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Research Article

Analytical Study on Correlation and Path Coefficient for Various Agronomical Traits in Sorghum [*Sorghum bicolor* (L.) Moench] in Tarai Region of Uttarakhand, India

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ABSTRACT

Sorghum genotypes were evaluated for genetic variability and interrelationships of characters during Kharif 2013-14 and 2014-15. A significant genotypic variation for all the characters was observed among the accessions. All the characters showed higher phenotypic and genotypic coefficient of variation which indicates that the expression of characters in sorghum population is genetic and can be exploited in sorghum breeding programme. High heritability coupled with high genetic advance was observed for plant height, panicle weight, stover yield and grain yield per plant which indicates that these characters are controlled by additive gene action, so the phenotypic selection for these will be effective. Grain yield was positively correlated with all the characters indicating the effective selection for these characters can be done to improve grain yield. The path coefficient analysis showed a positive and significant correlation as well as high or moderate direct effects of stover yield, plant height, panicle weight, 1000 seed weight on grain yield per plant.

Keywords: *Genotypes, Sorghum, Yield, Plant height*

INTRODUCTION

Sorghum is an important multi-purpose drought tolerant crop which ranks fifth after wheat, rice, maize and pearl millet among cereals. To fulfil the demands of continuously increasing population, maximizing the yield either fodder or grain is main objective of crop breeding and improvement programmes. For this purpose, adequate exploitation of the available variability in population is view to identify and select the superior genotypes with desirable traits is most important and difficult task. Therefore, it is necessary to know the relative magnitudes of genetic and non-genetic variability exhibited by various traits with the use of suitable parameters like genotypic and phenotypic coefficient of variability (GCV and PCV), heritability (H) & genetic advance (GA).

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Estimates of correlation measure the level of dependence of various traits and out of these numerous correlation coefficients, it is often difficult to determine the actual mutual effects among selected traits (Ikanovic et al., 2011). The estimates of correlations alone either genotypic or phenotypic may be often misleading due to mutual cancellation of component traits. So, it is necessary to study path coefficient analysis, which measures the casual relationship with the degree of relationship among traits by partitioning the correlation coefficient in to direct and indirect effect of independent variables on dependent variable. (Mahajan et al., 2011). The present study was done to assess the genetic variability (PCV and GCV), heritability, genetic advance, correlation and path coefficient analysis for yield and its contributing attributes to provide necessary information that could be useful in various sorghum improvement programmes.

MATERIALS AND METHODS

The experiment was conducted at the Instructional Dairy Farm of the G.B. Pant University of Agriculture and Technology, Pantnagar (U.S. Nagar) India, during *Kharif* season in 2013-14 and 2014-2015. The experimental materials for the present study was consisted of involving five diverse CMS lines (female), eight pollinator (male) lines and forty F_1 crosses developed through line × tester mating design. The details of genotypes presented in Table 1.

For data collection, 10 competitive plants were randomly selected, from each treatment/genotype in each replication during both the years. All the selected plants were tagged and observations for all the characters were taken. The means of different characters for the purpose of statistical analysis were calculated on the basis of the individual data recorded for each character, in each replication separately, for each cross. Days to 50 % flowering were calculated by counting the number of days between planting when one half of the panicles in a plot reached the half bloom stage. The plant height was measured from ground level to the tip of the uppermost leaf of each plant. Leaf length was measured from base to tip and leaf width was recorded from middle of leaf. Stem diameter was taken from middle of stem with the help of electronic Vanier callipers. Number of nodes was counted from base to panicle initiation of stem. Panicle length was measured at maturity, from the bottom panicle node to the upper most floret or the tip, while panicle width was taken from middle of panicle and panicle weight was measured at maturity. Stover yield was taken by weighing and averaging the ten randomly selected plants just after harvest. Weight of one thousand random grains from total grain yield of tagged plants was recorded in grams and mean was worked out. Average weight of grains obtained from ten random plants after threshing and sun drying was recorded in grams.

Analysis of variance was done by the method given by Panse and Sukhatme (1978). Phenotypic and genotypic coefficient of variation (PCV and GCV), heritability, genetic advance, genotypic coefficient and path coefficient using standard method suggested by Allard (1960), Johnson et al. (1955) and Searle (1961), respectively.

RESULTS AND DISCUSSION

A significant difference among all genotypes was reported by analysis of variance for all the characters which indicates sufficient variability and large scope for the selection of desirable genotypes for higher yield from material evaluated. The similar results were also earlier reported by scientists in fodder sorghum (Jadhav et al., 2011 & Jain & Patel, 2012). Highest range was recorded for stover yield (251.75-1012.75) followed by plant height (168.04-345.58), panicle weight (53.50-208.41), grain yield (31.33-127.43), leaf length (52.8-85.5), 1000 seed weight (16.02-37.51), days to 50% flowering (62.67-82.50), number of nodes per plant (26.45-45.58), panicle length (22.86-34.00), stem diameter (11.73-17.95), panicle width (5.25-10.52) and leaf width (6.57-11.08) **(Table2**). In present investigation, the phenotypic coefficient of variation (PCV) was recorded higher than the corresponding genotypic coefficient of variation (GCV) for all the characters indicating the influence of environmental factors. The highest PCV and GCV were recorded for grain yield (40.89 and 31.25, respectively) followed by panicle weight (38.89 and 31.13, respectively), stover yield (34.19 and 29.88, respectively), plant height (18.33 and 15.37, respectively), 1000 seed weight (15.15 and 15.02, respectively), panicle width (23.09 and 14.85, respectively), number of nodes per plant (13.37 and 8.96, respectively), stem diameter (12.63 and 8.54, respectively), leaf width (12.18 and 8.42, respectively), leaf length (11.65 and 7.72, respectively), panicle length (12.18 and 7.05, respectively) and days to 50% flowering (7.45 and 6.76, respectively) **(Table2)**. High magnitude of GCV and PCV indicated that there is a greater scope for selection of superior genotypes for these attributes. Same findings were confirmed by Khandelwal et al. 2015.

On the basis of GCV and PCV, the accuracy in determining the genetically heritable portion may be affected. In this direction, heritability along with coefficient of variation gives more accurate information. Burton (1952) also suggested that heritability alongwith GCV gives better information for the selection of superior genotypes. Highest values for heterosis were recorded in 1000 seed weight (0.98) and the lowest estimates were reported for panicle length (0.33). Most of the characters showed high magnitudes of heritability which indicates the genotypic control for these characters as reported by Jain et al. (2010). High heritability in association with with high genetic advance was observed stover yield (0.76 and 345.32, respectively), plant height (0.70 and 70.74, respectively), panicle weight (0.64 and 57.61, respectively) and grain yield (0.58 and 35.83, respectively) which indicates that these characters are associated with additive gene action and therefore, phenotypic selection for these characters will be more effective **(Table 3)**. High heritability and high genetic advance also has been reported by Jain et al. (2010) and Jadhav et al. (2011).

Genotypic study of any plant is very useful for the selection in a given pool which expresses in the form of phenotype. The phenotype of plant is determined by the interaction of a large number of factors which are controlled by genes. So, final yield of a plant is the sum total of several associated attributes. This association, either phenotypic or genotypic or both give very useful information for choosing the characters to conduct a study. In present investigation, the genotypic and phenotypic correlation coefficients were studied for different characters **(Table 4)** and it was observed that genotypic correlation coefficients were higher than phenotypic correlations for all the characters which suggested an inherent relationship between these characters. Stover yield and grain yield were found to be significantly correlated with all the traits except days to 50% flowering. 1000 seed weight showed significant and positive association with stover yield and grain yield only. Days to 50% flowering was positively associated with plant height, panicle width and panicle weight. It was found that all the characters were directly or indirectly associated with each other.

To understand the more accurate estimates of correlation among component attributes, studies based on path coefficient analysis are more effective because the estimation of relationship among traits on the basis of genotypic and phenotypic correlation only may be inadequate due to mutual cancellation of component traits. In path coefficient analysis, to know the relative effects and magnitudes of components, the genotypic and phenotypic correlation is partitioned into direct and indirect effects. Genotypic and phenotypic residual effects were recorded as 0.13 and 0.47, respectively. Lower values for residual effect shows the adequacy of traits at genetic level. The path correlation coefficient analysis indicated significant and positive correlation with high or moderate direct effects of leaf width, panicle length, and number of nodes per plant, stem diameter, panicle width, panicle weight and 1000 seed weight on grain yield per plant.

These results indicate that selection of these traits may be helpful to increase the yield in sorghum improvement programme **(Table and fig.)**. Similar kinds of findings are reported by Kumar and Singh (2012) and Mahendra et al. (2016).

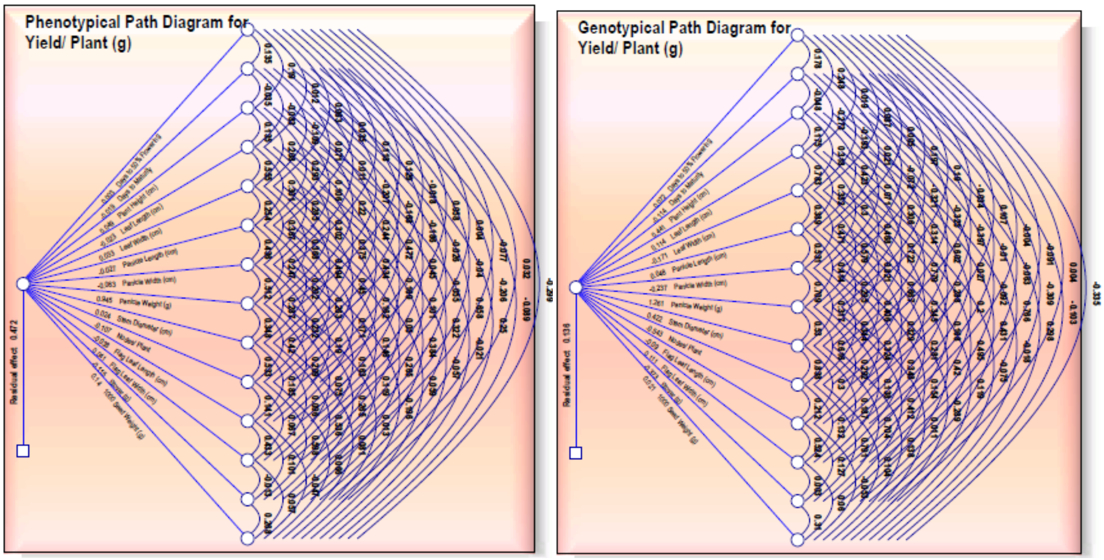

Fig. 1: Direct, indirect and residual effects of different traits on yield per plant (Genotypical and Phenotypical)

Table 1: Parentage, origin/source and important characteristic features of parental lines used for the study

Name of the Parental line	Parentage	Origin/Source	Tillering/ Non-Tillering
Male sterile lines			
ICSA 467	-	ICRISAT	Non-tillering
ICSA 469	[(ICSB 37 x ICSV 702) x PS 19349B]3-3-4-2	ICRISAT	Non-tillering
ICSA 276	(ICSB 101 x TRL 74/C 57) x PM17467B]2-5-1-3-3	ICRISAT	Non-tillering
$11A_2$	Non-milo	DSR, Hyderabad	Non-tillering
MR $750A_2$	Non-milo	DSR, Hyderabad	Non-tillering
Pollinator lines			
Pant Chari 5	CS 3541 x IS 6953	Pantnagar	Non-tillering
UPC 2	VIDISHA 60-1x ISC 953	Pantnagar	Non-tillering
CSV15	SPV 475 x SPV 462	DSR, Hyderabad	Non-tillering
CS3541	IS 3675 x IS3541	DSR, Hyderabad	Non-tillering
RS 29	IS 108 x SPV 126	DSR, Hyderabad	Non-tillering
M 35-1	Selection from Maldandi landraces	Mahol	Non-tillering
JJ1041	-	Indore	Non-tillering
SPV1616	-	DSR, Hyderabad	Non-tillering

Table 2: Genetic parameters of variability for grain yield per plant and other traits

SR.NO.	TOPIC	RANGE	MEAN	GCV(%)	PCV(%)	HERATIBILITY (%)	GENETIC ADVANCED	EXPECTED MEAN IN NEXT GENERATION
1	DAYS TO 50% FLOWERING	62.67-82.50	70.03	6.76	7.45	0.82	8.84	78.88
2	PLANT HEIGHT	168.04-345.58	266.17	15.37	18.33	0.7	70.74	336.92
3	LEAF LENGTH	52.8-85.5	65.71	7.72	11.65	0.43	6.92	72.64
4	LEAF WIDTH	6.57-11.08	8.89	8.42	12.18	0.47	1.06	9.96
5	STEM DIAMETER	11.73-17.95	2.08	8.54	12.63	0.45	0.24	2.33
6	NO. OF NODES PER PLANT	26.45-45.58	14.39	8.96	13.37	0.44	1.78	16.17
7	PANICLE LENGTH	22.86-34.00	27.31	7.05	12.18	0.33	2.29	29.61
8	PANICLE WIDTH	5.25-10.52	7.16	14.85	23.09	0.41	1.41	8.58
9	PANICLE WEIGHT	53.50-208.41	112.25	31.13	38.89	0.64	57.61	169.87
10	STOVER YIELD	251.75-1012.75	641.98	29.88	34.19	0.76	345.32	987.31
11	1000 SEEDS WEIGHT	16.02-37.51	28.69	15.02	15.15	0.98	8.8	37.51
12	GRAIN YIELD	31.33-127.43	72.85	31.25	40.89	0.58	35.83	108.69

Table 3: Phenotypic and Genotypic correlation between different quantitative traits in sorghum

		Days to 50% flowering	Plant height	Leaf length	Leaf width	Stem diameter	No. of nodes per plant	Panicle length	Panicle width	Panicle weight	Stover yield	1000 seed weight
Days to 50% flowering	G	**1.0000**	0.2483	0.0189	0.0872	-0.0344	0.1072	0.0051	0.1969	0.1897	0.0037	-0.3354
	P	**1.0000**	0.1900	0.0123	0.0630	-0.0178	0.0579	0.0349	0.1175	0.1290	0.0320	-0.2995
Plant height	G	0.2483	**1.0000**	0.1748	0.3178	0.3144	0.6020	0.4225	0.0711	0.3056	0.7657	0.2979
	P	0.1900	**1.0000**	0.1355	0.2077	0.2437	0.4725	0.2935	0.1062	0.2202	0.6584	0.2502
Leaf length	G	0.0189	0.1748	**1.0000**	0.7831	0.7217	0.7792	0.3523	0.3004	0.4682	0.4308	-0.0180
	P	0.0123	0.1355	**1.0000**	0.5550	0.3754	0.4340	0.3008	0.2853	0.3020	0.3222	-0.0207
Leaf width	G	0.0872	0.3178	0.7831	**1.0000**	0.8212	0.6666	0.3893	0.4710	0.5794	0.4948	-0.0747
	P	0.0630	0.2077	0.5550	**1.0000**	0.4943	0.4496	0.2542	0.3667	0.3683	0.3842	-0.0575
Stem diameter	G	-0.0344	0.3144	0.7217	0.8212	**1.0000**	0.8384	0.2947	0.3175	0.5303	0.7039	0.1382
	P	-0.0178	0.2437	0.3754	0.4943	**1.0000**	0.5334	0.2023	0.2875	0.3479	0.5360	0.0807
No. of nodes per plant	G	0.1072	0.6020	0.7792	0.6666	0.8384	**1.0000**	0.4059	0.3440	0.6161	0.7908	0.1041
	P	0.0579	0.4725	0.4340	0.4496	0.5334	**1.0000**	0.2628	0.2318	0.4199	0.5976	0.0662
Panicle length	G	0.0051	0.4225	0.3523	0.3893	0.2947	0.4059	**1.0000**	0.5309	0.4137	0.4203	0.1187
	P	0.0349	0.2935	0.3008	0.2542	0.2023	0.2628	**1.0000**	0.4365	0.2466	0.2651	0.0590
Panicle width	G	0.1969	0.0711	0.3004	0.4710	0.3175	0.3440	0.5309	**1.0000**	0.7092	0.1542	-0.2892
	P	0.1175	0.1062	0.2853	0.3667	0.2875	0.2318	0.4365	**1.0000**	0.5125	0.1190	-0.1959
Panicle weight	G	0.1897	0.3056	0.4682	0.5794	0.5303	0.6161	0.4137	0.7092	**1.0000**	0.4123	0.0112
	P	0.1290	0.2202	0.3020	0.3683	0.3479	0.4199	0.2466	0.5125	**1.0000**	0.2652	0.0128
Stover yield	G	0.0037	0.7657	0.4308	0.4948	0.7039	0.7908	0.4203	0.1542	0.4123	**1.0000**	0.3103
	P	0.0320	0.6584	0.3222	0.3842	0.5360	0.5976	0.2651	0.1190	0.2652	**1.0000**	0.2684
1000 seed weight	G	-0.3354	0.2979	-0.0180	-0.0747	0.1382	0.1041	0.1187	-0.2892	0.0112	0.3103	**1.0000**
	P	-0.2995	0.2502	-0.0207	-0.0575	0.0807	0.0662	0.0590	-0.1959	0.0128	0.2684	**1.0000**
Grain yield	G	**0.1062**	**0.2969**	**0.3402**	**0.4984**	**0.4291**	**0.5068**	**0.3526**	**0.5552**	**0.9496**	**0.3311**	**0.1852**
	P	**0.0634**	**0.1574**	**0.1833**	**0.2582**	**0.2420**	**0.2507**	**0.1468**	**0.3598**	**0.8552**	**0.1451**	**0.1449**

Table 4: Genotypic and Phenotypic path analysis for direct (diagonal) and indirect (off diagonal) effects of grain yield per plant

		Days to 50% flowering	Plant height	Leaf length	Leaf width	Stem diameter	No. of nodes per plant	Panicle length	Panicle width	Panicle weight	Stover yield	1000 seed weight	Grain yield
Days to 50% flowering	G	1.0000	0.2483	0.0189	0.0872	-0.0344	0.1072	0.0051	0.1969	0.1897	0.0037	-0.3354	0.1062
	P	1.0000	0.1900**	0.0123	0.0630	-0.0178	0.0579	0.0349	0.1175*	0.1290*	0.0320	-0.2995**	0.0634
Plant height	G		1.0000	0.1748	0.3178	0.3144	0.6020	0.4225	0.0711	0.3056	0.7657	0.2979	0.2969
	P		1.0000	0.1355*	0.2077**	0.2437**	0.4725**	0.2935**	0.1062	0.2202**	0.6584**	0.2502*	0.1574**
Leaf length	G			1.0000	0.7831	0.7217	0.7792	0.3523	0.3004	0.4682	0.4308	-0.0180	0.3402
	P			1.0000	0.5550**	0.3754**	0.4340**	0.3008**	0.2853**	0.3020**	0.3222**	-0.0207	0.1833**
Leaf width	G				1.0000	0.8212	0.6666	0.3893	0.4710	0.5794	0.4948	-0.0747	0.4984
	P				1.0000	0.4943**	0.4496**	0.2542**	0.3667**	0.3683**	0.3842**	-0.0575	0.2582**
Stem diameter	G					1.0000	0.8384	0.2947	0.3175	0.5303	0.7039	0.1382	0.4291
	P					1.0000	0.5334**	0.2023**	0.2875**	0.3479**	0.5360**	0.0807	0.2420**
No. of nodes per plant	G						1.0000	0.4059	0.3440	0.6161	0.7908	0.1041	0.5068
	P						1.0000	0.2628**	0.2318**	0.4199**	0.5976**	0.0662	0.2507**
Panicle length	G							1.0000	0.5309	0.4137	0.4203	0.1187	0.3526
	P							1.0000	0.4365**	0.2466**	0.2651**	0.0590	0.1468**
Panicle width	G								1.0000	0.7092	0.1542	-0.2892	0.5552
	P								1.0000	0.5125**	0.1190*	-0.1959**	0.3598**
Panicle weight	G									1.0000	0.4123	0.0112	0.9496
	P									1.0000	0.2652**	0.0128	0.8552**
Stover yield	G										1.0000	0.3103	0.3311
	P										1.0000	0.2684**	0.1451**
1000 seed weight	G											1.0000	0.1852
	P											1.0000	0.1449**
Grain yield	G												1.0000
	P												1.0000

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