Plant Archives Vol. 25, No. 1, 2025 pp. 518-522 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

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

DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2025.v25.no.1.078

GENETIC VARIABILITY, CORRELATION AND PATH COEFFICIENT STUDIES IN INTERSPECIFIC BC_2F_2 POPULATION IN CHILLI

Pragnya Singh Grover[1], B.V. Tembhurne[1]*, V. Hanumanth Nayak[1], Suvarna[1], B. Rajanna[1], Gururaj Sunkad[2], R. Somaraju[1] and S.N. Manoj[1]

[1]Department of Genetics and Plant Breeding, University of Agricultural Sciences Raichur, Karnataka, India.

[2]Department of Plant Pathology, University of Agricultural Sciences Raichur, Karnataka, India.

*Corresponding author E-mail : bvtembhurne@gmail.com

(Date of Receiving-08-12-2024; Date of Acceptance-09-02-2025)

ABSTRACT

The experiment was conducted using 200 segregants of interspecific BC_2F_2 population in chilli. The aim was to study and analyse the variability, heritability, genetic advance, correlation and direct and indirect effects of traits for fruit yield. From the experiment it was confirmed that the traits plant height, test weight, fresh fruit yield per plant and dry fruit yield revealed high values of GCV, PCV, heritability along with genetic advance of per cent mean. The characters like dry fruit weight, number of seeds per fruit, seed weight per fruit, test weight, fresh fruit yield per plant exhibited highly significant positive correlation with dry fruit yield per plant. Hence, the selection for these traits can be highly desirable for the yield improvement and further breeding programmes.

Key words : Genetic variability, Correlation, Path coefficient, Chilli.

Introduction

Chilli (*Capsicum annuum* L.) is one of the most significant crops as it can be used as both vegetable and spice. It is cultivated for its pungency, taste and vibrant colour (Hulagannavar *et al*., 2024). In India, chilli is cultivated across approximately 89.0 lakh hectares, yielding 291.28 lakh tonnes and the productivity is 3.27 MT/Ha (Anonymous, 2023). The major chilli producing states in the county are Andra Pradesh, Telangana, Madhya Pradesh and Karnataka. As Karnataka stands at fourth position among the major chilli growing states, it covers an area of 13.421 lakh hectares with a production of around 18.1 lakh tonnes. Increased fruit yield and quality improvement remains as a major objective in chilli. The estimation and analysis of genetic variability present in the germplasm of a crop is a pre-requisite for designing effective breeding programme (Parkash, 2012). Most of the chilli production is affected due to biotic and abiotic stresses. These stresses can be overcome by developing disease and pest resistant cultivars and timely management of the crop. Chilli is affected by various diseases, anthracnose being one of the most major disease in chilli causing a overall yield loss upto 80 per cent (Ridzuan *et al*., 2018). The present investigation was conducted to estimate the variability, heritability, correlation and direct and indirect effects in 200 segregants of interspecific BC_2F_2 population.

Materials and Methods

The material taken for the study were 200 segregants from BC_2F_2 population of chilli which was derived from interspecific cross between *Capsicum annuum* x *Capsicum baccatum* species of chilli. The experiment was carried out in an experimental plot at Department of Genetics and Plant Breeding, College of Agriculture, University of Agricultural Sciences Raichur, during *Kharif* 2023. Sowing of seeds was done during the month of July and 30 days old seedlings were transplanted during August 2023. All recommended agronomic package of practices were followed to raise the plants in the field. The observations for 9 quantitative traits were recorded for 200 segregants. The quantitative traits included in the studies were plant height (cm), days to 50 per cent flowering, fresh fruit weight per five fruits (g), dry fruit weight per five fruits (g), number of seeds per fruit, seed weight per fruit (g), test weight (g), fresh fruit yield per plant (g) and dry fruit yield per plant (g). The phenotypic and genotypic coefficient of variation was calculated using the formula given by Burton and Devane (1953). Broad sense heritability for all the nine characters was worked out using the formula given by Hanson *et al*. (1953) and genetic advance as per cent of mean for each character was worked out by adopting the formula given by Johanson *et al*. (1955). The correlation coefficients were calculated to determine the degree of association of the yield with its attributing traits. The analysis of covariance was conducted by following the method designed by Singh and Chaudhary (1985).

Results and Discussion

Through this study, an attempt was made to assess the mean performance and extent of variability in chilli genotypes which depicts the mean performance of 200 BC_2F_2 plants for 9 quantitative characters. Range, mean, phenotypic and genotypic coefficient of variability heritability estimates in broad sense and genetic advance as per cent mean for the nine quantitative characters are presented in Table 1. Maximum plant height was exhibited in segregants PL-187 (40 cm) and minimum in PL-151 (6 cm), with a mean value of 19.85 cm. Early flowering of 44 days was recorded by segregant PL-180 and maximum of 54 days by PL-129, PL-168 and PL-129. The mean of days to 50 per cent flowering was 50.01 with a standard error of 0.16. Fresh fruit weight per five fruits had recorded a mean of 18.58 g and a standard error of 1.22. The minimum weight registered was 3.47 g in PL-149 and maximum was 38.76 g in PL-154. The mean of dry fruit weight per five fruits registered was 1.61 g with a standard error of 0.10. The highest dry fruit weight was observed in PL-87 (8.13 g) and lowest in PL-121 (0.4 g). The mean number of seeds per fruit registered were 8.15 with a standard error of 0.51, ranging from 0 to 55 (PL-188) seeds. Seed weight per fruit has a mean of 0.29 g and a standard error of 0.01, with a range from 0.11 g in PL-110 and PL- 128 to 1.21 g in PL- 34. Test weight has a mean of 5.61 g with a standard error of 0.22, ranging from 2.5 g recorded in PL- 128 to 10.86 g registered in PL-114. The mean fresh fruit yield per plant was 58.88 g with a standard error of 3.934, and the range was recorded from 27.73 g in PL- 90 to 236.99 g in PL- 88. Dry fruit yield per plant has a mean of 20.03 g and a standard error of 1.33, ranging from 8.01 (PL- 90) to 85.32 (PL- 88) g. These results were on par with the recordings of Verma *et al*. (2008), Luitel *et al*. (2018), Amas *et al.* (2023) and Aruna *et al.* (2023).

The variability among 200 BC2F2 segregants was assessed using several metrics, including range, mean, heritability and genetic advance as a percentage of the mean, as shown in Table 1. Most traits exhibited high phenotypic and genotypic coefficients of variation, with the exception of days to 50 percent flowering, which demonstrated low GCV and PCV values. The PCV and GCV were high for plant height (29.66 and 28.65), fresh fruit weight (59.70 and 56.46), dry fruit weight (90.83 and 58.96), number of seeds per fruit (89.37 and 50.74), seed weight per fruit (86.78 and 63.74), test weight (57.17 and 52.11), fresh fruit yield per plant (76.90 and 55.65) and dry fruit yield per plant (73.90 and 53.70). Similar results were observed by Gopalkrishnan *et al.* (1985), Rani *et al.* (1996), Sreelathakumary and Manju (2002), Smitha and Basavaraj (2006), Sarkar *et al.* (2009), Sharma *et al.* (2010), Chattopadhya *et al.* (2011), Amit *et al.* (2014), Amas *et al.* (2023) and Swetha *et al.* (2023). The findings suggest substantial potential for enhancing yield through phenotypic selection, with minimal environmental influence on character expression and the presence of additive gene action. Low values were observed for both genotypic and phenotypic coefficients of variation regarding days to 50 percent flowering, at 4.21 and 4.66, respectively. The results were congruent with the results recorded by Dutta *et al.* (1976), Sharmeen and Islam (2024) and Banyal *et al.* (2024) for low GCV and PCV for the traits days to 50 per cent flowering. Heritability in broad sense was recorded as high for the traits plant height (93.29%), days to 50 per cent flowering (81.57%), fresh fruit weight (74.52%), test weight (83.10%), fresh fruit yield per plant (60.05%) and dry fruit yield per plant (60.71%). The high heritability coupled with high genetic advance, shows that the genetic components are strong enough to allow sustainable improvement through phenotypic selection. Moderate heritability was observed for the traits dry fruit weight per five fruits (42.14%), number of seeds per fruit (32.23%) and seed weight per fruit (53.95%). The genetic advance of per cent mean was high for eight traits *viz.*, plant height (57.01%), fresh fruit weight (91.65%), dry fruit weight (78.84%), number of seeds per fruit (59.34%), seed weight per fruit (96.44%), test weight (97.86%), fresh fruit yield per plant (95.13%) and dry fruit yield per plant (92.43%). Whereas, low heritability was recorded for days to 50 per cent flowering (7.83%). The observed results were similar to the readings registered by Ajith and Manju (2015) and Swetha *et al.* (2023), Sreekumar *et al.* (2023), Timmarao *et al.* (2023), Banyal *et al.* (2024) and Singh *et al*. (2024).

Table 1 : Estimates of genetic variability parameters for yield and its attributing traits in the BC_2F_2 generation.

S. no.	Characters	Mean±SE	Range		Coefficient of variation		h^2 Broad sense (%)	GAM (%)
			Max.	Min.	PCV (%)	GCV (%)		
1	Plant height (cm)	19.85±0.41	40	6	29.66	28.65	93.29	57.01
2	Days to 50 per cent flowering	50.01 ±0.16	54	44	4.66	4.21	81.57	7.83
3	Fresh fruit weight per five fruits (g)	18.58±1.22	38.76	3.47	59.70	56.46	74.52	91.65
4	Dry fruit weight per five fruits (g)	1.61±0.10	8.13	0.4	90.83	58.96	42.14	78.84
5	No. of seeds per fruit	8.15±0.51	55	0	89.37	50.74	32.23	59.34
6	Seed weight per fruit (g)	0.29±0.01	1.21	0.01	86.78	63.74	53.95	96.44
7	Test weight (g)	5.61±0.22	10.86	2.5	57.17	52.11	83.10	97.86
8	Fresh fruit yield per plant (g)	58.88±3.93	236.99	27.73	76.90	55.65	60.05	95.13
9	Dry fruit yield per plant (g)	20.03±1.33	85.32	8.01	73.91	53.70	60.71	92.43

Table 2 : Estimates of phenotypic correlation coefficients for the yield attributing traits in interspecific BC_2F_2 population.

	PLH	DFF	FFW	DFW	NSF	SWF	TW	FFY	DFY
PLH	1.000	0.159*	-0.019	0.010	0.155*	0.189**	0.100	-0.006	0.041
DFF		1.000	0.051	0.027	-0.166*	-0.218**	-0.152*	-0.086	-0.118
FFW			1.000	0.993**	0.474**	0.483**	0.553**	0.233**	0.181*
DFW				1.000	0.499**	0.504**	0.564**	0.245**	0.208**
NSF					1.000	0.829**	0.634**	0.319**	0.300**
SWF						1.000	0.643**	0.307**	0.285**
TW							1.000	0.275**	0.265**
FFY								1.000	0.593**
DFY									1.000

****** = Significant at 1 per cent ***** = Significant at 5 per cent.

PLH - Plant height DFF – Days to 50 per cent flowering FFW – Fresh fruit weight
DFW – Dry fruit weight NSF – No. of seeds per fruit SWF **-** Seed weight per fruit
TW **-** Test weight FFY **-** Fresh fruit yield per plant DFY **-** Dry fruit yield per plant

Phenotypic correlation coefficient was used as a statistical method to examine the relationships between different traits in a population. For the investigation, nine quantitative traits were evaluated and presented in Table 2. Plant height showed a positive and significant correlation with the number of seeds per fruit (0.155) and seed weight per fruit (0.189). This suggests that taller plants tend to have fruits with more seeds and higher seed weight. Days to 50 per cent flowering was negatively correlated with NSF (-0.166) and SWF (-0.218), indicating that plants that flower earlier tend to have fruits with fewer seeds and lower seed weight. Additionally, DFF showed a negative correlation with TW (-0.152), implying a delay in flowering reduces the test weight of seeds. Fresh fruit weight exhibited strong positive correlations with dry fruit weight (0.993), NSF (0.474), SWF (0.483), TW (0.553) and fresh fruit yield per plant (0.233). This indicates that heavier fresh fruits tend to have more seeds, higher seed weight and higher test weight, contributing positively to fruit yield. Dry fruit weight followed a similar trend to FFW, showing significant positive correlations with NSF (0.499), SWF (0.504), TW (0.564), FFY (0.245) and DFY (0.208), further emphasizing the relationship between fruit weight and overall yield. Number of seeds per fruit had strong correlations with SWF (0.829) and TW (0.634) and also correlated positively with FFY (0.319) and DFY (0.300). This suggests that fruits with a higher number of seeds generally have higher seed weight, test weight, and contribute positively to fruit yield. Seed weight per fruit was highly correlated with TW (0.643), FFY (0.307) and DFY (0.285), indicating that heavier seeds per fruit are associated with higher test weight and fruit yield. Test weight showed positive correlations with FFY (0.275) and DFY (0.265), exhibited a higher test weight contributes to both fresh and dry fruit yield per plant. Fresh fruit yield and dry fruit yield were found significantly correlated (0.593), suggesting that plants producing higher fresh fruit yields tend to also yield higher dry fruit. The results obtained were comparable with the results of Smita and Basavaraj (2006), Amas *et al.* (2023), Patel and Chaurasiya (2023) and Banyal *et al.* (2024).

Table 3 : Direct and indirect effects for dry fruit yield in chilli.

	PH	DFF	FFW	DFW	NSF	SWF	TW	FFY
PH	**0.024**	-0.003	0.021	0.010	-0.009	-0.003	0.008	-0.009
DFF	0.004	**-0.019**	-0.053	0.031	0.010	0.004	-0.013	-0.083
FFW	0.001	-0.001	**-1.060**	1.018	-0.027	-0.008	0.047	0.212
DFW	0.001	-0.001	-1.050	**1.028**	-0.029	-0.008	0.048	0.221
NSF	0.004	0.003	-0.498	0.514	**-0.057**	-0.013	0.053	0.294
SWF	0.005	0.004	-0.509	0.514	-0.048	**-0.016**	0.054	0.285
TW	0.002	0.003	-0.583	0.576	-0.036	-0.010	**0.085**	0.533
FFY	0.001	0.002	-0.244	0.247	-0.018	-0.005	0.049	**0.920**

Residual value: 0.071

PLH - Plant height DFF – Days to 50 per cent flowering FFW – Fresh fruit weight
DFW – Dry fruit weight NSF – No. of seeds per fruit SWF - Seed weight per fruit
TW - Test weight FFY - Fresh fruit yield per plant DFY - Dry fruit yield per plant

Path coefficient analysis serves as a robust statistical method for evaluating the direct and indirect impacts of various factors on a dependent variable. In the field of plant breeding, the primary objective is to improve yield and other beneficial characteristics. The examined data, which assessed direct and indirect effects, is displayed in Table 3. The findings indicated that dry fruit yield per plant was directly affected by several factors: plant height (0.024), dry fruit weight (1.028), test weight (0.085) and fresh fruit yield per plant (0.920). Consequently, focusing on these traits during selection can contribute to overall crop enhancement. The observations obtained were on the line the results of Vikram *et al.* (2014), Sran and Jindal (2019), Srinivas *et al.* (2020), Patel and Chaurasiya (2023). The negative direct effects were observed through the traits, days to 50 per cent flowering (-0.019), number of seeds per fruit (-0.057) and seed weight per fruit (-0.016). Similar results were registered by Vikram *et al.* (2014), Kadwey *et al.* (2015) and Patel and Chaurasiya (2023). However, for the trait seed weight per fruit the result recorded was contradictory to the results of Choudary and Samadia (2004) and Singh *et al.* (2009).

Conclusion

Maximum GCV and PCV was registered by the traits plant height, fresh fruit weight, dry fruit weight, number of seeds per fruit, seed weight per fruit, test weight, fresh fruit yield per plant and dry fruit yield per plant. Low GCV and PCV values was reported for the trait days to 50 per cent flowering. The traits that were concluded to be highly desirable for crop improvement through selection in this investigation were plant height, test weight, fresh fruit yield per plant and dry fruit yield which revealed high values of GCV, PCV, heritability along with genetic advance of per cent mean. It was revealed that the characters like dry fruit weight, test weight, fresh fruit yield per plant exhibited highly significant positive correlation with dry fruit yield per plant and dry fruit yield per plant was directly influenced by these traits. Hence, the selection for these traits can be helpful for the yield improvement and further breeding programmes.

Ackowledgement

The authors are thankful to Science and Engineering Research Board (SERB), DST, Government of India as the work is funded by research grant SB/EMEQ/2019/176.

References

Ajith, P.M. and Manju P. (2015). Genetic analysis of yield and resistance to anthracnose in chilli (*Capsicum annuum* L*). Int. J. Agric. Innov. Res*., **4(1)**, 2319-2321.

Amas, A.N.K., Musa Y., Farid M. and Anshori M.F. (2023). Genetic characteristics of F2 populations obtained through double and three-way crosses in cayenne peppers. *Sabrao J. Breed. Gene*., **55(2)**, 309-318.

Amit, K., Ahad I., Kumar V. and Thakur S. (2014). Genetic variability and correlation studies for growth and yield characters in chilli (*Capsicum annuum* L.). *J. Spices Aromat. Crops*, **23(2)**, 170-177.

Anonymous (2023). Area, production and productivity, Ministry of Agriculture and Farmers Welfare, Government of India. Website: http://www.indiastat.com.

Aruna, T.S., Srivastava A., Tomar B.S., Behera T.K., Krishna H., Jain P.K., Pandey R., Singh B., Gupta R. and Mangal M. (2023). Genetic analysis of heat tolerance in hot pepper: insights from comprehensive phenotyping and QTL mapping. *Front. Plant Sci.*, **14**, 1232800.

Banyal, N., Sharma A. and Lata H. (2024). Genetic variability and trait relationship in green chilli (*Capsicum annuum* L.) under high altitude conditions. *Electron. J. Plant Breed.*, **15(1)**, 185-193.

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

Chattopadhyay, A., Sharangi A., Dai N. and Dutta S. (2011). Diversity of genetic resources and genetic association analysis of green and dry chillies of eastern India. *Chil. J. Agric. Res*., **71(3)**, 350-356.

Choudhary, B.S. and Samadia D.K. (2004). Variability and character association in chilli land races and genotypes under arid environment. *Indian J. Hort.,* **61(2)**, 132-136.

Dutta, M., Dasgupta P.K., Chatterjee S.D. and Majumdar M.K. (1976). Variability, interrelationships and path coefficient analysis for some quantitative characters in chilli (*Capsicum annuum* L.). *Indian Agric*., **23(2)**, 95-102.

Gopalkrishnan, T.R., Nair C.S.I., Salikutty J. and Peter K.V. (1985). Studies on yield attributes in chilli. *Indian Cocoa Arec. Spices J*., **8**, 72-73.

Hanson, G.H., Robinson H.F. and Comstack R.E. (1953). Biometrical studies of yield in segregating populations of Korian Lespedeza. *Agron. J.,* **48**, 267-282.

Hulagannavar, P., Masuthi D.A., Lakshmidevamma T.N., Shet R., Ryavalad S., Tatagar M.H. and Abdul K.M. (2024). Assessment of Genetic Variability in Chilli (*Capsicum annuum* L.) Genotypes for Growth and Yield Traits. *J. Adv. Bio. Biotech*., **27(3)**, 140-148.

Johanson, R.E., Robinson H.W. and Comstock H.F. (1955). Estimates of genetic and environmental variability in soybean. *Agron. J*., **47**, 314-318.

Kadwey, S., Ashwini D., Sunil P. and Ravi K.T. (2015). Correlation and path co-efficient analysis of quantitative and qualitative traits in chilli (*Capsicum annuum* L.). *The Bioscan (Suppl. Gene. Plant Breed.)*, **10(4)**, 1909-1914.

Luitel, B.P., Ro N.Y., Ko H.C., Sung J.S., Rhee J.H. and Hur O.S. (2018). Phenotypic variation in a germplasm collection of pepper (*Capsicum chinense* Jacq.) from Korea. *J. Crop Sci. Biotech*., **21**, 499-506.

Parkash, C. (2012). Estimation of genetic variability and implications of direct and indirect effects of different traits on leaf yield in bathua (*Chenopodium album*). *Indian J. Agri. Sci*., **82(1)**, 71.

Patel, T. and Chaurasiya P.C. (2023). Genetic variability, correlation studies and path analysis in chilli (*Capsicum annuum* L.). *Pharma Innov. J.*, **12(11)**, 963-967.

Rani, P.U. (1996). Evaluation of chilli (*Capsicum annuum* L.) germplasm and its utility inbreeding for higher yield and better quality. *Mysore J. Agric. Sci*., **30**, 343-348.

Ridzuan, R., Rafii M.Y., Ismail S.I., Mohammad Yusoff M., Miah G. and Usman M. (2018). Breeding for anthracnose disease resistance in chili: Progress and prospects. *Int. J. Molecular Sci*., **19(10)**, 3122.

Sarkar, S., Murmu D., Chattopadhyay A. and Hazra P. (2009). Genetic variability, correlation and path analysis of some morphological characters in chilli. *J. Crop Weed,* **5(1)**, 157-161.

Sharma, V.K., Semwal C.S. and Uniyal S.P. (2010). Genetic variability and character association analysis in bell pepper (*Capsicum annuum* L.). *J. Hortic. For*., **2(3)**, 58-65.

Sharmeen, F. and Islam A.A. (2024). Genetic variability and correlation analysis based on yield and yield related traits in chilli (*Capsicum annuum* L.). *Fundam. Appl. Agric.*, **9(1)**, 44-50.

Singh, R.K. and Chaudhary B.D. (1985). Biometrical Methods in Quantitative Genetic Analysis. *Kalyani Publications*, Ludhiyana, p. 54.

Singh, R., Jindal S.K. and Patel S.A.H. (2024). Exploring pickled chilli genotypes through evaluation of variability parameters, character association studies and genetic divergence. *Scientia Horti*., **32(9)**, 113018.

Singh, Y., Sharma M. and Sharma A. (2009). Genetic variation, association of characters and their direct and indirect contributions for improvement in chilli peppers. *Int. J. Veg. Sci*., **15(4)**, 340-368.

Smita, R.P. and Basavaraj (2006). Variability and Correlation studies in Chilli (*Capsicum annuum* L.). *Karnataka J. Agric. Sci*., **19(4)**, 888-891.

Sran, T.S. and Jindal S.K. (2019). Genetic variability and character association analysis in chilli pepper (*Capsicum annuum* L.). *Agric. Res. J*., **56(1)**, 24-32.

Sreekumar, G., Janavi G.J., Nageswari K., Venkatesan K., Muthiah C. and Mohan M.M. (2023). Genetic variability studies in F3 generation of mundu chilli (*Capsicum annuum* L.) for growth, yield and quality. *Electron. J. Plant Breed*., **14(4)**, 1538-1540.

Sreelathakumary, I. and Manju P.R. (2002). Genetic variability, heritability and genetic advance in hot chilli (*Capsicum chinense* Jacq.). *J. Trop. Agric*., **40**, 4 -6.

Srinivas, J., Reddy K.R., Saidaiah P., Anitha K., Pandravada S.R. and Balram M. (2020). Correlation and path analysis study in chilli (*Capsicum annuum* L.) genotypes. *Int. Res. J. Pure Appl. Chem*., **21(21)**, 1-11.

Swetha, B., Devi H.U.N., Sankari A., Geethanjali S. and Sudha M. (2023). Variability studies and genetic divergence in chilli (*Capsicum* spp.) genotypes using multivariate analysis. *Electron. J. Plant Breed.*, **14(3)**, 928-937.

Timmarao, S.K., Sharma H. and Dogra R.K. (2023). Genetic Variability Studies in Chilli (*Capsicum annuum* L.) Genotypes under the Mid Hill region of Himachal Pradesh, India.

Verma, S.K., Negi K.S., Muneem K.C. and Arya R.R. (2008). Preliminary evaluation of chilli germplasm. *Pantnagar J. Res*., **6(1)**, 81-85.

Vikram, A., Warshamana I.K. and Gupta M. (2014). Genetic correlation and path coefficient studies on yield and biochemical traits in chilli (*Capsicum annuum* L). *Int. J. Farm Sci*., **4(2)**, 70-75.