

GENETIC VARIABILITY AND DIVERGENCE STUDIES IN
BYADAGI CHILLI (***Capsicum annum*** L.)

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GENETIC VARIABILITY AND DIVERGENCE STUDIES IN
BYADAGI CHILLI (***Capsicum annum*** L.)

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By

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C E R T I F I C A T E

This is to certify that the thesis entitled “ **GENETIC VARIABILITY AND DIVERGENCE STUDIES IN BYADAGI CHILLI (*Capsicum annuum L.*)**” submitted by **VIDYASHREE AJJAPPA BETAGERI** for the degree of **MASTER OF SCIENCE (HORTICULTURE)** in **VEGETABLE SCIENCE**, of the University of Horticultural Sciences, Bagalkot, is a record of research work carried out by her during the period of her study in this university, under my guidance and supervision, and the thesis has not previously formed the basis of the award of any degree, diploma, associateship, fellowship or other similar titles.

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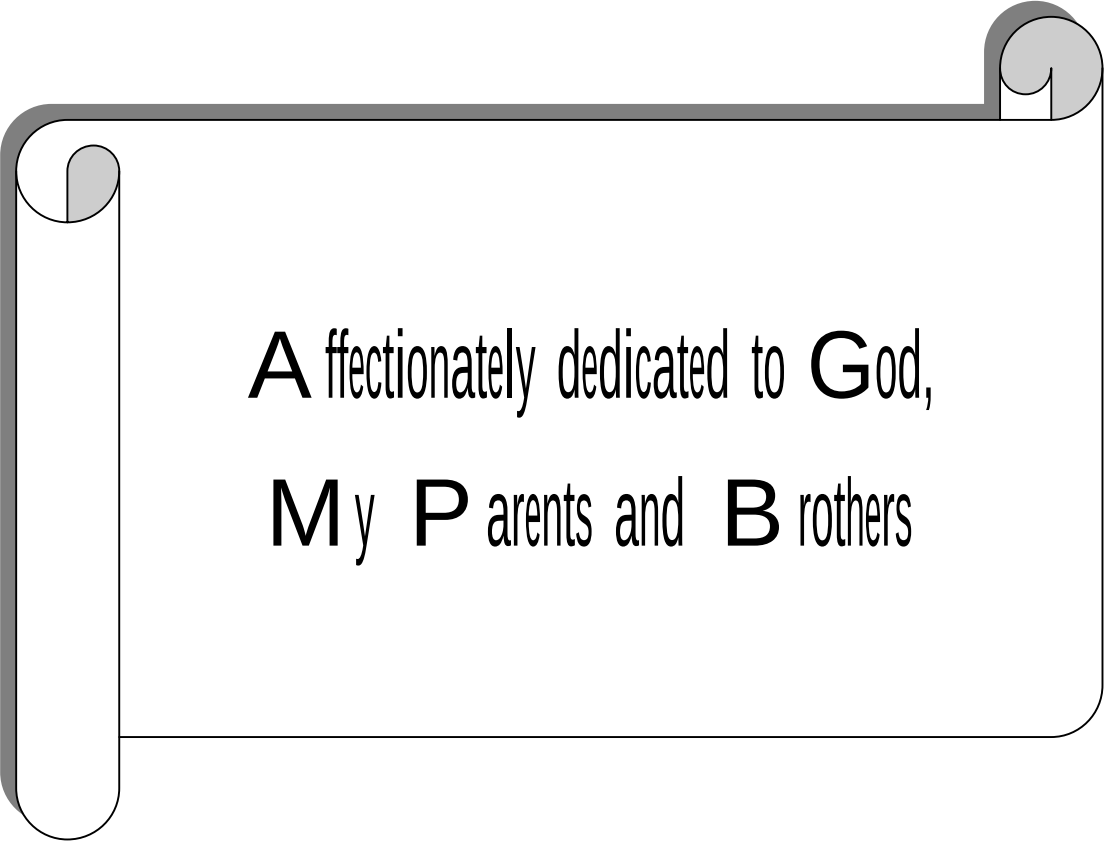
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JUNE, 2015**

(VIDYASHREE AJJAPPA BETAGERI)



Affectionately dedicated to **G**od,
My **P**arents and **B**rothers

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LIST OF ABBREVIATIONS

%	Per cent
cm	Centimeter
DAT	Days after transplanting
<i>et al.</i>	and others
GA	Genetic advance
GAM	Genetic Advance as percentage of Mean
GCV	Genotypic coefficient of variation
PCV	Phenotypic coefficient of variation
H^2	Heritability
g	Gram
mg	Milligram
<i>viz.</i>	Namely

1. INTRODUCTION

Chilli (*Capsicum annum* L.) a member of the family Solanaceae has the chromosome number $2n=24$. Chilli is one of the most important vegetable cum spice crop. The origin of chilli is said to be Mexico, with secondary centers in Guatemala and Bulgaria (Salvador, 2002).

It was introduced to Europe by Columbus in 15th century and spread to rest of the globe along the spice trading routes to Africa, India, China and Japan. In 17th century, Portuguese introduced it into India and was incorporated into national cuisines instantly (Bosland and Votava, 2000).

Chilli is grown for its spice and vegetable green fruits of commerce. It has different uses at mature green, red ripe and dried stages. It is valued for its pungency which is due to crystalline acrid volatile alkaloid capsaicin, present in the placenta of fruits. Capsaicin has diverse prophylactic and therapeutic uses in allopathic and ayurvedic medicine (Sumathy and Mathew, 1984). Apart from rich source of vitamin C, it has vitamins A and E, small quantity of proteins, fats, carbohydrates and traces of minerals (Hosamani, 1993). Chilli is also a good source of oleoresin, which is the total flavour extract of the dried ground and is a concentrated homogenous free flowing product, having varied uses in processed food and beverage industries. The natural colour extract of chillies is also finding its increased value in place of artificial colour in the food items, especially in developed nations (Owens, 1992).

The area under dry chilli crop in India is estimated as 775 thousand hectares with total production of 1492 thousand metric tonnes and with a productivity of 1.9 MT per hectare (Anon., 2015). Andhra Pradesh, Karnataka, Maharashtra, Orissa, and Tamil Nadu account for three-fourth of the total area under chilli cultivation. Andhra Pradesh stands first in area (131.32 thousand ha) and production (601.99 thousand metric tonnes) of dry chillies while Karnataka stands second in area (89.56 thousand ha) and production (111.55 thousand metric tonnes) (Anon., 2015). India has greater potential to increase the production of elite dry chilli types like Byadagi, in order to promote export, besides meeting the domestic requirement. However, despite continuous efforts at

various levels, the dry chilli productivity of Byadagi land races did not gain momentum. This could be attributed to a number of limiting factors of which lack of superior genotypes for the further development of superior high yielding cultivars or hybrids and also severe incidence of thrips, mites, powdery mildew, anthracnose and fruit borer etc. resulting in tremendous reduction in yield and quality.

The genus capsicum is often cross pollinated crop and natural cross pollination may go up to 50 per cent depending upon extent of style exertion, time of dehiscence of anthers, wind direction and insect population (Murthy and Murthy, 1962 and Hosamani, 1993). Hence, breeding methods of both self and cross-pollinated crops could be employed for crop improvement.

A comprehensive knowledge of the available variability within the breeding material of a crop species for desired characters enables the breeders to identify most potential genotype. The phenotypic variation arises as a result of phenotypic, genotypic and interaction between genotypic and environmental variations, but for making effective selections, the heritable unit *i.e.*, the genetic variation is most important. Burton (1952) suggested that genetic variability along with heritability should be considered for assessing the maximum and accurate effect of selection. Shift in the gene frequency towards desirable combinations under selection procedure is termed as genetic advance and is generally expressed as percentage of mean (genetic mean). Johnson *et al.* (1955) reported that heritability and genetic advance, when computed together, are more useful in predicting the resultant effect of selection.

Improvement made in crop varieties is mainly concentrated on increasing yield and yield attributing characters. A study of correlation between different quantitative characters provides an idea of association of different characters. It could be effectively exploited to formulate selection strategies for improving yield and quality. Association of characteristics among yield, its components and other economical traits is important for making selection in the breeding program. It suggests the advantage of a scheme of selection for more than one character at a time (Kalloo, 1994).

Yield is a complex character controlled by a large improvement made in crop varieties is mainly concentrated on increasing yield and yield attributing characters. A study of correlation between different quantitative characters provides an idea of association of different characters. It could be effectively exploited to formulate selection strategies for improving yield and quality. The correlation coefficient becomes more evident when genotypic correlations are partitioned into its components in path analysis in order to determine the relative magnitude of various attributes contributing to correlation. Path coefficient provides an effective means of entangling direct and indirect causes of association and measures the relative importance of each causal factors. Partitioning of total correlation into direct and indirect effect would be worthwhile for an effective selection programme (Kalloo, 1994).

Study of genetic divergence among the existing genetic stocks provides an opportunity for selecting the diverse parents for hybridization. Such parents are expected to produce superior segregants in combination with others and thus are most valuable for breeders (Kalloo, 1994). D^2 statistics developed by Mahalanobis (1936) provides a measure of magnitude for divergence between two genotypes under comparison. Grouping of genotypes based on D^2 analysis will be useful in choosing suitable parental lines for heterosis breeding. Crop improvement in chilli has so far been achieved by exploiting the available sources of the variability. Naturally, the genetic variation or diversity for most of the yield attributes is considerably high in chilli. There is an urgent need to seek improvement in complex quantitative trait such as yield. As a result of free exchange of chilli germplasm and lot of introgression of characters has taken place in many local chilli cultivars resulting in enhancement of variability and new genetic combinations.

The breeding programme on the basis of variability on the one hand and diversity on the other is scanty. The present investigation was undertaken to evaluate the genetic variability for different characters to estimate the scope of advance for selection and diversity of genotypes for identification of suitable parents for hybridization to improve yield and yield attributing characters. Therefore, the investigation on genetic

variability and divergence among chilli accession for various traits with the following objectives.

- 1) To study genetic variability for growth, earliness, yield and quality parameters in chilli accessions.
- 2) To study genetic diversity for growth, earliness, yield and quality parameters in chilli accessions.
- 3) To study the association of growth, earliness, yield and quality parameters in chilli accessions.

2. REVIEW OF LITERATURE

Vegetable breeder is primarily concerned with the improvement of both qualitative and quantitative plant characters. Hence, adequate knowledge of genetics of various traits is very essential in vegetable breeding programme for obtaining desired results in the next generation. However, the success of vegetable breeding depends on the extent and the magnitude of variability existing in the germplasm. At the same time, improvement is possible on the basis of heritable variation. Hence, for the improvement of chilli yield traits is necessary. Therefore, detailed information about genetic architecture of fruit yield and its attributes should be the main concern.

The literature pertaining to genetic variance (GV), phenotypic variance (PV), genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability (broad sense), genetic advance (GA), inter relationship between fruit yield and its component traits, direct and indirect effects of various traits towards fruit yield and diversity in chilli and other Solanaceous vegetables are outlined under the following sub headings.

2.1 Genetic variability

A critical estimate of genetic variability is a prerequisite for initiating appropriate breeding procedures in crop improvement programmes. The variability observed in any population could be due to two factors the genetic and environmental, which were discussed in the early part of last century by Johannsen (1909), who attributed the variation in a segregating population to both heritable and non-heritable factors and variation within pure line to only environmental factors. Nelson Ehle (1909) and East (1916) later confirmed Johannsen's work and showed that continuous variation also conforms to Mendelian Genetics.

Charles and Smith (1939), Powers (1942) and Powers *et al.* (1950) partitioned genetic variance from total variances using the estimate of environmental variance in non segregating population. The heritable variation was further divided into additive and non additive components and later fraction included dominance and interallelic interaction (Fischer *et al.*, 1932; Panse, 1940; Lush, 1945; Mather, 1949 and Falconer,

1981). Studies on assessment of genetic variability for its morphological and yield parameters in chilli have been carried out by several workers in the past.

2.2 Heritability

In crop improvement, the genetic component of variation is important as only this component is transmitted to the next generation. According to Hanson *et al.* (1956), heritability in broad sense is the ratio of genotypic variance to total variance in non-segregating population. Thus, heritability denotes the proportion of phenotypic variance that is due to genotype which is heritable.

Heritability is known to differ to some extent depending on the populations handled. The estimates of heritability serves as a useful guide to the breeder. The breeder is able to appreciate the proportion of variation that is due to genotypic effect in case of broad sense heritability and due to additive effects in narrow sense heritability. Selection for this trait would be fairly easy as there would be close correspondence between genotype and phenotype due to a relatively smaller contribution of environment to the phenotype. But, for a character of low heritability selection may be considerably difficult or virtually impractical due to the masking effect of environment on the genotypic effect (Singh, 1991).

2.3 Genetic advance

Genetic advance is the measure of improvement that can be achieved by practicing selection in a population. Since, the estimates of heritability gives the indication of the amount of progress expected from the selection, they are most meaningful when accompanied by estimates of genetic advance. Genetic advance is affected by factors like intensity of selection, heritability and phenotypic variance. High genetic advance coupled with high heritability is an indication of more additive gene action (Panse, 1957). Review of literature on mean, range, components of variance, heritability and genetic advance in chilli are presented in Table 1.

Table 1: Review of literature on mean, range, components of variance, heritability and genetic advance in chilli and related vegetable crops

Sl. No.	Characters		Mean	Range	PV	GV	PCV (%)	GCV (%)	h ² (%)	GA	GAM (%)	References
1	Plant height (cm)	Chilli	40.99	30.12-53.67	78.94	74.15	-	-	97.17	37.06	-	Amarchandra <i>et al.</i> (1990)
			97.4	61.7-92.66	-	-	-	-	0.51	10.82	-	Bhagyalakshmi <i>et al.</i> (1990)
			62.03	26-95.00	-	-	17.66	16.65	0.88	20.04	32.3	Nazer <i>et al.</i> (1990)
			60.29	43.20-66.50	48.96	25.57	11.64	8.35	51.45	7.44	12.34	Nehru and Manjunath (1996)
			-	-	140.2	147.18	20.38	19.89	95.25	23.83	-	Rani <i>et al.</i> (1996a)
			55.5	39.50-78.80	-	-	18.6	16.5	64.20	3.6	-	Warade <i>et al.</i> (1996b)
			62.66	32.36-94.60	-	-	17.94	16.37	83.28	19.27	30.76	Basavaraja (1997)
			-	-	-	-	29.69	29.39	98.01	59.94	-	Kataria <i>et al.</i> (1997)
			-	-	111.32	98.99	23.11	21.08	88.90	19.23	42.8	Saraladevi and Arumugam (1998)
			56.85	34.21-85.83	177.63	189.48	23.44	24.21	93.70	26.58	-	Nandadevi (1999)
			98.60 ±4.00	61.33-133.33			20.09	18.82	87.77	36.32	-	Manju and Shreelathakumary (2002)
			60.35	39.87-96.53	125.28	117.99	18.97	18	90	21.22	35.16	Kashinath (2003)
			63.13	-	14.08	10	5.94	5	71.03	5.49	8.7	Jadhav <i>et al.</i> (2004)
			43.08±1.20	27.42- 67.18	96.3	93.4	22.78	22.44	96.98	45.52	-	Sreelathakumary and Rajamony (2004)
			-	-	-	-	16.12	15.21	89.01	-	29.56	Ajith and Manju (2006)
			79.27	51.00-104.00	211.94	201.18	18.36	17.89	94.92	28.46	35.9	Smitha and Basavaraja (2006)
			58.53 ± 2.169	40.40-110.40	135.57	144.98	20.57	19.89	93.5	23.19	39.62	Krishna <i>et al.</i> (2007a)
			75.67	68.00-85.50	-	-	16.24	13.02	64.3	10.11	21.11	Madankumar (2008)
			67.38	-	-	-	13.98	10.52	56.6	16.3	-	Tembhurne <i>et al.</i> (2008)
			60.76	33.50-97.30	-	-	25.07	24.15	92.8	29.12	47.92	Sarkar <i>et al.</i> (2009)
2	Plant spread	Chilli	55.57	34.13-69.26	-	-	14.59	11.9	66.46	11.09	19.96	Basavaraja (1997)
			6.15	3.33-11.73	7.01	7.64	43.04	44.94	91.7	5.23	84.99	Nandadevi (1999)

Table 1: Contd...

Sl. No.	Characters		Mean	Range	PV	GV	PCV (%)	GCV (%)	h ² (%)	GA	GAM (%)	References
			49.56	39.53-61.67	31.95	24.59	14.08	10.01	50.5	7.26	14.65	Kashinath (2003)
			-	-	-	-	14.3	15.9	94.3	-	47.2	Jadhav <i>et al.</i> (2004)
			2.39	2.05-3.15	0.1192	0.0097	15.06	1.32	0.08	0.01	0.41	Krishna <i>et al.</i> (2007a)
			48.88	26.60-64.85	-	-	15.16	10.32	43.7	6.88	14.07	Madankumar (2008)
			53.93	38.43-76.60	-		19.18	17.87	86.8	18.5	34.3	Sarkar <i>et al.</i> (2009)
3	Number of primary branches per plant	Chilli	6.82	5.40-8.50	1.1	0.17	15.42	6.07	15.49	0.34	4.98	Nehru and Manjunath (1996)
			-	-	10.82	4.46	29.4	18.87	41.19	2.79	24.97	Rani <i>et al.</i> (1996a)
			4.4	2.17-7.40	-	-	25.4	23	82.1	1090	-	Warade <i>et al.</i> (1996b)
			3.55	2.01-5.61	-	-	20.89	16.93	85.71	-	28.26	Basavaraja (1997)
			-	-	1.59	1.59	29.78	29.56	98.5	2.569	60.16	Saraladevi and Arumugum (1998)
			6.15	3.33-11.73	7.65	7.01	44.94	43.04	91.7	5.23	84.99	Nandadevi (1999)
			5.44 ±8.67	3.33-8.67	-	-	30.56	19.17	39.33	24.77	-	Manju and Shreelathakumary (2002)
			3.15	2.27-3.80	7.54	0.18	14.56	13.38	84.4	0.8	25.36	Kashinath (2003)
			1.23	1.00-2.07	0.03	0.09	24.39	14.08	33.33	-	16.79	Verkey <i>et al.</i> (2005)
			-	-	-	-	32.86	31.56	92.3	-	62.56	Ajith and Manju (2006)
			8.55	3.50-12.70	4.18	3.97	27.33	24.6	81	3.85	45.02	Smitha and Basavaraja (2006)
			2.39	2.05-3.15	0.1192	0.0097	15.06	1.32	0.08	0.01	0.41	Krishna <i>et al.</i> (2007a)
			3.79	2.40-6.30	-	-	26.39	17.27	42.08	0.88	23.21	Madankumar (2008)
			4.89	-	-	-	12.46	5.55	62.4	5.09	-	Tembhurne <i>et al.</i> (2008)
			2.68 ± 0.12	2.00-3.23	0.11	0.067	9.66	12.38	60.88	0.41	15.29	Sharma <i>et al.</i> (2010)
4	Stem girth (cm)	Chilli	1.35	0.8-1.75	-	-	-	301.85	97.76	8.34	-	Arya and Saini (1976)
			1.19	0.85-1.58	-	-	14.74	8.08	30.04	0.1	9.12	Basavaraja (1997)
			1.42	1.15-1.67	7.47	0.11	21.07	20.43	3.6	0.13	9.13	Kashinath (2003)
			3.91 ± 0.15	2.80 - 4.80	0.19	0.15	11.25	9.95	78.26	18.16	-	Sreelathakumary and Rajamony (2004)
			1.35	0.84-2.98	0.14	0.04	27.81	14.97	29	0.22	16.27	Krishna <i>et al.</i> (2007a)

Table 1: Contd...

Sl. No.	Characters		Mean	Range	PV	GV	PCV (%)	GCV (%)	h ² (%)	GA	GAM (%)	References
5	Leaf area index	Brinjal	5.02	3.14- 7.39	2.1	2.05	28.85	28.49	98	2.91	57.95	Chandrashekhara <i>et al.</i> (2014)
6	Days to first flowering	Chilli	41.76	37.79-47.42	-	-	6.93	1.99	8	-	1.17	Ram and Lal (1992)
			-	24.33-33.34	-	-	9.28	4.67	25.3	1.43	4.82	Shirsat (1994)
			-	-	46.1	44.12	1012	9.9	95.7	13.32	-	Saraladevi and Arumugum (1998)
			70.18±1.54	54.67-83.00	-	-	8.85	7.9	81.6	14.87	-	Manju and Shreelathakumary (2002)
			36.8	-	1.54	0.15	5.95	1.05	9.7	0.25	0.67	Jadhav <i>et al.</i> (2004)
			27.74± 0.51	20.13 - 35.68	12.59	12.08	12.8	12.53	95.91	25.27	-	Sreelathakumary and Rajamony (2004)
			35.54	-	32.88	0.44	16.13	1.87	1.34	-	0.45	Verkey <i>et al.</i> (2005)
			-	-	-	-	16.12	15.21	89.01	-	29.56	Ajith and Manju (2006)
			23.92	17.5-36.5	13.8	12.25	20.03	16	63.8	6.23	26.04	Smitha and Basavaraja (2006)
			36.47 ± 1.782	23.5-50.00	32.258	38.614	17.04	15.57	83.5	10.69	29.31	Krishna <i>et al.</i> (2007a)
7	Days to fifty per cent flowering	Chilli	70.31 ± 1.90	58.00-77.33	47.76	36.84	9.83	8.63	77.1	10.97	15.6	Sharma <i>et al.</i> (2010)
			72.3	63.0-75.50	-	-	-	-	0.83	9.42	-	Bhagyalakshmi <i>et al.</i> (1990)
			-	31.00-39.00	-	-	7.34	4.2	32.7	0.92	10.6	Shirsat (1994)
			34.98	31.00-39.00	-	-	5.01	1.27	6.4	0.23	0.65	Giritammannavar (1995)
			-	-	33.7	24.04	6.61	7.83	71.29	8.53	11.51	Rani <i>et al.</i> (1996a)
			40.2	35.00-47.00	-	-	7.3	6.2	70.8	4.3	-	Warade <i>et al.</i> (1996b)
			45.96	37.33-54.66	-	-	9.82	9.27	88.91	8.26	17.99	Basavaraja (1997)
			33.7	28.33-41.00	18.04	15.64	12.6	11.73	86.7	7.59	22.52	Nndadevi (1999)
			42.8	35.33-49.33	17.45	10.1	9.76	7.42	57.8	4.98	11.63	Kashinath (2003)
			45.96	37.33-54.66	-	-	9.82	9.27	88.91	8.26	17.99	Jadhav <i>et al.</i> (2004)
			35.32	29.00-42.00	270.18	259.17	43.17	33.13	54.06	19.08	50.32	Smitha and Basavaraja (2006)
			44.21 ± 4.009	35.00-56.50	5.024	37.188	13.79	5.07	13.5	1.7	3.84	Krishna <i>et al.</i> (2007a)
			75.67	68.00-85.50	-	-	4.84	4.59	89.8	6.78	8.9	Madankumar (2008)
			4.75	-	-	-	39.53	31.23	62.4	50.82	-	Tembhurne <i>et al.</i> (2008)

Table 1: Contd...

Sl. No.	Characters		Mean	Range	PV	GV	PCV (%)	GCV (%)	h ² (%)	GA	GAM (%)	References
8	Fruit length	Chilli	47.23	24.00-64.00	-	-	23.14	24.15	96.3	21.93	46.43	Sarkar <i>et al.</i> (2009)
			38.84 ± 1.51	34.00-42.67	10.1	3.18	8.18	4.5	31.5	2.06	5.3	Sharma <i>et al.</i> (2010)
			-	-	-	-	27.97	27.47	96.5	-	25.33	Chattopadhyay <i>et al.</i> (2011)
			7.73	3.77-18.95	13.09	12.44	46.8	45.62	95	7.08	91.58	Nandadevi (1999)
			9.00± 0.40	2.16-12.35	4.44	4.19	35.09	34.08	94.3	4.1	68.33	Munshi and Behra (2000)
			5.28	3.46-6.36	-	-	19.22	18.89	94.27	2.09	39.58	Acharya <i>et al.</i> (2002)
			5.75±0.15	3.60-8.33	-	-	18.07	17.51	93.95	34.97	-	Manju and Shreelathakumary (2002)
			9.8	6.19-12.99	11.08	3.72	20.15	19.68	92.1	3.81	38.87	Kashinath (2003)
			7.34	-	-	-	-	23.25	87.05	-	31.69	Nehru <i>et al.</i> (2003)
			14.43	-	8.73	7.53	20.48	19.01	86.22	5.25	36.37	Jadhav <i>et al.</i> (2004)
			48.05 ±1.65	16.10 - 125.00	942.29	936.8	63.88	63.7	99.42	130.84	-	Sreelathakumary and Rajamony (2004)
			7.03	4.33-9.72	2.37	1.69	21.9	18.49	71.31	-	32.18	Verkey <i>et al.</i> (2005)
			-	-	-	-	32.76	32.21	96.68	-	45.19	Ajith and Manju (2006)
			9.02	2.65-13.48	5.83	5.702	29.45	24.58	69.7	3.75	41.57	Smitha and Basavaraja (2006)
			8.751± 0.474	3.45-14.05	5.443	5.889	27.74	26.66	92.4	4.62	52.8	Krishna <i>et al.</i> (2007a)
			9.88	-	-	-	14.19	9.81	47.8	13.96	-	Tembhurne <i>et al.</i> (2008)
			6.3	4.16-12.64			28	28.73	94.9	3.54	56.19	Sarkar <i>et al.</i> (2009)
9	Fruit diameter(cm)	Chilli	9.53 ± 0.27	7.39-10.14	0.78	0.56	9.31	7.88	71.7	1.31	11.86	Sharma <i>et al.</i> (2010)
			-	-	-	-	38.85	38.75	99.5	-	6.05	Chattopadhyay <i>et al.</i> (2011)
			1.12	0.77-1.93	0.09	0.07	26.51	23.61	79.3	0.48	42.93	Nandadevi (1999)
			3.14	2.27-4.42	0.44	0.27	21.12	16.55	61.36	-	26.57	Verkey <i>et al.</i> (2005)
			-	-	-	-	25.04	24.3	94.21	-	48.38	Ajith and Manju (2006)
			1.1	0.76-2.37	0.12	0.107	36.43	30.33	49.3	0.57	51.81	Smitha and Basavaraja (2006)
			0.957 ± 0.090	0.52-1.91	0.074	0.091	31.52	28.51	81.9	0.51	53.68	Krishna <i>et al.</i> (2007)
			1.05	-	-	-	17.64	15.08	73.1	26.55	-	Tembhurne <i>et al.</i> (2008)

Table 1: Contd...

Sl. No.	Characters		Mean	Range	PV	GV	PCV (%)	GCV (%)	h ² (%)	GA	GAM (%)	References
			1.85	1.02-2.59	0.15	0.1	21.08	17.22	66.7	0.54	29.19	Munshi and Behra (2009)
			5.45 ± 0.12	4.76-6.69	0.29	0.25	9.95	9.14	84.29	0.94	9.86	Sharma <i>et al.</i> (2010)
			-	-	-	-	89.76	48.93	96.7	-	1.18	Chattopadhyay <i>et al.</i> (2011)
10	Fruit length-diameter ratio	Brinjal	1.04	0.32-1.61	0.28	0.25	27.6	24.55	80.01	0.47	45.37	Naik (2005)
11	Average fruit weight (g)	Chilli	1.96	1.35-3.35	0.21	0.16	23.1	20.47	78.5	0.73	37.24	Munshi and Behra (2000)
			5.02± 0.15	1.22-8.63			33.41	33.03	97.75	67.28	-	Manju and Shreelathakumary (2002)
			2.68	2.50-2.87	-	-	4.09	3.85	88.4	0.2	7.46	Acharya and Rajput (2003)
			3.74	2.19-5.57	8.46	1.1	29.53	28.03	90.4	2.06	55.05	Kashinath (2003)
			0.89	-	0.05	0.05	24.36	24.1	97.87	0.44	49.11	Jadhav <i>et al.</i> (2004)
			6.02 ±0.17	2.55 - 16.40	9.45	9.39	51.04	50.89	98.86	104.48	-	Sreelathakumary and Rajamony (2004)
			-	-	-	-	45.93	45.98	96.9	-	93.59	Ajith and Manju (2006)
			37.93	15.19-83.36	290.15	274.66	46.94	35.58	57.3	20.5	54.04	Smitha and Basavaraja (2006)
			13.1	4.45-49.48	36.6	34.7	46.17	44.96	94.8	11.82	90.2	Krishna <i>et al.</i> (2007a)
			0.88	-	-	-	25.17	19.37	59.2	30.71	-	Tembhurne <i>et al.</i> (2008)
			2.44	1.38-4.28	-	-	25.53	25.11	87.8	1.11	45.49	Sarkar <i>et al.</i> (2009)
			56.15 ± 2.20	37.00-80.82	189.15	174.57	24.49	23.52	91.29	26.14	46.55	Sharma <i>et al.</i> (2010)
			-	-	-	-	111.96	111.26	98.8	-	12.88	Chattopadhyay <i>et al.</i> (2011)
12	Number of fruits per plant	Chilli	165.18	96.78-239.83	-	-	-	-	0.89	86.02	-	Bhagyalakshmi <i>et al.</i> (1990)
			-	32.33-157.33	-	-	48.72	32.36	44.1	33.1	44.29	Shirsat (1994)
			78.11	45.40-127.80	-	-	22.09	21.2	92.1	32.72	41.89	Giritammannavar (1995)
			-	-	1503.28	1492.73	55.31	55.11	99.3	79.39	113.24	Rani <i>et al.</i> (1996a)
			-	-	523.08	520.2	44.38	44.26	99.5	46.63	90.48	Saraladevi and Arumugam (1998)
			170.33	75.57-333.33	4714.47	3764.01	40.31	36.02	79.8	112.93	66.3	Nandadevi (1999)
			168.85± 9.54	18.99-637.44	-	-	90.08	89.54	98.82	183.37	-	Manju and Shreelathakumary (2002)

Table 1: Contd...

Sl. No.	Characters		Mean	Range	PV	GV	PCV (%)	GCV (%)	h ² (%)	GA	GAM (%)	References
			52.11	24.20-84.40	240.27	232.91	36.9	29.29	63	24.95	47.88	Kashinath (2003)
			43.4	-	41.28	26.28	14.8	11.82	63.67	8.43	19.42	Jadhav <i>et al.</i> (2004)
			-	-	-	-	39.15	38.1	97.7	-	76.39	Ajith and Manju (2006)
			76.4	31.50-144.00	874.32	854.52	40.04	39.02	95	59.54	77.93	Smitha and Basavaraja (2006)
			178.10 ± 16.50	51.50-502.50	4026.28	4571.28	37.96	35.63	88.1	122.67	70.05	Krishna <i>et al.</i> (2007a)
			39.83	18.58-61.31	-	-	25.67	21.44	69.8	14.7	36.9	Madankumar (2008)
			71.45	-	-	-	37.68	33.7	80	62.08	-	Tembhurne <i>et al.</i> (2008)
			48.19	19.20-98.34	-	-	42.33	44.85	89.1	39.65	82.27	Sarkar <i>et al.</i> (2009)
			6.50 ± 0.59	3.86-9.30	9.6	8.54	29.47	24.82	70.95	2.8	43.07	Sharma <i>et al.</i> (2010)
			-	-	-	-	86.05	85.02	97.6	-	74.75	Chattopadhyay <i>et al.</i> (2011)
13	Early green fruit yield per plant(g)	Chilli	234.54 ± 45.56	101.50-510.10	5549.01	9702.11	42	31.76	57.2	116.05	49.47	Krishna <i>et al.</i> (2007a)
14	Total green fruit yield per plant(g)	Chilli	89.89	40.50-134.70	-	-	23.65	20.53	75.4	30.81	36.72	Giritammanavar (1995)
			24.58	17.00-32.28	28.18	37.82	21.6	25.02	74.51	9.44	38.4	Nehru and Manjunath (1996)
			-	-	1814.91	1805.9	65	64.84	99.5	87.41	133.37	Rani <i>et al.</i> (1996a)
			185.8	97.4-279.7	-	-	25.4	25.4	97.7	97.5	-	Warade <i>et al.</i> (1996b)
			0.11	0.040-0.20	-	-	28.45	15.32	29.02	0.01	17.02	Basavaraja (1997)
			296.11	111.00-548.17	14756.32	13351.49	41.02	39.02	90.5	226.23	76.47	Nandadevi (1999)
			445.96± 8.14	51.31-1649.72	-	-	89.39	89.12	99.38	183.01	-	Manju and Shreelathakumary (2002)
			184.68	97.00-317.80	3131.63	3124.27	38.04	30.27	63.3	91.61	49.6	Kashinath (2003)

Table 1: Contd...

Sl. No.	Characters		Mean	Range	PV	GV	PCV (%)	GCV (%)	h ² (%)	GA	GAM (%)	References
			213.23 ± 6.32	73.75 - 382.88	6912.9	6992.68	39.21	38.99	94.45	79.87	-	Sreelathakumary and Rajamony (2004)
			174.72	42.50-384.20	10625.84	9907.75	58.99	56.97	93.24	-	113.32	Verkey <i>et al.</i> (2005)
			-	-	-	-	45.93	45.68	95.62	-	69.14	Ajith and Manju (2006)
			304.08	100.0-650.00	10238.46	9914.51	35.37	30.4	73.9	160.37	52.73	Smitha and Basavaraja (2006)
			427.99 ± 38.43	195.90-944.95	22499.29	25454.3 ₂	32.28	35.05	88.4	290.51	67.87	Krishna <i>et al.</i> (2007a)
			58.65	-	-	-	34.88	26.17	56.3	40.44	-	Tembhurne <i>et al.</i> (2008)
			119.14	48.03-279.49	-	-	50.22	48.92	94.9	116.95	98.16	Sarkar <i>et al.</i> (2009)
			404.30 ± 31.13	163.96-685.31	2652.11	23611.8 ₅	40.27	38	89.03	298.68	73.87	Sharma <i>et al.</i> (2010)
			-	-	-	-	50.87	50.58	99	-	122.97	Chattopadhyay <i>et al.</i> (2011)
15	Dry red chilli yield(g/plant)	Chilli	23.17	6.64-50.14	79.56	78.56	39.5	38.5	98.7	18.1	78.2	Sahoo <i>et al.</i> (1989)
			21.26	12.25-34.50	57.13	54.57	-	-	97	-	61	Amarchandra <i>et al.</i> (1990)
			74.02	53.00-100.00	-	-	-	-	0.9	22.23	-	Bhagyalakshmi <i>et al.</i> (1990)
			232.13	130.0-393.0	-	-	26.68	25.76	0.93	118.91	51.23	Nazer <i>et al.</i> (1990)
			24.4	10.00-45.17	11.17	9.07	14.44	43.22	94.6	20.96	86.59	Nandadevi (1999)
			65.18	58.07-72.89	-	-	8.72	7.67	77.4	9.06	13.3	Acharya <i>et al.</i> (2002)
			1.9	1.09-2.95	7.68	0.33	29.56	29.33	99.9	1.16	60.79	Kashinath (2003)
			37.48	-	24.8	16.58	13.29	10.87	66.86	6.86	18.3	Jadhav <i>et al.</i> (2004)
			32.16	15.05-51.64	-	-	29.55	26.75	81.9	16.26	49.86	Madankumar (2008)
			-	-	-	-	50.87	50.6	99	-	24.59	Chattopadhyay <i>et al.</i> (2011)

Table 1: Contd...

Sl. No.	Characters		Mean	Range	PV	GV	PCV (%)	GCV (%)	h ² (%)	GA	GAM (%)	References
16	Total green fruit yield per ha(t)	Chilli	8.44	2.77-18.05	7.896	7.634	33.28	32.73	96.69	5.597	66.31	Smitha and Basavaraja (2006)
			10.85±1.52	5.80-18.34	18.57	11.21	39.3	30.84	61.6	5.41	49.84	Kashinath (2003)
17	Total dry fruit yield per ha(q)	Chilli	5.83± 0.87	2.81- 9.71	11.33	3.97	42.98	34.16	63.1	3.26	55.84	Kashinath (2003)
18	Per cent dry matter in fruit	Chilli	7.53	5.25-9.3	-	-	12.29	10.09	67	-	16.99	Ram and Lal (1992)
19	Ascorbic acid Ascorbic acid (mg/100g)	Chilli	103.62	84.55-139.06	-	-	-	-	0.82	24.22	-	Bhagyalakshmi <i>et al.</i> (1990)
			-	-	177.95	167.22	41.55	40.28	93.98	81.54	80.44	Rani <i>et al.</i> (1996)
			98.07± 0.52	61.83-136.33	-	-	17.07	17.04	99.71	35.05	-	Manju and Shreelathakumary (2002)
			228.37	216.68-251.12	-	-	5.65	5.6	98.2	26.09	11.42	Acharya <i>et al.</i> (2003)
			152.04	110.67-269.75	836	828.63	20.19	18.33	76.9	51.99	33.11	Kashinath (2003)
			192.97	135.0-248.50	820.16	762.97	14.84	14.31	93.03	54.88	28.43	Smitha and Basavaraja (2006)
			131.65 ± 6.41	83.18-187.80	1398.05	1274.46	27.98	26.68	90.89	68.98	52.39	Sharma <i>et al.</i> (2010)
			-	-	-	-	61.79	61.7	99	-	102.6	Chattopadhyay <i>et al.</i> (2011)

2.4 Character association

The expression of a character in a plant is a consequence of a chain of interrelationships/interactions among characters either directly or through other events. In any crop, fruit yield is a complex character being influenced by several other traits. Selection for such traits may not necessarily lead to its improvement unless the unfavorable linkages among such components are favorably altered through hybridization. The correlation characters may be due to genetic linkage or pleiotropy (Harland, 1939).

The correlation coefficient analysis measures the mutual relationship between various characters and it determines the component traits on which selection can be relied upon to effect the improvement. There are three types of correlations viz., phenotypic, genotypic and environmental correlations.

Phenotypic correlation is the observable correlation between two variables and includes both genotypic and environmental effects. Genotypic correlation on the other hand, is the inherent association between two variables may be either due to pleiotropic action of genes or linkage, more likely both or developmentally induced relationships. A brief review of the nature of association of character in chilli investigated by several workers is presented in Table 2.

2.5 Path coefficient analysis

The path coefficient analysis was originally developed by Wright (1921), but the technique was first used in plant breeding by Dewey and Lu (1959). It is a technique used to find the relative contribution of component characters directly on the main characters and indirectly through other characters to increase the efficiency in selection programmes. Of the correlation between dependent and independent characters is due to the direct effect of the characters, it reflects a true relationship between them and selection can be practiced for such a character in order to improve dependent variable. Otherwise, broadly speaking a breeder has to select for the later through which the indirect effect is exerted. Brief review of direct effects of component characters on yield is presented in Table 3.

Table 2: Association of green chilli yield with other parameters

Sl. No.	Character	Association	S/NS	References
1	Plant height	Positive	S	Krishna (2002), Gogoi and Gautam (2003), Khurana <i>et al.</i> (2003), Ajjappalavara <i>et al.</i> (2005), Satish (2007), Krishna <i>et al.</i> (2007b)
		Negative	S	Ahmed <i>et al.</i> (2006), Smitha and Basavaraja (2006)
2	Plant spread	Positive	S	Mulge and Anand (1997), Ajith and Manju (2006), Ahmed <i>et al.</i> (2006), Shantanu <i>et al.</i> (2006), Smitha and Basavraj (2006)
3	Number of primary branches per plant	Positive	S	Mallikarjun <i>et al.</i> (2003), Hari <i>et al.</i> (2005), Nageshwar Rao (2005), Ajith and Manju (2006), Krishna <i>et al.</i> (2007b)
		Negative	S	Mubarak (2002), Ahmed <i>et al.</i> (2006)
4	Days to first flowering	Positive	S	Arya and Saini (1976), Achalshah <i>et al.</i> (1986), Akhilesh <i>et al.</i> (2001)
		Negative	S	Shirsat (1994)
5	Number of fruits per plant	Positive	S	Mubarak (2002), Mallikarjun <i>et al.</i> (2003), Nehru <i>et al.</i> (2003), Ajith and Manju (2006), Smitha and Basavaraja (2006), Satish (2007), Krishna <i>et al.</i> (2007b)
		Negative	S	Acharya and Rajput (2003), Ahmed <i>et al.</i> (2006)
6	Fruit length (cm)	Positive	S	Ibrahim <i>et at.</i> (2001), Mubarak (2002), Ajjappalavara <i>et al.</i> (2005), Ahmed <i>et al.</i> (2006), Smitha and Basavraj (2006), Krishna <i>et al.</i> (2007b)
		Negative	S	Prasannakumar <i>et al.</i> (1995), Satish (2007)
7	Fruit diameter (cm)	Positive	S	Ibrahim <i>et al.</i> (2001), Mubarak (2002), Choudhary and Samadia (2004), Ahmed <i>et al.</i> (2006), Krishna <i>et al.</i> (2007b)
		Negative	S	Hari <i>et al.</i> (2005), Shantanu <i>et al.</i> (2006), Satish (2007)
8	Ascorbic acid content	Positive	S	Akhi1esh <i>et al.</i> (2001), Mallikarjun <i>et al.</i> (2003), Hari <i>et al.</i> (2005)

Table 2: Contd...

Sl. No.	Character	Association	S/NS	References
				Ahmed <i>et al.</i> (2006)
		Negative	S	Satish (2007), Sonia <i>et al.</i> (2007)
Association of days to 50 per cent flowering with				
1	Plant height	Positive	S	Venkata Reddy (1997), Mubarak (2002) and Acharya and Rajput (2003)
		Positive	NS	Hari <i>et al.</i> (2005)
		Negative	S	Sundaram and Irulappan (1998), Ajjappalavara <i>et al.</i> (2005), Nageshwara Rao (2005)
		Negative	NS	Sarma and Roy (1995) and Choudary and Samadia (2004)
2	Number of primary branches per plant	Positive	S	Acharya and Rajput (2003), Nageshwara Rao (2005)
		Positive	NS	Rani <i>et al.</i> (1996b), Venkata Reddy (1997) and Ajjappalavara <i>et al.</i> (2005)
		Negative	S	Sarma and Roy (1995) and Hari <i>et al.</i> (2005)
3	Fruit length (cm)	Positive	S	Mubarak (2002)
		Positive	NS	Venkata Reddy (1997) and Acharya and Rajput (2003)
		Negative	NS	Sarma and Roy (1995), Basavaraja (1997), Choudary and Samadia (2004) and Hari <i>et al.</i> (2005)
		Negative	S	Nageshwara Rao (2005), Satish (2007)
4	Fruit diameter (cm)	Positive	S	Mubarak (2002), Ahmed <i>et al.</i> (2006)
		Positive	NS	Sundaram and Irulappan (1998)
		Negative	NS	Rani <i>et al.</i> (1996b), Basavaraja (1997), Venkata Reddy (1997), Acharya and Rajput (2003), Choudary and Samadia (2004), Hari <i>et al.</i> (2005), Ajjappalavara <i>et al.</i> (2005)
		Negative	S	Nageshwara Rao (2005)

Table 2: Contd...

Sl. No.	Character	Association	S/NS	References
5	Fruit weight (g)	Negative	S	Mubarak (2002)
		Positive	NS	Sundaram and Irulappan (1998), Acharya and Rajput (2003) and Ajjappalavara <i>et al.</i> (2005)
		Negative	NS	Sarma and Roy (1995), Mulge and Anand (1997), Basavaraja (1997), Choudary and Samadia (2004), Hari <i>et al.</i> (2005), Nageshwara Rao (2005)
6	Fresh fruit yield per plant	Positive	S	Mini <i>et al.</i> (2002) and Mubarak (2002)
			NS	Acharya and Rajput (2003)
7	Stem girth	Positive	S	Mubarak (2002)
			NS	Ajjappalavara <i>et al.</i> (2005)
	Association of plant height (cm) with			
1	Number of primary branches per plant	Positive	S	Sarma and Roy (1995), Rani <i>et al.</i> (1996b), Venkata Reddy (1997), Dipendra Gogoi and Gautam (2003), Achary and Rajput (2003)
		Positive	NS	Nageshwara Rao (2005)
		Negative	NS	Gouda and Mulge (2003), Hari <i>et al.</i> (2005), Mubarak (2002) and Ajjappalavara <i>et al.</i> (2005)
2	Number of secondary branches per plant	Positive	S	Saraladevi and Arumugam (1999), Ibrahim <i>et al.</i> (2001), Nageshwara Rao (2005)
		Positive	NS	Nehru <i>et al.</i> (2003), Choudary and Samadia (2004), Hari <i>et al.</i> (2005) and Ajjappalavara <i>et al.</i> (2005)
		Negative	S	Gouda and Mulge (2003)
3	Number of fruits per plant	Positive	S	Sundaram and Irulappan (1998), Ibrahim <i>et al.</i> (2001), Gouda and Mulge (2003), Hari <i>et al.</i> (2005), Ajjappalavara <i>et al.</i> (2005).
		Positive	NS	Venkata Reddy (1997), Nandadevi (1999), Dipendra Gogoi and Gautam (2003), Sreelathakumary and Rajamony (2002) and Nehru <i>et al.</i> (2003)

Table 2: Contd...

Sl. No.	Character	Association	S/NS	References
		Negative	NS	Basavaraja (1997), Acharya and Rajput (2003) and Choudary and Samadia (2004)
4	Fruit length (cm)	Positive	S	Basavaraja (1997), Venkata Reddy (1997), Nandadevi (1999), Mubarak (2002), Acharya and Rajput (2003) and Ajjappalavara <i>et al.</i> (2005)
		Positive	NS	Sarma and Roy (1995), Sundaram and Irulappan (1998), Ibrahim <i>et al.</i> (2001) and Hari <i>et al.</i> (2005)
		Negative	NS	Chaim and Paran (2000), Dipendra Gogoi and Gautam (2003), Gouda and Mulge (2003) and Nehru <i>et al.</i> (2003)
5	Fruit diameter (cm)	Positive	S	Ibrahim <i>et al.</i> (2001), Dipendra Gogoi and Gautam (2003), Mubarak (2002) and Ajjappalavara <i>et al.</i> (2005)
		Positive	NS	Sundaram and Irulappan (1998), Nandadevi (1999), Khurana <i>et al.</i> (2003), Choudary and Samadia (2004), Nageshwara Rao (2005)
		Negative	S	Chaim and Paran (2000) and Gouda and Mulge (2003)
		Negative	NS	Sarma and Roy (1995), Venkata Reddy (1997), Sreelathakumary and Rajamony (2002), Acharya and Rajput (2003) and Hari <i>et al.</i> (2005)
6	Fruit weight (g)	Positive	S	Dipendra Gogoi and Gautam (2003), Mubarak (2002), Acharya and Rajput (2003) and Khurana <i>et al.</i> (2003)
		Positive	NS	Basavaraja (1997), Nandadevi (1999) and Hari <i>et al.</i> (2005)
		Negative	S	Chaim and Paran (2000) and Sreelanthakumary and Rajmony (2002)
		Negative	NS	Sarma and Roy (1995), Sundaram and Irulappan (1998), Gouda and Mulge (2003), Choudary and Samadia (2004) and Nageshwara Rao (2005)
7	Stem girth	Positive	S	Ajjappalavara <i>et al.</i> (2005)

Table 2: Contd...

Sl. No.	Character	Association	S/NS	References
	Association of number of primary branches per plant with			
1	Number of secondary branches per plant	Positive	S	Gouda and Mulge (2003), Hari <i>et al.</i> (2005) and Ajjappalavara <i>et al.</i> (2005)
		Negative	S	Usha Rani (1995)
2	Number of fruits per plant	Positive	S	Venkata Reddy (1997), Mubarak (2002) and Nageshwara Rao (2005)
		Positive	NS	Dipendra Gogoi and Gautam (2003), Nehru <i>et al.</i> (2005) and Hari <i>et al.</i> (2005)
		Negative	S	Gouda and Mulge (2003)
			NS	Acharya and Rajput (2003) and Ajjappalavara <i>et al.</i> (2005)
3	Fruit length (cm)	Positive	S	Acharya and Rajput (2003)
		Positive	NS	Dipendra Gogoi and Gautam (2003), Gouda and Mulge (2003) and Hari <i>et al.</i> (2005)
		Negative	S	Rani <i>et al.</i> (1996b)
			NS	Sarma and Roy (1995), Nehru <i>et al.</i> (2003), Mubarak (2002) and Ajjappalavara <i>et al.</i> (2005)
4	Fruit diameter (cm)	Positive	NS	Gouda and Mulge (2003), Hari <i>et al.</i> (2005) and Ajjappalavara <i>et al.</i> (2005)
		Negative	S	Sarma and Roy (1995), Acharya and Rajput (2003) and Nageshwara Rao (2005)
		Negative	NS	Rani <i>et al.</i> (1996b), Venkata Reddy (1997), and Dipendra Gogoi and Goutam (2003)
5	Fruit weight (g)	Positive	S	Acharya and Rajput (2003)
		Positive	NS	Dipendra Gogoi and Gautam (2003), Gouda and Mulge (2003) and Nageshwara Rao (2005)
		Negative	S	Sarma and Roy (1995), Warade <i>et al.</i> (1996a), Hari <i>et al.</i> (2005) and Ajjappalavara <i>et al.</i> (2005)
		Negative	NS	Rani <i>et al.</i> (1996b)

Table 2: Contd...

Sl. No.	Character	Association	S/NS	References
6	Stem girth	Positive	S	Ajjappalavara <i>et al.</i> (2005)
		Negative	S	Mubarak Begum (2002)
			NS	Mallikarjun <i>et al.</i> (2003)
Association of fruit length (cm) with				
1	Fruit diameter (cm)	Positive	S	Sarma and Roy (1995), Ibrahim <i>et al.</i> (2001) and Sreelathakumary and Rajamony (2002)
			NS	Munshi <i>et al.</i> (2000), Mubarak Begum (2002), Choudhary and Samadia (2004) and Ajjappalavara <i>et al.</i> (2005)
		Negative	S	Sundaram and Irulappan (1998), Dipendra Gogoi and Gautam (2003), Acharya and Rajput (2003), Khurana <i>et al.</i> (2003) and Hari <i>et al.</i> (2005)
			NS	Basavaraja (1997), Chaim and Paran (2000), Gouda and Mulge (2003) and Mallikarjun <i>et al.</i> (2003)
2	Fruit weight (g)	Positive	S	Sharma and Roy (1995), Rani <i>et al.</i> (1996b), Usha Rani (1996), Warade <i>et al.</i> (1996a),Chaim and Paran (2000), Munshi <i>et al.</i> (2000), Mishra (2001), Mubarak Begum (2002), Sreelathakumari and Rajamony (2002), Mallikarjun <i>et al.</i> (2003), Choudhary and Samadia (2004) and Ajjappalavara <i>et al.</i> (2005)
			NS	Acharya and Rajput (2003) and Hari <i>et al.</i> (2005)
		Negative	S	Sundaram and Irulappan (1998)
			NS	Gouda and Mulge (2003)
3	Fruit yield per plant	Positive	S	Khurana <i>et al.</i> (2003)
			NS	Acharya and Rajput (2003) and Ajjappalavara <i>et al.</i> (2005)
4	Stem girth	Positive	S	Mubarak Begum (2002)

Table 2: Contd...

Sl. No.	Character	Association	S/NS	References
Association of fruit diameter with				
1	Fruit weight (g)	Positive	S	Sarma and Roy (1995), Sundaram and Irulappan (1998), Chaim and paran (2000), Munshi <i>et al.</i> (2000), Sreelathakumary and Rajamony (2002), Mubarak Begum (2002), Dipendra Gogoi and Gautam (2003), Gouda and Mulge (2003), Mallikarjun <i>et al.</i> (2003) and Choudary and Samadia (2004)
		Negative	NS	Hari <i>et al.</i> (2005) , Acharya and Rajput (2003)
2	Fruit yield per plant	Positive	NS	Khurana <i>et al.</i> (2003) and Hari <i>et al.</i> (2005)
Association of fruit weight (g) with				
1	Fruit yield per plant (g)	Positive	S	Saraladevi and Arumugam (1999a)
			NS	Acharya and Rajput (2003)
Association of number of fruits per plant with				
1	Fruit length	Positive	S	Rani <i>et al.</i> (1996b), Sundaram and Irulappan (1998), Mubarak (2002) and Choudary and Samadia (2004)
2	Fruit weight	Positive	S	Usha Rani (1996) and Ajjappalavara <i>et al.</i> (2005)
			NS	Rani <i>et al.</i> (1996b), Dipendra Gogoi and Gautam (2003) and Hari <i>et al.</i> (2005)
		Negative	S	Mishra <i>et al.</i> (2001), Sreelathakuamry and Rajamony (2002) and Gouda and Mulge (2003)
			NS	Mallikarjun <i>et al.</i> (2003)

Table 3: Direct effects of component characters on yield in chilli

Sl. No.	Character	Positive direct effect	Negative direct effect
1	Days to 50 per cent flowering	Venkata Reddy (1997), Nandadevi (1999), Singh <i>et al.</i> (2005), Nageshwara Rao (2005) and Chattopadhyay <i>et al.</i> (2011)	Giritammannavar (1995), Sarma and Roy (1995), Choudary and Samadia (2004), Ajjappalavara <i>et al.</i> (2005) and Mubarak (2002)
2	Plant height (cm)	Khurana <i>et al.</i> (2003), Dipendra Gogoi and Gautam (2003), Choudary and Samadia (2004), Singh <i>et al.</i> (2005) and Nageshwara Rao (2005), Ahmed <i>et al.</i> (2006), Satish (2007)	Nehru and Manjunath (1996), Nandadevi (1999), Ajjappalavara <i>et al.</i> (2005) and Mubarak (2002)
3	Plant spread	Manikanthan <i>et al.</i> (1984), Mubarak (2002), Satish (2007)	Nandadevi (1999)
4	Number of primary branches per plant	Dipendra Gogoi and Gautam (2003), Singh <i>et al.</i> (2005) and Nageshwara Rao (2005), Bharadwaj <i>et al.</i> (2007)	Venkata Reddy (1997) and Ajjappalavara <i>et al.</i> (2005), Ahmed <i>et al.</i> (2006), Satish (2007)
5	Number of fruits per plant	Munshi <i>et al.</i> (2000), Khurana <i>et al.</i> (2003), Mubarak (2002), Dipendra Gogoi and Gautam (2003), Choudary and Samadia (2004), Ajjappalavara <i>et al.</i> (2005) and Nageshwar Rao (2005), Chattopadhyay <i>et al.</i> (2011),	Prasannakumar <i>et al.</i> (1995)
6	Fruit length (cm)	Venkata Reddy (1997), Khurana <i>et al.</i> (2003) and Ajjappalavara <i>et al.</i> (2005), Chattopadhyay <i>et al.</i> (2011)	Munshi <i>et al.</i> (2000), Mubarak (2002), Singh <i>et al.</i> (2005) and Nageshwara Rao (2005)
7	Fruit weight (g)	Munshi <i>et al.</i> (2000), Mubarak (2002) and Nageshwara Rao (2005)	Choudary and Samadia (2004) and Chattopadhyay <i>et al.</i> (2011)
8	Fruit diameter	Munshi <i>et al.</i> (2000), Dipendra Gogoi and Gautam (2003), Ajjappalavara <i>et al.</i> (2005) and Singh <i>et al.</i> (2005) and Chattopadhyay <i>et al.</i> (2011)	Khurana <i>et al.</i> (2003, Mubarak (2002), Choudary and Samadia (2004) and Nageshwara Rao (2005)

2.6 Genetic divergence

The magnitude of divergence between two groups under consideration is provided by D^2 statistic developed by Mahalanobis (1936).

The technique in the form of generalized distance was first used by Mahalanobis in an anthropometric survey of the united province in India. For the first time D^2 statistic was applied for biological population by Nair and Mukharji (1960) to classify the natural and plantation teak tree types. Its application was extended later to taxonomic studies. Murthy and Pavate (1962) observed that D^2 analysis can be extended to the situations where overlapping species need to be discriminated and also when the discrimination at subspecies level is needed. This technique was subsequently used in different vegetable crops.

Thirty three chilli genotypes studied were grouped into 11 clusters by Varalaxmi and Haribabu (1991). Out of 10 characters studied, fruits per plant, leaf area index, fruit weight and total yield were reported to be the chief contributors towards genetic divergence. They also found no firm relationship between genetic divergence and geographical distances.

Based on D^2 statistic, Shirsat (1994) grouped 75 genotypes of chilli into 28 clusters. Maximum diversity was observed as inter cluster distance. Similarly, Warade *et al.* (1997) grouped 60 cultivars of chilli obtained from different ecogeographical regions into 9 clusters and observed maximum diversity because of maximum cluster distances. The clustering pattern also revealed that geographic diversity did not seem to have direct association with genetic diversity. A comparison of cluster means for different characters indicated considerable differences between clusters for all the characters (Sundaram *et al.*, 1980; Gill *et al.*, 1982; Varalakshmi and Haribabu, 1991; Shirsat, 1994 and Warade *et al.*, 1997).

Karad *et al.* (2002) grouped 40 chilli genotypes of indigenous and exotic origin into 8 clusters and D^2 values ranged between 0.1032 to 8.7702, while inter cluster distance was maximum (7.45) between cluster II and V and minimum (1.15) between cluster III and VII. The variance of cluster means revealed that fresh fruit weight and fruits per plant had the highest contribution towards divergence.

Mubarak (2002) grouped 46 chilli genotypes into 13 clusters which showed inter cluster D^2 values ranging between 18.91 and 87.12. Three characters namely seed number per fruit, dry fruit yield per plant and number of fruits per plant were the chief contributors towards diversity. Maximum diversity revealed by inter-cluster distance revealed between cluster VI and XIII with D^2 value 82.21.

Prabhudeva (2003) grouped 36 genotypes into 11 clusters with D^2 values ranging between 34.02 to 102.13. He concluded that genetic diversity was not a index of geographical diversity by clustering pattern. In his study, maximum contribution of characters towards diversity was fruits per plant followed by ten fruit weight and plant height. He observed maximum diversity *i.e.*, inter cluster distance between cluster I and II, suggesting that the genotypes belonging to these clusters form ideal pairs for developing hybrids.

Senapati *et al.* (2003) grouped 29 diverse chilli genotypes studied for 11 characters into 6 clusters. Cluster I was the largest with 13 genotypes followed by cluster III and IV with 2 genotypes each. They observed maximum genetic distance between cluster II and cluster VI, suggesting wide diversity between these groups and four characters *viz.*, fresh fruit weight, fruit girth, fruit length and fruit number per plant were the chief contributors towards genetic divergence.

Manju and Sreelathakumary (2004) grouped 32 accessions of hot chilli into 6 clusters. Cluster I was the largest with 21 accessions and had the highest intra cluster distance. Among the characters, fruit per plant and yield per plant contributed maximum divergence in *Capsicum chinense*.

Ajjappalavara (2009) reported that among 36 chilli genotype cluster-II was largest, consisting of 16 genotypes, while clusters IV, V, VI, VII, VIII, IX and XI contained single genotype each. There was no parallelism between genetic diversity and geographical distribution. Among the different characters studied fruits per plant, fruit yield per plant, plant height, ten green fruit weight, powdery mildew disease incidence; leaf curl complex incidence contribute significantly for the genetic diversity. The maximum inter cluster distance (125.45) was highest between the II and X. The genotypes Phule Sai, LCA-206, Pant C-1, KDC-1, Byadgi dabbi and AD-5 from these

clusters may be used as parental donors for future hybridization programme to develop higher fruit yield with resistant to disease pests.

Shrilekha *et al.* (2011) reported that among 38 chilli accessions, 55.263 per cent of the accessions could be grouped within one cluster I (21 accessions); in cluster II, 18.421 per cent (7 accessions); cluster III, 13.158 per cent (5 accessions) followed by cluster IV, 5.263 per cent (2 accessions). The cluster V, VI and VII were found unique included only one accession in each namely, 35, 30 and 36 which were in 7.896 per cent of the total accessions. Based on D^2 -values, all 38 accessions/genotypes could be grouped into seven clusters such that the genotype within the clusters had smaller D^2 -values among themselves than those belonging to different clusters based on D^2 -values, it is evident from the results, that the mean inter-cluster D^2 -values and the cluster mean indicated the highest divergence between clusters designated III and VII (D^2 -1665293). Divergence was also noted between clusters designated I and VII (D^2 = 1661982.0), II and VII (D^2 = 1167484.0) and between IV and VII (D^2 = 1119514.0). The lowest inter- cluster distance was noticed in between cluster I and cluster III (D^2 = 76941.01). The highest intra cluster D^2 values depicted by cluster III (D^2 = 60444.35) having 5 accessions followed by cluster II (D^2 = 55333.340) having 7 and cluster I (D^2 = 43480.89) having 21 accessions.

Tasso *et al.* (2014) studied genetic diversity with 30 chilli genotypes. 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. 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.

2.7 Disease incidence

2.7.1 Anthracnose

Angadi *et al.* (2003) studied the reaction of chilli genotypes against *Colletotrichum capsici*. The genotypes CO-1, PC-1, LeA-301, IHR-3023 and H232 showed less than 10 per cent incidence indicating resistant reaction, where as S-32 recorded maximum PDI (83.00%).

Prashant and Ponnuswami (2008) reported that the hybrids *viz.*, HY 2, HY 1, HY 4, HY 3 and HY5 were rated as moderately resistant against anthracnose disease under artificial screening. The orthodihydroxy phenols were significantly higher in the resistant and moderately resistant genotypes as compared to susceptible ones.

Seventeen chilli genotypes from various sources in India were screened against *Colletotrichum capsici* with respect to physiological and biochemical traits. A visual observation had identified four chilli genotypes namely LLS, Breek-1, Breek-2 and Jaun that were resistant to fruit rot/die back. There were a significant amount of variations at physiological and biochemical levels present in chilli genotypes for resistance to fruit rot/die back. Analysis on 10 physiological traits data revealed that the fruit rot/die back resistant chilli genotypes exhibited more plant height, fruit length, fruit width, days to first picking and less number of fruits per plant, fruit weight per plant as compared to the susceptible genotypes (Navneet *et al.*, 2011).

2.7.2 Leaf curl index

Ferry and Schalk (1991) reported resistance to thrips *Franknella accidentalis* was confined to five commercial varieties due to mechanism of tolerance to insect feeding rather than antibiosis or antixenosis. This type of resistance may be useful in preventing plant injury due to thrips feeding but would not help in controlling tomato spotted with (TOSPO) virus as a serious pathogen of pepper for which *Franknella accidentalis* is a common vectors.

The evidence so far available indicated that leaf curl complex in chilli could be due to mites, thrips and viruses transmitted by white flies. High GCV with moderate heritability and genetic advance was reported by Hiremath (1997).

Prabhu and Jagadeesha (1998) identified resistant sources for thrips and mites which cause leaf curl complex (Murda) the resistance among 43 germplasm ranged from 7.19 to 51.59 and 9.87 and 37.48 per cent leafcurl index for thrips and mites respectively. The chilli genotypes Pant c-1, LAC-304, LAC-312, LCA-301 and B1-1-1 were found promising for resistant against both chilli thrips and mites. The local check Byadagi was found susceptible and recorded 34.91 and 32.37 per cent leaf curl index for thrips and mites respectively.

Khalid Ahmed *et al.* (2000) reported mite as a serious pest on chilli it completes 5-6 generation on chilli feeds on the underside of the leaf causing down ward curling.

Mallapur (2000) screened 62 chilli genotypes against *Scirotothrips dorsalis* and *Polyphagotarsonemus latus* and found 13 genotypes with lower percentage of leaf curl of which two viz., KDSL-6 and KDSC-210-3 gave very high yields. Based on infestation of yellow mite, injury grade and damage index the cultivars were classified as resistant, susceptible and highly susceptible.

Reddy *et al.* (2000) screened 33 genotypes of chilli for leaf curl caused by *Scirotothrips dorsalis* and *Polyphagotarsonemus latus*. The selection 1-12 recorded highest yield (30.59 tonnes/ha) while lowest incidence was recorded in selection 4-1 (13.88 and 17.22 per cent at 90 and 120 days after planting, respectively). Selection 7-11-3-1 exhibited the highest tolerance to leaf curl.

Twenty one accessions of chilli were studied for the incidence of thrips and mites (Rajaram and Ramamurthy, 2001) of which accession 45 recorded least population of thrips.

The resistance of 20 chilli cultivars to *Scirotothrips dorsalis* was investigated by Kalaiyarajan *et al.* (2002) and results showed that accession PS64 recorded lower thrips population (0.47 and 0.81 thrips/leaf) in the field and in pot culture, respectively. Thrips infestation was lower in accessions PS64, PS69, PS166, PS177 and PS4 (in the range 12.9- 17.4%) compared to other accessions.

Mubarak (2002) screened 46 chilli genotypes against *Scirotothrips dorsalis* and *Polyphagotarsonemus latus* and found that GPC-69 and GPC-82 were highly resistant to

thrips, whereas AR-75 and VN-2 were resistant to mites and also high yielders as compared to susceptible checks Byadgi kaddi and Byadgi dabbi.

Yadawad (2005) screened parents involved in generating F₂ population along with checks and found that genotypes were either as resistant (S-32 and VN-2) or susceptible (BD and BK). High mean trichome length and density could be the mechanism for resistance in these two (S-32 and VN-2) genotypes.

Sanjay *et al.* (2011) studied that, 321 genotypes from four species of *Capsicum* screened under field condition for three consecutive years (2005- 08) at IIVR, six genotypes of *Capsicum annuum* viz., Punjab Lal, CM-334, CV-2, CV-1, Kalyanpur Chanchal and VR-339 showed highly resistant reaction of which Punjab Lal and CV-2 were virtually symptomless.

3. MATERIAL AND METHODS

The investigation on variability and divergence studies in chilli was undertaken during the year 2014-15. The details of the experiment, materials used and techniques adopted in the present investigation are presented in this chapter.

3.1 Experimental site

The experiment on variability and divergence studies in chilli was conducted in the field of Vegetable Science unit of Regional Horticulture Research and Extension Centre, Kumbapur, Dharwad District (Karnataka). The soil of research field comprised of red loamy texture with moderate water holding capacity.

3.2 Location and climate

The experiment Regional Horticultural Research and Extension Centre, Kumbapur, Dharwad situated at 15°-16' Northern latitude, 70°-07' Eastern longitude and at an altitude of 678 m above the mean sea level. The total rainfall of 961.9 mm was received during the year 2014, whereas the rainfall was 679.2 mm during the period of study (July 2014 to December 2014). The monthly mean temperature ranged from minimum 14.6°C (December) to a maximum of 29.7°C (October). The mean relative humidity was highest during the month of August (91.3%) and lowest in the month of November (49%). The meteorological data recorded during the period of experimentation is given in Appendix-I.

3.3 Experimental details

3.3.1 Experimental material

The experimental material comprised of 70 accessions of Byadagi chilli maintained at Regional Horticulture Research and Extension Centre, Kumbapur, Dharwad were used as research material. The accession numbers of the Byadagi chili with codes are given in Table 4. Fruits of chilli accessions used in the investigation are depicted in Plate 2.

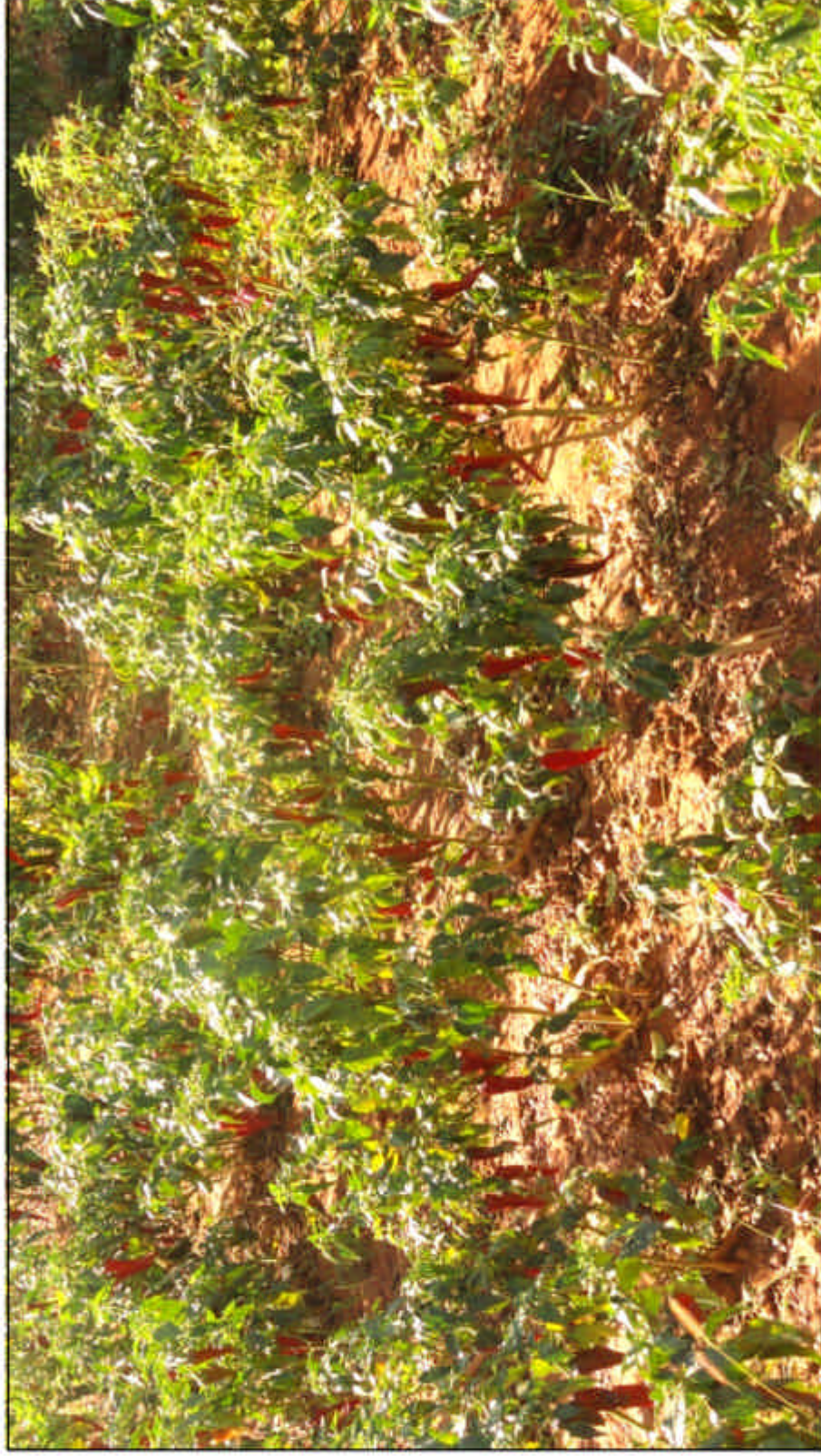


Plate 1. General view of experimental plot

Table 4: Details of chilli accessions used in the experiment with their sources

Sl. No.	Accessions	Source
01	BDS-01	RHREC, Dharwad
02	BDS-02	RHREC, Dharwad
03	BDS-03	RHREC, Dharwad
04	BDS-04	RHREC, Dharwad
05	BDS-05	RHREC, Dharwad
06	BDS-06	RHREC, Dharwad
07	BDS-07	RHREC, Dharwad
08	BDS-08	RHREC, Dharwad
09	BDS-09	RHREC, Dharwad
10	BDS-10	RHREC, Dharwad
11	BDS-11	RHREC, Dharwad
12	BDS-12	RHREC, Dharwad
13	BDS-13	RHREC, Dharwad
14	BDS-14	RHREC, Dharwad
15	BDS-15	RHREC, Dharwad
16	BDS-16	RHREC, Dharwad
17	BDS-17	RHREC, Dharwad
18	BDS-18	RHREC, Dharwad
19	BDS-19	RHREC, Dharwad
20	BDS-20	RHREC, Dharwad
21	BDS-21	RHREC, Dharwad
22	BDS-22	RHREC, Dharwad
23	BDS-23	RHREC, Dharwad
24	BDS-24	RHREC, Dharwad
25	BDS-25	RHREC, Dharwad
26	BDS-26	RHREC, Dharwad
27	BDS-27	RHREC, Dharwad
28	BDS-28	RHREC, Dharwad
29	BDS-29	RHREC, Dharwad
30	BDS-30	RHREC, Dharwad
31	BDS-31	RHREC, Dharwad
32	BDS-32	RHREC, Dharwad
33	BDS-33	RHREC, Dharwad
34	BDS-34	RHREC, Dharwad
35	BDS-35	RHREC, Dharwad
36	BDS-36	RHREC, Dharwad
37	BDS-37	RHREC, Dharwad
38	BDS-38	RHREC, Dharwad
39	BDS-39	RHREC, Dharwad
40	BDS-40	RHREC, Dharwad
41	BDS-41	RHREC, Dharwad
42	BDS-42	RHREC, Dharwad
43	BDS-43	RHREC, Dharwad



Plate 2: Fruits of chilli accessions used in the investigation

Table : 4 Contd...

Sl. No.	Accessions	Source
44	BDS-44	RHREC, Dharwad
45	BDS-45	RHREC, Dharwad
46	BDS-46	RHREC, Dharwad
47	BDS-47	RHREC, Dharwad
48	BDS-48	RHREC, Dharwad
49	BDS-49	RHREC, Dharwad
50	BDS-50	RHREC, Dharwad
51	BDS-51	RHREC, Dharwad
52	BDS-52	RHREC, Dharwad
53	BDS-53	RHREC, Dharwad
54	BDS-54	RHREC, Dharwad
55	BDS-55	RHREC, Dharwad
56	BDS-56	RHREC, Dharwad
57	BDS-57	RHREC, Dharwad
58	BDS-58	RHREC, Dharwad
59	BDS-59	RHREC, Dharwad
60	BDS-60	RHREC, Dharwad
61	BDS-61	RHREC, Dharwad
62	BDS-62	RHREC, Dharwad
63	BDS-63	RHREC, Dharwad
64	BDS-64	RHREC, Dharwad
65	BDS-65	RHREC, Dharwad
66	BDS-66	RHREC, Dharwad
67	BDS-67	RHREC, Dharwad
68	BDS-68	RHREC, Dharwad
69	BDS-69	RHREC, Dharwad
70	BDS-70	RHREC, Dharwad

BDS : Byadagi Dabbi Selection

RHREC: Regional Horticulture Research and Extension Centre, Kumbapur, Dharwad

3.3.2 Layout of the experiment

Number of treatments	: 70 accessions
Experimental design	: Randomized Complete Block Design
Replication	: 2

Seven raised nursery bed of 2.5 meter length, 1 meter breadth and 15 cm in height were prepared after mixing 10 kg of well decomposed farm yard manure. The Byadagi chilli seeds of 70 accessions were sown at the spacing of 10 cm between the rows and covered with a thin layer of soil and mulched with green leaves. Care was taken against damping off by drenching with 0.2 per cent of captan. Beds were regularly watered and plant protection measures were carried out. During July 2014, fields were brought to fine tilth by ploughing and harrowing and farm yard manure (25 tons/ha) was incorporated to the soil. The one month old seedlings were transplanted at the spacing of 75 cm x 45 cm. In each plot, there were 24 plants with net plot area of 8.1 meter square. Plants were nourished with recommended dose of NPK at 150:75:75 kg/ha. All the other recommended cultivation practices were followed as per the POP of UHS, Bagalkot (Anon., 2013). The overall view of experimental field layout is shown in Plate 1.

3.4 Observations recorded

Five randomly chosen plants in each replication of each entry were labeled and used for recording the observations. The mean of five plants was calculated and used for analysis. The characters studied and techniques adopted to record the observations are given below.

3.4.1 Growth parameters

3.4.1.1 Plant height (cm)

Height of the plant was measured from ground level to the tip of the plant at 45 and 90 days after transplanting (DAT).

3.4.1.2 Plant spread from east to west (cm)

Canopy spread of the plant was measured from east to west direction of the plant at 45 and 90 DAT.

3.4.1.3 Plant spread from north to south (cm)

Canopy spread of the plant was measured from north to south direction of the plant at 45 and 90 DAT.

3.4.1.4 Number of primary branches per plant

Number of branches arising on main stem was counted at 45 and 90 DAT.

3.4.1.5 Stem girth (cm)

The girth of the main stem at ground level was measured using vernier calipers at 45 and 90 DAT.

3.4.1.6 Leaf area index

Leaf area was determined by using leaf disc method, 20 leaf discs having a known diameter were collected randomly from fully expanded leaves of plant. The midrib on leaf lamina was avoided while taking the samples. The leaf discs thus collected and rest of the leaves were dried separately in hot air oven at 60° C for 72 hours (until constant weight were obtained). The dry weight of leaf discs and rest of the leaves was recorded and leaf area was calculated by using following formula given by Vivekanandan *et al.* (1972). The leaf area was expressed in cm².

$$\text{Leaf area (cm}^2\text{)} = \frac{a \times w}{b}$$

Where, a = Leaf area (cm²) of 20 leaf discs

b = Dry weight (g) of 20 leaf discs

w = Dry weight (g) of all the leaves including 20 discs weight

After getting the leaf area went for calculation of leaf area index. Observations were taken at 45 and 90 DAT. Leaf area index was calculated by following formula.

$$\text{Leaf area index} = \frac{\text{Leaf area per plant (cm}^2\text{)}}{\text{Land area per plant (cm}^2\text{)}}$$

3.4.2 Earliness parameters

3.4.2.1 Days to first flowering

Number of days taken from the date of transplanting to date of first flower opening was recorded.

3.4.2.2 Days to 50 per cent flowering

Number of days was recorded from the transplanting to the day on which 50 per cent of the plants flowered.

3.4.3 Yield parameters

3.4.3.1 Fruit length in cm (at third picking)

Length of 10 mature fruits at third picking was measured individually from the base of calyx to the tip of fruit and average of ten fruits was worked out.

3.4.3.2 Fruit diameter in cm (at third picking)

The fruits selected for measuring fruit length were used to measure the diameter of fruit using vernier callipers at widest point of the fruit. Average of 10 fruits diameter was worked out.

3.4.3.3 Fruit length-diameter ratio

Average value of fruit length was divided by average value fruit diameter to derive the ratio.

3.4.3.4 Average fruit weight (g)

Average fruit weight was calculated by adding the weight of ten randomly selected fruits (edible maturity stage) from each of five tagged plants at third harvest and divided it by total number of fruits.

3.4.3.5 Number of fruits per plant

Number of fruits harvested from each of the tagged plants in an experimental plot from all pickings during crop season was totaled and average number per plant was worked out.

3.4.3.6 Early green fruit yield per plant (first three pickings- g)

Total weight of fruits harvested from first three pickings was added from each of five tagged plants and average was worked out as early yield.

3.4.3.7 Total green fruit yield per plant (g)

Total weight of fruits harvested from five tagged plants of all pickings were added and average yield per plant was worked out.

3.4.3.8 Dry red chilli yield per plant (g)

Red ripe chilli fruits harvested from the five tagged plants were dried and weighed and the average value from five plants was recorded as dry red chilli yield per plant.

3.4.3.9 Total green fruit yield per hectare (q)

Yield per hectare was calculated by using the following formula.

$$\text{Yield/ ha (q)} = \frac{\text{Yield per plot (kg)}}{\text{Plot area}} \times \frac{10,000}{100}$$

Plot area= 8.1 square meter

3.4.4 Quality parameters

3.4.4.1 Per cent dry matter in fruit

Fresh weight of the fruit was noted and fruit samples were cut into pieces and kept in hot air oven for obtaining dry weight. The samples were dried at 60 °C till constant weight of samples was achieved over the two subsequent observations and dry weight of fruits was recorded and per cent dry matter in fruit was worked out as follows.

$$\text{Per cent dry matter in fruits} = \frac{\text{Dehydrated fruit weight}}{\text{Fresh fruit weight}} \times 100$$

3.4.4.2 Fruit colour

Based on visual observation the highest per cent of ripen fruit covered with particular colour is named based on intensity of colour as light, medium and dark. The fruit colour of accessions is presented in appendix II.

3.4.4.3 Estimation of ascorbic acid (mg/100g)

Samples of the mature green fruits were analysed for their ascorbic acid content using 2, 6 – dichlorophenol visual method. The green fruits were cut into two to three mm pieces and two gram sample was blended with 0.4 per cent oxalic acid and filtered through muslin cloth. To an aliquot of the extract (2ml) of the sample, 3 ml acid mixture was added and titrated against the standard dye to a pink end point which persisted for at least 15 seconds (V_2). Similar procedure was followed against acid mixture to get blank titre value and against standard solution made in 0.4 per cent oxalic acid to get standard titre value (V_1) (Anon., 1975).

$$\text{Ascorbic acid (mg/100g)} = \frac{\text{Ascorbic acid content in standard (mg)}}{\text{ml of aliquot}} \times \frac{V_2}{V_1} \times \frac{\text{Total sample volume (ml)}}{\text{Weight of the sample}} \times 100$$

3.4.4.4 pungency of green chilli (organoleptic test)

Organoleptic evaluation of fresh green chilli fruit was carried out by a group of 8 judges. The sensory characters of green chilli fruit such as size, colour and appearance, pungency of chilli and overall acceptability were evaluated using a five point Hedonic scale using following score card. The mean score given by 8 judges were used for statistical analysis.

Colour and appearance	Size	Pungency of chilli	Overall acceptability	Scores
Excellent	Excellent	Excellent	Excellent	4-5
Very good	Very good	Very good	Very good	3-3.99
Good	Good	Good	Good	2-2.99
Fair	Fair	Fair	Fair	1-1.99
Poor	Poor	Poor	Poor	0-0.99

3.4.5 Disease incidence

3.4.5.1 Anthracnose

Fully grown ten matured ripened red fruits of Byadagi chilli from each accessions were chosen for study. Observations were recorded at 120 days after planting based on symptoms.

The per cent disease index (PDI) was calculated as per the following formula

$$\text{Per cent disease index} = \frac{(\text{Sum of numerical disease rating values})}{(\text{No. of plants observed}) \times (\text{Maximum disease rating})} \times 100$$

The disease resistance was recorded based on the score chart suggested by Bansal and Grover (1970) as furnished below.

Grade	Amount of disease Percentage of Disease Index (PDI)	Reaction
0	No infection	Immune
1	1 - 5 % disease	Resistant
2	6 - 25 % disease	Moderately resistant
3	26 - 50 % disease	Susceptible
4	51 - 100 % disease	Highly Susceptible

3.4.5.2 Leaf curl index

Disease reactions for each accessions were scored at 75 days after transplanting. The disease resistance was recorded based on the score chart suggested by Kumar *et al.* (2006) as furnished below.

Grade	Per cent of disease severity	Reaction
0	No symptoms	Symptomless (SL)
1	Up to 5 per cent curling and clearing of upper leaves	Highly resistant (HR)
2	6–25 per cent curling, clearing of leaves and swelling of veins	Resistant (R)
3	26–50 per cent curling, puckering and yellowing of leaves, and swelling of veins	Moderately susceptible (MS)
4	51–75 per cent leaf curling, stunted plant growth and blistering of internodes	Susceptible (S)
5	More than 75 per cent curling and deformed small leaves, stunted plant growth with small flowers and no or small fruit set.	Highly susceptible(HS)

3.4.5.3 Powdery mildew

Powdery mildew was not observed in the field.

3.5 Statistical analysis

The data collected on the quantitative characters were subjected for statistical analysis and following different statistical parameters were worked out.

Source	D.F	SS	MSS	Cal. F
Replications	r-1	RSS	RSS/(r-1)	TMSS/EMSS
Treatments	t-1	TSS	TSS/(t-1)	
Error	(r-1)(t-1)	ESS	ESS/(r-1)(t-1)	
Total	(rt-1)	TSS		

3.5.1 Analysis of variance (ANOVA)

Analysis of variance was done separately for each character for all treatments. The model of analysis of variance was given below.

Where,

t = Number of treatments (accessions)

r = Number of replications

SS = Sum of square

MSS = Mean sum of square

DF = Degrees of freedom

The standard error was calculated as,

$$SEm = \sqrt{EMSS/r}$$

The significance of treatments mean squares and replication mean squares were tested by comparing with error mean squares referring to 'F' table values at 5 and 1 per cent level of probabilities.

3.5.2 Estimation of genetic variability parameters

3.5.2.1 Genotypic, phenotypic and environmental variances

The variance due to genotype, phenotype and environment were computed as follows.

$$\text{Genotypic variance } (\sigma_g^2) = \frac{\text{MS due to genotypes (adj)} - \text{MS due to error (intra block)}}{r \text{ (replication)}}$$

$$\text{Environmental variance } (\sigma_e^2) = \text{Error mean sum of squares}$$

$$\text{Phenotypic variance } (\sigma_p^2) = \sigma_g^2 + \sigma_e^2 \text{ (MS due to error)}$$

Where, 'r' is number of replications.

3.5.2.2 Genotypic and phenotypic coefficient of variation

Genotypic and phenotypic coefficients of variance were estimated according to Burton and Devane (1953) based on estimate of genotypic and phenotypic variance.

Genotypic co-efficient of variation (GCV)

$$\text{GCV (\%)} = \frac{\sigma_g}{\bar{X}} \times 100$$

Phenotypic co-efficient of variation (PCV)

$$\text{PCV (\%)} = \frac{\sigma_p}{\bar{X}} \times 100$$

Where,

X = Grand mean

r = Number of replications

σ_g = Genotypic standard deviation

σ_p = Phenotypic standard deviation

3.5.2.3 Heritability (h^2)

The broad sense heritability (h^2_{bs}) was estimated by following the procedure suggested by Weber and Moorthy (1952) as indicated here below.

$$h^2 = \frac{\sigma^2_g}{\sigma^2_p} \times 100$$

Where, h^2 (%) = Heritability (Broad sense)

σ^2_g = Genotypic variance

σ^2_p = Phenotypic variance

3.5.2.4 Expected genetic advance

Genetic advance for each character was predicted by the formula given by Johnson *et al.* (1955).

$$GA = h^2 \times s_p \times k$$

Where, k = selection differential (2.06) at 5 per cent selection intensity

h^2 = Heritability in broad sense

σ_p = Phenotypic standard deviation

3.5.2.5 Genetic advance as per cent over mean (GAM)

Genetic advance as per cent over mean was worked out as suggested by Johnson *et al.* (1955).

$$\text{Genetic advance as per cent over mean (GAM)} = \frac{GA}{\bar{X}} \times 100$$

Where, GA = Genetic advance

$\bar{X}$ = General mean

3.5.3 Correlation analysis

The correlation co-efficient among all possible character combinations at phenotypic (rp) and genotypic (rg) level were estimated employing formula (Al-Jibouri *et al.*, 1958).

$$\text{Phenotypic correlation} = r_{xy} (p) = \frac{\text{Cov}_{xy} (p)}{\sqrt{V_x (p) \times V_y (p)}}$$

$$\text{Genotypic correlation} = r_{xy} (g) = \frac{\text{Cov}_{xy} (g)}{\sqrt{V_x (g) \times V_y (g)}}$$

Where,

$\text{Cov}_{xy} (p)$ = Phenotypic covariance between x and y

$\text{Cov}_{xy} (g)$ = Genotypic covariance between x and y

$V_x(G)$ = Genotypic variance of character 'x'

$V_x(P)$ = Phenotypic variance of character 'x'

$V_y(G)$ = Genotypic variance of character 'y'

$V_y(P)$ = Phenotypic variance of character 'y'

The test of significance for association between characters was done by comparing table 'r' values at n-2 error degrees of freedom for phenotypic and genotypic correlations with estimated values, respectively.

3.5.4 Path co-efficient analysis

Path co-efficient analysis suggested by Wright (1921) and Dewey and Lu (1959) was carried out to know the direct and indirect effect of the morphological traits on plant yield. The following set of simultaneous equations were formed and solved for estimating various direct and indirect effects.

$$r_{1y} = a + r_{12}b + r_{13}c + \dots + r_{1I}I$$

$$r_{2y} = a + r_{21}a + b + r_{23}c + \dots + r_{2I}I$$

$$r_{3y} = r_{31}a + r_{32}b + c + \dots + r_{3I}I$$

$$r_{1y} = r_{11}a + r_{12}b + r_{13}c + \dots + I$$

Where,

r_{1y} to r_{Iy} = Co-efficient of correlation between causal factors 1 to I with dependent characters y.

r_{12} to r_{II} = Co-efficient of correlation among causal factors

a, b, c,.....i = Direct effects of characters 'a' to 'I' on the dependent character 'y'

Residual effect (R) was computed as follows.

$$\text{Residual effect (R)} = 1 - \sqrt{a^2 + b^2 + c^2 + \dots + I^2 + 2abr_{12} + 2acr_{13} + \dots}$$

3.5.5 Genetic divergence

Mahalanobis (1928) D^2 statistic was used for assessing the genetic divergence between different populations. The D^2 analysis was carried out using the data recorded on germplasms. Mahalanobis generalized distance (D^2) between any two populations is given by the formulas.

$$D^2 = \sum \lambda^{ij} \sigma^i \sigma^j$$

Where, D^2 = Square of generalized distance

λ^{ij} = Reciprocal of the common dispersal index

$$\sigma^i = \mu^{i1} - \mu^{i2}$$

$$\sigma^j = \mu^{j1} - \mu^{j2}$$

μ = General mean

Since the formula for computation requires inversion of higher order determinants, transformation of the original correlated unstandardized character mean (Xs) to standardize uncorrelated variable (Ys) was done to simplify the computational procedure. The D^2 values were obtained as the corresponding uncorrelated (Ys) values of any two uncorrelated genotypes (Rao, 1952).

Clustering D^2 values

All the $n(n-1)/2D^2$ values were clustered using Tocher's method (Rao, 1952).

Intra and inter-cluster distance

The intra and inter-cluster distances were calculated by following the formula described by Singh and Choudhary (1977).

$$\text{Square of intra cluster distance} = \frac{SD_i^2}{N}$$

Where,

SD_i^2 = Sum of distances between all possible combinations of the entries included in the cluster

N = Number of all possible combinations

$$\text{Square of inter-cluster distance} = \frac{SD_{ij}^2}{n_i n_j}$$

Where, SD_{ij}^2 = Sum of distances between all possible combinations ($n_i n_j$) of the entries included in the cluster

n_i = Number of entries in the cluster i

n_j = Number of entries in the cluster j

4. EXPERIMENTAL RESULTS

The present investigation was carried out with 70 accessions of Byadagi chilli (*Capsicum annuum* L.) in Regional Horticulture Research and Extension Centre, Kumbapur (Karnataka) to assess the nature and extent of genetic variability, correlation, path analysis and divergence. The results of the experiment are presented in this chapter.

4.1 Analysis of variance

The analysis of variance indicated significantly higher amount of variability among the accessions for all the characters studied viz., plant height, plant spread from east to west, plant spread from north to south, number of primary branches per plant, stem girth, leaf area index, days to first flowering, days to 50 per cent flowering, fruit length, fruit diameter, fruit length diameter ratio, average fruit weight, number of fruits per plant, early green fruit yield per plant, per cent dry matter in fruit, total green chilli yield per plant, green chilli yield per hectare, red dry chilli per plant, red dry chilli per hectare, anthracnose, leaf curl index and there was no incidence of powdery mildew in the field (Table 5).

4.2 Genetic variability, heritability and genetic advance

The estimates of mean, range, genotypic and phenotypic coefficients of variation, heritability, genetic advance and genetic advance as per cent over mean for all the characters were studied and the results are presented in Table 6, 7, 8, 9 and 10.

4.2.1 Plant height (Tables 6 and 7)

Plant height at 45 DAT ranged from 28.3 (BDS-59) to 64.80 cm (BDS-21) with an average mean of 42.85 cm. The GV and PV were 58.94 and 72.25, respectively. Moderate estimate of GCV (17.91 %) and PCV (19.83 %) were observed. High heritability (81.57 %) was observed along with high genetic advance as per cent of mean (33.33 %) and genetic advance (14.28) for this trait.

Table 5: Analysis of variance (mean sum of squares) for growth, earliness, yield, quality and disease incidence in chilli.

SI. No.	Source of variation/ Characters	Replication	Treatments (Accessions)	Error	S. Em±	CD (5%)
	Degrees of freedom	1	69	69		
A	Growth parameters					
1	Plant height at 45 DAT (cm)	352.69	131.19*	13.31	2.57	7.27
2	Plant height at 90 DAT (cm)	150.69	109.03*	9.73	2.20	6.22
3	Plant spread from east to west at 45 DAT (cm)	49.44	29.79*	0.69	0.58	1.65
4	Plant spread from east to west at 90 DAT (cm)	247.84	92.18*	3.51	1.32	3.73
5	Plant spread from north to south at 45 DAT (cm)	240.77	95.29*	8.18	2.02	5.70
6	Plant spread from north to south at 90DAT (cm)	154.67	86.97*	8.13	2.01	5.68
7	Number of primary branches per plant at45 DAT	2.52	1.20*	0.05	0.16	0.47
8	Number of primary branches per plant at90 DAT	4.82	1.17*	0.15	0.27	0.77
9	Stem girth at 45 DAT (cm)	0.18	0.04*	0.004614	0.04	0.13
10	Stem girth at 90 DAT (cm)	0.23	3.19*	0.00649	0.05	0.16
11	Leaf area index at 45 DAT	0.0008	0.0011*	0.0002	0.0094	0.0026
12	Leaf area index at 90 DAT	0.001474	0.0055*	0.000764	0.01955	0.05515
B	Earliness parameters					
1	Days to first flowering	0.71	29.89*	3.23	1.27	3.58
2	Days to 50 per cent flowering	20.82	74.97*	7.93	1.99	5.61
C	Yield parameters					
1	Fruit length (cm)	1.68	5.25*	0.24	0.34	0.97
2	Fruit diameter (cm)	0.06	0.42*	0.0081	0.06	0.18
3	Fruit length diameter ratio	0.00825	6.70*	0.35	0.42	1.18
4	Average fruit weight (g)	6.70	21.72*	0.18	0.30	0.86
5	Number of fruits per plant	9.87	128.51*	2.26	1.06	3.00
6	Early green fruit yield per plant (g)	0.54	573.19*	14.42	2.68	7.57

Table 5: Contd...

SI. No.	Source of variation/ Characters	Replication	Treatments (Genotypes)	Error	S. Em±	CD (5%)
7	Total green fruit yield per plant (g)	207.00	5126.66*	139.99	8.36	23.60
8	Dry red chilli yield per plant (g)	4074.74	259.76*	10.43	2.28	6.44
9	Total green fruit yield per ha (q)	2.47	201.86*	5.80	1.70	4.80
10	Total dry fruit yield per ha (q)	63.28	15.79*	0.22	0.33	0.93
D	Quality parameters					
1	Per cent dry matter in fruit	2.33	5.17*	0.69	0.59	1.66
2	Ascorbic acid (mg/100g)	16.32	4751.4*	36.97	4.29	12.12
E	Disease incidence					
1	Anthrachnose	207.98	504.40*	20.73	3.21	9.08
2	Leaf curl index	34.86	1119.22*	15.35	2.77	7.81

* Significant @ 5 %

DAT: Days after transplanting

At 90 DAT the plant height was ranged from 57.99 (BDS-3) to 89.79 cm (BDS-16) with grand mean of 69.58 cm. The GV and PV were 49.64 and 59.38, respectively. The estimates of GCV and PCV were moderate (10.12 % and 11.07 %, respectively). High heritability (83.60 %) was observed along with moderate genetic advance as per cent over mean (19.07 %) and genetic advance (13.27) for this trait.

4.2.2 Plant spread from east to west (Tables 6 and 7)

At 45 DAT plant spread from east to west was ranged from 22.90 (BDS-60) to 44.90 cm (BDS-49) with a mean value of 31.46 cm. The GV and PV were 14.55 and 15.24, respectively. The estimates of GCV and PCV were moderate (12.12 % and 12.40 %, respectively). Very high heritability (95.47 %) was observed along with high genetic advance as per cent over mean (24.40) and GA (7.67).

At 90 DAT plant spread from east to west was ranged from 37.93 (BDS-23) to 66.44 cm (BDS-49) with a mean value of 52.94 cm. The GV and PV were 44.33 and 47.84, respectively. The moderate estimates of genotypic coefficient of variation and phenotypic coefficient of variation (12.57% and 13.06 %, respectively) were associated with very high heritability (92.66 %), high genetic advance as per cent over mean (24.93 %) and GA was 13.20.

4.2.3 Plant spread from north to south (Tables 6 and 7)

At 45 DAT plant spread from north to south was ranged from 24.00 (BDS-13) to 53.30 cm (BDS-53) with a mean value of 35.24 cm. The GV and PV were 43.55 and 51.73, respectively. The moderate estimate of GCV (18.72) and moderate to high estimate of PCV (20.40 %). High heritability (84.18 %) was observed along with high genetic advance as per cent over mean (35.39 %) and GA (12.47).

At 90 DAT plant spread from north to south was ranged from 38.29 (BDS-61) to 68.95 cm (BDS-25) with a mean value of 54.24 cm. The GV and PV were 39.42 and 47.55, respectively. The moderate estimates of genotypic coefficient of variation and phenotypic coefficient of variation (11.57 % and 12.71 %, respectively) were associated with high heritability (82.90 %), high genetic advance as per cent over mean (21.70 %) and GA was 11.77.

Table 6: Estimates of mean, range, components of variance, heritability and genetic advance for growth and earliness parameters in chilli

Sl. No.	Character	Mean $\pm$ S.Em	Range	GV	PV	GCV (%)	PCV (%)	h^2 (%)	GA	GAM
A	Growth parameters									
1	Plant height at 45 DAT (cm)	42.85 $\pm$ 2.57	28.30-64.80	58.94	72.25	17.91	19.83	81.57	14.28	33.33
2	Plant height at 90 DAT (cm)	69.58 $\pm$ 2.20	57.99-89.79	49.64	59.38	10.12	11.07	83.60	13.27	19.07
3	Plant spread from east to west at 45 DAT (cm)	31.46 $\pm$ 0.58	22.90-44.90	14.55	15.24	12.12	12.40	95.47	7.67	24.40
4	Plant spread from east to west at 90 DAT (cm)	52.94 $\pm$ 1.32	37.93-66.44	44.33	47.84	12.57	13.06	92.66	13.20	24.93
5	Plant spread from north to south at 45 DAT (cm)	35.24 $\pm$ 2.02	24.00-53.30	43.55	51.73	18.72	20.40	84.18	12.47	35.39
6	Plant spread from north to south at 90DAT (cm)	54.24 $\pm$ 2.01	38.29- 68.95	39.42	47.55	11.57	12.71	82.90	11.77	21.70
7	Number of primary branches per plant at 45 DAT	4.35 $\pm$ 0.16	2.10-6.10	0.57	0.63	17.40	18.23	91.10	1.49	34.22
8	Number of primary branches per plant at 90 DAT	5.71 $\pm$ 0.27	4.50-8.16	0.50	0.66	12.48	14.23	76.98	1.28	22.57
9	Stem girth at 45 DAT (cm)	0.68 $\pm$ 0.048	0.45-1.04	0.017	0.022	19.46	21.84	79.40	0.24	35.72
10	Stem girth at 90 DAT (cm)	1.19 $\pm$ 0.056	0.82-1.47	0.019	0.026	11.76	13.54	75.43	0.25	21.05
11	Leaf area index at 45 DAT	0.08 $\pm$ 0.009	0.04 – 0.14	0.0005	0.0006	27.09	31.80	72.58	0.03	47.56
12	Leaf area index at 90 DAT	0.25 $\pm$ 0.019	0.19-0.47	0.0024	0.003178	18.89	21.68	75.94	0.08	33.92
B	Earliness parameters									
1	Days to first flowering	33.28 $\pm$ 1.27	28.00-42.50	13.32	16.56	10.96	12.22	80.46	6.74	20.26
2	Days to 50 per cent flowering	52.21 $\pm$ 1.99	42.50-66.50	33.52	41.45	11.08	12.33	80.87	10.72	20.54

DAT- Days after transplanting

GV- Genotypic variance

PV- Phenotypic variance

PCV- Phenotypic co-efficient of variation

GCV- Genotypic co-efficient of variation

h^2 - Broad sense heritability

GA- Genetic advance

GAM- Genetic advance as per cent of mean

Table 7: *Per se* performance of chilli accessions for growth and earliness parameters

Sl. No.	Accessions	1		2		3		4		5		6		7	8
		45 DAT	90 DAT	45 DAT	90 DAT	45 DAT	90 DAT	45 DAT	90 DAT	45 DAT	90 DAT	45 DAT	90 DAT		
1	BDS-01	40.60	65.50	31.50	50.16	27.30	61.63	4.50	5.67	0.72	0.95	0.08	0.22	32.50	52.50
2	BDS-02	43.00	58.94	31.80	45.89	29.10	55.87	4.70	6.17	0.60	0.90	0.08	0.25	28.50	48.50
3	BDS-03	43.80	57.99	31.70	51.94	30.30	48.58	4.70	6.33	0.56	0.87	0.10	0.26	32.50	59.00
4	BDS-04	51.50	60.94	33.50	46.28	34.40	53.78	4.80	5.67	0.73	0.84	0.09	0.28	39.00	58.00
5	BDS-05	39.50	63.11	31.70	59.18	35.50	55.91	4.80	6.83	0.53	1.04	0.10	0.23	28.50	42.50
6	BDS-06	40.90	67.45	29.60	59.78	29.20	59.77	4.50	6.17	0.77	0.82	0.07	0.23	37.00	52.50
7	BDS-07	40.60	59.27	31.90	54.96	34.40	56.17	5.30	5.67	0.77	1.24	0.05	0.26	30.00	49.00
8	BDS-08	53.30	73.60	29.60	55.11	28.40	58.39	4.20	4.50	0.62	1.15	0.10	0.28	29.50	56.00
9	BDS-09	44.60	62.87	30.70	55.61	32.00	55.77	4.30	5.50	0.54	1.16	0.09	0.23	39.00	66.50
10	BDS-10	55.30	63.09	31.20	50.61	31.20	55.66	2.60	5.33	0.50	1.08	0.06	0.33	30.50	53.00
11	BDS-11	36.00	63.60	32.00	57.06	38.80	51.94	3.70	5.83	0.50	1.09	0.10	0.19	28.50	57.50
12	BDS-12	59.40	67.52	31.50	45.35	40.90	50.74	3.60	4.50	0.60	1.02	0.09	0.36	31.50	44.00
13	BDS-13	43.30	68.77	25.70	50.78	24.00	56.94	3.10	5.83	0.45	0.95	0.08	0.23	42.50	59.50
14	BDS-14	48.50	69.95	33.10	52.61	25.80	53.90	3.40	4.83	0.56	1.10	0.10	0.22	29.50	43.50
15	BDS-15	52.10	71.59	33.50	53.62	34.80	56.95	4.30	6.83	0.55	1.13	0.09	0.25	33.00	42.50
16	BDS-16	49.90	89.79	32.40	62.96	34.30	58.90	4.20	5.83	0.53	1.13	0.07	0.24	37.50	52.50
17	BDS-17	44.10	66.42	34.80	46.55	37.50	54.77	6.10	7.33	0.75	1.14	0.09	0.25	28.50	44.50
18	BDS-18	30.90	66.32	30.50	52.89	30.50	54.62	4.00	5.17	0.63	1.06	0.05	0.22	35.00	48.00
19	BDS-19	43.90	78.89	29.50	64.29	27.20	63.75	4.20	6.83	0.53	1.15	0.06	0.22	35.50	55.00
20	BDS-20	54.50	75.61	30.30	58.78	32.90	51.49	4.30	4.50	0.51	1.16	0.07	0.36	39.50	47.00
21	BDS-21	64.80	74.75	32.80	59.90	29.80	50.95	4.00	5.83	0.77	1.18	0.09	0.33	28.50	42.50
22	BDS-22	33.50	79.95	31.50	54.94	33.20	51.11	5.00	5.67	0.65	1.38	0.08	0.23	30.50	45.50
23	BDS-23	58.20	64.87	27.40	37.93	27.90	45.26	5.30	6.00	0.51	1.18	0.06	0.26	40.50	54.50

1. Plant height (cm)

2. Plant spread from east to west (cm)

3. Plant spread from north to south (cm)

4. No. of primary branches per plant

5. Stem girth (cm)

6. Leaf area index

7. Days to first flowering

8. Days to 50 per cent flowering

Table 7: Contd...

Sl. No.	Accessions	1		2		3		4		5		6		7	8
		45 DAT	90 DAT	45 DAT	90 DAT	45 DAT	90 DAT	45 DAT	90 DAT	45 DAT	90 DAT	45 DAT	90 DAT		
24	BDS-24	51.00	83.87	29.90	55.66	41.30	63.61	4.40	7.50	0.63	1.24	0.06	0.23	34.50	56.00
25	BDS-25	49.80	80.11	32.60	62.11	35.30	68.95	6.10	6.83	0.84	1.31	0.11	0.47	42.00	64.00
26	BDS-26	41.90	68.44	29.20	54.06	29.70	53.62	3.60	5.00	0.51	1.21	0.09	0.21	31.50	48.00
27	BDS-27	39.80	65.11	32.00	53.12	35.40	55.10	4.60	5.83	0.57	1.35	0.11	0.23	36.50	59.50
28	BDS-28	36.10	59.94	33.40	53.77	29.00	56.94	6.10	7.00	0.90	1.47	0.12	0.23	31.50	48.50
29	BDS-29	43.90	64.66	28.80	50.61	31.60	51.27	4.50	5.17	0.63	1.30	0.13	0.25	31.50	48.00
30	BDS-30	40.10	82.48	33.80	62.96	31.90	51.78	4.80	5.67	0.62	1.35	0.11	0.25	32.00	54.00
31	BDS-31	42.10	77.28	39.30	63.83	36.00	55.28	4.40	8.16	0.62	1.13	0.12	0.28	30.50	61.50
32	BDS-32	55.50	80.79	28.30	51.30	31.10	59.85	3.70	5.17	0.72	1.29	0.09	0.47	28.50	65.50
33	BDS-33	44.70	92.94	33.60	59.61	33.10	61.45	4.80	5.17	0.57	1.19	0.12	0.27	30.50	46.50
34	BDS-34	37.70	64.61	34.10	57.12	32.90	53.11	4.30	5.33	0.73	1.38	0.12	0.25	31.00	47.50
35	BDS-35	35.30	66.89	26.90	45.54	27.40	52.78	4.60	4.83	0.51	1.24	0.08	0.19	38.50	56.50
36	BDS-36	37.90	65.49	32.10	46.96	28.20	49.10	3.80	5.17	0.61	1.12	0.12	0.25	35.50	56.50
37	BDS-37	32.30	78.89	27.00	44.28	25.50	57.96	4.00	5.17	0.56	1.12	0.08	0.22	38.00	54.50
38	BDS-38	56.00	69.07	31.20	43.02	34.40	44.97	3.90	5.50	0.55	1.15	0.06	0.23	33.00	51.00
39	BDS-39	56.90	65.96	28.50	60.94	33.70	49.62	4.60	5.83	0.75	1.10	0.06	0.25	31.50	47.00
40	BDS-40	35.10	72.93	29.90	57.71	41.50	44.42	4.00	5.33	0.72	1.20	0.08	0.19	28.00	43.00
41	BDS-41	32.50	64.07	27.10	54.45	27.40	50.52	3.50	4.83	0.73	1.20	0.07	0.23	30.00	48.00
42	BDS-42	41.70	58.45	26.10	54.78	27.10	46.63	3.40	5.17	0.54	1.13	0.05	0.25	34.00	53.50
43	BDS-43	33.60	72.28	31.80	58.96	30.60	51.33	4.20	5.83	0.63	1.38	0.05	0.23	28.50	46.50
44	BDS-44	33.20	66.65	28.80	46.60	26.80	51.00	4.20	4.83	0.73	1.13	0.08	0.25	36.50	61.50
45	BDS-45	43.30	68.39	32.00	61.62	33.70	42.62	4.10	5.33	0.79	1.16	0.06	0.29	41.00	66.00
46	BDS-46	35.40	62.71	26.40	45.99	33.70	66.62	4.00	5.83	0.52	1.12	0.07	0.30	41.00	63.50
47	BDS-47	40.20	68.29	28.50	49.27	33.90	44.79	4.10	5.50	0.81	1.11	0.08	0.32	31.50	53.50
48	BDS-48	34.00	73.59	37.90	60.35	37.90	46.95	4.70	5.83	0.77	1.40	0.07	0.20	36.50	56.00
49	BDS-49	42.00	75.28	44.90	66.44	35.90	62.83	4.10	6.50	0.78	1.27	0.05	0.26	37.50	56.50

1. Plant height (cm)

2. Plant spread from east to west (cm)

3. Plant spread from north to south (cm)

4. No. of primary branches per plant

5. Stem girth (cm)

6. Leaf area index

7. Days to first flowering

8. Days to 50 per cent flowering

Table 7: Contd...

Sl. No.	Accessions	1		2		3		4		5		6		7	8
		45 DAT	90 DAT	45 DAT	90 DAT	45 DAT	90 DAT	45 DAT	90 DAT	45 DAT	90 DAT	45 DAT	90 DAT		
50	BDS-50	43.20	72.62	34.70	61.71	40.60	60.35	4.10	5.17	0.66	1.36	0.05	0.33	34.00	54.50
51	BDS-51	31.60	66.88	36.90	54.75	45.60	54.28	5.40	6.67	0.83	1.37	0.07	0.22	28.50	44.00
52	BDS-52	54.30	75.13	35.90	50.94	50.10	61.28	5.30	5.33	0.99	1.37	0.05	0.30	32.50	53.00
53	BDS-53	40.30	75.16	33.10	56.65	53.30	67.62	5.40	5.50	1.04	1.40	0.09	0.25	30.50	53.00
54	BDS-54	36.80	77.04	32.90	56.83	45.10	50.77	5.90	6.83	0.92	1.54	0.09	0.24	30.00	47.50
55	BDS-55	33.10	61.93	30.90	48.91	36.70	52.79	4.50	5.33	0.81	1.25	0.06	0.25	36.50	55.00
56	BDS-56	43.80	75.83	32.60	52.76	51.40	61.45	5.60	6.83	0.92	1.18	0.05	0.28	36.00	55.50
57	BDS-57	44.10	77.16	41.80	48.17	51.50	63.11	5.40	6.00	0.80	1.35	0.05	0.31	31.00	45.50
58	BDS-58	38.10	74.59	39.50	62.61	48.90	61.83	4.60	5.33	0.88	1.38	0.05	0.28	35.00	56.50
59	BDS-59	28.30	61.73	36.60	48.66	42.10	55.94	4.70	4.83	0.58	1.20	0.08	0.21	30.00	46.50
60	BDS-60	33.80	60.10	22.90	41.81	28.70	41.62	3.20	4.83	0.66	1.25	0.07	0.26	34.50	52.00
61	BDS-61	41.80	65.50	26.50	43.00	35.30	38.29	2.10	4.83	0.94	1.30	0.05	0.31	33.50	54.00
62	BDS-62	33.10	68.45	28.80	63.95	42.50	56.18	3.80	5.83	0.88	1.06	0.09	0.23	31.50	50.00
63	BDS-63	43.60	59.44	28.70	40.45	38.10	56.78	3.60	6.33	0.79	1.30	0.04	0.26	37.50	55.50
64	BDS-64	36.60	73.59	27.60	45.16	43.80	56.18	4.20	6.17	0.61	1.27	0.04	0.22	35.00	54.50
65	BDS-65	54.10	66.28	28.00	54.16	34.00	44.12	4.00	5.67	0.75	1.29	0.06	0.31	28.50	45.00
66	BDS-66	39.90	68.46	33.40	46.12	41.30	55.06	3.10	6.33	0.53	1.47	0.05	0.23	29.00	44.00
67	BDS-67	50.20	68.62	33.80	45.75	45.00	60.67	4.30	5.50	0.90	1.46	0.05	0.25	32.50	52.00
68	BDS-68	51.60	66.79	27.60	42.11	39.60	44.63	4.80	5.83	0.81	1.17	0.05	0.25	31.00	50.50
69	BDS-69	40.50	66.29	25.40	46.77	34.40	40.29	5.00	5.17	0.62	1.11	0.04	0.21	32.00	48.50
70	BDS-70	36.50	69.12	32.90	46.66	44.80	57.95	3.90	4.50	0.86	1.13	0.04	0.22	32.50	51.50
	Mean	42.85	69.58	31.46	52.94	35.24	54.25	4.35	5.71	0.69	1.19	0.08	0.25	33.28	52.21
	S.Em±	2.57	2.21	0.59	1.32	2.02	2.01	0.16	0.27	0.04	0.05	0.01	0.01	1.27	1.99
	C.D(5%)	7.27	6.23	1.66	3.74	5.70	5.68	0.47	0.77	0.13	0.16	0.02	0.05	3.58	5.61
	C.D(1%)	9.66	8.27	2.20	4.96	7.57	7.55	0.62	1.03	0.17	0.21	0.03	0.07	4.76	7.45
	CV(%)	8.51	4.49	2.64	3.54	8.11	.25	5.43	6.82	9.91	6.71	16.65	10.63	5.40	5.39

1. Plant height (cm)

2. Plant spread from east to west (cm)

3. Plant spread from north to south (cm)

4. No. of primary branches per plant

5. Stem girth (cm)

6. Leaf area index

7. Days to first flowering

8. Days to 50 per cent flowering

4.2.4 Number of primary branches per plant (Tables 6 and 7)

At 45 DAT the number of primary branches per plant was ranged from 2.10 (BDS-61) to 6.10 (BDS-25) with a mean value of 4.35. The GV and PV were 0.57 and 0.63, respectively. Moderate estimates of GCV and PCV (17.40% and 18.23 %) were observed. Very high heritability (91.10 %) was observed along with high genetic advance as per cent over mean (34.22 %) and genetic advance (1.49) for this trait.

At 90 DAT the number of primary branches per plant was ranged from 4.50 (BDS-8, 12, 20, 70) to 8.16 (BDS-31) with a mean value of 5.71. The GV and PV were 0.50 and 0.66, respectively. Moderate estimate of GCV (12.48 %) and PCV (14.23 %) were observed. High heritability (76.98 %) was observed along with high genetic advance as per cent over mean (22.57 %) and genetic advance (1.28) for this trait.

4.2.5 Stem girth (Tables 6 and 7)

At 45 DAT stem girth was ranged from 0.45 (BDS-13) to 1.04 cm (BDS-53) with a mean value of 0.68 cm. The GV and PV were 0.017 and 0.022, respectively. The moderate estimate of GCV (19.46%) and high estimate of PCV (21.84 %) were observed. High heritability (79.40 %) was observed along with high genetic advance as per cent over mean (35.72 %) and GA (0.24).

At 90 DAT stem girth was ranged from 0.82 (BDS-6) to 1.47 cm (BDS-66) with a mean value of 1.19 cm. The GV and PV were 0.019 and 0.026, respectively. The estimates of GCV and PCV were moderate (11.76 % and 13.54 % respectively). High heritability (75.43 %) was observed along with high genetic advance as per cent over mean (21.05 %) and GA (0.25).

4.2.6 Leaf area index (Tables 6 and 7)

Leaf area index at 45 DAT ranged from 0.04 (BDS-70) to 0.14 (BDS-29) with an average mean of 0.08. The GV and PV were 0.0005 and 0.0006, respectively. High estimates of GCV (27.09 %) and PCV (31.80 %) were observed. Moderate heritability (72.58 %) was observed along with very high genetic advance as per cent over mean (47.56 %) and genetic advance (0.03) for this trait.

Leaf area index at 90 DAT ranged from 0.19 to (BDS-11) to 0.47 (BDS-32) with an average mean of 0.25. The GV and PV were 0.0024 and 0.0031, respectively. Moderate estimate of GCV (18.89 %) and moderate to high estimate of PCV (21.68 %) were observed. High heritability (75.94 %) was observed along with high genetic advance as per cent over mean (33.92 %) and genetic advance (0.088) for this trait.

4.2.7 Days to first flowering (Tables 6 and 7)

The chilli accession BDS-40 took least number of days (28.00) and BDS-13 took maximum number of days (42.50) to first flowering. On average chilli accession took 33.28 days for appearance of first flower. The genotypic and phenotypic variances were 13.32 and 16.56, respectively. The moderate estimates of phenotypic coefficient of variation and genotypic coefficient of variation (12.22% and 10.96%, respectively) with high heritability (80.46 %) along with high genetic advance as per cent over mean (20.26 %) and genetic advance (6.74).

4.2.8 Days to 50 per cent flowering (Tables 6 and 7)

The chilli accession BDS-5 took least number of days (42.50) for 50 per cent flowering, while BDS-9 took maximum number of days (66.50). On an average chilli accession took 52.21 days for appearance of 50 per cent flowering. The genotypic and phenotypic variances were 33.52 and 41.45 respectively. Moderate estimates of GCV (11.08%) and PCV (12.33 %) were observed. High heritability (80.87%) was observed along with high genetic advance as per cent over mean (20.54%) and genetic advance (10.72) for this trait.

4.2.9 Fruit length (Tables 8 and 9)

Fruit length ranged from 5.62 (BDS-62) to 14.21 cm (BDS-16) with a mean value of 11.46 cm. The GV and PV were 2.50 and 2.75, respectively. The estimates of GCV and PCV were moderate (13.81 % and 14.46 %, respectively). Very high heritability (91.23 %) was observed along with high genetic advance as per cent over mean (27.18 %) and GA (3.11).

4.2.10 Fruit diameter (Tables 8 and 9)

Fruit diameter ranged from 1.09 (BDS-48) to 2.87 cm (BDS-17) with a mean value of 1.70 cm. The GV and PV were 0.21 and 0.21, respectively. The estimates of GCV and PCV were high (26.82 % and 27.34%, respectively). Very high heritability (96.26 %) was observed along with very high genetic advance as per cent over mean (54.22%) and GA (0.92).

4.2.11 Fruit length diameter ratio (Tables 8 and 9)

Fruit length diameter ratio ranged from 2.62 (BDS-64) to 11.12 (BDS-35) with a mean value of 7.20. The GV and PV were 3.53 and 3.88, respectively. The estimates of GCV and PCV were high (26.09 % and 27.35 %, respectively). Very high heritability (90.99 %) was observed along with very high genetic advance as per cent over mean (51.28 %) and GA (3.69).

4.2.12 Average fruit weight (Tables 8 and 9)

Average fruit weight was maximum in BDS-16 (21.37 g) and minimum was observed in BDS-51 (6.70 g). Average fruit weight ranged from 6.70 to 21.37 g with a mean value of 10.44 g. The GV and PV were 10.77 and 10.95, respectively. The estimates of GCV and PCV were high (31.41 and 31.68 %, respectively). Very high heritability (98.29 %) was observed along with very high genetic advance as per cent over mean (64.15 %) and GA (6.70).

4.2.13 Number of fruits per plant (Tables 8 and 9)

Number of fruits per plant was maximum in BDS-66 (66.00) followed by BDS-27 (61.00), BDS-16 (51.00), BDS-9 (47.00) and BDS-21 (44.75) and it was minimum in BDS-3 (21.50). Number of fruits per plant ranged from 21.50 to 66.00 with a mean value of 33.14. The GV and PV were 63.12 and 65.38, respectively. The estimates of GCV and PCV were high (23.96 % and 24.39 %, respectively). Very high heritability (96.54 %) was observed along with very high genetic advance as per cent over mean (48.51 %) and GA (16.08).

Table 8: Estimates of mean, range, components of variance, heritability and genetic advance for yield and quality parameters in chilli

SI. No.	Character	Mean $\pm$ S.Em	Range	GV	PV	GCV (%)	PCV (%)	h^2 (%)	GA	GAM
C	Yield parameters									
1	Fruit length	11.46 $\pm$ 0.34	5.62-14.21	2.50	2.75	13.81	14.46	91.23	3.11	27.18
2	Fruit diameter	1.70 $\pm$ 0.06	1.09-2.87	0.21	0.21	26.82	27.34	96.26	0.92	54.22
3	Fruit length diameter ratio	7.20 $\pm$ 0.41	2.62-11.12	3.53	3.88	26.09	27.35	90.99	3.69	51.28
4	Average fruit weight	10.44 $\pm$ 0.30	6.70-21.37	10.77	10.95	31.41	31.68	98.29	6.70	64.15
5	Number of fruits per plant	33.14 $\pm$ 1.03	21.50-66.00	63.12	65.38	23.96	24.39	96.54	16.08	48.51
6	Early green fruit yield per plant	74.86 $\pm$ 2.68	49.18-108.83	279.38	293.81	22.32	22.89	95.08	33.57	44.84
7	Total green fruit yield per plant	226.74 $\pm$ 8.36	145.29-326.50	2493.30	2633.33	22.02	22.63	94.68	100.09	44.14
8	Dry red chilli yield per plant	50.98 $\pm$ 2.28	32.82-73.48	124.66	135.10	21.89	22.79	92.27	22.09	43.33
9	Total green fruit yield per ha (q)	44.68 $\pm$ 1.70	29.14-64.49	98.02	103.83	22.15	22.80	94.40	19.81	44.35
10	Total dry fruit yield per ha (q)	11.77 $\pm$ 0.33	6.25-17.13	7.78	8.00	23.70	24.04	97.24	5.66	48.16
D	Quality parameter									
1	Per cent dry matter in fruit	10.10 $\pm$ 0.59	6.88-14.11	2.23	2.93	14.80	16.95	76.24	2.69	26.63
2	Ascorbic acid (mg/100g)	120.41 $\pm$ 4.29	42.68-259.18	2357.21	2394.18	40.32	40.63	98.45	99.24	82.41

DAT- Days after transplanting

GV- Genotypic variance

PV- Phenotypic variance

PCV- Phenotypic co-efficient of variation

GCV- Genotypic co-efficient of variation

h^2 - Broad sense heritability

GA- Genetic advance

GAM- Genetic advance as per cent of mean

Table 9: Per se performance of chilli accessions for yield parameters

SI. No.	Accessions	1	2	3	4	5	6	7	8	9	10
1	BDS-01	10.46	1.11	09.43	07.16	26.48	49.57	151.70	34.11	29.96	06.96
2	BDS-02	12.92	1.20	10.76	07.77	26.50	58.58	175.74	39.59	34.71	08.73
3	BDS-03	11.24	1.19	09.44	06.99	21.50	48.43	145.29	32.82	28.70	07.64
4	BDS-04	11.71	1.29	09.05	08.87	28.50	62.30	186.91	42.12	36.92	09.82
5	BDS-05	11.89	1.48	08.07	10.10	31.50	64.07	202.70	45.54	40.04	10.13
6	BDS-06	12.32	1.17	10.50	07.33	25.00	52.78	158.35	35.52	31.28	07.79
7	BDS-07	12.02	1.51	07.95	10.34	32.00	71.62	210.37	47.15	41.55	11.01
8	BDS-08	10.27	1.21	08.53	06.80	26.65	52.07	168.21	37.69	33.23	08.81
9	BDS-09	09.57	1.50	06.38	10.76	47.00	105.46	316.39	71.32	62.50	16.62
10	BDS-10	10.58	1.57	06.74	10.13	30.50	80.79	242.36	54.39	47.87	12.20
11	BDS-11	07.98	1.89	04.24	08.93	29.00	64.41	188.73	42.42	37.28	09.90
12	BDS-12	13.19	2.32	05.69	16.02	40.65	102.80	308.41	69.58	60.92	16.20
13	BDS-13	11.04	2.25	04.91	13.10	34.43	87.60	262.79	59.28	51.91	13.81
14	BDS-14	11.04	2.20	05.02	13.45	26.30	57.97	181.41	40.85	35.83	09.52
15	BDS-15	12.16	1.42	08.53	19.01	38.00	96.55	286.66	64.59	56.62	15.05
16	BDS-16	14.21	2.59	05.50	21.37	51.00	104.53	313.60	70.49	61.95	16.45
17	BDS-17	14.29	2.87	04.98	20.28	40.30	84.47	286.42	64.42	56.58	15.03
18	BDS-18	12.62	2.80	04.50	11.82	27.50	78.84	236.52	53.06	46.72	12.39
19	BDS-19	10.59	2.23	04.75	11.82	28.50	65.88	214.15	48.65	42.30	11.29
20	BDS-20	11.33	2.68	04.22	15.14	26.00	80.42	250.27	56.42	49.44	13.14
21	BDS-21	11.09	1.87	05.94	16.10	44.75	104.41	313.24	70.62	61.87	16.45
22	BDS-22	11.07	1.70	06.51	09.78	26.75	59.98	188.93	42.46	35.82	09.72
23	BDS-23	12.00	1.62	07.42	10.69	31.50	69.26	218.28	48.72	43.12	11.40

1. Fruit length (cm)

2. Fruit diameter (cm)

3. Fruit length diameter ratio

4. Average fruit weight (g)

5. No. of fruits per plant

6. Early green fruit yield per plant (g)

7. Total green fruit yield per plant (g)

8. Dry red chilli yield per plant (g)

9. Total green fruit yield per ha (q)

10. Total dry fruit yield per ha (q)

Table 9: Contd...

SI. No.	Accessions	1	2	3	4	5	6	7	8	9	10
24	BDS-24	11.07	1.52	07.29	08.81	27.65	51.11	168.32	37.93	33.25	08.84
25	BDS-25	13.26	1.39	09.52	08.37	26.65	60.16	180.48	40.62	34.15	09.28
26	BDS-26	11.55	2.21	05.25	08.04	25.80	60.41	181.23	40.80	34.30	09.32
27	BDS-27	11.86	1.49	07.94	08.29	61.00	107.64	322.92	72.15	63.79	16.88
28	BDS-28	13.58	1.93	07.04	09.83	28.65	61.18	183.54	41.23	35.25	09.50
29	BDS-29	10.75	1.32	08.16	07.55	24.00	57.00	171.00	38.46	33.78	08.97
30	BDS-30	10.52	1.53	06.88	07.87	29.00	67.97	203.92	45.97	40.28	10.71
31	BDS-31	13.50	1.89	07.15	10.76	34.65	82.77	248.32	55.93	49.05	13.04
32	BDS-32	13.60	1.59	09.13	09.68	34.65	89.53	268.58	60.26	53.05	14.07
33	BDS-33	11.46	1.79	06.39	10.07	40.50	93.13	279.39	62.83	53.19	14.40
34	BDS-34	12.41	1.38	09.01	09.89	31.00	74.81	224.42	49.82	44.33	11.69
35	BDS-35	13.12	1.18	11.12	08.54	31.00	76.52	229.57	51.59	45.35	12.04
36	BDS-36	11.70	1.48	07.90	08.67	43.65	102.95	308.85	69.68	61.01	16.23
37	BDS-37	13.05	1.31	09.97	08.65	39.50	82.95	248.85	55.92	49.16	13.05
38	BDS-38	12.30	1.80	06.83	10.49	38.50	84.93	254.80	57.34	50.33	13.37
39	BDS-39	12.57	1.62	07.77	10.90	31.50	69.05	207.15	46.64	40.92	10.87
40	BDS-40	12.60	1.51	08.33	08.29	32.50	74.46	223.37	50.32	44.12	11.73
41	BDS-41	10.69	1.31	08.18	07.48	26.50	63.39	190.18	43.18	37.57	10.03
42	BDS-42	13.95	1.79	07.79	10.78	32.50	78.14	234.41	52.67	46.30	12.29
43	BDS-43	11.99	1.61	07.47	09.61	36.00	83.34	250.02	56.11	49.39	13.10
44	BDS-44	10.14	1.57	06.47	08.41	37.00	80.32	252.96	56.60	49.97	13.23
45	BDS-45	10.69	1.43	07.50	09.83	31.00	67.85	203.54	45.75	40.20	10.67
46	BDS-46	11.66	1.48	07.89	07.45	25.75	50.91	152.74	34.39	30.17	08.02
47	BDS-47	13.93	1.58	08.83	09.59	35.65	76.69	230.07	51.04	45.45	11.98
48	BDS-48	11.79	1.09	10.72	07.55	26.80	51.71	155.14	34.95	30.65	07.15
49	BDS-49	12.45	1.52	08.21	08.09	33.00	76.08	228.25	51.31	45.09	11.97

1. Fruit length (cm)

2. Fruit diameter (cm)

3. Fruit length diameter ratio

4. Average fruit weight (g)

5. No. of fruits per plant

6. Early green fruit yield per plant (g)

7. Total green fruit yield per plant (g)

8. Dry red chilli yield per plant (g)

9. Total green fruit yield per ha (q)

10. Total dry fruit yield per ha (q)

Table 9: Contd...

SI. No.	Accessions	1	2	3	4	5	6	7	8	9	10
50	BDS-50	10.66	1.45	7.33	7.95	34.00	56.81	170.43	38.13	33.66	08.92
51	BDS-51	11.67	1.43	8.16	6.70	26.80	49.19	147.56	33.13	29.14	06.73
52	BDS-52	11.08	1.92	5.78	9.88	32.50	70.61	211.84	47.80	41.85	11.13
53	BDS-53	11.76	1.29	9.11	8.87	42.00	96.45	298.36	67.34	58.94	15.68
54	BDS-54	12.54	1.25	10.01	9.92	40.50	95.13	285.39	64.23	56.37	14.98
55	BDS-55	11.79	1.58	7.46	9.14	41.00	95.99	287.97	64.91	56.88	15.12
56	BDS-56	12.60	1.70	7.40	12.02	37.00	79.23	237.69	53.96	46.95	12.53
57	BDS-57	11.16	1.51	7.39	8.86	28.90	61.98	185.93	41.76	36.73	09.75
58	BDS-58	10.80	1.31	8.21	8.02	27.50	57.78	173.33	39.10	34.24	09.11
59	BDS-59	11.22	1.47	7.66	9.00	35.50	78.43	235.30	53.07	46.48	12.36
60	BDS-60	10.59	1.50	7.08	8.73	31.00	72.60	217.79	48.82	43.02	11.40
61	BDS-61	10.40	1.89	5.50	9.94	35.00	79.50	238.49	53.71	47.11	12.52
62	BDS-62	05.62	1.76	3.20	8.70	29.00	56.16	168.49	37.98	33.28	06.25
63	BDS-63	08.89	1.40	6.36	10.85	26.50	61.10	183.31	41.18	36.21	09.61
64	BDS-64	06.81	2.59	2.62	12.55	29.50	80.64	256.93	57.39	50.75	13.43
65	BDS-65	08.07	2.83	2.86	18.79	30.50	101.19	303.58	68.38	59.97	15.94
66	BDS-66	08.95	2.11	4.24	12.18	66.00	108.83	326.50	73.48	64.49	17.13
67	BDS-67	10.28	2.86	3.60	18.40	39.75	104.18	312.54	70.17	61.74	16.38
68	BDS-68	11.70	2.58	7.42	14.77	29.00	71.40	214.20	48.22	42.31	11.24
69	BDS-69	10.58	1.50	7.07	07.87	24.00	65.41	196.24	43.76	38.76	10.25
70	BDS-70	13.58	1.69	8.04	10.96	29.75	70.18	210.54	47.25	41.59	11.03
	Mean	11.46	1.70	7.20	10.45	33.15	74.86	226.74	50.98	44.68	11.77
	S.Em±	0.34	0.06	0.41	0.30	1.06	2.68	8.36	2.28	1.70	0.33
	C.D(5%)	0.97	0.18	1.17	0.86	3.00	7.57	23.60	6.44	4.80	0.93
	C.D(1%)	1.30	0.23	1.56	1.14	3.98	10.06	31.34	8.55	6.38	1.24
	CV(%)	4.28	5.38	8.20	4.13	4.53	5.07	5.21	6.33	5.39	3.99

1. Fruit length (cm)

2. Fruit diameter (cm)

3. Fruit length diameter ratio

4. Average fruit weight (g)

5. No. of fruits per plant

6. Early green fruit yield per plant (g)

7.Total green fruit yield per plant (g)

8. Dry red chilli yield per plant (g)

9. Total green fruit yield per ha (q)

4.2.14 Early green fruit yield per plant (Tables 8 and 9)

Early yield per plant was maximum in BDS-66 (108.83g) followed by BDS-27 (107.64 g), BDS-9 (105.46 g), BDS-16 (104.53 g), BDS-21 (104.41 g), BDS-67 (104.18 g) and minimum was in BDS-51(49.18 g). Early yield per plant ranged from 49.18 g to 108.83 g with a mean value of 74.86 g. The GV and PV were 279.38 and 293.81, respectively. The estimates of GCV and PCV were high (22.32 and 22.89 %, respectively). Very high heritability (95.08 %) was observed along with very high genetic advance as per cent over mean (44.84 %) and GA (33.57).

4.2.15 Total green fruit yield per plant (Tables 8 and 9)

Total green fruit yield per plant was maximum in BDS-66 (326.50 g) followed by BDS-16 (313.60 g), BDS-21 (313.24 g), BDS-67 (312.54 g), BDS-36 (308.85 g) and BDS-12 (308.41g) and it was minimum in BDS-3 (145.29 g). Total green fruit yield per plant ranged from 145.29 g to 322.92 g with a mean value of 226.74 g. The GV and PV were 2493.33 and 2633.33, respectively. The estimates of GCV and PCV were high (22.02 % and 22.63 %, respectively). Very high heritability (94.68 %) was observed along with very high genetic advance as per cent over mean (44.14 %) and GA (100.09).

4.2.16 Dry red chilli yield per plant (Tables 8 and 9)

The highest dry red chilli yield per plant was observed in accession BDS-66 (73.48 g) followed by BDS-27 (72.15 g), BDS-9 (71.32 g), BDS-21 (70.62 g), BDS-16 (70.49 g), BDS- 67 (70.17 g) and BDS-36 (69.68 g) and the lowest yield was observed in BDS-3 (32.82 g). Dry red chilli yield per plant ranged from 32.82 to 73.48 g with a mean value of 50.98 g. The GV and PV were 124.66 and 135.10, respectively. The estimates of GCV and PCV were high (21.89 % and 22.79 %, respectively). Very high heritability (92.27 %) was observed along with very high genetic advance as per cent over mean (43.33 %) and GA (22.09).

4.2.17 Total green fruit yield per hectare (Tables 8 and 9)

The highest green fruit yield per hectare was observed in accession BDS-66 (64.49 q) followed by BDS-27 (63.79 q), BDS-9 (62.50 q), BDS-16 (61.95 q),

Table 10. *Per se* performance of chilli accessions for quality and disease incidence parameters

SI. No.	Accessions	1	2	3	4
1	BDS-01	08.39	259.19	0.00	0.00
2	BDS-02	08.64	144.36	4.92	76.93
3	BDS-03	10.14	078.23	0.00	0.00
4	BDS-04	09.70	125.30	19.60	27.68
5	BDS-05	10.16	065.02	6.80	12.67
6	BDS-06	09.33	114.77	33.10	36.75
7	BDS-07	10.54	246.73	16.80	75.15
8	BDS-08	09.23	195.29	18.50	34.00
9	BDS-09	09.69	148.08	23.25	0.00
10	BDS-10	10.33	107.58	20.00	42.66
11	BDS-11	08.97	141.87	14.50	45.15
12	BDS-12	08.97	143.87	0.00	0.00
13	BDS-13	13.13	188.07	0.00	36.67
14	BDS-14	09.97	135.73	0.00	77.68
15	BDS-15	10.66	080.74	0.00	0.00
16	BDS-16	13.28	090.94	0.00	0.00
17	BDS-17	10.28	092.91	0.00	0.00
18	BDS-18	09.29	042.68	19.35	70.12
19	BDS-19	09.79	077.58	38.00	31.12
20	BDS-20	09.10	053.18	0.00	0.00
21	BDS-21	10.68	089.95	0.00	0.00
22	BDS-22	11.08	130.47	51.38	0.00
23	BDS-23	09.74	093.67	32.10	0.00
24	BDS-24	10.00	125.75	0.00	0.00
25	BDS-25	09.72	128.74	56.28	23.16
26	BDS-26	09.24	115.79	0.00	79.43
27	BDS-27	10.09	092.45	0.00	32.61
28	BDS-28	13.25	155.81	3.78	42.66
29	BDS-29	10.82	234.76	0.00	0.00
30	BDS-30	10.30	115.32	10.83	0.00
31	BDS-31	09.29	114.87	20.11	0.00
32	BDS-32	09.52	078.18	60.18	0.00
33	BDS-33	09.62	157.12	0.00	12.66
34	BDS-34	08.19	064.59	0.00	0.00
35	BDS-35	09.77	062.31	39.77	0.00
36	BDS-36	10.36	237.26	21.10	21.75
37	BDS-37	11.93	134.66	0.00	0.00
38	BDS-38	7.63	146.80	32.54	0.00

1. Per cent dry matter in fruit

2. Ascorbic acid (mg/100 g)

3. Anthracnose (%)

4. Leaf curl index (%)

Table 10: Contd...

SI. No.	Accessions	1	2	3	4
39	BDS-39	09.83	131.75	0.00	0.00
40	BDS-40	08.90	072.77	24.47	12.80
41	BDS-41	07.29	154.24	15.03	25.50
42	BDS-42	06.88	056.46	3.37	5.32
43	BDS-43	10.10	124.64	0.00	0.00
44	BDS-44	14.11	068.11	0.00	0.00
45	BDS-45	09.96	206.65	11.62	0.00
46	BDS-46	09.10	132.44	59.35	78.30
47	BDS-47	08.30	096.22	0.00	0.00
48	BDS-48	09.45	126.62	0.00	15.53
49	BDS-49	08.02	107.25	0.00	0.00
50	BDS-50	08.24	108.58	20.93	20.00
51	BDS-51	10.39	125.18	18.56	0.00
52	BDS-52	08.32	092.39	15.87	15.53
53	BDS-53	12.45	200.74	0.00	0.00
54	BDS-54	12.99	124.63	0.00	6.33
55	BDS-55	10.51	092.46	21.03	0.00
56	BDS-56	10.93	164.64	0.00	0.00
57	BDS-57	11.89	147.61	0.00	20.40
58	BDS-58	10.85	087.26	0.00	30.21
59	BDS-59	09.62	115.31	4.25	15.50
60	BDS-60	11.62	106.46	27.50	20.00
61	BDS-61	13.18	081.77	15.53	0.00
62	BDS-62	08.54	050.96	23.70	70.45
63	BDS-63	10.64	072.40	0.00	10.30
64	BDS-64	13.38	066.51	0.00	23.50
65	BDS-65	11.92	103.33	0.00	0.00
66	BDS-66	07.78	093.79	11.32	15.30
67	BDS-67	13.49	164.68	0.00	0.00
68	BDS-68	09.06	187.58	0.00	10.50
69	BDS-69	10.45	091.46	0.00	0.00
70	BDS-70	08.29	063.38	0.00	0.00
	Mean	10.10	120.41	11.65	16.78
	S.Em±	0.59	4.29	3.21	2.77
	C.D(5%)	1.66	12.12	9.08	7.81
	C.D(1%)	2.21	16.10	12.06	10.37
	CV(%)	8.26	5.04	39.09	23.33

1. Per cent dry matter in fruit

2. Ascorbic acid (mg/100 g)

3. Anthracnose (%)

4. Leaf curl index (%)

BDS-21(61.87 q) and BDS-67 (61.74 q) and the lowest yield was observed in BDS-51 (29.14 q). Green fruit yield per hectare ranged from 29.14 to 64.49 quintal with a mean value of 44.68 quintal. The GV and PV were 98.02 and 103.83, respectively. The estimates of GCV and PCV were high (22.15 % and 22.80 %, respectively). Very high heritability (94.40 %) was observed along with very high genetic advance as per cent over mean (44.35 %) and GA (19.81).

4.2.18 Total dry fruit yield per hectare (Tables 8 and 9)

The highest dry fruit yield per hectare was observed in accession BDS-66 (17.13 q) followed by BDS-27 (16.88 q), BDS-9 (16.62 q), BDS-16 and BDS-21(16.45 q) and BDS-67 (16.38 q) and the lowest yield was observed in BDS-62 (6.25 q). Dry fruit yield per hectare ranged from 6.25 to 17.13 quintal with a mean value of 11.77 quintal. The GV and PV were 7.78 and 8.00, respectively. The estimates of GCV and PCV were high (23.70 % and 24.04 %, respectively). Very high heritability (97.24 %) was observed along with very high genetic advance as per cent over mean (48.16 %) and GA (5.66).

4.2.19 Per cent dry matter in fruit (Tables 8 and 10)

Per cent dry matter in fruit was maximum in BDS-44 (14.11 %) followed by BDS- 66 (13.49 %), BDS-64 (13.38 %), BDS-16 (13.28%), BDS-28 (13.25%), BDS-61 (13.18%) and BDS-13 (13.13 %) and it was minimum in BDS-42 (6.88 %). Per cent dry matter in fruit was ranged from 6.88 to 14.11 % with a mean value of 10.10 %. The GV and PV were 2.23 and 2.93, respectively. The estimates of GCV and PCV were moderate (14.80 % and 16.95 %, respectively). High heritability (76.24 %) was observed along with high genetic advance as per cent over mean (26.63 %) and GA (2.69).

4.2.20 Ascorbic acid content (Tables 8 and 10)

Ascorbic acid content was maximum in BDS-1 (259.18 mg/100 g) and it was minimum in BDS-18 (42.68 mg/100 g). Ascorbic acid content ranged from 42.68 to 259.18 mg/100 g with a mean value of 120.41 mg/100 g. The GV and PV were 2357.21 and 2394.18, respectively. The estimates of GCV and PCV were very high (40.32 %

and 40.63 %, respectively). Very high heritability (98.45 %) was observed along with very high genetic advance as per cent over mean (82.41 %) and GA (99.24).

4.2.21 Pungency of green chilli (Organoleptic test) (Table 11)

4.2.21.1 Colour and appearance

The data on the sensory score for color and appearance of green chilli was recorded and maximum score was observed in BDS- 41 (4.66 out of 5) followed by BDS-23 (4.60 out of 5) and minimum score was observed in BDS- 62 (0.48 out of 5).

4.2.21.2 Size of the green chilli

The data on the sensory score for size of green chilli was recorded and maximum score was observed in BDS- 23 (4.71 out of 5) followed by BDS-30 (4.69 out of 5) and minimum score was observed in BDS- 18 (0.51 out of 5).

4.2.21.3 Pungency of the green chilli

The data on the sensory score for pungency of green chilli was recorded and maximum score was observed in BDS- 15 (4.70 out of 5) followed by BDS-4 (4.68 out of 5) and minimum score was observed in BDS- 58 (1.46 out of 5).

4.2.21.3 Overall acceptability of the green chilli

The data on the sensory score for overall acceptability of green chilli was recorded and maximum score was observed in BDS- 23 (4.80 out of 5) followed by BDS-15 (4.73 out of 5) and minimum score was observed in BDS- 18 (0.68 out of 5).

4.3 Correlation studies (Tables 12 and 13)

Genotypic and phenotypic correlation coefficients among yield, quality, earliness, growth parameters are presented in tables 12 and 13, respectively.

4.3.1 Genotypic correlation (Table 12)

At genotypic level total green fruit yield per plant was positively and significantly (at $p = 0.01$) associated with early green fruit yield per plant ($r_g = 0.993$),

Table 11: Organoleptic evaluation of green chilli accessions

Accessions	Color and apperance	Size	Pungency of green chilli	Overall acceptability
BDS-01	2.36	3.93	3.74	2.68
BDS-02	3.31	1.74	3.48	3.68
BDS-03	3.44	1.84	2.54	1.79
BDS-04	2.83	3.69	4.68	3.74
BDS-05	1.10	1.49	2.44	1.68
BDS-06	3.60	4.62	4.47	4.26
BDS-07	2.33	1.80	3.53	2.00
BDS-08	2.06	2.69	2.30	2.74
BDS-09	2.63	3.21	3.89	3.60
BDS-10	3.85	2.34	3.45	3.06
BDS-11	2.31	1.28	2.31	2.04
BDS-12	0.80	2.09	3.54	1.96
BDS-13	1.22	2.78	4.41	2.75
BDS-14	0.56	0.91	3.02	0.79
BDS-15	4.45	4.13	4.70	4.73
BDS-16	3.35	1.72	3.83	2.50
BDS-17	2.50	3.34	3.56	3.76
BDS-18	0.64	0.51	2.30	0.68
BDS-19	1.48	2.49	3.74	1.76
BDS-20	1.05	2.52	4.55	2.14
BDS-21	4.18	4.49	4.42	4.81
BDS-22	2.33	3.31	4.23	3.77
BDS-23	4.60	4.71	4.22	4.80
BDS-24	1.11	1.17	2.68	1.87
BDS-25	1.27	1.71	3.08	1.86
BDS-26	2.50	0.69	2.82	1.72
BDS-27	1.44	3.50	3.63	2.80
BDS-28	3.36	4.10	4.52	4.43
BDS-29	2.71	1.62	2.28	1.78
BDS-30	4.24	4.69	4.06	4.44
BDS-31	2.23	3.40	3.56	3.07
BDS-32	4.06	4.65	3.97	4.71
BDS-33	0.66	1.28	2.69	1.01
BDS-34	1.39	2.59	3.12	1.62
BDS-35	1.39	2.58	3.44	2.41
BDS-36	3.55	4.20	4.03	4.50
BDS-37	1.50	2.73	3.71	2.86
BDS-38	1.39	0.68	3.10	1.26
BDS-39	3.49	3.78	3.64	3.74
BDS-40	2.00	4.37	3.52	3.86

Table 11: Contd...

Accessions	Color and apperance	Size	Pungency of green chilli	Overall acceptability
BDS-41	4.66	3.74	2.89	4.32
BDS-42	2.33	4.68	4.60	3.63
BDS-43	3.55	3.54	3.49	2.84
BDS-44	1.16	0.72	2.33	0.79
BDS-45	2.29	2.46	3.30	2.30
BDS-46	1.37	3.06	3.39	3.39
BDS-47	1.49	3.07	3.97	3.34
BDS-48	1.32	1.30	2.03	1.87
BDS-49	3.34	1.89	2.67	2.04
BDS-50	0.72	1.27	2.55	0.78
BDS-51	4.48	3.64	3.79	4.20
BDS-52	3.14	3.68	2.86	3.81
BDS-53	3.24	4.35	4.24	3.69
BDS-54	2.34	2.15	3.47	2.35
BDS-55	2.41	2.28	3.37	1.64
BDS-56	2.12	2.65	4.53	2.96
BDS-57	2.42	2.74	4.60	3.40
BDS-58	1.39	1.56	1.46	1.64
BDS-59	1.54	0.96	2.64	0.80
BDS-60	0.91	1.10	2.65	1.73
BDS-61	2.31	3.67	3.41	1.68
BDS-62	0.48	0.63	2.53	0.73
BDS-63	3.67	4.41	3.77	3.14
BDS-64	0.41	1.69	3.16	0.79
BDS-65	1.47	2.04	3.17	2.56
BDS-66	1.49	1.76	2.54	2.15
BDS-67	2.51	1.50	3.51	2.79
BDS-68	2.25	1.72	4.36	3.34
BDS-69	1.55	2.12	2.74	2.34
BDS-70	3.29	3.56	3.22	3.59
Mean	2.30	2.61	3.40	2.69
S.Em±	0.17	0.18	0.23	0.17
C.D(5%)	0.48	0.52	0.65	0.48
C.D(1%)	0.64	0.70	0.86	0.63
CV(%)	10.64	10.13	9.60	8.93

number of fruits per plant ($r_g = 0.695$), average fruit weight ($r_g = 0.617$), fruit diameter ($r_g = 0.448$), plant height at 45 DAT ($r_g = 0.230$) and per cent dry matter in fruit ($r_g = 0.220$) and also it was negatively and significantly (at $p = 0.01$) associated with fruit length-diameter ratio ($r_g = -0.339$). Total green fruit yield per plant was positively and significantly (at $p = 0.05$) associated with stem girth at 90 DAT ($r_g = 0.208$), plant height at 90 DAT ($r_g = 0.188$) and leaf area index at 45 DAT ($r_g = 0.181$).

Early yield per plant was positively and significantly (at $p = 0.01$) associated with number of fruits per plant ($r_g = 0.631$), fruit weight ($r_g = 0.625$), fruit diameter ($r_g = 0.485$) and plant height at 45 DAT ($r_g = 0.222$) and it was also negatively and significantly associated with fruit length: diameter ratio ($r_g = -0.388$). It was positively and significantly (at $p = 0.05$) associated with stem girth at 90 DAT ($r_g = 0.243$), per cent dry matter in fruit ($r_g = 0.222$), plant height at 90 DAT ($r_g = 0.186$) and leaf area index at 45 DAT ($r_g = 0.181$).

Ascorbic acid content was positively and significantly (at $p = 0.05$) associated with fruit length diameter ratio ($r_g = 0.203$) and number of primary branches per plant at 45 DAT ($r_g = 0.184$) and it was negatively and significantly associated with fruit diameter ($r_g = -0.200$).

Per cent dry matter in fruit was positively and significantly (at $p = 0.01$) associated with average fruit weight ($r_g = 0.246$). Per cent dry matter in fruit was positively and significantly (at $p = 0.05$) associated with stem girth at 90 DAT ($r_g = 0.215$), stem girth at 45 DAT ($r_g = 0.213$), number of primary branches per plant at 45 DAT ($r_g = 0.191$) and fruit diameter ($r_g = 0.181$) and it was also negatively and significantly (at $p = 0.05$) associated with leaf area index at 45 DAT ($r_g = -0.207$), plant spread from east to west at 90 DAT ($r_g = -0.189$) and plant spread from east to west at 45 DAT ($r_g = -0.172$).

Number of fruits per plant was positively and significantly (at $p = 0.01$) associated with average fruit weight ($r_g = 0.629$), fruit diameter ($r_g = 0.462$) and plant height at 45 DAT ($r_g = 0.301$) and it was negatively and significantly associated with fruit length diameter ratio ($r_g = -0.361$). Number of fruits per plant was positively and significantly (at $p = 0.05$) associated with stem girth at 90 DAT ($r_g = 0.204$) and plant height at 90 DAT ($r_g = 0.190$).

Table 12. Genotypic correlation coefficients among growth, earliness, yield and quality parameters in chilli

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1	1.000	0.194*	-0.017	-0.034	-0.039	0.007	-0.048	0.046	-0.108	-0.168*	0.945**	0.604**	0.006	-0.038	0.104	0.279**	-0.173*	0.501**	0.301**	-0.059	0.078	0.222**	0.230**
2		1.000	0.299**	0.473**	0.232**	0.432**	0.175*	0.166*	0.053	0.323**	0.145	0.252**	0.027	0.017	0.132	0.14	-0.071	0.167*	0.190*	0.135	-0.04	0.186*	0.188*
3			1.000	0.424**	0.506**	0.423**	0.387**	0.350**	0.289**	0.314**	0.084	0.07	-0.183*	-0.101	0.163	-0.095	0.12	-0.011	-0.043	-0.172*	0.067	0.015	-0.018
4				1.000	0.051	0.302**	0.163	0.264**	0.08	0.117	0.033	0.087	-0.056	0.015	0.014	-0.095	0.031	-0.072	-0.062	-0.189*	-0.049	-0.167*	-0.126
5					1.000	0.308**	0.366**	0.234**	0.656**	0.493**	0.069	0.072	-0.223**	-0.159	-0.146	0.067	-0.126	0.069	0.032	0.055	-0.046	0.126	0.057
6						1.000	0.299**	0.317**	0.101	0.099	-0.006	0.204*	0.16	0.215*	0.066	-0.081	0.08	-0.053	-0.076	-0.083	0.124	-0.064	-0.088
7							1.000	0.495**	0.401**	0.258**	-0.113	0.014	-0.03	-0.075	0.324**	-0.156	0.341**	-0.051	-0.113	0.191*	0.184*	-0.154	-0.152
8								1.000	0.112	0.049	0.115	-0.051	-0.056	0.05	0.111	0.015	0.048	0.138	-0.049	0.16	-0.027	-0.074	-0.064
9									1.000	0.487**	-0.026	0.19	-0.151	-0.028	0.006	-0.103	0.122	-0.072	-0.154	0.213*	0.108	-0.056	-0.077
10										1.000	-0.304**	0.072	-0.191*	-0.129	-0.088	0.035	-0.092	-0.01	0.204*	0.215*	-0.025	0.243**	0.208*
11											1.000	0.493**	-0.094	-0.035	0.026	0.201*	-0.141	0.408**	0.16	-0.207*	0.101	0.181*	0.181*
12												1.000	0.133	0.310**	0.175*	0.08	-0.02	0.133	0.111	-0.037	-0.044	0.09	0.12
13													1.000	0.722**	0.046	-0.091	0.102	-0.066	-0.019	0.121	-0.037	-0.068	-0.03
14														1.000	-0.031	-0.277**	0.211*	-0.347**	-0.108	0.047	0.099	-0.144	-0.092
15															1.000	-0.091	0.545**	0.09	0.086	-0.088	-0.008	0.062	0.111
16																1.000	-0.822**	0.773**	0.462**	0.181*	-0.200*	0.485**	0.448**
17																	1.000	-0.554**	-0.361**	-0.128	0.203*	-0.388**	-0.339**
18																		1.000	0.629**	0.246**	-0.148	0.625**	0.617**
19																			1.000	0.185*	-0.124	0.631**	0.695**
20																				1.000	0.123	0.222**	0.220**
21																					1.000	-0.058	-0.087
22																						1.000	0.993**
23																							1.000

Critical r_g value at 5% =0.166 *Significant at $p=0.05$

Critical r_g value at 1% =0.217 **Significant at $p=0.01$

1. Plant height at 45 DAT (cm)

5. Plant spread from north to south at 45 DAT (cm)

9. Stem girth at 45 DAT (cm)

13. Days to first flowering

17. Fruit length- diameter ratio

21. Ascorbic acid (mg/100g)

2. Plant height at 90 DAT (cm)

6. Plant spread from north to south at 90 DAT (cm)

10. Stem girth at 90 DAT (cm)

14. Days to fifty per cent flowering

18. Fruit weight(g)

22. Early green fruit yield per plant (g)

3. Plant spread from east to west at 45 DAT (cm)

7. Number of primary branches per plant at 45 DAT (cm)

11. Leaf Area Index at 45 DAT

15. Fruit length(cm)

19. Number of fruits per plant

23. Total green fruit yield per plant (g)

4. Plant spread from east to west at 90 DAT (cm)

8. Number of primary branches per plant at 90 AT(cm)

12. Leaf Area Index at 90 DAT

16. Fruit diameter(cm)

20. Per cent dry matter in fruit

Average fruit weight was positively and significantly (at $p = 0.01$) associated with fruit diameter ($r_g = 0.773$), plant height at 45 DAT ($r_g = 0.501$), leaf area index at 45 DAT ($r_g = 0.408$) and it was also negatively and significantly associated with fruit length diameter ratio ($r_g = -0.544$) and days to 50 per cent flowering ($r_g = -0.347$). Average fruit weight was positively and significantly (at $p = 0.05$) associated with plant height at 90 DAT ($r_g = 0.167$).

Fruit length diameter ratio was positively and significantly (at $p = 0.01$) associated with fruit length ($r_g = 0.545$), number of primary branches per plant at 45 DAT ($r_g = 0.341$). It was also negatively and significantly associated with fruit diameter ($r_g = -0.822$). Fruit length diameter ratio was positively and significantly (at $p = 0.05$) associated with days to 50 per cent flowering ($r_g = 0.211$) and it was negatively and significantly associated with plant height at 45 DAT ($r_g = -0.173$).

Fruit diameter was positively and significantly (at $p = 0.01$) associated with plant height at 45 DAT ($r_g = 0.279$) and it was negatively and significantly associated with days to 50 per cent flowering ($r_g = -0.277$). Fruit diameter was positively and significantly (at $p = 0.05$) associated with leaf area index at 45 DAT ($r_g = 0.201$).

Fruit length was positively and significantly (at $p = 0.01$) associated with number of primary branches per plant at 45 DAT ($r_g = 0.324$). Fruit length was positively and significantly (at $p = 0.05$) associated with leaf area index at 90 DAT ($r_g = 0.175$).

Days to 50 per cent flowering positively and significantly (at $p = 0.01$) associated with days to first flowering ($r_g = 0.722$), leaf area of index at 90 DAT ($r_g = 0.310$) and it was positively and significantly (at $p = 0.05$) associated with plant spread from north to south at 90 DAT ($r_g = 0.215$).

Days to first flowering negatively and significantly (at $p = 0.01$) associated with plant spread from north to south at 45 DAT ($r_g = -0.223$) and it was negatively and significantly (at $p = 0.05$) associated with stem girth at 90 DAT ($r_g = -0.191$) and plant spread from east to west at 45 DAT ($r_g = -0.183$).

Leaf area index at 90 DAT was positively and significantly (at $p = 0.01$) associated with plant height at 45 DAT ($r_g = 0.604$), leaf area index at 45 DAT ($r_g = 0.493$) and plant height at 90 DAT ($r_g = 0.252$). Leaf area index at 90 DAT was positively and significantly (at $p = 0.05$) associated with plant spread from north to south at 90 DAT ($r_g = 0.204$) and stem girth at 45 DAT ($r_g = 0.190$).

Leaf area index at 45 DAT was positively and significantly (at $p = 0.01$) associated with plant height at 45 DAT ($r_g = 0.945$) and it was also negatively and significantly associated with stem girth at 90 DAT ($r_g = -0.304$).

Stem girth at 90 DAT was positively and significantly (at $p = 0.01$) associated with plant spread from north to south at 45 DAT ($r_g = 0.493$), stem girth at 45 DAT ($r_g = 0.487$), plant height at 90 DAT ($r_g = 0.323$), plant spread from east to west at 45 DAT ($r_g = 0.314$) and number of primary branches per plant at 45 DAT ($r_g = 0.258$). Stem girth at 90 DAT was negatively and significantly (at $p = 0.05$) associated with plant height at 45 DAT ($r_g = -0.168$).

Stem girth at 45 DAT was positively and significantly (at $p = 0.01$) associated with plant spread from north to south at 45 DAT ($r_g = 0.656$), number of primary branches per plant at 45 DAT ($r_g = 0.401$) and plant spread from east to west at 45 DAT ($r_g = 0.289$).

Number of primary branches per plant at 90 DAT was positively and significantly (at $p = 0.01$) associated with number of primary branches per plant at 45 DAT ($r_g = 0.495$), plant spread from east to west at 45 DAT ($r_g = 0.350$), plant spread from north to south at 90 DAT ($r_g = 0.317$), plant spread from east to west at 90 DAT ($r_g = 0.264$) and plant spread from north to south at 45 DAT ($r_g = 0.234$). Number of primary branches per plant at 90 DAT was positively and significantly (at $p = 0.05$) associated with plant height at 90 DAT ($r_g = 0.166$).

Number of primary branches per plant at 45 DAT was positively and significantly (at $p = 0.01$) associated with plant spread from east to west at 45 DAT ($r_g = 0.387$), plant spread from north to south at 45 DAT ($r_g = 0.366$), plant spread from north to south at 90 DAT ($r_g = 0.299$) and number of primary branches per plant at 45

DAT was positively and significantly (at $p = 0.05$) associated with plant height at 90 DAT ($r_g = 0.175$).

Plant spread from north to south at 90 DAT was positively and significantly (at $p = 0.01$) associated with plant height at 90 DAT ($r_g = 0.432$), plant spread from east to west at 45 DAT ($r_g = 0.423$), plant spread from north to south at 45 DAT ($r_g = 0.308$) and plant spread from east to west at 90 DAT ($r_g = 0.302$).

Plant spread from north to south at 45 DAT was positively and significantly (at $p = 0.01$) associated with plant spread from east to west at 45 DAT ($r_g = 0.506$) and plant height at 90 DAT ($r_g = 0.232$).

Plant spread from east to west at 90 DAT was positively and significantly (at $p = 0.01$) associated with plant height at 90 DAT ($r_g = 0.473$) and plant spread from east to west at 45 DAT ($r_g = 0.424$).

Plant spread from east to west at 45 DAT was positively and significantly (at $p = 0.01$) associated with plant height at 90 DAT ($r_g = 0.299$).

Plant height at 90 DAT was positively and significantly (at $p = 0.05$) associated with plant height at 45 DAT ($r_g = 0.194$).

4.3.2 Phenotypic correlation (Table 13)

At phenotypic level total green fruit yield per plant was positively and significantly (at $p = 0.01$) associated with early green fruit yield per plant ($r_g = 0.965$), number of fruits per plant ($r_g = 0.615$), average fruit weight ($r_g = 0.599$), fruit diameter ($r_g = 0.425$) and plant height at 45 DAT ($r_g = 0.219$) and also it was negatively and significantly (at $p = 0.01$) associated with fruit length diameter ratio ($r_g = -0.318$). Total green fruit yield per plant was positively and significantly (at $p = 0.05$) associated with per cent dry matter in fruit ($r_g = 0.182$) and stem girth at 90 DAT ($r_g = 0.177$).

Early yield per plant was positively and significantly (at $p = 0.01$) associated with average fruit weight ($r_g = 0.595$), number of fruits per plant ($r_g = 0.551$), fruit diameter ($r_g = 0.455$) and it was also negatively and significantly associated with fruit length diameter ratio ($r_g = -0.367$). Early yield per plant was positively and significantly (at $p = 0.05$) associated with stem girth at 90 DAT ($r_g = 0.198$) and plant height at 45 DAT ($r_g = 0.195$).

Table 13: Phenotypic correlation coefficients among growth, earliness, yield and quality parameters in chilli

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1	1.000	0.176*	-0.016	-0.034	-0.042	0.02	-0.033	0.021	-0.051	-0.173*	0.744**	0.479**	0.009	-0.014	0.072	0.256**	-0.16	0.449**	0.222**	-0.059	0.067	0.195*	0.219**
2		1.000	0.270**	0.441**	0.211*	0.336**	0.170*	0.132	0.047	0.240**	0.104	0.195*	0.016	0.019	0.104	0.126	-0.07	0.157	0.163	0.136	-0.034	0.146	0.155
3			1.000	0.408**	0.457**	0.378**	0.362**	0.302**	0.269**	0.265**	0.083	0.042	-0.156	-0.095	0.156	-0.089	0.111	-0.006	-0.048	-0.148	0.062	0.027	-0.013
4				1.000	0.05	0.266**	0.145	0.246**	0.078	0.094	0.053	0.035	-0.084	0.031	0.013	-0.083	0.019	-0.067	-0.048	-0.151	-0.049	-0.145	-0.114
5					1.000	0.264**	0.309**	0.166*	0.510**	0.379**	0.077	0.071	-0.177*	-0.105	-0.12	0.05	-0.091	0.064	0.009	0.056	-0.045	0.123	0.064
6						1.000	0.289**	0.288**	0.103	0.07	-0.026	0.186*	0.136	0.174*	0.048	-0.074	0.071	-0.045	-0.046	-0.064	0.11	-0.042	-0.076
7							1.000	0.419**	0.326**	0.200*	-0.129	0.130	-0.015	-0.077	0.292**	-0.14	0.301**	-0.048	-0.117	0.16	0.169	-0.149	-0.141
8								1.000	0.081	0.083	0.075	-0.062	-0.008	0.022	0.11	0.02	0.035	0.13	-0.034	0.12	-0.032	-0.051	-0.049
9									1.000	0.331**	0.011	0.191*	-0.132	-0.016	0.04	-0.093	0.128	-0.055	-0.141	0.15	0.101	-0.048	-0.074
10										1.000	-0.219**	0.073	-0.154	-0.083	-0.071	0.026	-0.068	-0.018	0.177*	0.136	-0.017	0.198*	0.177*
11											1.000	0.409**	-0.083	-0.044	0.045	0.181*	-0.115	0.377**	0.144	-0.178	0.095	0.13	0.137
12												1.000	0.08	0.221**	0.16	0.008	0.071	0.104	0.097	-0.027	-0.042	0.054	0.105
13													1.000	0.571**	0.051	-0.067	0.077	-0.051	-0.01	0.101	-0.037	-0.056	-0.024
14														1.000	-0.035	-0.243**	0.180*	-0.302**	-0.106	0.019	0.086	-0.09	-0.066
15															1.000	-0.093	0.544**	0.086	0.059	-0.103	-0.002	0.036	0.091
16																1.000	-0.82	0.755**	0.407**	0.163	-0.192	0.455**	0.425**
17																	1.000	-0.529**	-0.313**	-0.124	0.194*	-0.367**	-0.318**
18																		1.000	0.586**	0.213*	-0.149	0.595**	0.599**
19																			1.000	0.154	-0.117	0.551**	0.615**
20																				1.000	0.098	0.148	0.182*
21																					1.000	-0.059	-0.088
22																						1.000	0.965**
23																							1.000

Critical r_g value at 5% =0.166

*Significant at $p=0.05$

Critical r_g value at 1% =0.217

**Significant at $p=0.01$

1. Plant height at 45 DAT (cm)

2. Plant height at 90 DAT (cm)

3. Plant spread from east to west at 45 DAT (cm)

4. Plant spread from east to west at 90 DAT (cm)

5. Plant spread from north to south at 45 DAT (cm)

6. Plant spread from north to south at 90 DAT (cm)

7. Number of primary branches per plant at 45 DAT (cm)

8. Number of primary branches per plant at 90 AT(cm)

9. Stem girth at 45 DAT (cm)

10. Stem girth at 90 DAT (cm)

11. Leaf Area Index at 45 DAT

12. Leaf Area Index at 90 DAT

13. Days to first flowering

14. Days to fifty per cent flowering

15. Fruit length(cm)

16. Fruit diameter(cm)

17. Fruit length- diameter ratio

18. Fruit weight(g)

19. Number of fruits per plant

20. Per cent dry matter in fruit

21. Ascorbic acid (mg/100g)

22. Early green fruit yield per plant (g)

23. Total green fruit yield per plant (g)

Ascorbic acid content was positively and significantly (at $p = 0.05$) associated with fruit length diameter ratio ($r_g = 0.194$) and number of primary branches per plant at 45 DAT ($r_g = 0.169$) and it was negatively and significantly associated with fruit diameter ($r_g = -0.192$).

Per cent dry matter in fruit was positively and significantly (at $p = 0.05$) associated with average fruit weight ($r_g = 0.213$) and it was also negatively and significantly (at $p = 0.05$) associated with leaf area index at 45 DAT ($r_g = -0.178$).

Number of fruits per plant was positively and significantly (at $p = 0.01$) associated with average fruit weight ($r_g = 0.586$), fruit diameter ($r_g = 0.407$), plant height at 45 DAT ($r_g = 0.222$) and it was negatively and significantly associated with fruit length diameter ratio ($r_g = -0.313$). Number of fruits per plant was positively and significantly (at $p = 0.05$) associated with stem girth at 90 DAT ($r_g = 0.177$).

Average fruit weight was positively and significantly (at $p = 0.01$) associated with fruit diameter ($r_g = 0.755$), plant height at 45 DAT ($r_g = 0.449$) and leaf area index at 45 DAT ($r_g = 0.377$) and it was also negatively and significantly associated with fruit length diameter ratio ($r_g = -0.529$) and days to 50 per cent flowering ($r_g = -0.302$).

Fruit length diameter ratio was positively and significantly (at $p = 0.01$) associated with fruit length ($r_g = 0.544$) and number of primary branches per plant at 45 DAT ($r_g = 0.301$) and it was also negatively and significantly associated with fruit diameter ($r_g = -0.820$). Fruit length diameter ratio was positively and significantly (at $p = 0.05$) associated with days to 50 per cent flowering ($r_g = 0.180$).

Fruit diameter was positively and significantly (at $p = 0.01$) associated with plant height at 45 DAT ($r_g = 0.256$) and it was negatively and significantly associated with days to 50 per cent flowering ($r_g = -0.243$). Fruit diameter was positively and significantly (at $p = 0.05$) associated with leaf area index at 45 DAT ($r_g = 0.181$).

Fruit length was positively and significantly (at $p = 0.01$) associated with number of primary branches per plant at 45 DAT ($r_g = 0.292$).

Days to 50 per cent flowering positively and significantly (at $p = 0.01$) associated with days to first flowering ($r_g = 0.571$), leaf area of index at 90 DAT

($r_g = 0.221$) and it was positively and significantly (at $p = 0.05$) associated with plant spread from north to south at 90 DAT ($r_g = 0.174$).

Days to first flowering negatively and significantly (at $p = 0.05$) associated with plant spread from north to south at 45 DAT ($r_g = -0.177$).

Leaf area index at 90 DAT was positively and significantly (at $p = 0.01$) associated with plant height at 45 DAT ($r_g = 0.479$) and leaf area index at 45 DAT ($r_g = 0.409$). Leaf area index at 90 DAT was positively and significantly (at $p = 0.05$) associated with plant height at 90 DAT ($r_g = 0.195$), stem girth at 45 DAT ($r_g = 0.191$) and plant spread from north to south at 90 DAT ($r_g = 0.186$).

Leaf area index at 45 DAT was positively and significantly (at $p = 0.01$) associated with plant height at 45 DAT ($r_g = 0.744$) and it was also negatively and significantly associated with stem girth at 90 DAT ($r_g = -0.219$).

Stem girth at 90 DAT was positively and significantly (at $p = 0.01$) associated with plant spread from north to south at 45 DAT ($r_g = 0.379$), stem girth at 45 DAT ($r_g = 0.331$), plant spread from east to west at 45 DAT ($r_g = 0.265$), plant height at 90 DAT ($r_g = 0.240$). Stem girth at 90 DAT was positively and significantly (at $p = 0.05$) associated with number of primary branches per plant at 45 DAT ($r_g = 0.200$) and it was negatively and significantly associated with plant height at 45 DAT ($r_g = -0.173$).

Stem girth at 45 DAT was positively and significantly (at $p = 0.01$) associated with plant spread from north to south at 45 DAT ($r_g = 0.510$), number of primary branches per plant at 45 DAT ($r_g = 0.326$) and plant spread from east to west at 45 DAT ($r_g = 0.269$).

Number of primary branches per plant at 90 DAT was positively and significantly (at $p = 0.01$) associated with number of primary branches per plant at 45 DAT ($r_g = 0.419$), plant spread from east to west at 45 DAT ($r_g = 0.302$), plant spread from north to south at 90 DAT ($r_g = 0.288$), plant spread from east to west at 90 DAT ($r_g = 0.246$). Number of primary branches per plant at 90 DAT was positively and significantly (at $p = 0.05$) associated with plant spread from north to south at 45 DAT ($r_g = 0.166$).

Number of primary branches per plant at 45 DAT was positively and significantly (at $p=0.01$) associated with plant spread from east to west at 45 DAT ($r_g=0.362$), plant spread from north to south at 45 DAT ($r_g=0.309$) and plant spread from north to south at 90 DAT ($r_g=0.289$). Number of primary branches per plant at 45 DAT was positively and significantly (at $p=0.05$) associated with plant height at 90 DAT ($r_g=0.170$).

Plant spread from north to south at 90 DAT was positively and significantly (at $p=0.01$) associated with plant spread from east to west at 45 DAT ($r_g=0.378$), plant height at 90 DAT ($r_g=0.336$), plant spread from east to west at 90 DAT ($r_g=0.266$) and plant spread from north to south at 45 DAT ($r_g=0.264$).

Plant spread from north to south at 45 DAT was positively and significantly (at $p=0.01$) associated with plant spread from east to west at 45 DAT ($r_g=0.457$) and plant height at 90 DAT ($r_g=0.211$).

Plant spread from east to west at 90 DAT was positively and significantly (at $p=0.01$) associated with plant height at 90 DAT ($r_g=0.441$) and plant spread from east to west at 45 DAT ($r_g=0.408$).

Plant spread from east to west at 45 DAT was positively and significantly (at $p=0.01$) associated with plant height at 90 DAT ($r_g=0.270$).

Plant height at 90 DAT was positively and significantly (at $p=0.05$) associated with plant height at 45 DAT ($r_g=0.176$).

4.4 Path analysis (Table 14)

Genotypic path coefficients for total yield per plant with 22 independent characters are presented in Table 14.

4.4.1 Genotypic path coefficient analysis of yield and its component characters

Early yield per plant had high positive direct effects on total green yield per plant (0.90532). It had moderate positive indirect effects through number of fruits per

Table 14 : Genotypic path coefficient analysis for total yield per plant in chilli

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	r _g
1	0.0941	0.00643	0.00019	-0.00105	0.00143	-0.04439	0.00047	0.00142	-0.00639	0.01143	-0.0430	0.00884	-0.00019	-0.02561	0.00224	-0.04892	0.00302	0.03035	0.03671	0.00186	0.20134	0.230**
2	0.0182	0.03311	-0.00338	0.01476	-0.00848	-0.02369	-0.00173	0.00508	0.00315	-0.02201	-0.02081	0.00369	-0.00091	0.00116	0.00285	-0.01148	0.00123	0.01015	0.02321	-0.00424	0.16831	0.188*
3	-0.00159	0.00991	-0.01129	0.01323	-0.0185	-0.02316	-0.00382	0.01074	0.01718	-0.02141	-0.01201	0.00102	0.00619	-0.00683	0.00351	0.00776	-0.0021	-0.00066	-0.00522	0.00539	0.01342	-0.018
4	-0.00316	0.01565	-0.00479	0.03121	-0.00187	-0.01655	-0.00161	0.0081	0.00477	-0.008	-0.0048	0.00128	0.00189	0.00102	0.0003	0.0078	-0.00055	-0.00438	-0.00751	0.00594	-0.15097	-0.126
5	-0.00368	0.00768	-0.00571	0.0016	-0.03657	-0.01685	-0.00361	0.00716	0.03894	-0.03366	-0.00988	0.00106	0.00754	-0.01079	-0.00315	-0.00549	0.0022	0.00419	0.00385	-0.00172	0.11399	0.057
6	0.00068	0.01431	-0.00477	0.00943	-0.01125	-0.05479	-0.00295	0.00971	0.00598	-0.00676	0.00089	0.003	-0.00542	0.01464	0.00143	0.00666	-0.0014	-0.00322	-0.00927	0.00262	-0.0577	-0.088
7	-0.00448	0.0058	-0.00437	0.0051	-0.01337	-0.01638	-0.00986	0.01517	0.02381	-0.01763	0.01622	0.0002	0.00101	-0.00512	0.00698	0.01278	-0.00595	-0.0031	-0.01378	-0.00601	-0.13913	-0.152
8	0.00435	0.00549	-0.00395	0.00824	-0.00854	-0.01736	-0.00488	0.03067	0.00667	-0.00333	-0.01657	-0.00075	0.00191	0.00337	0.0024	-0.0012	-0.00084	0.00837	-0.00599	-0.00504	-0.06722	-0.064
9	-0.01013	0.00176	-0.00327	0.00251	-0.02398	-0.00552	-0.00395	0.00345	0.05938	-0.03322	0.00379	0.00278	0.00511	-0.00193	0.00014	0.00849	-0.00213	-0.00434	-0.01873	-0.0067	-0.05035	-0.077
10	-0.01577	0.01069	-0.00354	0.00366	-0.01805	-0.00543	-0.00255	0.0015	0.02892	-0.06821	0.04378	0.00105	0.00648	-0.00876	-0.00191	-0.00284	0.00161	-0.0006	0.02494	-0.00677	0.22005	0.208*
11	0.01132	0.00479	-0.00094	0.00104	-0.00251	0.00034	0.00111	0.00353	-0.030334	0.02076	0.07769	0.00722	0.0032	-0.059934	0.00057	-0.07401	0.00246	0.02474	0.01951	0.00651	0.16361	0.181*
12	0.05683	0.00835	-0.00079	0.00272	-0.00264	-0.0112	-0.00013	-0.00158	0.01127	-0.0049	-0.07089	0.01465	-0.00451	0.02105	0.00377	-0.00658	0.00035	0.00805	0.01348	0.00116	0.08133	0.12
13	0.00054	0.00089	0.00206	-0.00174	0.00814	-0.00877	0.00029	-0.00173	-0.00895	0.01304	0.01358	0.00195	-0.03387	0.04906	0.001	0.00749	-0.00178	-0.00402	-0.00227	-0.0038	-0.06132	-0.03
14	-0.00361	0.00056	0.00113	0.00047	0.00581	-0.0118	0.00074	0.00152	-0.00169	0.0088	0.00505	0.00454	-0.02445	0.06794	-0.00067	0.02275	-0.00369	-0.02101	-0.01318	-0.00146	-0.13011	-0.092
15	0.00978	0.00437	-0.00184	0.00044	0.00534	-0.00362	-0.00319	0.00341	0.00038	0.00603	-0.00378	0.00256	-0.00157	-0.00211	0.02157	0.00743	-0.0095	0.00545	0.0105	0.00278	0.05656	0.111
16	0.02632	0.00463	0.00107	-0.00297	-0.00245	0.00445	0.00154	0.00045	-0.00615	-0.00236	-0.02889	0.00117	0.00309	-0.01884	-0.00195	-0.08203	0.01435	0.04688	0.05636	-0.0057	0.43891	0.448**
17	-0.0163	-0.00234	-0.00136	0.00098	0.00462	-0.0044	-0.00337	0.00147	0.00726	0.00631	0.02031	-0.00029	-0.00345	0.01436	0.01175	0.06744	-0.01745	-0.03359	-0.04399	0.00403	-0.35139	-0.339**
18	0.04715	0.00554	0.00012	-0.00226	-0.00253	0.00291	0.0005	0.00423	-0.00426	0.00067	-0.05872	0.00195	0.00224	-0.02355	0.00194	-0.06342	0.00967	0.06062	0.07671	-0.00774	0.56546	0.617**
19	0.02833	0.0063	0.00048	-0.00192	-0.00115	0.00416	0.00111	-0.00151	-0.00912	-0.01395	-0.02301	0.00162	0.00063	-0.00734	0.00186	-0.0379	0.00629	0.03812	0.12198	-0.00581	0.58583	0.695**
20	-0.00558	0.00446	0.00194	-0.0059	-0.002	0.00457	-0.00189	0.00492	0.01266	-0.01469	0.0298	-0.00054	-0.0041	0.00317	-0.00191	-0.01486	0.00224	0.01493	0.02254	-0.03143	0.20143	0.220**
21	0.02094	0.00616	-0.00017	-0.00521	-0.0046	0.00349	0.00152	-0.00228	-0.0033	-0.01658	-0.026	0.00132	0.00229	-0.00977	0.00135	-0.03977	0.00677	0.03787	0.12043	-0.00699	0.90532	0.993**

r_g genotypic correlation coefficients with total yield per plant. Diagonal values indicate direct effects. Residual = 0.03

*Significant at p=0.05

**Significant at p=0.01

1. Plant height at 45 DAT (cm)

2. Plant height at 90 DAT (cm)

3. Plant spread from east to west at 45 DAT (cm)

4. Plant spread from east to west at 90 DAT (cm)

5. Plant spread from north to south at 45 DAT (cm)

6. Plant spread from north to south at 90 DAT (cm)

7. Number of primary branches per plant at 45 DAT (cm)

8. Number of primary branches per plant at 90 DAT (cm)

9. Stem girth at 45 DAT (cm)

10. Stem girth at 90 DAT (cm)

11. Leaf Area Index at 45 DAT

12. Leaf Area Index at 90 DAT

13. Days to first flowering

14. Days to fifty per cent flowering

15. Fruit length (cm)

16. Fruit diameter (cm)

17. Fruit length- diameter ratio

18. Fruit weight (g)

19. Number of fruits per plant

20. Per cent dry matter in fruit

21. Early green fruit yield per plant (g)

22. Total green fruit yield per plant (g)

plant (0.12043) followed by indirect positive effects through average fruit weight (0.03787) and plant height at 45 DAT (0.02094) on total green fruit yield per plant. It also had negligible negative indirect effects through fruit diameter (-0.03977), leaf area index at 45 DAT (-0.026) and stem girth at 90 DAT (-0.01658) on total green yield per plant.

Number of fruits per plant had moderate positive direct effects (0.12198) on total green fruit yield per plant. It had high indirect positive effects through early green fruit yield per plant (0.58583) followed by indirect positive effects through average fruit weight (0.03812) and plant height at 45 DAT (0.02833). Number of fruits per plant had negligible negative indirect effects on total green fruit yield per plant through fruit diameter (-0.0379) followed by leaf area index at 45 DAT (-0.02301) and stem girth at 90 DAT (-0.01395).

Average fruit weight had negligible positive direct effects (0.06062) on total green fruit yield per plant. It had high indirect positive effects (0.56547) through early green fruit yield per plant and indirect positive effects through number of fruits per plant (0.07671) and plant height at 45 DAT (0.04715) on total green fruit yield per plant. It had negligible negative indirect effects through fruit diameter (-0.06342), leaf area index at 45 DAT (-0.05872) and days to 50 per cent flowering (-0.02355) on total green fruit yield per plant.

Fruit diameter had negligible negative direct effects (-0.08203) on total green fruit yield per plant. It had high indirect positive effects through early green yield per plant (0.43891) and indirect positive effects through number of fruits per plant (0.05636), average fruit weight (0.04688), plant height at 45 DAT (0.02632) and fruit length diameter ratio (0.01435). It had negligible negative indirect effects through leaf area index at 45 DAT (-0.02889) and days to fifty per cent flowering (-0.01884) on total green yield per plant.

Fruit length diameter ratio had negligible negative direct effects (-0.01745) on total green fruit yield per plant. It had negligible indirect positive effects through fruit diameter (0.06744), leaf area index at 45 (0.02031), days to fifty per cent flowering (0.01436) and fruit length (0.01175). It had high negative indirect effects through early

green yield per plant (-0.35139), number of fruits per plant (-0.04399), average fruit weight (-0.03359) and plant height at 45 DAT (-0.0163) on total green yield per plant.

Stem girth at 90 DAT had negligible negative direct effects (-0.06821) on total green fruit yield per plant. It had moderate positive indirect effects through early green yield per plant (0.22005), leaf area index (0.04378), stem girth at 45 DAT (0.02892) and number of fruits per plant (0.02494). It had negligible negative indirect effects was through plant spread from north to south at 45 DAT (-0.01805) and plant height at 45 DAT (-0.01577) on total green fruit yield per plant.

Per cent dry matter in fruit had negligible negative direct effects on total green fruit yield per plant (-0.03143). It had moderate positive indirect effects through early green yield per plant (0.20143), leaf area index at 45 DAT (0.0298), number of fruits per plant (0.02254), average fruit weight (0.01493) and stem girth at 45 DAT (0.01266) on total green fruit yield per plant. It also had negligible negative indirect effects through fruit diameter (-0.01486) and stem girth at 90 DAT (-0.01469) on total green fruit yield per plant.

Plant height at 45 DAT had negligible direct effects (0.09416) on total green fruit yield per plant and had moderate indirect and positive effects through early green fruit yield per plant (0.20134) followed number of fruits per plant (0.03671) and average fruit weight (0.03035) and stem girth at 90 DAT (0.01143) on total green fruit yield per plant. It had indirect negative effects through fruit diameter (-0.04892) and plant spread from north to south at 90 DAT (-0.04439) on total green fruit yield per plant.

Plant height at 90 DAT had negligible positive direct effects (0.03311) on total green yield per plant and it also had moderate indirect and positive effects through early green fruit yield per plant (0.16831) followed by number of fruits per plant (0.02321), plant height at 45 DAT (0.01828), plant spread from east to west at 90 DAT (0.01476) and average fruit weight (0.01015). The negligible negative indirect effect was through plant spread from north to south at 90 DAT (-0.02369), stem girth at 90 DAT (-0.02201), leaf area index at 45 DAT (-0.02081) and fruit diameter (-0.01148).

Leaf area index at 45 DAT had negligible positive direct effects (0.07769) on total green fruit yield per plant. It had indirect positive effects through early green yield per plant (0.16361), average fruit weight (0.02474), stem girth at 90 DAT (0.02076), number of fruits per plant (0.01951) and plant height at 45 DAT (0.01132) on total green yield per plant. Leaf area index at 45 DAT had negative indirect effects on total green yield per plant through fruit diameter (-0.07401).

Number of primary branches per plant at 45 DAT had negligible negative direct effects (-0.00986) on total green yield per plant. It had positive indirect effects through stem girth at 45 DAT (0.02381), leaf area index 45 DAT (0.01622), number of primary branches per plant at 90 DAT (0.01517) and fruit diameter (0.01278). It had negative indirect effects was through early green fruit yield per plant (-0.13913), stem girth at 90 DAT (-0.01763), plant spread from north to south at 90 DAT (-0.01638), number of fruits per plant (-0.01378) and plant spread from north to south at 45 DAT (-0.01337).

Plant spread from east to west at 90 DAT had negligible direct and positive effects (0.03121) on total green fruit yield per plant and it also had negligible indirect and positive effects through plant height at 90 DAT (0.01565). It had moderate negative indirect effect through early green fruit yield per plant (-0.15097) and plant spread from north to south at 90 DAT (-0.01655) on total green fruit yield per plant.

Leaf area index at 90 DAT had negligible positive direct effects (0.01465) on total green fruit yield per plant. It had indirect positive effects through early green fruit yield per plant (0.08133), plant height at 45 DAT (0.05683), days to fifty per cent flowering (0.02105), number of fruits per plant (0.01348) and stem girth at 45 DAT (0.01127) on total green fruit yield per plant. Leaf area index at 45 DAT had negative indirect effects on total green fruit yield per plant through leaf area index at 45 DAT (-0.07089).

Fruit length had negligible positive direct effects (0.02157) on total green fruit yield per plant. It had negligible positive indirect effects through early green yield per plant (0.05656) and number of fruits per plant (0.0105) on total green fruit yield per plant.

Plant spread from north to south at 45 DAT had negligible negative direct effects (-0.03657) on total green fruit yield per plant and it also had high indirect and positive effects through early green yield per plant (0.11399) and stem girth at 45 DAT (0.03894). It had negative indirect effects through stem girth at 90 DAT (-0.0366) and days to fifty per cent flowering (-0.01079) on total green fruit yield per plant.

Plant spread from east to west at 45 DAT had negligible negative and direct effects (-0.01129) on total green yield per plant and it also had negligible indirect positive effects through early green fruit yield per plant (0.01342) followed by plant spread from east to west at 90 DAT (0.01323), stem girth at 45 DAT (0.01718) and number of primary branches at 90 DAT (0.01074). It also had negligible negative indirect effects through plant spread from north to south at 90 DAT (-0.02316), stem girth at 90 DAT (-0.02141), plant spread from north to south at 45 DAT (-0.0185) and leaf area index at 45 DAT (-0.01201) on total green fruit yield per plant.

Plant spread from north to south at 90 DAT had negligible negative direct effects (-0.05479) on total green fruit yield per plant. It had positive indirect effects through days to fifty per cent flowering (0.01464), plant height at 90 DAT (0.01431). It had negligible negative indirect effects was through early green fruit yield per plant (-0.0577) and plant spread from north to south at 45 DAT (-0.01125) on total green fruit yield per plant.

Number of primary branches per plant at 90 DAT had negligible positive direct effects (0.03067) on total green fruit yield per plant. It had negligible negative indirect effects through early green fruit yield per plant (-0.06722), plant spread from north to south at 90 DAT (-0.01736), and leaf area index at 45 DAT (-0.01657) on total green fruit yield per plant.

Stem girth at 45 DAT had negligible positive direct effects (0.05938) on total green fruit yield per plant. It had negligible negative indirect effects through early green fruit yield per plant (-0.05035), stem girth at 90 DAT (-0.03322), plant spread from north to south at 45 DAT (-0.02398) and number of fruits per plant (-0.01873).

Days to first flowering had negligible negative direct effects on total green fruit yield per plant (-0.03387). It had negligible positive indirect effects through days to fifty

per cent flowering (0.04906), leaf area index at 45 DAT (0.01358) and stem girth at 90 DAT (0.01304) on total green fruit yield per plant. It also had negligible negative indirect effects through early green fruit yield per plant (-0.06132) on total green fruit yield per plant.

Days to fifty per cent flowering had negligible positive direct effects on total green fruit yield per plant (0.06794). It had negligible positive indirect effect through fruit diameter (0.02275). It also had moderate negative indirect effects through early green fruit yield per plant (-0.13011), Days to first flowering (-0.02445), average fruit weight (-0.02101) and number of fruits per plant (-0.02101) on total green yield per plant.

4.5 Genetic divergence

Seventy accessions were assessed for 24 characters and data obtained was subjected to D^2 statistics to assess the genetic diversity. Eight clusters were constructed using Tocher's method.

4.5.1 Relative contribution of different characters towards divergence (Table 15)

The relative contribution of different characters for genetic divergence (D^2) is given in table 15. Ascorbic acid (26.7495 %) contributed maximum to the total genetic diversity among the accessions followed by dry red chilli yield per plant (19.4203 %), average fruit weight (10.3520 %), early green fruit yield per plant (9.8551 %), number of fruits per plant (8.7371 %), total green fruit yield per plant (8.4472 %), leaf area index at 45 DAT (3.1056 %), plant spread from east to west at 45 DAT (2.9814), fruit length diameter ratio (2.5259 %), fruit diameter (2.0290 %), fruit length (1.6563 %), per cent dry matter in fruit (1.1594 %), number of primary branches per plant at 45 DAT (0.7867 %), plant spread from east to west at 90 DAT (0.6625 %), leaf area index at 90 DAT (0.4555 %), days to first flowering (0.4555 %), days to 50 per cent flowering (0.2899 %), plant height at 90 DAT (0.1242 %), plant spread from north to south at 90 DAT (0.1242 %) and number of primary branches per plant at 90 DAT (0.0828 %). Characters like plant height at 45 DAT, plant spread from north to south at 45 DAT, stem girth at 45 DAT and stem girth at 90 DAT did not contribute to divergence.

Table 15. Relative per cent contribution of different characters to divergence in chilli

Sl. No.	Character or source	Number of first rank	Per cent contribute
1	Plant height at 45 DAT (cm)	0	0.0000
2	Plant height at 90 DAT (cm)	3	0.1242
3	Plant spread from east to west at 45 DAT (cm)	72	2.9814
4	Plant spread from east to west at 90 DAT (cm)	16	0.6625
5	Plant spread from north to south at 45 DAT (cm)	0	0.0000
6	Plant spread from north to south at 90 DAT (cm)	3	0.1242
7	Number of primary branches per plant at 45 DAT	19	0.7867
8	Number of primary branches per plant at 90 DAT	2	0.0828
9	Stem girth at 45 DAT (cm)	0	0.0000
10	Stem girth at 90 DAT (cm)	0	0.0000
11	Leaf area index at 45 DAT	75	3.1056
12	Leaf area index at 90 DAT	11	0.4555
13	Days to first flowering	11	0.4555
14	Days to 50 per cent flowering	7	0.2899
15	Fruit length (cm)	40	1.6563
16	Fruit diameter (cm)	49	2.0290
17	Fruit length diameter ratio	61	2.5259
18	Average Fruit weight (g)	250	10.3520
19	Number of fruits per plant	211	8.7371
20	Per cent dry matter (%)	28	1.1594
21	Ascorbic acid (mg/100g)	646	26.7495
22	Early green fruit yield/plant (g)	238	9.8551
23	Total green fruit yield per plant (g)	204	8.4472
24	Dry red chilli yield per plant (g)	469	19.4203

Table 16. Classification of chilli accessions into different clusters based on D² value

Clusters	Number of accessions	accessions included in the cluster
I	2	BDS-34, BDS-40
II	13	BDS-2, BDS-3, BDS-4, BDS-5, BDS-6, BDS-7, BDS-8, BDS-9 , BDS-10, BDS-11, BDS-44, BDS-55
III	2	BDS-30, BDS-50
IV	2	BDS-60, BDS-69
V	8	BDS-12, BDS-13, BDS-14, BDS-15, BDS-16, BDS-17, BDS-43, BDS-59
VI	13	BDS-18, BDS-19, BDS-20, BDS-21, BDS-22, BDS-23, BDS-24, BDS-25, BDS-26, BDS-27, BDS-28, BDS-47, BDS-70
VII	25	BDS-29, BDS-31, BDS-32, BDS-33, BDS-35, BDS-36, BDS-37, BDS-38, BDS-39, BDS-41, BDS-42, BDS-45, BDS-46, BDS-48, BDS-49, BDS-51, BDS-52, BDS-53, BDS-54, BDS-56, BDS-57, BDS-58, BDS-61, BDS-62, BDS-63
VIII	5	BDS-64, BDS-65, BDS-66, BDS-67, BDS-68

Table 17: Average intra- and inter -cluster D^2 values along with their D values (in parenthesis) for 24 characters formed by 70 accessions of Byadagi chilli

Cluster	I	II	III	IV	V	VI	VII	VIII
I	117.777 (10.852)	732.273 (27.061)	90.332 (19.757)	380.984 (19.519)	1573.064 (39.662)	776.864 (27.672)	762.435 (27.612)	2113.780 (45.976)
II		677.806 (26.035)	512.677 (22.642)	626.650 (25.033)	1720.367 (41.477)	1102.704 (33.207)	841.608 (29.010)	2468.526 (49.684)
III			138.219 (11.757)	491.761 (22.176)	1542.525 (39.275)	807.664 (28.419)	641.241 (25.323)	2375.261 (48.737)
IV				165.780 (12.876)	1539.122 (39.232)	863.416 (29.384)	818.716 (28.613)	2135.756 (46.214)
V					1193.205 (34.543)	1346.202 (36.691)	1873.662 (43.266)	1388.386 (37.261)
VI						1034.463 (32.163)	1197.126 (34.600)	1747.706 (41.806)
VII							983.655 (31.363)	2529.309 (50.292)
VIII								918.582 (30.308)

Note: Diagonal values indicate intra-cluster distances

4.5.2 Classification of chilli accessions (Table 16)

By following Tocher's method, seventy accessions were grouped into eight clusters by treating estimated D^2 values as the square of the generalized distance. The distribution of entries into various clusters is given in Table 16.

Cluster VII was the largest having 25 accessions followed by clusters II and VI (13), cluster V had eight accessions, cluster VIII (5) and cluster I, III and IV had two accessions each, given in Table 16.

Intra and inter cluster average D^2 values are presented in Table 17. Among the eight clusters, cluster V with 8 number of accessions showed maximum intra-cluster diversity ($D^2 = 1193.205$) followed by cluster VI ($D^2 = 1034.463$), cluster VII ($D^2 = 983.655$), cluster VIII ($D^2 = 918.582$), Cluster II ($D^2 = 677.806$), Cluster IV ($D^2 = 165.780$) and Cluster III ($D^2 = 138.219$). Cluster I ($D^2 = 117.777$) showed minimum intra-cluster diversity.

Based on distance between clusters, *ie.*, inter-cluster distances, the maximum divergence was observed between clusters VII and VIII ($D^2 = 2529.309$) followed by clusters II and VIII ($D^2 = 2468.526$), clusters III and VIII ($D^2 = 2375.261$), clusters IV and VIII ($D^2 = 2135.756$), clusters I and VIII ($D^2 = 2113.780$), clusters V and VII ($D^2 = 1873.662$), clusters VI and VIII ($D^2 = 1747.706$), clusters II and V ($D^2 = 1720.367$), clusters I and V ($D^2 = 1573.064$), clusters III and V ($D^2 = 1542.525$), clusters IV and V ($D^2 = 1539.122$), clusters V and VIII ($D^2 = 1388.386$) and clusters V and VI ($D^2 = 1346.202$). Cluster I had the least inter - cluster distance ($D^2 = 90.332$) with the cluster III.

4.5.3 Cluster means

The mean value of 24 characters for eight clusters are summarized in Table 18.

4.5.3.1 Plant height at 45 DAT

Highest cluster mean for this character was observed in the cluster VIII (46.48 cm) followed by cluster V (44.90 cm), cluster VI (44.70), cluster II (42.72), cluster III (41.65), cluster VII (41.64) and the lowest cluster mean was observed in cluster I (36.40).

Table 18. Mean value of 24 characters for eight clusters in chilli

SI.No.	Characters	Clusters							
		I	II	III	IV	V	VI	VII	VIII
1	Plant height at 45 DAT (cm)	36.40	42.72	41.65	37.15	44.90	44.70	41.64	46.48
2	Plant height at 90 DAT (cm)	68.76	63.46	77.55	63.19	71.00	71.94	71.18	68.74
3	Plant spread from east to west at 45 DAT (cm)	32.00	31.14	34.25	24.15	32.42	30.80	32.27	30.08
4	Plant spread from east to west at 90 DAT (cm)	57.41	52.46	62.33	44.28	52.43	54.10	53.59	46.66
5	Plant spread from north to south at 45 DAT (cm)	37.20	31.85	36.25	31.55	33.75	33.14	37.54	40.74
6	Plant spread from north to south at 90 DAT (cm)	48.76	55.17	56.06	40.95	54.93	55.24	54.80	52.13
7	Number of primary branches per plant at 45 DAT	4.15	4.36	4.45	4.10	4.20	4.58	4.36	4.08
8	Number of primary branches per plant at 90 DAT	5.33	5.67	5.41	5.00	5.72	5.85	5.72	5.90
9	Stem girth at 45 DAT (cm)	0.72	0.64	0.64	0.63	0.58	0.67	0.74	0.72
10	Stem girth at 90 DAT (cm)	1.28	1.04	1.35	1.18	1.13	1.22	1.24	1.33
11	Leaf area index at 45 DAT	0.10	0.085	0.08	0.06	0.086	0.063	0.076	0.058
12	Leaf area index at 90 DAT	0.22	0.25	0.29	0.23	0.25	0.27	0.26	0.25
13	Days to first flowering	29.50	32.96	33.00	33.25	32.62	34.57	33.74	31.20
14	Days to 50 per cent flowering	45.25	54.73	54.25	50.25	47.43	51.80	53.80	49.20
15	Fruit length (cm)	12.50	10.99	10.58	10.58	12.39	12.11	11.59	9.16
16	Fruit diameter (cm)	1.45	1.40	1.49	1.49	2.09	1.90	1.52	2.59
17	Fruit length diameter ratio	8.66	8.07	7.10	7.07	6.22	6.71	7.83	4.14
18	Average Fruit weight (g)	9.09	8.67	7.90	8.30	15.23	10.71	9.21	15.33
19	Number of fruits per plant	36.57	32.23	30.25	27.50	25.61	32.06	37.42	31.05
20	Per cent dry matter (%)	8.54	9.97	9.27	11.03	10.75	9.89	9.98	11.12
21	Ascorbic acid (mg/100g)	68.66	137.45	111.94	98.95	121.52	97.35	129.15	123.17
22	Early green fruit yield/plant (g)	74.63	68.18	62.39	69.00	86.96	72.78	73.36	93.25
23	Total green fruit yield per plant (g)	223.89	206.74	187.17	207.01	265.57	222.96	220.44	282.75
24	Dry red chilli yield per plant(g)	50.07	46.47	42.05	46.28	59.79	50.07	49.64	63.52

4.5.3.2 Plant height at 90 DAT

Highest cluster mean for this character was observed in the cluster III (77.55 cm) followed by cluster VI (71.94cm), cluster VII (71.18cm), cluster V (71.00 cm) and the lowest cluster mean was observed in cluster IV (63.19 cm).

4.5.3.3 Plant spread from east to west at 45 DAT

Highest cluster mean for this character was observed in the cluster III (34.25 cm) followed by cluster V (32.42 cm), cluster VII (32.27 cm), cluster I (32.00 cm) and the lowest cluster mean was observed in cluster VIII (30.08 cm).

4.5.3.4 Plant spread from east to west at 90 DAT

Highest cluster mean for this character was observed in the cluster III (62.33 cm) followed by cluster I (57.41 cm), cluster VI (54.10), cluster VII (53.59) and the lowest cluster mean was observed in cluster IV (44.28 cm).

4.5.3.5 Plant spread from north to south at 45 DAT

Highest cluster mean for this character was observed in the cluster VIII (40.74 cm) followed by cluster VII (37.54 cm), cluster I (37.20 cm), cluster III (36.25 cm), cluster V (33.75 cm) and the lowest cluster mean was observed in cluster IV (31.55 cm).

4.5.3.6 Plant spread from north to south at 90 DAT

Highest cluster mean for this character was observed in the cluster III (56.06 cm) followed by cluster VI (55.24 cm), cluster II (55.17 cm), cluster V (54.93 cm), cluster VII (54.80 cm) and the lowest cluster mean was observed in cluster IV (40.95 cm).

4.5.3.7 Number of primary branches per plant at 45 DAT

Highest cluster mean for this character was observed in the cluster VI (4.58) followed by cluster III (4.45), cluster II and VII (4.36), cluster V (4.20) and the lowest cluster mean was observed in cluster VIII (4.08).

4.5.3.8 Number of primary branches per plant at 90 DAT

Highest cluster mean for this character was observed in the cluster VIII (5.9) followed by cluster VI (5.85), cluster V and VII (5.72), cluster II (5.67) and the lowest cluster mean was observed in cluster IV (5.00).

4.5.3.9 Stem girth at 45 DAT

Highest cluster mean for stem girth was observed in the cluster VII (0.74) followed by cluster I and VIII (0.72), cluster VI (0.67), cluster II and III (0.64) and the lowest cluster mean was observed in cluster V (0.58).

4.5.3.10 Stem girth at 90 DAT

Highest cluster mean for this character was observed in the cluster III (1.35) followed by cluster VIII (1.33), cluster I (1.28), cluster VII (1.24), cluster VI (1.22) and the lowest cluster mean was observed in cluster II (1.04).

4.5.3.11 Leaf area index at 45 DAT

Highest cluster mean for leaf area index at 45 DAT was observed in the cluster I (0.10) followed by cluster V (0.0862), cluster II (0.0858), cluster III (0.08) and the lowest cluster mean was observed in cluster VIII (0.058).

4.5.3.12 Leaf area index at 90 DAT

Highest cluster mean for leaf area index at 90 DAT was observed in the cluster III (0.29) followed by cluster VI (0.27), cluster VII (0.26), cluster II, V and VIII (0.25) and the lowest cluster mean was observed in cluster I (0.22).

4.5.3.13 Days to first flowering

Lowest cluster mean for days to first flowering was observed in cluster I (29.50) followed by cluster II (32.96), cluster III (33.00), cluster IV (33.25), cluster VII (33.74), and the highest cluster mean was observed in cluster VI (34.57).

4.5.3.14 Days to 50 per cent flowering

Lowest cluster mean for this character was observed in cluster I (45.25) followed by cluster IV (50.25), cluster VI (51.80), cluster VII (53.80), cluster III (54.25) and the highest cluster mean was observed in cluster II (54.73).

4.5.3.15 Fruit length (cm)

Highest cluster mean for this character was observed in the cluster I (12.50 cm) followed by cluster V (12.39 cm), cluster VI (12.11 cm), cluster VII (11.59 cm), cluster II (10.99 cm), cluster III and IV (10.58 cm) and the lowest cluster mean was observed in cluster VIII (9.16 cm).

4.5.3.16 Fruit diameter (cm)

Highest cluster mean for fruit diameter was observed in the cluster VIII (2.59 cm) followed by cluster V (2.09 cm), cluster VI (1.90 cm), cluster VII (1.52 cm), cluster III and IV (1.49 cm) and the lowest cluster mean was observed in cluster II (1.40 cm).

4.5.3.17 Fruit length diameter ratio

Highest cluster mean for this character was observed in the cluster I (8.66) followed by cluster II (8.07), cluster VII (7.83), cluster III (7.10), cluster IV (7.07) and the lowest cluster mean was observed in cluster VIII (4.41).

4.5.3.18 Average fruit weight (g)

Highest cluster mean for fruit weight was observed in the cluster VIII (15.33 g) followed by cluster V (15.23 g), cluster VI (10.71 g), cluster VII (9.21 g), cluster I (9.09 g) and the lowest cluster mean was observed in cluster III (7.90 g).

4.5.3.19 Number of fruits per plant

Highest cluster mean for number of fruits per plant observed in the cluster VII (37.42) followed by cluster I (36.57), cluster II (32.23), cluster VI (32.06), cluster VIII (31.05) and the lowest cluster mean was observed in cluster V (25.61).

4.5.3.20 Per cent dry matter in fruit

Highest cluster mean for this character was observed in the cluster VIII (11.12 %) followed by cluster IV (11.03 %), cluster V (10.75 %), cluster VII (9.98 %), cluster II (9.97 %), cluster VI (9.89 %) and the lowest cluster mean was observed in cluster I (8.54 %).

4.5.3.21 Ascorbic acid

Highest cluster mean for ascorbic acid content in fruit was observed in the cluster II (137.45 mg/100g) followed by cluster VII (129.15 mg/100g), cluster VIII (123.17 mg/100g), cluster V (121.52 mg/100g), cluster III (111.94 mg/100g) and the lowest cluster mean was observed in cluster I (68.66 mg/100g).

4.5.3.22 Early green fruit yield per plant (g)

Highest cluster mean for this character was observed in cluster VIII (93.25 g) followed by cluster V (86.96 g), cluster I (74.63 g), cluster VII (73.36 g), cluster VI (72.78 g) and the lowest cluster mean was observed in cluster III (62.39 g).

4.5.3.23 Total green fruit yield per plant (g)

Highest cluster mean for total green fruit yield per plant was observed in cluster VIII (282.75 g) followed by cluster V (265.57 g), cluster I (223.89 g), cluster VI (222.96 g), cluster VII (220.44 g) and the lowest cluster mean was observed in cluster III (187.17 g).

4.5.3.24 Dry red chilli yield per plant (g)

Highest cluster mean for this character was observed in cluster VIII (63.52 g) followed by cluster V (59.79 g), cluster I and VI (50.07 g), cluster VII (49.64 g) and the lowest cluster mean was observed in cluster III (42.05 g).

4.6 Disease incidence

4.6.1 Anthracnose

Reaction of chilli accessions to anthracnose is given in Appendix III and Table 10. The incidence of anthracnose on fruit ranged from zero (BDS- 1, BDS-3, BDS- 12,



BDS-66



BDS-27



BDS-21



BDS-67



BDS-36



BDS-57



Plate 3: Promising chilli accessions

BDS- 13, BDS- 14, BDS- 15, BDS- 16, BDS-17, BDS-20, BDS- 21, BDS- 24, BDS- 26, BDS- 27, BDS- 29, BDS- 33, BDS- 34, BDS- 39, BDS- 43, BDS- 44, BDS- 47, BDS- 48, BDS- 49, BDS- 53, BDS- 54, BDS- 56, BDS- 57, BDS- 58, BDS- 63, BDS- 64, BDS- 65 , BDS-67, BDS-68, BDS- 69, BDS- 70) to 60.18 per cent (BDS- 32).

4.6.2 Leaf curl index

Reaction of chilli accessions to leaf curl index is given in Appendix IV and Table 10. The incidence of leaf curl index ranged from zero (BDS- 1, BDS-3, BDS-9 , BDS-12, BDS-15 , BDS- 16, BDS- 17 , BDS- 20, BDS-21, BDS- , BDS-23 , BDS- 24 , BDS-29, BDS-30, BDS-31, BDS-, BDS- 34, BDS- 35, BDS-37, BDS-38, BDS-39, BDS-43, BDS-44, BDS-45, BDS- 47 , BDS-49, BDS-51, BDS-53, BDS-55, BDS- 56 , BDS-61, BDS-65, BDS-67, BDS-69, BDS-70) to 79.43 per cent (BDS- 26).

5. DISCUSSION

Crop improvement largely depends on the existence of variability and its exploitation by the plant breeder. Plant breeder has to identify sources of favorable genes, incorporate them into breeding populations/lines and select for a combination of desirable traits that might result in the isolation of productive genotypes. To achieve these goals, plant breeder needs to know the extent of variability present in a population. Evaluation of large number of germplasm lines is the first step towards the goal. Improvement in any crop is based on the extent of genetic variation and magnitude of available beneficial genetic variability. The proportion of genotypic and environmental variance and their interaction ($G \times E$), can be determined by employing useful biometrical and genetical methods. Some of these parameters include genotypic (GCV) and phenotypic (PCV) coefficients of variation. High value of these coefficients indicates wider variability. Similarly narrow differences between GCV and PCV reveals low sensitivity to the environmental effects. Heritability is the ratio of genetic variance to total variance. This is broad sense heritability and gives an idea about that portion of observed variability which is attributable to genetic differences. Heritability estimates supplemented by genetic variance are more meaningful. Heritability is a component in the computation of expected progress which is most meaningful when accompanied by genetic advance. Genetic advance would be less in cases where the non-additive genetic variance is more than additive genetic variance (Lush, 1949).

Genotypic and phenotypic correlations reveal the degree of association between different characters. Thus it helps to base selection procedure to a required balance when two opposite desirable characters affecting the principle character are being selected. It also helps to improve different characters simultaneously (Falconer, 1981).

The other genetic parameter commonly used is the path analysis as given by Dewey and Lu (1959). Path analysis gives the cause and effect relationship. It critically breaks up different direct effects and indirect effects which finally makes up correlation coefficient. In this study genotypic and phenotypic path for yield per plant was analysed by selecting most influencing independent variables.

To study genetic divergence among the genotypes Mahalanobis D^2 statistics was used. The D^2 statistics enables to discriminate among different cultivars according to the diversity present (Mahalanobis, 1936). It gives clear idea about the diverse nature of the populations. The clusters formed according to Tocher's method (Rao, 1952) were used to know the distances between and within the cluster. These results could give an insight about diverse nature of the genotypes in a cluster.

Several factors are known to affect successful cultivation and yield potential of chilli. Hence selections of genotypes with such characters are expected to meet the challenging situations.

In the present investigation 70 accessions of chilli were studied for variability, correlation studies, path analysis, diversity for quantitative and quality characters. The results obtained are discussed here under.

5.1 Genetic variability, heritability and genetic advance

Totally 70 accessions were evaluated to know the amount of variability for yield and yield contributing characters. The analysis of variance indicated highly significant differences among accessions for most of the characters viz., plant height at 45 and 90 DAT, plant spread from east to west at 45 and 90 DAT, plant spread from north to south at 45 and 90 DAT, number of primary branches per plant at 45 and 90 DAT, stem girth at 45 and 90 DAT, leaf area index at 45 and 90 DAT, days to first flowering, days to 50 per cent flowering, fruit length, fruit diameter, fruit length: diameter ratio, average fruit weight, number of fruits per plant, early green fruit yield per plant, total green fruit yield per plant, , green fruit yield per hectare, dry red chilli yield per hectare, per cent dry matter in fruit, ascorbic acid and diseases like anthracnose and leaf curl index. It is indicated that, high variability existed for the characters studied and considerable improvement could be achieved in most of the characters by selection. However, the analysis of variance by itself is not enough conclusive to explain all the inherent genotypic variance in the accessions.

One of the way by which the variability present in these characters were assessed through a simple approach of examining the range of variation. Range of

variation observed for all the traits in the present study indicated that the presence of sufficient amount of variation among the accessions for all the characters studied.

The range in the values reflects the amount of phenotypic variability, which is not reliable, since it includes genotypic, environmental and genotype x environment interaction components and does not reveal as to which character is showing higher degree of genetic variability. Further, the genotype of crop is influenced by additive gene effect (heritable), dominance (non-heritable) and epistasis (non-allelic interaction). It is important to split the observed variability into phenotypic coefficient of variation and genotypic coefficient of variation, which ultimately indicate the extent of heritable variability existing for various traits. However, even this does not give a true picture about the extent of inheritance of the character. Therefore, the heritability of a character can be relied upon, as it enables the plant breeder to decide the extent of selection pressure to be applied under a particular environment, which separates out the environmental influence from the total variability. Never-the-less, its use would be limited as this is prone to change with the environment, material, *etc.* The estimation of heritability has a greater role to play in determining the effectiveness of selection of a character provided it is considered in conjunction with the predicted genetic advance as suggested by Johnson *et al.* (1955). Heritability is influenced by biometrical method, generation of hybrid, sample size of experimental material and environment. With these, the results of the present investigation on various parameters are discussed here under.

In the present investigation very high genotypic coefficient of variation and phenotypic coefficient of variation was observed for ascorbic acid, similar results were supported by Rani *et al.* (1996a). High genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) were observed for average fruit weight, leaf area index at 45 DAT, fruit diameter, fruit length-diameter ratio, number of fruits per plant, total dry fruit yield per hectare, early green fruit yield per plant, total green fruit yield per hectare, total green fruit yield per plant and dry red chilli yield per plant. These characters having higher range of variation have better scope of improvement through selection. High estimates of GCV and PCV were observed for early green fruit yield per plant, these results are in confirmation with Krishna *et al.* (2007a). Nehru and Manjunath (1996) and Warade *et al.* (1996b) reported high estimates of GCV and PCV for total green fruit yield per plant. High estimates of GCV and PCV for dry red chilli

yield per plant, these results are in agreement with Giritammannavar (1995) and Mishra *et al.* (2001). High estimates of GCV and PCV for number of fruits per plant were observed by Acharya *et al.* (2002) and Mubarak (2002). Nayeema *et al.* (1998) and Wasule *et al.* (2004) reported high GCV and PCV for the character of fruit diameter. High estimates of GCV and PCV for average fruit weight, the results are in accordance with Manju and Shreelathakumary (2002) and Kashinath (2003). Total green fruit yield per hectare and total dry fruit yield per hectare were showed high GCV and PCV, results are in confirmation with Ajjappalavara *et al.* (2009), Kulkarni *et al.* (2010), Sharma *et al.* (2010) and Chattopadhyay *et al.* (2011). High estimates of coefficient of variation for the above traits indicated wide range of variability for the characters studied. Narrow differences between phenotypic and genotypic coefficients of variation noticed for these traits further indicating lower sensitivity of these parameters to environmental modifications. The expression of these attributes is more dependent on genetic factors rather than on non-genetic factors. It indicates existence broad genetic base, which would be amenable for further selection.

In the present study moderate GCV and PCV were observed for plant height at 45 and 90 DAT, plant spread from east to west at 45 and 90 DAT, plant spread from north to south at 45 and 90 DAT, number of primary branches per plant at 45 and 90 DAT, stem girth at 90 DAT, days to first flowering, days to 50 per cent flowering, fruit length and per cent dry matter in fruit indicating moderate amount of variability. Moderate GCV and PCV for plant height at 45 DAT were supported by Manju and Shreelathakumary (2002), Smitha and Basavaraja (2006), Ajjappalavara *et al.* (2009), Kulkarni *et al.* (2010), Surya Kumari *et al.* (2010) and Berhanu *et al.* (2011). Ajith and Manju (2006), Smitha and Basavaraja (2006) and Madankumar (2008), reported moderate estimates of GCV and PCV for plant height at 45 and 90 DAT. Moderate GCV and PCV for plant spread from at 45 and 90 DAT are in agreement with Jadhav *et al.* (2004) and Sarkar *et al.* (2009). Moderate GCV and PCV for number of primary branches per plant at 45 and 90 DAT are in agreement with results of Saraladevi Arumugum (1998), Basavaraja (1997), Kashinath (2003), Prabhudev (2003) and Verkey *et al.* (2005). Krishna *et al.* (2007a) reported that moderate GCV and PCV for the character of stem girth at 90 DAT. Sreelathakumary and Rajamony (2004) reported moderate GCV and PCV for days to first flowering. Moderate estimates of GCV and

PCV for days to 50 per cent flowering are in accordance with findings of Nandadevi (1999) and Akhilesh Sharma and Susheel Sharma (2006). Ram and Lal (1992) for per cent dry matter in fruit were noticed moderate estimates of GCV and PCV. Moderate GCV and PCV for fruit length, which the results are in line with Venkateshwar Rao (2000), Rathod *et al.* (2002) and Wasule *et al.* (2004). Moderate GCV and high PCV were observed for stem girth at 45 DAT and leaf area index at 90 DAT.

In the present study, very high heritability coupled with very high genetic advance as per cent over mean were recorded for the characters viz., ascorbic acid content, average fruit weight, total dry fruit yield per hectare, fruit diameter, number of fruits per plant, early green fruit yield per plant, total green fruit yield per hectare, total green fruit yield per plant, dry red chilli yield per plant and fruit length diameter ratio. Very high heritability with very high genetic advance as per cent over mean were observed in ascorbic acid, these results are in agreement with Rani *et al.* (1996a) and Chattopadhyay *et al.* (2011). Very high heritability coupled with very high genetic advance as per cent over mean for average fruit weight, similar results are reported by Kashinath (2003), Jadhav *et al.* (2004) and Sarkar *et al.* (2009). Mubarak Begum (2002), Singh *et al.* (2005) and Ajith and Manju (2006) reported similar results for fruit diameter. Prabhudeva (2003), Choudhary and Samadia (2004) and Nageshwar Rao (2005) reported the very high heritability and very high genetic advance as per cent over mean for number of fruits per plant. Similar findings for early green fruit yield per plant were reported by Krishna *et al.* (2007a). Ajith and Manju (2006) reported the same result for total green fruit yield per plant. Very high heritability and very high genetic advance as per cent over mean was observed for dry red chilli yield per plant, results are in line with Kashinath (2003). Very high heritability and very high genetic advance as per cent over mean was observed for green and dry fruit yield per plant, green and dry fruit yield per hectare, these results are in accordance with Shirsat *et al.* (2007), Vani *et al.* (2007), Ajjappalavara *et al.* (2009), Kulkarni *et al.* (2010), Sharma *et al.* (2010) and Chattopadhyay *et al.* (2011). Very high heritability along with very high genetic advance as per cent over mean was observed for fruit length diameter ratio. In the present investigation very high heritability along with high genetic advance as per cent over mean was observed in fruit length, similar results are reported by Venkateshwar Rao (2000) and Nageshwar Rao (2005). Very high heritability with high genetic

advance as per cent over mean was observed for plant spread from east to west at 45 and 90 DAT, these results are in line with Sarkar *et al.* (2009). Very high heritability along with high genetic advance as per cent over mean was observed for number of primary branches per plant at 45 DAT. High heritability with high genetic advance as per cent over mean were observed for plant spread from north to south at 45 and 90 DAT, plant height at 45 DAT, days to first flowering, days to 50 per cent flowering, leaf area index leaf at 90 DAT, stem girth at 45 and 90 DAT, number of primary branches per plant at 90 DAT and per cent dry matter in fruit. Krishna (2002) and Prabhudeva (2003) reported the same results for stem girth at 45 and 90 DAT. High heritability with high genetic advance as per cent over mean observed for number of primary branches per plant at 90 DAT. Dipendra Gogoi and Gautam (2002), Prabhudeva (2003) and Singh *et al.* (2005) reported same results for number of primary branches per plant at 90 DAT. Results obtained for plant spread from north to south at 45 and 90 DAT are in accordance with findings of Sarkar *et al.* (2009). Same results for plant height at 45 and 90 DAT were reported by Basavaraja (1997), Khurana *et al.* (2003) and Mallikarjun *et al.* (2003). High heritability with high genetic advance as per cent over mean for per cent dry matter in fruit. High heritability with high genetic advance as per cent over mean for days to first flowering, similar findings were obtained by Krishna *et al.* (2007a). Elangovan *et al.* (1981) and Nandadevi (1999) reported high heritability with high genetic advance as per cent over mean for the days to 50 per cent flowering. Moderate heritability and very high genetic advance as per cent over mean was observed for leaf area index at 45 DAT. Therefore, additive component is predominant here. Thus, there is ample scope for improving these characters through direct selection.

Promising chilli accessions in the present investigation is depicted in Plate 3. BDS-66, BDS-27, BDS-21, BDS-67, BDS-36, BDS-12, BDS-65, BDS-53, BDS-55, BDS-17, BDS-54, BDS-33 and BDS-32 were the high yielding accessions.

The data on the sensory score for color and appearance of green chilli was recorded and maximum score was observed in BDS-41 followed by BDS-23 and minimum score was observed in BDS-62. For size of green chilli maximum score was observed in BDS-23 followed by BDS-30 and minimum score was observed in BDS-18. The data on the sensory score for pungency of green chilli was recorded and maximum score was observed in BDS-15 followed by BDS-4 and minimum score was

observed in BDS-58. The overall acceptability of green chilli maximum score was observed in BDS- 23 followed by BDS-15 and minimum score was observed in BDS-18.

5.2 Correlation analysis

Variability studies provide information on the extent of improvement possible in different characters, but they do not throw light on the extent and nature of relationship existing between yield and various contributory characters. As a rational approach for the improvement of yield, selection has to be made for components of yield, since there may not be gene for yield *per se* but for various yield components (Grafius, 1959). Genetic correlations between two characters arise because of linkage, pleiotrophy or development induced functional relationship (Harland, 1939). Further, many of these yield contributing characters are interacted in desirable and undesirable direction. Hence, a knowledge regarding the association of various characters among themselves and with economic characters is necessary for making indirect selection for improvement of economic characters. Character association or correlation is a measure of the degree of association between two characters.

The phenotypic correlations indicate the extent of the observed relationship between two characters. This does not give true genetic picture of the relationship because it includes hereditary as well as environmental influences. Genotypic correlation provides an estimate of inherent association between genes controlling any two characters. Hence, it is of greater significance and could be effectively utilized in formulating an effective selection scheme. Therefore, in the present study, the genotypic and phenotypic correlation coefficients were worked out.

A narrow difference between the genotypic and phenotypic correlation coefficients was observed for various traits in the present finding and this indicates the lesser influence of the environment in the expression of these traits and presence of strong inherent association among the traits.

Total green fruit yield per plant was positively and significantly associated with early green fruit yield per plant, number of fruits per plant, average fruit weight, fruit diameter, plant height at 45 DAT, per cent dry matter in fruit and stem girth at 90 DAT

both at genotypic and phenotypic levels. Plant height at 90 DAT and leaf area index at 45 DAT were positively and significantly associated with total green fruit yield per plant at genotypic level only. Since these association characters are in desirable direction, selection for these traits may improve the total green fruit yield per plant. These results are in conformation with those of Nageshwara Rao (2005), Ajith and Manju (2006) and Krishna *et al.* (2007b). Whereas total green fruit yield per plant was negatively and significantly associated with fruit length-diameter ratio both at genotypic and phenotypic levels. Positive association of yield with number of fruits per plant and fruit weight are in confirmation with findings of Usha Rani (1996), Ajjappalavara *et al.* (2005) and Sarkar *et al.* (2009).

Positive association of total green chilli yield per plant with fruit weight and fruit diameter is in accordance with earlier reports of Dipendra Gogoi and Gautam (2003), Gouda and Mulge (2003) and Choudary and Samadia (2004). Positive association of total green chilli yield per plant with plant height and number of fruits per plant fruit is in accordance with reports of Ajjappalavara *et al.* (2005), Hari *et al.* (2005) and Nageshwar Rao (2005). Mubarak (2002) and Dipendra Gogoi and Gautam (2003) reported positive association of chilli yield per plant with plant height, average fruit weight and fruit diameter. Correlation study revealed that yield can be improved by selecting accessions having early green fruit yield per plant, average fruit weight, fruit diameter, plant height at 45 DAT and per cent dry matter in fruit, stem girth at 90 DAT, number of fruits per plant, plant height at 90 DAT and leaf area index at 45 DAT.

Early yield per plant was positively and significantly associated with number of fruits per plant, average fruit weight, fruit diameter and plant height at 45 DAT, stem girth at 90 DAT, these findings were similar with Krishna *et al.* (2007b). It was also negatively and significantly associated with fruit length diameter ratio at genotypic and phenotypic levels. Per cent fruit dry matter, leaf area index at 45 DAT and plant height at 90 DAT was positively and significantly associated with early yield per plant at genotypic level only.

Ascorbic acid content was positively and significantly associated with fruit length diameter ratio and number of primary branches per plant and it was negatively and significantly associated with fruit diameter both at genotypic and phenotypic levels.

Per cent dry matter in fruit was positively and significantly associated with average fruit weight and it was also negatively and significantly associated with leaf area index at 45 DAT both at genotypic and phenotypic levels. Per cent dry matter in fruit was positively and significantly associated stem girth at 90 DAT, stem girth at 45 DAT, number of primary branches per plant at 45 DAT and fruit diameter at genotypic level only. To maximize per cent dry matter in fruit, average fruit weight should be considered simultaneously for selection.

Number of fruits per plant was positively and significantly associated with average fruit weight, fruit diameter, plant height at 45 DAT and stem girth at 90 DAT both at genotypic and phenotypic levels. It was negatively and significantly associated with fruit length diameter ratio. Number of fruits per plant was positively and significantly associated with plant height at 90 DAT at genotypic level only. This indicates as the plant height increases, number of fruits per plant also increases. Number of fruits per plant was positively and significantly associated with stem girth, these result is in accordance with the findings of Mubarak Begum (2002). Usha Rani (1996) and Ajjappalavara *et al.* (2005) reported similar results for number of fruits per plant was positively and significantly associated average fruit weight.

Average fruit weight was positively and significantly associated with fruit diameter, plant height at 45 DAT, leaf area index at 45 DAT and it was also negatively and significantly associated with fruit length diameter ratio and days to 50 per cent flowering both at phenotypic and genotypic levels. Average fruit weight was positively and significantly associated with plant height at 90 DAT at genotypic level only. These findings were similar with Saraladevi and Arumugam (1999). Average fruit weight was positively and significantly associated with fruit diameter, plant height at 45 DAT, these results are in confirmation with Khurana *et al.* (1993).

Fruit length diameter ratio was positively and significantly associated with fruit length, days to 50 per cent flowering and number of primary branches per plant at 45 DAT. It was also negatively and significantly associated with fruit diameter both at genotypic and phenotypic levels. Fruit length diameter ratio negatively and significantly associated with plant height at 45 DAT only at genotypic level.

Fruit diameter was positively and significantly associated with plant height at 45 DAT, leaf area index at 45 DAT and it was negatively and significantly associated with days to 50 per cent flowering both at genotypic and phenotypic levels. Fruit diameter was positively and significantly associated with plant height at 45 DAT, these results are in agreement with Ibrahim *et al.* (2001), Mubarak Begum (2002), Dipendra Gogoi and Gautam (2003) and Ajjappalavara *et al.* (2005). Fruit diameter was negatively and significantly associated with days to 50 per cent flowering, results are in similar with Nageshwara Rao (2005).

Fruit length was positively and significantly associated with number of Primary branches per plant at 45 DAT both at genotypic and phenotypic levels, these results are in accordance with Warade *et al.* (1996a) and Acharya and Rajput (2003). Leaf area index at 90 DAT was positively and significantly correlated with fruit length only at genotypic level.

Days to 50 per cent flowering was positively and significantly associated with days to first flowering, leaf area of index at 90 DAT and plant spread from north to south at 90 DAT both at genotypic and phenotypic levels.

Days to first flowering was negatively and significantly associated with plant spread from north to south at 45 DAT both at genotypic and phenotypic levels and it was negatively and significantly associated with stem girth at 90 DAT and plant spread from east to west at 45 DAT only at genotypic level.

Leaf area index at 90 DAT was positively and significantly associated with plant height at 45 DAT, leaf area index at 45 DAT, plant height at 90 DAT, plant spread from north to south at 90 DAT and stem girth at 45 DAT both at genotypic and phenotypic levels.

Leaf area index at 45 DAT was positively and significantly associated with plant height at 45 DAT and it was also negatively and significantly associated with stem girth at 90 DAT both at genotypic and phenotypic levels.

Stem girth at 90 DAT was positively and significantly associated with plant spread from north to south at 45 DAT, stem girth at 45 DAT, plant height at 90 DAT,

plant spread from east to west at 45 DAT and number of primary branches per plant at 45 DAT. Stem girth at 90 DAT was negatively and significantly associated with plant height at 45 DAT both at genotypic and phenotypic levels. Stem girth at 45 DAT was positively and significantly associated with plant spread from north to south at 45 DAT, number of primary branches per plant at 45 DAT and plant spread from east to west at 45 DAT both at genotypic and phenotypic levels. Stem girth positively and significantly associated with plant height at 90 DAT and number of primary branches per plant at 45 DAT, these results are in agreement with Ajjappalavara *et al.* (2005).

Number of primary branches per plant at 90 DAT was positively and significantly associated with number of primary branches per plant at 45 DAT, plant spread from east to west at 45 DAT, plant spread from north to south at 90 DAT, plant spread from east to west at 90 DAT, plant spread from north to south at 45 DAT both at genotypic and phenotypic levels. Number of primary branches per plant at 90 DAT was positively and significantly associated with plant height at 90 DAT only at genotypic level. Number of primary branches per plant at 45 DAT was positively and significantly associated with plant spread from east to west at 45 DAT, plant spread from north to south at 45 DAT, plant spread from north to south at 90 DAT. Number of primary branches per plant at 45 DAT was positively and significantly associated with plant height at 90 DAT both at genotypic and phenotypic level. Acharya and Rajput (2003), Dipendra Gogoi and Gautam (2003) reported the similar results of positive association of number of primary branches per plant at 45 and 90 DAT with plant height at 90 DAT.

Plant spread from north to south at 90 DAT was positively and significantly associated with plant height at 90 DAT, plant spread from east to west at 45 DAT, plant spread from north to south at 45 DAT and plant spread from east to west at 90 DAT both at genotypic and phenotypic level. Plant spread from north to south at 45 DAT was positively and significantly associated with plant spread from east to west at 45 DAT, plant height at 90 DAT both at genotypic and phenotypic level.

Plant spread from east to west at 90 DAT was positively and significantly associated with plant height at 90 DAT and plant spread from east to west at 45 DAT both at genotypic and phenotypic level. Plant spread from east to west at 45 DAT was

positively and significantly associated with plant height at 90 DAT at genotypic and phenotypic level.

Plant height at 90 DAT was positively and significantly associated with plant height at 45 DAT at genotypic and phenotypic level.

5.3 Path analysis

Though correlation analysis indicates the association pattern of components traits with yield, they simply represent the overall influence of a particular trait on yield rather than providing cause and effect relationship. The technique of path coefficient analysis developed by Wright (1921) and demonstrated by Dewey and Lu (1959) facilitates the partitioning of correlation coefficients into direct and indirect contribution of various characters on yield. It is standardized partial regression coefficient analysis. As such, it measures the direct influence of one variable upon other. Such information would be of great value in enabling the breeder to specifically identify the important component traits of yield and utilize the genetic stock for improvement in a planned way.

Path analysis also measures the relative importance of causal factors involved. This is simply a standardized partial regression analysis, where in total correlation values were subdivided into individual causal factors.

In the present study, path coefficient analysis between the components of total green yield per plant in chilli was worked out. As the genotypic associations are inherent, the path analysis is discussed only at genotypic level.

In the present investigation among 21 characters chosen for path analysis plant height at 45 DAT, plant spread from east to west at 90 DAT, number of primary branches per plant at 90 DAT, stem girth at 45 DAT, leaf area index at 90 DAT, days to 50 per cent flowering, fruit length, average fruit weight, number of fruits per plant, early green yield per plant showed positive direct effects on total green yield per plant. Among these early green yield per plant and number of fruits per plant had high positive direct effects on total green yield per plant. This indicates the true positive association with total green yield per plant. Therefore, direct selection for these traits would reward

for improvement of yield. High positive direct effects on total yield per plant through number of fruits per plant was supported by the findings of Khurana *et al.* (2003), Choudary and Samadia (2004), Ajjappalavara *et al.* (2005), Nageshwar Rao (2005) and Chattopadhyay *et al.* (2011). Nageshwar Rao (2005) and Singh *et al.* (2005) reported positive direct effect of plant height at 45 DAT, days to fifty per cent flowering on yield. Average fruit weight had positive direct effect on yield, these findings were similar with Munshi *et al.* (2000), Mubarak (2002) and Nageshwar Rao (2005). Dipendra Gogoi and Gautam (2003) and Nageshwar Rao (2005) reported that the number of primary branches per plant had direct positive effects on yield. Fruit length had direct positive effects on yield, these results are in agreement with Khurana *et al.* (2003), Ajjappalavara *et al.* (2005) and Chattopadhyay *et al.* (2011). Highest direct positive effect of number of fruits per plant followed by average fruit weight was reported by Sarkar *et al.* (2009). Interestingly, these characters also exhibited significant positive correlation with yield and therefore, should be considered as important selection criteria for yield. In view of the direct and indirect contributions of component traits towards fruit yield, selection on the basis of horticultural traits viz., early green fruit yield per plant, average fruit weight and number of fruits per plant is worthwhile.

Days to first flowering, fruit length diameter ratio, fruit diameter, per cent dry matter in fruit, stem girth at 90 DAT, number of primary branches at 45 DAT, plant spread from north to south at 45 and 90 DAT and plant spread from east to west at 45 DAT had negative direct effects on total yield per plant. Negative direct effects of fruit diameter on total green fruit yield per plant was supported by the findings of Mubarak (2002), Khurana *et al.* (2003), Choudary and Samadia (2004) and Nageshwar Rao (2005). Negative direct effects of plant spread was supported by the findings of Nandadevi (1999). Negative direct effects of number of primary branches at 45 DAT on total yield per plant was supported by the findings of Ajjappalavara *et al.* (2005), Ahmed *et al.* (2006) and Satish (2007).

Early yield per plant had high positive direct effects on total green yield per plant. It had moderate positive indirect effects through number of fruits per plant followed by average fruit weight and plant height at 45 DAT on total green fruit yield per plant. It also had negligible negative indirect effects through fruit diameter, leaf area index at 45 DAT and stem girth at 90 DAT on total green yield per plant. Hence the

resultant correlation between early yield per plant and total yield per plant became highly significant and positive. According to Sidhu and Singh (1989) early yield per plant exhibited high direct positive effect on yield per plant in tomato.

Number of fruits per plant was positively and significantly correlated with total yield per plant. It had moderate positive direct effect on total green fruit yield per plant and it had high indirect positive effects through early green fruit yield per plant followed by average fruit weight and plant height at 45 DAT. Similar findings were observed by Munshi *et al.* (2000), Mubarak (2002), Dipendra Gogoi and Gautam (2003), Khurana *et al.* (2003) and Choudary and Samadia (2004). Number of fruits per plant had negative indirect effects on total yield per plant through fruit diameter followed by leaf area index at 45 DAT and stem girth at 90 DAT. The indirect causal factors to be given due consideration along with number of fruits per plant simultaneously for selection.

Average fruit weight was positively and significantly correlated with total green yield. It had negligible positive direct effects and high positive indirect effects through early green fruit yield per plant and indirect positive effects through number of fruits per plant and plant height at 45 DAT. Positive direct effects of average fruit weight on total yield per plant agreement with earlier findings of Munshi *et al.* (2000), Mubarak (2002) and Nageshwara Rao (2005). It had negligible negative indirect effects through fruit diameter, leaf area index at 45 DAT and days to fifty per cent flowering on total green fruit yield per plant. This character exhibited significant positive correlation with yield and therefore, should be considered as important selection criteria for yield.

Fruit diameter had negligible negative direct effects on total green yield per plant was confirmed with Mubarak (2002), Khurana *et al.* (2003), Choudary and Samadia (2004) and Nageshwara Rao (2005). It had high indirect positive effects through early green fruit yield per plant, number of fruits per plant, average fruit weight, plant height at 45 DAT and fruit length diameter ratio. It had negligible negative indirect effects through leaf area index at 45 DAT and days to fifty per cent flowering on total green yield per plant made significant positive correlation between fruit diameter and total green fruit yield per plant.

Fruit length diameter ratio had negligible negative direct effects on total green fruit yield per plant but indirect positive effects through fruit diameter followed by leaf area index at 45, days to fifty per cent flowering and fruit length. It had high negative indirect effects through early green yield per plant followed number of fruits per plant, average fruit weight and plant height at 45 DAT on total green fruit yield per plant made significant negative correlation between fruit length diameter ratio and total green fruit yield per plant.

Stem girth at 90 DAT had negligible negative direct effects on total green yield per plant. It had moderate positive indirect effects through early green yield per plant, leaf area index at 45 DAT, stem girth at 45 DAT, number of fruits per plant and number of primary branches per plant at 90 DAT. It had negligible negative indirect effects was through plant spread from north to south at 45 DAT and plant height at 45 DAT on total green fruit yield per plant resulted in significant positive correlation of stem girth at 90 DAT with total green fruit yield per plant.

Positive correlation of per cent dry matter in fruit with total green yield per plant was due to the positive indirect effects through early green fruit yield per plant, leaf area index at 45 DAT, number of fruits per plant, average fruit weight and stem girth at 45 DAT on total yield per plant. It also had negative indirect effects through fruit diameter and stem girth at 90 DAT on total green yield per plant. Hence, the resultant association with total yield per plant became significant and positive.

Plant height at 45 DAT had moderate indirect and positive effects through early green fruit yield per plant followed number of fruits per plant, average fruit weight and stem girth at 90 DAT on total green fruit yield per plant and it had indirect negative effects through fruit diameter on total green fruit yield per plant resulted in significant positive correlation of plant height at 45 DAT with total green fruit yield per plant.

Plant height at 90 DAT had negligible direct and positive effects on total green yield per plant and it also had indirect and positive effects through early green fruit yield per plant followed by number of fruits per plant and plant height at 45 DAT. The negative indirect effect was through plant spread from north to south at 90 DAT, stem girth at 90 DAT, leaf area index at 45 DAT and fruit diameter. Nageshwara Rao (2005)

and Singh *et al.* (2005) reported the positive direct effect of plant height on total green fruit yield per plant.

Leaf area index at 45 DAT had positive direct effects on total green fruit yield per plant. It had low indirect positive direct effects through early green yield per plant, average fruit weight, stem girth at 90 DAT, number of fruits per plant and plant height at 45 DAT on total green yield per plant. Leaf area index at 45 DAT had negative indirect effects on total green yield per plant through fruit diameter. Hence, made significant positive correlation between leaf area index at 45 DAT and total green fruit yield per plant.

Number of primary branches per plant at 45 DAT had positive indirect effects through stem girth at 45 DAT, leaf area index 45 DAT, number of primary branches per plant at 90 DAT and fruit diameter. It had low negative indirect effects was through early green yield per plant , stem girth at 90 DAT, plant spread from north to south at 90 DAT , number of fruits per plant and plant spread from north to south at 45 DAT.

Leaf area index at 90 DAT had negligible positive direct effects on total green fruit yield per plant. It had negligible indirect positive effects through early green yield per plant, plant height at 45 DAT, days to 50 per cent flowering, number of fruits per plant and stem girth at 45 DAT on total green yield per plant. Leaf area index at 45 DAT had negative indirect effects on total green yield per plant through leaf area index at 45 DAT. Hence, the resultant association with total yield per plant became positive.

Fruit length had negligible positive direct effects on total green fruit yield per plant, these results are in agreement with Khurana *et al.* (2003), Ajjappalavara *et al.* (2005) and Chattopadhyay *et al.* (2011). It had negligible positive indirect effects through early green yield per plant and number of fruits per plant on total green yield per plant. Hence, the resultant correlation between fruit length and total yield per plant became positive.

Plant spread from east to west at 45 DAT had negligible negative and direct effects on total green yield per plant and it also had negligible indirect positive effects through early green fruit yield per plant followed by plant spread from east to west at 90 DAT, stem girth at 45 DAT and number of primary branches at 90DAT. It also had

negligible negative indirect effects through plant spread from north to south at 90 DAT, stem girth at 90 DAT, plant spread from north to south at 45 DAT and leaf area index at 45 DAT on total green yield per plant.

Plant spread from east to west at 90 DAT had negligible direct and positive effects on total green yield per plant and it also had negligible indirect and positive effects through plant height at 90 DAT. It had low negative indirect effect through early green fruit yield per plant and plant spread from north to south at 90 DAT on total green fruit yield per plant.

Plant spread from north to south at 45 DAT had negligible negative direct effects on total green yield per plant and it also had low indirect and positive effects through early green yield per plant and stem girth at 45 DAT. It had negligible negative indirect effects through stem girth at 90 DAT and days to 50 per cent flowering on total green fruit yield per plant.

Plant spread from north to south at 90 DAT had negligible negative direct effects on total green yield per plant. It had low positive indirect effects through days to fifty per cent flowering. It had negligible negative indirect effects was through early green fruit yield per plant and plant spread from north to south at 45 DAT on total green fruit yield per plant. Negative direct effects of plant spread was supported by the findings of Uddin *et al.* (1986) and Nandadevi (1999).

Number of primary branches per plant at 90 DAT had negligible positive direct effects on total green yield per plant. It had negligible negative indirect effects through early green yield per plant, plant spread from north to south at 90 DAT and leaf area index at 45 DAT on total green yield per plant. Bharadwaj *et al.* (2007) noticed direct positive effect of primary branches on total green fruit yield per plant.

Stem girth at 45 DAT had negligible positive direct effects on total green yield per plant. It had negligible negative indirect effects through early green yield per plant, stem girth at 90 DAT, plant spread from north to south at 45 DAT and number of fruits per plant made non significant positive correlation between stem girth at 45 DAT and total green fruit yield per plant.

Days to first flowering had negligible negative direct effects on total green yield per plant. It had negligible positive indirect effects through days to fifty per cent flowering, leaf area index at 45 DAT and stem girth at 90 DAT on total green yield per plant. It also had negligible negative indirect effects through early green yield per plant on total green fruit yield per plant.

Days to 50 per cent flowering had negligible positive direct effects on total green fruit yield per plant. Similar results were reported by Nageshwara Rao (2005), Singh *et al.* (2005) and Chattopadhyay *et al.* (2011). It had positive indirect effect through fruit diameter. It also had low negative indirect effects through early green yield per plant, Days to first flowering, average fruit weight and number of fruits per plant on total green yield per plant. Hence, the resultant correlation between days to 50 per cent flowering and total yield per plant became negative.

5.4 Genetic divergence

Chilli was first cultivated in Mexico which is regarded as the primary centre of origin/diversity. Information on genetic divergence among the available germplasm is vital to a plant breeder for an efficient choice of parents for hybridization. It is an established fact that genetically diverse parents are likely to contribute desirable segregants. It was also observed that the more diverse the parents, greater are the chances of obtaining high heterotic F₁s and broad spectrum of variability in the segregating generation (Arunachalam, 1981). Improvement in yield and quality is normally achieved by selecting genotypes with desirable character combinations existing in the nature or by hybridization. Selection of parents identified on the basis of divergence analysis would be more promising for a hybridization programme. Of the several methods available, Mahalanobis generalized distance estimated by D^2 statistic (Rao, 1952) is a unique method for disseminating populations considering a set of parameters together rather than inferring from indices based upon morphological similarities, eco-geographical diversity and phylogenetic relationships. D^2 statistic has found favour as a tool estimating genetic divergence in plant breeding experiments. Being a numerical estimate, it has the added advantage over other criteria permitting precise comparison among all possible pairs of population in any group. Such analysis revealed that 70 accessions included in the present study, varied significantly for all the

characters under evaluation. The results of the present study point out a positive contribution of genetic divergence and yield components; this can be of considerable help in selecting for yield and other economic traits. Ascorbic acid (26.7495 %) contributed maximum to the total genetic diversity among the accessions followed by dry red chilli yield per plant (19.4203%), average fruit weight (10.3520 %), early green fruit yield per plant (9.8551 %), number of fruits per plant (8.7371 %) and total green fruit yield per plant (8.4472 %).

The material for present study includes 70 accessions and grouped into eight clusters using Tocher's method. Of the 8 clusters, cluster VII was the largest having 25 accessions followed by clusters II and VI (13), cluster V had eight accessions, cluster VIII had 5 accessions and cluster I, III and IV had two accessions each.

Intra-cluster distance revealed that cluster V with 8 number of accessions showed maximum intra-cluster diversity ($D^2 = 1193.205$) followed by cluster VI ($D^2 = 1034.463$), cluster VII ($D^2 = 983.655$), cluster VIII ($D^2 = 918.582$), cluster II ($D^2 = 677.806$), cluster IV ($D^2 = 165.780$) and cluster III ($D^2 = 138.219$). Cluster I ($D^2 = 117.777$) showed minimum intra-cluster diversity. Maximum intra – cluster diversity indicated that accessions included in the cluster II are very diverse.

Based on distance between clusters, *i.e.*, inter-cluster distances, the maximum divergence was observed between clusters VII and VIII ($D^2 = 2529.309$) followed by clusters II and VIII ($D^2 = 2468.526$), clusters III and VIII ($D^2 = 2375.261$), clusters IV and VIII ($D^2 = 2135.756$), clusters I and VIII ($D^2 = 2113.780$), clusters V and VII ($D^2 = 1873.662$), clusters VI and VIII ($D^2 = 1747.706$), clusters II and V ($D^2 = 1720.367$), clusters I and V ($D^2 = 1573.064$), clusters III and V ($D^2 = 1542.525$), clusters IV and V ($D^2 = 1539.122$), clusters V and VIII ($D^2 = 1388.386$) and clusters V and VI ($D^2 = 1346.202$). Cluster I had the least inter - cluster distance ($D^2 = 90.332$) with the cluster III. This indicated close relationship among the accessions included in the clusters I and III. Maximum inter-cluster D^2 values was observed between the clusters VII and VIII indicated that the accessions included in these clusters can be used as a parent in hybridization programme to get higher heterotic hybrids from the segregating population. Similar results were revealed by Shirsat (1994), Mubarak (2002) and Prabhudeva (2003).

These clusters have been formed based on the contribution of different characters to the divergence. Ascorbic acid (26.7495 %) contributed maximum to the total genetic diversity among the accessions followed by dry red chilli yield per plant (19.4203 %), average fruit weight (10.3520 %), early green fruit yield per plant (9.8551 %), number of fruits per plant (8.7371 %), total green fruit yield per plant (8.4472 %), leaf area index at 45 DAT (3.1056 %), plant spread from east to west at 45 DAT (2.9814 %), fruit length diameter ratio (2.5259 %), fruit diameter (2.0290 %), fruit length (1.6563 %), per cent dry matter in fruit (1.1594 %), number of primary branches per plant at 45 DAT (0.7867 %), plant spread from east to west at 90 DAT (0.6625 %), leaf area index at 90 DAT (0.4555 %), days to first flowering (0.4555 %), days to 50 per cent flowering (0.2899 %), plant height at 90 DAT (0.1242 %), plant spread from north to south at 90 DAT (0.1242 %) and number of primary branches per plant at 90 DAT (0.0828 %). Characters like plant height at 45 DAT, plant spread from north to south at 45 DAT, stem girth at 45 DAT, stem girth at 90 DAT did not contribute to divergence.

Number of fruits per plant found maximum contribution towards the diversity. Characters like plant height and number of primary branches per plant contributed very little (0.28%) towards diversity, these results were supported by Mehra and Peter (1980).

Number of fruits per plant, leaf area index, average fruit weight and total green fruit yield per plant contribution are in accordance with Varalaxmi and Haribabu (1991). Dry fruit yield per plant and number of fruits per plant were the chief contributors towards diversity, these results found similar to Mubarak (2002).

Average fruit weight, fruit diameter, fruit length and number of fruit per plant contributions are in accordance with Senapati *et al.* (2003).

Ascorbic acid has contributed maximum to the divergence (26.74 %) and highest cluster mean for this trait was observed in the cluster II (137.45 mg/100g) followed by cluster VII (129.15 mg/100g).

The study also indicated that the character such as ascorbic acid content should also be considered while selecting parents for hybridization as they are important contributors of genetic divergence. For ascorbic acid content in fruit highest cluster

mean was observed in the cluster II (137.45 mg/100g) followed by cluster VII (129.15 mg/100g).

Dry red chilli yield per plant was the second highest contributor to the diversity (19.42%) and highest cluster mean for this character was observed in cluster VIII (63.52 g) followed by cluster V (59.79 g). Maximum divergence was observed between these clusters. Hence the crosses between accessions of these clusters may be tried for improvement of yield.

Average fruit weight had significant contribution for divergence (10.3520 %) and highest cluster mean for average fruit weight was observed in the cluster VIII (15.33 g) followed by cluster V (15.23 g). The inter-cluster distance between cluster clusters V and VIII ($D^2 = 1388.386$) was high. Hence crosses can be made between the accessions of these clusters for improvement of average fruit weight which ultimately contributed to yield.

Early green fruit yield per plant had significant contribution for divergence (9.8551 %) and highest cluster mean for this character was observed in cluster VIII (93.25 g) followed by cluster V (86.96 g). The highest inter-cluster distance was observed between clusters. Hence the crosses between accessions of these respective clusters may be tried to improve early yield per plant.

For number of fruits per plant highest cluster mean was observed in the cluster VII followed by cluster I. The inter-cluster distance between cluster I and cluster VII was comparatively high. Hence crosses between accessions of these respective clusters may be tried for improvement of number of fruits per plant which ultimately contribute to the yield.

Total green fruit yield per plant had significant contribution for divergence (8.4472 %) and highest cluster mean for total green fruit yield per plant was observed in cluster VIII (282.75 g) followed by cluster V (265.57 g). The inter-cluster distance between cluster VIII and V was high. Hence crosses can be made between the accessions of these clusters can improve the green fruit yield per plant.

Future line of work

- 1) Ascorbic acid content, average fruit weight, leaf area index at 45 DAT, fruit diameter, fruit length diameter ratio, number of fruits per plant, total dry fruit yield per hectare, early green fruit yield per plant, total green fruit yield per hectare, total green fruit yield per plant and dry red chilli yield per plant can be improved through direct selection from the existing germplasm, as there is high degree of additive components of variance and high to very high GCV and PCV for these traits.
- 2) From the association analysis, it was evident that early green fruit yield per plant, number of fruits per plant, average fruit weight and fruit diameter can improve yield. Therefore, future breeding programmes aimed in this direction may yield fruitful results.
- 3) The present investigation on path-coefficient analysis revealed that, early green fruit yield per plant had high positive direct and indirect effects on total green fruit yield per plant. Number of fruits per plant had positive direct effect on total green fruit yield per plant and it also had high indirect positive effects through early green fruit yield per plant. Average fruit weight had high indirect positive effects through early green fruit yield per plant. Hence, importance has to be given for these characters in future breeding programmes to improve yield in chilli.
- 4) Genetic diversity is largely contributed by ascorbic acid, dry red chilli yield per plant, average fruit weight, early green fruit yield per plant, number of fruits per plant and total green fruit yield per plant. Thus, these characters may be given high emphasis while selecting the lines for hybridization programme to generate large variability and it will provide immense scope for improvement of yield through selection.
- 5) High yielding accessions BDS-66, BDS-27, BDS-21, BDS-67, BDS-36, BDS-12 can be further assessed for stability before exploiting them for future use.
- 6) Resistant accessions BDS-1, BDS-3, BDS-12, BDS-15, BDS-16, BDS-17 and BDS-20 can be used for further crop improvement.

6. SUMMARY AND CONCLUSIONS

The principle objective of the present investigation was to study the nature and extent of genetic variability and divergence for growth, earliness, yield and quality parameters and to study association of growth, earliness, yield and quality parameters in chilli accessions. The work was carried out at experimental block of Vegetable Science unit of Regional Horticulture Research and Extension Centre, Kumbapur with 70 accessions.

Variability studies

Analysis of variance revealed that highly significant difference among accessions for all the growth, yield and quality parameters. The phenotypic coefficient of variation was higher than genotypic coefficient of variation for all the traits. Very high (>40 %) genotypic coefficient of variation (GCV) and phenotypic coefficient variation were observed for ascorbic acid. High GCV and PCV (20- 40 %) were observed for average fruit weight, leaf area index at 45 DAT, fruit diameter, fruit length diameter ratio, number of fruits per plant, total dry fruit yield per hectare, early green fruit yield per plant, total green fruit yield per hectare, total green fruit yield per plant and dry red chilli yield per plant. These characters having higher range of variation have better scope of improvement through selection. Moderate GCV and PCV (10 -20 %) were observed for plant height at 45 and 90 DAT, plant spread from east to west at 45 and 90 DAT, plant spread from north to south at 45 and 90 DAT, number of primary branches per plant at 45 and 90 DAT, stem girth at 90 DAT, days to first flowering, days to 50 per cent flowering, fruit length and per cent dry matter in fruit indicating moderate amount of variability. The presence of narrow gap between PCV and GCV for all the characters under study suggested that these traits studied has low environmental influence so that phenotypic variability may be a good measure of genotypic variability.

In the present study, very high heritability (>90%) coupled with very high genetic advance as per cent over mean (>40%) was recorded for the characters viz., fruit diameter, fruit weight, number of fruits per plant, early green fruit yield per plant, total green fruit yield per plant, dry red chilli yield per plant, total green fruit yield per hectare, total dry fruit yield per hectare and ascorbic acid content. Very high heritability

along with high GAM (20-40%) was observed in fruit length diameter ratio, fruit length, plant spread from east to west at 45 DAT, plant spread from east to west at 90 DAT. Moderate (72 %) with very high GAM were observed in leaf area index at 45 DAT. High heritability with high GAM was observed in leaf area index leaf at 90 DAT, stem girth at 45 and 90 DAT, number of primary branches per plant at 90 DAT, plant spread from north to south at 45 DAT, days to first flowering, days to 50 per cent flowering, plant spread from north to south at 90 DAT and plant height at 45 and 90 DAT. Therefore, additive component is predominant here. Thus, there is ample scope for improving these characters through direct selection.

Accessions like BDS—66, BDS-27, BDS-21, BDS-67, BDS-36, BDS-12, BDS-65, BDS-53, BDS-55, BDS-17, BDS-54, BDS-33 and BDS-32 were reported high yield.

Correlation and path analysis studies

A narrow difference between the genotypic and phenotypic correlation coefficients was observed for various traits in the present findings and this indicates the lesser influence of the environment in the expression of these traits and presence of strong inherent association among the traits.

Total green fruit yield per plant was positively and significantly associated with early green fruit yield per plant, number of fruits per plant, average fruit weight, fruit diameter, plant height at 45 DAT, per cent dry matter in fruit and stem girth at 90 DAT both at genotypic and phenotypic levels. Plant height at 90 DAT and leaf area index at 45 DAT were positively and significantly associated with only total green fruit yield per plant at genotypic level. Number of fruits per plant was positively and significantly associated with average fruit weight, fruit diameter and plant height at 45 DAT, stem girth at 90 DAT and plant height at 90 DAT. Average fruit weight was positively and significantly associated with fruit diameter, plant height at 45 DAT, leaf area index at 45 DAT, days to 50 per cent flowering and plant height at 90 DAT. Strong association of these traits revealed that selection based on these traits would ultimately improve the fruit yield and it is also suggested that hybridization of accessions possessing combination of such characters is most useful for obtaining desirable high yielding segregants.

Correlation study revealed that yield can be improved by selecting accessions having more number of fruits per plant, high average fruit weight, more fruit diameter, plant height at 45 DAT, high per cent dry matter in fruit, stem girth at 90 DAT, plant height at 90 DAT and leaf area index at 45 DAT.

High positive direct effects on total green yield per plant was shown by early green fruit yield per plant followed by number of fruits per plant. Highest negative direct effects on total yield per plant was shown by stem girth at 90 DAT. High positive indirect effects on total green yield per plant was shown by number of fruits per plant followed by leaf area index at 45 DAT, average fruit weight. Characters having high positive direct effects along with positive significant correlation with yield per plant can be directly selected, and simultaneously the characters which show high positive indirect effects can also be selected for the improvement of yield.

Genetic divergence

Seventy accessions were grouped into eight clusters. Cluster VII was the largest having 25 accessions followed by clusters II and VI (13), cluster V had eight accessions, cluster VIII (5) and cluster I, III and IV had two accessions each.

Intra- cluster distance revealed that cluster V with 8 number of accessions showed maximum intra-cluster diversity ($D^2 = 1193.205$) followed by cluster VI ($D^2 = 1034.463$), cluster VII ($D^2 = 983.655$), cluster VIII ($D^2 = 918.582$), cluster II ($D^2 = 677.806$), cluster IV ($D^2 = 165.780$) and Cluster III ($D^2 = 138.219$). Cluster I ($D^2 = 117.777$) showed minimum intra-cluster diversity. Maximum intra-cluster diversity indicated that accessions included in the cluster V are very diverse.

Based on distance between clusters, *i.e.*, inter-cluster distances, the maximum divergence was observed between clusters VII and VIII ($D^2 = 2529.309$) followed by clusters II and VIII ($D^2 = 2468.526$), clusters III and VIII ($D^2 = 2375.261$), clusters IV and VIII ($D^2 = 2135.756$), clusters I and V ($D^2 = 2113.780$), clusters V and VII ($D^2 = 1873.662$), clusters VI and VIII ($D^2 = 1747.706$), clusters II and V ($D^2 = 1720.367$), clusters I and V ($D^2 = 1573.064$), clusters III and V ($D^2 = 1542.525$), clusters IV and V ($D^2 = 1539.122$), clusters V and VIII ($D^2 = 1388.386$), clusters V and VI ($D^2 = 1346.202$). Cluster I had the least inter- cluster distance ($D^2 = 90.332$) with the

cluster III. It is desirable to select accessions from clusters having high inter-cluster distance and with high fruit yield as parents in the recombination breeding programmes.

Ascorbic acid (26.7495 %) contributed maximum to the total genetic diversity among the accessions followed by dry red chilli yield per plant (19.4203 %), average fruit weight (10.3520 %), early green fruit yield per plant (9.8551 %), number of fruits per plant (8.7371 %), total green fruit yield per plant (8.4472 %) , leaf area index at 45 DAT (3.1056 %), plant spread from east to west at 45 DAT(2.9814), fruit length diameter ratio (2.5259 %), fruit diameter (2.0290 %), fruit length (1.6563 %), per cent dry matter in fruit (1.1594 %), number of primary branches per plant at 45 DAT (0.7867 %), plant spread from east to west at 90 DAT (0.6625 %), leaf area index at 90 DAT (0.4555 %), days to first flowering (0.4555 %), days to 50 per cent flowering (0.2899 %), plant height at 90 DAT (0.1242 %), plant spread from north to south at 90 DAT (0.1242 %) and number of primary branches per plant at 90 DAT (0.0828 %). Characters like plant height at 45 DAT, plant spread from north to south at 45 DAT, stem girth at 45 DAT, stem girth at 90 DAT did not contribute to divergence.

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Appendix-I

Meteorological data recorded during the period of experimentation from Agricultural Research Station, Dharwad- 2014

Month	Temperature (C ⁰)		Relative Humidity (%)		Rain fall (mm)	Rainy days
	Maximum	Minimum	Maximum	Minimum		
January 2014	29.50	14.70	66.60	38.10	0.00	0.00
February 2014	31.10	16.10	55.80	32.10	0.00	0.00
March 2014	34.50	18.50	56.40	25.40	11.40	1.00
April 2014	36.40	21.10	65.30	36.70	44.90	3.00
May 2014	33.70	21.10	75.50	51.30	197.20	7.00
June 2014	31.00	21.50	84.60	63.40	29.20	4.00
August 2014	26.80	20.50	91.30	82.70	158.40	19.00
September 2014	28.00	20.30	87.40	75.40	100.20	8.00
October 2014	29.70	19.70	82.30	69.70	103.40	7.00
November 2014	29.00	15.50	72.50	49.00	48.80	2.00
December 2014	27.90	14.60	76.90	52.60	26.20	1.00
Total				961.90	69.00	

Appendix – II

Fruit colour of chilli accessions

Sl.No.	Accessions	Fruit colour
01	BDS-01	Fruits dark red
02	BDS-02	Fruits medium red
03	BDS-03	Fruits dark red
04	BDS-04	Fruits medium red
05	BDS-05	Fruits medium red
06	BDS-06	Fruits dark red
07	BDS-07	Fruits dark red
08	BDS-08	Fruits dark red
09	BDS-09	Fruits light red
10	BDS-10	Fruits light red
11	BDS-11	Fruits light red
12	BDS-12	Fruits dark red
13	BDS-13	Fruits dark red
14	BDS-14	Fruits medium red
15	BDS-15	Fruits medium red
16	BDS-16	Fruits dark red
17	BDS-17	Fruits medium red
18	BDS-18	Fruits dark red
19	BDS-19	Fruits medium red
20	BDS-20	Fruits light red
21	BDS-21	Fruits dark red
22	BDS-22	Fruits dark red
23	BDS-23	Fruits medium red
24	BDS-24	Fruits light red
25	BDS-25	Fruits dark red
26	BDS-26	Fruits medium red
27	BDS-27	Fruits dark red
28	BDS-28	Fruits dark red
29	BDS-29	Fruits dark red
30	BDS-30	Fruits medium red
31	BDS-31	Fruits dark red
32	BDS-32	Fruits light red
33	BDS-33	Fruits dark red
34	BDS-34	Fruits dark red

Appendix II Contd...

SI.No.	Accessions	Fruit colour
35	BDS-35	Fruits medium red
36	BDS-36	Fruits medium red
37	BDS-37	Fruits dark red
38	BDS-38	Fruits light red
39	BDS-39	Fruits dark red
40	BDS-40	Fruits light red
41	BDS-41	Fruits dark red
42	BDS-42	Fruits dark red
43	BDS-43	Fruits medium red
SI.No.	Accessions	Fruit colour
44	BDS-44	Fruits light red
45	BDS-45	Fruits dark red
46	BDS-46	Fruits light red
47	BDS-47	Fruits dark red
48	BDS-48	Fruits dark red
49	BDS-49	Fruits medium red
50	BDS-50	Fruits medium red
51	BDS-51	Fruits dark red
52	BDS-52	Fruits dark red
53	BDS-53	Fruits medium red
54	BDS-54	Fruits dark red
55	BDS-55	Fruits dark red
56	BDS-56	Fruits medium red
57	BDS-57	Fruits light red
58	BDS-58	Fruits dark red
59	BDS-59	Fruits medium red
60	BDS-60	Fruits dark red
61	BDS-61	Fruits medium red
62	BDS-62	Fruits dark red
63	BDS-63	Fruits dark red
64	BDS-64	Fruits dark red
65	BDS-65	Fruits dark red
66	BDS-66	Fruits dark red
67	BDS-67	Fruits medium red
68	BDS-68	Fruits dark red
69	BDS-69	Fruits dark red
70	BDS-70	Fruits dark red

Appendix III

Reaction of chilli accessions to anthracnose

Sl. No.	Reaction	Amount of disease Percentage of Disease Index (PDI)	Accessions
1	Immune	No infection	BDS- 1, BDS-3, BDS- 12, BDS- 13, BDS- 14, BDS- 15, BDS- 16, BDS-17, BDS-20, BDS- 21, BDS- 24, BDS- 26, BDS- 27, BDS- 29, BDS- 33, BDS- 34, BDS- 39, BDS- 43, BDS- 44, BDS- 47, BDS- 48, BDS- 49, BDS- 53, BDS- 54, BDS- 56, BDS- 57, BDS- 58, BDS- 63, BDS- 64, BDS- 65 , BDS-67, BDS- 68, BDS- 69, BDS- 70
2	Resistant	1 - 5 % disease	BDS- 2, BDS- 28, BDS- 42, BDS- 59
3	Moderately resistant	6 - 25 % disease	BDS- 4,BDS- 5, BDS- 7,BDS- 8, BDS- 9,BDS-10,BDS- 11, BDS-18, BDS- 30, BDS- 31, BDS-36, BDS- 37 , BDS-40, BDS- 41, BDS- 45, BDS- 50, BDS- 51, BDS- 52, BDS- 55, BDS- 61, BDS- 62, BDS- 66
4	Susceptible	26 - 50 % disease	BDS- 6, BDS- 19, BDS – 23, BDS- 35,BDS- 38, BDS- 60
5	Highly Susceptible	51 - 100 % disease	BDS- 22, BDS- 25, BDS- 32, BDS-46

Appendix IV

Reaction of chilli accessions to leaf curl index

SI. No.	Reaction	Amount of disease Percentage of Disease Index (PDI)	Accessions
1	Symptomless (SL)	No symptoms	BDS- 1, BDS-3, BDS-9 , BDS-12, BDS-15 , BDS- 16, BDS- 17 , BDS- 20, BDS-21, BDS- , BDS-23 , BDS- 24 , BDS-29, BDS-30, BDS-31, BDS-, BDS- 34, BDS-35, BDS-37, BDS-38, BDS-39, BDS-43, BDS-44, BDS-45, BDS- 47 , BDS-49, BDS-51, BDS-53, BDS-55, BDS- 56 , BDS-61, BDS-65, BDS-67, BDS-69, BDS-70
2	Highly resistant (HR)	1 - 5 % disease	-
3	Resistant (R)	6 - 25 % disease	BDS-5 , BDS-33 , BDS-36 , BDS- 40, BDS-42 , BDS- 48, BDS-50 , BDS-52, BDS-54, BDS-59 , BDS-60, BDS-63 , BDS-64 , BDS-66 , BDS-68
4	Moderately susceptible (MS)	26 - 50 % disease	BDS-4 , BDS-8 , BDS-10 , BDS-11,BDS- 13, BDS- 19, BDS- 27, BDS-28, BDS- 41, BDS-46, BDS- 58,
5	Susceptible (S)	51 - 75 % disease	BDS- 18 , BDS-62
6	Highly susceptible (HS)	More than 75 %	BDS- 2, BDS- 7, BDS- 26, BDS- 46

**GENETIC VARIABILITY AND DIVERGENCE STUDIES IN BYADAGI
CHILLI (*Capsicum annuum* L.)**

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2015

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ABSTRACT

Seventy chilli accessions were evaluated in randomized block design with two replications to study the variability, divergence and correlation studies at Regional Horticultural Research and Extension Center, Kumbapur (Dharwad). Analysis of variance revealed that highly significant ($P= 0.05$) difference among accessions for all the growth, earliness, yield and quality parameters. Very high GCV and PCV were observed for ascorbic acid content and high GCV and PCV was observed for average fruit weight, leaf area index at 45 DAT, fruit diameter, number of fruits per plant, total green fruit yield per plant and dry red chilli yield per plant. Very high heritability coupled with very high GAM were observed for the characters fruit diameter, average fruit weight, number of fruits per plant, early green fruit yield per plant, total green fruit yield per plant and dry red chilli yield per plant. Therefore, additive component is predominant here. Thus, there is ample scope for improving these characters through direct selection.

Total green fruit yield per plant was positively and significantly associated with early green fruit yield per plant, number of fruits per plant, average fruit weight, fruit diameter, plant height at 45 DAT, per cent dry matter in fruit and stem girth at 90 DAT. Path analysis revealed that highest positive direct effects on total green yield per plant was shown by early green fruit yield per plant followed by number of fruits per plant.

By following Mahalanobis D^2 analysis, 70 accessions of chilli were grouped into 8 clusters. The cluster V showed maximum intra –cluster distance and the maximum inter- cluster distance was observed between clusters VII and VIII. Ascorbic acid (26.74 %) followed by dry red chilli yield per plant (19.42 %) contributed maximum to the total genetic diversity. Highest cluster mean for total green fruit yield per plant was observed in the cluster VIII followed by cluster V. Maximum divergence was observed between these clusters. Hence the crosses between accessions of these clusters may be tried for improvement of yield. The high yielding accessions BDS- 66, BDS-27, BDS-21, BDS- 67 and BDS-36 can be further assessed for stability before exploiting them for future use.

[illegible]