VARIABILITY,CORRELATION AND PATH ANALYSIS OF CHILLI GERMPLASM

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CERTIFICATE

This is to certify that the thesis entitled **"Variability, correlation and path analysis of chilli germplasm"** submitted to the Department of Horticulture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE** in **HORTICULTURE**, embodies the result of a piece of *bona fide* research work carried out by **Subrato Gope Partho**, Registration No. **09-03685** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

I further certify that any help or source of information, received during the course of this investigation has been duly acknowledged.

Dated: June, 2015
Dhaka, Bangladesh

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ABSTRACT

The experiment was conducted to study variability, correlation and path analysis of 10 germplasm of chilli at Horticultural farm of Sher-e-Bangla Agricultural University, Dhaka during the period from November 2013 to May 2014. The experiment was laid out in Randomized Complete Block Design with three replications. The highest yield per hectare (17.10 ton) was obtained from CF 07 treatment and the lowest yield per hectare (8.32 ton) was obtained from CF 09 treatment. Higher inter and intra-cluster distances indicated that higher genetic diversity among genotypes between and within clusters respectively. Data revealed that yield per hectare of chilli germplasm was significantly correlated with number of fruits per plant (0.825), individual fruit weight (0.864), length of fruit (0.409), diameter of fruit (0.855) and chlorophyll content (0.779). From path analysis it was found that number of flowers per plant, number of fruits per plant, individual fruit weight, ascorbic acid content and chlorophyll content had positive direct effect on yield per hectare. Considering the magnitude of variability, correlation, path analysis and agronomic performance, CF 07 (Bullet) may be selected as promising line for future breeding program.

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ABBREVIATIONS		ELABORATIONS
AEZ	:	Agro Ecological Zone
ANOVA	:	Analysis of Variance
@	:	at the rate of
Adv.	:	Advanced
Agric.	:	Agricultural
BARI	:	Bangladesh Agricultural Research Institute
Bio.	:	Biological
BBS	:	Bangladesh Bureau of Statistics
CV	:	Coefficient of Variation
df	:	Degrees of Freedom
DMRT	:	Duncan`s Multiple Range Test
DAT	:	Days After Transplanting
^{0}C	:	Degree Celsius
et al.	:	and others
etc.	:	etcetera
GCV	:	Genotypic Coefficient of Variation

HRC	:	Horticulture Research Centre
Intl.	:	International
MoP	:	Muriate of Potash
PCV	:	Phenotypic Coefficient of Variation
pH	:	Hydrogen ion concentration
%	:	Percentage
RH	:	Relative humidity
SAU	:	Sher-e-Bangla Agricultural University
SRDI	:	Soil Resource Development Institute
TSP	:	Triple Super Phosphate

CHAPTER I
INTRODUCTION

Chilli (*Capsicum frutescence* L.) is one of the most important vegetable-cum-spice crops valued for its aroma, taste, flavour and pungency. The origin of chilli is Mexico. Chilli is grown in all parts of tropical and subtropical regions of the world**.** Owing to its high cash value and consumption rate, the annual trade of chilli is approximately 17 per cent of total spice trade in the world (Krishna *et al*. 2007). Chilli is the second most important Solanaceous crop after tomato throughout the world (Souvanalat, 1999). It is a self pollinated crop but a few percentage of cross pollination may happen by insect.

In Bangladesh the total production of chilli is about 387,368 thousand tons which was produced from 176,015 hectare of land in the year 2014(BBS, 2014).However, low productivity of chilli is a major concern. Consumption of small amount chilli enriches diet and considered as of minerals, vitamins and other food components(Farhad *et al.*, 2010). Chilli contain a complex mixture of essential oils, waxes, coloured materials (mainly capsanthin, capsorubin, zeaxanthin, cryptoxanthin, and lutein), several capsaicinoids and are commonly used as a pungent flavour in food, natural plantcolour, and pharmaceutical ingredient (Hui and Barta, 2006; Sanatombi and Sharma, 2008). The reddish colouring matter of oleoresin is due to carotenoids (0.3% to 0.8% in fruit) (Raghavan, 2007). Hence, if is highly important to develop high yieldingvarieties/hybrids to meet out the increasing demand. Improving of chilli through developing high yielding varieties with desirable qualities could reverse the existing trend of low productivity of this crop (Sreelathakumary and Rajamony, 2002;Verma*et al.*, 2004). To increase the yield, genetic information and efficient breeding methods are required.

Knowledge of inter character relationship is very important in plant breeding for indirect selection for characters that are not easily measured. However, under complex situation, correlation alone become insufficient to explain relationships amongcharacters and thus path analysis of economic yield components with yield is important. Wright, (1921) was first to proposethe correlation and path analysis to

organizethe relationship between the predictor andresponse variables. Correlation simplymeasures the association between yield andother traits whereas path coefficient analysispermits the separation of correlation intodirect effects (path coefficient) and indirecteffects (effects exerted through othervariables). Therefore field investigation wascarried out with a view to study thecharacter association and direct and indirecteffect of independent characters on dependent green chilli yield by assessing the chilli germplasm.

A few old varieties are still recommended for commercialcultivation, which indicates that very limited improvementwork has been carried out because of narrow geneticbase of the crop (Singh *et al*., 1993). Early flowering is generally anindication of early yield which is mostpreferred by the growers to fetch the highmarket price prevailing in the early croppingseason and also reduce the risk of cropmaintenance in late season (Patil *et al*., 2012). For achieving a substantial genetic improvement, a high knowledge of genetic diversity and variability is essential to improve new varieties of chilli in the country. Selection of better plant type either from local or exotic genotypes can be of immense value to the breeder. Keeping this view in mind, 10 germplasms of chilli were collected from throughout the country and their variability, correlation and path analysis was assessed by this study.

Collection andmaintenance of the genetic diversity in chilli are important to avoid geneticerosion. Besides the identification of species, the characterization and evaluation ofgenotypes maintained in gene banks are of fundamental importance (Sudre *et al*.,2010).Genetic cataloguing based on standard descriptors helps to easily describe themorphological features of a genotype and thus helps exchange of information aboutnew genotypes. Genetic diversity plays an important role in plant breeding because hybrids between lines of diverse origin generally display a great heterosis than those between closely related strains (Singh, 1983) which permits to select the genetically divergent parents to obtain the desirable recombination of the segregating generations. Improvement in yield and quality of any crop is achieved

by selecting genotypes with desirable character combinations that are generally present in the nature or genetic manipulation of diverse parents through hybridization program (Golakia and Maken, 1992).

Multivariate analysis with D^2 technique measures the amount genetic diversity in a given population in respect of several characters. It is one of the potent techniques for measuring the genetic divergence both in intra and inter cluster level. If a plant breeding program is to be advanced more rapidly and efficiently, knowledge of inter-relationships between yield contributing characters is necessary. Thus, determination of correlation between characters has a considerable importance in selection practices, since it helps in the construction of selection indices and also permits for the prediction of correlated response. Characterization and evaluation of germplasm are prerequisite for theutilization of the available diversity in the chilli improvement programme. Desirableparental combinations provide the basis for selection in the follow up hybrid breedingprocess for exploitation of heterosis (Thul *et al.,* 2009).

Desirable parentalcombination can be identified on the basis of cluster analysis. To initiate anybreeding work, it is necessary to assess the genetic variability present in theindigenous genotypes for yield and its components. Hence, the genotypes were characterized toassess the variability and identification of promising genotypes which can be used in further breeding programme. The development of an intensive breeding and improvement program needs detailed biological information and an understanding of genetic variation for yield and its components. There must be a thorough knowledge of the existence of variability, correlations and path analysis between yield and its components.

Considering the above mentioned facts this research work was under taken with the following objectives-

1. To evaluate the performance of different chilli cultivars for yield and yield contributing characters;
2. To estimate genetic diversity of chilli germplasm;
3. To assess the relationship of yield and different yield contributing characters; and
4. To select the promising line for future breeding programs.

CHAPTER II

REVIEW OF LITERATURE

Very few research reports are available on the improvement of this crop have been done in Bangladesh. Research effort on variability, correlation between different characters and path analysis of chilligermplasm seems to be also meager. However, some of the important and informative works conducted at home and abroad in this aspect reviewed under the following headings:

2.1 Variability

Understanding genetic diversity presented among cultivars or accessions have practical application in protecting genotypes, conservation and widening the genetic basis of varieties (Charcosset*et al*., 1998).

Datta and Das (2013) werecollected fifty three genotypes ofchilli*(Capsicum annuum*L.) from different parts of the West Bengal, India were characterized for 23 charactersnamely, stem colour, plant growth habit, branching habit, leaf size, leaf shape, leaf margin, leaf colour, leaf pubescence, pigment at node, flower per axil, corolla colour, anther colour, calyx margin, mature fruit colour at intermediate stage, fruit shape, fruit position, fruit adherence to the calyx, fruit shape at pedicel attachment, blossom end fruit shape, ascorbic acid content of the fruit, capsaicin in red fruit and colour value of the ripe fruit. These genotypes upon cataloguing showed distinct variations with respect to vegetative, inflorescence, fruit and quality characters. A wide range of variation was also observed among the genotypes for several morphological, fruit and quality characters. Among the different characters, white corolla colour showed 100 % frequency and higherfrequency was also recorded in single flower per axil (86.79 %), number pigmentation at node (83.02 %) and green fruit colour (69.81%) at intermediate stage. Predominance of single descriptor state was found in more than 50 % genotypes for 15 characters. Based on the D^2 value 53 genotypes were grouped into 17 clusters and results indicated that Cluster I and Cluster VII comprised with 29 and 9 genotypes respectively. Rest of clusters consisted of one genotype in each

case. Variability studies revealed that there was a wide range of variability for all the characters studied. High heritability along with higher genetic advance (as a %age ofmean) was found in capsaicin content in fruit, number of fruits per plant,yield per plant and primary branches per plant.

Yatung *et al.*(2014) were conducted genetic diversity on 30 chilli (*Capsicum annuum* L.) genotypes of Indian origin at the research farm of Vegetable Science, College of Horticulture and Forestry, Central Agricultural University, Pasighat, Arunachal Pradesh, India. Twelve quantitative characters *viz.* plant height (cm), number of primary branch per plant, days to first flowering, fruit length (cm), fruit diameter (cm), number of fruit per plant, average fruit weight (g), green fruit yield per plant (g), number of seed per fruit, ascorbic acid (mg/100g), capsaicin content (%) and chlorophyll content (mg/g) were taken into consideration. The analysis of variance revealed considerable variability among the genotypes for the character studied. Cluster analysis was used for grouping of 30 chilli genotypes under the study grouped into six clusters. Cluster III had maximum (14) and cluster IV and V had the minimum number (1) of genotypes. The highest (459.81) inter cluster distance was observed between cluster II and IV and the lowest (36.04) between cluster I and IV. Cluster III (D^2= 67.66) have exhibited highest intra cluster distance and the lowest was observed in cluster II (D^2=11.19). The characters capsaicin content and ascorbic acid contributed maximum towards divergence.
Ajjapplavara and Channagoudra (2009) were studied genetic variability, heritability and genetic advance for 18 different quantitative charactersin 36 genotypes of chillies. The study indicated that the moderate to high genotypiccoefficient of variation (GCV) and phenotypic coefficient of variation (PCV) were observed formost of the characters except days to 50 percent flowering. High heritability (broad sense) withhigh genetic advance as per cent mean was observed for most of the characters except plant heightand days to 50 per cent flowering, respectively.

Janaki *et al.* (2015) were carried out the investigation during kharif 2012-13 at Horticultural Research Station, Lam, Gunturwith 63 genotypes of chilli (*Capsicum*

annuum L.) in a randomized block design with two replications to estimatethe genetic variability, heritability and genetic advance for ten quantitative traits. Analysis of variance revealedsignificant differences among the genotypes for all the traits studied indicating the presence of sufficient variabilityin the studied material. The PCV was higher than GCV and the difference between PCV and GCV was narrow formost of the characters revealing little influence of the environment in the expression of these traits. Highmagnitude of PCV and GCV were observed for percent of fruit set, number of fruits per plant, fruit diameter,average dry fruit weight, number of seeds per fruit and yield per plant suggesting the existence of wide range ofgenetic variability in the germplasm for these traits and thus the scope for improvement of these charactersthrough simple selection would be better. High heritability coupled with high genetic advance as percent ofmean was observed for all the characters except days to 50 % flowering indicating the predominance of additivegene action making the simple selection more effective.

Zehra *et al.* (2015)were conducted the genetic divergence study in 64 genotypes of chilli (*Capsicum annuum* L.) for 15 agro-morphological traits. Significant divergence existed among 64 chilli genotypes almost for all the traits. The genotypes under study were grouped into eight clusters as per Mahalanobis D^2 (1928) analysis employing Tocher's method with maximum number of genotypes in cluster I (37) followed by cluster IV (12), cluster II (6), cluster V (5) and rest of the clusters were mono-genotypic. Maximum intercluster distance was observed between clusters II and VI (19369.21), while maximum intra-cluster distance was observed in cluster IV (4230.34). The percent contribution towards the total genetic divergence revealed that plant spread (29.76%), seed yield per plant (25.69%), average fruit weight (17.41%), number of fruits per plant (10.22%), days to first flower (4.01%), fruit length (4.76%), number of branches per plant (4.51%) and fruit diameter (2.88%) were the major contributing characters towards total genetic divergence. The crosses between the genotypes from cluster VI with II and VIII

and cluster VIII with those of I, III and IV are likely to exhibit high heterosis and produce recombinants with desired traits in segregating generations.

Sharma *et al.* (2010) were investigated on genetic variability including mean, genotypic and phenotypic variances, coefficient of variation, heritability, and genetic advance was conducted on genetically diverse twenty three genotypes of bell pepper. Significant differences were observed among the genotypes for all the traits. On the basis of mean performance, genotypes PRC-1, SSP, Kandaghat Sel. and Ranichauri Sel-1 were outperformed for fruit yield per plant, average fruit weight, number of fruits per plant and took less number of days to 50% flowering. The phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) were high for fruit yield per plant and ascorbic acid content indicating that these traits had wide genetic variability and would respond better to selection. High heritability and high genetic advance were recorded for average fruit weight, fruit yield per plant, fruit diameter, number of lobes per fruit, days to first harvest, leaf area and ascorbic acid content indicating the role of additive gene action for the inheritance of these traits. At genotypic levels, the traits fruit length, fruit diameter and number of fruits per plant revealed significant positive correlation with fruit yield per plant. Number of fruits per plant exhibited the highest positive direct effect followed by average fruit weight, number of branches per plant, pedicel length and harvest duration at genotypic level.

Chattopadhyay *et al*. (2011) were characterizedthirty four genotypes during a 2-yr period. Most of the genotypes possessed the character constellation of *C. annuum*. Two genotypes, ‘Chaitali Pointed’ and ‘BC CH Sel-4’ were found most promising with respect to green fruit yield (272.79 g, 221.10 g per plant) and dry fruit yield (54.56 g, 44.44 g per plant). Phenotypic and genotypic coefficient of variation values for green fruit weight (119.95%, 111.26%), green fruit girth (89.76%, 48.93%), weight of red ripe fruit (112.02%, 111.93%), weight of dry fruit (111.63%, 110.97%) and number of fruits per plant (86.05%, 85.02%) were recorded to be high. Green fruit yield per plant, ascorbic acid content, and number

of fruits per plant also showed very high broad-sense heritability and genetic advance. From the study of correlation and path coefficient analyses, the number of fruits per plant, green fruit length for green chilli, weight of dry fruit and the number of fruits per plant for dry chilli were found to the most important selection indices.

Ullah *et al.* (2011) were testedtwelve selected open pollinated genotypes at the research and development center (R&D) of Energypac Agro Ltd., Monipur, Gazipur, Bangladesh in Randomized Complete Block Design (RCBD) with three replications during Rabi season 2009. Statistically, significant variation was observed among tested materials for all the characters studied. The higher genotypic coefficient of variations was found in case of fruit yield per plant followed by fruits per plant, average fruit weight and fruit length. High heritability was observed for all the tested characters except fruit diameter. High heritability with high genetic advance in percentage of mean was recorded for the characters fruit yield per plant, fruits per plant, plant height and days to 50% flowering indicating role of additive gene action in the expression of these traits. Fruits per plant, fruit length and fruit diameter were the major characters contributing to yield as these traits were significantly and positively associated with yield per plant. Maximum contribution of fruits per plant to yield was observed in path analysis, which was followed by average fruit weight, days to first flowering and fruit length through higher direct effect.

Krishnamurthy *et al.* (2013) were used twenty four Indian chilli inbreed lines of different regions and six inbreed lines of Taiwan as pollen parents and five CMS lines from Taiwan were used as female parents for crossing. In 2006 and 2007, crossings were made between 24 Indian and six Taiwan testers with the five Taiwan CMS A – lines in Line × Tester mating design. Single floret was selected and used for crossing in insect proof net house and pollinated floret was covered with thin layer of cotton to control out crossing. The F_1 seeds were harvested from all the crosses at the end of respective cropping season, 2006 and 2007. The 150 F_1

progenies were obtained from 30 testers and five female parents along with 30 selfed parents and five maintained CMS B Lines. Seeds of the 35 parental genotypes (30 testers and 5 CMS B Lines) and their 150 F_1s were sown at two locations viz., University of Agricultural Sciences (UAS), Bangalore and Indian Institute of Horticultural Sciences (IIHR) Bangalore during 2008. All the 150 progenies along with their parents were transplanted in randomized complete block design (RCBD) at both locations. All the recommended package of practices was followed to raise a healthy crop. Ten plants in each genotype were tagged from each replication and recorded nine characters viz., Days to 50 per cent flowering, Days to first fruit maturity, Plant height (cm), Fruits per plant, Fruit length (cm), Fruit width (cm), Hundred seed weight (g), Green fruit yieldper plant (g) and Red fruit yieldper plant (g) in each environment.

Kadwey *et al*. (2016) were evaluated twenty five diverse chilli (*Capsicum annuum* L.) genotypes in a field study to assess genetic variability, heritability and genetic advance. The highest PCV were recorded for number of fruit perplant(42.0), dry fruit yield perplant (30.34), seed yield perplant (28.94), fruit weight of dry chilli (23.38), number of primary branchesper plant at 30 DAT (21.88) and fruit width (21.0). While, highest GCV was observed for number of fruitper plant (41.77), dry fruit yieldper plant (29.61), seed yieldper plant (27.67) and fruit weight of dry chilli (21.67), The value of heritability (h^2bs) was found to be very high for fruit yieldper plant (97.91), seed yieldper plant (96.82), dry fruit yieldper plant (95.24), days to first picking (94.88), fruit length (93.30), fruit weight of green chilli (93.26), fruit yield per plot(92.91), fruit yieldper ha (92.90) and fruit width (92.02). The highest estimates of genetic advance as percentage of mean was recorded for number of fruitper plant (45.59), fruit weight of dry chilli (41.38), fruit width (39.82), dry fruit yieldper plant (39.52), seed yieldper plant (38.70), fruit weight of green chilli (38.10), fruit yield per plant (37.33) and fruit length (36.78) were observed for these all the above characters, imply the potential for crop improvement in chilli through selection.

Tilahun *et al*.(2013) were analyzed genetic relationships between thirteen genotypes of chilli and paprika collected from different places of India using twelve RAPD and nine SSR primers. Clustering based on the generated markers was conducted using NTSYS software's. The RAPD primers produced a total of 78 bands of which 65 were polymorphic with a mean of 5.41 polymorphic bands per primer while the SSR primers produced 28 SSR loci with a mean of 3.22 alleles per SSR locus. The similarity index matrix ranged from 0.36 to 0.91 (RAPD) and 0.117 to 0.9 (SSR) with mean of 0.62 and 0.39 respectively. Polymorphic Information Content (PIC) values of the SSR primersranged from 0.00 to 0.75 with an average value of 0.546. The resulting RAPD and SSR dendrograms separated the cultivars with small and erect fruit position from the large and medium fruited cultivars with declining fruit position. Both RAPD and SSR markers showed genetic variability in the studied pepper genotypes and they are powerful tools for estimating genetic similarities and diversity.

Sreelathakumary and Rajamony(2004) were evaluated thirty-five chilli (*Capsicum annuum* L.) genotypes in a field study to assess genetic variability, heritability andgenetic advance. Higher phenotypic and genotypic coefficients of variation were observed for leaf area, fruits per plant, fruitweight, fruit length, fruit girth and yield per plant. High heritability coupled with high genetic advance observed for these characters imply the potential for crop improvement through selection.

Kumar *et al.* (2010) were revealed a study of genetic diversity in 25 chilli genotypes for various characters shows substantial differences for all the traits. Based on D^2 values, the genotypes were clustered into eight constellations. Cluster I contained nine genotypes followed by cluster-II (four) cluster IV and V (two each). The maximum inter cluster distance (D=12.75) was observed between cluster VI and cluster VIII. The cluster IV recorded maximum intra-cluster distance (D=5.91). Intercrossing among the genotypesbelonging to cluster III, IV and I was suggested to develop high yielding varieties with other desirable characters or may

be used as potential donors for future hybridization programme to develop better chilli variety with good fruit yield.

Gogoi and Gautam (2002) were studied genetic variability for various characters in fifty-two chilli *(Capsicum* spp.) genotype comprising local collections, established varieties and advanced breeding lines. Wide variationswere observed for all the characters indicating diverse genetic nature of the base population.The characters fruit drop percentage, fresh fruit yield per plant and dry fruit yield per plantshowed high genotypic and phenotypic coefficient of variation. Heritability estimates were moderateto high for all the characters, except for number of primary branches. High heritability along withhigh genetic advance were observed for fruit length, number of fruits per plant, fresh and dry fruit yield per plant, fruit drop percentage and leaf area index, indicating the importance of these traits in yield improvement programme.

Bhutia *et al*. (2015) were selected five genetically diverse parents out of twenty two genotypes of diverse origin through multivariate analysis. They were crossed in diallel fashion without reciprocals to produce 10 F_1 hybrids to determine mode of gene action, extent of heterosis and dominance effect, and to estimate combining ability for 14 quantitative characters. The predictability ratio revealed overwhelming response of non-additive gene action in controlling the expression of fresh fruit yield per plant and most of the yield components, antioxidant vitamins (vitamin C and beta-carotene, a precursor of vitamin A) content of fruit and severity of leaf curl virus disease. The breeding procedures applicable to improvement of studied characters are discussed. The maximum extent of significant heterobeltiosis in desired directions was recorded from hybrids in a five-parent diallel of chilli for fruit yield per plant (71.06%*, significant at the 5% level), PDI of leaf curl virus (−47.61%**, significant at the 1% level), capsaicin content of fruit (46.67%**), beta carotene content of fruit (36.17%**) and vitamin C content of fruit (28.93%**). The study depicted that hybrid vigour is available for commercial production of chilli hybrid, and that isolation of pure lines from the segregating

generation of heterotic F_1s is an alternative approach to improve fruit yield, quality and viral disease tolerance. Partial- to over-dominance effects were found to be involved in the inheritance of fruit yield and other horticultural traits. Two inbred lines BCCH Sel-4 and Chaitali were the most promising general combiners for fruit yield per plant and other important traits that could be utilized in future chilli improvement programmes. We could also able to isolate a promising hybrid, BCCH Sel-4 × AC-575 on the basis of its *per se* performance; heterosis manifested in them and the sca effects, and this hybrid could make a dent by fulfilling the major horticultural attributes in commercial chilli growing zones of the tropics.

Hasan *et al*. (2015) were investigated thirteen genotypes of chilli (*Capsicum annuum* L.) to understand the extent of genetic diversity through 6 yield attributing characters. Genetic diversity in chilli genotypes based on six characters was estimated using Mahalanobis's D^2 statistics. The genotypes were grouped into five different clusters by non-hierarchical clustering. The cluster I had the maximum number (5) of genotypes while cluster IV and V each contained only one genotype. The highest inter-cluster distance was observed between cluster I and IV (24.483) and the lowest inter-cluster distance was observed between the clusters II and V (11.633). The results indicated that fruits/plant (35.8%) contributed maximum to the total divergence followed by fruit length (21.6%) and yield/plant (21.1%). Cluster IV produced highest mean for fruit weight (4.48), fruits/plant (149.90) and yield/plant (676.03). Cluster V produced highest mean for fruit length (10.23), pedicel length (4.94) and fruit diameter (10.36). Cluster I and III produced maximum lowest mean for almost all characters. Therefore, genotypes belonging to the cluster IV and V may be used as potential parents for future hybridization programme to develop superior chilli variety with desired traits.

Bignardi *et al*. (2016) were monitored two varieties of pepper with different pungencies for capsaicinoids, colour and furosine. Aliquots were stored at room and at low temperature during one year. At low temperature all indicators were stable in both varieties, while at room temperature, redness and capsacinoids

decreased significantly, while furosine increased. High correlation was found between those markers. The more pungent variety exhibited higher stability in terms of all parameters. Differences observed suggest a potential protective effect exerted by capsaicinoids on powder stability. The decrease in capsaicinoids and redness accompanied by furosine increase showed a linkage between those markers never reported before. Considering that capsaicinoids and furosine occurrence have strong impact on the nutritional profile, the findings of this work show relevant changes in the nutritional value of chilli pepper powder after storage.

Datta and Jana (2010) were evaluated 65 genotypes in a randomized block design with three replications in two consecutive winter seasons of the year 2005-06 and 2006-07. Genetic variability, heritability, genetic advance as percentage of mean, correlation and path coefficient analysis were computed for different growth, yield and quality characters. On the basis of pooled value estimates of GCV and PCV were recorded for those characters which indicated that contribution of those characters towards final phenotypic expression were mostly of genetic rather than environmental factors. The high GCV value was observed for capsaicin content in green fruit, number of fruits per plant, extractable fruit colour, fruit length and individual fruit weight. High heritability along with higher genetic advance (as a percentage of mean) was found for capsaicin content in green fruit, number of fruits per plant, extractable fruit color, individual fruit weight, plant height and days to flowering and these may be considered as reliable selection indices. Correlation studies revealed that fruit yield per plant was positively and significantly correlated with primary and secondary branches per plant, fruit number and fruit diameter. Path analysis indicated that among the different characters higher direct effect was noticed in individual fruit weight, number of fruits per plant, primary and secondary branches per plant and fruit diameter.

2.2 Correlation coefficient of variation

A high positive significant correlation of days to 50% flowering and days to first harvest suggested that early flowering genotypes would be an appropriate selection

criterion to get early marketable fruit yield.The number of fruits per plant had positive correlation with fruit yield per plant at genotypic level. Similar findings were noticed by Mishra *et al*. (1998) and Ibrahim *et al*. (2001). Average fruit weight at marketable stage had significant positive relationship with number of pickings, ascorbic acid content and fruit yield per plant. Whereas, it had negative association with plant height at phenotypic level and fruit weight only at genotypic level.

Rohini and Lakshmanan(2015) were evaluated,association of correlation and cause effect analysis in six parents and their thirty hybrids from a diallel design for fruit yield and its components. Statistically, significant variation was observed among tested materials for all the characters studied. Number of fruits per plant, fruit length, individual fruit weight, fruit girth, plant height and seeds per fruit were the major characters contributing to yield as these traits were significantly and positively associatedwith dry pod yield per plant. Maximum contribution of fresh fruits yield per plant to dry pod yield was observed in path analysis, which was followed by individual dry pod weight, number of fruits per plant, number of harvest, days to 50% flowering, pedicel length and number of branches per plant through higher direct effect. So, for increasing fruit yield per plant a chilli hybrid should have higher number of fruits per plant, coupled with large fruit length, high fruit girth and high average fruit weight.

Ajith and Manju (2015) were evaluated seventy six chilli genotypes simultaneously for anthracnose resistance and yield traits as two parallel experiments. Three genotypes showed less than 10 per cent disease incidence at 30 DAT, 45 DAT and 60 DAT (Days After Transplanting). Fruit weight per plant recorded the maximum values of PCV, GCV, heritability and genetic advance. Percent disease incidence and disease intensity were negatively associated with capsaicin content and harvest index. Fruit yield displayed positive correlation with number of branches, number of fruits per plant, average green fruit weight, fruit length, fruit girth, 100-seed weight, crop duration, harvest index and capsaicin content.

Amit *et al*. (2014) were used twenty three genotypes to study the genetic variability, heritability, genetic advance and correlation for growth and yield contributing characters in chilli under Kashmir conditions. Significant variations were observed for all the characters studied except for days to flowering and crop duration [mature (green) as well as dry (red)]. High Phenotypic Coefficient Variation(PCV) and Genotypic Coefficient Variation (GCV) were recorded for number of fruitsper plant, fruit weight and dry (red) yield. All the characters showed high heritability estimates. However,number of the fruitsper plant, green fruit yieldper plant, dry (red) yield perplant, number of seedsper plant and plant height exhibited high genetic advance as percentage of mean indicating additive gene effect. Fruit yield (green and red)per plant was positively and significantly correlated with number of fruitsper plant and fruit length. It revealed that the characters viz., plant height, fruitlength, number of fruits perplant, fruit weight and fruit yield (green & red) are the most important traits for genetic improvement of chilli.

Kumar *et al*. (2012) were studied genetic variability, heritability, genetic advance and correlation for different yield contributing characters in 20 genotypes of chilli. Significant differences were observed among the genotypes for all the traits. The phenotypic coefficient of variation (PCV) was higher than genotypic coefficient of variation (GCV) for all the traits. Traits like number of branches at 150 DAT, days to flower anthesis, number of fruits per plant, average fruit weight, ascorbic acid, capsaicin content and fruit length showed positive correlation with fruit yield per plant (g). While leaf curl incidence showed negative correlation at genotypic level. Genetic advance at 5% was found high for plant height after 150 DAT, number of fruits per plant, ascorbic acid and fruit yield per plant (g). Whereas, genetic advance as percent of mean at 5% was noticed high for all the traits except days to flower initiation and days to first harvest. Number of fruits per plant exhibited the highest positive direct effect followed by days to flower anthesis, plant spread (N-S) at 150 DAT, ascorbic acid content, plant height at 150 DAT and fruit length at

genotypic level. In view at the direct and indirect contributions of component traits towards fruit yield per plant, selection on the basis of horticultural traits viz., average fruit weight and number of fruits per plant would be a paying preposition in the genotypes included in the study.

Gupta *et al*. (2009) were evaluated a total of 40 hybrids of chilli on a field experiment atPAU, Ludhiana during 2005–06 to estimate variability, heritability, genetic advance and correlation among fruit yield and component traits. Genotypic and phenotypic coefficients of variation were high for number of fruits and fruit yield per plant and fruit weight and length. High heritability estimates coupled with high-expected genetic advances percent of men were observed for number of fruits perplant, fruit yieldperplant, fruit length, fruit weight and capsaicin content. Fruit yieldper plant was positively correlated with number of fruits perplant and fruit length.

2.3 Path analysis

Path analysis helps in partitioning correlation coefficients into direct and indirect effects of component characters in yield. Direct and indirect effects of all the traits on yield were computed at the genotypic level.

Krishna *et al*. (2007) was studied character association and path analysis in eighty genotypically diverse indigenous and exotic genotypes of chilli for 13 important characters. They stated that, the phenotypic and genotypic association of fruit yield was significantly positive with all the characters except days to first flowering and ten fruit weight. Early fruit yield and late fruit yield per plant found highly significant and positive correlation with total fruit yield might assigned to more number of fruits produced by the early and late genotypes. The genotypic and phenotypic path coefficient reveled that total green chilli had high direct positive effect from early and late fruit yield.

Singh *et al.* (2014) were used twenty three genotypes to study the correlation and path analysis for growth and yield contributing characters in chilli under Kashmir

conditions. The experiment was laid out in randomized block design at KVK farm Pulwama, SKUAST-K during Kharif season of 2010 and 2011. The number of fruits per plant was significantly and positively correlated with fruit weight per plant and red ripened fruit yield. Green fruit yield per plant and dry yield per plant was positively and highlysignificantly correlated with number of fruits per plant (0.6585) and fruit weight (0.9839). The path coefficient analysis brought out the number of fruits per plant, fruit width and average fruit weight as major yield components which could be considered selection indices for improvement. The results suggested that due emphasis should be on to the genotypes that are having maximum number of fruits per plant, fruit length, fruit girth and fruit weight in the selection process due to their high positive direct effect on dry fruit yield.

Patel *et al.* (2015) were studied genetic variability, correlation and path coefficient analysis for green fruit yield and its components in 40 diverse genotypes of chilli. The analysis of variance revealed the significant differences among the genotypes for all the characters studied which indicating that presence of great deal of genetic variability for different traits. The high estimates of GCV and PCV were obtained for number of primary branches per plant, number of secondary branches per plant, number of fruits per plant, average fruit length (cm), average fruit girth (cm), fruit shape index, average fruit weight (g), green fruit yield per plant (g), chlorophyll content (%), ascorbic acid content (mg/100g) and capsaicin content (mg/g), while it was low for moisture content (%). The characters like days to flowering (days), plant height (cm), number of primary branches per plant, number of secondary branches per plant, number of fruits per plant, average fruit length (cm), average fruit girth (cm), fruit-shape index, average fruit weight (g), green fruit yield per plant (g), chlorophyll content (%), ascorbic acid content (mg/100g) and capsaicin content (mg/g) exhibited high genetic advance coupled with high heritability, indicating better scope for improvement of these traits by an effective selection programme. The results of correlation studies indicated that genotypic correlation coefficients were higher in magnitude than their corresponding phenotypic correlation coefficients for all the traits. Green fruit yield per plant had high,

significant and positive association with number of fruits per plant, average fruit weight, moisture content and chlorophyll content at both genotypic and phenotypic levels which indicating that these traits were main yield attributing traits. Path analysis revealed that characters like number of secondary branches per plant, number of fruits per plant and average fruit weight had high and positive direct effects on green fruit yield. For maximizing the green fruit yield per plant weightage should be given to early flowering, more number of fruits per plant, high average fruit weight, more number of secondary branches per plant and high moisture content.

Bijalwan and Mishra (2016) were studied the correlation and path coefficient analysis in sixteen genotypes in chilli for 15 different qualitative and quantitative characters. Correlation coefficients at genotypic and phenotypic levels indicated that fruit yield per plant was positively and significantly correlated with fruit weight at edible maturity, number of fruits per plant, fruit length, number of branches per plant and ascorbic acid content but negative and significant association was found with days to 50% flowering indicating that early flowering and early picking might be associated with increasing the fruits yield per plant. Path coefficient analysis revealed that the highest positive direct effect on fruit yield per plant was exerted by fruit weight at edible maturity followed by number of fruits per plant and fruit length, while as highest negative direct effect on fruit yield per plant was exerted by number of branches per plant and pedicel length.

Kulkarni (2006) was undertaken an investigation during *kharif*2005 at Botany Garden of University of Agricultural Sciences, Dharwad with three experiments. The experiment I consisted of evaluation of chilli germplasm for productivity, its component traits, genetic diversity,correlation and path analysis. The analysis variance indicated significant differences amongthe genotypes for all the characters under study. Yield and fruit related traits, exhibited high GCV, PCV and high heritability coupled with high genetic advance.Correlation study for yield per plant showed significant positive association with allgrowth related, yield related and

fruit related traits. Plant height, fruit diameter, fruit surface area, pericarp weight showed negative direct effect while all other characters showed positive and high direct effect. The 55 genotypes were grouped into 14 clusters. Cluster XIV having IC-16 genotype showed maximum average mean value for plant height, fruits per plant and yield per plant. RAPD analysis with 20 random primers showed high polymorphism with primer OPJ-01 and OPJ-10. No correlation was observed between morphological and molecular diversity. Segregating F_4 populations of chilli was source material for experiment II, in which genetic variability, correlation and path analysis were estimated. Variability studies revealed high within family variance for most of the characters in all the populations indicating its segregating nature. High phenotypic variance was for productivity traits was observed in S-32 × LCA-312 and S-32 × SK populations. In all the populations, plant growth characters showed positive association with yield. Path analysis revealed that number of fruits per plant had maximum direct effect on yield per plant.In experiment III, 20 selected F4 families were screened for thrips and mites resistance. Pest susceptibility index and yield stability ratio of above families indicated that, families involving S-32 × SK, S-32 × LCA-312 crosses showed high resistance with high yield in pest environment than checks which could be attributed to resistance of parent S-32 to leaf curl complex.

Luitel*et al*. (2013) were undertaken correlation and path coefficient analysis were undertaken for the fruit yield and quality characters in segregating F_2 population of mini-paprika cv. ‘Vine sweet-yellow’ and ‘Vine sweet-orange’. The direction and magnitude of association for fruit characters showed less difference in two populations. Fruit yield had strong positive association with fruit number, fruit weight and fruit length in both fruit forms of mini-paprika. Fruit width, fruit shape index, pericarp thickness and fruit volume had significant positive correlation with fruit yield in both F_2 populations. Path coefficient analysis showed that fruit weight had highest direct effect (0.7400) in ‘Vine sweet-yellow’ and the highest direct effect (0.7390) in ‘Vine sweet-orange’ is due to fruit number. Fruit shape index showed the highest negative direct effect in both populations. Fruit length and fruit

volume expressed the highest indirect effect in ‘Vine sweet-yellow’ (0.5979) and ‘Vine sweet-orange’ (0.3761) via fruit weight, respectively. Fruit weight in ‘Vine sweet-yellow’ and fruit number in ‘Vine sweet-orange’ are found to be most important characters for improving the yield. A positive response to direct selection is possible for fruit number, fruit weight, fruit length, and pericarp thickness in both F_2 populations.

Jogi*et al.* (2013) were studied character association and path analysis in fifty genetically diverse indigenous and exotic genotypes of chilli for 16 important characters. The phenotypic and genotypic association of fruit yield was significantly positive with all the characters except days to first flowering and ten fruit weight. Early fruit yield and late fruit yield per plant were found highly significant and positive correlation with total fruit yield. The genotypic path co-efficient analysis revealed that ascorbic acid and chlorophyll content had high direct positive effect on total fruit yield.

Vikram*et al*. (2014) were undertaken an experiment on chilli (*Capsicum annuum*L.) to study the genetic correlations and path coefficients among twenty traits under study. Green yield per plant showed positive and significant correlation with average green fruit weight, fruit length and fruit breadth at middle while dry fruit yield exhibited the same with fruit length, green yield per plant and â-carotene content indicating the effective improvement in yield (green and dry) through above characters. Capsaicinoid content showed positive association with number of fruits per plant while average green and dry fruit weight had negative effect on capsaicinoid content in chilli. Positive and significant associations between capsaicinoid content in green and dry chilli, ascorbic acid content in green and red ripe chilli indicated continuous increase in capsaicinoid and ascorbic acid contents with the maturity. Path analysis towards dry yield per plant revealed the importance of average dry fruit weight, number of fruits per plant, fruit length, green yield per plant and â-carotene content in improvement of dry yield per plant.

CHAPTER III
MATERIALS AND METHODS

This chapter deals with the materials and methods that were used in carrying out the experiment.

3.1 Location of the experiment field

The experiment was conducted at Horticultural farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka during the period from November 2013 to May 2014. The location of the experimental site was at $23^0 75^/$N latitude and $90^0 34^/$E longitudes with an elevation of 8.45 meter from sea level.

3.2 Climate of the experimental area

The experimental area is characterized by subtropical rainfall during the month of May to September and scattered rainfall during the rest of the year. Information regarding average monthly temperature as recorded by Bangladesh Meteorological Department (climate division) during the period of study has been presented in Appendix I.

3.3. Soil of the experimental field

Soil of the study site was silty clay loam in texture belonging to series. The area represents the Agro-Ecological Zone of Madhupur tract (AEZ No. 28) with pH 5.8-6.5, ECE-25.28 (Haider*et al*., 1991). The analytical data of the soil sample collected from the experimental area were determined in the Soil Resources Development Institute (SRDI), Soil Testing Laboratory, Khamarbari, Dhaka and have been presented in Appendix II.

3.4 Plant materials collection

Tenchilligermplasmwere collected from different parts of Bangladesh.The places from where thesechilligermplasm have been collectedare given in Table 1.

Table 1.Germplasm number and source of 10 chilligermplasm

Germplasm number	Source
CF 01	Dhaka
CF02	Dhaka
CF 03	Dhaka
CF 04	Gazipur
CF05	Bogra
CF 06	Bogra
CF 07	Bogra
CF 08	Jamalpur
CF 09	Jamalpur
CF 10	Jamalpur

3.5 Raising of seedlings

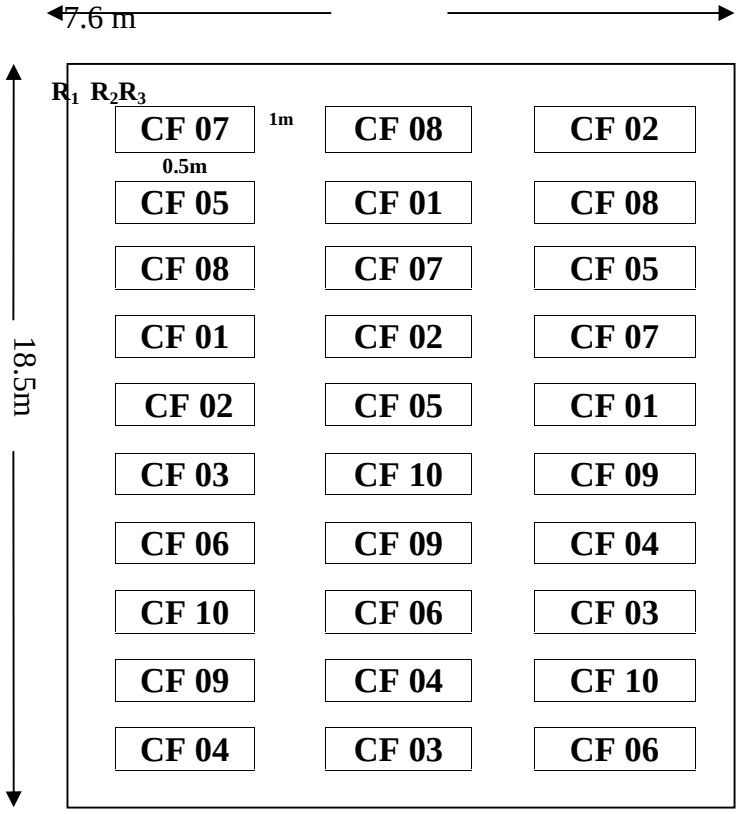
Chilliseedlings were raised in different polybags. The soil was well prepared and converted into loose friable and dried mass by spading. All weeds and stubbles were removed and 5 kg well rotten cow dung was mixed with the soil. 3-5 seeds was sown on each polybag on 15th November 2013. After sowing, seeds were covered with light soil. The emergence of the seedlings took place within 5 to 6 days after sowing. Weeding, mulching and irrigation were done as and when required. After 35 days of seed sowing they are ready for transplanting.

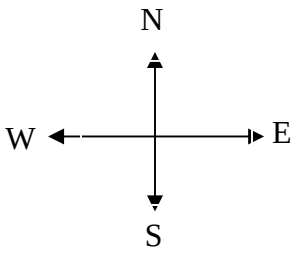
3.6 Treatments of the experiment

The experiment comprised ten chilligermplasm.

3.7 Design and layout of the experiment

The experiment was laid out in Randomized Complete Block Design (RCBD) having single factor with three replications. An area of 18.5 m × 7.6 m was divided into three equal blocks. Each block was consists of 10 plots where 10 treatments were allotted randomly. There were 30 unit plots in the experiment. The size of a unit plot was 1.2 m ×1.2 m, which accommodated 16 plants at a spacing of 30 cm ×30cm. The distance between two blocks and two plots were kept 1.0 m and 0.5 m respectively. A layout of the experiment has been shown in figure 1.





Plot size: 1.2 m × 1.2 m
Spacing: 30 cm × 30 cm
Spacing between plots: 0.50 m
Spacing between replication: 1 m

Factor:

Collected chilligermplasm

Fig. 1. Field layout of the experiment

3.8 Cultivation procedure

3.8.1Land preparation

The soil was well prepared and good tilth was ensured for crop production. The land of the experimental field was ploughed with a power tiller on November 2013. Later on the land was ploughed three times followed by laddering to obtain desirable tilth. The corners of the land were spaded and larger clods were broken into smaller pieces. After ploughing and laddering, all the stubbles and uprooted weeds were removed and then the land was made ready. The field layout and design or the experiment was followed after land preparation.

3.8.2 Manure and fertilizers and its methods of application

Fertilizer	Quantity	Application method
Cow dung	10 t/ha	Basal dose
Urea	210 kg/ha	25,50 and 75 DAT
TSP	330 kg/ha	Basal dose
MoP	200 kg/ha	25,50 and 75 DAT mixed with urea
Borax	5 kg/ha	Basal dose

Source: Razzak*et al.* (2011).

According toRazzak*et al.* (2011),the entire amount of cowdung,TSP and Borax were applied as basal dose during land preparation. Urea and MoP were used as top dressing in equal splits at 25, 50 and 75 days after transplanting.

3.8.3Transplanting of seedlings

Healthy and uniform 35 days old seedlings were uprooted separately from the polybag and were transplanted in the experimental plots in 20th December, 2013where size of a unit plot was 1.2 m ×1.2 m, which accommodated 16 plants at a spacing of 30 cm × 30 cm. The distance between two blocks and two plots were kept 1.0 m and 0.5 m, respectively. The seedlings were watered after transplanting. Seedlings were also planted around the border area of the experimental plots for gap filling.

3.8.4Intercultural operations

After transplanting the seedlings, different intercultural operations were accomplished for better growth and development of the plants, which are as follows:

3.8.4.1Gap filling

When the seedlings were well established, the soil around the base of each seedling was pulverized. A few gaps filling was done by healthy seedlings of the same stock where initial planted seedling failed to survive.

3.8.4.2Weeding

Numbers of Weeding were accomplished as and whenever necessary to keep the crop free from weeds.

3.8.4.3 Irrigation

Number of irrigation was given throughout the growing period by garden pipe, watering cane. The first irrigation was given immediate after the transplantation whereas other were applied when and when required depending upon the condition of soil.

3.8.4.4 Plant protection

The established plants were affected by aphids. Diazinon 60EC (15cc/10 liter) was applied against aphids and other insects. Chilli plants infected with anthracnose and die back were controlled by spraying cupravit (3g/L) at 15 days interval. Few plants found to be infected by bacterial wilt were uprooted.

3.9 Harvesting

Fruits were harvested at 6 to 7 days intervals during early ripe stage when they attained marketable size. Harvesting was started from 15th April, 2014 and was continued up to 19th of May 2014.

3.10 Data collection

Five plants were selected randomly from each plot for data collection in such a way that the border effect could be avoided for the highest precision. Data on the following parameters were recorded from the sample plants during the course of experiment.

3.10.1 Plant height

The plant height was measured in centimeters from the base of plant to the terminal growth point of main stem on tagged plants was recorded at 10 days interval starting from 20 days of planting up to 60 days to observe the growth rate of plants. The average height was computed and expressed in cm.

3.10.2 Number of leaves per plant

The number of leaves per plant was manually counted at 20, 30, 40, 50 and 60 days after transplanting on tagged plants. The average of five plants were computed and expressed in average number of leaves per plant.

3.10.3Leaf length of plant

The leaf length of plant was measured at 50 days after transplanting from tagged plants. The average of five plants were computed and expressed in cm.

3.10.4Leaf breadth of plant

50 days after transplanting the leaf breadth of plant was measured at from tagged plants. The average of five plants were computed and expressed in averageleaf breadth of plant in cm.

3.10.5 Number of primarybranches per plant

Manually counted the number of primary branch per plant was at 50 days after transplanting from tagged plants. The average of five plants were computed and expressed in average number of primary branch per plant.

3.10.6Number of secondarybranches per plant

The number of secondary branch per plant was manually counted at 50days after transplanting from tagged plants. The average of five plants were computed and expressed in average number of secondary branch per plant.

3.10.7Canopy size ofplant

It was measuredthe canopy of plantat 50 days after transplanting from tagged plants. The average of five plants were computed and expressed in averagecanopy of plant in cm.

3.10.8Stem diameter of plant

A digital calipers-515 (DC-515) was used to measure the stem diameter of plant at 50days after transplanting from tagged plants. The average of five plants was taken and expressed in cm.

3.10.9Days required for first flowering of plant

The number of days from the date of transplanting to the date of first flower opening was recorded.

3.10.10Days required for 50% flowering of plant

The number of days from the date of transplanting to the date of 50% flower opening was recorded.

3.10.11Number of flowers per plant

The number of flowers from the5 sample plantswas counted at 50days after transplanting.

3.10.12Days required for first fruiting of plant

The number of days from the date of transplanting to the date of first fruiting was recorded.

3.10.13 Number of fruits per plant

The total number of fruits produced in a plant was counted and recorded.

3.10.14 Length of fruit

The length of fruit was measured with a meter scale from the neck of the fruit to the bottom of 5 randomly selected marketable fruits from each plot and there average was taken and expressed in cm.

3.10.15 Diameter of fruit

Diameter of fruit was measured at the middle portion of 5randomly selected marketable fruit from each plot with a digital calipers-515 (DC-515) and average was taken and expressed in cm.

3.10.16 Length of pedicel

It was measured the length of pedicelwith a meter scale from the tip of the fruit to the neck of 5 randomly selected marketable fruits from each plot and there average was taken and expressed in cm.

3.10.17 Individual fruit weight

A digital weighing balance was used to measure the weight of individual fruit from 5randomly selected marketable fruits from each selected plots and there average was taken and expressed in gram.

3.10.18 Length of root

The length of root was measured with a meter scale from the stem end portion of the plant to the bottom of 5randomly selected roots from each plot and there average was taken and expressed in cm.

3.10.19 Diameter of root

Diameter of root was measured at the middle portion of 5randomly selected root from each plot with a digital calipers-515 (DC-515) and average was taken and expressed in cm.

3.10.20Weight of 1000-seeds

The weight of 1000 seeds of fruits was measured by an electric balance from each plot and was expressed in gram (g).

3.10.21Chlorophyll content

The SPAD meter, a product of Konica Minolta Sensing Ltd, Singapore was used to measure the chlorophyll content of leaves from 5randomly selected plant from each plots and there average was taken.

3.10.22Ascorbic acid content

Preparation of Dye solution:

Dye (2,6Dichlorophenol indophenol) = 260 mg

$NaHCO_3$= 21 mg

Distilled water= 1L= 1000 mL

Here,

Known sample of ascorbic acid= 10 mg % of ascorbic acid

Meta phosphoric acid= 3%

Titration value of known sample = 5.3

Procedure:

At first 5 gm fruit with 50 ml metaphosphoric acid was blending well in a Blender. Then it was filtered in a 100 ml volumetric flask and was maken it 100 mL with metaphosphoric acid. Then it was taken 5 ml solution in 250 ml volumetric flask and was titrated with dye solution. Then titration value of each treatment was recorded and was calculated by the following formula:

$$\text{Ascorbic acid (mg/100g)} = \times 100\frac{T \times D \times V_1}{\mathbf{V_2 \times W}}$$

Where,

T= Titrate value

D= Dye factor $=\frac{0.5}{\text{Titrate}}$

V1= Volume to be made (ml)

V2= Volume of extract taken for titration (ml)

W= Weight of sample taken for estimation (g)

3.10. 23 Yield of fruits per plant

An electric balance was used to measure the weight of fruits per plant. The total fruit yield of each plant measured separately during the harvest period and was expressed in gram (g).

3.10. 24 Yield of fruits per plot

The weight of fruits per plot was measured by an electric balance. The total fruit yield of each unit plot measured separately during the harvest period and was expressed in kilogram (kg).

3.10.25 Yield of fruits per hectare

It was measured by the following formula:

$$\text{Fruit yield (ton/ha)} = \frac{\text{Fruit yield per plot (kg)} \times 10000}{\textbf{Area of plot in square meter} \times \textbf{1000}}$$

3.11 Statistical analysis

The data obtained for different characters were statistically analyzed using MSTAT-C software to find out the significance of the difference for differentchilligermplasm. The mean values of all the recorded characters were evaluated and analysis of variance was performed by the 'F' (variance ratio) test. The significance of the difference among the means of treatment combinations was estimated by Least Significance Difference (LSD)test at 5% level of probability (Gomez and Gomez, 1984).

3.12 Estimation of correlation

Simple correlation was estimated of the 9 traits with the following formula (Singh and Chaudhary, 1985):

$$r = \frac{\sum xy - \frac{\sum x . \sum y}{N}}{\left[\left\{\sum x^2 - \frac{(\sum x)^2}{N}\right\}\left\{\sum y^2 - \frac{(\sum y)^2}{N}\right\}\right]^{1/2}}$$

Where,

$\sum$ = Summation

x and y are the two variables

N = Number of observations

3.13 Path co-efficient analysis

Path co-efficient analysis was done according to the procedure employed by Dewey and Lu (1959) also quoted in Singh and Chaudhary (1985) using simple correlation values. In path analysis, correlation co-efficient is partitioned into direct and indirect of independent variables on the dependent variable.

In order to estimate direct and indirect effect of the correlated characters, say x_1, x_2, x_3 yield y, a set of simultaneous equations (three equations in this example) is required to be formulated as given below:

$$ryx_1 = Pyx_1 + Pyx_2 rx_1x_2 + Pyx_3 rx_1x_3$$

$$ryx_2 = Pyx_1 rx_1x_2 + Pyx_2 + Pyx_3 rx_2x_3$$

$$ryx_3 = Pyx_1 rx_1x_3 + Pyx_2 rx_2x_3 + Pyx_3$$

Where, r's denotes simple correlation co-efficient and P's denote path co-efficient (unknown). P's in the above equations may be conveniently solved by arranging them in matrix form. Total correlation, say between x_1 and y is thus partitioned as follows:

Pyx_1 = The direct effect of x_1 on y

$Pyx_1rx_1x_2$ = The indirect effect of x_1 via x_2 on y

$Pyx_1rx_1x_3$ = The indirect effect of x_1 via x_3 on y

After calculating the direct and indirect effect of the characters, residual effect (R) was calculated by using the formula given below (Singh and Chaudhary, 1985):

$$P^2RY = 1 - \sum Piy.riy$$

Where,

$P^2RY = (R^2)$; and hence residual effect, $R = (P^2RY)^{1/2}$

Piy = Direct effect of the character on yield

riy = Correlation of the character with yield

3.14 Analysis of genetic divergence

Genetic divergences among the genotypes studied were assessed by using Mahalanobis' D^2 statistics and its auxiliary analysis. Both techniques estimate divergences among a set of genotypes on multivariate scale.

Mahalanobis' D^2 statistics

First the variation among the materials were tested by Wilkin's criteria '^'.

$$'\wedge' = \frac{|W|}{|S|} = \frac{|\text{Determination of error matrix}|}{|\text{Determination of error + variety matrix}|}$$

Now, $'v'_{(stat)} = -m \log_{e\wedge} = -\{n-(p+q+1)/2\}\log_{e\wedge}$

Where,

m = n-(p+q+1)/2

p = number of variables or characters

q = number of varieties – 1 (or df for population)

n = df for error + varieties

e = 2.7183

Data were then analysed for D^2 statistics according to Rao*et al*. (1952). Error variance and covariance matrix obtained from analysis of variance and covariance were inverted by pivotal condensation method. Using the pivotal elements the

original means of the characters (X_1, X_2---------X_8) were transformed into a set of uncorrelated variables (Y_1, Y_2---------Y_8).

Now, the genetic divergence between two varieties/lines (suppose Vi and Vj was calculated as –

$$D^2ij = \sum_{k=1} (Vik - Vjk)^2$$

Where,

D^2ij = Genetic divergence between 'i' th and 'j' th genotypes

Vik = Transformed mean of the 'i' th genotype for 'k' th character

Vjk = Transformed mean of the 'j' th genotype for 'k' th character

The D^2 values between all varieties were arranged in order of relative distances from each other and were used for clusters formation, as suggested by Rao*et al*.(1952).

$$\text{Average intra-cluster } D^2 = \frac{\sum D^2 i}{n}$$

Where,

$\sum D^2 i$ = Sum of distances between all possible combinations (n) of the genotypes included in a cluster.

N = All possible combinations.

CHAPTER IV

RESULT AND DISCUSSION

The experiment was conducted to study the variability, correlation and path analysis of 10 chilligermplasm. The analysis of variances of the data on different yield and yield contributing charactersare given in Appendix III-XI. The results of the present study have been presented and discussed in this chapter under the following headings:

4.1 Mean performance of yield contributing characters and yield

4.1.1Plant height

The plant height of chilli was measured at 20, 30, 40, 50 and 60 DAT. It was evident from Figure 2 that the height of plant was significantly influenced by different germplasmat all the sampling dates. Figure2showed that plant height increased with advancing growing period irrespective of varieties.Thechilliplant height increased rapidly at the early stages of growth and rate of progression in height was slow at the later stages. At 20, 30, 40, 50 and 60 DAT, the tallest plant (10.83, 15.33, 20.00, 27.00 and 31.00 cm, respectively) was observed from the CF 01 treatment which was statistically similar with CF 03 (10.33, 14.50, 18.67, 26.00 and 31.00 cm, respectively), CF 09 (9.83, 14.00, 18.50, 25.33 and 30.67 cm, respectively) and CF10(10.00, 13.50, 17.67, 24.33 and 30.17 cm, respectively). On the other hand, the shortest plant (6.66, 10.33, 14.00, 19.17 and 22.17 cm, respectively) was found in CF 07 treatment; which was statistically similar with CF 04 (8.00, 10.17, 12.50, 17.00 and 22.00 cm, respectively) and CF 06 (7.83, 10.33, 13.00, 17.17 and 26.50 cm, respectively). Plant height of a crop depends on the plant vigor, cultural practices, growing environment and agronomic management. In the present experiment all the chilligermplasmwere grown in the sameenvironment and were given same cultural practices.

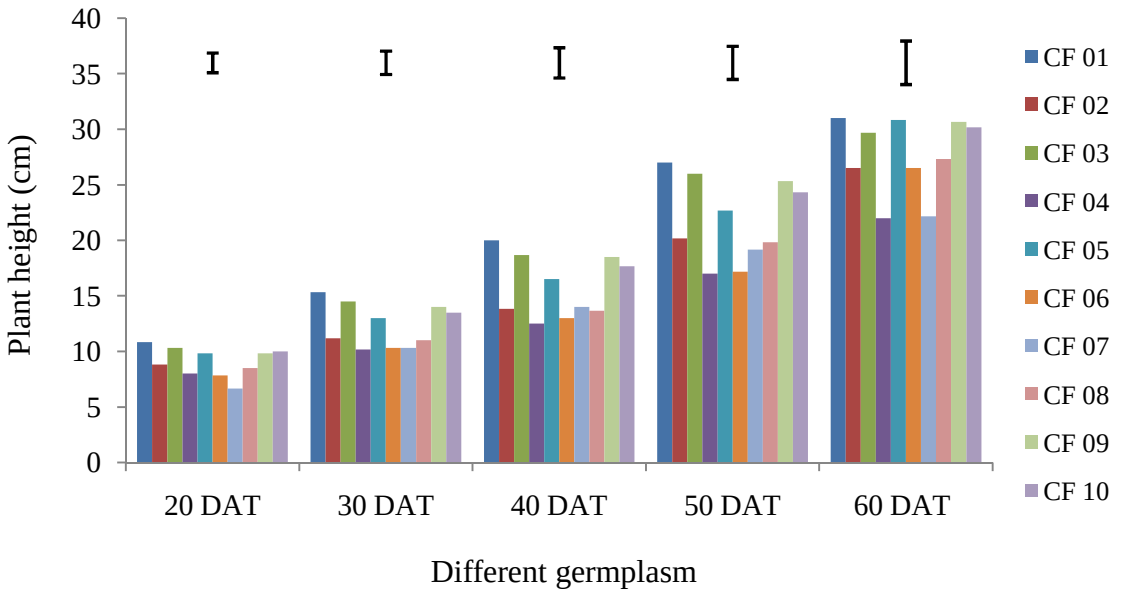


Fig. 2. Plant height at different DAT ofchilligermplasm
(Vertical bars represents LSD value)

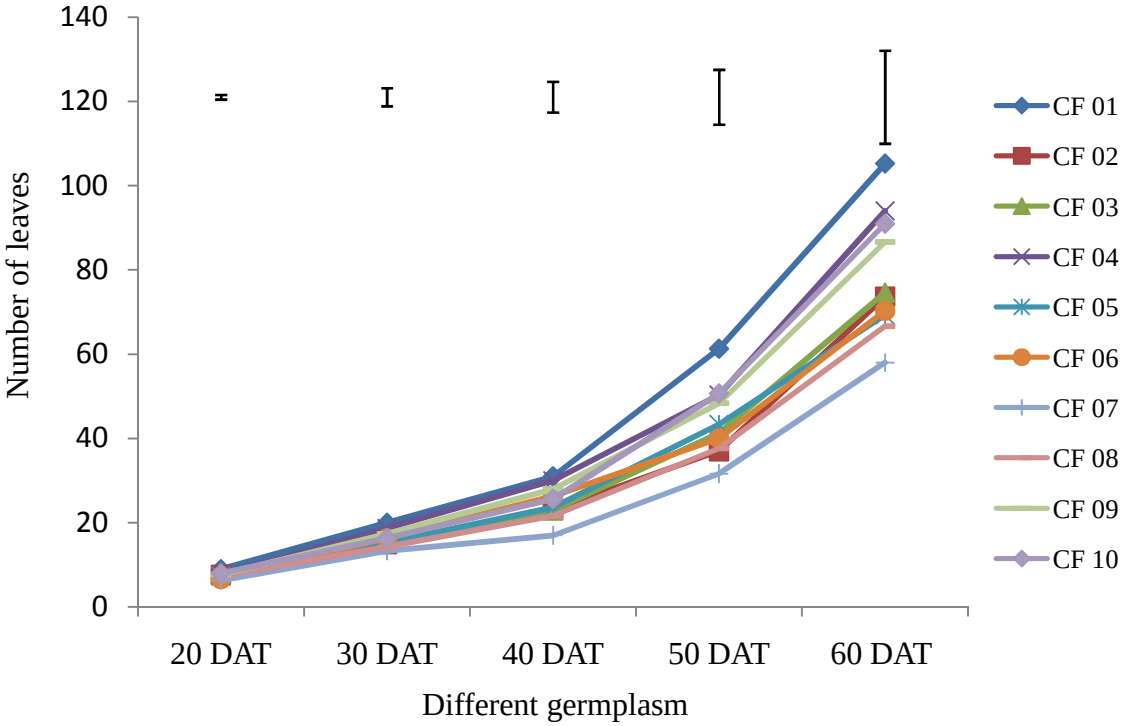


Fig.3.Number of leaves at different DAT ofchilligermplasm
(Vertical bars represents LSD value)

So, the variation of plant height might be due to the effect of differentgermplasm.This result agree with that of Yatung*et al.* (2014) who reported that significant differences among the germplasm for plant height.

4.1.2 Number of leaves per plant

Different germplasmexhibited significant variation in respect of number of leaves per plant. Results revealed that, the number of leaves per plant of chilli increased gradually with advancing growing period irrespective of germplasmat 20, 30, 40, 50 and 60 DAT (Figure 3). At 20, 30, 40, 50 and 60 DAT, the maximum number of leaves per plant (9.00, 20.00, 31.00, 61.33 and 105.30, respectively) was observed from the CF 01 treatment which was statistically similar with CF 04 (7.66, 18.67, 30.00, 50.33 and 94.00, respectively), CF 09 (7.66, 17.33, 28.00, 48.33 and 86.67, respectively) and CF 10 (8.00, 16.33, 25.67, 50.67 and 91.00, respectively). On the other hand, the minimum number of leaves per plant (6.33, 13.33, 17.00, 31.67 and 58.00, respectively) was found in CF 07 treatment which was statistically similar with CF 08 (7.33, 14.33, 21.67, 37.67and 66.67, respectively).A wide range of variation was observed among the germplasm for number of leaves per plant due to different morphological characters of several germplasm. Datta and Das (2013) were reported that analysis of variance showed significant differences among the germplasm for number of leaves.

4.1.3 Leaf length

Leaf length of chilli was significantly varied among the different germplasmof chilli(Table 2). The maximum length of leaf (14.33 cm) was recorded from CF 08 treatment which was statistically similar with CF 02 (12.17 cm).On the other hand, the minimum length of leaf (8.40 cm) was recorded from CF 10 treatment which was statistically similar with CF 06treatment (9.60 cm) and CF 01 treatment (8.40 cm).According to Patel *et al.* (2015),the analysis of variance revealed the significant differences among the germplasm for leaf length which indicating that presence of great deal of genetic variability among the germplasm.Datta and Das (2013) were also reported that analysis of variance

showed significant differences among the germplasm for leaf length which supported this result.

4.1.4 Leaf breadth

Different germplasmof chilli showed significant influence on leaf breadth of chilli plant (Table 2). The maximum breadth of leaf (4.20 cm)was recorded from CF 08 treatment. In comparison, the minimum breadth of leaf at (2.37 cm) was recorded from CF 01 treatment which was statistically similar with CF 03(2.57 cm)and CF 04 (2.53 cm)treatment.Datta and Das (2013) were revealed that leaf breadth of germplasm was showed significant differences in analysis of variance.In the present experiment all the chilligermplasm were grown in the sameenvironment and were given same cultural practices. So, that, Leaf breadth might be different due to different genetic make-up of germplasms.

4.1.5 Number of primary branches

Different germplasmof chilli showed significant influence on primary branch of chilli plant (Table 2). The maximum number of primary branch (7.00) was recorded from CF 01 treatment which was statistically similar with CF 09 (6.66) and CF 10 (6.66). On the other hand, the minimum number of primary branch (4.33) was recorded from CF 07 treatment which was statistically similar with CF 08 (4.33) and CF 02 (4.66).The analysis of variance revealed considerable variability among the germplasm for the character of number of primary branches of plant.According to Patel *et al.* (2015),the analysis of variance revealed the significant differences among the germplasm for number of secondary branches which indicating that presence of great deal of genetic variability among the germplasm.Yatung*et al.* (2014) reported that analysis of variance showed significant differences among the germplasm for number of primary branches which supported this result.

Table 2.Performance on growth parameter of chilligermplasm

Treatments	Leaf length (cm)	Leaf breadth (cm)	Primary Branch	secondary branch	Canopy size (cm)	Stem diameter (cm)
CF 01	8.40 e	2.37 d	7.00 a	17.33 a-c	33.00 a	0.90 de
CF 02	12.17 b	3.47 b	4.67 c	15.00 bc	24.50 de	1.10 bc
CF 03	9.47 de	2.57 d	6.00 a-c	18.00 a-c	32.33 ab	0.90 de
CF 04	9.03 de	2.53 d	5.33 a-c	19.67 a	24.17 de	1.03 cd
CF 05	10.23 cd	3.10 c	5.00 bc	18.67 ab	26.00 c-e	0.93 de
CF 06	9.60 de	3.40 bc	5.00 bc	15.00 bc	22.67 e	1.27 a
CF 07	11.50 bc	3.70 b	4.33 c	17.00 a-c	23.83 de	1.13 a-c
CF 08	14.33 a	4.20 a	4.33 c	14.00 c	26.00 c-e	1.20 ab
CF 09	8.90 de	2.47 d	6.67 ab	16.67 a-c	26.50 cd	0.80 e
CF 10	8.40 e	2.47 d	6.67 ab	15.00 bc	29.00 bc	0.93 de
LSD $_{0.05}$	1.72	0.34	1.79	4.07	3.47	0.15
CV%	9.87	6.60	9.07	8.66	9.22	8.65

In a column means having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability.

CF 01 : DeshiMorich
CF 02 : Indonesian Morich
CF 03 : Bindu
CF 04 : BARI Morich-1
CF 05 : Kona
CF 06 : Pakistani Morich
CF 07 : Bullet
CF 08 : Lalon
CF 09 : JhallombaMorich
CF 10 : JhalMorich

4.1.6 Number of secondary branches

Secondary branchof chilli plantwas significantly varied among the different germplasmof chilli (Table 2). The maximum number of secondary branch (19.67) was recorded from CF 04 treatment which was statistically similar with CF 05 (18.67), CF 03 (18.00), CF 01 (17.33) and CF 07 (17.00) treatment. On the other hand, the minimum number of secondary branch (14.00) was recorded from CF 08 treatment which was statistically similar with CF 02 (15.00), CF 06 (15.00) and CF 10 (15.00) treatment.According to Patel *et al.* (2015),the analysis of variance revealed the significant differences among the germplasm for number of secondary branches which indicating that presence of great deal of genetic variability among the germplasm. Zehra*et al.* (2015) were reported that analysis of variance showed significant differences among the germplasm for number of secondary branches.

4.1.7 Canopy size

Canopy size was significantly varied among the different germplasmof chilli (Table 2). The largest size of canopy (33.00 cm) was recorded from CF 01 treatment which was statistically similar with CF 03 (32.33 cm) treatment. On the other hand, the smallest size of canopy (22.67 cm) was recorded from CF 06 treatment which was statistically similar with CF 07 (23.83 cm) and CF 04 (24.17 cm) treatment.Datta and Das (2013) were reported that analysis of variance showed significant differences among the germplasm for canopy size which supported this result.In the present experiment all the chilligermplasm were grown in the sameenvironment and were given same cultural practices. So that, Canopy size differs due to different genetic build up of germplasms.

4.1.8 Stem diameter

Different germplasmof chilli showed significant influence on stem diameter (Table 2) of chilli plant.The largest stem diameter (1.26cm) was recorded from CF 06 treatment which was statistically similar with CF 08 (1.20 cm) and CF 07 (1.13 cm) treatment. On the other hand, the smallest stem diameter (0.80

cm) was obtained in CF 09 treatment which was statistically similar with CF 03 (0.90 cm), and CF 10 (0.93 cm) treatment.This might be caused by different genetic make-up of germplasm. Kadwey*et al*. (2016) were also observed that analysis of variance showed significant differences among the germplasm for stem diameter.

4.1.9 Number of flowers per plant

Different germplasmexhibited significant variation in respect of number of flowers per plant of chilli(Table 3). The highest number of flowers per plant was observed in CF 04 treatment (16.67) which was statistically similar with CF 02 (13.67), CF 03 (12.00), CF 05 (14.00), CF 06 (12.00), CF 07 (15.33) and CF 08 (11.67) treatment. On the other hand, the lowest number of flowers per plant was obtained from CF 10 (7.00) which was statistically similar with CF 09 (8.00) and CF 01 (9.66) treatment. Number of flowers per plant varies due to the genetical characters of that germplasm. Yatung*et al.* (2014) were also observed significant differences among the germplasm for number of flowers per plant.

4.1.10 First flowering

First flowering in chilli plant was significantly varied among the different germplasmof chilli (Table 3). The maximum days required to first flowering (80.67) was recorded from CF 06 treatment. On the other hand, the minimum days required to first flowering (39.00) was recorded from CF 03 treatment which was statistically similar with CF 01 (40.33), CF 10 (40.67) and CF 09 (41.67) treatment.Yatung*et al.* (2014) were reported that analysis of variance showed significant differences among the germplasm for first flowering which supported this result.In the present experiment all the chilligermplasm were grown in the sameenvironment and were given same cultural practices. So that, first flowering differs due to different genetic build up of germplasms.

4.1.11 Fifty percent flowering

Different germplasmexhibited significant variation in respect of fifty percent flowering of chilli (Table 3). The maximum days required to fifty percent flowering (84.33) was recorded from CF 06 treatment. On the other hand, the minimum days required to fifty percent flowering (47.67) was obtained from CF 03 treatment which was statistically similar with CF 01 (49.33) treatment.AjjapplavaraandChannagoudra (2009) were also observed significant differences among the germplasm for fifty percent flowering.

4.1.12 First fruiting

First fruiting in chilli plant was significantly varied among the different germplasmof chili (Table 3). The maximum days required to first fruiting (86.67) was recorded from CF 06 treatment which was statistically similar with CF 02 (80.33) treatment. On the other hand, the minimum days required to first fruiting (50.67) was recorded from CF 03 treatment which was statistically similar with CF 01 (50.67), CF 09 (51.00) and CF 10 (51.00) treatment.First fruiting Janaki*et al.* (2015) were reported that analysis of variance showed significant differences among the germplasm for first fruiting which supported this result.

4.1.13 Number of fruits per plant

Different germplasmexhibited significant variation in respect of number of fruits per plant (Table 3). The highest number of fruits per plant was observed in CF 01 treatment (72.57) which was statistically similar with CF 03 (62.33), CF 04 (65.33), CF 05 (67.90), CF 07 (62.43) and CF 10 (61.67) treatment. On the other hand, the lowest number of fruits per plant was obtained from CF 06 (46.00) which was statistically similar with CF 08 (53.00) and CF 02 (55.00) treatment.Sharma *et al.* (2010) were also reported the wide range of variability in chilli for number of fruits per plant.According to Patel *et al.* (2015) the analysis of variance revealed the significant differences among the germplasm

Table 3.Performance on growth parameter of chilligermplasm

Treatments	No. of Flowers per plant	First flowering (DAT)	Fifty percent flowering (DAT)	First fruiting (DAT)	Number of fruits Per plant	Chlorophyll Content (%)
CF 01	9.67 b-d	40.33 e	49.33 fg	50.67 e	72.57 a	56.60 ab
CF 02	13.67 a-d	74.00 b	78.67 b	80.33 ab	55.00 c-e	50.40 d
CF 03	12.00 a-d	39.00 e	47.67 g	50.67 e	62.33 a-d	50.47 d
CF 04	16.67 a	52.33 d	70.67 e	64.00 d	65.33 a-c	51.80 cd
CF 05	14.00 a-c	68.00 c	74.00 d	71.67 cd	67.90 ab	54.83 a-c
CF 06	12.00 a-d	80.67 a	84.33 a	86.67 a	46.00 e	56.20 ab
CF 07	15.33 ab	66.67 c	74.33 cd	74.00 bc	62.43 a-d	57.13 a
CF 08	11.67 a-d	72.33 bc	77.33 bc	71.33 cd	53.00 de	55.83 ab
CF 09	8.00 cd	41.67 e	51.00 f	51.00 e	56.43 b-e	50.30 d
CF 10	7.00 d	40.67 e	52.00 f	51.00 e	61.67 a-d	53.27 b-d
LSD $_{0.05}$	6.69	5.92	3.16	8.15	12.13	3.64
CV%	6.92	6.00	4.80	7.30	9.96	8.24

In a column means having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability.

CF 01 : DeshiMorich
CF 02 : Indonesian Morich
CF 03 : Bindu
CF 04 : BARI Morich-1
CF 05 : Kona
CF 06 : Pakistani Morich
CF 07 : Bullet
CF 08 : Lalon
CF 09 : JhallombaMorich
CF 10 : JhalMorich

fornumber of fruits per plant which indicating that presence of great deal of genetic variability among the germplasm.

4.1.14 Chlorophyll content

Chlorophyll content was significantly varied among the different germplasm of chilli (Table 3). The maximumchlorophyll content (57.13 %) was recorded from CF 07 treatment which was statistically similar with CF 01 (56.60 %), CF 06 (56.20%) and CF 08 (55.83 %) treatment. On the other hand, the minimum chlorophyll content (50.30 %) was observed in CF 09 treatment which was statistically similar with CF 02 (50.40 %), CF 03 (50.47 %) and CF 04 (51.80 %) treatment.This changes might be the different genetical characters among the germplasm. Yatung*et al.* (2014) were also observed significant differences among the germplasm for chlorophyll content.

4.1.15 Fruit length

Fruit length was found to be significant due to different germplasmof chilli(Table 4). The longest fruit (7.40 cm) was observed from CF 06 treatment. In comparison, the shortest fruit (4.26 cm) was recorded from CF 05 treatment which was statistically similar with CF 09 (4.63 cm), CF 03 (4.70 cm), CF 10 (4.80 cm),CF 01 (5.00 cm) and CF 07 (5.06 cm) treatment.Yatung*et al.* (2014) also observed that analysis of variance showed significant differences among the germplasm for fruit length.According to Patel *et al.* (2015),the analysis of variance revealed the significant differences among the germplasm for fruit length which indicating that presence of great deal of genetic variability among the germplasm.

4.1.16 Pedicel length

Pedicel length varied significantly due to the influence of different germplasmof chilli(Table 4). The longest pedicel (3.06 cm) was observed from CF 06 treatment which was statistically similar with CF 02 (2.53 cm). In comparison, the shortest pedicel (1.53 cm) was recorded from CF 01 treatment which was

Table 4.Performance on growth parameter of chilligermplasm

Treatments	Fruit length (cm)	Pedicel length (cm)	Fruit diameter (cm)	Individu weigh
CF 01	5.00 cd	1.53 e	0.83 de	1.34
CF 02	5.36 bc	2.53 ab	0.76 e	1.61
CF 03	4.70 cd	1.53 e	0.76 e	1.2
CF 04	5.36 bc	1.80 c-e	0.96 cd	1.8
CF 05	4.26 d	1.90 c-e	0.86 c-e	1.6
CF 06	7.40 a	3.06 a	1.13 b	2.8
CF 07	5.06 b-d	2.33 bc	1.50 a	2.5
CF 08	5.93 b	2.17 b-d	1.00 bc	2.5
CF 09	4.63 cd	1.67 de	0.83 de	1.39
CF 10	4.8 cd	1.80 c-e	0.77 e	1.8
LSD $_{0.05}$	0.87	0.55	0.14	0.
CV%	9.73	8.96	8.82	9.

In a column means having similar letter (s) are statistically identical and those having dissimilar lette
level of probability.

CF 01 : DeshiMorich
CF 02 : Indonesian Morich
CF 03 : Bindu
CF 04 : BARI Morich-1
CF 05 : Kona
CF 06 : Pakistani Morich
CF 07 : Bullet
CF 08 : Lalon
CF 09 : JhallombaMorich
CF 10 : JhalMorich

statistically similar with CF 03 (1.53 cm), CF 09 (1.66 cm), CF 04 (1.80 cm) and CF 10 (1.80 cm) treatment. Pedicel length differs among the germplasm for their different genetic make-up. Sharma *et al.* (2010) were also reported the wide range of variability in chilli for pedicel length.

4.1.17 Fruit diameter

Fruit diameter was significantly influenced by the different germplasmof chilli(Table 4). The largest fruit diameter (1.50 cm) was obtained from CF 06 treatment. On the other hand, the smallest fruit diameter (0.76 cm) was recorded from CF 02 treatment which was statistically similar with CF 03 (0.76 cm), CF 10 (0.76 cm), CF 09 (0.83 cm) and CF 05 (0.86 cm)

treatment.According to Patel *et al.* (2015) the analysis of variance revealed the significant differences among the germplasm for fruit diameter indicating that presence of great deal of genetic variability among the germplasm. Yatung*et al.* (2014) reported that analysis of variance showed significant differences among the germplasm for fruit diameter which supported this result.

4.1.18 Individual fruit weight

Different germplasmexhibited significant variation in respect of individual fruit weight of chilli(Table 4). The maximumweight of individual fruit (2.81 gm) was observed in CF 06 treatment which was statistically similar with CF 07 (2.57 gm) and CF 08 (2.52 gm) treatment. In comparison, the minimum weight of individual fruit (1.28 gm) was obtained from CF 03 treatment which was statistically similar with CF 01 (1.34 gm) and CF 09 (1.39 gm) treatment.Yatung*et al.* (2014) also observed that analysis of variance showed significant differences among the germplasm for individual fruit weight.

4.1.19 Root length

Root length was found to be significant due tothe influence of different germplasmof chilli(Table 5). The longest root (18.33 cm) was observed from CF 07 treatment which was statistically similar with CF 01 (15.50 cm), CF 02 (16.17 cm), CF 03 (17.67 cm) and CF 04 (17.17 cm) treatment. On the other hand, the shortest root (11.17 cm) was recorded from CF 09 treatment which was statistically similar with CF 06 (11.67 cm) and CF 08 (11.67 cm) treatment.Root length differs due to the germplasmsgenetical characters. Kadwey*et al*. (2016) werereported that analysis of variance showed significant differences among the germplasm for root length which supported this result.

4.1.20 Root diameter

Root diameter was significantly influenced by the different germplasmof chilli(Table 5). The highest root diameter (0.88 cm) was obtained from CF 03 treatment which was statistically similar with CF 04 (0.85 cm), CF 05 (0.78 cm), CF 07 (0.78 cm) and CF 08 (0.71 cm) treatment. On the other hand, the smallest diameter of root (0.48 cm) was recorded from CF 09 treatment which was statistically similar with CF 06 (0.58 cm) treatment.This might be change

with germplasm. Kadwey*et al*. (2016) were also observed that analysis of variance showed significant differences for root diameteramong the germplasm.

4.1.21 1000-seed weight

1000-seed weight was found to be significantly different due to different germplasmof chilli(Table 5). The maximum weight of 1000 seed (3.77 gm) was obtained from CF 06 treatment which was statistically similar with CF 04 (3.75 gm), CF 01 (3.52 gm), CF 07 (3.53 gm) and CF 08 (3.46 gm) treatment. On the other hand, the minimumweight of 1000 seed (2.91 gm) was obtained from CF 10 treatment which was statistically similar with CF 09 (2.96 gm) and CF 05 (3.22 gm) treatment. 1000 seed weight depends on size of individual seed of different germplasms those are different genetic build up. Krishnamurthy *et al.* (2013) were observed the germplasmshowed significant differences of analysis of variance for seed weight.

Table 5.Variation in root length, root diameter, 1000-seed weight and ascorbic acid content of chilligermplasm

Treatments	Root length (cm)	Root diameter (cm)	1000 seed weight (g)	Ascorbic acid content (mg/100g)
CF 01	15.50 a-d	0.68 a-c	3.52 ab	81.87 ab
CF 02	16.17 a-c	0.68 a-c	3.41 a-d	70.57 bc
CF 03	17.67 ab	0.88 a	3.26 a-d	85.67 ab
CF 04	17.17 a-c	0.85 a	3.75 ab	40.37 d
CF 05	13.83 b-d	0.78 ab	3.22 b-d	85.67 ab
CF 06	11.67 d	0.58 bc	3.77 a	78.17 a-c
CF 07	18.33 a	0.78 ab	3.53 ab	68.10 bc
CF 08	11.67 d	0.71 a-c	3.46 a-c	99.53 a
CF 09	11.17 d	0.48 c	2.96 cd	59.27 cd
CF 10	13.00 cd	0.68 a-c	2.91 d	59.27 cd
LSD $_{0.05}$	4.47	0.23	0.54	22.06
CV%	7.86	8.12	9.34	7.66

In a column means having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability.

CF 01 : DeshiMorich
CF 02 : Indonesian Morich
CF 03 : Bindu
CF 04 : BARI Morich-1
CF 05 : Kona
CF 06 : Pakistani Morich
CF 07 : Bullet
CF 08 : Lalon
CF 09 : JhallombaMorich
CF 10 : JhalMorich

4.1.22 Ascorbic acid content (mg/100g)

Chilli an important food nutrient and chili is an important source of Ascorbic acid. Ascorbic acidcontent was found to be significantly influenced by different germplasmof chilli (Table 5). The highest ascorbic acidcontent was recorded from CF 08 treatment (99.53 mg) which was statistically similar to CF 01 (81.87 mg/100g), CF 03 (85.67mg/100g), CF 05 (85.67mg/100g) and CF 06 (78.17 mg/100g) treatment.In comparison, the lowest ascorbic acidcontent (40.37mg/100g)was recorded from CF 04 treatment which was statistically similar to CF 09 (59.27 mg/100g)and CF 10 (59.27mg/100g) treatment. Ascorbic acid might be varies among the germplasm due to genetic make up of these germplasm.Datta and Das (2013) also observed significant variation in ascorbic acid content among chilligermplasm.

4.1.23 Yield per plant (g)

Different germplasmshowed significant influence on yield per plant of chilli (Table 6). The highest yield per plant of chilli (153.90 g) was obtained from CF 07 treatment which was statistically similar with CF 08 (133.00 g) treatment. On the other hand, the lowest yield per plant of chilli(74.90 g) was produced by CF 09 treatment which was statistically similar with CF 02 (85.90 g)and CF 03 (80.76 g) treatment.Due to increased number of fruits,individual fruit weight and fruit size yield per plant also increases. Yatung*et al.* (2014) reported that analysis of variance showed significant differences among the germplasm for yield per plant which supported this result.

4.1.24 Yield per plot (kg)

Yield per plot was found to be significantly different due to different germplasmof chilli (Table 6). The maximum yield per plot (2.46 kg) was obtained from CF 07 treatment which was statistically similar with CF 08 (2.12 kg) treatment. In comparison, the minimumyield per plot (1.19 kg) was produced byCF 09 treatment which was statistically similarwith CF 03 (1.29 kg) and CF 02 (1.37 kg) treatment. Yield per plot increases with the increase of individual fruit weight and yield per plant.Kadwey*et al*. (2016) also observed

Table 6.Yield parameter of different chilligermplasm

Treatments	Yield per plant (g)	Yield per plot (kg)	Yield per hectare (ton)
CF 01	96.77 cde	1.54 c-e	10.75 c-e
CF 02	85.90 de	1.37 de	9.54 de
CF 03	80.77 e	1.29 e	8.97 e
CF 04	117.33 bc	1.87 bc	13.04 bc
CF 05	112.23 b-d	1.79 b-d	12.47 b-d
CF 06	126.67 b	2.02 b	14.07 b
CF 07	153.90 a	2.46 a	17.10 a
CF 08	133.00 ab	2.12 ab	14.78 ab
CF 09	74.90 e	1.19 e	8.32 e
CF 10	107.90 b-d	1.72 b-d	11.99 b-d
LSD $_{0.05}$	27.01	0.43	3.00
CV%	4.56	4.56	4.56

In a column means having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability.

CF 01 : DeshiMorich
CF 02 : Indonesian Morich
CF 03 : Bindu
CF 04 : BARI Morich-1
CF 05 : Kona
CF 06 : Pakistani Morich
CF 07 : Bullet
CF 08 : Lalon
CF 09 : JhallombaMorich
CF 10 : JhalMorich

significant variation for yield per plot among chilligermplasm. According to Patel *et al.* (2015),the analysis of variance revealed the significant differences among the germplasm for yield per plot which indicating that presence of great deal of genetic variability among the germplasm.

4.1.25 Yield per hectare

Yield per hectare was significantly affected by different germplasmof chilli (Table 6). The highest yield per hectare (17.10 ton) was obtained from CF 07 treatment which was statistically similar with CF 08 (14.78 ton). On the other hand, the lowestyield per hectare (8.32 ton) was obtained from CF 09 treatment which was statistically similar with CF 03 (8.97 ton) and CF 02 (9.54 ton) treatment. The yield of chilligermplasm depends on number of fruits, individual fruit weight and fruit size of different germplasm. Due to increase number of fruits, individual fruit weight and fruit size, the yield of chilli varies among the germplasm. Kadwey*et al.* (2016) also observed that analysis of variance showed significant differences among the germplasm for yield per hectare.

4.2 Genetic Diversity

Study of genetic diversity among 10 germplasm of chilli assessed through Mahalanobis' D^2 statistics which has been discussed below:

Mahalanobis D^2 statistics was used to measure the degree of diversification among the genotypes. Using this technique, grouping of genotypes was done in five clusters where genotypes grouped together were less divergent than the ones placed in different clusters based on yield performance. The clusters separated by greatest statistical distance exhibited maximum divergence. Composition of different clusters with their corresponding genotypes and their number are shown in Table 7. Cluster I was the largest cluster comprising of 4 genotypes followed by cluster III with 3 genotypes and the cluster II, IV, V contains 1genotypes. The most promising genotype CF 07 belongs to cluster I.

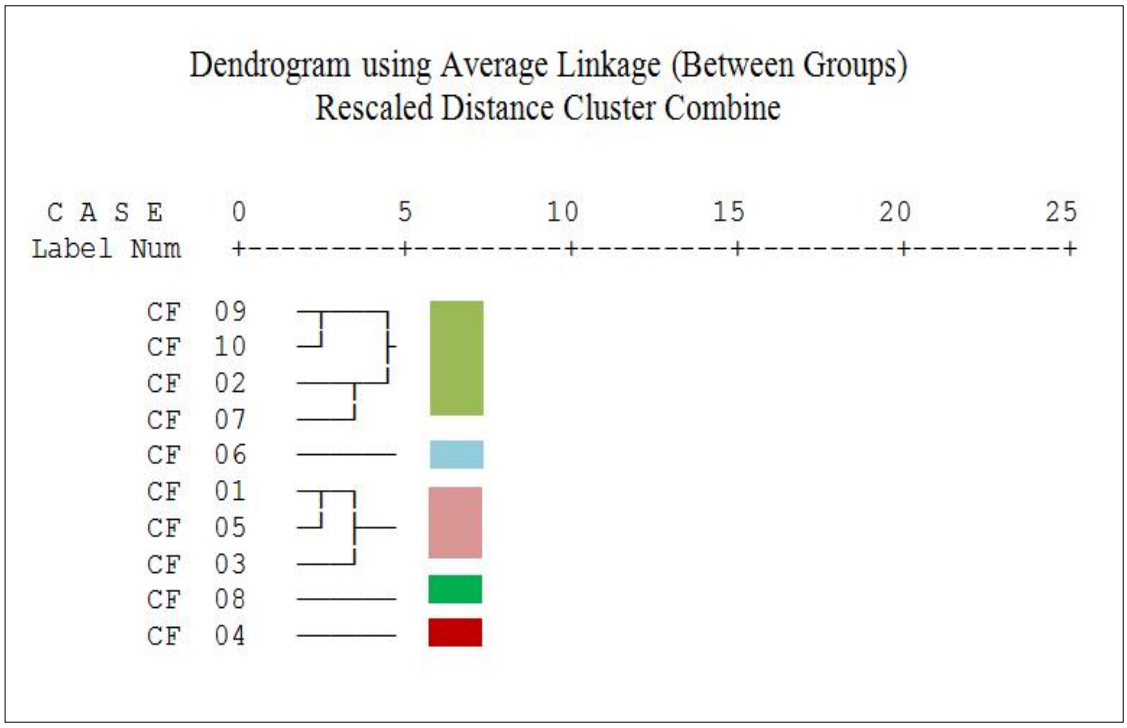


Fig.4. Dendrogram showing cluster of 10 chilli genotypes (Based on yield performance)

Table 7: Distribution of 10 chilligenotypes in different clusters by Tocher's method

Cluster no.	Germplasm no.	Number of genotype	Name of the genotype
I	CF 09, CF 10,CF 02, CF 07	04	JhalLombaMorich, JhalMorich, Indonesian Morich, Bullet
II	CF 06	01	Pakistani Morich
III	CF 01, CF 05, CF 03	03	DeshiMorich, Kona, Bindu
IV	CF 08	01	Lalon
V	CF 04	01	BARI Morich-1

The inter and intra-cluster distance were presented in Table 8. The results showed that the inter-cluster distances between the different clusters of chilligenotypes differed widely. The inter-cluster distances were larger than the intra-cluster distance suggesting wider genetic diversity among the genotypes of different groups.

Table 8.Average intra (bold) and inter-cluster D^2 values of 5 clusters for10 chilligenotypes formed by Tocher's method

Cluster	I	II	III	IV	V
I	**0.2013**				
II	36.018	**0.4875**			
III	22.084	21.789	**0.8412**		
IV	26.287	61.036	45.276	**0.7456**	
V	20.564	23.128	24.505	43.010	**0.6325**

The highest inter-cluster distance was 61.036 between cluster II and IV followed by cluster III and IV and moderate inter-cluster distance was 36.018 between cluster I and II followed by cluster I and IV (26.287), minimum inter-cluster distance was 20.564between cluster I and V followed by cluster II and III(21.789). The maximum value of inter cluster distance indicated that the genotypes belonging to cluster I was far away from those of cluster IV. Similarly, the higher cluster distance between cluster III and IV indicated that the genotypes belonging to each pair of cluster were more diverse. The moderate inter cluster distance between cluster I and II followed by cluster I and IVindicate moderate genetic divergence among the genotypes. The minimum inter cluster distance between cluster I and V followed by cluster II and III indicate minimum genetic divergence among the genotypes.

Higher inter and intra-cluster distances indicated that higher genetic diversity among genotypes between and within clusters respectively. The minimum inter and

intra-cluster distances indicated that the genotypes are closed of two clusters and within the cluster also.

4.3Correlation coefficient

Estimation of simple correlation coefficient was made among eight important yield contributing characters with yield of the 10 chilligermplasm. The value of ‘r’ and the characters correlated are presented in table 9.

4.3.1 Plant height

The relationship among yield contributing characters and yield of chilli differed from variety to variety. As shown in Table 9, the results of association between pairs of components among the varieties revealed that plant height had significant highly positive correlation with numberof flowers per plant (0.577) and positive correlation with yield per hectare (0.507). But plant height showed highly significant negative correlation with length of fruit (−0.772) and individual fruit weight (−0.639). Due to positive correlation with yield per hectare plant height might be used for a trait of selection of a promising chilligermlasm. Rohini and Lakshmanan(2015) were reported similar result in chilli.

4.3.2 Number of flowers per plant

Number of flowers per plant showed positive correlation with chlorophyll content (0.098) and yield per hectare (0.458). Number of flowes per plant showed positive correlation with yield per hectare, so that, itmight be a selection trait of germplasm.Gupta *et al*. (2009) were revealed similar result for selection chilligermplasm.

4.3.3 Number of fruits per plant

Number of fruits per plant had highly significantly positive correlation with yield perhectare (0.825) and positive relationship with chlorophyll content (0.073). But, a significant negative correlation with length of fruit (−0.741) and individual fruit weight (−0.595) was found in case of no. of fruits per plant.Number of fruits per plant had highly significantly positive correlation with yield perhectare, so that it might be a major concern about chilligermplasm selection.Similar findings were noticed by Amit*et al*. (2014).

4.3.4 Length of fruit

Length of fruit had significant and positive correlation with individual fruit weight (0.746) and yield per hectare (0.409). Yield per hectare significantly and positively correlated by length of fruit, for this reason it is a basic concern of better germplasm selection.Ajith and Manju (2015) were supported this result.

4.3.5 Diameter of fruit

Diameter of fruit showed highly significant and highly positive correlation with individual fruit weight (0.779), chlorophyll content (0.637) and yield per hectare (0.855).Diameter of fruit showed highly significant and highly positive correlation with yield per hectare, so that, it highly enhances selection procedure of chilligermplasm. Similar findings were noticed by Rohini and Lakshmanan(2015).

4.3.6 Individual fruit weight

Individual fruit weight was found to be highly significant and highly positively correlated with chlorophyll content (0.643) and yield per hectare (0.864).Individual fruit weight is the basis of enhances yield of chilligermplasm because yield are increases when individual fruit weight shows good potential value. Gupta *et al.* (2009) were found similar result in selection ofchilligermplasm.

4.3.7 Ascorbic acid content

Ascorbic acid content was found positively correlated with individual fruit weight (0.162) and yield per hectare (0.092), but negatively correlated with number of fruits per plant (−0.138). Due to lower correlated value of ascorbic

Table 9. Correlation matrix of different yield contributing characters and yield of chilli

Characters	Plant height	No. of flowers per plant	No. of fruits per plant	Length of fruit	Diameter of fruit	Individual fruit weight	Ascorbic acid content (mg/100g)	Chlorophyll content (%)	Yield per hectare (ton)
Plant height	1.000								
No. of flowers per plant	0.577*	1.000							
No. of fruits per plant	0.431	0.089	1.000						
Length of fruit	-0.772**	0.133	-0.741*	1.000					
Diameter of fruit	-0.491	0.488	-0.184	0.366	1.000				
Individual fruit weight	-0.639*	0.290	-0.595	0.746*	0.779**	1.000			
Ascorbic acid content (mg/100g)	0.345	-0.112	-0.138	0.140	-0.026	0.162	1.000		
Chlorophyll content (%)	0.194	0.098*	0.073*	0.355	0.637*	0.643*	0.412	1.000	
Yield per hectare (ton)	0.507	0.458*	0.825**	0.409**	0.855**	0.864**	0.092	0.779**	1.000

** Significant at 0.01 level of probability; * Significant at 0.05 level of probability

acid content with yield per hectare, it might be slightly enhances the yield. Similar result was also observed by Kumar *et al*. (2012).

4.3.8 Chlorophyll content

Chlorophyll content showed highly significant and highly positive correlation with yield per hectare (0.779). Due to highly significant and highly positive correlation, chlorophyll content enhances yield at a great extent. Rohini and Lakshmanan(2015) were reported similar result in chilligermplasm selection.

4.4Path coefficient analysis

Association of characters determined by correlation may not provide an exact picture of the relative significance of direct and indirect influence of each of the yield components towards yield. In true sense, in order tofind a clear picture of the interrelationships among the fruit yield and yield contributing characteristics, direct and indirect effects were worked out by using path analysis. Phenotypic path analysis is explained in the following headings in table 10.

4.4.1 Yield perhectare *vs*plant height

Path analysis showed that plant height had negative direct effect (-0.506) on yieldperhectare (Table 10). It showed negligible positive indirect effect through Diameter of fruit, number of fruits perplant, plant height, length of fruit,ascorbic acid content and chlorophyll content. Plant height showed negative indirect effect through number of flowers perplant and individual fruit weight. Due to negative direct effect, plant height should not be the trait for selection of a superior germplasm. Patel *et al.* (2015) reported that plant height exerted the highest negative direct effect on fruit yield perhectare, which supported this result.

4.4.2 Yield perhectare *vs*number of flowers perplant

The number of flowers perplant had positive direct effect (0.274) on yield perhectare (Table 10). It showed negligible positive indirect effect through number of flowers perplant, individual fruit weight, number of fruits perplant and yield perplant. Number of flowers per plant showed negative indirect effect throughdiameter of fruit, ascorbic acid content, chlorophyll content and length of fruit. Increasing number of flower should be increase yield symmetrically.

4.4.3 Yield perhectare *vs*number of fruits perplant

Findings of path analysis revealed that number of fruits/plant had positive direct effect (0.179) on yieldperhectare (Table 10). It showed negligible positive indirect effect through days to 1st flowering, number of flowersperplant, length of fruit and diameter of fruits. Number of fruitsperplant showed negative indirect effect through plant height, individual fruit weight, ascorbic acid content and chlorophyll content. Singh *et al.* (2014) showed that, the germplasm that are having maximum number of fruits per plant in the selection process due to their high positive direct effect on fruit yield.

4.4.4 Yield perhectare *vs*length of fruit

From the path analysis we found that length of fruit had highly negative direct effect (-1.108) on yieldperhectare (Table 10). It showed negligible positive indirect effect through number of flowersperplant, individual fruit weight, plant height, ascorbic acid content and chlorophyll content. Diameter of fruit and number of fruitsperplant showed negative indirect effect.Due to negative direct effect length of fruit should not be a reasonable trait for germplam selection. Singh *et al.* (2014) reported that length of fruit exerted the highest negative direct effect on fruit yield/hectare.

4.4.5 Yield perhectare *vs*diameter of fruit

The diameter of fruit had negative direct effect (-0.620) on yieldperhectare (Table 10). It showed negligible positive indirect effect through number of flowersperplant, plant height, individual fruit weight,and chlorophyll content. Diameter of fruit showed negative indirect effect through number of fruitsperplant and ascorbic acid content. The diameter of fruit shows negative direct effect on yieldperhectare, so that it should be affected yield.Singh *et al.* (2014) reported that path coefficient analysis revealed diameter of fruit had negative direct effect on yield/hectare, which supported this result.

4.4.6 Yield perhectare *vs*individual fruit weight

The path analysis revealed that individual fruit weight had highly positive direct effect (1.812) on yieldperhectare (Table 10). It showed negligible positive indirect effect through plant height, number of flowersperplant, ascorbic acid content and

chlorophyll content. Individual fruit weight showed negative indirect effect through number of fruits per plant, length of fruit, and diameter of fruit. Due to show highly positive direct effect, increasesindividual fruit weight increase the yield at a great extent. So that, individual fruit weight should be a major concern for selection a superior germplasm. Singh *et al.* (2014) also reported that individual fruit weight exerted the highest positive direct effect on fruit yieldperhectare.

4.4.7 Yield perhectare *vs*ascorbic acid content

Path analysis revealed that ascorbic acid contenthad positive direct effect (0.155) on yieldperhectare (Table 10). It showed negligible positive indirect effect through individual fruit weight, diameter of fruit and chlorophyll content. Ascorbic acid content showed negative indirect effect through number of flowersperplant, number of fruits per plant and length of fruit. Ascorbic acid contentshows positive direct effect on yield per hectare which support that, increases ascorbic acid content will increase yield per hectare. Patel *et al.* (2015) also revealed that ascorbic acid content exerted the positive direct effect on fruit yieldperhectare, which supported this result.

4.4.8 Yield perhectare *vs*Chlorophyll content

Path analysis revealed that chlorophyll content had positive direct effect (0.109) on yieldperhectare (Table 10). It showed negligible positive indirect effect through individual fruit weight and ascorbic acid content. Chlorophyll content showed negative indirect effect through number of flowersperplant, number of fruits perplant, length of fruit and diameter of fruit.Positive direct effect between chlorophyll content and yield per hectare shows symmetrical changes of one another. Patel*et al.* (2015) also reported that chlorophyll content exerted the positive direct on fruit yieldperhectare.

Table 10. Partitioning of genotypic into direct and indirect effects of different yield contributing characters and yield of chilli

Characters	Plant height	No. of flowers per plant	No. of fruits per plant	Length of fruit	Diameter of fruit	Individual fruit weight	Ascorbic acid content (mg/100g)	Chlorophyll content (%)	Yield per hectare (ton)
Plant height	**-0.506**	-0.205	0.122	0.917	0.316	-1.279	0.054	0.044	-0.537
No. of flowers per plant	0.378	**0.274**	0.002	-0.283	-0.441	0.877	-0.022	-0.067	0.718
No. of fruits per plant	-0.345	0.003	**0.179**	1.079	0.146	-1.191	-0.023	-0.121	-0.273
Length of fruit	0.419	0.070	-0.174	**-1.108**	-0.236	1.426	0.022	0.009	0.427
Diameter of fruit	0.258	0.195	-0.042	-0.422	**-0.620**	1.458	-0.003	0.057	0.881
Individual fruit weight	0.357	0.133	-0.118	-0.873	-0.499	**1.812**	0.028	0.066	0.906
Ascorbic acid content (mg/100g)	-0.176	-0.040	-0.026	-0.156	0.010	0.322	**0.155**	0.027	0.117
Chlorophyll content (%)	-0.204	-0.167	-0.198	-0.094	-0.321	1.094	0.038	**0.109**	0.257
Yield per hectare (ton)	-0.506	-0.205	0.122	0.917	0.316	-1.279	0.054	0.044	-0.537

Residual effect = 1.218

CHAPTER V

SUMMARY AND CONCLUSION

The present experiment was conducted to study variability, correlation and path analysis of 10 germplasm of chilli(*Capsicum frutescence* L.) at Horticultural farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka during the period from November 2013 to May 2014. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. Data on yield contributing characters and yield of fruit were recorded. The statistical analysis of variance indicated the existence of wide variability for different characters.

The height of plant was significantly influenced by different germplasmat all the sampling dates. At 20, 30, 40, 50 and 60 DAT, the tallest plant (10.83, 15.33, 20.00, 27.00 and 31.00 cm, respectively) was observed from the CF 01 treatment and the shortest plant (6.6, 10.33, 13.00, 17.00 and 22.17 cm, respectively) was found in CF 07 treatment.

Differentgermplasm exhibited significant variation in respect of number of leaves per plant. At 20, 30, 40, 50 and 60 DAT, the maximum number of leaves per plant (9.00, 20.00, 31.00, 61.33 and 105.30, respectively) was observed from the CF 01 treatment whereas the minimum number of leaves per plant (6.33, 13.33, 17.00, 31.67 and 58.00, respectively) was found in CF 07 treatment.

Leaf length was significantly influenced by different germplasmof chilli. The maximum length of leaf (14.33 cm) was recorded from CF 08 treatment and the minimum length of leaf (8.40 cm) was recorded from CF 10 treatment.

Leaf breadth was significantly affected by different germplasmof chilli. The maximum breadth of leaf (4.20 cm) was recorded from CF 08 treatment while the minimum breadth of leaf (2.36 cm) was recorded from CF 01 treatment.

The maximum number of primary branch (7.00) was recorded from CF 01 treatment while the minimum number of primary branch (4.33) was recorded from CF 07 treatment. The maximum number of secondary branch (19.67) was recorded from CF 04 treatment and the minimum number of secondary branch (14.00) was recorded from CF 08 treatment. The largest size of canopy (33.00 cm) was recorded from CF 01 treatment while the smallest size of canopy (22.67 cm) was recorded from CF 06 treatment.

The largest stem diameter (1.26 cm) was recorded from CF 06 treatment while the smallest stem diameter (0.80 cm) was obtained in CF 09 treatment. The highest number of flowers per plant was observed in CF 04 treatment (16.67) while the lowest number of flowers per plant was obtained from CF 10 (7.00). The maximum days required to first flowering (80.67) was recorded from CF 06 treatment and the minimum days required to first flowering (39.00) was recorded from CF 03 treatment.

The maximum days required to fifty percent flowering (84.33) was recorded from CF 06 treatment and the minimum days required to fifty percent flowering (47.67) was obtained from CF 03 treatment.The maximum days required to first fruiting (86.67) was recorded from CF 06 treatment while the minimum days required to first fruiting (50.67) was recorded from CF 03 treatment. The highest number of fruits per plant was observed in CF 01 treatment (72.57) and the lowest number of fruits per plant was obtained from CF 06 (46.00).

The maximum chlorophyll content (57.13 %) was recorded from CF 07 treatment while the lowest chlorophyll content (50.30 %) was observed in CF 09 treatment. The longest fruit (7.40 cm) was observed from CF 06 treatment and the shortest fruit (4.26 cm) was recorded from CF 05 treatment. The longest pedicel (3.06 cm) was observed from CF 06 treatment and the shortest pedicel (1.53 cm) was recorded from CF 01 treatment. The largest fruit

diameter (1.50 cm) was obtained from CF 07 treatment while the smallest fruit diameter (0.76 cm) was recorded from CF 02 treatment.

The maximum weight of individual fruit (2.81 gm) was observed in CF 06 treatment and the minimum weight of individual fruit (1.28 gm) was obtained from CF 03 treatment.

The longest root (18.33 cm) was observed from CF 07 treatment while the shortest root (11.17 cm) was recorded from CF 09 treatment. The highest root diameter (0.88 cm) was obtained from CF 03 treatment and the smallest diameter of root (0.48 cm) was recorded from CF 09 treatment. The maximum weight of 1000-seed (3.77 gm) was obtained from CF 06 treatment while the minimum weight of 1000-seed (2.91 gm) was obtained from CF 10 treatment.

The highest ascorbic acid content was recorded from CF 08 treatment (99.53 mg) and the lowest ascorbic acid content was recorded from CF 04 treatment (40.37 mg). The highest yield per plant of chili (153.90 g) was obtained from CF 07 treatment and the lowest yield per plant of chili (74.90 g) was produced by CF 09 treatment. The maximum yield per plot (2.46 kg) was obtained from CF 07 treatment while the minimum yield per plot (1.19 kg) was produced by CF 09 treatment. The highest yield per hectare (17.10 ton) was obtained from CF 07 treatment and the lowest yield per hectare (8.32 ton) was obtained from CF 09 treatment.

The highest inter-cluster distance was 61.036 between cluster II and IV followed by cluster III and IV and moderate inter-cluster distance was 36.018 between cluster I and II followed by cluster I and IV (26.287), minimum inter-cluster distance was 20.564 between cluster I and V followed by cluster II and III (21.789). The maximum value of inter cluster distance indicated that the genotypes belonging to cluster I was far away from those of cluster IV. Similarly, the higher cluster distance between cluster III and IV indicated that the genotypes belonging to each pair of cluster were more diverse. The moderate inter cluster distance between cluster I and II followed by cluster I

and IV indicate moderate genetic divergence among the genotypes. The minimum inter cluster distance between cluster I and V followed by cluster II and III indicate minimum genetic divergence among the genotypes.

Data revealed that significant correlation for yield per hectare of chilligermplasm with number of fruitsperplant (0.825), individual fruit weight (0.864), length of fruit (0.409), diameter of fruit (0.855), number of fruitsperplant (0.825) and chlorophyll content (0.779), while the non significant positive correlation for yieldperhectare (0.092).

From path analysis it was found that number of flowersperplant, number of fruits/plant, individual fruit weight, ascorbic acid content and chlorophyll content, had positive direct effect on yieldperhectare, whereas plant height, length of fruit and diameter of fruit had negative direct effect on yield/hectare.

Conclusion:

The result of the present experiment revealed that a wide variability existed among the collected chilligermplasm.CF 01 treatment was obtainedmaximum results in plant height (10.83, 15.33, 20.00, 27.00 and 31.00 cm, respectively), number of leaves per plant (9.00, 20.00, 31.00, 61.33 and 105.30, respectively),number of primary branch (7.00),canopy size (33.00 cm) and number of fruits per plant (72.57). Whereas CF 03 treatment was obtained the highest root diameter (0.88 cm).CF 04 treatment was obtainedmaximum results in number of secondary branch (19.67) and number of flowers per plant (16.67). CF 06 treatment was obtainedmaximum results in days required to first flowering (80.67), days required to fifty percent flowering (84.33), days required to first fruiting (86.67) , longest fruit (7.40 cm), longest pedicel (3.06 cm) , weight of individual fruit (2.81 gm),maximum weight of 1000-seed (3.77 gm) and plant diameter (1.26 cm). On the other hand, CF 07 treatment was obtained highest result in fruit diameter (1.50 cm), longest root (18.33 cm), chlorophyll content (57.13 %),yield per plant (153.90 g), yield per plot (2.46 kg) andyield per hectare (17.10 ton).CF 08 treatment was obtained maximum

results in leaf length (14.33 cm), leaf breadth (4.20 cm) and ascorbic acid content (99.53 mg).

The highest inter-cluster distance was 61.036 between cluster II and IV. The maximum value of inter cluster distance indicated that the genotypes belonging to cluster I was far away from those of cluster IV. Data revealed that significant correlation for yield per hectare of chilligermplasm with number of fruitsperplant (0.825), individual fruit weight (0.864), length of fruit (0.409), diameter of fruit (0.855), number of fruitsperplant (0.825) and chlorophyll content (0.779), while the non significant positive correlation for yieldperhectare (0.092).

From path analysis it was found that number of flowersperplant, number of fruitsperplant, individual fruit weight, ascorbic acid content and chlorophyll content, had positive direct effect on yieldperhectare, whereas plant height, length of fruit and diameter of fruit had negative direct effect on yieldperhectare.

Considering the magnitude onthe basis of variability, cluster analysis, correlation, path analysis and agronomic performance, CF 07 (Bullet) may be selected as promising line for future breeding program.

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APPENDICES

Appendix I. Monthly average temperature, relative humidity and total rainfall of the experimental site during the period from November 2013 to May 2014

Month	Air temperature (^{0}C)		R. H. (%)	Total rainfall (mm)
	Maximum	Minimum		
November,13	25.82	16.04	78	0
December,13	22.4	13.5	74	0
January,14	24.5	12.4	68	0
February ,14	27.1	16.7	67	3
March ,14	31.4	19.6	54	11
April , 14	35.3	22.4	51	15
May, 14	38.2	23.2	62	17

Source: Bangladesh Metrological Department (Climate and weather division) Agargaon, Dhaka

Appendix II.Results of morphological, mechanical and chemical analysis of soil of the experimental plot

A. Morphological Characteristics

Morphological features	Characteristics
Location	Horticulture Farm, SAU, Dhaka
AEZ	Modhupur Tract (28)
General Soil Type	Shallow redbrown terrace soil
Land Type	Medium high land
Soil Series	Tejgaon
Topography	Fairly leveled
Flood Level	Above flood level
Drainage	Well drained

B. Mechanical analysis

Constituents	Percentage (%)
Sand	28.78
Silt	42.12
Clay	29.1

C. Chemical analysis

Soil properties	Amount
Soil pH	5.8
Organic carbon (%)	0.95
Organic matter (%)	0.77
Total nitrogen (%)	0.075
Available P (ppm)	15.07
Exchangeable K (%)	0.32
Available S (ppm)	16.17

Source: Soil Resource Development Institute (SRDI)

Appendix III. Analysis of variance of differentgermplasm of chillion plant height at different DAT

Source of variation	Degrees of freedom (df)	Mean square on plant height				
		20 DAT	30 DAT	40 DAT	50 DAT	60 DAT
Replication	2	1.458	0.558	4.908	7.908	25.833
Factor A (Germplasm of chilli)	9	5.189**	11.370**	22.50**	40.756**	35.194**
Error	18	1.069	1.512	2.519	3.019	5.213

** : Significant at 1% level of probability; * : Significant at 5% level of probability

Appendix-IV. Analysis of variance of different germplasmof chillion number of leaves per plant at different DAT

Source of variation	Degrees of freedom (df)	Mean square of number of leaves per plant				
		20 DAT	30 DAT	40 DAT	50 DAT	60 DAT
Replication	2	0.533	18.100	40.133	95.033	1659.633
Factor A (Germplasmof chilli)	9	1.633**	12.163*	52.356**	222.759**	643.367**
Error	18	0.422	6.285	18.133	57.515	165.411

** : Significant at 1% level of probability; * : Significant at 5% level of probability

Appendix-V. Analysis of variance of different germplasmof chilli on growth parameters

Source of variation	Degrees of freedom (df)	Mean square on growth parameters					
		Leaf Length	Leaf Breadth	Primary Branch	secondary branch	canopy size	Plant diameter
Replication	2	2.550	0.121	0.100	11.633	11.100	0.103
Factor A (Germplasm of chilli)	9	11.024**	1.229**	3.056*	10.256^{NS}	37.793**	0.068**
Error	18	1.014	0.040	1.100	9.633	6.109	0.008

** : Significant at 1% level of probability; * : Significant at 5% level of probability, NS : Non Significant

Appendix-VI. Analysis of variance of different germplasmof chilli on different parameters

Source of variation	Degrees of freedom (df)	Mean square on different parameters				
		No. of Flowers per plant	First flowering (DAT)	Fifty percent flowering (DAT)	First fruiting (DAT)	Number of fruits
Replication	2	11.100	36.133	0.633	177.633	1946.100
Factor A (Germplasm of chilli)	9	28.741*	806.967**	605.022**	557.941**	1633.348*
Error	18	31.730	11.911	3.411	22.596	1301.915

** : Significant at 1% level of probability; * : Significant at 5% level of probability

Appendix-VII. Analysis of variance of different germplasmof chilli on fruit parameters

Source of variation	Degrees of freedom (df)	Mean square on fruit parameters			
		Fruit length (cm)	Pedicel length(cm)	Fruit diameter (cm)	Individual Fruit weight (gm)
Replication	2	0.080	0.026	0.004	379.300
Factor A (Germplasmof chilli)	9	2.355**	0.729**	0.158**	16883.126**
Error	18	0.261	0.106	0.007	2231.448

** : Significant at 1% level of probability; * : Significant at 5% level of probability

Appendix-VIII. Analysis of variance of different germplasmof chilli on growth parameters

Source of variation	Degrees of freedom (df)	Mean square on gro		
		Root length (cm)	Root diameter (cm)	10
Replication	2	23.333	0.308	
Factor A (Germplasm of chilli)	9	21.779*	0.043^{NS}	
Error	18	6.815	0.019	

** : Significant at 1% level of probability; * : Significant at 5% level of probability,

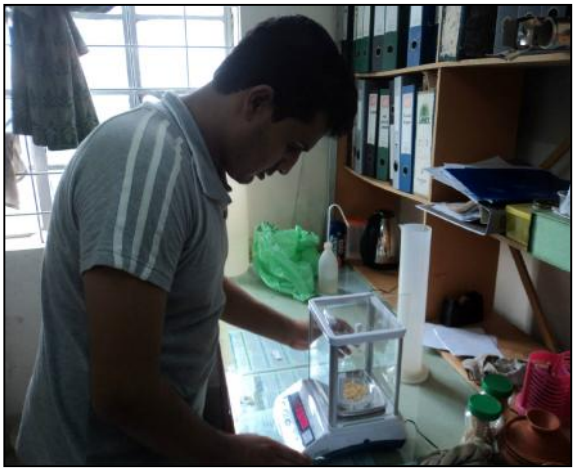
Appendix-IX. Analysis of variance of different germplasmof chilli on yield parameters

Source of variation	Degrees of freedom (df)	Mean square on yield parameters		
		Yield per plant (gm)	Yield per plot (kg)	Yield per hectare (ton)
Replication	2	0.013	0.011	0.523
Factor A (Germplasm of chilli)	9	0.475**	0.480**	23.151**
Error	18	0.024	0.063	3.061

** : Significant at 1% level of probability; * : Significant at 5% level of probability

E **F**

Plate 3. Photograph showing different steps of ascorbic acid estimation process



D

Plate 4. Panoramic view of the experiment: A. Polybag preparation for seed germination; B. SPAD meter; C. Data collection in field and D. Weighing of 1000-seeds.