www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; 12(12): 2010-2014

www.thepharmajournal.com
Received: 17-10-2023
Accepted: 28-11-2023

YS Borde
M.Sc. Students, Department of Genetics and Plant Breeding, College of Agriculture, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India

Dr. JD Deshmukh
Assistant Professor, Department of Agriculture Botany, College of Agriculture, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India

Dr. HV Kalpande
Head of Department, Department of Agriculture Botany, College of Agriculture, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India

SL Lagad
M.Sc. Students, Department of Genetics and Plant Breeding, College of Agriculture, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India

VS Chavan
M.Sc. Students, Department of Genetics and Plant Breeding, College of Agriculture, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India

Mohammedi Begum
M.Sc. Students, Department of Genetics and Plant Breeding, College of Agriculture, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India

Corresponding Author:
YS Borde
M.Sc. Students, Department of Genetics and Plant Breeding, College of Agriculture, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India

Character association and path analysis studies in *rabi* sorghum (*Sorghum bicolor* (L.) Moench)

YS Borde, Dr. JD Deshmukh, Dr. HV Kalpande, SL Lagad, VS Chavan and Mohammedi Begum

Abstract
Mutation was induced in sorghum genotype 'TSV-32' with the help of electron beam. Mutants from different five mutagenic treatments *viz*., T_1 (100 Gy), T_2 (200 Gy), T_3 (300 Gy), (400 Gy) and (500 Gy) were electron beam treatments with two control treatments *viz*., T_5 (wet control) and T_6 (dry control) were evaluated for correlation and path analysis for the grain yield and some of the independent traits. Association studies indicated that days to maturity, number of primaries, Number of grains per primaries, panicle length, panicle width, 100 seed weight, leaf area and flag leaf area showed significantly positive correlation with grain yield per plant at both genotypic and phenotypic levels. Genotypic correlation magnitude was higher than phenotypic correlation. Partitioning of yield and yield components at both phenotypic and genotypic levels into direct and indirect effects revealed that the characters that had positive direct effects on grain yield were days to 50% flowering, 100 seed weight at both genotypic and Phenotypic level. On grain yield indicating importance of these characters hence, due consideration should be given to these characters while planning a breeding strategy by utilizing *rabi* sorghum.

Keywords: Sorghum mutants, genotypic correlation, phenotypic correlation and genotypic path analysis, phenotypic path analysis

Introduction
Sorghum (*Sorghum bicolor* L. Moench), a C_4 grass and relative of maize, ranks fifth in global cereal production and is an important source of food, feed, fiber and fuel. About 3000 years ago, Ethiopia was the hub of sorghum domestication; other origin centers can be found in portions of the Congo, India, Sudan, and Nigeria (Ayana and Bekele, 1998) [1]. Sorghum is especially adapted to growth in hot, arid, or semi-arid climates. Sorghum crop exhibits considerable differences in plant traits, panicle and grain characteristics including physiological responses to selection and is highly influenced by environmental factors (Ezeaku *et al*., 1997) [5]. The study of relationships among quantitative traits is important for assessing the feasibility of joint selection of two or more traits and hence for evaluating the effect of selection for secondary traits on genetic gain for the primary trait under consideration. A positive genetic correlation between two desirable traits makes the job of the plant breeder easy for improving both traits simultaneously. Even the lack of correlation is useful for the joint improvement of the two traits. On the other hand, a negative correlation between two desirable traits impedes or makes it impossible to achieve a significant improvement in both traits. However, simple correlations do not give an insight into the true biological relationships of these traits with yield. Yield, being quantitative in nature is a complex trait with low heritability and depends upon several other components with high heritability (Grafius, 1959) [6]. These traits are in turn interrelated. Their interdependence influences the direct relationship with yield and as a result the information obtained on their association becomes unreliable (Khairwal *et al*., 1999) [9]. The path coefficient analysis initially suggested by Wright (1921) [17] and described by Dewey and Lu (1959) [4] allows partitioning of correlation coefficient into direct and indirect contributions (effects) of various traits towards dependent variable and thus helps in assessing the cause-effect relationship as well as effective selection. Hence, this study is aimed to analyze and determine the traits having greater interrelationship with grain yield utilizing the correlation and path analysis.

Materials and Methods
The present investigation was undertaken in sorghum (*Sorghum bicolor* L. Moench) at Dept. of Agricultural Botany, VNMKV, Parbhani during *Rabi* 2022-23.

The material for the present study was made available from Bhabha Atomic Research Centre (BARC), headquartered in Trombay, Mumbai, Maharashtra. The pure selfed seed of one *rabi* sorghum genotype 'TSV-32' (*Sorghum bicolor* L. Moench) selection from CSV-20 X Phule Anuradha, were used for mutagenic treatment. By dibbing one seed per hill at a spacing of 45 cm row to row and 15 cm between seeds. The experiment was laid in randomized block design with three replications. As many as 7 treatments including 2 controls (untreated seeds) were sown in plot size of 5.4 m x 4 m (12 rows of 4 meter length) comprising of 300 hills per treatment in each replication. Estimation phenotypic and genotypic correlations were calculated by using the formulae given by Burton (1952) [2] and Johnson *et al*., (1955) [8]. The simple correlation coefficient was subjected to path analysis (Dewey and Lu, 1959) [4].

Results and Discussion

Correlation coefficient analysis

Correlation coefficient is a statistical measure, which denotes the degree and magnitude of association between any two casually related variables. This association is due to pleitropic gene action or linkage or more likely both. In plant breeding correlation coefficient analysis measures the mutual relationship between two characters and it determines character association for improvement yield and other economic characters. Since the association pattern among yield components help to select the superior genotypes from divergent population based on more than one interrelated characters. Thus information on the degree and magnitude of association between characters is of prime important for the breeder to initiate any selection plan. In the present investigation the estimates of genotypic correlation was higher than those of phenotypic correlation for most of the traits. These higher genotypic values whenever observed were contributed to the relative stability of the genotypes. Thus trait with higher genetic correlation may throw light on validity of selection for those traits. Correlation studies revealed that, genotypic and phenotypic coefficients among fourteen yield and yield attributing characters are presented in table 1 and 2. The correlation studies in the present investigation revealed that the grain yield per plant recorded positive and significant correlation with Days to 50% flowering (G= 0.670*, P=0.460*), Plant height (G= 0.651*, P=433*), number of primaries per panicle (G= 0.783**, P=543**), number of grains per panicle (G= 0.813*, P=483*), panicle length (G= 0.844**, P =0.575**), panicle width (G= 0.816*, P=0.634**), 100 seed weight (G= 0.981**, P= 0.493*), leaf area (G= 0.834**, P= 0.482*) and flag leaf area (G= 0.920**, P=489*) at both genotypic and phenotypic level, respectively. The results revealed that any positive increase in these traits will accelerate the yield potential of *rabi* sorghum. So, these traits should be attract for selection in *rabi* sorghum breeding programmes. The positive and significant correlations between yield and yield components in were also reported by Nimbalkar *et al*. (1988) [14], Deepak Kumar *et al*. (2011) [3], Mahajan *et al*. (2011) [12], Khandelwal *et al*. (2015) [10], Jimmy *et al*. (2017) [7], Narkhede *et al*. (2017) [13], Zinzala *et al*. (2018) [18].

Table 1: Genotypic correlation coefficient for fourteen characters studied in *rabi* sorghum.

Character	Days to 50% Flowering	Plant height	Days to maturity	No. of primaries per panicle	No. of grains per primary	Panicle length	Panicle width	100 seed weight	Fodder yield per plant	Relative water content	Chlorophyll content	Leaf area	Flag leaf area	Grain yield per plant
Days to 50% Flowering	1.000	0.892**	0.984**	-0.0126	0.273	-0.363	-0.156	0.555	0.567	-0.371	0.109	-0.487	-0.303	0.670*
Plant height		1.000	0.611*	-0.591	-0.185	0.045	-0.070	0.131	-0.362	0.472	-0.403	-0.117	-0.185	0.651*
Days to maturity			1.000	-0.163	0.195	-0.598	-0.038	0.193	0.310	0.270	-0.236	-0.507	-0.285	0.796 *
No. of primaries per panicle				1.000	0.367	-0.020	-0.389	0.025	0.554 *	-0.671 *	0.966 **	-0.311	0.378	0.783**
No. of grains per primary					1.000	-0.958 **	0.885 **	0.879 **	0.801 *	-0.941 **	0.819 *	-0.545	-0.441	0.813**
Panicle length						1.000	-0.873 **	-0.888 **	-0.908 **	0.699	-0.556	0.947 **	0.836 *	0.844**
Panicle width							1.000	0.746	0.519	-0.434	0.497	-0.816 *	-0.816 *	0.816 *
100 seed weight								1.000	0.689	-0.783 *	0.774 *	-0.584	-0.914 **	0.981 **
Fodder yield per plant									1.000	-0.655 *	0.930 **	-0.950 **	-0.510	0.387
Relative water content										1.000	-0.418*	0.587	0.106	-0.166
Chlorophyll content											1.000	-0.669	-0.153	0.284
Leaf area												1.000	0.545	0.834**
Flag leaf area													1.000	0.920**
Grain yield per plant														1.000

*, ** shows significance at 0.05 and 0.01 levels of probability, respectively.

Table 2: Phenotypic correlation coefficient for fourteen characters studied in *rabi* sorghum

Character	Days to 50% Flowering	plant height	Days to maturity	No. of primaries per panicle	No. of grains per primary	Panicle length	Panicle width	100 seed weight	Fodder yield per plant	Relative water content	Chlorophyll content	Leaf area	Flag leaf area	Grain yield per plant
Days to 50% Flowering	1.000	0.721 **	0.788 **	0.115	-0.074	0.011	0.159	0.183	0.279	0.057	0.278	0.052	0.122	0.460*
Plant height		1.000	0.726 **	-0.410	-0.213	0.108	0.015	0.134	0.023	0.435 *	-0.153	0.170	0.139	0.433 *
Days to maturity			1.000	-0.063	-0.033	0.243	0.033	-0.018	0.035	0.112	0.198	0.070	0.409	0.325
No. of primaries per panicle				1.000	0.329	-0.197	0.121	-0.017	0.298	-0.499 *	0.559 **	-0.188	0.204	0.543**
No. of grains per primary					1.000	-0.566 **	0.488 *	0.289	0.322	-0.414	0.523 *	-0.480 *	-0.189	0.483*
Panicle length						1.000	-0.687 **	-0.431	-0.331	0.363	-0.269	0.605 **	0.657 **	0.575**
Panicle width							1.000	0.631 **	-0.010	-0.311	0.328	-0.453 *	-0.447 *	0.634 **
100 seed weight								1.000	0.283	-0.425	0.265	-0.376	-0.592 **	0.493 *
Fodder yield per plant									1.000	-0.200	0.501 *	-0.142	-0.116	0.047
Relative water content										1.000	-0.594 **	0.531 *	0.300	-0.224
Chlorophyll content											1.000	-0.375	0.072	0.230
Leaf area												1.000	0.587 **	0.482*
Flag leaf area													1.000	0.489*
Grain yield per plant														1.000

Table 3: Direct and indirect effects (Genotypic level) of different characters on seed yield in *rabi* sorghum

Character	Days to 50% Flowering	Plant height	Days to maturity	No. of primaries per panicle	No. of grains per primaries	Panicle length	Panicle width	100 seed weight	Fodder yield per plant	Relative water content	Chlorophyll content	Leaf area	Flag leaf area	Grain yield per plant
Days to 50% Flowering	0.229	0.205	0.262	-0.003	0.063	-0.083	-0.036	0.127	0.130	-0.085	0.025	-0.112	-0.070	0.670
Plant height	0.320	0.358	0.434	-0.212	-0.066	0.016	-0.025	0.047	-0.130	0.169	-0.144	-0.042	-0.066	0.651
Days to maturity	-0.191	-0.202	-0.167	0.027	-0.033	0.100	0.006	-0.032	-0.052	-0.045	0.039	0.085	0.048	0.796*
No. of primaries per panicle	0.003	0.125	0.034	-0.211	-0.078	0.004	0.082	-0.005	-0.270	0.270	-0.204	0.066	-0.080	-0.515
No. of grains per primaries	-0.069	0.046	-0.049	-0.092	-0.250	0.262	-0.297	-0.220	-0.201	0.236	-0.205	0.137	0.110	0.531
Panicle length	0.059	-0.007	0.097	0.003	0.169	-0.161	0.168	0.143	0.147	-0.113	0.090	-0.153	-0.135	-0.744
Panicle width	0.003	0.001	0.001	0.008	-0.024	0.021	-0.020	-0.015	-0.010	0.009	-0.010	0.016	0.016	0.816*
100 seed weight	0.194	0.046	0.068	0.009	0.307	-0.310	0.261	0.349	0.241	-0.274	0.271	-0.204	-0.319	0.981**
Fodder yield per plant	-0.226	0.144	-0.124	-0.510	-0.319	0.362	-0.207	-0.275	-0.398	0.721	-0.371	0.378	0.203	0.387
Relative water content	-0.057	0.073	0.042	-0.197	-0.145	0.108	-0.067	-0.121	-0.279	0.154	-0.217	0.091	0.016	-0.166
Chlorophyll content	0.067	-0.248	-0.146	0.594	0.504	-0.342	0.306	0.476	0.572	-0.868	0.615	-0.411	-0.094	0.284
Leaf area	0.260	0.063	0.271	0.166	0.291	-0.505	0.435	0.312	0.507	-0.313	0.357	-0.533	-0.291	-0.823*
Flag leaf area	0.078	0.048	0.073	-0.097	0.113	-0.214	0.209	0.234	0.131	-0.027	0.039	-0.140	-0.256	-0.918*

Residual effect = 0.36

Table 4: Direct and indirect effects (phenotypic level) of different characters on seed yield in *rabi* sorghum

Character	Days to 50% Flowering	Plant height	Days to maturity	No. of primaries per panicle	No. of grains per primaries	Panicle length	Panicle width	100 seed weight	Fodder yield per plant	Relative water content	Chlorophyll content	Leaf area	Flag leaf area	Grain yield per plant
Days to 50% Flowering	0.874	-0.014	-0.260	-0.046	-0.017	-0.008	-0.040	0.072	-0.136	-0.004	-0.006	-0.017	0.062	0.460 *
plant height (cm)	0.630	-0.020	-0.239	0.164	-0.048	-0.080	-0.004	0.053	-0.011	-0.031	0.003	-0.055	0.071	0.433 *
Days to maturity	0.689	-0.014	-0.330	0.025	-0.008	-0.178	-0.008	-0.007	-0.017	-0.008	-0.004	-0.023	0.208	0.325
No. of primaries per panicle	0.101	0.008	0.021	-0.399	0.074	0.145	-0.030	-0.007	-0.145	0.036	-0.011	0.061	0.104	-0.044
No. of grains per primaries	-0.065	0.004	0.011	-0.132	0.225	0.415	-0.122	0.114	-0.157	0.030	-0.011	0.155	-0.096	0.371
Panicle length (cm)	0.009	-0.002	-0.080	0.079	-0.128	-0.733	0.173	-0.169	0.161	-0.026	0.005	-0.195	0.335	-0.570 **
Panicle width (cm)	0.140	0.000	-0.011	-0.049	0.110	0.505	-0.249	0.249	0.005	0.022	-0.007	0.146	-0.228	0.634 **
100 seed weight (g)	0.160	-0.003	0.006	0.007	0.065	0.315	-0.158	0.395	-0.138	0.030	-0.005	0.121	-0.302	0.493 *
Fodder yield per plant (g)	0.245	0.000	-0.012	-0.119	0.073	0.243	0.003	0.112	-0.486	0.014	-0.010	0.046	-0.059	0.047
Relative water content (%)	0.051	-0.008	-0.037	0.200	-0.093	-0.266	0.078	-0.167	0.098	-0.071	0.012	-0.171	0.153	-0.224
Chlorophyll content (sped values)	0.244	0.003	-0.065	-0.223	0.118	0.197	-0.082	0.105	-0.244	0.042	-0.020	0.121	0.037	0.230
Leaf area (cm^2)	0.046	-0.003	-0.023	0.075	-0.108	-0.443	0.113	-0.148	0.069	-0.038	0.008	-0.322	0.299	-0.475 *
Flag leaf area (cm^2)	0.107	-0.003	-0.135	-0.082	-0.043	-0.481	0.112	-0.233	0.057	-0.021	-0.001	-0.189	0.509	-0.403

Residual effect = 0.22

Path coefficient analysis

Path coefficient analysis Table 3 and 4. revealed that days to 50% flowering and plant height exhibited positive direct effect on grain yield, coupled with significant correlation with grain yield per plant. Positive indirect effects were manifested through plant height, days to maturity, number of grains per primaries, 100 seed weight, fodder yield per plant, chlorophyll content at genotypic level. Though, 100 seed weight exhibited positive direct effects on grain yield coupled with significant association with grain yield. Panicle length and leaf area showed negative direct effect along with negative significant correlation with grain yield per plant. The negative indirect effects were manifested through plant height and leaf area included in the study. Similar results were reported by, Kole *et al.* (2008) [11], Mahajan *et al*. (2011) [12], prasad and Sridhar, (2019) [16] Patil *et al.* (2023) [15]. The results of path analysis indicated that days to 50% flowering and 100 seed weight showed highest positive direct effects along with positive significant correlation with grain yield at both genotypic and phenotypic level in the present material under study. Thus, the present study indicated that the days to 50% flowering, plant height and 100-seed weight are important characters in deciding the grain yield per plant in the present material under study. Hence these characters may be considered as suitable selection indices in sorghum breeding programmes in the present investigation. Residual effect was negligible at genotypic (0.36) and phenotypic (0.22) level. Hence most of the yield and yield contributing character included in the study.

References

1. Ayana A, Amsalu, Bekele E. Geographical Patterns of Morphological Variation in Sorghum (*Sorghum bicolor* (L.) Moench) Germplasm from Ethiopia and Eritrea: Qualitative Characters. Hereditas. 1998;129(3):195-205.
2. Burton GW. Quantitative inheritance in grasses. Proceedings of the 6th International Grassland Congress. 1952;227-283.
3. Deepak Kumar, Shinde G, Biradar BD, Deshpande SK, Salimath PM, Kamatar MY, *et al*. Character association and path coefficient analysis among the derived lines of B B, B R, and R R crosses for productivity traits in *rabi* sorghum (*Sorghum bicolor* L. Moench). Electron J Plant Breed. 2011;2(2):209.
4. Dewey DR, Lu KH. A correlation and path coefficient analysis of components of crested wheatgrass seed production. Agron J. 1959;51:515-518.
5. Ezeaku IE, Gupta SC, Prabhakar VR. Classification of Sorghum germplasm accessions using multivariate methods. Afr Crop Sci J. 1997;7:97-108.
6. Grafius JE. Heterosis in barley. Agron J. 1959;51:551-554.
7. Jimmy M, Nzuve LF, Flourence O, Manyasa E, Muthomi J. Genetic variability, heritability, genetic advance and trait correlations in selected sorghum (*Sorghum bicolor* L. Moench) Varieties. Int. J Agron Agric. Res. 2017;11(5):47-56.
8. Johnson HW, Robinson HF, Comstock RE. Genotypic and phenotypic correlations in soybean and their implications in selection. Agron J. 1955;47:477-483.

9. Khairwal IS, Rai KN, Andrew DJ, Harinarayana G. Pearl millet Breeding. Oxford and IBH Publishing Co., New Delhi; c1999. p. 511.
10. Khandelwal V, Shukla M, Jodha BS, Nathawat VS, Dashora SK. Genetic parameters and character association in sorghum (*Sorghum bicolor* L. Moench). Indian J Sci Tech. 2015;9(22).
11. Kole PC, Chakraborty NR, Bhat JS. Analysis of variability, correlation and path coefficients in induced mutants of aromatic nonbasmati rice. Trop Agric Res Ext. 2008;11:60-64.
12. Mahajan RC, Wadikar PB, Pole SP, Dhuppe MV. Variability, correlation and path analysis studies in sorghum. Res J Agric Sci. 2011;2(1):101-103.
13. Narkhede GW, Mehtre SP, Jadhav RR, Ghuge VR. Correlation and Path Analysis for Grain Yield, its Components and Drought Tolerance in Sorghum [*Sorghum bicolor* (L.) Moench] Genotypes. J Agric Res Technol. 2017;42(3):173-178.
14. Nimbalkar VS, Bapat DR, Patil RC. Genetic variability inter relationship and path coefficients of grain yield and its attributes in sorghum. J Maharastra Agric Univ. 1988;13(2):207-208.
15. Patil S, Kalpande H, Dhutmal R, Badigannavar A, More A, Karpe R. Correlation and path analysis studies in mutant lines of *Rabi* sorghum (*Sorghum bicolor* L. Moench). Pharma Innov J. 2023;12(2):3404-3412.
16. Prasad BV, Sridhar V. Studies on Genetic Variability, Correlation and Path Analysis in Yellow Pericarp Sorghum [*Sorghum bicolor* (L.) Moench] Genotypes. Int. J Curr Microbiol App Sci. 2019;8(12):367-373.
17. Wright S. Systems of mating. Genetics. 1921;6:111-178.
18. Zinzala S, Davda BK, Modha KG, Pathak VD. Studies on Variability, Correlation and Path Coefficient Analysis in Sorghum (*Sorghum bicolar* L. Moench). Int. J Agric. Sci. 2018;10(19):7285-7287.