Plant Archives Vol. 24, No. 2, 2024 pp. 214-220 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org

DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2024.v24.no.2.027

CHARACTER ASSOCIATION AND PATH ANALYSIS FOR GRAIN YIELD AND ITS RELATIVE COMPONENTS IN PEARL MILLET (*PENNISETUM GLAUCUM* L. R. BR.)

Rajdeep Mundiyara[1]*, Giradhari Lal Yadav[1], Rohitash Bajiya[2], Ishwar Singh[1], Vikas Khandelwal[3] and Varsha Kumari[4]

[1]Department of Genetics and Plant Breeding, Agricultural Research Sub-Station, Nagaur - 341 001 (Rajasthan), India.
[2]Department of Agronomy, Agricultural Research Sub-Station, Nagaur - 341 001 (Rajasthan), India.
[3]Department of Genetics and Plant Breeding, Agricultural Research Station, Mandor, Jodhpur - 342 304 (Rajasthan), India.
[4]Department of Genetics and Plant Breeding, Sri Karan Narendra Agriculture University, Jobner, Jaipur - 303 329 (Rajasthan), India.
*Corresponding author E-mail : rmundiyara5@gmail.com

(Date of Receiving-25-02-2024; Date of Acceptance-12-05-2024)

ABSTRACT

Thirty-one entries of pearl millet were evaluated during the *Kharif* season of 2023 using a randomized block design with three replications at the research farm of Agricultural Research Sub-Station, Nagaur (Rajasthan) to estimate the variability parameters, characters association and path analysis for the various traits. The results were revealed that mean sum of squares due to genotypes showed significant differences for all the traits under study, suggested that the entries were genetically divergent. The phenotypic coefficient of variation values was higher than genotypic coefficient of variation values for all the traits which reflect the influence of environment on the expression of traits. High genetic advance as a percentage of mean along with high heritability was observed for number of productive tillers per plant, fodder yield, grain yield, panicle diameter, 1000 grain weight, panicle length and days to 50% flowering**.** The correlation of grain yield was positive and significant at phenotypic and genotypic level with characters *viz.*, days to 50% flowering, panicle diameter and fodder yield. Path coefficient analysis revealed that the traits such as days to 50% flowering, panicle diameter and fodder yield were the most important traits for selection of high yielding genotypes as they exerted highest positive direct effect as well as positive correlation with grain yield.

Key words : Character association, Genetic variability, Heritability, Path analysis, Pearl millet.

Introduction

Pearl millet, scientifically known as *Pennisetum glaucum*, is a resilient and versatile crop that plays a vital role in the agricultural landscape, particularly in arid and semi-arid regions. It is belonging to the Poaceae family and diploid species with chromosome number 2n=14. Pearl millet is a highly cross-pollinated crop because of the protogynous nature of its hermaphrodite flowers. Pearl millet is India's fourth important cereal crop after rice, pearl millet and sorghum (Kumar *et al*., 2022). This grain crop is commonly referred to as bajraand is renowned for its adaptability to adverse environmental conditions, including low rainfall, high temperatures and poor soil fertility. Originating from Africa, bajra has been cultivated for centuries, gradually spreading to other parts of the world, including the Indian subcontinent. The majority of this area is in Asia, Africa and Americas (Gupta *et al*., 2015). In India, it holds significant cultural and agricultural importance, particularly in regions characterized by scanty rainfall and limited irrigation facilities. It occupies 6.70 million hectares with an average production of 9.62 million tonnes and the productivity of 1436 kg/ha (Anonymous, 2022). It is consumed as both feed and fodder for livestock. When compared to other crops, pearl millet is much more nutritious and palatable since it has a higher percentage of calories, proteins (6–15%), fat (5–6%), carbohydrates (60–72%), fiber (1–1.8%) and minerals with a lower HCN content (Fleck, 1981). The foremost pre-requisite in crop breeding is, exploitation of genetic variability existing in the crop for yield and related traits. Correlation and path co-efficient analysis are the important biometrical technique to determine the yield components. The characters that are positively correlated with yield are considerably important to plant breeder for selection purpose. Correlation analysis is a statistical technique used to evaluate the relationship between two or more variables. It measures the strength and direction of association between the traits and reveals the traits that might be useful as an index of selection. Although, the correlation coefficient indicates the nature of association among the different traits. Understanding the direct and indirect contributions of each character to yield is made possible by path analysis, which divides the correlation coefficient into measures of direct and indirect effects (Dadarwal *et al.*, 2020). In order to determine the variability parameters, character association and path coefficient between grain yield and yield related traits in pearl millet, the current study was conducted.

Materials and Methods

Thirty-one entry of pear millet were obtained from ICAR-AICRP on Pearl millet unit, ARS (Agricultural Research Station), Jodhpur, Rajasthan. During the *Kharif* season of 2023, the entries of pearl millet were assessed using a randomized block design with three replications at the research farm of Agricultural Research Sub-Station, Nagaur (Rajasthan). The ground water of the experimental site was saline with a PH of 7.8, electrical conductivity of 5.7 ds m^{-1} and TDS 4500 mg/l. The soil of the experiment site was sandy loam (sand 49.1%, silt 29.6% and clay 21.3%) with a PH of 7.1. It contained 0.55% organic carbon. Each entry was planted in a 4.0 m × 1.80 m plot with three rows that were 60 cm apart from one another. Plants were kept 15 cm apart from one another. Ten plants were chosen at random from each genotype and replication to recorded observations at various stages of crop growth on characteristics such as plant height (cm), number of productive tillers per plant, panicle length (cm), panicle diameter (cm), fodder yield (q/ha) and grain yield (q/ha). However, observations on days to 50% flowering, days to maturity and 1000 grain weight (g) were recorded on a plot-by-plot basis. All the recommended package of practices for pearl millet was followed to raise a healthy crop. The data were subjected to analysis of variance (Panse and Sukhatme, 1985) to determine genotypic and phenotypic coefficients of variation (Burton and De vane, 1953), broad sense heritability (Hanson *et al.*, 1956). The genotypic and phenotypic correlation coefficients were calculated as described by Singh and Choudhary (1985) and as per formula given by Johnson *et al*. (1955). The direct and indirect effects were estimated through path coefficient analysis as suggested by Wright (1921) and elaborated by Dewey and Lu (1959).

Results and Discussion

Genetic variability parameters

The mean sum of squares due to genotypes showed significant differences for all the traits under study, suggested that the entries were genetically different (Table 1). This indicates that there is sufficient scope for selection of promising lines from the present gene pool for grain yield and its components. Thus, it indicates ample scope for selection for different morphological traits for pearl millet enhancement. The genetic variability parameters such as genotypic coefficient of variation, phenotypic coefficient of variation, heritability and genetic advance as percentage of mean for the traits are presented in Table 2. The phenotypic coefficient of variation values was higher than genotypic coefficient of variation values for all the traits, which reflect the influence of environment on the expression of traits. The estimates of GCV and PCV were moderate for days to 50% flowering, number of productive tillers per plant, panicle length, panicle diameter, 1000 grain weight and grain yield; lowest for days to maturity and plant height. Fodder yield was showed higher PCV and moderate GCV. Similar results were also observed by Singh and Singh (2016), Nehra *et al*. (2017) and Talawar *et al.* (2017). Highest heritability estimates were recorded for all the traits. The highest genetic advance as percentage of mean was observed for number of productive tillers per plant, fodder yield, grain yield, panicle diameter, 1000 grain weight, panicle length and days to 50% flowering. The character plant height was showed moderate genetic advance as percentage of mean. Similar findings have been reported in pearl millet by Vidyadhar *et al*. (2007), Dapke *et al.* (2014), Jyothsna *et al*. (2016), Sharma *et al.* (2018) and Singh *et al.* (2018). In the current study, high genetic advance as a percentage of mean along with high heritability was observed fornumber of productive tillers per plant, fodder yield, grain yield, panicle diameter, 1000 grain weight, panicle length and days to 50% flowering**.** This showed the presence of lesser environmental impact and existence of additive gene action in their expression and these traits possessed high selective value.

Correlation coefficient analysis

In general, genotypic correlation coefficients were greater than their corresponding phenotypic correlation coefficients (Table 3), indicating the preponderance of genetic variance in expression of traits as well as masking

Table 1 : Analysis of variance for different morphological traits in pearl millet.

Source of variation	d.f	Mean Sum of Squares								
		Days to 50% flowering	Days to maturity	Plant height (cm)	No. of productive tillers/plant	Panicle length (cm)	Panicle diameter (cm)	Fodder yield (q/ha)	1000 grain weight (g)	Grain yield (q/ha)
Replications	2	3.36	1.96	5.04	0.01	3.36	0.01	8.67	0.07	1.03
Genotypes	30	78.76**	37.41**	414.68**	1.01**	24.63**	0.47**	149.95**	2.96**	34.44**
Error	60	2.22	2.03	7.25	0.03	1.34	0.01	12.98	0.04	2.05

**Significant at P = 0.01

Table 2 : Estimation of genetic variability parameters for different morphological traits in pearl millet.

Characters	Range	Mean	Genotypic coefficient of variation (%)	Phenotypic coefficient of variation (%)	Heritability (%)	Genetic advance as percentage of mean
Days to 50% flowering	39.67-55.67	46.66	10.83	11.29	91.99	21.39
Days to maturity	72.00-84.67	77.84	4.41	4.78	85.29	8.39
Plant height (cm)	154.67-199.33	175.82	6.63	6.80	94.93	13.30
No. of productive tillers per plant	2.23-4.43	3.40	16.85	17.74	90.14	32.95
Panicle length (cm)	19.00-28.33	24.08	11.57	12.54	85.25	22.02
Panicle diameter (cm)	1.70-3.57	2.67	14.62	15.43	89.75	28.53
Fodder yield (q/ha)	24.49-52.59	37.59	17.98	20.37	77.85	32.67
1000 grain weight (gm)	6.49-10.26	8.18	12.06	12.30	96.08	24.35
Grain yield (q/ha)	12.73-23.41	19.55	16.81	18.34	83.99	31.73

effect of environment in modifying the total expression of the genotypes. The correlation of grain yield was positive and significant at phenotypic and genotypic level with characters *viz*., days to 50% flowering, panicle diameter and fodder yield. Number of productive tillers per plant was showed positive and significant correlation with grain yield at genotypic levels. These characters need due consideration during any selection programmes. Similar findings of positive and significant correlation had been reported by Izge *et al*. (2006), Abuali *et al*. (2012) and Bikash *et al*. (2013). Days to 50% flowering showed significant and positive association with days to maturity at genotypic and phenotypic levels. Number of productive tillers per plant had highly significant and positive genotypic and phenotypic correlations with plant height, panicle length, panicle diameter and fodder yield. Panicle lengthhad highly significant and positive genotypic and phenotypic correlations with number of productive tillers per plant, panicle diameter and 1000 grain weight. Panicle diameter had highly significant and positive genotypic and phenotypic correlations with number of productive tillers per plant, panicle length, 1000 grain weight and grain yield. Fodder yield had highly significant and positive genotypic and phenotypic correlations with days to 50% flowering, number of productive tillers per plant, 1000 grain weight and grain yield. Like outcomes were also observed by earlier researcher such as Kumar *et al*. (2016), Bhasker *et al*. (2017), Annamalai *et al*. (2020) and Patil *et al*. (2021).

Path coefficient analysis

In the current study, path coefficient analysis was computed at phenotypic level as well as

Table 3 : Genotypic and phenotypic correlation coefficients between different morphological traits in pearl millet.

Characters		Days to 50% flowering	Days to maturity	Plant height (cm)	No. of productive tillers per plant	Panicle length (cm)	Panicle diameter (cm)	Fodder yield (q/ha)	1000 grain weight (g)	Grain yield (q/ha)
Days to 50% flowering	r_g	1	0.233*	-0.187	0.059	-0.044	0.192	0.324**	-0.074	0.409**
	r_p	1	0.215*	-0.167	0.051	-0.056	0.168	0.280**	-0.077	0.391**
Days to maturity	r_g		1	-0.235*	0.016	0.024	-0.104	-0.213*	0.023	0.097
	r_p		1	-0.227*	0.012	0.015	-0.087	-0.147	0.018	0.081
Plant height (cm)	r_g			1	0.296**	0.204	0.012	-0.102	0.006	0.146
	r_p			1	0.284**	0.179	0.005	-0.088	0.010	0.125
No. of productive tillers per plant	r_g				1	0.277**	0.345**	0.281**	0.058	0.231*
	r_p				1	0.240*	0.294**	0.213*	0.050	0.178
Panicle length (cm)	r_g					1	0.258*	0.069	0.271**	0.195
	r_p					1	0.230*	0.094	0.231*	0.163
Panicle diameter (cm)	r_g						1	0.221*	0.348**	0.377**
	r_p						1	0.197	0.325**	0.329**
Fodder yield (q/ha)	r_g							1	-0.068	0.404**
	r_p							1	-0.057	0.337**
1000 grain weight (gm)	r_g								1	0.024
	r_p								1	0.013

*Significant at P = 0.05 and **Significant at P = 0.01

Table 4 : Direct (diagonal) and indirect (non-diagonal) effects of different morphological traitson grain yield in pearl millet at genotypic (G) and phenotypic (P) levels.

Characters		Days to 50% flowering	Days to maturity	Plant height (cm)	No. of productive tillers per plant	Panicle length (cm)	Panicle diameter (cm)	Fodder yield (q/ha)	1000 grain weight (g)	Grain yield (q/ha)
Days to 50% flowering	G	**0.24558**	0.04999	-0.05339	-0.00561	-0.00361	0.05859	0.11295	0.00471	0.409**
	P	**0.2927**	0.02703	-0.03694	-0.00223	-0.00449	0.04279	0.0677	0.00417	0.391**
Days to maturity	G	0.05719	**0.21465**	-0.06726	-0.00153	0.002	-0.03183	-0.07429	-0.00149	0.097
	P	0.06298	**0.12563**	-0.05014	-0.00051	0.00116	-0.02214	-0.03546	-0.00098	0.081
Plant height (cm)	G	-0.04587	-0.05051	**0.28587**	-0.02797	0.01684	0.0036	-0.03566	-0.00037	0.146
	P	-0.04887	-0.02847	**0.22127**	-0.01239	0.01434	0.00118	-0.0213	-0.00055	0.125
No. of productive tillers per plant	G	0.01459	0.00348	0.08467	**-0.09443**	0.02287	0.10543	0.09803	-0.00372	0.231*
	P	0.01493	0.00147	0.06274	**-0.04371**	0.01916	0.07479	0.0516	-0.00272	0.178
Panicle length (cm)	G	-0.01072	0.00519	0.05821	-0.02612	**0.0827**	0.07878	0.02424	-0.01731	0.195
	P	-0.01642	0.00183	0.03968	-0.01047	**0.07998**	0.05853	0.02261	-0.01246	0.163
Panicle diameter (cm)	G	0.04713	-0.02238	0.00337	-0.03262	0.02134	**0.30527**	0.07705	-0.02221	0.377**
	P	0.04927	-0.01094	0.00102	-0.01286	0.01841	**0.25422**	0.04757	-0.01751	0.329**
Fodder yield (q/ha)	G	0.07952	-0.04571	-0.02922	-0.02654	0.00575	0.06743	**0.34884**	0.00437	0.404**
	P	0.08196	-0.01842	-0.01949	-0.00933	0.00748	0.05002	**0.24179**	0.00308	0.337**
1000 grain weight (gm)	G	-0.01811	0.005	0.00167	-0.00551	0.02244	0.10627	-0.02389	**-0.0638**	0.024
	P	-0.02262	0.00229	0.00225	-0.00221	0.01846	0.0825	-0.01379	**-0.05396**	0.013

Residual effect at genotypic levels and phenotypic levels are 0.58793 and 0.67805, respectively.

genotypic level for all the morphological traits. Path coefficient analysis was carried out by taking grain yield as dependent variable to partition the correlation coefficient into direct and indirect effect in order to determine the contribution of various traits towards the grain yield (Table 4). At phenotypic level, highest positive direct effect on grain yield was observed for days to 50% flowering followed by panicle diameter, fodder yield, plant height, days to maturity and panicle length. These findings support the observations made by Bikash *et al*. (2013). While highest direct negative effect was recorded for 1000 grain weight and number of productive tillers per plant. At genotypic level, highest direct positive effect on grain yield were observed for fodder yield followed by panicle diameter, plant height, days to 50% flowering, days to maturity and panicle length. While highest direct negative effect was recorded for number of productive tillers per plant and 1000 grain weight. The residual effects were low at genotypic level as compared to phenotypic level.Same results were reported by Chaudhary *et al*. (2003), Arulselvi *et al*. (2008), Kumar *et al*. (2014) and Bhasker *et al*. (2017).

Conclusion

Considering the above findings, it becomes clear that direct selection can be done based on days to 50% flowering, panicle diameter and fodder yield, which can support for the enhancement of grain yield in pearl millet.

Acknowledgements

All authors are thankful to ICAR-AICRP on Pearl millet unit, ARS (Agricultural Research Station), Jodhpur, Rajasthan for providing research materials and Officer Incharge of Agricultural Research Sub-Station, Nagaur for providing the facilities to carry out this study.

References

Abuali, A.I., Abdelmulla A.A. and Idris A.E. (2012). Character association and path analysis in pearl millet (*Pennisetum glaucum* L.). *J. Exp. Agricult. Int.*, **2**(3), 370-381.

Annamalai, R.N., Ananthi M., Pillai A. and Leninraja D. (2020). Assessment of variability and character association in pearl millet [*Pennisetum glaucum* (L) R.Br.]. *Int. J. Curr. Microbiol. Appl. Sci.,* **9(6)**, 3247-3259.

Anonymous (2022). *Agricultural statistics at a glance*. Directorate of Economics and Statistics, Department of Agriculture, Cooperation and Farmers Welfare, Ministry of Agriculture and Farmers Welfare, Government of India, pp. 36.

Arulselvi, S., Mohanasundaram K. and Selvi B. (2008). Correlation and path analysis for grain yield and its components in pearl millet [*Pennisetum glaucum* (L.) R. Br.]. *Madras Agricult. J.*, **95 (7-12)**, 311-314.

Bhasker, K., Shashibhushan D., Murali Krishna K. and Bhave M.H.V. (2017). Correlation and path analysis for grain yield and it components in pearl millet [*Pennisetum glaucum* (L). R. Br.]. *Bull. Environ., Pharmacol. Life Sci*., **6(1)**, 104-106.

Bikash, A., Yadav I.S. and Arya R.K. (2013). Studies on variability, correlation and path analysis in pearl millet. *Forage Res*., **39(3)**, 134-139.

Burton, G.W. and De vane E.H. (1953). Estimating heritability in tall fescue (*Festuca arundinacea*) from replicated clonal material. *Agron. J.*, **45**, 478-481.

Chaudhary, M.H., Subhani G.M., Shaheen M.S. and Saleem U. (2003). Correlation and path coefficients analysis in pearl millet (*Pennisetum glaucum* L.). *Pak. J. Biolog. Sci*., **6(6)**, 597- 600.

Dadarwal, S.L., Rajput S.S. and Yadav G.L. (2020). Studies on correlation and path analysis for grain yield and its components in maintainer lines of pearl millet [*Pennisetum glaucum* (L.) R. Br.]. *Int. J. Curr. Microbiol. Appl. Sci.,* **9(12)**, 1158-1164.

Dapke, J.S., Shah D.S., Pawar G.N. Dhembre V.M. and Kumar M. (2014). Genetic variability and character association over environment in pearl millet [*Pennisetum glaucum* (L.) R. Br.] under dryland conditions of Gujarat. *The Bioscan*, **9(2)**, 863-867.

Dewey, D.I. and Lu K.H. (1959). A correlation and path coefficient analysis of components of crested wheat grass seed production. *Agron. J.*, **51**, 515- 518.

Fleck, H. (1981). *Introduction to nutrition*. Macmillan Publishing Co., India, 49.

Gupta, S.K., Nepolean T., Sankar S.M., Rathore A., Das R.R., Rai K.N. and Hash C.T. (2015). Patterns of molecular diversity in current and previously developed hybrid parents of pearl millet [*Pennisetum glaucum* (L.) R. Br.]. *Amer. J. Plant Sci*., **6(11)**, 1697-1712.

Hanson, C.H., Robinson H.F. and Comstock R.E. (1956). Biometrical studies of yield and segregating populations of Korean Lespedza. *Agron. J.*, **47**, 313-318.

Izge, A.U., Kadams A.M. and Gungula D.T. (2006). Studies on character association and path analysis of certain quantitative characters among parental lines of pearl millet (*Pennisetum glaucum*) and their F_1 hybrids in a diallel cross. *Afr. J. Agricult. Res.*, **1(5)**, 194-198.

Johnson, H.W., Robinson H.F. and Comstock R.E. (1955). Estimation of genetic variability and environmental variability in soybeans. *Agron. J.*, **47(7)**, 314-318.

Jyothsna, S., Patro T.S.S.K., Ashok S., Sandhya Rani Y. and Neeraja B. (2016). Studies on genetic parameters, character association and path analysis of yield and its components in finger millet (*Eluesine coracana*). *Int. J. Theoret. Appl. Sci.*, **8(1)**, 25-30.

Kumar, M., Gupta P.C. and Shekhawat H.V.S. (2016). Correlation studies among pearl millet [*Pennisetum glaucum* (L) R. Br.] hybrids. *Elect. J. Plant Breed.*, **7(3)**, 727- 729.

Kumar, R., Harish S., Dalal M.S., Malik V., Devvart, Chugh

L.K., Garg P. and Raj K. (2014). Studies on variability, correlation and path analysis in pearl millet genotypes. *Forage Research*, **40(3)**, 163-167.

Kumar, R., Sanadya S.K., Kumar A., Yadav M.K., Chandel D. and Gupta P.C. (2022). Estimation of correlation coefficient and path analysis in hybrids of pearl millet [*Pennisetum glaucum* (L.) R. Br.]. *The Pharma Innov. J*., **11(4)**, 880-882.

Nehra, M., Kumar M., Kaushik J., Vart D. Sharma R.K. and Punia M.S. (2017). Genetic divergence, character association and path coefficient analysis for yield attributing traits in pearl millet [*Pennisetum glaucum* (L.) R. Br] inbreds. *Chem. Sci. Rev. Lett.,* **6(21)**, 538-543.

Panse, V.G. andSukhatame P.V. (1985). *Statistical methods for agricultural workers*. ICAR, New Delhi, India. p 381.

Patil, S.H., Wadikar P.B., Dhutraj D.N. and Sargar P.R. (2021) Correlation analysis for grain yield and its components in pearl millet [*Pennisetum glaucum* (L.) R. Br.]. *Madras Agricult. J.,* **107**, 10-12.

Sharma, B., Chugh L.K., Sheoran R.K., Singh V.K. and Sood M. (2018). Study on genetic variability, heritability and correlation in pearl millets germplasm. *J. Pharmacog. Phytochem.,* **7(6)**, 1983-1987.

Singh, O.V. and Singh A.K. (2016). Analysis of genetic variability and correlation among traits in exotic germplasm of pearl millet [*Pennisetum glaucum* (L.) R. Br.]. *Indian J. Agricult. Res*., **50(1)**, 76-79.

Singh, O.V., Gowthami R., Singh K. and Shekhawat N. (2018). Assessment of inter-characters associations in the germplasm of pearl millet [*Pennisetum glaucum* (L.) R. Br.] over five years in hot arid climate of Rajasthan, India. *Int. J. Curr. Microbiol. Appl. Sci.*, **7(1)**, 3133-3149.

Singh, R.K. and Chaudhary B.D. (1985). *Biometrical methods in quantitative genetic analysis*. Kalyani Publication, New Delhi.

Talawar, A.M., Girish G., Channabasavanna A.S. and Kitturmath M.S. (2017). Studies on genetic variability, correlation and path analysis in pearl millet (*Pennisetum glaucum* L.) germplasm lines. *Agricult. Sci. Digest-A Res. J.*, **37(1)**, 75-77.

Vidyadhar, B., Chand P. and Devi I.S. (2007). Genetic variability and character association in pearl millet [*Pennisetum glaucum* (L.) R. Br.] and their implications in selection. *Indian J. Agricult. Res*., **41(2)**, 150-153.

Wright, S. (1921). Correlation and causation. *J. Agricult. Res.*, **20**, 557-587.