trait and Giriraj (1981) observed expression of heterosis for this trait.

The parental mean values for 1000 grain weight ranged from 12.430 to 27.820 g (296A) for lines and 15.670 to 37.455g (IL 101)in respect of testers. The mean of the hybrids ranged from 16.090 to 38.840g (3050 A X IL 103). The maximum relative heterosis was observed in the hybrid A2A X IL 105 (Table 1).

The parental mean performance for grain yield ranged form 14.82 to 71.76 g for lines and 32.72 to 98.63 g for tester. 2077A among the lines and Co 25 among the testers had high mean grain yield. The mean of the hybrids ranged from 23.75 to 124.79g.The hybrid 2077A X Co 26 recorded the highest grain yield. Significant and positive relative heterosis was observed in forty two hybrids, the increase ranged from 12.38 to 121.58 per cent and the maximum was recorded by the hybrid TNAU us 1A X IL 105 (Table 1).Jebaraj *et al.*, (1988) recorded upto 163 per cent heterosis and the present study proves it.

The cross combination 2077A X Co 26, 296A X IL 105, 3002A X Co 25 and TNAU ms 1A X IL 105 were indetified as the best hybrids for grain yield on the basis of *per se* performance with high heterotic expression.

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GENETIC VARIABILITY IN NAPIER GRASS, *Pennisetum purpureum*

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ABSTRACT

Studies were made to estimate the available genetic variability for 12 characters of forage value on a germplasm collection of 53 genotypes of napier grass. High level of variability was observed for all the characters excepting leaf length. Higher estimates of GCV and heritability showed that the characters were highly heritable with scope of improvement through selection. Green fodder yield was significantly and positively correlated with plant height, leaves per tiller, leaf weight, stem weight, dry matter and crude protein yield. A number of high yielding genotypes was indentified for use in interspecific hybridisation with *bajra*

Napier grass (*Pennisetum purpureum* is a vigorous, tall growing and profusely tillering, perennial grass. It is highly productive and gives a high biomass in an unit time and spece. It has an adequate amount of protein wall balanced with calcium and phosphorus (Narayanan and Dabadghao, 1972). It is, however, less preferred as a forage crop as it has some undesirable quality attributes such as high oxalic acid content . (an anti-nutritional factor causing injury to the health of the animals) hard and fibrous stem, coarse leaf sheath and leaf blade along with serrated leaf

Table 1. Variability parameters in Napier grass

Characters	Mean	S.E	Range	GCV	h^2	G.A (% of mean)	Co-efficient of correlation between GFY and others
Green fodder yield (g)	94.59	3.72	18.00 - 258.00	45.51	96.69	92.19	-
Plant height (cm)	154.63	11.35	57.00 - 274.00	27.89	99.74	57.38	0.66**
Tillers / clump (No)	12.95	0.44	4.40 - 22.35	29.38	97.44	59.68	0.16
Leaves / tiller (No)	10.63	1.10	5.50 - 16.60	34.94	94.38	69.92	0.43**
Leaf weight (g)	29.11	7.63	5.10 - 98.80	80.69	82.60	43.97	0.90**
Stem weight (g)	52.00	8.41	12.50 - 142.40	40.69	92.07	80.40	0.98**
Leaf length (cm)	93.40	1.72	71.50 - 107.50	8.94	92.14	17.70	-0.09
Leaf breadth (cm)	3.79	0.08	2.50 - 5.35	19.34	97.99	39.41	0.01
Stem thickness (cm)	1.45	0.01	0.95 - 2.41	24.17	99.51	49.51	0.14
L/S ratio	0.45	0.02	0.17 - 0.78	32.03	96.26	66.39	-0.22
Dry matter yield (g)	27.22	0.44	6.04 - 71.34	37.65	83.61	70.93	0.97**
Crude protein yield (g)	2.38	0.20	0.47 - 6.53	40.19	86.73	77.09	0.89**

** Significant at 1% level.

margins . Efforts have been taken to reduce the level of oxalic acid concentration to non-toxic level by hybridisation with *Bajra*. The inter -specific hybrid between *bajra*, *Pennisetum americanum* 2n=14) and napier grass (*Pennisetum purpureum* 2n=28) was highly vigorous and produced an abundance of forage with much reduced and acceptable level of oxalic acid content. There were also an increased protein and sugar contents besides being more succulent, juicy, less fibrous and less serrated leaf margins (Patil and Ghosh, 1962; Patil, 1964; Gupta, 1969) The inter-specific hybrid thus combine the good forage quality attributes found in *bajra* and the high yielding ability and perenniality found in napier grass. The inter-specific hybrid between *bajra* and napier grass is otherwise called as hybrid napier grass (i.e. Bajra Napier (BN) or Napier Bajra (NB) it is possible to improve the yielding ability and quality attributes, of napier grass through hybridisation. Basic informations on the extent of variability for yield and quality characters are scarcely available in napier grass and hence the present study was taken up.

MATERIALS AND METHODS

The germplasm collection of napier grass maintained at the Department of Forage Crops, Tamil Nadu Agricultural University, Coimbatore was used as the base material for the present study. Rooted slips from 53 genotypes of napier grass were planted in three row plots of 3m. length with a spacing of 50 X 50 cm. in a randomised block design with two replications. Nine quantitative characters *viz.*, plant height, number of tillers, number of leaves, leaf length, leaf breadth, stem thickness, green leaf weight, stem weight and green fodder yield, and three quality characters *viz.*, crude protein, dry matter and leaf-stem ratio were taken up for study. Five tallest tillers, one each from five random clumps in a plot were used for measurements of quantitative characters. Green fodder yield was recorded on clump basis and converted to a single tiller. Number of tillers was based on clump basis. Fifth leaf from top was used for measuring length and breadth. Stem thickness was taken at 20 cm height from base.

Using the mean values, the data were analysed for variation following the standard statistical procedures (Panse and Sukhatme, 1967). Genetic coefficient of variation (GCV), heritability in broad sense (h^2) and genetic advance as per cent of mean (GA) were worked out according to Burton (1952), Panse and Sukhatme (1967) and Johnson *et al.*, 1955) respectively. Simple correlations between green fodder yield and its component characters as also quality characters were worked out following the method of Al-Jibouri *et al.*, (1958).

RESULTS AND DISCUSSION

Genetic parameters like GCV, h^2 and GA alongwith mean and range are presented in Table 1. The range of variation was high enough for all the quantitative and qualitative characters taken up for study. The GCV was the highest in stem weight

Table 2. Top ranking genotypes for fodder and quality characters in Napier grass with their *per se* performance

Green fodder yield (gm)		Plant height (cm)		Tillers / clump (No).		Leaves/tiller (No).		Leaf weight (gm)		Stem weight (gm)	
FD 442	258.0	FD 444	274.0	FD 471	22.4	FD 436	16.6	FD 442	98.8	FD 453	171.4
FD 453	258.0	FD 432	241.5	FD 447	20.9	FD 435	12.5	FD 453	86.6	FD 442	159.2
FD 441	205.5	FD 457	238.0	FD 466	20.5	FD 432	12.5	FD 441	67.6	FD 457	142.4
FD 430	182.5	FD 428	219.5	FD 450	18.8	FD 439	10.5	FD 429	57.6	FD 426	138.4
FD 457	178.0	FD 442	216.5	FD 464	17.8	FD 437	10.3	FD 431	56.7	FD 441	137.9
Leaf length (cm)		Leaf breadth (cm)		Stem thickness (cm)		Leaf-stem ratio		Dry fodder yield (gm)		Crude protein yield (gm)	
FD 454	111.0	FD 476	5.4	FD 455	2.4	FD 434	0.8	FD 442	71.3	FD 441	6.5
FD 450	110.0	FD 427	5.1	FD 459	2.3	FD 467	0.7	FD 441	63.7	FD 442	6.5
FD 457	107.5	FD 429	5.1	FD 456	2.2	FD 481	0.7	FD 453	61.6	FD 429	4.6
FD 476	107.5	FD 473	5.1	FD 469	2.0	FD 455	0.6	FD 430	46.6	FD 430	4.5
FD 431	105.5	FD 429	5.1	FD 454	1.9	FD 464	0.6	FD 450	46.4	FD 426	4.3

followed by leaf weight, green fodder yield, crude protein yield, dry matter yield, leaves per tiller, L/S ratio, tillers per clump, plant height and stem thickness. This would show that the level of variability was substantial and appreciably high in these above characters. Leaf length was least variable. The heritability estimates were uniformly high for all the characters and consequently high GA. The GA was maximum for green fodder yield followed by stem weight, crude protein yield, dry matter yield, leaves per tiller, L/S ratio, tillers per clump. plant height, stem thickness, leaf weight and leaf breadth. All these characters that showed a higher extent of variation had high GA. High heritability along with high, GA observed for most of the characters would indicate that it would be fairly easy to make improvement through selection. As napier grass is a sexually propagated, it would instantly be possible to make use of the natural variability already present in the population. There is also certain amount of seed set and this can be taken advantage in crossing certain genotypes and exercise selection in the F1 progeny.

In recent years, a number of inter-specific hybrids have been secured between napier grass and *bajra*. It would be worth studying the individual genotypes so that a selective few of them would be identified as valuable ones for use in hybridisation programme. A detailed study of the individual genotypes brought out that 26 for plant height, 19 for tillers per clump, 12 for leaves per tiller, 13 for leaf length, 26 for leaf breadth, 24 for stem thickness, 10 for leaf weight, 21 for stem weight 18 for green fodder yield, 25 for dry matter, 19 for crude protein and 18 for L/S ratio had mean measurements in excess of $\bar{x}$+2SE, and these were considerd as superior geneotypes to be utilised in crossing programme.

It was quite revealing that all the 53 genotypes proved to be superior in performance for any one or more characters. FD, 431 was unique in that it manifested superior performance for as many as ten characters with the exception of stem thickness and dry matter. FD 441 exhibited superior performance for nine characters and both FD.444 and FD 450 had high expression for eight characters. Other genotypes like FD 429, FD 434, FD 435, FD 436 and FD 442 excelled in per formance for a total of seven different characters.

For convenience , the first five top ranking genotypes with high *per se* performance are listed out in Table 2. It could be seen that some of those genotypes that jointly expressed superior performance for many characters were also rank genotypes and these could be considered as highly promising for use in breeding programmes. As for example, FD 441 and FD 442 occupied positions of rank for six characters including green fodder yield.FD.431 (leaf length leaf weight), FD430 (green fodder yield, dry fodder yield, crude protein yield), FD432 (plant height, leaves per tiller, stem thickness) and FD 450 (tillers per clump leaf length, dry fodder yield) were other promising genotypes with rank performance for two or three characters. Depending upon the requirement, any genotypes can be closen for use in hybridisation with *bajra*

As regards association between green fodder yield and other characters, six characters *viz.*, stem weight, dry fodder yield, leaf weight, crude protein yield, plant height and leaves per tiller showed significant positive correlations with green foder yield. These six characters that were positively correlated with green fodder yield had high heritability estimates combined with high genetic advance. Selection for visible characters like plant height and leaves per tiller can easily be practised for improvement in green fodder yield.

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GROWING HYBRID TOMATO IN HILLS THROUGH TISSUE CULTURE TECHNIQUE

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ABSTRACT

For propagation, a hybrid tomato was selected after observations on its performance in the U.P hilly climatic conditions and it was multiplied successfully through the technique of tissue culture at the Defence Agricultural Research Laboratory, Almora.

Tomato *(Lycopersicon esculentum* Mill.) is an important fruit vegetable and its cultivation in northern Uttar Pradesh hills is restricted due to danger from frost and low temperature climatic conditions. Generally, only one crop of tomato is taken in hills annually during the summer season. But some of the hybrid tomatoes have got good resistance against frost and low temperature and growing such hybrids may enable the vegetable growers to take more than one crop annually in hilly regions of U.P. Once the plants are grown from seeds of such hybrids, there is problem of further multiplication since conventional method of multiplication through seed production is not applicable in case of hybrids. Secondly plant breeding requires the repetition of the same process by which seeds were produced earlier. This becomes a long time taking affair and also a limited number of seeds are produced by this method. For the rapid mass propogation of such hybrids tissue culture proves to be a very fruitful technique. Moreover, it has been observed that mutation rate in case of *in-vitro* culture is very- very less i.e. 10^{-5}.