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Simultaneous Selection for Fodder and Grain Yield in Sorghum

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Abstract: A total of 31 selection indices were constructed on five characters in 33 diversed genotypes of sorghum (*Sorghum bicolor* L.). High heretability couple with high genetic advance expected in the next generation and association of characters were the basis for choosing of the characters for discriminant function analysis. Green fodder yield and grain yield have to be simultaneously improved through selection. Amongst the single character selection indices, grains/panicle offered maximum genetic worth (11.51). In general, inclusion of every character in the function, exerted a progressive relative efficiency over straight selection. The highest relative efficiency over straight selection on grain yield alone was realized while grain yield/plant (x_1), fodder cutting maturity (x_2), green fodder yield/plant (x_3) digestible dry matter/plant (x_4) and grains/panicle (x_5) were concurrently integrated in the function.

Key words: Heretability, association, simultaneous selection, sorghum.

Introduction

The drought resistant and moderately salt tolerant crop, sorghum (*Sorghum bicolor L.*) (Mass, 1994) is mainly grown in semi-arid regions under limited moisture conditions (Mohammad *et al.*, 1993). An important aspect of breeding in sorghum is the development of dual purpose varieties. Therefore, it is desirable to have plants which have high fodder as well as high grain yield. Both these attributes are dependent upon several components, hence, assessment of the contribution of different morphological characters to productivity is of vital obligation in sorghum. However, grain yield is a complex character which is influenced by the fluctuation of environmental conditions. Studies on character association considering both panicle components and developmental traits are limited in sorghum (Giriraj and Gond, 1983). Moreover, the efficiency of selection invariably depends upon the magnitude of heritable variation and the direction and association between yield and its components. It is necessary to realize the relative efficiency of simultaneous selection over straight selection to make reliable and sustainable improvement of sorghum, both for fodder and grain yield. The partitioning of the total variability into heritable and non-heritable components and the nature of relationships are the pre-requisite tools for furnishing the multiple selection criteria in discriminant function analysis (Biswas *et al.*, 1996). The discriminant function for suitable index selection was developed by Fisher (1936) and there is an immense scope to adopt this function in sorghum. With the premise of the above attitudes, the present investigation was aimed to construct a simultaneous selection model by discriminant function analysis based on variability and relationships of yield and yield components in sorghum.

Materials and Methods

The investigation was conducted at Hajee Mohammad Danesh University of Science and Technology Farm in 1998. A set of 33 diverse genotypes including a local cultivar as check was laid out in randomized block design with three replications. The distances between the rows and between the plants in a row was 60 cm and 30 cm respectively. All the agronomic practices were provided for each plot as and when necessary. Ten plants were randomly selected from each plot for recording data on plant height (cm), fodder cutting maturity (days), green fodder yield/plant (g), digestible dry matter/plant (g), days to maturity, panicles/plant, panicle length (cm), grains/panicle, 1000-grain weight (g) and grain yield/plant (g). Genotypic and phenotypic coefficient of variations were estimated according to the method of Burton (1952). Broad sense heritability and genetic advance expressed as percentage of mean were calculated following the method of Hanson *et al.* (1956). Character association both at genotypic (rg) and phenotypic (rp) levels were computed by the method described by Fisher (1954) from the variance and co-variance components. A total of 31 selection indices were constructed by discriminant function technique(Hazel, 1943). The grain yield/plant (g) was considered as 100 and the values of expected genetic worths scored by other indices were transferred accordingly to judge the relative efficiency of simultaneous selection over selection for grain yield/plant alone.

Results and Discussion

Analysis of variance revealed significant variations among the 33 genotypes for the characters under study. The genotypic and phenotypic coefficient of variations were higher for grain yield/plant, digestible dry matter/plant, panicle length and fodder cutting maturity (Table 1). As it is foggy to assign heritable variation with Gcv and/or Pcv, high heritability coupled with high genetic advance expected in the next generation, may be taken into account for prediction of phenotypic expression of a character under selection (Johnson *et al.*, 1955). The heretability values for panicle length, fodder cutting maturity, grains/panicle and green fodder yield/plant, but among them appreciable genetic advances were observed for panicle length, green fodder yield, digestible dry matter and fodder cutting maturity indicated that the characters are inherited in additive genetic fashion (Panse, 1957). The genotypic and phenotypic correlation coefficients were computed in all possible combinations to assess the magnitude and direction of relationships among the characters (Table 2). In general, genotypic correlation coefficient (rg) was higher than corresponding phenotypic correlation coefficient (rp), suggested that the characters are transmitted through generations with tightly linkage effects of the polygenes

Table 1: Estimation of genetic parameters for different characters in sorghum.

Characters	Mean ± SE	Mean range	S^2g	S^2p	Gcv	Pcv	h^2b	GA	GA in % of mean
Plant height (cm)	105.00 ± 1.25	97.25-112.20	9.25	22.82	2.89	4.56	40.53	3.97	3.80
Fodder cutting maturity (days)	96.27 ± 2.14	89.82-103.58	93.95	118.07	10.6	11.32	79.50	17.79	18.48
Green fodder yield/plant (g)	490.76 ± 4.97	415.30-515.69	830.89	1623.17	5.88	8.21	71.16	59.06	12.03
Digestible dry matter/plant (g)	174.66 ± 3.35	167.00-181.29	488.32	992.30	12.70	18.08	49.21	31.93	18.27
Days to maturity	138.00 ± 2.91	124.55-149.00	50.12	152.86	5.49	8.96	33.45	8.52	6.18
Panicles/plant	2.45 ± 1.02	2.00-4.02	63.53	108.16	3.24	4.26	58.72	12.59	5.13
Panicle length (cm)	21.12 ± 0.84	17.56-25.40	7.07	7.78	12.64	13.20	90.60	5.20	24.65
Grains/panicle	985.22 ± 3.28	756.05-1000.05	3578.89	4695.80	7.91	21.76	76.78	108.38	11.00
1000-grain weight (g)	18.05 ± 1.53	16.72-23.13	1.58	2.36	6.69	8.54	66.70	4.02	22.25
Grain yield/plant (g)	56.40 ± 2.09	48.77-63.36	70.56	136.72	17.23	20.88	51.59	12.43	22.03

Table 2: Genotypic (rg) and phenotypic (rp) correlation coefficients among different characters in sorghum.

Characters		Plant height	Fodder cutting maturity	Green fodder yield/plant	Digestible dry matter/plant	Days to maturity	Panicles/ plant	Panicle length	Grains/ panicle	1000-grain weight
Fodder cutting maturity	rg	0.219								
	rp	0.203								
Green fodder yield/plant	rg	0.514	0.725**							
	rp	0.480	0.611*							
Digestible dry matter/plant	rg	0.593*	0.694**	0.810***						
	rp	0.610*	0.517	0.724**						
Days to maturity	rg	-0.397	-0.561*	0.209	0.199					
	rp	-0.284	-0.692**	0.202	0.107					
Panicles/plant	rg	0.436	-0.363	0.364	0.384	-0.460				
	rp	0.518	-0.248	0.495	0.298	-0.380				
Panicle length	rg	0.624*	0.105	0.527	0.168	-0.517	-0.487			
	rp	0.573*	0.086	0.310	0.099	0.317	-0.325			
Grains/panicle	rg	0.489	0.275	0.226	0.476	0.639*	0.242	0.717**		
	rp	0.365	0.200	0.198	0.355	0.576*	0.201	0.675**		
1000-grain weight	rg	0.125	0.455	0.505	-0.207	0.711**	0.286	0.555	-0.425	
	rp	0.110	0.408	0.493	-0.189	0.595*	0.189	0.490	-0.321	
Grain yield/plant	rg	0.431	0.737**	0.664*	0.611*	0.430	0.420	0.637*	0.477	0.538
	rp	0.336	0.689**	0.581*	0.586	0.369	0.314	0.566*	0.328	0.454

*, ** and *** significant at 5%, 1% and 0.1% levels of probability, respectively.

(Mather and Harrison, 1949). Whereas, phenotypic correlation coefficient was higher than corresponding genotypic correlation coefficient for plant height with digestible dry matter plant and panicles/plant; fodder maturity with days to maturity and green fodder yield/plant with panicles/plant, suggested that the associations were flexible to environmental fluctuation. The oppositely directed relationships like plant height with days to maturity; fodder cutting maturity with days to maturity and panicles/plant; digestible dry matter with 1000-grain weight, and grains/panicle with 1000-grain weight, indicated that in addition to genetic and environmental effects otherwise, physiological mechanisms might be involved in such types of associations (Falconer, 1981). However, plant height was positively and significantly associated with digestible dry matter/plant and panicle length. Hussain *et al.* (1992) reported positive and significant correlation between plant height and forage yield in Sudan grass. The results indicated that with increasing plant height the later two components simultaneously increased. The fodder cutting maturity had positive and significant correlation with green fodder yield/plant, digestible dry matter/plant and grain yield/plant. Besides, positive and significant correlation were observed between green fodder yield/plant and digestible dry matter/plant and grain yield/plant, indicated that green fodder and grain yield concurrently considered in sorghum improvement. Amongst the other positive and significant associations, the strong relations of the vital components, viz., panicle length, grains/panicle and grain yield/plant, suggested that the three components may be taken into selection in sorghum. Gomez *et al.* (1986) also reported positive correlation of grains/panicle with grain yield. Akhond *et al.* (1998) suggested that for grain yield improvement, selection could be made mainly on panicles/plant and grains/panicle. Therefore, taking into joint venture of genetic parameters and association of characters, fodder cutting maturity, green fodder yield/plant, digestible dry matter/plant and grains/panicle along with grain yield/plant were considered in discriminant function analysis.

A total of 31 selection indices along with genetic worths and relative efficiencies over straight selection are presented in Table 3. It is apparent that greater the number of characters included in discriminant function, higher was the efficiency over straight selection. The maximum relative efficiency over straight selection was realised when grain yield/plant (x_1), fodder cutting maturity (x_2), green fodder yield/plant (x_3), digestible dry matter/plant (x_4) and grains/panicle (x_5) comprised the selection index (I_{12345}). A plant breeder is always interested to have maximum genetic gain with incorporation minimum characters in selection function. Keeping eyes on judicious breeding exercise, so far ranking of the single character index selection, grains/panicle is the key component to construct selection index in sorghum. However, among the

Table 3: Discriminant function analysis on selected characters in sorghum

Index selection	Expected genetic worth	Relative efficiency over straight selection (%)
$I_1 = 0.156\ x_1$	12.43	100.00
$I_2 = 0.343\ x_2$	10.72	86.25
$I_3 = .0219\ x_3$	9.830	79.10
$I_4 = 0.520\ x_4$	7.890	63.46
$I_5 = 0.709\ x_5$	11.51	92.59
$I_{12} = 0.205\ x_1 + 0.391\ x_2$	13.08	105.21
$I_{13} = 0.395\ x_1 + 0.094\ x_3$	13.97	112.37
$I_{14} = 0.448\ x_1 + 0.512\ x_4$	13.55	109.00
$I_{15} = 0.607\ x_1 + 0.816\ x_5$	16.87	135.74
$I_{23} = 0.413\ x_2 + 0.027\ x_3$	18.54	149.16
$I_{24} = 0.293\ x_2 + 0.496\ x_4$	19.65	158.05
$I_{25} = 0.075\ x_2 + 0.608\ x_5$	20.30	163.30
$I_{34} = 0.218\ x_3 + 0.259\ x_4$	18.29	147.17
$I_{35} = 0.020\ x_3 + 0.921\ x_5$	22.69	182.58
$I_{45} = 0.177\ x_4 + 0.270\ x_5$	21.91	176.26
$I_{123} = 0.810\ x_1 + 0.362\ x_2 + 0.009\ x_3$	24.66	198.36
$I_{124} = 0.107\ x_1 + 0.500\ x_2 + 0.066\ x_4$	23.46	188.75
$I_{125} = 0.550\ x_1 + 0.222\ x_2 + 0.324\ x_5$	24.99	201.04
$I_{134} = 0.401\ x_1 + 0.505\ x_3 + 0.050\ x_4$	16.39	131.86
$I_{135} = 0.007\ x_1 + 0.616\ x_3 + 0.112\ x_5$	26.93	216.67
$I_{145} = 0.585\ x_1 + 0.169\ x_4 + 0.429\ x_5$	24.28	195.30
$I_{234} = 0.170\ x_2 + 0.002\ x_3 + 0.129\ x_4$	23.51	189.15
$I_{235} = 0.489\ x_2 + 0.716\ x_3 + 0.599\ x_5$	27.66	222.49
$I_{245} = 0.184\ x_2 + 0.572\ x_4 + 0.196\ x_5$	24.77	199.25
$I_{345} = 0.290\ x_3 + 0.095\ x_4 + 0.703\ x_5$	31.12	250.33
$I_{1234} = 0.514\ x_1 - 0.328\ x_2 + 0.600\ x_3 + 0.604\ x_4$	30.02	241.52
$I_{1235} = 0.100\ x_1 + 0.370\ x_2 + 0.222\ x_3 + 0.460\ x_5$	32.22	259.19
$I_{1245} = 0.702\ x_1 + 0.205\ x_2 + 0.151\ x_4 - 0.017\ x_5$	30.80	247.82
$I_{1345} = 0.284\ x_1 - 0.620\ x_3 + 0.494\ x_4 + 0.167\ x_5$	32.57	262.05
$I_{2345} = 0.211\ x_2 + 0.069\ x_3 + 0.005\ x_4 + 0.836\ x_5$	29.74	239.23
$I_{12345} = 0.828\ x_1 + 0.473\ x_2 + 0.198\ x_3 + 0.756\ x_4 + 0.529\ x_5$	33.25	267.50

Where x_1 = Grain yield/plant, x_2 = Fodder cutting maturity, x_3 = Green fodder yield/plant, x_4 = Digestible dry matter/plant and x_5 = Grains/panicle.

two character combination functions a substantial gain of 182.58% was observed when green fodder yield/plant was selected together with grain yield/plant. It is obvious that the index, I_{345} accounted a profitable efficiency (250.33%) as compared to other three character functions studied. Nevertheless, cumbersome in breeding program, the four character index, I_{1345} appeared to be highly beneficial over straight selection. However, the tedious approach, I_{12345} might be adopted while attention of a breeder is solely engaged for increasing grain yield in sorghum.

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