P: ISSN No. 0976-8602 RNI No. UPENG/2012/42622 VOL.-10, ISSUE-1, January 2021
E: ISSN No. 2349-9443 Asian Resonance

Genetic Variability, Heritability and Genetic Advance in Chilli Parental and Cross Varieties

Paper Submission: 25/12/2020, Date of Acceptance: 25/01/2021, Date of Publication: 26/01/2021

Nabarun Sen
Ex-Research Scholar,
Department of Botany,
University of Kalyani,
Kalyani, West Bengal, India

Sankar Narayan Sinha
Environmental Microbiology
Research Laboratory,
Department of Botany,
University of Kalyani,
Kalyani, West Bengal, India

Abstract

Chilli parental varieties along with inter-and intra-specific cross varieties under 3 most popular chilli species (*Capsicum annuum* L.,*Capsicum chinense* Jacq.,*Capsicum frutescens* L.) at the research farm of Bidhan Chandra Krishi Viswavidyalaya, Directorate of Research, Kalyani, West Bengal. India were evaluated to study genetic variation and the relationship between yield and its component using a randomized complete block design during 2009-2011. There were significant variances among genotype of all traits. The phenotypic coefficient of variation (PCV) for all the characters of chilli varieties were greater than genotypic coefficient of variation (GCV), which emphasized the presence of environmental influence to some degree in the phenotypic expression of characters. Number of fruit(s)/plant had the highest PCV (119.97) and GCV (118.99). The findings imply that the narrow sense heritability (h2) was observed to be inferior to those of broad sense heritability (H2) for all the characters of chilli varieties. Genetic advance was observed for plant height (86.23), whereas genetic advance as percent of mean was highest for dry fruit weight (84.09). Greater heritability (h2) was linked with greater genetic advance (86.23) calculated for plant height, which suggested that the character is controlled by additive genes and therefore further advancement could conducted by selection. Fruit yield was significantly associated with most of the characters of chilli varieties at both genotypic and phenotypic levels; therefore, these are fundamental requirement to prepare a successful crop improvement program.

Keywords: Correlation, Coefficient of Variations, Genetic Variability, Genetic Advance, Heritability.

Introduction

Capsicum is a genus of plants from Solanaceae family. It is commonly known as 'chilli'. It is mainly used as vegetable while green and as spices when dried and processed. Likewise it is use in food, natural plant colour and also for its pharmaceutical ingredients. Chilliis exported about 33% of the total spice export from India and share about 16% of the world spice trade (Kadwey *et al*., 2016). India is the second largest producer of vegetables after China and also maximum numbers of vegetable crops are grown due to great diversity of agro climatic condition.Throughout the world, chilli has highly demanding crop. So, genetic improvement program is required to overcome its demand.In genetic improvement program germplasm collection and assessment of genetic variability are the most important steps. Mixing of different characters, yield is influenced by a number of yield-attributing characters, by environment, and by polygenes. So the variability in the plants for these characters are the sum total of heredity effects of concerned genes.A broad range of genetic variability observed in this crop, (Nandi, 2012). This genetic variability in plant is very important for any crop improvement programme. For enhancing the efficiency of selection in any parental population, the presence of genetic variability is of utmost importance. However, since most of the economically important plant characters are polygenic in nature and are highly influenced by environment, it becomes difficult to conclude whether the observed variability is heritable or is due to environmental factors.

Aim of the Study

To study genetic variation and the relationship between yield and its component using a randomized complete block design.

Review of literature

Genetic variability and traits were previously studied by various workers, especially for *Capsicum annuum* as it is the most ecofriendly (economically as well as ecologically) species in the Indian subcontinent (Choudhary and Samadia 2004; Munshi *et al*. 2000) Sreelatha kumary and Rajamony. (2004), observed that high heritability linked with high genetic advance observed for some characters have potential for crop improvement through selection. Similar observation also reported by Singh *et al*. 2013, Janaki *et al*. 2015, as well as Singh.*et al*. 2017. The phenotypic coefficient of variation (PCV) was greater than that of genotypic coefficient of variation (GCV) for all the characters showing that the environment had an important role in influencing the expression of the characters. The findings were in close related with the findings of Jyothi *et al*. 2011, Singh *et al*. 2013.Similar result was also observed by Sreelathakumari and Rajamony 2004, Patel *et al*. 2015. Presence of moderate number (PCV) was observed for characters viz., plant height, fruit length, fruiting span, and days to first picking were observed by Diwakar *et al*. (2012). Low PCV was exhibited for some characters were similar to the finding of Manju and Sreelatha kumari 2002, Tembhurne *et al*., 2008 and Wilson and Philip 2009, Chakarbarty *et al*. 2017,Zehra 2014, A in 2018 for number of fruits plant-1, fruit length, fruit diameter, fruit weight, number of fruits plant, and fruit yield plant-1; Jogi *et al.* (2017) for plant spread. Farwah *et al.*(2020) observed the high estimates of heritability of some traits.

Material and Methods

The breeding programme of chilli varieties were performed in the experimental garden of Bidhan Chandra Krishi Viswavidyalaya, Directorate of Research, Kalyani, Nadia. Seeds of following six pure chilli varieties were procured from germplasm bank of Bidhan Chandra Krishi Viswavidyalaya, Kalyani, Nadia, West Bengal. Seeds were sown in the experimental field and green house of BCKV and fruits were harvested after 3-4 months of growth.The following chilli varieties were selected for breeding programme.

1. Local Line Mahadev Pramanick (MP)-(*Capsicum annuum* L.)
2. Sukhia bullet (SB)-(*Capsicum annuum* L.)
3. Kohima Jolokia (KJ)-(*Capsicum chinense* Jacq.)
4. Habanero orange (HO)-(*Capsicum chinense* Jacq.)
5. Dolle khursani (D)-(*Capsicum frutescens* L.)
6. Mousinram chilli (M)-(*Capsicum frutescens* L.)

The 2-3 weeks old seedlings were transplanted using row to row on the basis of a randomized complete block design with four replications. cowdung was applied. The observations were recorded on four randomly selected plants of each genotype on qualitative and quantative characters. Statistical package for agricultural research (SPAR) version 1.0 programme and SPSS were used to analyses chillivariabilty

Results and Discussion

The genetic parameters *viz.* genotypic variances, phenotypic variances, phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV), heritability estimates and predicted genetic advance as percent of mean for characters studied are presented in Table 1-3.

Correlation coefficient

The correlation coefficient of characters 1(Plant height) and character 2 (primary branches) at genotypic level (Table 1) and phenotypic level (Table 2) are -0.546 and -0.485 ,respectively, characters 1(Plant height) and character 3 (secondary branches) at genotypic level (Table 1) and phenotypic level (Table 2) are 0.095 and 0.093 respectively, characters 1(Plant height) and character 4 (number of flower) at genotypic level (Table 1) and phenotypic level (Table 2) are -0.143 and -0.136 respectively, characters 1(Plant height) and character 5 (number of fruits per plant) at genotypic level (Table 1) and phenotypic level (Table 2) are -0.186 and -0.179 respectively, characters 1(Plant height) and character 6 (dry fruit weight) at genotypic level (Table 1) and phenotypic level (Table 2) are -0.008 and -0.012 respectively,characters 1(Plant height) and character 7 (fruit length) at genotypic level (Table 1) and phenotypic level (Table 2) are -0.089 and -0.083 respectively,characters 1(Plant height) and character 8 (fruit diameter) at genotypic level (Table 1) and phenotypic level (Table 2) are -0.232 and -0.224 respectively,characters 1(Plant height) and character 9 (pedicel length) at genotypic level (Table 1) and phenotypic level (Table 2) are -0.034 and -0.027 respectively, characters 1(Plant height) and character 10 (Pericarp thickness) at genotypic level (Table 1) and phenotypic level (Table 2) are -0.396 and -0.389 respectively, characters 1(Plant height) and character 11 (seeds/fruit) at genotypic level (Table 1) and phenotypic level (Table 2) are -0.236 and -0.232 respectively, character 1(Plant height) and character 12 (seed weight) at genotypic level (Table 1) and phenotypic level (Table 2) are -0.484 and -0.476 respectively there by indicating a very nominal effect of environment on this correlation coefficient.Thus the negative correlation between characters 1(Plant height) and other remaining characters(primary branches, secondary branches , number of Flower,number of fruit per plant , dry fruit weight ,fruit length , fruit diameter, pedicel length,pericarp thickness, seeds/fruit, seeds weight) may be taken as genetically governed.

The correlation coefficient of character 2 (primary branches) and characters 3 (secondary branches) and at genotypic level (Table 1) and phenotypic level (Table 2) are -0.063 and -0.027 ,respectively, character 2 (primary branches) and character 4 (number of flower) at genotypic level (Table 1) and phenotypic level (Table 2) are 0.541 and 0.488 respectively, character 2 (primary branches) and character 5 (number of fruits per plant) at genotypic level (Table 1) and phenotypic level

(Table 2) are 0.603 and 0.541 respectively, character 2 (primary branches) and character 6 (dry fruit weight) at genotypic level (Table 1) and phenotypic level (Table 2) are -0.261 and -0.212 respectively,character 2 (primary branches) and character 7 (fruit length) at genotypic level (Table 1) and phenotypic level (Table 2) are 0.502 and 0.453 respectively, character 2 (primary branches) and character 8 (fruit diameter) at genotypic level (Table 1) and phenotypic level (Table 2) are 0.456 and 0.412 respectively, character 2 (primary branches) and character 9 (pedicel length) at genotypic level (Table 1) and phenotypic level (Table 2) are 0.293 and 0.261 respectively, character 2 (primary branches) and character 10 (pericarp thickness) at genotypic level (Table 1) and phenotypic level (Table 2) are 0.316 and 0.284 respectively, character 2 (primary branches) and character 11 (seeds/fruit) at genotypic level (Table 1) and phenotypic level (Table 2) are 0.639 and 0.592 respectively, character 2 (primary branches) and character 12 (seed weight) at genotypic level (Table 1) and phenotypic level (Table 2) are 0.427 and 0.382 respectively there by indicating a very nominal effect of environment on this correlation coefficient.Thus the negative correlation between character 2 (primary branches) and other remaining characters(secondary branches , number of Flower,number of fruit per plant , dry fruit weight,fruit length, fruit diameter, pedicel length,pericarp thickness, seeds/fruit , seeds weight) may be taken as genetically governed.

The correlation coefficient of characters 3 (secondary branches) and character 4 (number of flower) at genotypic level (Table 1) and phenotypic level (Table 2) are 0.170 and 0.166 respectively, characters 3 (secondary branches) and character 5 (number of fruits per plant) at genotypic level (Table 1) and phenotypic level (Table 2) are 0.097 and 0.092 respectively, characters 3 (secondary branches) and character 6 (dry fruit weight) at genotypic level (Table 1) and phenotypic level (Table 2) are -0.107 and -0.271 respectively,characters 3 (secondary branches) and character 7 (fruit length) at genotypic level (Table 1) and phenotypic level (Table 2) are -0.289 and -0.271 respectively, character characters 3 (secondary branches) and character 8 (fruit diameter) at genotypic level (Table 1) and phenotypic level (Table 2) are 0.067 and 0.072 respectively, characters 3 (secondary branches) and character 9 (pedicel length) at genotypic level (Table 1) and phenotypic level (Table 2) are -0.042 and -0.018 respectively, characters 3 (secondary branches) and character 10 (pedicel length) at genotypic level (Table 1) and phenotypic level (Table 2) are 0.077 and 0.077 respectively, characters 3 (secondary branches) and character 11 (seeds/fruit) at genotypic level (Table 1) and phenotypic level (Table 2) are -0.348 and 0.306 respectively, characters 3 (secondary branches) and character 12 (seed weight) at genotypic level (Table 1) and phenotypic level (Table 2) are 0.105 and 0.105 respectively there by indicating a very nominal effect of environment on this correlation coefficient.Thus the negative correlation between characters 3 (secondary branches) and other remaining characters(number of Flower,number of fruit per plant , dry fruit weight ,fruit length , fruit diameter, pedicel length,pericarp thickness, seeds/fruit, seeds weight) may be taken as genetically governed.

The correlation coefficient of character 4 (number of flower) and character 5 (number of fruits per plant) at genotypic level (Table 1) and phenotypic level (Table 2) are 0.963 and 0.960 respectively,character 4 (number of flower)and character 6 (dry fruit weight) at genotypic level (Table 1) and phenotypic level (Table 2) are 0.345 and 0.342 respectively,character 4 (number of flower) and character 7 (fruit length) at genotypic level (Table 1) and phenotypic level (Table 2) are 0.484 and 0.480 respectively, character 4 (number of flower) and character 8 (fruit diameter) at genotypic level (Table 1) and phenotypic level (Table 2) are 0.005 and 0.005 respectively,character 4 (number of flower) and character 9 (pedicel length) at genotypic level (Table 1) and phenotypic level (Table 2) are 0.245 and 0.238 respectively, character 4 (number of flower) and character 10 (pedicel length) at genotypic level (Table 1) and phenotypic level (Table 2) are -0.135 and -0.132 respectively, character 4 (number of flower) and character 11 (seeds/fruit) at genotypic level (Table 1) and phenotypic level (Table 2) are 0.489 and 0.474 respectively, character 4 (number of flower) and character 12 (seed weight) at genotypic level (Table 1) and phenotypic level (Table 2) are 0.094 and 0.093 respectively there by indicating a very nominal effect of environment on this correlation coefficient.Thus the negative correlation between character 4 (number of flower)and other remaining characters(number of fruit per plant , dry fruit weight, fruit length, fruit diameter, pedicel length,pericarp thickness, seeds/fruit , seeds weight) may be taken as genetically governed.

The correlation coefficient of character 5 (number of fruits per plant) and character 6 (dry fruit weight) at genotypic level (Table 1) and phenotypic level (Table 2) are 0.447 and 0.440 respectively,character 5 (number of fruits per plant) and character 7 (fruit length) at genotypic level (Table 1) and phenotypic level (Table 2) are 0.567 and 0.559 respectively,character 5 (number of fruits per plant) and character 8 (fruit diameter) at genotypic level (Table 1) and phenotypic level (Table 2) are 0.086 and 0.083 respectively,character 5 (number of fruits per plant) and character 9 (pedicel length) at genotypic level (Table 1) and phenotypic level (Table 2) are 0.121 and 0.113 respectively, character 5 (number of fruits per plant) and character 10 (pedicel length) at genotypic level (Table 1) and phenotypic level (Table 2) are -0.024 and -0.020 respectively, character 5 (number of fruits per plant) and character 11 (seeds/fruit) at genotypic level (Table 1) and phenotypic level (Table 2) are 0.559 and 0.538 respectively, character 5 (number of fruits per plant) and character 12 (seed weight) at genotypic level (Table 1) and phenotypic level (Table 2) are 0.191 and 0.188 respectively there by indicating a very nominal effect of environment on this correlation coefficient.Thus the negative correlation between character 5 (number of fruits per plant)and other remaining characters(dry fruit weight,fruit length, fruit diameter, pedicel length,pericarp thickness, seeds/fruit , seeds weight) may be taken as genetically governed.

The correlation coefficient of character 6 (dry fruit weight) and character 7 (fruit length) at genotypic level (Table 1) and phenotypic level (Table 2) are 0.352 and 0.346 respectively,character 6 (dry fruit weight) and character 8 (fruit diameter) at genotypic level (Table 1) and phenotypic level (Table 2) are 0.076 and 0.073 respectively,character 6 (dry fruit weight) and character 9 (pedicel length) at genotypic level (Table 1) and phenotypic level (Table 2) are 0.077 and 0.072 respectively, character 6 (dry fruit weight) and character 10 (pedicel length) at genotypic level (Table 1) and phenotypic level (Table 2) are 0.145 and 0.146 respectively, character 6 (dry fruit weight) and character 11 (seeds/fruit) at genotypic level (Table 1) and phenotypic level (Table 2) are 0.428 and 0.409 respectively, character 6 (dry fruit weight) and character 12 (seed weight) at genotypic level (Table 1) and phenotypic level (Table 2) are -0.124 and -0.121 respectively there by indicating a very nominal effect of environment on this correlation coefficient.Thus the negative correlation between character 6 (dry fruit weight)and other remaining characters (fruit length, fruit diameter, pedicel length, pericarp thickness, seeds/fruit , seeds weight) may be taken as genetically governed.

The correlation coefficient of character 7 (fruit length) and character 8 (fruit diameter) at genotypic level (Table 1) and phenotypic level (Table 2) are -0.108 and -0.105 respectively, character 7 (fruit length) and character 9 (pedicel length) at genotypic level (Table 1) and phenotypic level (Table 2) are 0.416 and 0.407 respectively, character 7 (fruit length) and character 10 (pedicel length) at genotypic level (Table 1) and phenotypic level (Table 2) are -0.142 and -0.142 respectively, character 7 (fruit length) and character 11 (seeds/fruit) at genotypic level (Table 1) and phenotypic level (Table 2) are 0.401 and 0.397 respectively, character 7 (fruit length) and character 12 (seed weight) at genotypic level (Table 1) and phenotypic level (Table 2) are -0.104 and -0.102 respectively there by indicating a very nominal effect of environment on this correlation coefficient.Thus the negative correlation between character 7 (fruit length)and other remaining characters(fruit diameter, pedicel length,pericarp thickness, seeds/fruit, seed weight) may be taken as genetically governed.

The correlation coefficient of character 8 (fruit diameter) and character 9 (pedicel length) at genotypic level (Table 1) and phenotypic level (Table 2) are -0.293 and -0.278 respectively, character 8 (fruit diameter) and character 10 (pericarp thickness) at genotypic level (Table 1) and phenotypic level (Table 2) are 0.715 and 0.710 respectively, character 8 (fruit diameter) and character 11 (seeds/fruit) at genotypic level (Table 1) and phenotypic level (Table 2) are -0.057 and -0.055 respectively, character 8 (fruit diameter) and character 12 (seed weight) at genotypic level (Table 1) and phenotypic level (Table 2) are 0.740 and 0.731 respectively there by indicating a very nominal effect of environment on this correlation coefficient.Thus the negative correlation between character 8 (fruit diameter) and other remaining characters (pedicel length, pericarp thickness, seeds/fruit, seed weight) may be taken as genetically governed.

The correlation coefficient of character 9 (pedicel length) and character 10 (Pericarp thickness) at genotypic level (Table 1) and phenotypic level (Table 2) are -0.406 and -0.392 respectively, character 9 (pedicel length) and character 11 (seeds/fruit) at genotypic level (Table 1) and phenotypic level (Table 2) are 0.065 and 0.070 respectively, character 9 (pedicel length) and character 12 (seed weight) at genotypic level (Table 1) and phenotypic level (Table 2) are -0.395 and -0.383 respectively there by indicating a very nominal effect of environment on this correlation coefficient.Thus the negative correlation between character 9 (pedicel length) and other remaining characters (pericarp thickness, seeds/fruit, seed weight) may be taken as genetically governed.

The correlation coefficient of character 10 (pericarp thickness) and character 11 (seeds/fruit) at genotypic level (Table 1) and phenotypic level (Table 2) are -0.193 and-0.192 respectively, character 10 (Pericarp thickness) and character 12 (seed weight) at genotypic level (Table 1) and phenotypic level (Table 2) are 0.469 and 0.466 respectively there by indicating a very nominal effect of environment on this correlation coefficient.Thus the negative correlation between character 10 (pericarp thickness) and other remaining characters (seeds/fruit, seed weight) may be taken as genetically governed.

The correlation coefficient of character 11 (seeds/fruit) and character 12 (seed weight) at genotypic level (Table 1) and phenotypic level (Table 2) are 0.224 and 0.228 respectively there by indicating a very nominal effect of environment on this correlation coefficient.Thus the negative correlation between character 11 (seeds/fruit) and character 12 (seed weight) may be taken as genetically governed.

Heritability (h^2b)

In the present study, high heritability linked with high genetic advance was recorded only few characters except for dry fruit weight (0.65), number ofprimary (5.48) and secondary branches (4.27), fruit length(1.87),fruit diameter (1.18) (Table 3). These results indicate that these characters are under the influence of additive gene action. These results were similar with the findings of Rai *et al*. (2006) and Savitha (2008) for marketable pod yield per plant, Ganesh (2005) for days to 50% flowering, pod length and plant height, Rai *et al*. (2006) and Savitha (2008) for number pods per plant, Bendale *et al*. (2004). High heritability and moderate GA as percent mean values were observed for the characters numbers of flower per plant. This indicates the influence of non additive gene action and considerable influence of environment on the expression of these traits. Thesetraits could be exploited through manifestation of dominance and epistatic components through heterosis.

Manju and Sreelathakumary (2002) studied thirty two accessions of hot chilli (*C chinense* Jacq) to estimate the variability, heritability and genetic advancein randomized block design with three replications. Higher phenotypic and genotypic coefficients of variation were observed for fruits per plant, yield per plant, seeds per fruit and fruit weight. High estimates of heritability coupled with high genetic advance were also observed for these characters.

Coefficient of Variance

In the present study phenotypic coefficient of variation in general were higher than genotypic coefficient of variation for all the traits, but the difference was very low, indicating low environmental effect on the expression of all the traits and is suggestive of the heritable nature of the traits. These results were similar with the findings of Ganesh *et al*. (2005). The estimates of various genetic parameters are given in Table 3.High GCV and PCV were observed for number of fruit per plant having 118.96 and 119.97 respectively. In case number of flower, seed weight (g), pericarp thickness (mm) showed the higher magnitude of variability for these traits and consequently more scope for their improvement through selection. Similar results were reported by Savitha (2008) and Upadhyay and Mehta (2010) for green pod yield per plant (g). This implied equal importance of additive and non additive gene action.Low GCV and PCV estimates were recorded for days to pedicel length, fruit length and plant height. These results were in confirmation with the findings of Golani *et al*. (2007). The differences between GCV and PCV were low for fruit length (0.15), fruit diameter (0.19) and pericarp thickness (0.19) that these traits are less influenced by the environment and the effect of heritable components was high. Similar results were observed by Ganesh *et al*. (2005) and Rai *et al*. (2008). Number of secondary branches, number of primary branches recorded wider difference between GCV and PCV values indicating dominant role played by the environment in the expression of these traits. Similar observations were also reported by Upadhyay and Mehta (2010).All the yield and yield contributing characters showed moderate to high GCV and PCV values except length and height related parameters. Among these traits the difference between PCV and GCV values was minimum indicating that these traits are less influenced by the environment and indicates a high degree of genetic variability present in these characters and thus a greater scope for effective selection as these characters are less influenced by the environment.

Path Coefficient Analysis

The correlation coefficient between fruit weight (character 6) and other yield characters were portioned into direct and indirect effect through path coefficient analysis in order to find more realistic picture of relationship. Path coefficient analysis was performed using the values of genotypic and phenotypic correlation and the results were presented in Table 65 and 66.The results of path coefficient analysis at genotypic and phenotypic levels are described below.

Path Coefficient at Genotypic Level

The correlation coefficient between dry fruit weight (character 6) and others characters at genotypic level was calculated and the results are presented in Table 65. Whereas some characters had direct effect and some had indirect effect at genotypic level. It was observed that seeds per fruit had the highest (4.845) direct positive effect on fruit weight followed by fruit diameter (4.258), primary Branches (3.435), secondary Branches (1.861), pedicel length(1.546), fruit length(1.453), seed weight (1.334), plant height (1.174), number of fruit/Plant(1.118), pericarp thickness(1.043), number of flower(0.147). The lowest direct positive effect 0.147was found for number of flower towards dry fruit weight. The highest direct negative effect was found for dry fruit weight towards number of primary branches (-6.288) and lowest was (-0.005) found for number of flower. The correlation coefficient between dry fruit weight and number of primary branches was 0.261 (Table 1.) Thus the manifestation of high negative direct effect between fruit weight and number of primary branches was masked by the indirect effect of other characters specially character 10(seeds per fruit), character 1(plant height) and character 7(fruit diameter).

Path Coefficient at Phenotypic Level

The correlation coefficient between dry fruit weight (character 6) and others characters at phenotypic level was calculated and the results are presented in Table 66. Whereas some characters had direct effect and some had indirect effect at phenotypic level. It was observed that number of fruit per plant had the highest (1.036) direct positive effect on fruit weight followed by seeds per fruit (0.697), pericarp thickness (0.544), seed weight (0.254), primary Branches (0.203), secondary Branches (0.171), number of flower (0.100), fruit length (0.096), fruit diameter (0.072), pedicel length (0.040), plant height (0.023). The lowest direct positive effect 0.002 was found for plant height towards dry fruit weight. The highest direct negative effect was found for dry fruit weight towards number of flower (-0.738) and lowest was (-0.001) found for plant height. The correlation coefficient between dry fruit weight and number of number of flower was 0.342 (Table 2.) Thus the manifestation of high negative direct effect betweenfruit weight and plant height was masked by the indirect effect of other characters specially character 11(seeds per fruit) and character 3(number of secondary-branches).

Table 1.Genotypic Correlations for Morphological Characters of Chilli Genotype

Characters	PH	PB	SB	Fl	Fr	FW	FL	FD	PL	PT	S	SW
1.Plant Height	1.000											
2.Primary Branches	-0.546	1.000										
3.Secondary Branches	0.095	-0.063	1.000									
4.Number of Flower	-0.143	0.541	0.170	1.000								
5.Number of Fruit/Plant	-0.186	0.603*	0.097	0.963**	1.000							
6.Dry fruit weight	0.008	0.261	-0.107	0.345	0.447	1.000						
7.Fruit length	-0.089	0.502	-0.289	0.484	0.567	0.352	1.000					
8.Fruit diameter	-0.232	0.456	0.067	0.005	0.086	-0.108	-0.076	1.000				
9.Pedicel length	-0.034	0.293	-0.042	0.245	0.121	-0.077	0.416	-0.293	1.000			
10.Pericarp thickness	-0.396	0.316	0.077	-0.135	-0.024	0.145	-0.142	0.715**	-0.406	1.000		
11.seeds/fruit	-0.236	0.639*	-0.348	0.489	0.559	0.428	0.401	-0.057	0.065	-0.193	1.000	
12.seeds weight	-0.484	0.427	0.105	0.094	0.191	-0.124	-0.104	0.740**	-0.395	0.469	0.224	1.000

** Significant at 0.01 level; * Significant at 0.05 level
PH- Plant height, PB- Primary branches, SB- Secondary branches, Fl- Number of flower, Fr- Number of fruit/Plant, FW- Dry fruit weight, FL- Fruit length, FD- Fruit diameter, PL- Pedicel length, PT- Pericarp thickness, S- seeds/fruit, SW- seeds weight

Table 2.Phenotypic Correlations for Morphological Characters of Chilli Genotype

CHARACTERS	PL	PB	SB	Fl	Fr	FW	FL	FD	PL	PT	S	SW
1.Plant Height	1.000											
2.Primary Branches	-0.485	1.000										
3.Secondary Branches	0.093	-0.027	1.000									
4.Number of Flower	-0.136	0.488	0.166	1.000								
5.Number of Fruit/Plant	-0.179	0.541	0.092	0.960**	1.000							
6.Dry fruit weight	0.012	0.212	-0.092	0.342	0.440	1.000						
7.Fruit length	-0.083	0.453	-0.271	0.480	0.559	0.346	1.000					
8.Fruit diameter	-0.224	0.412	0.072	0.005	0.083	-0.073	-0.105	1.000				
9.Pedicel length	-0.027	0.261	-0.018	0.238	0.113	-0.072	0.407	-0.278	1.000			
10.Pericarp thickness	-0.389	0.284	0.077	-0.132	-0.020	0.146	-0.142	0.710**	-0.392	1.000		
11.seeds/fruit	-0.232	0.592*	-0.306	0.474	0.538	0.409	0.397	-0.055	0.070	-0.192	1.000	
12.seeds weight	-0.476	0.382	0.105	0.093	0.188	-0.121	-0.102	0.731	-0.383	0.466	0.228	1.000

** Significant at 0.01 level; * Significant at 0.05 level
PL- Plant height, PB- Primary branches, SB- Secondary branches, Fl- Number of flower, Fr- Number of fruit/Plant, FW- Dry fruit weight, FL- Fruit length, FD- Fruit diameter, PL- Pedicel length, PT- Pericarp thickness, S- seeds/fruit, SW- seeds weight.

Table 3.Estimation of Parameters of Variability in Various Characters of Chilli

SOURCE	HERITABILITY VALUES	GENETIC ADVANCE VALUES(K=2.06)	GCV	PCV
1.Plant Height	0.974	86.23	39.24	39.76
2.Primary Branches	0.820	5.48	50.71	55.99
3.Secondary branches	0.879	4.27	60.04	64.03
4.Number of flower	0.992	79.34	114.99	115.47
5.Number of fruit/Plant	0.983	53.54	**118.99**	**119.97**
6.Dry fruit weight	0.971	0.65	44.23	44.88
7.Fruit length	0.990	1.87	29.74	29.89
8.Fruit diameter	0.992	1.18	46.57	46.76
9.Pedicel length	0.958	1.37	25.19	25.73
10.Pericarp thickness	0.996	0.73	88.38	88.57
11.seeds/fruit	0.971	49.06	67.12	68.13
12.seeds weight	0.987	0.96	88.26	88.83

Conclusion

The parental and cross varieties of 3 most popular chilli species (*Capsicum annuum* L., *Capsicum chinense* Jacq., *Capsicum frutescens* L.) were taken into the breeding program.From the above findings it may be concluded that there was a wide variability among some parental and cross varieties for most of the characters studied.So, these varieties may be utilized for future breeding programme. The phenotypic coefficient of variation (PCV) for all the characters of chilli varieties were greater than genotypic coefficient of variation (GCV), which concluded that the presence of environmental influence to some cases in the phenotypic expression of characters. Number of fruit(s)/plant had the highest PCV (119.97) and GCV (118.99). The findings imply that the narrow sense heritability (h2) was observed to be inferior to those of broad sense heritability (H2) for all the characters of chilli varieties. Traits observed for high heritability coupled with high genetic gain to be considered well in selection for improvement of the crop.

Acknowledgements

The authors are thankful to Dr.S.K Samanta, Ex Joint Director of Research BCKV and Dr. P.K Sahu, Department of Agricultural Statistics, BCKV, West Bengal for providing every kind of assistance during the present investigation.

The authors are also extend their sincere gratitude to Dr. Shyamal Kanti Mallick, Associate Professor, Ramananda College, Bishnupur, District-Bankura, West Bengal for his co-operation and Support

References

1. *Ain QU. (2018). M.Sc. thesis submitted to Division of Vegetable Science, SKUAST-Kashmir, Shalimar, Srinagar.*
2. *Bendale, V.W., Topare, S.S., Bhave, S.G., Mehta, J.K. and Madav, R.R. (2004). Genetic analysis of yield and yield components in lablab bean [Lablab purpureus (L.) Sweet]. Orissa. J. Hort., 32:99-101*
3. *Chakrabarty S, Islam AKMA.(2017).Selection criteria for improving yield in chilli (Capsicum annum L.). Advances in Agriculture Article ID 5437870, 9p.*
4. *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: 132-36.*
5. *Diwaker K., Vijay B, Rangare SB and Devi S. (2012). Genetic variability, heritability and correlation studies in chilli (Capsicum annuum L.). HortFlora Research Spectrum 1 (3): 248-252.*
6. *Farwah S et al. (2020).Genetic variability, heritability and genetic advance studies in chilli (Capsicum annuum L.) genotypes. International Journal of Chemical Studies 2020; 8(3): 1328-1331*
7. *Ganesh BN. (2005). Genetic variability and divergence studies by D2 statistics and RAPD analysis in field bean (Lablab purpureus L. Sweet). M. Sc. (Agri.) Thesis, Acharya N. G. RangaAgril. Uni. S.V.Agri. College, Tirupati.*
8. *Golani IJ, MehtaDR, Naliyadhra R, K.andKanzariya MV. (2007). Genetic variability, correlation and path analysis for green pod yield and its characters in hyacinth bean.The Orissa Journal of Horticulture, 35(1):71-75.*
9. *Janaki M., Naidu L.N, Ramana CV., and Rao M. P.(2015).Assesment of genetic variability, heritability and genetic advance for quantitative traits in chilli (Capsicum annuum L.).The bioscan10 (2):729-733.*
10. *Jogi MY, Madalageri MB, Mallimar M, Bawoor S, Mangi V, Porika H.(2017). Genetic variability studies in chilli (Capsicum annuum L.) for growth and early yield. International Journal of Pure Applied Bioscience. 5(5):858-862.*
11. *Jyothi, K.U., Kumari SS and Ramana CV. (2011). Variability studies in chilli (Capsicum annuum L.) with reference to yield attributes. J. Hortic. Sci. Biotechnol. 6 (2): 133-135.*
12. *Kadwey, S. Dadiga, A. and Prajapati, S. (2016). Genotypes performance and genetic variability studies in hot chilli (Capsicum annuum L.).Indian Journal of Horticultural Sciences Vol 50 No. (1): Pages 56-60*
13. *Manju, P. R. and Sreelathakumary, I. (2002). Genetic variability, heritability and genetic advance in hot chilli (Capsicum chinense Jacq).. J. Tropical Agric., 40:4-6..*
14. *Munshi, A. D., Behra, T. K. and Singh, G. (2000). Correlation and Path coefficient analysis in chilli. Indian J. Hort. , 57 : 157-59*

15. *Nandi, A. (1992). Genetic variability in chilli (Capsicum annuum L.). Indian journal of Coca Arecanut and Spices Vol.16 No (3/4):Pages 140-05*
16. *Rai N, Asati B.S, Singh A.K, Yadav DS. (2006). Genetic variability, character association and path coefficient study in pole type French bean. Indian Journal of Horticulture, 63(2): 188-191. 506 V.*
17. *Savitha B N. (2008). Characterization of Avare (Lablab purpureus L. Sweet) local collections for genetic variability. MS Thesis, University of Agricultural Sciences, Dharwad.*
18. *Singh P, Jain P.K. and Sharma A. (2017).Genetic Variability, Heritability and Genetic Advance in Chilli (Capsicum annum L.) Genotypes, Int.J.Curr.Microbiol.App.Sci 6(9): 2704-2709.*
19. *Singh, S.K., Sachan C.P and Dubey A.K. (2013) Genetical Studies on Chilli (Capsicum annuum L.). Annals of Horticulture 6 (1): 164-169.*
20. *Sreelathakumary, I., and Rajamony L.(2004). Variability, heritability and genetic advance in chilli (Capsicum annuum L.). Journal of Tropical Agriculture 42 (1-2): 35-37.*
21. *Tembhurne, B.V., Revanappa R and Kuchanur. (2008). Varietal performance, genetic variability and correlation studies in chilli (Capsicum annuum L.). Karnataka j. Agric. Sci. 21 (4): 541-543.*
22. *Upadhyay C, Mehta N (2010). Biometrical studies in Dolichos Bean (Dolichos lablab L.) for Chattisgarh Plains. Research Journal of Agricultural Science, 1(4): 441-447.*
23. *Wilson, D., and Philip. (2009). Genetic variability and genetic divergence in paprika (Capsicum annuum L.) ICHpp16*
24. *Zehra SB. (2014). M.Sc. thesis submitted to Division of Vegetable Science, SKUAST-Kashmir, Shalimar, Srinagar.*