Didactic Journals 2063-2144

Didactic Journal of Agricultural Research
Vol 1(1) pp. 001-004 August, 2015.
http://www.didacticjournals.org/djar

Original Research Paper

Variability among Fodder Yield and Quality in Sudangrass Hybrids

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Accepted 24th April, 2015.

Six Sorghum x Sudangrass hybrids and 9 elite lines will be evaluated for their comparative performance in field for green fodder yield and its quality attributes following randomized complete block design with three replications, for the estimation of variability and association among fodder yield and quality attributes at genetic level. Maximum genetic variability was present in green fodder yield (Kg) followed by number of leaves per plant, plant height (cm), dry matter percentage, leaf area (cm^2), sugar contents, number of tillers per plant and leaf to stem ratio. The highest heritability (0.82) was estimated for plant height followed by dry matter percentage (0.59), green fodder yield (0.53), leaf area (0.46), leaf to stem ratio (0.43), number of leaves per plant (0.42), sugar contents (0.40) and number of tillers per plant (0.30) (Table-2). Genotypic correlations of different traits under study were in general higher than their respective phenotypic ones indicating thereby an association among the traits under study due to genetic factors rather than environmental effects in all possible combinations. The genotypic correlation coefficient revealed that plant height, number of leaves per plant, number of tillers per plant, leaf area, leaf to stem ratio and sugar contents had positive and significant genotypic correlation with green fodder yield in sorghum x sudangrass hybrids., whereas dry matter percentage had negative significant correlation with green fodder yield in sorghum x sudangrass hybrids. Genotypes AKS 5 X Hegeri and CS 11 X SPV 462 had the highest plant height, Honey Pasture and SPL 13 X JS 100 had highest number of leaves and CS 11 X SPV 462 and AKS 5 X Hegeri had the largest leaves. These lines could be included in hybridization programme to conserve the genes for plant height, leaf area and number of leaves per plant. There is a strong hope of finding better performing sorghum x sudangrass hybrids genotypes with contribution of these said characters.

Keywords: Genetic variability and association, Sorghum x Sudangrass hybrid, Genotype, Phenotype, TDN, DP, Fodder.

INTRODUCTION

Green fodder is the main source of feed for livestock. The area under fodder production is about 3.35 million hectares out of a total cropped area of 21.85 million ha, in the country, producing more than 60 million tons of fodder [1]. The area under fodder in Punjab is 2.03 million ha; with a production of 45 million tones of fodder crops with an average yield of 22 tones/ha. Livestock population in Pakistan is supported by feed resources derived mainly from fodder crops. It is estimated that 155.85 million tonnes of total digestible nutrients (TDN) and 12.68 million tonnes of digestible protein (DP) is required to meet the demand of 134.1 million animal heads in the country [1]. In terms of TDN, we are short by about 30.85 million tonnes and in terms of digestible protein by about 2.99 million tonnes [1]. Estimate of digestibility of the fodder is given by total digestible nutrients (TDN). It refers to the sum total of digestible protein, Carbohydrates and fats. The local production of green fodder is very low to meet the requirements of existing animal heads. The main source of proteins and other nutrients for human beings is milk and meat obtained from livestock. The existing livestock is producing below their optimum potential due to inadequate supply of fodder. The available ration for livestock is deficient in both quantity as well as quality. This occurs because of poor quality and low quantity of forages.

In Pakistan, the major fodder crops during summer are maize and sorghum. In May and June we face two major problems, drought and high temperature that reduce the growth of fodder for livestock. This is called the lien period. In this period no other fodder crop gives good quality of fodder except Sorghum x Sudangrass hybrids. Because it is drought tolerant and heat tolerant. These features make the plant superior to that of maize, which has almost similar seasonal requirements. Sorghum x Sudangrass hybrids are developed by the interspecific cross between sorghum and sudangrass.

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It is characterized by abundant sweet juice in stalks and the height usually ranges from 1.5 to 3.5 m. We can take three cuttings in summer by applying proper inputs when sacristy of fodder occurs. It is grown on all types of soils except waterlogged and saline soils. Plant foliage is used for green chop, hay, silage and pasture. Many characters from sorghum and sudangrass are pyramided to Sorghum x Sudangrass like drought tolerance, heat tolerance, large number of leaves, more tillers, tall stature etc.

Fodder team in the Department of Plant Breeding and Genetics has regular activity of producing the interspecific hybrids of sorghum and Sudangrass to develop the high yielding and high quality forage type to feed the livestock to get the maximum milk and meat production. There is a need to evaluate the performance of the hybrids for various yield components to develop selection criteria.

Correlation analysis provides information on relationship of important plant traits and, therefore, leads to directional model for yield response, whereas path coefficient analysis quantifies the direct and indirect contribution of particular traits of plants to yield. This quantification helps in ranking the traits of plants which can be utilized by indirect selection.

The Present studies are planned to undertake the correlation and path coefficient analysis for different plant performing traits in sorghum x sudangrass hybrids. The objectives of the present study are:

a. to evolve an efficient selection criterion.,
b. to select the lines on the basis of possession of traits having high contribution
c. to yield, for the future hybridization programme aimed at evolving high yielding.

The study on eight hundred and twenty seven (*Sorghum bicolor*) varieties of Kaolioug type; Protein contents were generally in the range of 10-20 percent with nine ~~varities~~ varieties having less than 14% protein, including Lao Han Ye (16.05%), Daun San Chi (14.06%) and Hang Gao Liaxy (14.09). Lysine content was 0.27-3.97 % with Er Mao Kui, and Havng and Xiao San Er Tou having less than 3.5 % lysine, the content of tannin was 0.06-1.2 percent, with 41 varieties having more than 0.1 % tannin [2].

Six Sudan grass varieties and sorghum x sudangrass hybrids were used to prepare dried fodder. The hybrids exceeded the varieties in green matter production; the highest green matter yields at the first + second cuts were given among the varieties by Stanichnaya 7 (20.8 + 14.4 t/ha) and Stepnyachka (15.7 + 12.7 t/ha) and among hybrids by ~~intensivny~~ (29.2 + 14.1 t/ha). These forms also had the highest sugar content in the fodder [3].

The study on the growth and biomass production characteristics for sorghum x sudangrass [*Sorghum bicolor* x *Sorghum sudanense*] hybrids, 6 R lines and 6 adopted lines, grown at the University of Isfaha, Iran. Plant higher of lines, cultivars and hybrids did not differ significantly. Numbers of tillers were higher in hybrids than in the lines and cultivars. The total fresh and dry weight of hybrids were higher than those of lines and cultivars. The hybrid 52A x IS646 had higher fresh and dry weight and crude protein than other hybrids [4].

Evaluation of seven sorghum (*Sorghum bicolor*) male sterile lines (ICSA 73, ICSA 74, ICSA 75, ICSA 77, ICSA 81, AKMS 14A, and SB 1085A2) and nine sudangrass (*S. sudanense*) restorer parents (IS 3312, IS 3313, IS 3314, IS 3316, IS 3332, IS 3345, IS 3353, IS 3359, and IS 3381) were used in Pantnagar, Uttar Pardesh, India to assess the variability and heterosis for plant height, stem diameter, numbers of leaves, total leaf area, green forage yield and dry forage yield. Higher variability was observed for dry forage yield followed by green forage yield, plant height and total leaf area. All the characters expressed higher amount of heritability. The crosses involving ICSA 77 as a female parent namely, ICSA 77 x IS 3312, ICSA 77 x IS 3314 and ICSA 77 x IS 3332 exhibited higher heterobeltiosis as well as standard heterosis for most of the characters in both first and second cut. Thus, these hybrids serve as potential multicut hybrids for commercial exploitation to boost the net forage production in the country [5].

An experiment was conducted during 1996-98 in Romania, to study the variability of quantitative traits in Sudan grass [*Sorghum sudanense*] germplasm, which consisted of 28 offsprings and 2 Romanian cultivars (Sirius and Sonet), for the identification of valuable genotypes from the existing biological material and their introduction into a breeding programme for releasing new cultivars. The tested germplasm showed a large variability of traits, which contributed to superior yields compared with cultivars extended into production. The cultivars Privolzskaya, Voronenskaya 24, Donskaya, and I.S. 3318 achieved, on an average, 14.9-16.4 t dry matter/ha. Privolzskaya, Szudan 2, and I.S. 3332 were selected for a better repartition of yield per cuttings (45.5-48.8% first cutting; 38.7-38.9% second cutting). I.S. 3319 was chosen for its rich foliage, with a leaf percentage of 41.0% in the first cutting, 46.7% in the second cutting, and 61.3% in the third harvest [6].

Evaluation and characterization of 106 genotypes of forage sorghum was done and recorded the data for plant height, leaf length, leaf breadth, leaves per plant, stem girth, tillers per plant, leaf stem ratio, days to 50% flowering, regeneration potential, growth rate, green fodder yield per plant and dry fodder yield per plant. High variability was observed among the genotypes for the recorded forage yield components [7].

Evaluation of the eight strains of multicut sorghum for their nutrient content, digestibility and yield of nutrients was done. The yields of green fodder, dry matter, crude protein and digestible dry matter ranged from 311.7-686.6, 78.2-188.0, 4.87-11.08 and 76.6-109.2 q/ha respectively in first cut. In second cut, the corresponding values were 93.3-291.7, 1.25-5.07 and 11.97-76.60 q/ha, respectively. The HCN content determined only in second cut varied from 40.06-275.5 ppm. On the basis of yield and quality the varieties FSH 92079 TNFS 9602, FS 156, SSG 1001, and SSG 5000 were found to be superior to the rest [8].

MATERIAL AND METHODS

The proposed study was carried out in the experimental area of the Department of Plant Breeding and Genetics, University of agriculture, Faisalabad. The experimental material comprised of the following nine elite lines and six sorghum x sudangrass hybrids.

Honey pastuer	Graze king
Sweet bale grazer	SPL 67 X 1744
Hey master	AKS 45 X Fc.26 II
Honey sweet	SPL 13 X JS100
Got cha	CS 67 X JS 88
Diamond sugar bale II	AKS 5 X Hegeri
Happy cow	CS 11 X SPV 462
Cattle man's choice	

The experiment will be laid out in a randomized complete block design with three replications. Two rows 4 m in length of each entry in each replication will be sown keeping row to row and plant to plant distance of 60 cm and 15 cm respectively. Identical cultural and agronomic practices will be applied to all the lines and hybrids.

When the emergence of heads will start the data will be recorded on the following traits from randomly taken 5 plants of each entry in each replication. The data will be recorded of 2 harvests.

- Plant height
- Number of leaves per plant
- Number of tillers per plant
- Leaf area
- Green fodder yield per plot

Quality Attributes

- Leaf to stem ratio
- Dry matter
- Sugar contents

Statistical Analysis

The data collected will be subjected to analysis of variance and variance will be portioned into genotypic and phenotypic components [9]. Genetic correlations among various attributes will be calculated according to [10] and heritability in brad sense will be estimated according to [11]. Genetic variability will be estimated at genotypic and phenotypic level an each character accordingly. Path coefficient analysis will be carried out according to [12]. Selection of lines for yield and its contributing attributes to be utilized in hybridization programme.

RESULTS AND DISCUSSION

The experiment was conducted in a Randomized Complete Block Design with three replications in the experimental area of the Department of Plant Breeding and Genetics, University of Agriculture Faisalabad. The data was recorded on various plant attributes like plant height, number of leaves per plant, number of tillers per plant, leaf area; leaf to stem ratio, dry matter percentage sugar contents and green fodder yield per plot to determine the extent of genetic variability among the genotypes and interrelationship among the above mentioned traits. Genotypic, phenotypic variances, coefficient of variability and heritability were estimated.

The analysis of variance indicated that the genetic variability for all the traits studied vs. plant height, number of leaves per plant, number of tillers per plant, leaf area, leaf to stem ratio, dry matter sugar contents and green fodder yield per plot were significant (Table-1). Phenotypic variances and coefficient of variability were higher than the respective genotypic ones (Table-2), showing the effect of environment on the development of variability, although the magnitude of this influence was not higher. Maximum genetic variability was present in green fodder yield (Kg) followed by number of leaves per plant, plant height (cm), dry matter percentage, leaf area (cm^2), sugar contents, number of tillers per plant and leaf to stem ratio. The highest heritability (0.82) was estimated for plant height followed by dry matter percentage (0.59), green fodder yield (0.53), leaf area (0.46), leaf to stem ratio (0.43), number of leaves per plant (0.42), sugar contents (0.40) and number of tillers per plant (0.30) (Table-2).

Genotypic correlations of different traits under study were in general higher than their respective phenotypic ones indicating thereby an association among the traits under study due to genetic factors rather than environmental effects in all possible combinations. The genotypic correlation coefficient revealed that plant height, number of leaves per plant, number of tillers per plant, leaf area, leaf to stem ratio and sugar contents had positive and significant genotypic correlation with green fodder yield in sorghum x sudangrass hybrids., whereas dry matter percentage had negative significant correlation with green fodder yield in sorghum x sudangrass hybrids.

Therefore said discussion based on presence of genetic variability, heritability, estimates of correlations, indicated that plant height, number of leaves and leaf area could serve as a selection for green fodder yield per the higher amount of genetic variability coupled with relatively high heritability was found in green fodder yield followed by leaf area, plant height and number of leaves.

CONCLUSION

Genotypes AKS 5 X Hegeri and CS 11 X SPV 462 had the highest plant height, Honey Pasture and SPL 13 X JS 100 had the highest number of leaves and CS 11 X SPV 462 and AKS 5 X Hegeri had the largest leaves. These lines could be included in hybridization programme to conserve the genes for plant height, leaf area and number of leaves per plant. There is a strong hope of finding better performing sorghum x sudangrass hybrids genotypes with contribution of these said characters.

Table -1. Mean squares of analysis of variance for green fodder yield and other quantitative characters in Sorghum x Sudangrass hybrids.

Characters	Accessions	Replications	Error
D.F	14	2	28
Plant height	4553.64**	532^{ns}	294.87
No. Leaves/plant	2.204*	0.200^{ns}	0.944
No. Tillers/plant	2.53**	1.05^{ns}	0.794
Leaf area	1829.14**	604.75^{ns}	505.37
Leaf /Stem ratio	4.02**	6.77^{ns}	1.21
Dry matter %	32.76	8.60^{ns}	6.02
Sugar contents	4.161**	1.02^{ns}	1.35
Green fodder yield	40.06**	27.75^{ns}	8.904

** = Highly Significant
ns = Non Significant

Table- 2. Genetic parameters for plant height, number of leaves per plant, number of tillers per plant, leaf area, green fodder yield, leaf to stem ratio and dry matter percentage and sugar contents in differen Sorghum x Sudangrass hybrids accessions.

Characters	∂^2g	∂^2p	Gcv	Pcv	h^2
Plant height	149.589	1714.469	16.44	18.07	0.828
No. Leaves/plant	0.42	1.36	17.17	2.52	0.422
No. Tillers/plant	0.58	1.37	4.73	26.4	0.308
Leaf area	441.256	946.63	6.57	9.62	0.466
Leaf /Stem ratio	9.35	2.14	3.73	5.65	0.435
Dry matter %	8.91	14.939	10.28	13.31	0.597
Sugar contents	0.934	2.29	5.82	9.12	0.407
Green fodder yield	10.38	19.291	16.97	23.13	0.538

∂^2g = Genotypic variance
∂^2p = Phenotypic variance
Gcv = Genotypic coefficient of variance
Pcv = Phenotypic coefficient of variance
h^2 = Heritability (broad sense)

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