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GENETIC VARIABILITY AND ASSOCIATION OF FORAGE QUALITY CHARACTERS IN STRAINS OF *LASIURUS SINDICUS* HENR.

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ABSTRACT

Coefficients of variation, heritability, genetic advance, correlations and path analysis were studied in relation to eight forage quality characters of 33 strains of *Lasiurus sindicus*. Wide range of variations were observed in the strains for silica, dry matter, lignin and crude protein which exhibited high heritability and genetic advance. Neutral detergent fibre (NDF), acid detergent fibre (ADF), lignin and cellulose had positive and significant inter-correlations at both, genotypic and phenotypic levels. Path analysis revealed high direct effect of ADF and cellulose on dry matter per cent. Considering both, direct and indirect effects, cellulose, ADF and protein assume importance in the selection of high forage yielding and nutritive strains of *L. sindicus*.

INTRODUCTION

Per cent dry matter is one of the major fodder yield traits in forages. But it has invariably been observed to have negative correlation with quality characters mainly digestibility and crude protein as the bulk of dry matter is composed of cellulose, pectin and hemicellulose. Cellulose alone constitutes nearly 40 to 60 per cent of the dry matter. For selecting a desirable variety having good quality and quantity of forage, a plant breeder has to consider the magnitude of genetic variations and interrelationships among quality characters as well as their association with dry matter. The present study on the desert grass *L. sindicus* reports variability in its forage quality characters and their genetic association.

MATERIAL AND METHODS

Thirty three strains of *L. sindicus* were grown in a randomised block design with three replications at the Central Research Farm of the CAZRI, Jodhpur. Forage samples were collected from five randomly selected plants of each strain in each replication at the half bloom stage. Samples were dried in oven at 60°C, till constant weight, ground and analysed for the following quality traits. Crude protein content was estimated by Kjeltec Auto System II and neutral detergent fibre (NDF), acid detergent fibre (ADF), lignin, cellulose and silica by Fibertec M-6 system. Data were statistically analysed for variability (Burton, 1951), correlation Johnson *et al.*, 1955) and path coefficient (Dewey and Lu, 1959).

RESULTS AND DISCUSSION

The range of variation was comparatively high for silica, dry matter, lignin and crude protein content (Table 1). The phenotypic and genotypic coefficients of variation ranged from 4.27 to 39.90 and 3.67 to 34.67, respectively. Both, phenotypic and genotypic coefficients of variation were high for silica, moderate for dry matter, lignin and crude protein and low for other traits. Information on heritability alongwith the genetic advance (as per cent of mean) is more helpful than heritability alone in selecting the best individuals (Johnson *et al.*, 1955). In this study, the high heritability alongwith high genetic advance was observed for silica and high heritability with moderate genetic advance for lignin and dry matter percentage. The remaining traits showed high heritability and low genetic advance. This trend suggests the possibility of improvement through selection for these traits.

Genotypic and phenotypic correlation coefficients between all possible pairs of eight quality components are presented in Table 2. The crude protein content was negatively correlated with all characters except hemicellulose. Dry matter per cent exhibited significant and negative correlation with hemicellulose content. NDF, ADF, lignin and cellulose were positively and significantly associated among themselves. Similar results have been reported in C. ciliaris (Gupta, 1983). The correlation of hemicellulose was negative and significant with ADF, lignin, cellulose and dry matter per cent. In some cases, the genotypic correlation coefficients were more than one. This may possibly be due to estimation error or negative environmental association between replications (Burton, 1951)

Data in Table 3 reveal high positive effect of ADF, cellulose and high negative direct effect of NDF, cellulose, lignin and silica on dry matter per cent. High indirect effect of ADF on dry matter per cent was also observed. The crude protein and hemicellulose contents negatively affect dry matter per cent through ADF. The indirect contribution of lignin and cellulose through ADF was high and positive on dry matter per cent. ADF and cellulose were positively associated. The residual effect was less than 0.5 which indicated that all the important traits were included in the study. Considering direct and indirect effects, cellulose, ADF and protein

Table 1. Phenotypic variation, heritability and genetic advance among quality traits in *Lasiurus sindicus*

Characters	Range	Grand mean	CD at 5%	Phenotypic coefficient of variation	Genotypic coefficient of variation	Heritability	Genetic advance (per cent of mean)
Crude protein	4. 650-8. 787	6.562	1.966	21.25	10.04	22.3	9.753
NDF	67.267-80.267	72.627	2.524	4.27	3.67	74.1	6.513
ADF	30·533-42.933	37.175	1.982	9.19	8.43	84.1	15.925
Hemicellulose	29.133-41.553	35.518	1.721	8.50	7.94	87.3	15.260
Lignin	4.667- 9.933	7.298	0.590	18.72	18.02	92.7	35.763
Cellulose	22.767-30.933	27.355	2.123	9.35	7.99	73.1	14.074
Silica	1.000- 4.867	2.491	2.748	39.90	34.67	75.5	62.225
Dry matter	19.667-44.333	27.646	0.435	19.20	16.48	73.6	29.118

Table 2. Genotypic (upper right) and phenotypic (lower left) correlation coefficients among forage quality components in *Lasiurus sindicus*

Characters	Crude Protein	NDF	ADF	Hemi-cellulose	Lignin	Cellulose	Silica	Dry Matter
Crude protein	—	0.842	1.160	0.456	0.796	0.179	0.024	0.336
NDF	0.411*	—	0.524	0.369	0.559	0.585	0.140	0.068
ADF	0.545**	0.577**	—	0.599	0.763	0.970	0.013	0.396
Hemicellulose	0.198	0.386	0.521**	—	0.497	0.509	0.114	0.503
Lignnin	0.377*	0.372*	0.733**	0.431*	—	0.703	0.517	0.279
Cellulose	0.454**	0.628**	0.945**	0.422*	0.622**	—	0.112	0.433
Silica	0.070	0.192	0.036	0.153	0.470**	0.183	—	1.191
Dry matter	0.096	0.024	0.303	0.357*	0.197	0.314	0.057	—

**Significant at 1 per cent, and *sign.ficant at 5 per cent levels

Table 3. Direct (underlined) and indirect effects of forage quality components on dry matter precent of *Lasiurus sindicus*.

Characters	Crude protein	NDF	ADF	Hemi-cellulose	Lignin	Cellulose	Sillca	Genotypic correlation with dry matter percent
Crude protein	<u>0.412</u>	5.033	17.607	2.605	3.088	7.021	0.066	0.336
NDF	0.346	<u>5.977</u>	7.948	2.104	1.394	3.483	0.385	0.068
ADF	0.478	3.131	<u>15.173</u>	3.421	2.961	5.777	0.035	0.396
Hemicellulosə	0.188	2.206	9.094	<u>5.707</u>	1.928	3.034	0.312	0.503
Lignin	0.327	2.147	11.581	2.838	<u>3.880</u>	4.184	1.420	0.278
Cellulose	0.486	3.498	14.725	2.909	2.727	<u>5.953</u>	0.308	0.432
Silica	0.009	0.838	0.195	0.649	2.004	0.668	<u>2.748</u>	1.191

with the soil before sowing. Six seeds of soybean per pot (variety 'Black Tur') were sown and plants raised for 45 days. Deionized water was used during the growth period. After harvest the plant samples were oven-dried at 70± 1C. The physico-chemical characteristics of experimental soils were determined as per Chopra and Kanwar (1976). Zinc in soil and plant samples was determined by using atomic absorption spectrophotometer.

RESULTS AND DISCUSSION

Dry matter yield

The dry matter yield (Table 1) of soybean in sodic soils ranged from 0.74 to 16.21 g/pot and decreasel progressively with increasing levels of ESP. In the absence of zinc, reduction in the yield was 61, 73 and 93 per cent at 14.6, 27.2 and 41.3 ESP, respectively. Application of zinc improved the dry matter yield by 23.5 per cent over control irrespective of zinc levels. Zinc sulphate and zinc-titriplex were equaly effective in increasting dry matter production.

The effect of increasing levels of ESP on the yield of soybean was significant. At higher ESP (56.5), plants failed to survive. The plant mortality and poor yields at other ESP levels is attributed to adverse physical conditions of the soil affecting seedling emergence, root development and penetration. Sodic environ-

Table 1. Effect of sodicity and zinc sources on shoot yield of soybean (g/pot)

		Zinc sources							
		$ZnSO_4 \cdot 7H_2O$			Zn—EDTA				
	Control	Zn levels (ppm)			Zn levels (ppm)				
ESP levels	0	5	10	Mean	5	10	Mean	Mean
0	12.27	14.96	13.21	14.09	16.21	14.07	15.14	14.14
14.6	4.55	5.06	6.34	5.70	4.82	5.83	5.33	5.32
27.2	3.36	4.84	4.76	4.80	4.24	4.94	4.59	4.43
41.3	0.74	0.99	1.22	1.11	0.87	0.91	0.89	0.95
Mean	5.23	6.46	6.38	6.42	6.54	6.44	6.49	—

C. D. at 5%	
ESP levels	0.37
Zn sources × ESP levels	0.53
Zn levels × ESP levels	0.53
Control vs. Zn application	0.42

ment of the soil also restricts plant growth and causes nutritional inbalance due to alkaline reaction, high ESP and sodium toxicity (Verma and Abrol, 1980). Mortality of plants under such conditions was also observed by Joffee and Zimmerman (1945) and Bajwa and Bhumbla (1971).

The increase in the yield due to zinc application in sodic soils is in agreement with the findings of Shukla and Prasad (1974) and Abrol *et al.* (1972) who reported ameliorative role of zinc on the yield of maize and paddy, respectively. Results also revealed that the soybean is more sensitive to sodicity than cereals and the adverse effect of sodicity on soybean can be slightly overcome with the application of zinc. It is thus surmised that, in soybean, not only the zinc status of the plant but soil conditions also influence its yield.

Zinc concentration and uptake

Increasing ESP and zinc levels resulted in significant increase in zinc concentration of soybean shoot (Table 2). Application of 10 ppm zinc resulted in significantly higher content of zinc over 5 ppm zinc under both the sources. The zinc concentration was nearly two-fold higher in Zn-EDTA treatment than that in zinc sulphate. In the absence of zinc application the zinc in plant tissues remained more or less constant with increasing ESP upto 27.2 but increased abruptly at ESP 41.3 due to extremely reduced growth.

Increase in zinc concentration with zinc application was due to higher availability of zinc in the root zone. A comparison of two sources indicated that plants supplied with Zn-EDTA had higher zinc in tissue than that with zinc sulphate. This could be due to the chelating effect of EDTA which increased zinc availability. The decreased concentration of zinc in zinc sulphate treatment due to induced alkali soil conditions upto ESP 27.2, may be attributed to the reduction in zinc availability in soil and thus lower absorption and/or translocation of zinc from root to shoot. Agarwala *et al.* (1964) and Shukla and Mukhi (1980) also reported reduction in zinc concentration in plant tissue at higher levels of ESP.

It is evident from the data (Table 2) that uptake of zinc increased significantly with zinc application irrespective of zinc sources. In the absence of applied zinc, the uptake of zinc decreased from 189, μg at ESP O (control) to 21.3 μg/pat at ESP 41.3, indicating 88 per cent reduction in zinc uptake. The increased in zinc uptake was much higher in zinc-EDTA than zinc sulphate. This could be due to chelating effect of EDTA which increased zinc availability.

The uptake of zinc decreased markedly with increasing rates of sodicity irrespective of zinc sources. The decrease in zinc uptake was more pronounced than its concentration due to extremely reduced growth. In the present investigation there was no striking recovery in plant growth with zinc application despite an adequate concentration of zinc in plant on sodic soils. Shukla and Mukhi (1980) also reported decreased uptake of zinc with increasing ESP levels.

Table 2. Effect of sodicity and Zn sources on Zn concentration and uptake by soybean shoot

		Zinc sources						
		$ZnSO_4.7H_2O$			Zn—EDTA			
	Control	Zn levels (ppm)			Zn levels (ppm)			
ESP levels	0	5	10	Mean	5	10	Mean	Mean
				Zinc concentration (ppm)				
0	15.4	30.1	36.4	33.2	41.4	65.9	53.7	37.8
14.6	14.4	17.0	31.4	19.2	49.2	94.7	72.0	39.3
27.2	15.2	22.3	31.1	26.7	57.4	98.8	78.1	45.0
41.3	28.8	31.1	44.4	37.8	59.9	113.8	86.9	55.6
Mean	18.5	25.1	33.3	29.3	52.0	93.3	72.7	—
				Zinc uptake (μq/pot)				
0	189.0	450.4	481.0	465.7	672.0	928.3	800.2	544.1
14.6	65.6	86.1	136.7	111.4	237.3	552.3	394.8	215.6
27.2	51.1	107.3	147.9	127.6	210.4	485.6	348.0	200.5
41.3	21.3	31.0	53.9	42.5	52.5	103.3	77.8	52.3
Mean	82.0	168.7	204.9	186.8	293.0	517.4	405.2	—

C. D. at 5%	For concentration	For uptake
Zn sources	1.36	6.7
Zn levels	1.36	6.7
Zn sources × Zn levels	1.92	9.5
ESP levels	2.71	13.4
Zn sources × ESP levels	2.71	13.4
Zn levels × ESP levels	2.71	9.5
Zn sources × Zn levels × ESP levels	3.83	19.0
Zn control vs. Zn application	2.14	10.6

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