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Research Article

EVALUATION OF NAPIER BAJRA HYBRIDSFORYIELD AND OTHER PARAMETERS

TOOR A.K.*, KUMAR A. AND KAPUR R.
ICAR- Regional Research Station, Krishi Vigyan Kendra, Gurdaspur, 143521, Punjab Agricultural University, Ludhiana, 141004, Punjab
*Corresponding Author: Email- arvinderktoor2@gmail.com

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Abstract- Genetic variability in six derivatives of Napier Bajra hybrid was studied for forage yield and its component characters *viz.,* plant height, number of tillers per plant, number of leaves per tiller, leaf length and green forage yield. Green fodder yield is between 42.9 to 53.3 kg/plot and check variety PBN233 gave yield43.7 kgs. Entry no.2 and Entry no. 1 gave highest green fodder. The number of tillers, yield per plot and leaf breadth estimates in the germplasm studied for genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) was high. The estimates of heritability in broad sense and genetic advance as percentage of mean were high for characters *viz*., number of tillers (67.80 and 17.05), leaf breadth (59.70 and 9.05) and number of leaves (56.17and 0.14). Positive correlation was shown leaf breadth (0.6631 and 0.3410) and plant height (0.1435 and 0.2427) through yield of green fodder. Leaf breadth and plant height were yield contributing factors. The study shows that genotypes could be exploited for direct selection and improvement of derivatives of grass hybrids.

Keywords- Napier bajra grass, Genetic Advance, Heritability, Variability, Forage Yield

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Introduction

Napier bajra is a man-made hybrid developed by crossing common Napier grass (*Pennisetum purpureum Schum)* with bajra (pearl millet) (*Pennisetum glacum* L.). It is a triploid (AA'B genomes) interspecific hybrid with 2n=3x=21 chromosomes (7 chromosomes from Pearl Millet and 14 from Napier Grass). It is usually highly variable due to the heterozygosis of napier grass, even if the pearl millet parent is an inbred [1]. It is a perennial, heavy tillering grass with leafiness of *bajra* with height of 3-4m and leaves particularly near stem are profusely hairy and stiff [2]. It provides nutritional and edible green fodder all the year round containing 8.2% protein, 34% crude fibre, 10.5% ash with calcium and phosphorus in proper balance. It is cut-and-carry forage for stall feeder systems and good for hay and silage making. Napier is also used as a soil stabilizer in soil conservation methods and can be intercropped with various forage legumes.

Napier grass is native of South Africa and was introduced to India and USA in 1912 and 1913 respectively. It is widely distributed in tropical and sub-tropical regions of Asia, Africa, southern Europe and America. In India, it is cultivated on about 1 lakh ha mainly in the states of Punjab, Haryana, Uttar Pradesh, Bihar, Madhya Pradesh, Orissa, Gujarat, West Bengal, Assam, and Andhra Pradesh. This grass is prone to heavy rainfall and frost. Napier *bajra* hybrid performs well in areas having temperatures above 15oC. It can with stand drought for a short spell, and regenerate with rains.

In recent years, several new cultivars of hybrid Napier were released and are becoming popular among farmers. The present study was carried out to characterize six Napier bajra accessions for correlation coefficients and direct and indirect path effects on green forage yield and to identify promising traits for future Napier bajra breeding program.

Materials

The field experiment was conducted during 2014- 2015 at the Regional Research Station, Gurdaspur. The experiment was laid out in randomized complete block design (RCBD) with three replications. The treatments comprised of six hybrids napier bajras planted through rooted slips with inter and intra row spacing of 60cm. The first harvest was taken at 60 days after planting and subsequent harvests at 45 days interval. After the fifth harvest, no more harvesting could be planned because of the non-receipt of rains. Recommended package of practices was used to raise good crop. Fertilization was done with 20 tonnes farm yard or town compost to the soil before planting and 66 kg Urea after 15 days. Urea application was repeated after each cutting. Also, two doses of 240 kg single super phosphate every year, first half in spring and second half during monsoon. After planting one irrigation was given and subsequent irrigations were given at an interval of 10-12 days. Observations were recorded on plant characters such as height (cm), leaf length (cm), leaf breadth (cm), stem girth (cm), number of leaves/tiller, number of tillers/plant on randomly selected five competitive plants andyield/plot. The data were analyzed for variability, divergence, correlation and path coefficient study.

The genotypic and phenotypic coefficients of correlation were calculated as described by Singh and Chaudhary (1977) and Johnson and Robinson (1995) [3,4]. Direct and indirect effects were calculated by path coefficient analysis as suggested by Dewey and Lu (1959) at both phenotypic and genotypic levels [5]. Genotypic and phenotypic coefficients were calculated using the formula as used by Burton and Devane 1952 [6]. Heritability in broad sense was estimated as suggested by Burton and Devane (1952). The expected genetic advance at 5% selection intensity was calculated by the formula as used by *Johnson, Robinson et al*., (1995). The data collected on individual characters were subjected to the method of analysis of variance commonly applicable to the Randomized Complete Block Design [7]. SPAR and RBDVARI software were used for analysis of correlation coefficient, path analysis and genetic variability parameters.

Results and Discussion

The mean performance of six napier bajra hybrids were provided by using basic statistics in [Table-1] and production yield in [Fig-1]. Genetic variability was observed in green fodder yield, height, leaf length, leaf breadth stem girth, number of tillers and number of leaves. Considerable variation was observed in among the entries under study. Plant height was ranged between 109.1 to 117.8 cm. Plant height was highest in Napier hybrid Entry no.6 and the check variety PBN 233 was close to mean value (114.280) of this trait. High variation in height may attribute to the varietal characters and increase in photosynthesis to reproductive parts which further increases yield production. Leaf length showed an incredibly high variation ranging between 59.960 (Entry no. 1) and 67.720 (Entry no.4) with an average of 58.80 cm. It was highest for Entry no.4. Similarly leaf breadth wasamong1.86 to 2.18 cm more than average of 1.85. Stem girth showed 3.83 to 4.31. Numbers of tillers were amongst 37.5 to 44.7. Number of leaves per tiller was amid of 7.71 to 8.51of these accessions. Green fodder yield is an important trait attributed after plant height, leaf length, leaf breadth, number of leaves per tiller, stem girth and number of tillers. Green fodder yield is between 42.9 to 53.3 kg/plot. Check variety PBN233 falls to 43.7 kgs and it was highest for Entry no.2 with yield of 53.3 kg in [Table-1]. Comparing green fodder yield of all entries one can easily identify the lines transfer more photosynthesis to their reproductive part than those lines with higher proportionate from their biomass to vegetative part. Three entries correspond Entry no. 1,2 and 6 gave high green fodder yield.

Table-1 *Yield and other components of Napier Bajra*

Entry no.	Plant Height (in cms)	Leaf Length (in cms)	Leaf Breadth (in cms)	Stem girth (in cms)	No. of tillers	No. of leaves/per tiller	Yield(kg/plot)
Entry1	114.4	60	2.2	4.0	38.4	7.9	45.7
Entry2	115.4	59.8	2.2	3.9	37.5	7.7	53.3
PBN233	114.3	58.1	2.0	4.0	50.3	8.3	43.7
Entry4	116.7	67.7	1.9	3.8	44.7	7.7	42.9
Entry 5	109.1	62	1.7	4.0	43.1	8.2	43.0
Entry6	117.8	60.1	2.0	4.3	43.9	8.5	44.4
C.D.	N/A	5.172	0.190	N/A	7.896	0.487	6.800
C.V.	7.356	6.352	6.986	8.148	13.823	4.545	8.108

Check variety in bold

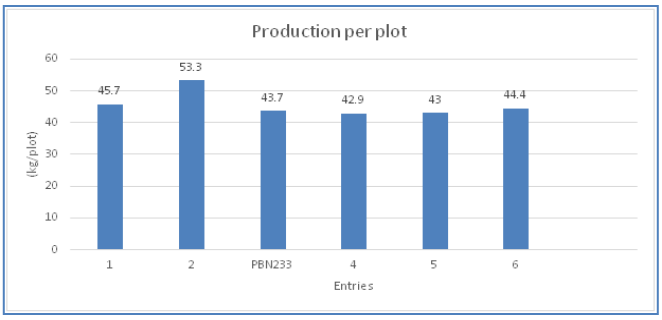

Fig-1 Production of Napier Bajra hybrid per plot

Estimates of genetic variability:

The mean range of different traits Napier bajra genotypes were evaluated in [Table-2], these have diverse genetic background. The traits like plant height (109.1-117.8), leaf length (58.1-67.7), leaf breadth (1.86-2.16), stem girth (3.83-4.30), number of tillers (37.5-44.7), number of leaves per plant (7.73-8.50) and yield (42.9-53.3) kg/plot had wide range of mean values. Genetic co-efficient of variation (GCV), phenotypic coefficient of variation (PCV), broad sense of heritability (h^2) and genetic advance as percent of means (GA) were given in [Table-2]. The PCV and GCV of data revealed were high for yield, leaf breadth, leaf length and number of tillers indicating genetic control for traits rather than environmental effect alone. These high estimates of PCV and GCV revealed that varieties have broad sense of genetic background, which respond to selection and would facilitate successful isolation of desirable types. Bello *et al*., (2007), also reported high value of PCV and GCV for panicle length per plant, 1000 seed weight, days to flowering and days to maturity in contrary to the present study. The high values of GCV were reported for plant yield/plot(kg), leaf length, number of tillers, dry weight and number of nodes per tiller are in accordance with findings of Shankar (2002) [9].

In general, PCV values were marginally higher than GCV values in plant height, stem girth and number of leaves/tiller [Table-2]. Number of leaves, stem girth and plant height had low GCV values indicating little scope of improvement of these traits. The magnitude of variation was maximum for number of tillers followed by green forage yield, leaf length and leaf width, while it was lowest for plant height. However, the genetic variability with heritability estimate is better idea for amount of GA expected from selection [6,7].

Table-2 *Estimates of genetic parameters of Napier Bajra*

Characters	GMean	Range	PCV	GCV	h^2	GA (Mean)	S.E.	C.D.(5%)	CV (%)
Yield(Kg/plot)	45.52	42.9-53.3	10.92	7.35	45.22	10.18	2.12	6.70	8.08
Plant height(cm)	114.62	109.1-117.8	3.55	2.03	32.67	2.39	1.92	6.08	2.91
Leaf length (cm)	61.28	58.1-67.7	6.59	4.86	54.42	7.39	1.57	4.96	4.45
Leaf breadth (cm)	2.05	1.86-2.16	7.36	5.68	59.70	9.05	0.05	0.17	4.67
Stem girth (cm)	4.01	3.83-4.30	4.64	3.38	53.03	5.07	0.07	0.23	3.18
No. of tillers	43.00	37.5-44.7	12.20	10.04	67.80	17.04	1.71	5.42	6.92
No. of leaves/tiller	8.06	7.73-8.50	4.80	3.60	56.17	5.56	0.14	0.46	3.18

The estimated broad sense heritability ranged between 32.67- 67.80%. High heritability along with high GA was estimated for number of tillers (67.80), leaf breadth (59.70), number of leaves per tiller (56.17), leaf length (54.42) and stem girth (53.30) in an environment. Selection based on those traits with a relatively high genetic advance as percent of mean will result in the improvement of the performance of the varieties for the traits. Bello *et al*., (2007) also found low heritability of grain yield (10%) and highly variable result of heritability of grain yield indicated that it is a typical example of quantitative trait in which environmental variations highly influence its phenotypic expression [8]. According to Singh (2001), high heritability of a trait (≥ 80%) provides selection for such traits could be easy due to a close correspondence between the variety and the phenotype due to the relative small contribution of the environment to the phenotype [10]. In other words, if environmental variability is small in relation to genotypic differences, selection will be efficient because the selected character will be transmitted to its progeny.

The remaining characters recorded high heritability with low genetic advance indicating that the characters were unstable and environment had major impact on the expression of those characters, since, breeder should not rely on the estimates of the heritability alone. Mahajan *et al*., (2011) reported high heritability value and genetic advance of grain yield, days to flowering, panicle length and plant height [11]. Selection based on these traits with a relatively high genetic advance as percent means will result in the improvement of the performance of varieties for the traits. Traits having high heritability and genetic advance prominently governed by additive gene effects and selection of these traits would be more effective [12,13].

In this study, traits such as number of tillers, yield of green fodder and leaf breadth have positive potential to respond to selection an environment because of their better broad sense heritability coupled with relatively high genetic advance across locations.

Genotypic and phenotypic correlation coefficient

The estimates of correlation co-efficient among the different characters were used in this experiment are shown in [Table-3]. The correlation co-efficient provides reliable measure of association among the characters and helps to differentiate vital associations useful in breeding from those of the non-vital ones [14]. Thus, for achieving rational improvement in green fodder yield and its components information regarding association mechanism, cause and effect relationship provides a basic strategy to devise suitable selection methods for green fodder yield.

The present investigation showed phenotypic and genotypic correlations are presented in [Table-3] for six characters in an environment [Table-3]. The genotypic and phenotypic correlation for yield per plot showed positive and significant association with plant height (0.1435, 0.2427) and leaf breadth (0.6631, 0.3410) [Table-3]. Similarly, positive and significant association with stem girth through leaf breadth (0.0315 and 0.1064), number of leaves through stem girth (1.1051, 0.4118) and plant height through stem girth (0.0685, 0.2650). These findings were similar to [15,16] in Oats, [17] in rice and [18] in wheat. Hence, selection for these characters will help in selecting genotypes with high green fodder yield per plot. A strong correlation with yield indicated that simultaneous improvement of both the characters is possible. Manickam and Vijendradass (1994) noticed positive association of plant height, number of tillers, number of leaves, leaf area per plant, dry matter yield and crude protein with green fodder yield [19]. Sood and Singh (1982) also computed correlation in thirty napier bajra hybrids anddry matter digestibility and total digestible dry matter [20]. Zhang *et al.,* (2009) studied the relationship between yield and some important morphological traits in napier grass and found significantly positive correlations between yield and plant height tillers/plant and significantly negative correlations between yield and leaf length, leaf/stem ratio [21]. Shinde *et al*., (2010) studied correlation coefficients of forty derivatives of bajra x napier grass hybrids for green forage yield and twelve yield contributing characters and found that green forage yield was significantly and positively associated with dry matter [22].

Similarly, number of leaves per tillers provides negative correlation for yield (-0.6236, -0.3341), leaf length (-0.5112,- 0.3914), leaf breadth (-0.1029,-0.1800) and yield per plot (-0.6236,-0.3341) and positively correlated to stem girth and number of tillers. Negative correlation for leaf length through yield, leaf breadth through leaf length, stem girth through yields and leaf length and also plant height through leaf breadth in [Table-3]. Panicle length was negatively correlated with productive tillers quoted by Nirmalkumari *et al*., (2013) [23]. From these results, it could be inferred plant height have positive correlation with yield/plot, leaf length and stem girth and at the same time leaf breadth is negatively correlated with plant height. Hence, optimum plant height should be aimed while breeding for higher green fodder yield.

Table-3 *Genotypic and phenotypic correlation coefficient between plot yield and yield related traits*

	Characters		Yield (Kg/plot)	Leaf Length (cm)	Leaf Breadth (cm)	Stem girth (cm)	No. of tillers	No. of leaves/ tiller	Plant Height (cm)
1	Yield (Kg/plot)	G	1	-0.5235	0.6631	-0.0836	-0.9652	-0.6236	0.1435
		P	1	- 0.1676	0.3410	-0.0402	-0.3617	-0.3341	0.2427
1	Leaf Length (cm)	G		1	-0.6626	-0.6405	0.0260	- 0.5112	0.0813
		P			-0.3889	-0.2969	-0.0012	-0.3914	0.1472
2	Leaf Breadth (cm)	G			1	0.0315	-0.6957	-0.1029	-0.9103
		P				0.1064	-0.5608	-0.1800	- 0.3643
3	Stem girth (cm)	G				1	0.0786	1.1051	0.0685
		P					-0.1312	0.4118	0.2650
4	No.of tillers	G					1	0.6970	-0.0976
		P						0.4094	0.0805
5	No. of leaves/ tiller	G						1	0.1482
		P							-0.3366
6	Plant Height (cm)	G							1
		P							1

G = genotypic correlation, P =phenotypic correlation

Path analysis fodder yield

Correlation coefficients are not considered to determine traits as selection criteria. In agriculture, path analyses have been used by plant breeders to assist in identifying traits that are useful as selection criteria to improve crop yield [5]. The path analysis was conducted to determine direct and indirect effects of traits on napier bajra green fodder yield. The partitioning of genotypic correlation coefficient was done into direct and indirect effects and results were displayed in [Table-4]. Out of 6 characters fifty percent showed positive direct effects. In present study, green fodder yield was considered as dependent character and other were considered independent. The residual effect of path analysis showed 0.5311. The lower residual effect showed character chosen in path analysis were adequate and appropriate. Plant height showed maximum direct effect on green fodder yield followed by leaf breadth and number of tillers.

Direct Effects

Out of 6 characters fifty percent showed positive direct effects. Highest positive direct effect was shown by plant height (0.6367) followed by leaf breadth (0.4883) and number of leaves per tiller is (0.0898). Negative direct effects were observed for leaf length, stem girth and number of tillers [Table-4]. Plant height showed highest positive direct effect. Yang 1986; Moradi, Rezai *et al*., 2005; Bibi *et al*., 2012**,** found that height showed highest direct effect on green fodder yield [24,25]. Our findings agree with these results. Negative direct effects were observed for leaf length [26] and Bibi, Sadaqat *et al*., (2012)**,** also reported negative direct effect of plant height on grain yield. Mahajan *et al*., (2011) found panicle length and number of grains/panicle has positive direct effect on grain yield. Sood and Singh (1982) computed path coefficients in thirty napier bajra hybrids showed a positive and high direct effect of dry matter digestibility, leaf stem ratio and average internode length on dry matter yield, whereas the direct effect of the number of leaves was negative and high [20]. Similarly, Sukanya (1998) reported path analysis of green fodder yield revealed high and positive and direct effects on number of leaves per tiller, leaf length, average internodal length, leaf width and number of tillers per plant and this study concluded that in napier germplasm, selection of correlated leaf characters only increases the green fodder yield but also improve quality [27]. Our findings are in partial agreement with these results mentioned above

Indirect Effects

Indirect effects of leaf breadth, number of tillers and number of leaves per tiller were negative with values (0.3250, 0.0164 and 0.0497). Stem girth (0.3233) and height (0.0522) were recorded positive values through leaf length. Indirect effects of leaf breadth (0.3367), height (-0.5200), stem girth had negative value (-0.0211). Characters like stem girth and number of leaves per tiller were negligible. Nirmalkumamari *et al*., (2013) showed panicle length and harvest index showed negative indirect effects through number of tillers, number of productive tillers and dry matter yield. The remaining characters were negligible. Thousand grain weights showed negative indirect effects through productive tillers, panicle weight, groat percentage, harvest index and single plant yield. Our results agree with findings of previous researchers. Daher *et al.,* (2004) studied path analysis for dry matter production and related traits (plant height diameter of stem at the base and no of tillers) in pennisetum purpureum clones and found that the number of tillers and diameter stem at the base had greater effects on dry matter production the effects being directs and inverse respectively varying according to environment condition during growth [28]. Shinde (2005) studied path analysis of napier hybrids revealed that characters *viz.,* DMY and plant height exhibited positive direct effects on GFY as well as they showed significant and positive correlation with GFY [29]. Thus, the relationship between these characters and GFY was true and positive. Chongjian *et al*., (2011) also evaluated path analysis, found that the greatest direct and indirect effects on fresh yield of hybrid giant napier were its effectual stem numbers, node and tiller numbers [30].

Table-4 *Estimation of direct and indirect effects of path coefficient analysis on yield attributes of napier bajra*

Characters	Leaf Length(cm)	Leaf Breadth (cm)	Stem girth (cm)	No.of tillers	No. of leaves/ tiller	Height(cm)
Leaf Length (cm)	**-0.5058**	0.3367	0.26490	-0.0147	0.2797	-0.0415
Leaf Breadth (cm)	-0.3250	**0.4883**	0.0167	-0.3405	-0.0224	-0.3987
Stem girth (cm)	0.3233	-0.0211	**-0.6175**	-0.0470	-0.6352	-0.1171
No.of tillers	-0.0164	0.3943	0.0924	**-0.5654**	-0.3694	0.0530
No. of leaves/ tiller	-0.0497	-0.0041	-0.0431	0.0587	**0.0898**	0.0110
Height(cm)	0.0522	-0.5200	0.1207	-0.0596	0.0783	**0.6367**
Residual Effect Due To Selected Character = 0.5311						

Conclusion

These results show the importance of correlation studies and path analysis for the understanding of the relationships among and green fodder yield and other components in Napier bajra. Traits with high heritability and genetic advance are important to give attention to bring effective response in yield improvement. The study of relationship to support joint selection of two or more traits and evaluate them. This is since the magnitude of simple correlation does not always adequately reflect the cause–effect relationship between these traits. In breeding programs, this relationship among traits must be considered, because the change in one, by means of selection, causes changes in another. It is concluded that the significant results will be effectively utilized for developing high yielding genotypes suitable for Punjab conditions.

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