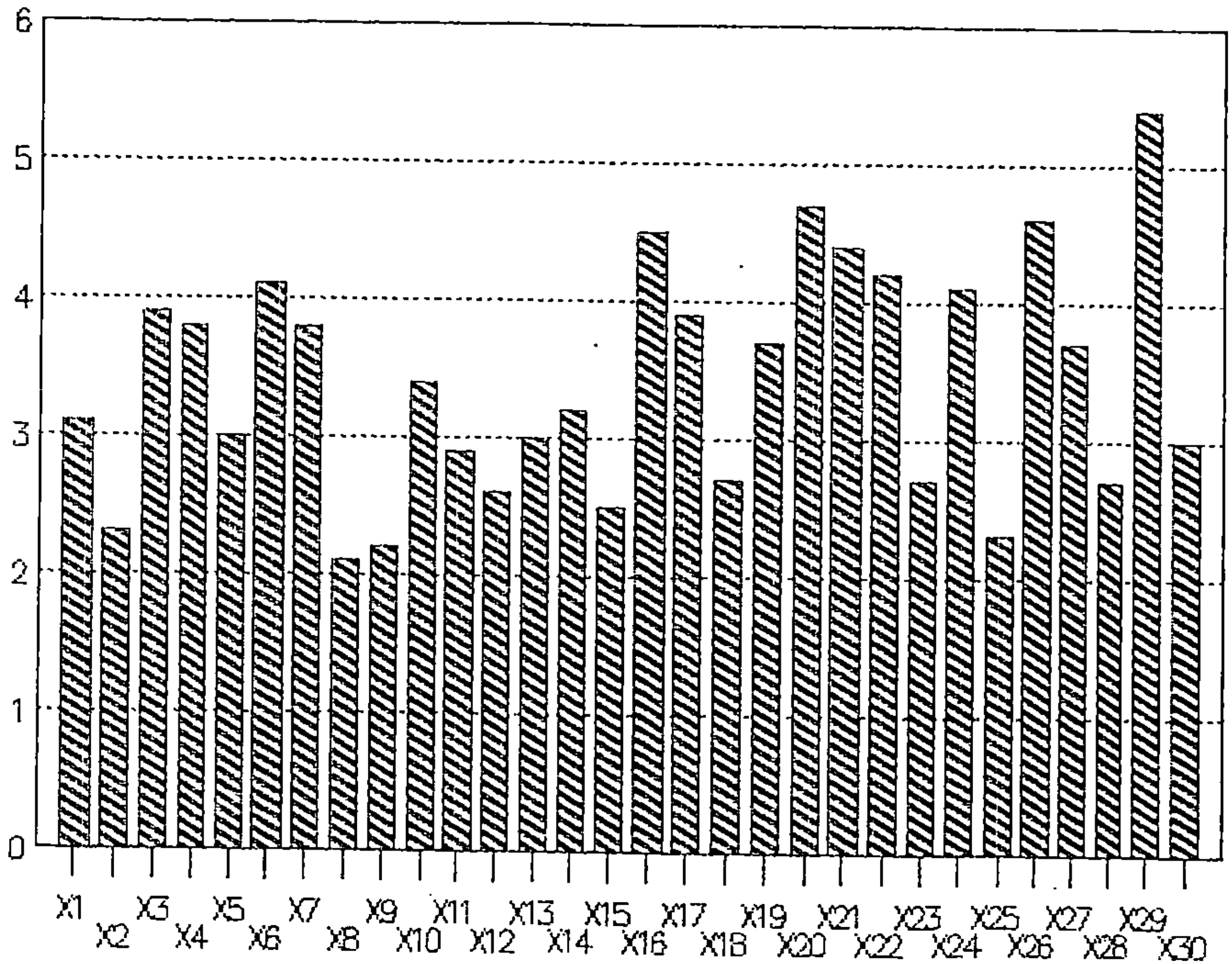


Fig. 5 Mean No. of tillers/hill of thirty clones of guinea grass

X1. MS 4600	X11. PGG 92	X21. FR 42
X2. MS 4675	X12. PGG 112	X22. FR 426
X3. MS 4681	X13. PGG 123	X23. FR 428
X4. MS 4685	X14. PGG 132	X24. FR 429
X5. MS 4691	X15. PGG 147	X25. FR 443
X6. MS 4732	X16. MC 14	X26. FR 550
X7. MS 4733	X17. MC 16	X27. FR 552
X8. PGG 9	X18. GG2	X28. FR 553
X9. PGG 14	X19. Haritha	X29. FR 559
X10. PGG 26	X20. Mackuenii	X30. FR 600

Fig : 5 MEAN No. OF TILLERS/HILL OF

THIRTY CLONES OF GUINEA GRASS

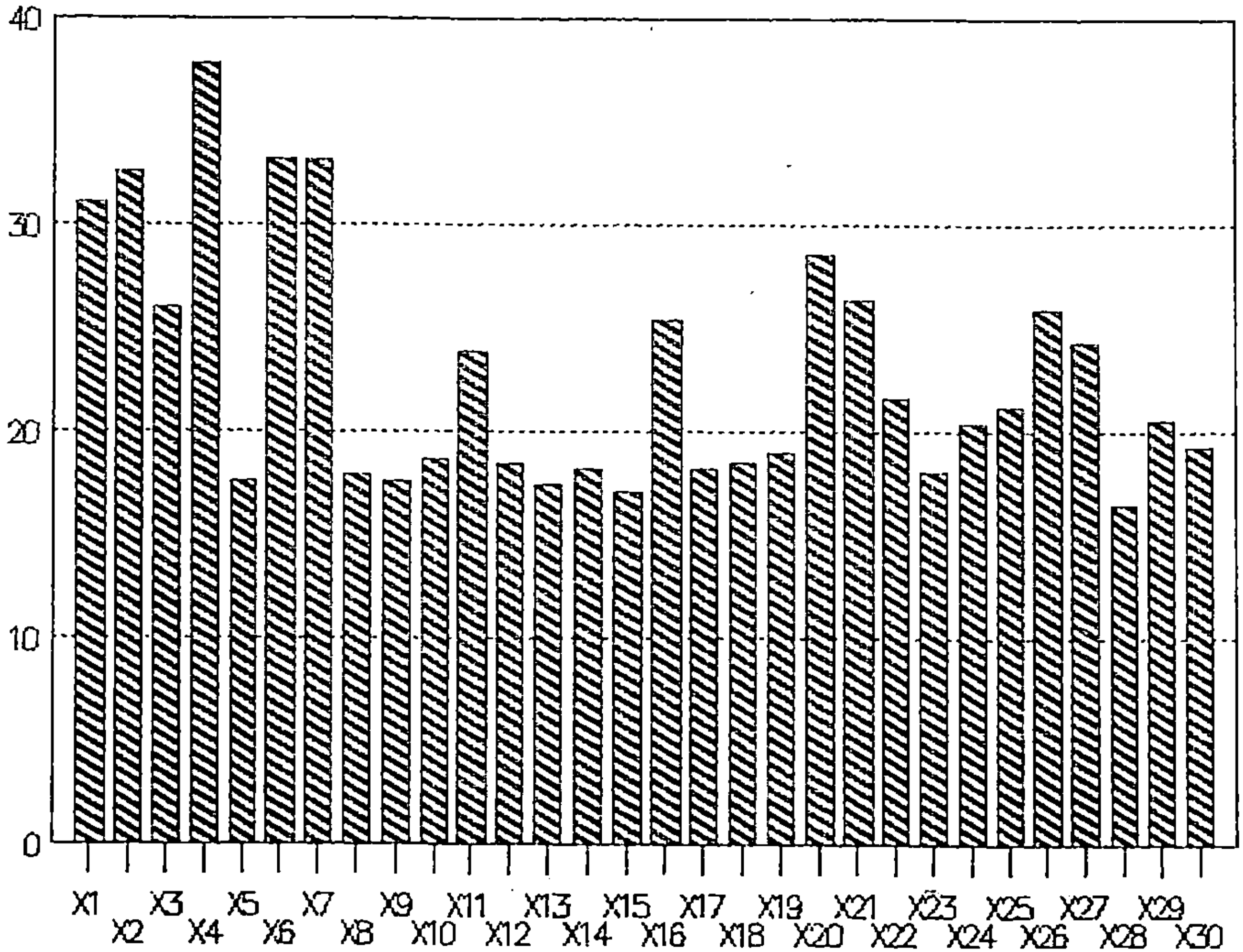
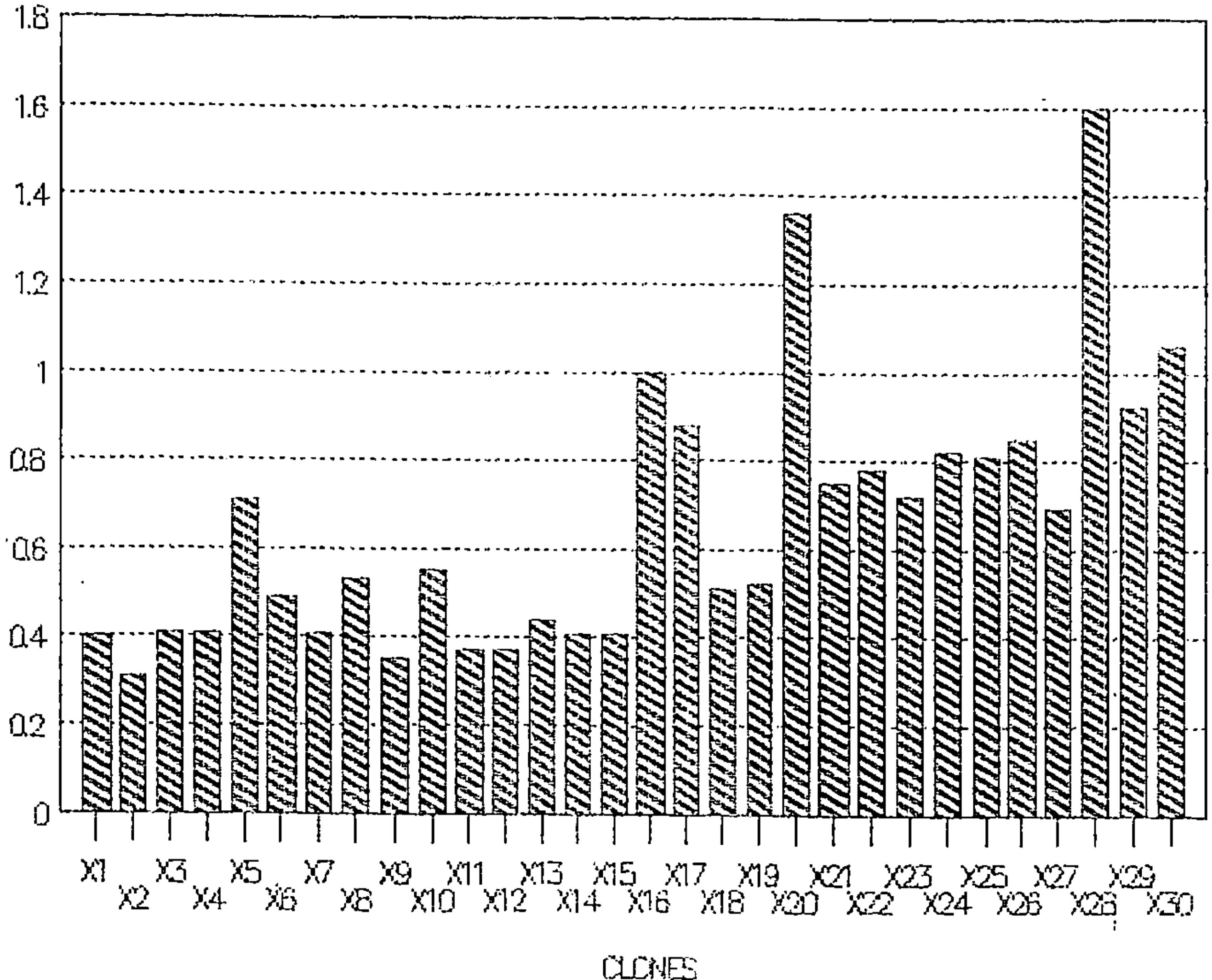


Fig. 6 Mean leaf stem ratio of thirty clones of guinea grass

X1. MS 4600	X11. PGG 92	X21. FR 42
X2. MS 4675	X12. PGG 112	X22. FR 426
X3. MS 4681	X13. PGG 123	X23. FR 428
X4. MS 4685	X14. PGG 132	X24. FR 429
X5. MS 4691	X15. PGG 147	X25. FR 443
X6. MS 4732	X16. MC 14	X26. FR 550
X7. MS 4733	X17. MC 16	X27. FR 552
X8. PGG 9	X18. GG2	X28. FR 553
X9. PGG 14	X19. Haritha	X29. FR 559
X10. PGG 26	X20. Mackuenii	X30. FR 600

Fig : 6 MEAN LEAF STEM RATIO OF THIRTY

CLONES OF GUINEA GRASS



3. Leaf breadth

The maximum leaf breadth was recorded for the clone FR 553 (2.3 cm) and minimum for the clone Ms 4685 (0.8cm). The clones MS 4691 and FR 428 (both 2.1 cm) were on par with the clone FR 553.

4. Leaf area index

The leaf area index was maximum for the clone FR 559 (5.4) and minimum for PGG 9 (2.1). The clones Mackuenii (4.7), FR 550 (4.6), MC 14 (4.5) and FR 42 (4.4) were on par with FR 559.

5. Number of tillers per hill

The number of tillers per hill was maximum for the clone MS 4685 (37.8 Nos.) and minimum for FR 553 (16.4 Nos.) The clone MS 4685 was on par with MS 4732 (33.2 Nos.), MS 4733 (33.1 Nos.) and MS 4675 (32.6 Nos.)

6. Leaf stem ratio

The maximum leaf stem ratio was recorded for the clone FR 553 (1.60) and minimum for the clone MS 4675 (0.31). FR 553 was significantly superior to all other clones.

Fig. 7 Mean No. of panicles/hill of thirty clones of guinea grass

X1. MS 4600	X11. PGG 92	X21. FR 42
X2. MS 4675	X12. PGG 112	X22. FR 426
X3. MS 4681	X13. PGG 123	X23. FR 428
X4. MS 4685	X14. PGG 132	X24. FR 429
X5. MS 4691	X15. PGG 147	X25. FR 443
X6. MS 4732	X16. MC 14	X26. FR 550
X7. MS 4733	X17. MC 16	X27. FR 552
X8. PGG 9	X18. GG2	X28. FR 553
X9. PGG 14	X19. Haritha	X29. FR 559
X10. PGG 26	X20. Mackuenii	X30. FR 600

Fig : 7 MEAN No. OF PANICLES/HILL OF

THIRTY CLONES OF GUINEA GRASS

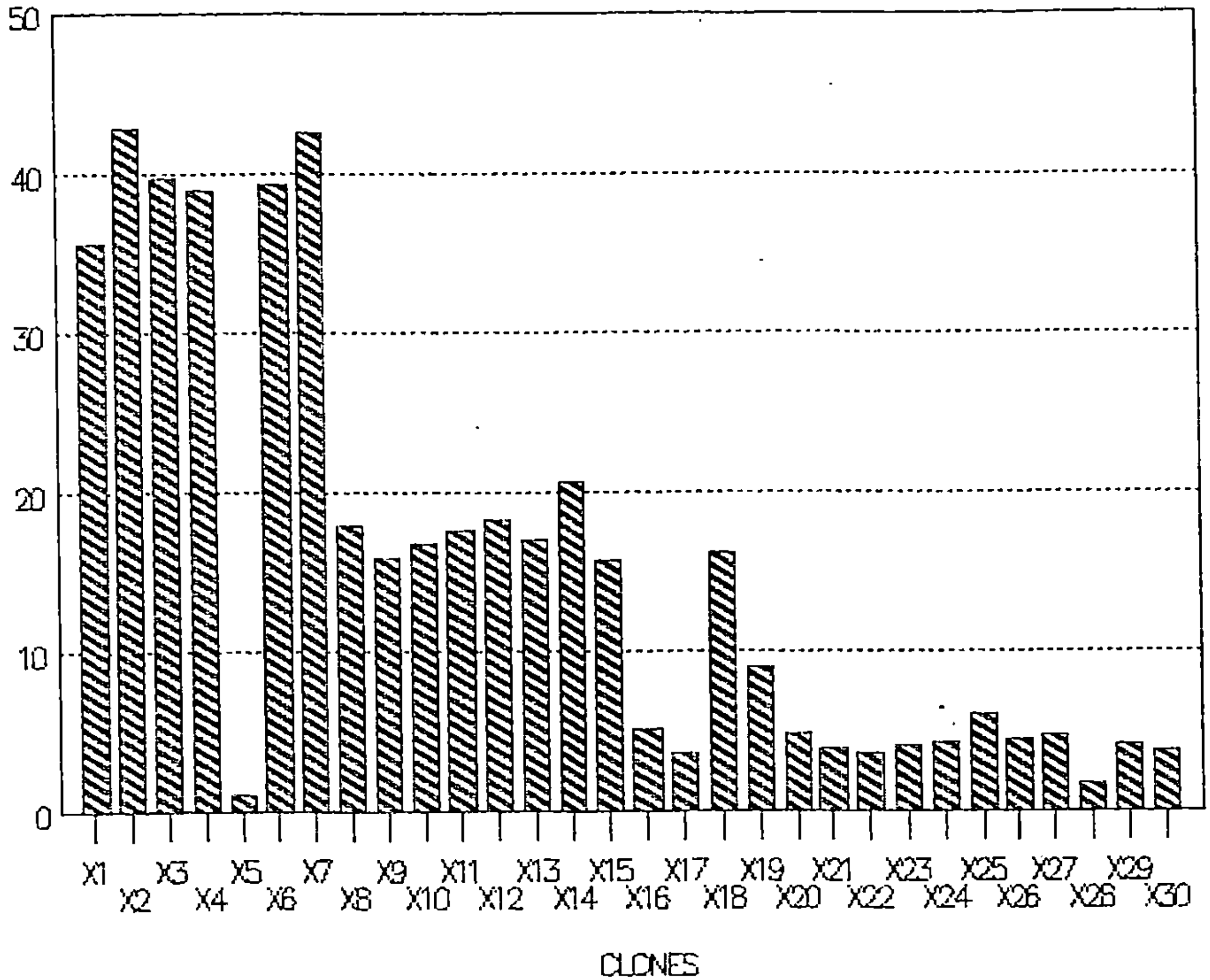
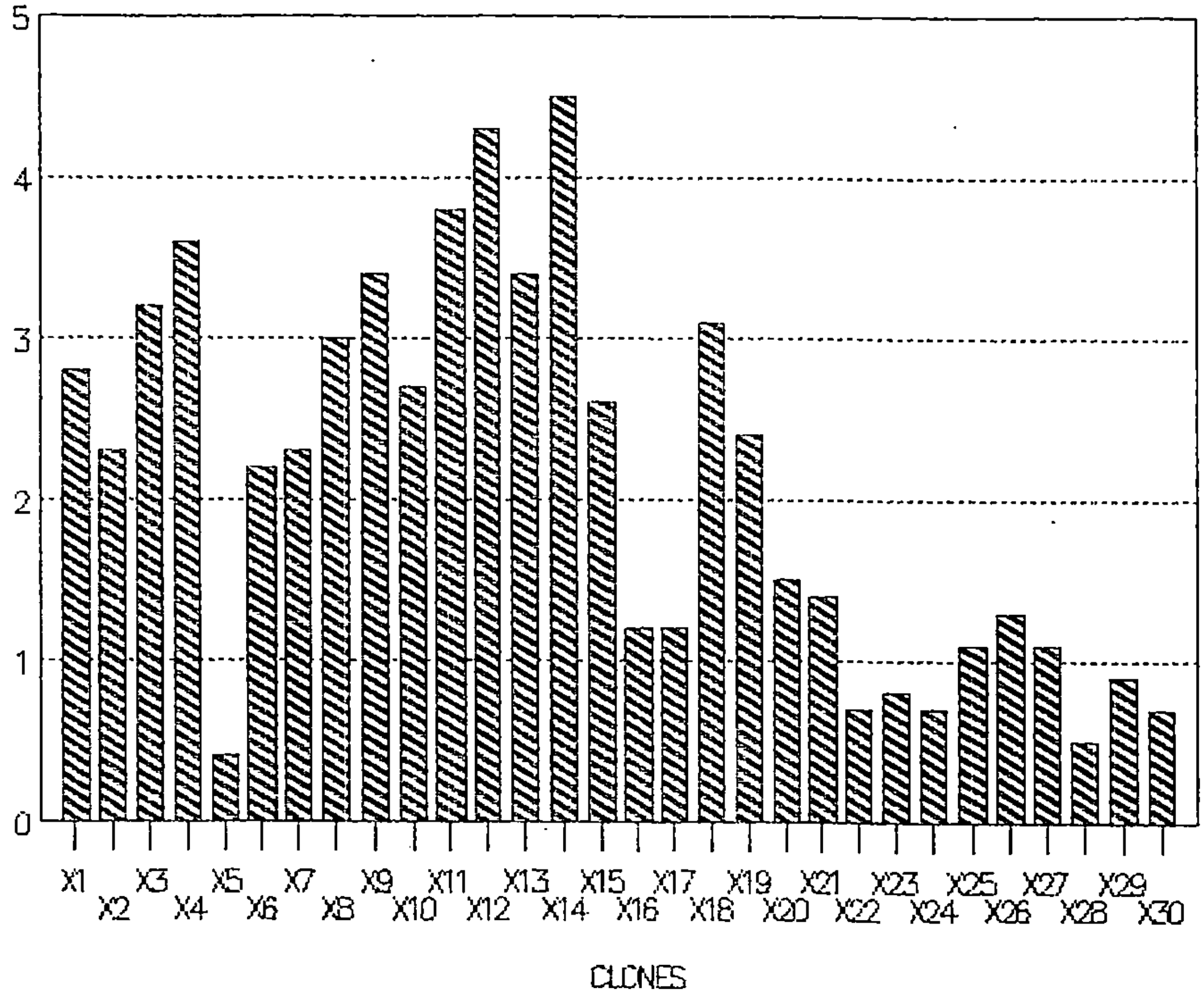


Fig. 8 Mean weight of seeds/hill of thirty clones of guinea grass

X1. MS 4600	X11. PGG 92	X21. FR 42
X2. MS 4675	X12. PGG 112	X22. FR 426
X3. MS 4681	X13. PGG 123	X23. FR 428
X4. MS 4685	X14. PGG 132	X24. FR 429
X5. MS 4691	X15. PGG 147	X25. FR 443
X6. MS 4732	X16. MC 14	X26. FR 550
X7. MS 4733	X17. MC 16	X27. FR 552
X8. PGG 9	X18. GG2	X28. FR 553
X9. PGG 14	X19. Haritha	X29. FR 559
X10. PGG 26	X20. Mackuenii	X30. FR 600

Fig : 8 MEAN WEIGHT OF SEEDS/HILL OF

THIRTY CLONES OF GUINEA GRASS



7. Number of panicles per hill

The maximum number of panicles per hill was recorded for the clone MS 4675 (42.8) and minimum for MS 4691 (1 No.) MS 4675 was on par with MS 4733 (42.5 Nos.), MS 4681 (39.7 Nos.), MS 4732 (39.3 Nos.) and MS 4685 (38.9 Nos.).

8. Weight of seeds per hill

The weight of seeds per hill was maximum for the clone PGG 132 (4.5g) and minimum for MS 4691 (0.4 g). PGG 132 was on par with PGG 112 (4.3 g), PGG 92 (3.8 g) and MS 4685 (3.6 g).

9. Protein percentage

The crude protein percentage was maximum for the clone Haritha (9.9) and the minimum for the clone FR 428 (6.1). Haritha was on par with MS 4681, FR 552 (both 9.5) and MS 4675 (9.4).

10. Green fodder yield

The maximum green fodder yield was recorded for the clone MC 14 (27.14 kg) and minimum for the clone MS 4685 (12.64 kg). MC 14 was on par with 16 other clones.

11. Dry fodder yield

Dry fodder yield was maximum for the clone PGG 92 (8.32kg) and minimum for the clone MS 4685 (4.14kg).

Fig. 9 Mean protein percentage of thirty clones of guinea grass

X1. MS 4600	X11. PGG 92	X21. FR 42
X2. MS 4675	X12. PGG 112	X22. FR 426
X3. MS 4681	X13. PGG 123	X23. FR 428
X4. MS 4685	X14. PGG 132	X24. FR 429
X5. MS 4691	X15. PGG 147	X25. FR 443
X6. MS 4732	X16. MC 14	X26. FR 550
X7. MS 4733	X17. MC 16	X27. FR 552
X8. PGG 9	X18. GG2	X28. FR 553
X9. PGG 14	X19. Haritha	X29. FR 559
X10. PGG 26	X20. Mackuenii	X30. FR 600

Fig : 9 MEAN PROTEIN PERCENTAGE OF

THIRTY CLONES OF GUINEA GRASS

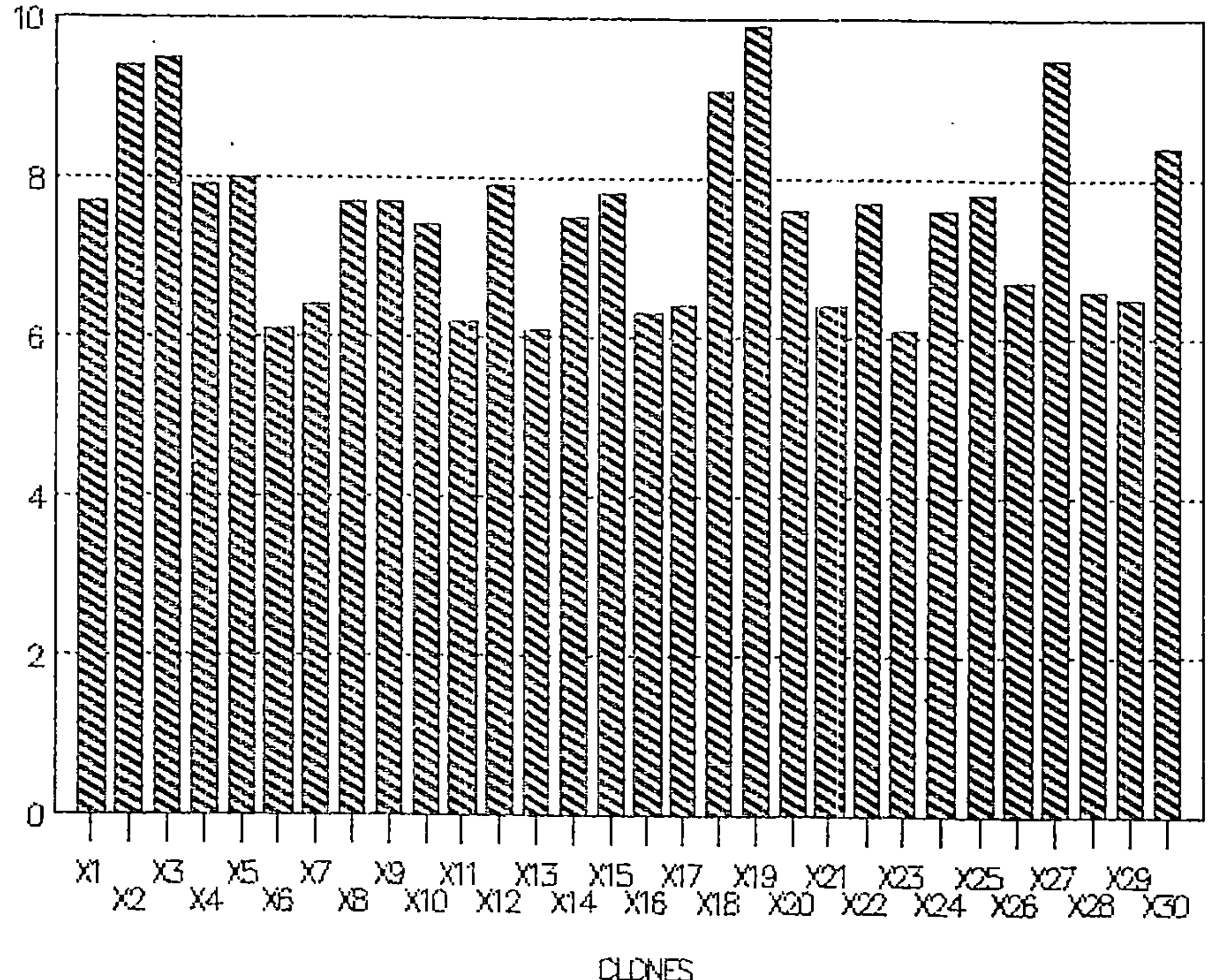


Fig. 10 Mean green fodder yield of thirty clones of guinea grass

X1. MS 4600	X11. PGG 92	X21. FR 42
X2. MS 4675	X12. PGG 112	X22. FR 426
X3. MS 4681	X13. PGG 123	X23. FR 428
X4. MS 4685	X14. PGG 132	X24. FR 429
X5. MS 4691	X15. PGG 147	X25. FR 443
X6. MS 4732	X16. MC 14	X26. FR 550
X7. MS 4733	X17. MC 16	X27. FR 552
X8. PGG 9	X18. GG2	X28. FR 553
X9. PGG 14	X19. Haritha	X29. FR 559
X10. PGG 26	X20. Mackuenii	X30. FR 600

Fig : 10 MEAN GREEN FODDER YIELD OF

THIRTY CLONES OF GUINEA GRASS

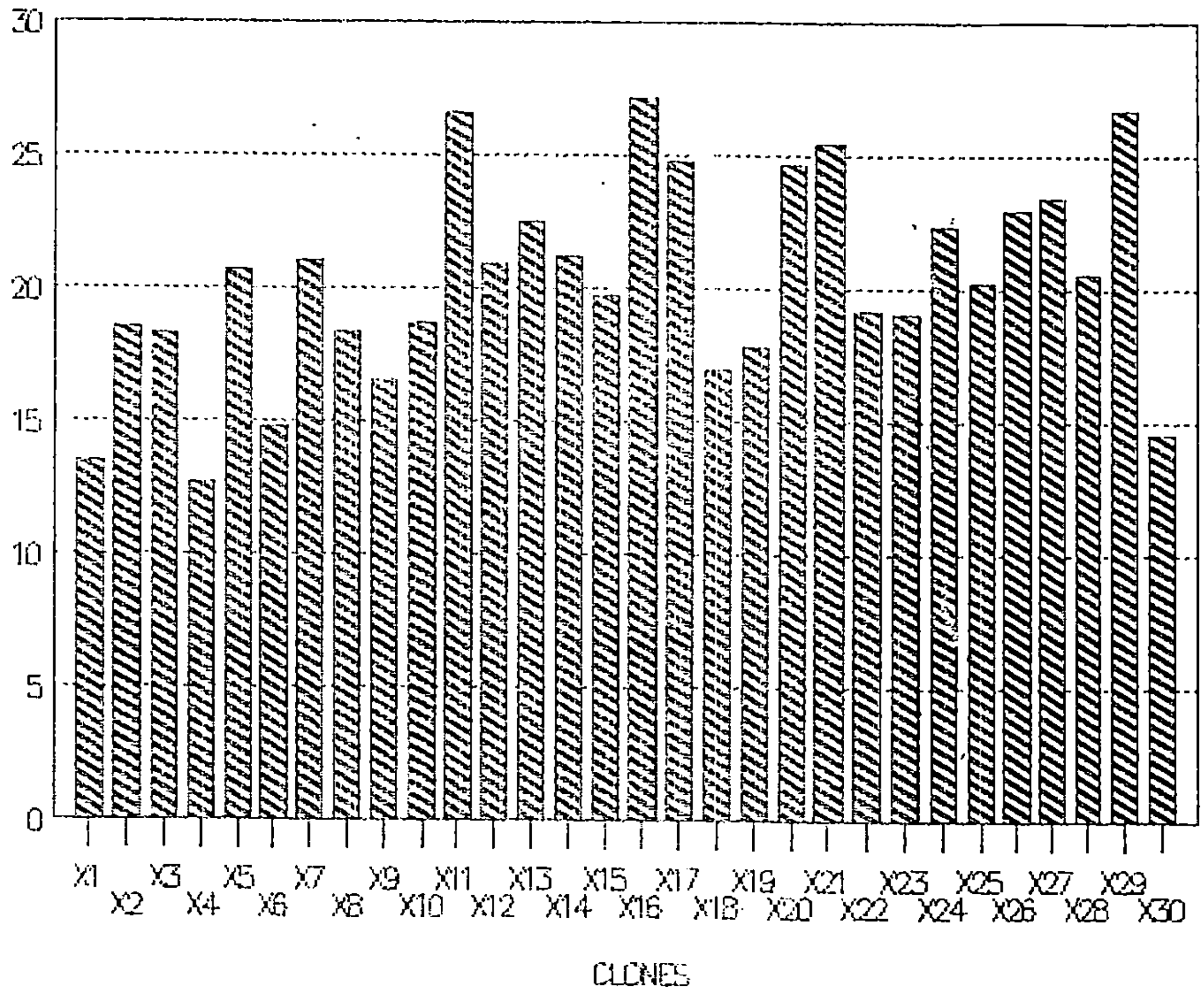
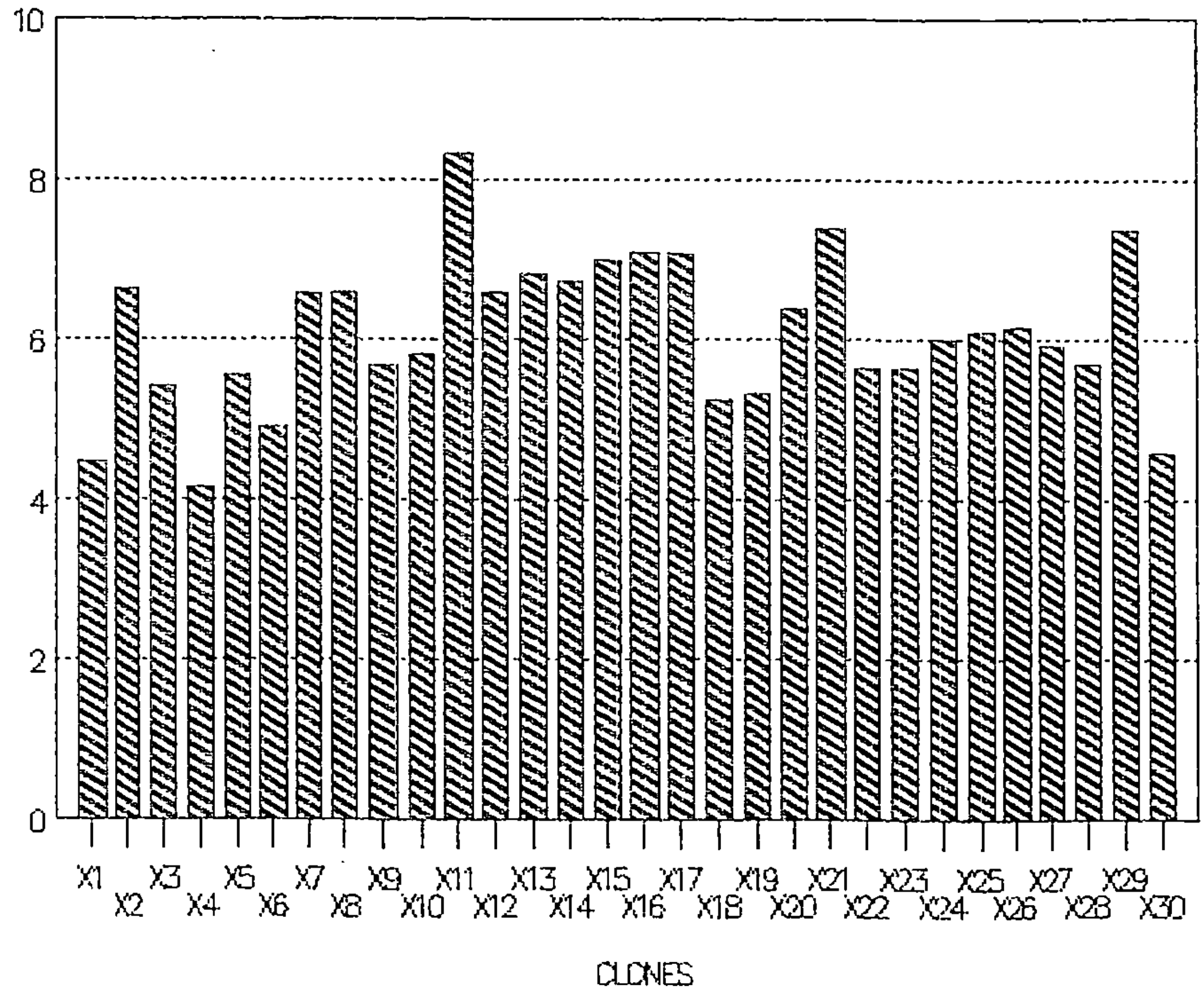


Fig. 11 Mean dry fodder yield of thirty clones of guinea grass

X1. MS 4600	X11. PGG 92	X21. FR 42
X2. MS 4675	X12. PGG 112	X22. FR 426
X3. MS 4681	X13. PGG 123	X23. FR 428
X4. MS 4685	X14. PGG 132	X24. FR 429
X5. MS 4691	X15. PGG 147	X25. FR 443
X6. MS 4732	X16. MC 14	X26. FR 550
X7. MS 4733	X17. MC 16	X27. FR 552
X8. PGG 9	X18. GG2	X28. FR 553
X9. PGG 14	X19. Haritha	X29. FR 559
X10. PGG 26	X20. Mackuenii	X30. FR 600

Fig : 11 MEAN DRY FODDER YIELD OF

THIRTY CLONES OF GUINEA GRASS



II. Variability

The variability was assessed as genotypic and phenotypic variance and genotypic and phenotypic coefficients of variation. The genotypic and phenotypic variances for eleven characters are presented in Table 4. The genotypic and phenotypic coefficients of variation for eleven characters are presented in Table 5 and figure 12.

Number of panicles per hill showed the highest genotypic variance (187.32) followed by leaf length (119.64) and plant height (116.26). Lowest value was recorded for leaf breadth and leaf stem ratio (0.09) followed by dry fodder yield (0.20). The phenotypic variance was also maximum for number of panicles per hill (196.07). Next to the number of panicles per hill the characters, plant height (158.16) and leaf length (124.43) recorded higher values. Lowest phenotypic variance was noticed for the characters leaf breadth and leaf stem ratio (0.10).

The maximum genotypic coefficient of variation was noted for the character number of panicles per hill (89.50) followed by weight of seeds per hill (56.10) and leaf stem ratio (45.22). The minimum values were recorded for the character, dry fodder yield (7.32) followed by plant height (10.57). Number of panicles per hill (91.57) had maximum phenotypic coefficient of variation followed

Table 4

Genotypic and Phenotypic variances for

Eleven characters in Guinea grass

Sl. No.	Characters	Genotypic variance (V_g)	Phenotypic variance (V_p)
1.	Plant height	116.26	158.16
2.	Leaf length	119.64	124.43
3.	Leaf breadth	0.09	0.10
4.	Leaf area index	0.57	0.87
5.	Number of tillers per hill	32.10	38.72
6.	Leaf stem ratio	0.09	0.10
7.	Number of paanicles per hill	187.32	196.07
8.	Weight of seeds per hill	1.38	1.60
9.	Protein percentage	1.24	1.30
10.	Green fodder yield	7.61	22.61
11.	Dry fodder yield	0.20	1.49

Table 5

Genotypic and Phenotypic coefficients of variation

for eleven characters in Guinea grass

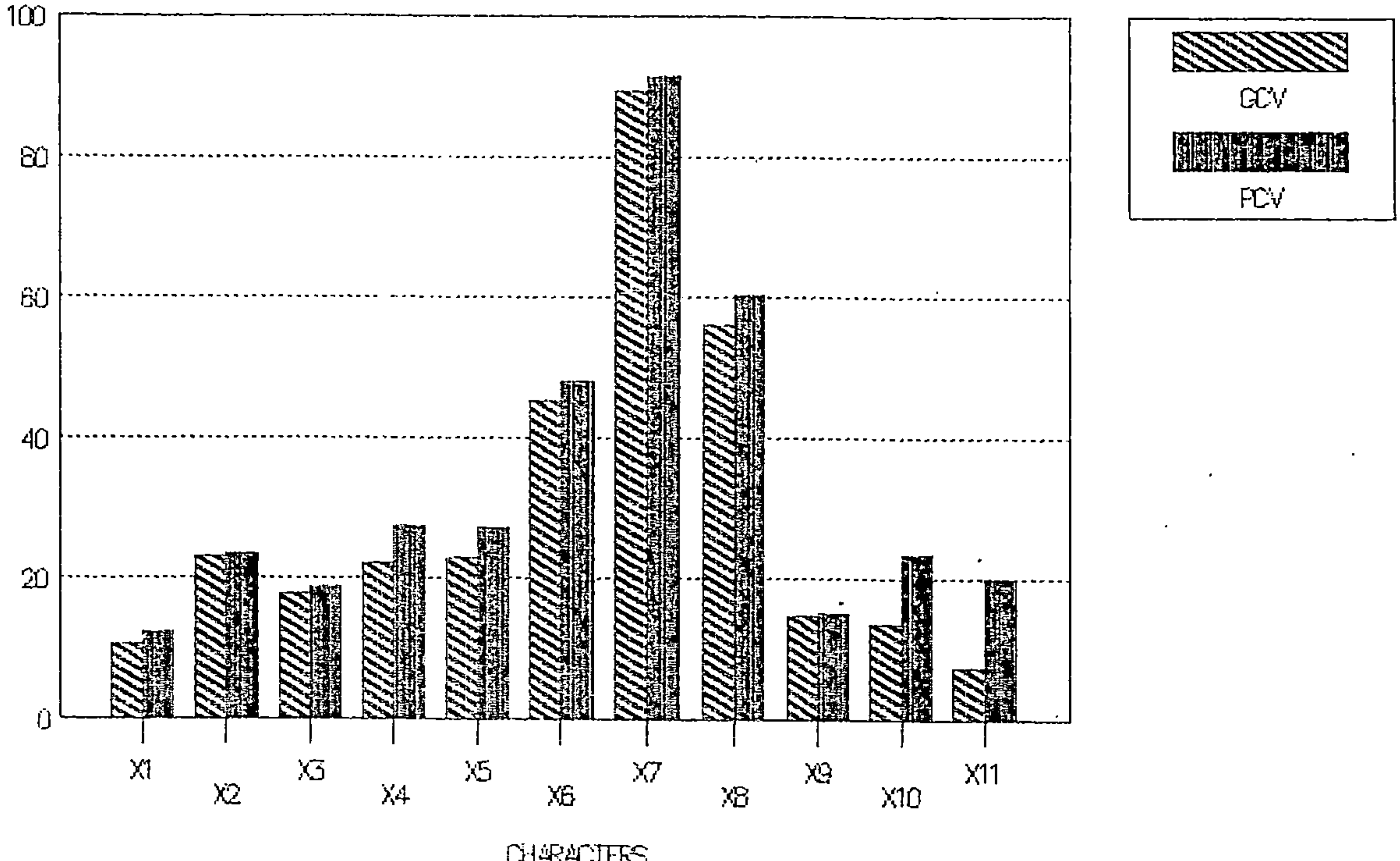
Sl. No.	Characters	Genotypic coefficient of variation (GCV%)	Phenotypic coefficient of variation (PCV%)
1.	Plant height	10.57	12.32
2.	Leaf length	22.99	23.44
3.	Leaf breadth	17.85	18.72
4.	Leaf area index	22.09	27.42
5.	Number of tillers per hill	22.85	27.29
6.	Leaf stem ratio	45.22	48.10
7.	Number of panicles per hill	89.50	91.57
8.	Weight of seeds per hill	56.10	60.42
9.	Protein percentage	14.77	15.14
10.	Green fodder yield	13.58	23.41
11.	Dry fodder yield	7.32	19.99

Fig. 12. GCV and PCV for eleven characters in guinea grass

X1.	Plant height
X2.	Leaf length
X3.	Leaf breadth
X4.	Leaf area index
X5.	Number of tillers per hill
X6.	Leaf stem ratio
X7.	Number of panicles per hill
X8.	Weight of seeds per hill
X9.	Protein percentage
X10.	Green fodder yield
X11	Dry fodder yield

Fig : 12 GCV AND PCV FOR ELEVEN

CHARACTERS IN GUINEA GRASS



by weight of seeds per hill (60.42) and leaf stem ratio (48.10). The minimum estimate of phenotypic coefficient of variation was for the character, plant height (12.32) followed by protein percentage (15.14).

III. Genetic parameters

The estimates of heritability (Broad sense) and genetic advance as percentage of mean for eleven characters in guinea grass are presented in Table 6 and figure 13.

A. Heritability

Generally a high estimates of heritability were recorded for all the characters except green fodder yield and dry fodder yield. The characters viz. leaf length (96.15 per cent), number of panicles per hill (95.54 per cent), protein percentage (95.16 per cent), leaf stem ratio (88.38 per cent), leaf breadth (87.23 per cent), weight of seeds per hill (86.21 per cent) and number of tillers per hill (82.90 per cent) recorded high heritability estimates. The dry fodder yield (20.58 per cent) and green fodder yield (33.63 per cent) recorded low estimates of heritability.

B. Genetic advance

Nuber of panicles per hill (180.22) and weight of seed per hill (107.29) and leaf stem ratio (87.57) showed high values of

Table 6

Heritability (Broad sense) and Genetic advance as percentage of mean for eleven characters in Guinea grass

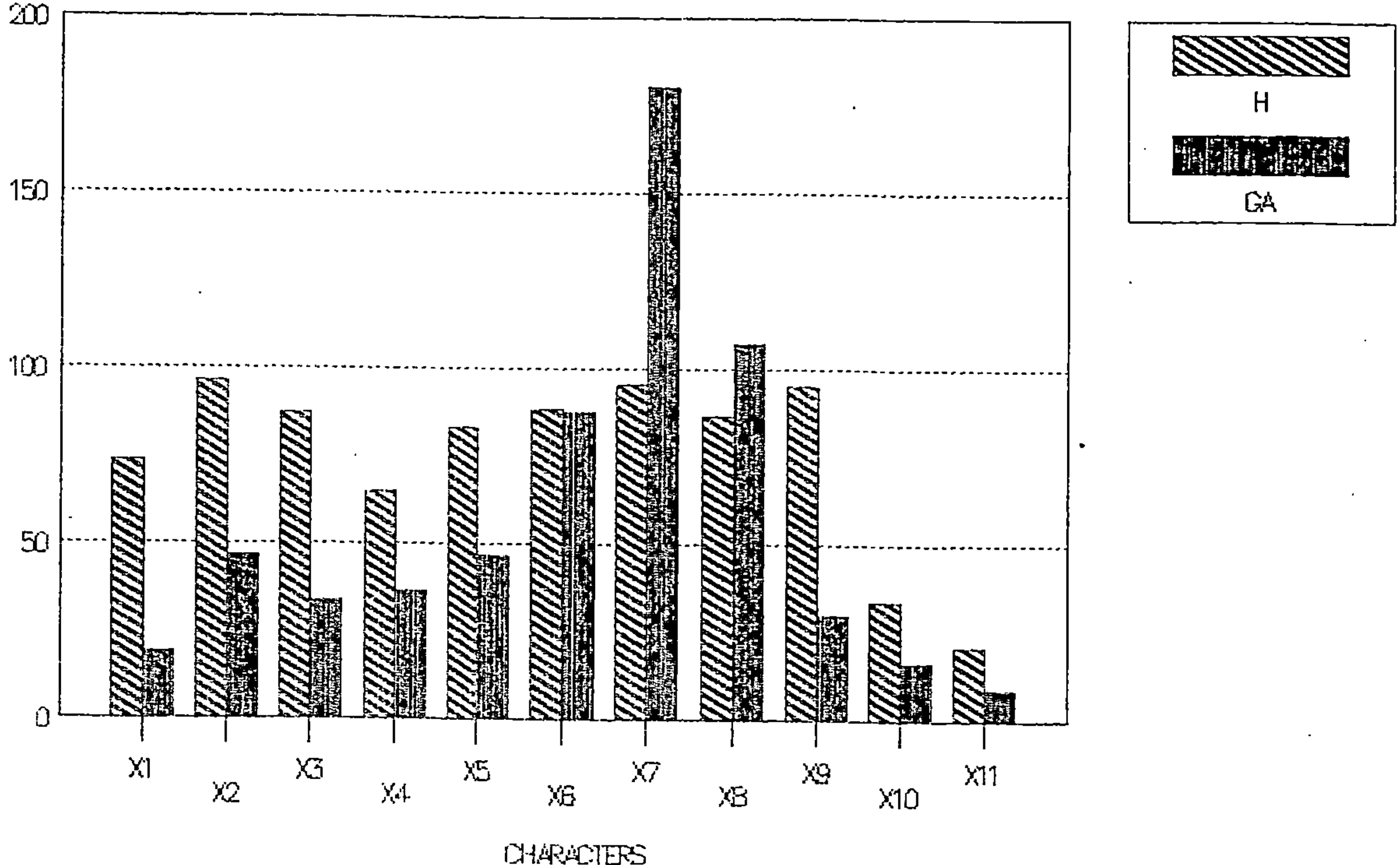
Sl. No.	Characters	Heritability	Genetic advance (percentage of mean)
1.	Plant height	73.51	18.66
2.	Leaf length	96.15	46.44
3.	Leaf breadth	87.23	33.64
4.	Leaf area index	64.86	36.14
5.	Number of tillers per hill	82.90	46.60
6.	Leaf stem ratio	88.38	87.57
7.	Number of panicles per hill	95.54	180.22
8.	Weight of seeds per hill	86.21	107.29
9.	Protein percentage	95.16	29.68
10.	Green fodder yield	33.63	16.22
11.	Dry fodder yield	20.58	8.48

Fig.13. Heritability & GA as percentage of mean for eleven characters

X1.	Plant height
X2.	Leaf length
X3.	Leaf breadth
X4.	Leaf area index
X5.	Number of tillers per hill
X6.	Leaf stem ratio
X7.	Number of panicles per hill
X8.	Weight of seeds per hill
X9.	Protein percentage
X10.	Green fodder yield
X11	Dry fodder yield

Fig:13 HERITABILITY & GA AS PERCENTAGE

OF MEAN FOR ELEVEN CHARACTERS



genetic advance. The other characters recorded an estimate below 50 per cent. The day fodder yield (8.48), green fodder yield (16.22) and plant height (18.66) recorded low estimates of genetic advance.

IV. Correlation studies

Analysis of covariance was done and the genotypic and phenotypic covariance and correlation coefficients were estimated.

Correlation coefficients of green fodder yield with other characters.

The genotypic and phenotypic covariance between green fodder yield and other yield components are presented in Table 7 and figure 14. The phenotypic (r_p) and genotypic (r_g) correlation coefficients between green fodder yield and other yield components are presented Table 8.

The genotypic correlations were negative with the characters viz. number of tillers per hill, number of panicles per hill, weight of seed per hill, and protein percentage. All the other characters showed positive correlation with green fodder yield. Dry fodder yield recorded maximum genotypic correlation with green fodder yield (0.849) followed by leaf length (0.842),

Table 7

Genotypic and Phenotypic covariance between green fodder yield and other yield components

Sl. No.	Characters	Covariance	
		Genotypic	Phenotypic
1.	Plant height	18300.14	34913.38
2.	Leaf length	25404.93	29147.45
3.	Leaf breadth	489.56	553.58
4.	Leaf area index	842.31	2058.21
5.	Number of tillers per hill	-6806.79	-2495.96
6.	Leaf stem ratio	424.65	440.42
7.	Number of panicles per hill	-30295.07	-24771.48
8.	Weight of seeds per hill	-1453.15	-1063.19
9.	Protein percentage	-1833.29	-1757.74
10.	Green fodder yield	1296296.00	5007201.00

Table 8

Phenotypic (r_p) and genotypic (r_g) correlation coefficient between green fodder yield and other yield components

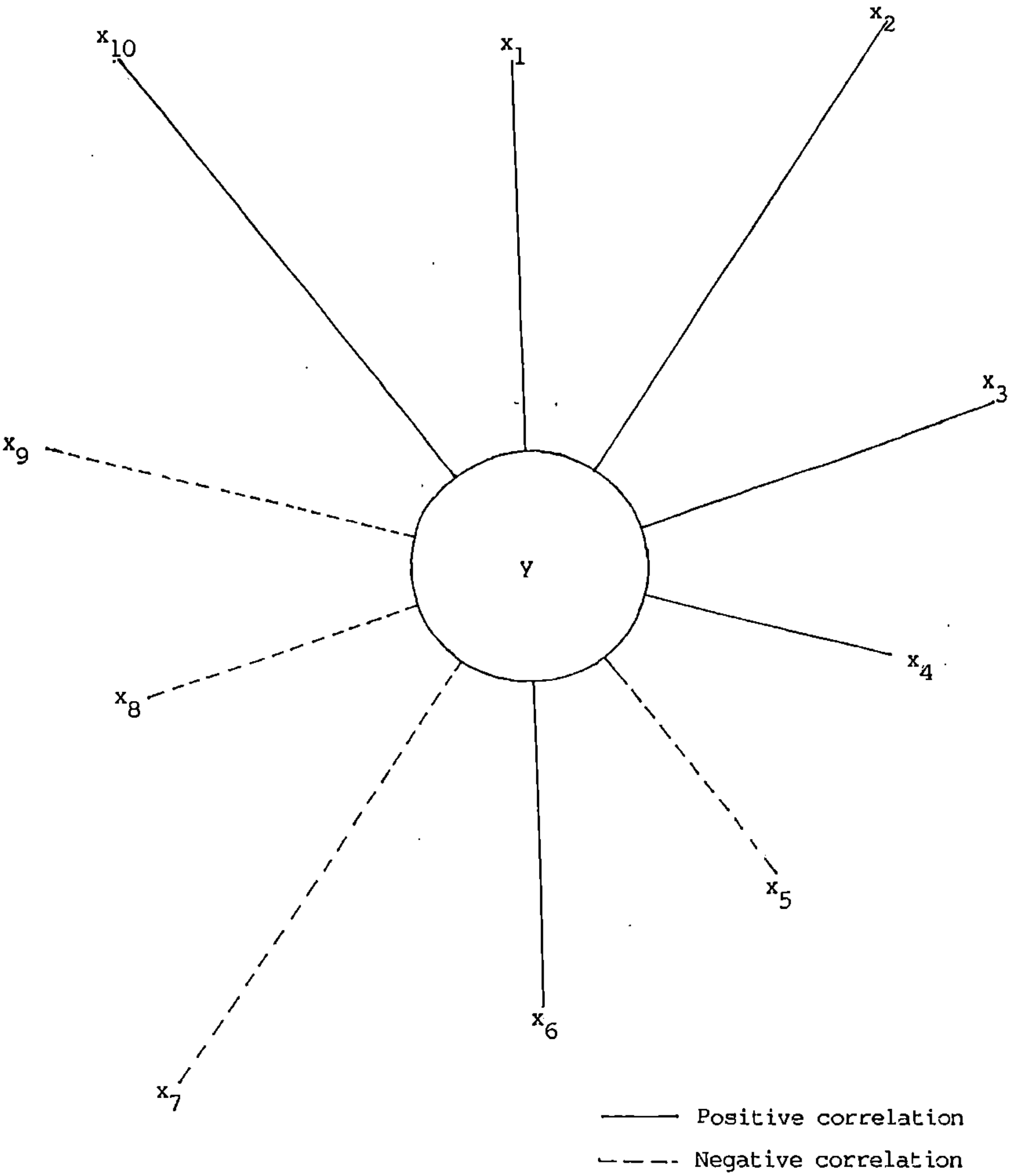
Sl. No.	Characters	Correlation	
		Genotypic	Phenotypic
1.	Plant height	0.615	0.584**
2.	Leaf length	0.842	0.549**
3.	Leaf breadth	0.590	0.261*
4.	Leaf area index	0.405	0.462**
5.	Number of tillers per hill	-0.436	-0.084
6.	Leaf stem ratio	0.512	0.289*
7.	Number of panicles per hill	-0.802	0.372**
8.	Weight of seeds per hill	-0.448	0.177
9.	Protein percentage	-0.598	0.324*
10.	Green fodder yield	0.849	0.862**

** Significant at 1% level of probability
* Significant at 5% level of probability

Fig. 14 Genotypic correlation coefficient between Green fodder yield and other yield components

X1.	Plant height
X2.	Leaf length
X3.	Leaf breadth
X4.	Leaf area index
X5.	Number of tillers per hill
X6.	Leaf stem ratio
X7.	Number of panicles per hill
X8.	Weight of seeds per hill
X9.	Protein percentage
X10.	Green fodder yield
X11	Dry fodder yield

Fig. 14 Genotypic correlation coefficient between Green fodder yield and other yield components



plant height(0.615), the breadth (0.590), leaf sten ratio (0.512) and leaf area index (0.405).

Phenotypic correlations of green fodder yield were positive and significant with characters dry fodder yield (0.862), plant height (0.584), leaf length (0.549), leaf area index (0.462) and number of panicles per hill (0.372), protein percentage (0.324), leaf stem ratio (0.289) and leaf breadth (0.261). The weight of seeds per hill (0.177) recorded positive non-significant correlation and number of tillers per hill recorded negative nonsignificant correlation (-0.084) with green fodder yield.

Correlation among the yield component characters

The genotypic and phenotypic covariance among the yield components are presented in Table 9 and genotypic (r_g) and phenotypic (r_p) correlation coefficients among the yield components are presented in Table 10.

Plant height showed positive and high genotypic correlation with leaf length (0.777) dry fodder yield (0.733) leaf breadth (0.678) and number of panicles per hill (0.643). Whereas leaf stem ratio recorded low positive correlation (0.330). The genotypic correlations of plant height with all the other characters viz.,

Table 9 Genotypic and phenotypic covariance among the yield components

Characters		Leaf length	Leaf breadth	Leaf area index	Number of tillers per hill	Leaf stem ratio	Number of panicle per hill	Weight of seeds per hill	Protein percentage	Dry fodder yield
Plant height	G	91.653	2.197	-0.333	-35.012	1.071	-94.870	-0.051	-4.352	4374.069
	P	96.752	2.314	0.970	-32.339	1.444	-89.614	0.309	-4.059	8663.725
Leaf length	G	-	2.760	1.394	-45.602	1.834	-141.808	-5.309	-2.868	4300.034
	P	-	2.784	1.519	-44.354	1.849	-140.162	-5.299	-2.978	5199.207
Leaf Breadth	G		-	-0.036	-1.567	0.042	-3.405	-0.126	-0.067	89.266
	P		-	-0.059	-1.650	0.042	-3.345	-0.121	-0.068	120.139
Leaf area index	G			-	1.591	0.090	-2.211	-0.384	-0.253	52.022
	P			-	2.016	0.102	-1.992	-0.382	-0.232	218.414
Number of tillers per hill	G				-	-0.352	52.028	0.590	-0.176	-1524.517
	P				-	-0.359	56.033	0.819	-0.073	-989.793
Leaf stem ratio	G					-	-2.905	-0.288	-0.082	4.654
	P					-	-2.876	-0.278	-0.087	1.080
Number of panicles per hill	G						-	10.180	2.414	-3755.009
	P						-	10.851	2.435	-2525.733
Weight of seeds per hill	G							-	0.197	18.522
	P							-	0.212	149.294
Protein percentage	G								-	-456.552
	P								-	-426.65

Table 10 Genotypic (r_g) and phenotypic (r_p) correlation coefficient among the yield components

Characters		Leaf length	Leaf breadth	Leaf area index	Number of tillers per hill	Leaf stem ratio	Number of panicle per hill	Weight of seeds per hill	Protein percentage	Dry fodder yield
Plant height	r_g	0.777	0.678	-0.041	-0.573	0.330	0.643	-0.004	-0.363	0.733
	r_p	0.690**	0.571**	0.083	-0.413**	0.284*	-0.509**	0.019	-0.283*	0.538**
Leaf length	r_g	-	0.839	0.169	-0.736	0.558	-0.947	-0.413	-0.236	0.710
	r_p	-	0.775**	0.146	-0.639**	0.518**	-0.897**	-0.375**	-0.234	0.382**
Leaf breadth	r_g		-	-0.160	-0.920	0.470	-0.827	-0.356	-0.200	0.536
	r_p		-	-0.195	-0.823**	0.406**	-0.742**	-0.296*	-0.184	0.306*
Leaf area index	r_g			-	-0.373	0.399	-0.214	-0.434	-0.302	-0.125
	r_p			-	-0.346**	0.340**	-0.152	-0.322*	-0.218	0.191
Number of tillers per hill	r_g				-	-0.207	0.671	0.089	-0.028	-0.486
	r_p				-	0.180	0.643**	0.104	-0.010	-0.130
Leaf stem ratio	r_g					-	-0.706	-0.814	-0.246	0.028
	r_p					-	-0.642**	-0.685**	-0.238	0.003
Number of panicles per hill	r_g						-	0.633	0.159	-0.496
	r_p						-	0.612**	0.153	-0.148
Weight of seeds per hill	r_g							-	0.151	0.029
	r_p							-	0.147	0.097
Protein percentage	r_g								-	-0.745
	r_p								-	-0.307*

* Significant at 5% level of probability

number of panicles per hill (-0.573), protein percentage (-0.363), leaf area index (-0.041) and weight of seeds per hill (-0.004) were negative.

Plant height recorded significant positive phenotypic correlation with leaf length (0.690), leaf breadth (0.571), dry fodder yield (0.538) and leaf stem ratio (0.284) and non-significant positive correlations with leaf area index (0.083) and weight of seeds per hill (0.019).

Leaf length showed positive high genotypic correlation with leaf breadth (0.839), dry fodder yield (0.710) and leaf stem ratio (0.558) whereas leaf area index recorded low positive correlation (0.169). The genotypic correlations of leaf length with all other characters viz. number of panicles per hill (-0.947), number of tillers per hill (-0.736), weight of seeds per hill (-0.413) and protein percentage (-0.236) were negative.

Leaf length recorded significant positive phenotypic correlation with leaf breadth (0.775), leaf stem ratio (0.518) and dry fodder yield (0.382).

Leaf breadth recorded positive genotypic correlation and significant positive phenotypic correlations with dry fodder yield (0.536, 0.306) and leaf stem ratio (0.470,0.406).

Leaf area index recorded positive genotypic correlations with leaf stem ratio (0.399) and number of tillers per hill (0.373) and negative genotypic correlations with weight of seeds per hill (0.434), protein percentage (-0.302) number of panicles per hill (-0.214) and dry fodder yield (-0.125).

Leaf area index recorded positive significant phenotypic correlations with number of tillers per hill (0.346) and leaf stem ratio (0.340) and negative significant phenotypic correlation with weight of seeds per hill (-0.322).

Number of tillers per hill recorded positive genotypic correlations with number of panicles per hill (0.671) and weight of seeds per hill (0.089) and negative genotypic correlations with dry fodder yield (-0.486) leaf stem ratio (-0.207) and protein percentage (-0.028).

Number of tillers per hill showed significant positive phenotypic correlation with number of panicles per hill (0.643) and non-significant positive phenotypic correlation with weight of seeds per hill (0.104).

Leaf stem ratio showed positive genotypic correlation with dry fodder yield (0.028) and negative genotypic correlations with weight of seeds per hill (-0.814), number of panicles per hill (-0.706) and protein percentage (-0.246).

Leaf stem ratio recorded negative significant phenotypic correlations with weight of seeds per hill (-0.685) and number of panicles per hill (-0.642) and non-significant positive phenotypic correlation with dry fodder yield (0.003). Protein percentage (0.238) recorded a non-significant negative phenotypic correlation with leaf stem ratio.

Number of panicles per hill recorded positive genotypic and phenotypic correlations with weight of seeds per hill (0.633, 0.612) and protein percentage (0.159, 0.153) and negative genotypic and phenotypic correlations with dry fodder yield (-0.496, -0.148).

Weight of seeds per hill recorded positive genotypic and phenotypic correlations with protein percentage (0.151, 0.147) and dry fodder yield (0.029, 0.097).

Protein percentage recorded a negative genotypic and phenotypic correlations with dry fodder yield (-0.745, -0.307).

V. Path coefficient analysis

Path coefficient analysis was done using green fodder yield as effects and characters such as plant height, leaf area index, number of tillers per hill and leaf stem ratio as causal factors.

Direct and indirect effects of four component characters on green fodder yield are presented in Table 11. The path diagram showing the direct effects and genotypic correlations of four component characters on green fodder yield are represented in figure 15.

Direct effect

All the characters except the number of tillers per hill showed positive direct effects on green fodder yield. Leaf area

Table 11 Direct and indirect effect of four component characters on green fodder yield.

Sl. No.	Characters	Direct and Indirect effects				Total correlation
		Plant height	Leaf area index	Number of tillers per hill	Leaf stem ratio	
1.	Plant height	0.378	-0.022	0.228	0.031	0.615
2.	Leaf area index	-0.016	0.532	-0.148	0.037	0.405
3.	Number of tillers per hill	-0.217	0.198	-0.398	-0.019	-0.436
4.	Leaf stem ratio	0.125	0.212	0.082	0.093	0.512

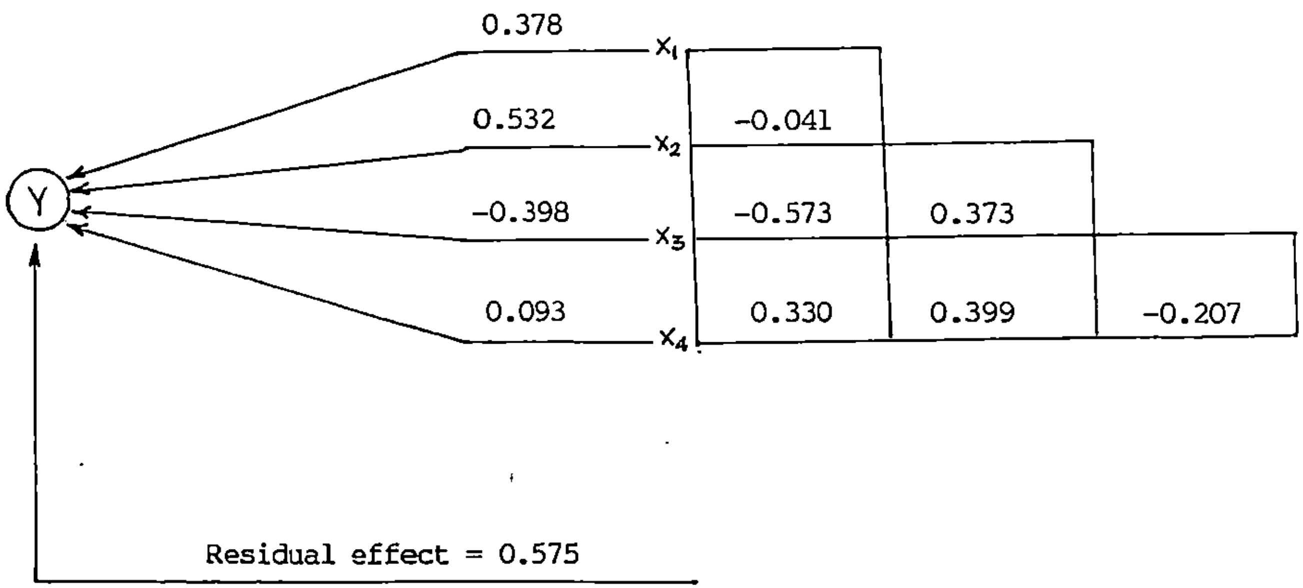
Residual effect = 0.575

Underlined figures are the direct effects

Fig. 15 Path diagram showing direct effect and genotypic correlations in guinea grass

Y	Green fodder yield
X_1	Plant height
X_2	Leaf area index
X_3	Number of tillers/hill
X_4	Leaf stem ratio

Fig. 15 Path diagram showing direct effect and Genotypic correlations in guinea grass



index (0.532) recorded maximum direct effect followed by plant height (0.378) and leaf stem ratio (0.093). Number of tillers per hill (-0.398) showed negative direct effect.

Indirect effect

Plant height exerted maximum positive indirect effect through number of tillers per hill (0.228) followed by leaf stem ratio (0.031) and negative indirect effect (-0.022) through leaf area index.

Leaf area index exerted low positive indirect effect through leaf stem ratio (0.037) and low negative indirect effects through number of tillers per hill (-0.148) and plant height (-0.016).

Number of tillers per hill exerted positive indirect effect on green fodder yield through leaf area index (0.198) and negative indirect effects through plant height (-0.217) and leaf stem ratio (-0.019).

Leaf stem ratio exerted positive indirect effects on green fodder yield through leaf area index (0.212), plant height (0.125) and number of tillers per hill (0.082).

About 42.5% of the variation in green fodder yield was through the direct and indirect influence of the above four component characters considered for path analyis.

VI. Discriminant function analysis

Discriminent function analysis was done for constructing selection indices for green fodder yield and the other variables used are plant height, leaf area index, number of tillers per hill, leaf stem ratio, number of panicles per hill and weight of seeds per hill. The selection criterion on the index values for each individual was determined and the varieties ranked accordingly. Estimates of selection indices and ranking of clones based on green fodder yield and related characters is presented in Table 12. Twenty per cent selection was exercised and the clones FR 42, (10788.3) MC 14 (10446.8), FR 559 (10411.6), Mackuenii (9912.6), FR 550 (9773.5) and MC 16 (9443.4) were identified as superior clones.

Table 12 Estimate of selection indices and ranking of clones based on green fodder yield and six other related characters

Sl. No.	Clones	Selection criterion based on green fodder yield and other characters	Rank
1.	MS 4600	-2696.9	27
2.	MS 4675	-4143.5	30
3.	MS 4681	-2666.2	26
4.	MS 4685	-2219.3	25
5.	MS 4691	8233.9	9
6.	MS 4732	-3351.6	29
7.	MS 4733	-2702.4	28
8.	PGG 9	2754.0	24
9.	PGG 14	3468.2	22
10.	PGG 26	3762.0	21
11.	PGG 92	7419.0	11
12.	PGG 112	4761.6	18
13.	PGG 123	5088.5	16
14.	PGG 132	4355.1	19
15.	PGG 147	3933.1	20
16.	MC 14	10446.8	2
17.	MC 16	9443.4	6
18.	GG 2	3344.0	23
19.	Haritha	6391.6	14
20.	Muckuenii	9912.6	4
21.	FR 42	10788.3	1
22.	FR 426	7924.6	10
23.	FR 428	6464.7	13
24.	FR 429	8458.9	8
25.	FR 443	6619.3	12
26.	FR 550	9773.5	5
27.	FR 552	9385.7	7
28.	FR 553	6169.2	15
29.	FR 559	10411.6	3
30.	FR 600	50.31.5	17

Other related characters used : Plant height, Leaf area index, Number of tillers per hill, Leaf stem ratio, Number of panicles per hill and Weight of seeds per hill.

DISCUSSION

DISCUSSION

The success of any breeding programme depends on the correct choice of suitable breeding method. In general, crop improvement programme depends on altering the genetic make up of the existing varieties. Selection is one of the basic plant breeding method employed to develop superior varieties. For improving the efficiency of selection, informations on the available genetic variability, association of traits, cause-effect relationship and the selection index are necessary. The present study was taken up to assess the extent of variability, association between different characters, to estimate the components having direct and indirect contribution towards fodder yield and to formulate selection index.

1. Variability

Phenotypic variability is the measurable variability which is the result of genetic and environmental effects. The variability present in a population can be partitioned into heritable and non-heritable components. The genetic parameters like heritability and genetic advance estimated can be used as reliable guidelines for selection.

The analysis of variance showed significant differences for all the characters except dry fodder yield indicating the existence of wide differences between the genotypes tested. Similar difference for various characters were reported earlier by Burton *et al.* (1973), Pillai *et al.* (1974), Jose *et al.* (1978), Sreenivasan (1983), Sally (1988) and Thejasse Bhai (1988) and Santhipriya (1991) in guinea grass. High genotypic and phenotypic variances were observed for the characters number of panicles per hill, leaf length and plant height. High genotypic and phenotypic variances observed for number of panicles per hill is contrary to the findings of Thejasse Bhai (1988) in guinea grass. High genotypic variance recorded for plant height is in conformity with the findings of Thejasse Bhai (1988) and Santhipriya (1991) in guinea grass, Kaushik (1987) and Kulkarani and Shinde (1987) in fodder sorghum Gupta and Gupta (1971) in pearl millet, Patnaik (1968) in ragi and Subramaniam (1979) in little millet. High phenotypic variance observed for plant height is in agreement with the result of Swarup and Chaugale (1962a) in sorghum.

The extent of genetic variability of quantitative characters measured in different scales from a population can be compared by estimating genotypic coefficient of variation. High phenotypic and genotypic coefficients of variation observed for the characters number of panicles per hill, weight of seeds per hill and leaf stem ratio indicates the presence of large amount of genetic variability. The rest of the characters showed low phenotypic and genotypic coefficients of variation. High phenotypic and genotypic coefficients of variations observed for number of panicles per hill is in conformity with the findings of Thejasee Bhai (1988) and Santhipriya (1991) in guinea grass and Subramaniam (1979) in little millet. Contrary to the results of this study a low value of phenotypic and genotypic coefficients of variation was reported by Sally (1988) in guinea grass. High phenotypic and genotypic coefficients of variation observed for leaf stem ratio is in agreement with Sreenivasan (1983) and Santhipriya (1991) in guinea grass, Dhanakodi (1980) in ragi and Nair and Gupta (1977) in fodder oats. Sally (1988) and Thejasse Bhai (1988) have reported low phenotypic and genotypic coefficients of variation for leaf stem ratio in guinea grass.

2. Heritability

Burton (1952) suggested that genotypic coefficient of variation along with heritability will give a clear idea about the amount of genetic advance to be expected by selection. Allard (1960) suggested that gain from selection for a particular character depends largely on the heritability of the character. High heritability value indicates highly heritable nature and minimum influence of the environment on the expression of the character. High heritability values were observed for all the characters except green and dry fodder yield. Lower heritability estimates observed for green and dry fodder yield indicate that environment largely influences the expression of these two characters. High heritability observed for leaf length is in conformity with Sood and Ahluwalia (1980) in sorghum and Mohan and Dua (1984) in pearl millet. Low and medium heritability has been reported by Phul et al. (1972) and Rahaman and Roquib (1987) respectively in oats. High heritability observed for number of panicles per hill is in agreement with the result of Sally (1988), Thejasee Bhai (1988) and Santhipriya (1991) in guinea grass. High heritability for protein percentage observed in this study is in conformity with Sally (1988) in guinea grass. However, low heritability reported by Singhania et al. (1977) in Sorghum and medium heritability reported by Machado et al. (1983) in guinea grass were not in agreement with the present findings. High heritability estimates recorded for leaf stem ratio is in consonance with the findings of Thejasee Bhai (1983) and Santhipriya (1991) in guinea grass, Nair and Gupta (1977) and Tyagi et al. (1977) in oats. Contrary to this, Sally (1988) in guinea grass, Singhania et al. (1977) in Sorghum and Singh and Patil (1983) in barley reported low heritability estimates for leaf stem ratio. High heritability recorded for leaf breadth is in conformity with the reports of Sidhu and Mehindiratta (1980) in Sorghum, Mohan and Dua (1980) in Peral millet and Tyagi et al. (1977) in oats. However, Sally (1988) in guinea grass and Tyagi et al. (1980) in pearl millet reported low heritability for leaf breadth contrary to the results of this study. High heritability for number of tillers per hill is in agreement with the findings of Joharar and Paroda (1976), Mathur and Patil (1982) in Sorghum, Sangha and Singh (1973) and Kunjir and Patil (1986) in pearl millet and Singh and Prasad (1974) in Pennisetum pedicellatum. Contrary to this low heritability for number of tillers per hill was reported by Patnaik (1968) and medium heritability by Sally (1988) in guinea grass and Kempanna and Thirumalachar (1968) and Patnaik and Jana (1973) in ragi. High heritability observed for plant height is in consonance with the results of Machado et al. (1988) and Santhipriya (1991) in guinea grass, Rana et al. (1976) and Mathur and Patil (1982) in Sorghum, Gupta and Gupta (1971) and Mohan and Dua (1984) in Pearl millet, Phul et al. (1972) and Choubey and Gupta (1986) in Oats, Patnaik (1968) and Mahudeswaran and Murugesan (1973) in ragi, Sethi and Singh (1978) and Singh and Patil (1983) in barley, but contrary to the result of Sally (1988) and Thejasee Bhai (1988) in guinea greass, Patnik and Jana (1973) and Appadurai et al. (1977) in ragi. High heritability observed for leaf area index is contrary to the findings of Thejasee Bhai (1988) in guinea grass.

3. Genetic Advance

Johnson et al. (1955) suggested that along with the heritability estimate the genetic advance should also be considered for identifying characters during selection programme. High genetic advance was observed for the characters number of panicles per hill, weight of seeds per hill, leaf stem ratio, number of tillers per hill, leaf length, leaf area index and leaf breadth. High genetic advance recorded for number of panicles per hill and leaf stem ratio are in conformity with the results of Sally (1988) and Shanthipriya (1991) in guinea grass. Contrary to this, Thejasee Bhai (1988) in guinea grass, Nair and Gupta (1977) in oats and Singh and Patil (1983) in barley reported low genetic advance for leaf stem ratio. The present findings of high genetic advance for number of tillers per hill are in agreement with those of Kunjir and Patil (1986) and Sangha and Singh (1973) in pearl millet, Phul et al. (1972) in oats and Yadav et al. (1976) in Pasture grass. However, Sally (1988) in guine grass and Patnaik and Jana (1973) in ragi reported low genetic advance for number of tillers per hill. High genetic advance for leafarea index obtained is contrary to the results of Thejasee Bhai (1988) in guine grass. High genetic advance observed in this study for leaf breadth is contrary to the findings of Sally (1988) in guine grass and Tyagi et al. (1980) in pearl millet. High heritability estimates along with high genetic advance observed for number of panicles per hill, weight of seeds per hill, leaf stem ratio, number of tillers per hill, leaf length, leaf area index and leaf breadth indicates the presence of additive gene action as suggested by Panse (1957). Therefore the characters having high heritability and genetic advance may be considered during selection programmes for the improvement of fodder yield. The characters such as leaf stem ratio, number of tillers per hill, leaf area index, leaf length and leaf breadth which had high estimate of genotypic coefficient of variation, heritability and genetic advance may be considered during selection programmes for the improvement of fodder yield in guinea grass.

4. Correlation

Correlation provides information on the nature and extent of relationship between characters. The component characters also show inter-correlations. So when the breeder applies selection pressure for a trait, the population under selection is not only improved for that trait, but also improved in respect of other characters associated with it. This facilitates simultaneous improvement of two or more characters. Therefore, analysis of yield in terms of genotypic and phenotypic correlation coefficient of component characters leads to the understanding of characters that can form the basis of selection. The genotypic correlations provide a relaible measure of genetic association between the characters and help to differentiate the vital association useful in breeding from non-vital ones (Falconer, 1981). The genotypic and phenotypic correlation coefficient of green fodder yield and ten other characters and their inter-correlations were computed.

Correlation coefficients of green fodder yield with other characters

Green fodder yield recorded high positive genotypic correlations with dry fodder yield, leaf length, plant height, leaf breadth, leaf stem ratio and leaf area index and high negative genotypic correlations with number of panicles per hill, protein percentage, weight of seed per hill and number of tillers per hill. High positive genotypic correlations of green fodder yield with plant height, leaf area index, leaf stem ratio and dry fodder yield and high negative genotypic correlation with protein percentage and number of tillers per hill were in conformity with the findings of Sreenivasan (1983) in guinea grass. High positive genotypic correlation of green fodder yield with leaf area index observed in our study is in agreement with the findings of Thejasee Bhai (1988) in guinea grass. Positive genotypic correlation between green fodder yield and number of tillers per hill reported by Thejasee Bhai (1988) in guinea grass is contrary to the present findings. High positive genotypic correlations observed for green fodder yield with plant height, leaf length and leaf breadth were in consonance with the result obtained by Paroda *et al.* (1975) in sorghum. High positive genotypic correlation of green fodder yield with plant height and leaf breadth was also reported by Yadav *et al.* (1974) in *Cenchrus ciliaris*.

Green fodder yield recorded significant positive phenotypic correlation with all the components except weight of seeds per hill and negative non-significant correlation with number of tillers per hill. Significant positive phenotypic correlation of green fodder yield with dry fodder yield observed in this study is in conformity with the result obtained by Sreenivasan (1983) and Thejasee Bhai (1988) in guinea grass and Tyagi et al. (1980) in Pearl millet. However, Clyde and Hill (1983) in timothy grass, and Riley and Vogel (1983) in Andropogon halli reported negative phenotypic correlation of green fodder yield with dry fodder yield ... Significant positive phenotypic correlation of green fodder yield with plant height is in consonance with the findings of Sreenivasan (1983) in guinea grass, Hussain and Khan (1973), Paroda et al. (1975) and Vasudeva Rao and Ahluwalia (1977) in sorghum, Sethi and Singh (1978) and Singh and Patil (1983) in barley, Achutha Kumar (1982), Paramathma and Balasubramanian (1986) and Patel and Shelke (1988) in maize and Solanki (1977) and Choubey and Gupta (1986) in oats. C ... Sood (1975) reported a negative phenotypic correlation of green fodder yield with plant height in Sorghum. Positive significant phenotypic correlation of green fodder yield with leaf length observed in our study is in agreement with the results obtained by Paroda et al. (1975) and Sidhu and Mahindiratta (1980) in Sorghum, AchuthaKumar (1982) in maize, Dhanakodi (1980) and Dhanakodi and Chandrasekharan (1989) in ragi and Choubey and Gupta (1986) in forage oats. Significant and positive phenotypic correlation of green fodder yield with leaf area index recorded in this study is in accordance with the result obtained by Sreenivasan (1983) and Thejasee Bhai (1988) in guinea grass. Significant positive phenotypic correlation observed between green fodder yield and number of panicle per hill is contrary to the observations of Sally (1988) and Thejasee Bhai (1988) in guinea grass who have reported negative non-significant correlation between these two characters. Significant positive phenotypic correlation of green fodder yield with protein percentage observed is contrary to the reports of Sreenivasan (1983) and Sally (1988) in guinea grass.

Significant positive phenotypic correlation of green fodder yield with leaf stem ratio recorded is in conformity with the result obtained by Sreenivasan (1983) in guinea grass and Vasudeva Rao and Ahluwalia (1977) in sorghum. Contrary to this, Sally (1988) in guinea grass, Vaidyanathan (1982) in sorghum, Dhanakodi and Chandrasekharan (1989) in ragi and Jatasra and Thakral (1986) in Cenchrus ciliaris reported negative correlation between these two characters. The positive significant correlation of green fodder yield with leaf breadth observed in the present study is in agreement with the results of Paroda et al. (1975), Sidhu and Mehindiratta(1980) in sorghum, AchuthaKumar (1982) and Paramathma and Balasubramanian (1986) in maize, Dhanakodi (1980) and Dhanakodi and Chandrasekharan (1989) in ragi, Solanki (1977) in oats and Yadav et al. (1974) in Cenchrus ciliaris.

The phenotypic correlation between green fodder yield and number of tillers per hill was negative and non-significant. This is in consonance with the findings of Sreenivasan (1983) in guinea grass and Dhanakodi and Chandrasekharan (1989) in ragi. Contrary to our finding Thejasee Bhai (1988) in guinea grass, Hussain and Khan (1973) in Sorghum, Sethi and Singh (1978) in barley, Sangha and Singh (1973) in bajra, Solanki (1977) and Murtaza et al. (1979) in oats and Gupta et al. (1974) in marval grass reported significant positive correlations of these two characters.

High positive genotypic correlations and significant positive phenotypic correlation of green fodder yield with dry fodder yield, plant height, leaf length and leaf area index indicates that selection based on any one of the above characters may also result in the improvement of fodder yield in guinea grass.

Correlation among yield component characters

Correlation among the yield components will help to gather more information about the association among components of yield. Plant height recorded positive genotypic correlation with leaf length,leaf breadth, leaf stem ratio, number of panicles per hill and dry fodder yield and negative genotypic correlation with leaf area index, number of tillers per hill, weight of seed per hill and protein percentage. The phenotypic correlation of plant height was significant and positive with leaf length, leaf breadth, leaf stem ratio and dry fodder yield. Whereas, it was significant but negative with number of tillers per hill, number of panicles per hill and protein percentage. Significant positive phenotypic correlation of plant height with leaf length observed in this study is in agreement with the results obtained by Tyagi et al. (1980) in pearl millet. Significant positive phenotypic correlation of plant height and leaf breadth recorded in the present study is contrary to the findings of Sally (1988) who has reported a non-significant positive phenotypic correlation. Significant positive phenotypic correlation recorded for plant height with leaf stem ratio is in agreement with the findings of Sreenivasan (1983) in guinea grass. Contrary results were reported by Sally (1988) and Thejasee Bhai (1988) in guinea grass and Dhanakodi (1980) in ragi. Plant height recorded significant positive phenotypic correlation with dry fodder yield. Similar results were reported by Sewi et al. (1988) and Sally (1988) in guinea grass, Paroda et al. (1975) and Vasudeva Rao and Ahluwalia (1977) in sorghum, Mahudesewaran and Murugesan (1973) and Appadurai et al. (1977) in ragi and Solanki (1977) in oats. Contrary to this, Thejasee Bhai (1988) in guinea grass reported a non-significant positive phenotypic correlation of these two characters.

Significant negative phenotypic correlation between plant height and number of tillers per hill observed in the present study is in consonance with Cill and Randhawa. (1975) in foxtail millet and Murtaza et al. (1979) in oats. Sreenivasan (1988) in guinea grass and Phul et al. (1974) in pearl millet reported significant positive correlation of plant height with number of tillers per hill which is contrary to the present findings. Significant negative correlation of plant height with number of tillers indicate that as height increases the number tillers will be reduced. Significant negative phenotypic correlation observed for plant height with number of panicles per hill is contrary to the results of Thejasee Bhai (1988) and Sally (1988) in guinea grass. This negative correlation indicate that shorter varieties have more number of panicles. Significant negative phenotypic correlation reported between plant height and protein percentage is in agreement with the results of Sreenivasan (1983) in guinea grass. However, Sally (1988) in guinea grass reported non-significant negative correlation.

Leaf length recorded positive genotypic corelations with leaf breadth, leaf area index, leaf stem ratio and dry fodder yield and negative genotypic correlations with number of tillers per hill, number of panicles per hill, weight of seeds per hill and protein percentage. The phenotypic correlation of leaf length was significant and positive with leaf breadth, leaf stem ratio, and dry fodder yield but negative with number of tillers per hill, number of panicles per hill and weight of seeds per hill. Leaf breadth recorded positive genotypic correlations with leaf stem ratio, and dry fodder yield while leaf area index, number of tillers per hill, number of panicles per hill, weight of seeds per hill and protein percentage recorded negative correlations. Significant positive phenotypic correlation of leaf breadth with leaf stem ratio observed in this study is contrary to the result obtained by Sally (1988) in guinea grass who has reported a non-significant negative correlation. Significant positive phenotypic correlation of leaf breadth with dry fodder yield is in conformity with the results obtained by Paroda et al. (1975) in sorghum and Solanki (1977) in oats. Contrary to the present finding, Sally (1988) in guinea grass reported a positive non-significant phenotypic correlation. Phenotypic correlation of leaf breadth with number of tillers per hill, number of panicles per hill and weight of seed per hill were significant but negative. Non-significant positive phenotypic correlation of leaf breadth with number of tillers per hill reported by Sally (1988) in guinea grass and significant positive phenotypic correlation reported by Tyagi et al. (1980) in pearl millet are contrary to the present findings.

The genotypic correlaions of leaf area index with number of tillers per hill and leaf stem ratio were positive whereas it was a negative with number of panicles per hill, weight of seeds per hill,protein percentage and dry fodder yield. Significant positive phenotypic correlation of leaf area index with number of tillers per hill is in consonance with the results of Thejasee Bhai (1988) in guinea grass. But Sreenivasan (1983) in guinea grass reported a non-significant negative phenotypic correlation between these two characters contrary to the present finding. Significant positive phenotypic correlation of leaf area index with leaf stem ratio is in conformity with the the result obtained by Sreenivasan (1983) and Thejasee Bhai (1988) in guinea grass. Phenotypic correlation between leaf area index and weight of seeds per hill was negative but significant. Genotypic correlations of number of tillers per hill with number of panicles per hill and weight of seeds per hill were positive, whereas it was negative with leaf stem ratio, protein percentage and dry fodder yield. Number of tillers per hill recorded significant positive phenotypic correlations with number of panicles per hill in agreement to the results of Subramaniam (1979) in little millet. Contrary to this Sally (1988) in guinea grass observed a non-significant negative correlation.

Leaf stem ratio recorded positive genotypic correlation with dry fodder yield while negative correlations were noticed with number of panicles per hill, weight of seeds per hill and protein percentage. The phenotypic correlations of leaf stem ratio with number of panicles per hill and weight of seeds per hill were negative but signifiant. Significant positive phenotypic correlation of leaf stem ratio with number of panicles per hill is in agreement with the results of Thejasee Bhai (1988) in guinea grass. Contrary to this, Sally (1988) in guinea grass observed a positive non-significant phenotypic correlation.

Genotypic correlations of panicles per hill was positive with weight of seeds per hill and protein percentage and negative with dry fodder yield. The number of panicles per hill recorded significant positive phenotypic correlation with weight of seeds per hill and non-significant positive correlation with protein percentage. Number of panicles per hill recorded negative phenotype correlations with dry fodder yield.

Genotypic correlation of protein percentage with dry fodder yield was negative. The phenotypic correlation of protein percentage was significant but negative with dry fodder yield. This is in agreement with Sreenivasan (1983) in guinea grass. Contrary to this, Sally (1988) in guinea grass reported positive non-significant phenotypic correlation of protein percentage with dry fodder yield. Negative correlations between protein percentage and dry fodder yield indicates that simultaneous improvement of yield and quality in difficult by selection. Correlation studies indicates that selection based on plant height, leaf length and breadth and leaf area index will be effective in the improvement of green and dry fodder yield in guines grass.

5. Path Analysis

The green fodder yield is influenced by the different components both directly and indirectly. The path analysis (Wright, 1921) is very effective in seperating the correlation coefficient into direct and indirect effects. Hence it gives information on the components having direct and indirect contribution towards yield.

The path analysis was done using plant height, leaf area index, number of tillers and leaf stem ratio as causes and the green fodder yield as the effect. Leaf area index, plant height and leaf stem ratio showed positive direct effect on green fodder yield, while number of tillers per hill showed negative direct effect. Leaf area index recorded maximum positive direct effect on green fodder yield followed by plant height. Leaf stem ratio had low but positive direct effect.

The leaf area index had the maximum direct effect on green fodder yield. But the correlation between leaf area index and green fodder yield was less than its direct effect. This was due to negative indirect effects exerted through plant height and number tillers per hill. Contrary to the findings of this study, Thejasee Bhai (1988) reported negative direct effect of leaf area index on green fodder yield.

Plant height is the second component having maximum positive direct effect on green fodder yield. The correlation between plant height and green fodder yield was higher than its direct effect. This was due to the positive indirect effect exerted through the number of tillers per hill and leaf stem ratio. The correlation explains the true relationship between plant height and green fodder yield and a direct selection based on plant height will improve the green fodder yield as suggested by Singh and Choudhary (1979). Positive direct effect of plant height on green fodder yield observed in our study is in agreement with the findings of Sreenivasan (1983) and Thejasee Bhai (1988) in guinea grass, Naphade (1972) and Patel et al. (1973) in sorghum, Dhumale and Mishra (1978) and Murtaza et al. (1979) in oats. But contrary to the present findings Paroda et al. (1975) in sorghum reported a negative direct effect of plant height on green fodder yield.

Leaf stem ratio recorded low but positive direct effect on green fodder yield. But its correlation was high. This was due to positive indirect effects exerted through all the three characters viz. Plant height, leaf area index and number of tillers per hill. The positive direct effect of leaf stem ratio on green fodder yield obtained in this study is in conformity with the result obtained by Thejasee Bhai (1988) in guinea grass.

The negative direct effect of number of tillers per hill observed on green fodder yield is in consonance with the results of Singh et al. (1980) in fodder oats. Contrary to our finding Sreenivasan (1983) and Thejasee Bhai (1988) in guinea grass, Solanki (1977) in fodder oats, Tyagi et al. (1980) in pearl millet, Ramaswamy (1974) and Gopalan and Ramaswamy (1979) in Cenhrus ciliaris reported positive direct effect of number of tillers on green fodder yield. Based on the results of variable correlations and path analysis it can be recommended that selection based on plant height, leaf area index and leaf stem ratio will be effective for the improvement of green fodder yield in guinea grass.

6. Discriminatnt function analysis

The discriminant function analysis was first developed by Fisher (1936), and later applied for making selection on several characters simultaneously by Smith (1936). According to Hazel (1943) selection based on suitable selection index is more efficient than selection based on individual characters. In this study, selection index was constructed using green fodder yield and other variables such as plant height, leaf area index, number of tillers per hill, leaf stem ratio, number of panicles per hill and weight of seeds per hill. Economic weight given for all the characters was unity. Earlier, Santhiprya (1991) also constructed selection index for increasing the efficiency of selection in guinea grass. Based on the index constructed, twenty per cent selection was exercised and top ranking six superior guinea grass clones viz. FR 42, MC 14, FR 559, Mackuenii, FR 550 and MC 16 were identified and recommended for future use in breeding programme.

SUMMARY

SUMMARY

Thirty guinea grass clones were evaluated in a field experiment laid out in an RBD with two replications at the Instructional Farm, College of Agriculture, Vellayani during 1990. Observations on plant height, leaf length, leaf breadth, leaf area index, number of tillers per hill, leaf stem ratio, number of panicles per hill, weight of seeds per hill, protein percentage, green fodder yield and dry fodder yield were recorded from three harvests at 45 days interval. The data collected were subjected to analysis of variance, covariance and the genetic parameters like heritability, genetic advance and correlations (genotypic and phenotypic) were estimated. The path coefficient analysis was done using green fodder yield as the effect and four other component character viz. plant height, leaf area index, number of tillers per hill and leaf stem ratio as causes. Discriminant function analysis was done to formulate selection index to identify superior clones.

The analysis of variance revealed significant difference with respect to all the characters except dry fodder yield indicating the existence of wide difference between the clones tested. High phenotypic and genotypic variances were observed for the number of panicles per hill, leaf length and plant height. The characters such as leaf breadth, leaf area index and leaf stem ratio recorded low

Phenotypic and genotypic variances. High phenotypic and genotypic coefficients of variation observed for the number of panicles per hill, weight of seeds per hill and leaf stem ratio indicate the presence of large amount of variability and the scope of utilising such variability by means of selection.

High heritability estimate recorded for the leaf length, number panicles per hill, protein percentage, leaf stem ratio, leaf breadth, weight of seeds per hill, number of tillers per hill, plant height and leaf area index indicates the highly heritable nature and minimum influence of the environment on the expression of these charactersl Lower heritability estimates recorded for green and dry fodder indicates that environment largely influences the expression of fodder yield. High heritability along with high genetic advance observed for number of panicles per hill, weight of seeds per hill, leaf stem ratio, number of tillers per hill, leaf length, leaf area index and leaf breadth indicates the presence of additive gene action and the reliability of these characters during selection programme. Among the characters having high heritability estimates, the economically imortant characters such as leaf stem ratio, number of tillers per hill, leaf area index, leaf length and leaf breadth may be considered during selection programmes for the improvement of fodder yield in guinea grass.

Green fodder yield recorded high positive genotypic correlations with dry fodder yield, leaf length, plant height, leaf breadth, leaf stem ratio and leaf area index and high negative genotypic correlations with number of panicles per hill, protein percenage and weight of seeds per hill. Green fodder yield recorded significant positive phenotypic correlation with dry fodder yield, plant height, leaf length, leaf area index, number of panicles per hill, protein percentage, leaf stem ratio and leaf breadth and positive non-significant phenotypic correlation with number of tillers per hill. The yield components showed varying degrees of association among themselves. High positive genotypic correlation and significant positive phenotypic correlations of green fodder yield with dry fodder yield, plant height, leaf length and leaf area index indicates that selection based on any one of the above characters may result in the improvement of fodder yield.

Leaf area index had the maximum positive direct effect on green fodder yield followed by plant height and leaf stem ratio. Number of tillers per hill showed negative direct effect. Based on the result of variablity, correlation and path analysis it can be concluded that selection based on plant height, leaf area index and leaf stem ratio will be effective for the improvement of fodder yield in guinea grass.

A selection index was formulated using green fodder yield and other variables like plant height, leaf area index, number of tillers per hill, leaf stem ratio, number of panicles per hill and weight of seeds per hill. Twenty per cent selection was done and six top ranking clones, viz. FR 42, MC 14, FR 559, Mackuenii, FR 550 and MC 16 were identified for future breeding programme.

REFERENCES

REFERENCES

Achuthakumar, R. (1982). Studies on genitic variability of quantitatve characters contributing to forage yield in maize. Thesis Abstracts, 8:120

Agalodia, A.V., Deasai, K.B. and Tikka, S.B.S. (1979). Analysis of the parameters of variability and inter relationship of yield attributes in finger miller. Indian J. Agric. Sci., 49:924-928.

Allard, R.W (1960). Principales of Plant Breeding. John Wiley and Sons, Inc., New York, 89-98 and 428-429.

Annoymous (1989) Package of practices Recommendations. Directors of Extension Education, Kerala Agricultural University, Vellanikkara. pp. 236-237.

Appadurai, R., Thangam, M.S., Ravindran, T.S. and Natarajan, V.S. (1977). Gennotypic association, heritability and path analysis in ragi (Elensine coracana Gaerth). Madras Agric. J., 64:18-21.

Aranjo, M.R.A.DE., Columan, B.E., Faris, M.S. and Wrobel, C. (1983). Genetic variation and corrrelation of agronomic traits in tall fascue (Festuca arundinecea Schreb) germ plasm. Can. J. Plant sci., 63:453-460.

Arora, S.K., Luthray, P. and Das, B. (1975). Variability in Sorghym. Sorghum Newsletter, 18:30-35.

Asay, K.H. and Hansen, W.T. (1984). Propspects for genetic improvement in the Quack grass x Blue bunch wheat grass hybrid. Crop Sci., 24:743-745.

Bahl, A., Rao, S.K. and singh, C.B. (1988). Association analysis of fodder yield and it's components in different environments in oats. Crop Improvement, 15:132-137.

Bainiwal, C.R., Kanwasra, R.R., Solanki, K.R. and Jatasra, D.S. (1983). Correlation and path coefficient analysis for forage attributes in barley under spaced and drill sowing conditions. Forage Res., 9:21-24.

Booman, J.G. (1978). Herbage quality in Rhodes grass (Chloris gayana Kunth). 2. Intra variety variation in yield and digestability in plants of similar heading date. Netherlands J. Agric. Sci., 26:337-343.

*Bugge, G. (1984). Herbtability estimates for forage yield, ear emergence and quality characteristics of the dry matter in Lolium multiflorum Lam. Zeitschrift Fur Pflanzenzuchtung, 92:321-327.

*Burton, G.W. (1952). Quantiative inheritance in grasses. Proc. 6th Int. Grassld. Congr., 1:277-283.

Burton, G.W., Millot, J.C. and Monson, W.G. (1973). Breeeding procedures for Panicum maximum Jacq. suggested by plant variability and mode of reproduction. Crop Sci., 6:717-720.

Chauhan, B.P.S. and Singh, S.P. (1975). Correlation of different morphological characters with fodder and grain yield in sorghum. Agra Univ. J. Res. (Sci.)., 24:87-92.

Choubey, R.N. and Gupta, S.K. (1986). Correlation and Path analysis in forage oats. Indian J. Agric. Sci., 56:674-677.

Cill, A.S. and Randhawa, A.S. (1975). Hertable variation and inter relationship in fox-tail millet (Seteria italica (L) P. Beauv.). Madras Agric. J., 62:253-258.

Clyde, C.B. and Hill, R.R. (1983). Quantitative inheritance and correlation among forage yield and quality in timothy. Crop Sci., 23:380-384.

Dhanakodi, C.V. (1980). Studies on genetic divergence in ragi (Eleusine coracana (L) Gaertn.) for yield of fodder. M.Sc. (Ag.) thesis, Tamil Nadu Agricultural University, Coimbatore.

Dhanakodi, C.V. and Chandrasekharan, P.V. (1989). Path analysis in Ragi (Eleusine coracana Gaertu.) for yield of fodder. Madras Agri. J., 76:355-357.

Dhumale, D.B. and Mishra, N. (1978). Charater association between forage yield and its component in oats. Indian J. Agri. Sci., 49:918-924.

Falconer, D.S. (1981). Introduction to quantitative genetics, Longman, New York. pp-340.

Fisher, R.H. (1936) The use of multiple measurement in taxonomic problems. Ann. Ungen., 7:179-188.

*Fujimato, F. and Susuki, S. (1975). Studies on variation and selection in Italian rye grass. Jap. J. Breed., 25:323-333.

Girija, R. and Nataraja Rathanam, N. (1989). Green matter and dry matter accumulation trends in forage sorghum cultivars. Madras Agric. J., 76:261-265.

Gopalan, A., and Balasubramanian, M. (1978). Character association studies in fodder sorghum. Madras Agric. J., 65:284-286.

Gopalan, A., and Ramaswamy, K.R., (1979). Correlation and Path coefficient analysis in Cenchrus ciliaris L. Madras Agric. J., 66:146-153

Goud, J.V. and Lakshmi, P.V. (1977). Morphological and genetic variabilities for quantitative characters in ragi (Elensine coracana Gaertn.). Mysore J. Agric. Sci., 11:438-443.

Gupta B.S.; Kalla, J.C. and Rao, J.S. (1974). Statistical evaluation of forage yield of marval grass under arid conditions of Rajastan. Indian J. Agric. Sci., 44:833-837.

Gupta V.P. and Athwal, D.S (1966). Genetic variability correlation and selection indices for green fodder characters in pearl millet J. Res., Punjab Agricultural University. Ludhiana , 3:379-384.

Gupta, V.P. and Gupta, S.P. (1971). Genetic variability, parent offspring correlations and heritability of some green fodder characters in pearl millet. Indian J. Genet., 31:342-344.

Gupta, V.P. and Nanda, G.S. (1971) Component analysis of green fodder yield in bajra. Indian J. Genet., 31:140-142.

Hacker, J.B. and Bray, R.A. (1981). Genetic analysis of Pasture grass, setaria sphacelata. I. Dry matter yield and flowering. Australian J. Agric. Res., 32:295-309.

Hazel, L.N. (1943). The genetic basis of constructing selection Indexes. Genetics, 28:476-490.

*Hussain M.K. and Khan M.A. (1973). Correlation studies in sorghum Sudan grass hybrid forage SABRAO Narsl., 5:51-53.

Jackson, M.L. (1967). Soil chemical analysis. Parentice Hall of India Pvt. Ltd., New Delhi. 1-498.

Jain J.P. (1982). Statistical techniques in quantitative genetics. Tata Mc Graw. Hill. Co., New Delhi. pp-281.

Jatasra, D.S. and Thakral, N.K. (1986) Components of forage productivity in buffel grass. Forage Res., 12:59-62.

Jhorar, B.S. and Paroda, R.S. (1976). Correlation and Path coefficient analysis in forage sorghum. Forage Res., 2:151-157.

Johnson, H.W.; Robinson, H.F. and Com Stock, K.L. (1955). Estimation of genetic and environmental variability in soy bean. Agron. J., 43:314-318.

Jones R.J.; Nelson C.J. Sleeper, D.A. (1979) seedling selection for morphological characters associated with forage yield of tall fescue. Crop Sci., 19:631-634.

Jose, A., Usberti, Jr. and Jain S.K. (1978). Variation in Panicum maximum. A comparison of sexual and Asexual population. Bot. Gaz., 139:112-116.

Kaushik, V.S. (1987). Variability and Path coefficient studies in forage sorghum (Sorghum biocolor L.) Moench. In relation to stem borer resistance. Thesis abstracts, 13:222.

*Kauzuba, J., Pronczuk, S. and M. Puzio-Idzkowska (1981). The heritability characters in timothy (Phleum Pratense). Binletyn Instytuta Hodowli i. Aklimatyzayl Roslin., 143:191-198.

Kempanna, C, and Thirumalachar, D.K. (1968). Studies on phenotypic and genotypic variations in ragi (Elensine coracana). Mysore J. Genet., 30:424-430.

Kempanna, C., Vijayamma, R. and Setty, M.V.N. (1971). The impact of genotypic and environment interaction on the determination of the components of variation and other genetic parameters in Elensine coracana. Mysore J. Agric. Sci., 5:295-301.

*Kondo, T., Nakajimak, Sawai and Ara, S. (1984). Variation in the chemical components of Panicum maximum. Bulletin of the National Grass Land Research Institute, 29:49-54.

Kulkarani, N. and Shinde, V.K. (1987). Genetic analysis of yield components in rabi sorghum. J. Maharashtra Agric. Univ., 12:378-379.

Kunjir, A.N. and Patil, R.B. (1986). Variability and correlation studies in pearl millet. J. Maharashtra Agric. Univ., 11:273-275.

Lodhi, G.P., Paroda, R.S. and Hetram, (1977). Hybrids Vs varieties in forage sorghum. Indian J. Genet., 37:207-214.

*Machado, H., Rodic, R., Thamayo, A. and Segvi, E. (1988). Selection of sexual plants and possibility of cross breeding Panicum maximum in cuba. Past or Y Forsajes. 11:31-36.

*Maggiore, T., Gentinetta, E., Motto, M., Perenzin, Salamini, F. and Lorenzoni. C. (1980). Variability for protein and fibre content in three maize diallels for forage production. Annali dell Instituto Superimetale Per la Corealicoltuna, 11:184.

Mahudeswaran, K., and Murugesan, M. (1973). Correlation and Path analysis in Eleusine coracana. Madras Agric. J., 60:1287-1291.

Mangath, K.S. (1986). correlation of some characters contributing fodder yield in pearl millet (Pennisetum typhoides). Indian Agriculturist, 30:143-146.

Manoharan, V. (1978). An appraisal fo genetic diversity in prosomillet (Panicum miliaceum L). M.Sc. (Ag.) Thesis, Tamil Nadu Agricultural University, Coimbatore.

Mathur, P.D. and Patil, B.D. (1982). Genetic variability, correlation and path coefficient analysis in forage sorghum. Indian J. Agric. Res., 16:269-272.

Mehra, K.L., Bhagmal, Sreenath, P.R., Magoon, M.L. and Katiyar, D.S. (1971). Factor analysis of fodder yield componetns in oats. Euphytica, 20:597-601.

Mishra, H.P, Patnaik, M.C., and Nayak, B.K. (1978). Variation in quantitiative traits in finger millet. Indian J. Agric. Sci., 50:298-301.

Mohan, N. and Dua, R.P. (1984). Genetic variability for forage yield and its quality under single and double cut system in pearl millet. Indian J. Agric Res., 18:68-72.

Murtaza., Tyagi, I.D. Dixit, R.K. and Singh, H.G. (1979). Components of fodder yield in oats (Avena sativa L.). Forage Res., 5:179-182.

Nagarajan, K. and Prasad, M.N. (1980). Studies on variability correlation and path analysis in Fox tail millet Setaria italica). Madras Agric. J., 67:220-227.

Nair, P.S. and Gupta Y.K. (1976) path coefficient analysis of the first order and second order components of fodder yield in oats (Avena sativa L.). Agric Res. J. Kerala, 14:138-144.

Nair P.S. and Gupta, Y.K. (1977). Analysis of genetic parameters on dry matter yield and its components in fodder oats. Aagric Res. J. Kerala, 15:128-132.

Naphade, D.S., (1972). Correlation and path analysis for some characters contributing to fodder yield in sorghum. Indian J. Agric. Sci., 42:790-791.

Narasimha Rao, D.V. and Pardhasaradhi, A.V. (1968). Studies on genetic variability in ragi. II. Phenotypic, genotypic and environmental correlations between important characters and their implications in selection. Madras Agric. J., 55:397-400.

Nelson, C.J., Asaiy, K.H. and Sleper, D.A. (1977). Mechanism of canopy development of Tall fescue. Crop Sci., 17:449-452

Panse, V.G. (1957). Genetics of quantitative characters in relation to plant breeding. Indian J. Genet., 17:318-328.

Paramathma, M. and Balasubramanian, M. (1986). Correlation and path coefficient analysis in forage maize. Madras Agric. J., 73:6-10.

Paroda, R.S., Dangi, O.P. and Grewa, R.P.S. (1975). Correlation and path analysis in forage sorghum. Indian J. Genet., 35:83-89.

Patel, K.C., Dabholkar, A.R., Felang, S.W. and Baghel, S.S (1973). Components of fodder yield in Sorghum bicolor (L.) Moench. Indian J. Agric. Sci., 43:602-604.

Patel, M.P. and Shelke, D.K. (1988). Correlation studies in forage maize. Journal of Maharashtra Agrl. Univ., 13:218-129.

Patil, B.D. and Singh, A. (1990). Forage crops and grasses. Hand Book of Agriculture, ICAR, New Delhi 1128-1129.

Patnaik, H.B. and Jana, M. (1973). Genetic variability in Eleusine coracana Gaertu. Madras Agric. J., 60:1283-1286.

Patnaik, M.C. (1968). Variation and correlation in Finger millet. Indian J. Genet., 28:225-229.

Phul, P.S., Gupta S.K. and Gill, K.C. (1974). Association analysis of some morphological and physiological traits in pearl millet. Indian J. Genet., 34:346-351.

Phul, P.S., Mehudiratta, P.D. and Manmohan Singh (1972). Quantitative variability in fodder oats (Avena sativa L.) Indian J. Agric. Sci., 42:562-564.

Pillai, G.R., Kuriakose, T.F. and Sadanandan, N. (1974). Studies on isolation of superior clones in guinaa grass. (Panicum maximum). Agric. Res. J. Kerala, 12:7-10.

Pillai, G.R. and Nair G.G.K (1989) strategy for forage production and improvement in Kerala by 2000 A.D. National symposium on forage production and improvement by 2000 A.D., College of Agri. Vellayani.

Prakash, O. (1983). Variability studies for forage traits in some of the strains of Pennisetum typhoides. Thesis abstracts, 9:311.

Rahaman, R. and Roquib, M.A (1987). Genetic variability in fodder oats Avena sativa. Environment and Ecology, 5:747-750.

Ramaswamy, K.R. (1974). Studies in the genus Cenchrus L. M.Sc. (Ag.) Thesis, Tamil Nadu Agricultural University, Coimbatore.

Rana, V.K.S., Daljit Singh and Ahluwalia, M. (1976). Phenotypic variability and character association forage sorghum. Forage Res., 2:63-69.

Riley, R.D. and Vogel, K.P. (1983). Heritability of mature plant traits in sand blue stem. Agron. Abstrs., 78:308.

Rohewal, S.S., Singh, D. and Singh, S.P. (1964). Correlation of some characters contributing to fodder yield in sorghum. Indian J. Genet., 24:272-274.

*Ross, W.M.; Gorz, J.J. Haskins, F.A. and Kofid, K.D. (1979). Combining ability in Forage sorghum hybrids. Mydica., 24:83-93.

Sainy, M.L. and Paroda, R.S. (1975). Genetics of forage characters in Eu-sorghum. Forage Res., 1:75-80.

*Salach, W.K. and Goral, S. (1979). Heritability on yield components in timothy (Phelum pratense) Hodowla Roslin. Aklimatyzooja i Nasiennietwo., 23:259-268.

Sally, V.J. (1988). Genetic analysis of open pollinated seed progeny Guinea grass (Panium maximum Jacq) clones. M.Sc. (Ag.) Thesis. Kerala Agricultural University.

Sangha, A.S. and Singh, B.V. (1973). Genetic variability and correlation studies of morphological characters in (Pennisetum typhoides Stapf. & Hubb. Madras Agric. J., 60: 1258 - 1265.

Sankaran, S. and Kalippa, R.(1974). Relationship betweem grain and straw yield with measurable morphological characters in pearl millet. Madras Agric. J.,61:359-364.

SanthiPriya, G. 1991. Genetic evaluation of M_2V_1 Guinea grass Panicum maximum (Jacq). Clones under partially shaded condition. M.Sc. (Ag) Thesis, Kerala Agricultural University.

Saxena, M.B.L.; Subha Rao, G.V. and Verma, R.C. (1978). Path analysis in Panicum miliaceum. Indian J. Genet., 39:237-239.

*Schitea, M. (1983). Study of the chief characters of cultivars of Italian rye grass using the method of correlations. Probleme de Genetica Teorelica si Aplicata., 15:263-275.

Res., 4:53-59.

*Sewi, E.; Tomer, A. and Machado. H. (1988). Effect of environmental factors on veriability and selction in a population of (Panicum maximum Jacq.). Partos J. Forrages., 11:221-234.

Sidak, V; Segni, E. and Perez, C. (1977). Variability in Panicum maximum. Jacq. and some results of the selection proceedings of 13th international grass land congress - sectional papers 1-2:300-315.

Sidhu, B.S. and Mehindiratta, P.D. (1980). The genetic analysis of forage yield components in sorghum. crop improvement. 7:38-42.

Simpson, J.E.; Adair, C.R.; Kochler, G.O.; Dabald, H.A.; Kestev, F.R. and Hlide, J.T. (1965). Quality evaluation studies of foreign and domestic rices. Tech. Bull. 1331 service; USDA; 1-186

Sindagi, S.S.; Swamp, V. and Singh, D. (1970). Variation and heritability of some quantitative characters in F_2 progenies of inter varietal crosses of sorghum. Indian J. Genet., 30:660-664.

Singh, A.P. and Prasad, B. (1974). Genetic and Phynotipic variability in yield and other quantative characters in Pennisetum pedicellatum. Trin. Proc. Bihar Acad. Agric. Sci., 22+23:84-88.

Singh, M.P. (1982). Studies on genetic variability in quantitative characters contributing to forage yield in Jowar (Abstract) Thesis Abstracts, 8:11-12.

Singh, R.K. and choudhary, B.D. (1979). Biometrical methods in Quantitative genetic Analysis. Kalyani Publications, NewDelhi. pp 39-79.

Singh, S.P.; Yadav, B.S.; Takur, G.S. and Narasinghani, V.G. (1980). Note on correlation and path analysis studies in fodder oats. Indian J. Agric. Sci., 50:973-975.

Singh S.S. and Patil , B.D. (1983). Genetic variability and correlation studies in forage barely. Indian J. Agric. Res., 17:37-41

Singh U. and Singh, D. (1974). Application of discriminant function Techniques for improving the fodder yield in sorghum. Indian J. Agric. Sci., 44:127-129.

Singhania, D.L., Retnalikav, V.P.; Gupta, S.C. and Singh, V. (1977). Genetic analysis of forage yield and quality in sorghum. Indian J. Genet., 37:235-240.

Sleper, D.A; Nelson, C.J. and Asay, K.H. (1977). diallel and path coefficient analysis of tall fescue - Regrowth under controlled condition. Can. J. Genet. Cytol., 19:537-564.

Smith, F.H. (1936). A discriminant function for plant selections. Ann. Engen., 7:240-50.

Solanki, K.R. (1977). Improvement of oats for yield and quality. Indian J. Genet., 37:230-233.

Sood, B.C. (1975). A study of Genetic variability in forage sorghum. M.Sc. Thesis. IARI. New Delhi.

Sood, B.C. and Ahluwalia, M. (1980). Phenotypic and genotypic variability in forage sorghum. Forage Res., 6:226-230.

*Sotomayor-Rios, A.; Acosta - Matoenzo, A. and Velez-Fortuno, J. (1972). Yield comparison and plant character correlation in sixteen Panicum accessions. J. Agric. Univ. Puerto Rico., 55:174-183.

Sreenivasan, E. (1983). Correlation and path coefficient analysis in guinea grass (Panicum maximum Jacq). M.Sc. (Ag.) Thesis Kerala Agricultural University.

Subramaniam, E. (1979). Biometrical studies on variability, correlation path analysis and genetic divergenice in little millet (Panicum miliare Lam.) M.Sc. (Ag.) Thesis, Tamil Nadu Agricultural University, Coimbatore.

Surprenaul, J. and Michand, R. (1988). Genetic variability in the physical properties and other quality traits of timothy. Can. J. Plant Sci., 68:713-726.

Swarup, v. and Chaugale, D.S. (1962 a). Studies on genetic variability in sorghum 1. Phenotypic variation and its heritable component in some important quantitative characters contributing towards yield. Indian J. Genet., 22:31-35.

Swarup, V. and Chaugale, D.S (1962 b). Studies on genetic variability in sorghum II. correlation of some important quantitative characters contributing towards yield and application of some selection indices for varietal selction. Indian J. Genet., 22:37-44.

Tan, W.K.; Tan, G.Y. and Walton, P.D. (1979). Genotypic Environmental interactions in smooth brome grass. II morphological cnaracters and their association with Forage yield. Can. J. Genet. Cytol., 21:73-80.

Tan, W.K.; Tan, G.Y. and Walton, P.D. (1979). Genotypic Environmental interactions in smooth brome grass. II morphological characters and their association with Forage yield. Can. J. Genet. Cytol;, 21:73-80.

TerinderKumar. (1982). Studies on genetic variability of quantitative charactrs contributing to forage yield in bajra (Pennisetum Typhoides). Thesis Abstracts, 8:125.

Thejasee Bhai, V. (1988). Production potential of guines grass clones under partial shade in coconut gardens. M.Sc. (Ag.) Thesis. Kerala Agricultural University.

*Titov, A.F.; Drozdov, S.N. and Olimpienko, G.S. (1978). Study of correlation between economically usefull and morphological characters in Festuca pratense. Sel' skokhozuaistvennaya Bidogiya, 13:579-582.

Tyagi, I.D.; Dixit, R.K.; Murthy, A. and Singh, H.G. (1977). Note on genetic variability in fodder oats. Indian J. Agric Sci., 50:645-649.

Tyagi, I.D., Singh M., Dixit, R.K. (1980) component analysis for green fodder yield in pearl millet. Indian J. Agric. Sci., 50:645-649.

Vaidyanathan, P. (1973). An analysis of natural and induced variation in respect of atributes related to fodder production in blue panic grass (Panic antidotale RETZ.). M.Sc. (Ag.) thesis Tamil Nadu

Vaidyanathan, P. (1982). Combining ability and character associaiton studies for atributes related to fodder production in sorghum (Sorghum bicolor (L) Moencb.). PhD. Thesis Tamil Nadu Agricultural University, Coimbatore.

Vaithialingam, R. (1979). Genetic analysis of fodder yield components in sorghum, PhD. Thesis Tamil Nadu Agricultural University, Coimbatore.

Vasudeva Rao, M.J. and Ahluwalia, M. (1977). Genetic analysis of fodder yield and quality in sorghum (Sorghum bicolor). Sorghum Newsl., 20:9-10.

*Vogel, K.P. (1983). Evaluation of brome grass introduction for forage yield and quality. Research bulletin No.300. Agriculture experimental station, University of Nehraska.

Vogel, K.P.; Gorz, H.J. and Haskins, f.A. (1981). Heritability estimates for height, colour erectness, leafiness and vigour in Indian grass. Crop Sci., 21:734-736.

Wai-Koon, Geok-Young Tan. and Walter, P.D. (1977). Canopy characters and their relationship to spring productivity in Bromus incermis. Crop Sci., 17:7-10.

*Wakankar, S.M., Yadav, L.N. and Sharma, R.V. (1970). Studies on heritability, correlation and discriminant function selection in sorghum. Ind. J. Sci. Ind., 4:107-114.

William, R.F. (1946). The physiology of plant grown with special reference to the concept of net assimilation vale. Ann. Bot., 10:41-42.

Wright, S. (1921). Correlation and causation. J. Agric. Res., 20:557-585.

Yadav, M.S.; Mehra, K.L. and Magoon, M.L. (1974). Genetic variability and correlations of a few quantitative characters in the pasture grass, cenchrus ciliaris. Ind. for., 100:512-517.

Yadav, M.S.; Mehra, K.L. and Magoon, M.L. (1976). Heritability and correlation among fodder yield componants in pasture grass, Dichanthium annulatum. Ind for., 102:64-68.

Yadav, A. and Srivastava, D.P. (1976). Genotypic and phenotypic variability in Panicum miliare Lam. Mysore J. Agric. Sci., 10:185-189.

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GENETIC VARIABILITY IN GUINEA GRASS
(*Panicum maximum* Jacq.)

BY

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ABSTRACT OF A THESIS

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ABSTRACT

Thirty guinea grass clones were evaluated in a field experiment laid out in an RBD with two replications at the Instructional Farm, College of Agriculture, Vellayani during 1990. Data on nine biometric characters and fodder yield were collected and subjected to analysis of variance and co-variance. Genetic parameters like heritability, genetic advance and correlations were estimated. The path analysis was done to assess the cause-effect relationship and discriminant function analysis was done to formulate selection index for identifying superior clones.

The analysis of variance revealed significant difference with respect to all the characters except dry fodder yield. High genotypic and phenotypic variances were observed for number of panicles per hill, leaf length, and plant height. High phenotypic and genotypic coefficients of variation were observed for number of panicles per hill, weight of seeds per hill and leaf-stem ratio indicating the presence of large amount of genetic variability.

High heritability estimates were recorded for the leaf length, number of panicles per hill, protein percentage, leaf-stem ratio, leaf breadth, weight of seeds per hill, number of tillers per hill, plant height and leaf area index. High heritability along with

high genetic advance observed for number of panicles per hill, weight of seeds per hill, leaf-stem ratio number of tillers per hill, lenght, leaf area index and leaf breadth indicates additive gene action and the reliability of these characters during selection.

High positive genotypic correlation and significant positive phenotypic correlations of green fodder yield with dry fodder yield, plant height, leaf length and leaf area index indicate that selection based on any one of these characters will result in the improvement of green fodder yield. The yield components showed varying degrees of association among themselves. Correlation studies indicate that selection based on plant height, leaf length and leaf breadth will be effective in the improvement of fodder yield.

Path analysis revealed that leaf area index had the maximum direct effect on green fodder yield followed by plant height and leaf-stem ratio. Number of tillers per hill exerted negative direct effect on green fodder yield.

Based on the results of variability, correlation and path analysis it can be concluded that selection based on plant height, leaf area index and leaf-stem ratio will be effective for the improvement of fodder yield in guinea grass.

A selection index was constructed and by practicing twenty per cent selection, six top ranking clones viz. FR 42, MC 14, FR 559, Mackuenii, FR 550 and MC 16 were identified for use in future breeding programmes.