

GENETIC DIVERSITY IN CHILLI

(Capsicum annum L.)

BY

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B. Sc. (Hort.)

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PARBHANI - 431402 (M.S.), INDIA
2018**

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DISSERTATION

*Submitted to the
Vasantao Naik Marathwada Krishi Vidyapeeth, Parbhani
in partial fulfillment of the
requirements for the award of the degree of*

MASTER OF SCIENCE
(HORTICULTURE)
IN
VEGETABLE SCIENCE

DEPARTMENT OF HORTICULTURE,
COLLEGE OF AGRICULTURE,
VASANTRAO NAIK MARATHWADA KRISHI VIDYAPEETH,
PARBHANI - 431402 (M.S.), INDIA
2018

CANDIDATE'S DECLARATION

I, hereby declare that, the entire work
embodied
in this dissertation or part thereof,
has not been previously submitted
by me for a degree of
any University or
Institution.

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Date: 31/05 /2018

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CERTIFICATE-I

This is to certify that **Mr. LANGUTE HANMANT NANA** Reg. No. **2016/13M** has satisfactorily prosecuted his course credits and research for a period of not less than two years and the dissertation entitled "**GENETIC DIVERSITY IN CHILLI (*Capsicum annum* L.)**" submitted by him is the result of original research work and is of sufficiently high standard to warrant its presentation to the examination for the award of the degree of **MASTER OF SCIENCE (Horticulture)** in the subject of **VEGETABLE SCIENCE**.

I also certify that the dissertation or part there of has not been previously submitted by him for a degree of any University or institution.

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CERTIFICATE-II

This is to certify that the dissertation entitled "**GENETIC DIVERSITY IN CHILLI (*Capsicum annum* L.)**" submitted by **Mr. LANGUTE HANMANT NANA** (Reg.No.2016HT/13M) to the Vasantrya Naik Marathwada Krishi Vidyapeeth, Parbhani in partial fulfillment of the requirement for the degree of **MASTER OF SCIENCE (Horticulture)** in the subject of **VEGETABLE SCIENCE** has been approved by the student's advisory committee after oral examination in collaboration with the external examiner.

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To succeed in your mission, you must have single -minded devotion to your goal
-Dr.A.P.J.Abdul kalam.

"Hard work never fail, Set your goal work hard achieve it, Success in a life"

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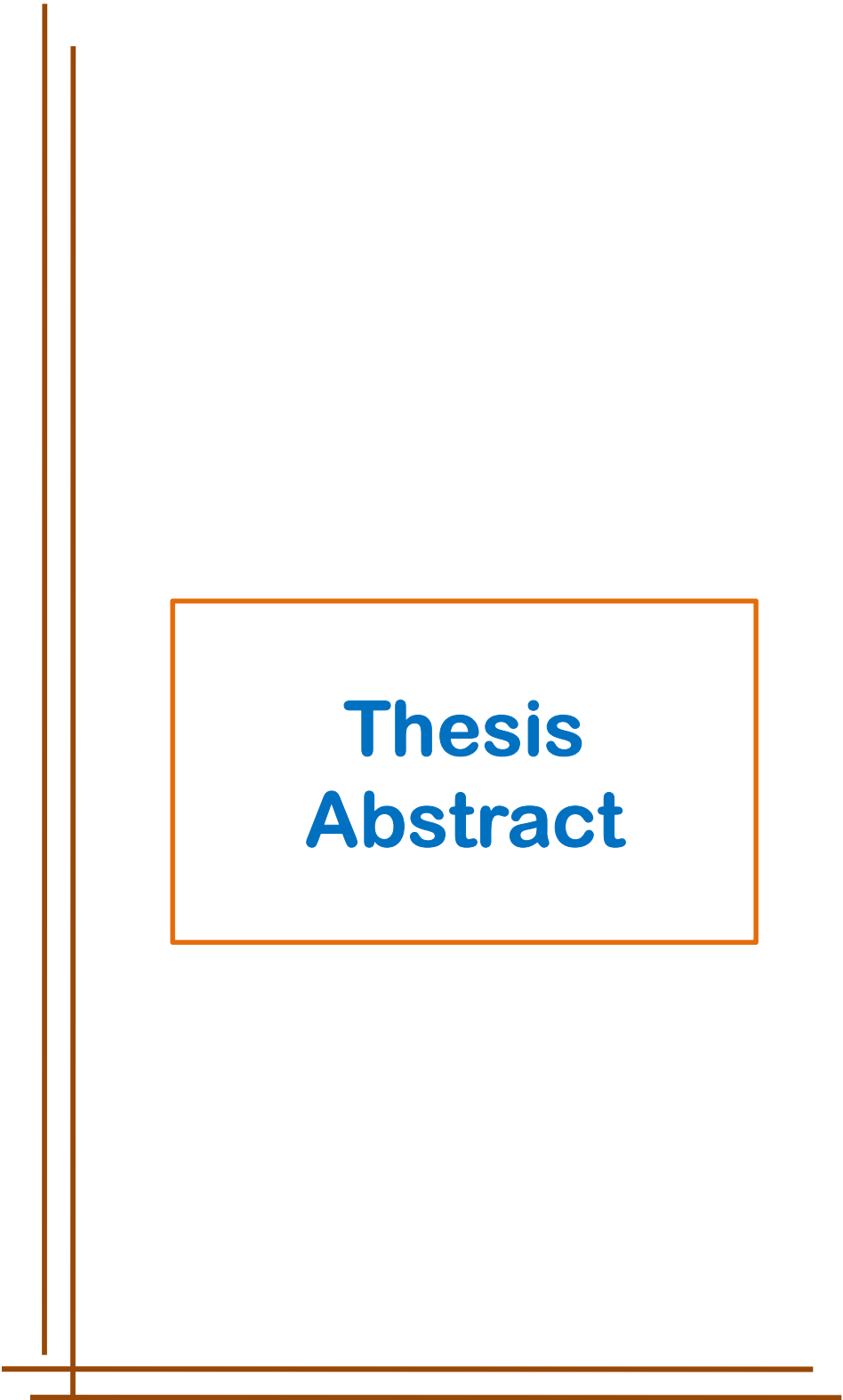
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ABBREVIATIONS

@	-	at the rate
%	-	per cent
/	-	per
CD	-	Critical difference
cm	-	Centimeter
CV	-	Coefficient of variance
DF	-	Degrees of freedom
e.g.	-	Exempli gratia
<i>et al.</i>	-	Et alia (and associates)
etc.	-	Et cetera
Fig.	-	Figure
g	-	Grams
G	-	Genotypic
GA	-	Genetic advance
GCV	-	Genotypic coefficient of variation
ha	-	Hectare
i.e.	-	That is
kg	-	Kilogram (s)
m	-	Meter
mm	-	Millimeter
MPA	-	Meta phosphoric acid
MSS	-	Mean sum of squares
No.	-	Number
P	-	Phenotypic
PCV	-	Phenotypic coefficient of variation
q	-	Quintal
r	-	Correlation coefficient
SE $\pm$	-	Standard error
Sig.	-	Significant
TSS	-	Total soluble solid
<i>Viz.</i>	-	Videlicet (namely)

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Thesis Abstract

ABSTRACT

GENETIC DIVERSITY IN CHILLI (*Capsicum annum* L.)

By

LANGUTE HANMANT NANA

A candidate for the degree of

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In

VEGETABLE SCIENCE

College of Agriculture, Parbhani

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Research Guide	:	Dr. D.P. Waskar
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The present investigation was undertaken to estimate the genetic divergence in Chilli and to carry out yield component analysis through correlation and path analysis. Eighteen genotypes were sown in a randomized block design with two replications, during *Kharif*, 2017-2018 at Horticulture Research Scheme (Vegetable), College of agriculture, VNMKV, Parbhani, Maharashtra.

The D^2 analysis was carried out for twenty eight characters which partitioned the eighteen genotypes into five clusters. The maximum genetic divergence was observed between clusters II and V (123.16). The maximum intra cluster distance was shown by cluster IV (44.59). The characters *viz.*, number of seeds per fruit, yield per plot, days to last picking, fruit length, plant spread N-S, plant spread E-W, plant height, number of branches per plant, yield per hectare, fruit girth and days to 50% flowering contributed greatly towards diversity. The clusters showed high genetic divergence that could be effectively utilized in heterosis breeding programme. If a breeding programme is used at improving nutritional characters, then cluster III (90.25) showing maximum ascorbic acid that can be utilized in breeding programme.

The analysis of variance revealed significant difference for twenty eight characters studied suggesting considerable amount of variability exists among the genotypes. Wide range of variability was observed for plant height, number of leaves per plant, fruit length, pedicel length, number of fruits per plant, number of seeds per fruit and fruit yield per plant indicating the scope for selection of suitable initial breeding material for further improvement.

GA as percent of mean, GCV and PCV values are on par with each other for most of the characters that the influence of the environment on the traits. The values observed are not confounding with the environment. It is a true to the reflection of the homeostasis effect or buffer reaction of the gene. Thus, the true reflection of the trait is exhibited.

In a true agreement with the GCV and PCV values in the present investigation for the twenty eight characters was noticed, indicating additive genetic variance governing the high heritability with genetic advance as percent of mean. Thus a breeder can employ a simple selection process which will be a rewarding one to improve the characters *viz.*, plant spread, number of leaves per plant, number of picking, yield per plant, number of seeds per fruit, capsaicin, pericarp thickness.

From correlation studies it was observed that fruit yield per plant was recorded positive significant correlation with characters number of branches per plant (0.2827 P, 0.4704 G), plant spread N-S (0.4432 P, 0.1963 G), plant spread E-W (0.3806 P, 0.5905 G), number of leaves per plant (0.0808 P, 0.3269 G), days to 50% flowering (0.0283 P, 0.1160 G), day to 50% fruit set (0.0865 P, 0.2270 G), days to last picking (0.3528 P, 0.6643 G), fruit length (0.5309 P, 0.8016 G), fruit girth (0.3436 P, 0.4414 G), number of fruits per plant (0.8651 P, 1.1316 G), pedicel length (0.2929 P, 0.1963 G), yield per hectare (0.8189) and it was noticed significant negative correlation with plant height (-0.1261 P, -0.5619 G), pericarp thickness (-0.2025 P, -0.3246 G). Ascorbic acid (0.26165 G) and capsaicin (0.0610 G) has recorded positive and significant association with fruit yield per plant at genotypic level.

Path analysis revealed that maximum positive indirect effect on fruit yield per plant was exhibited yield per hectare (1.2672) followed by number of fruits per plant (1.1316), and fruit length (0.8016) at genotypic level, Whereas; number of fruits per plant (0.8651), yield per hectare (0.8189) and fruit length (0.5309) at phenotypic level.

Therefore, it is emphasized to lay attention on these traits like, number of fruits per plant and fruit weight in crop improvement programme of chilli in future.

On the basis of the mean performance of the genotypes among traits studied, the promising lines and fruit weight for further crop improvement in chilli were identified *viz.*, Pusa Sadabahar, Pusa Jwala, Byadgi-341, Ajooba.

CHAPTER - I

Introduction

CHAPTER- I

INTRODUCTION

Chilli (*Capsicum annum* L.) is an important cash crop grown for national and international market. It is native of new world tropics, which was brought to India by Portuguese prior to year 1785. Centre of origin of chilli is Mexico while Guatemala is secondary centre of origin (Salvador, 2002). Diploid chromosome number of chilli is $2n=24$. Genus *Capsicum* belongs to family Solanaceae and comprises about twenty species (Gadaginmath, 1992).

India is the largest producer, consumer and exporter of chilli, which contributes about 40 percent of total world production. In India chilli occupied an area of 24.00 lakh hectare with annual production of 321.00 lakh MT and its productivity is 13.38 MT/ha. Maharashtra contribute 1.60 lakh hectare area with annual production of 18.68 lakh MT/ha its productivity is of 11.68 MT/ha (Anon, 2017). In India, Andhra Pradesh is the largest producer of chilli contributing to about 44 percent to the total production, followed by Karnataka (12%), West Bengal (8%), Madhya Pradesh (7%), Maharashtra (4%) and Tamil Nadu (2%) (Anon, 2017). The major chilli growing districts in Maharashtra are Nagpur, Chandrapur, Dhule, Nanded, Pune, Kolhapur, Amravati, Jalgaon, Beed, Aurangabad, Nasik and Yawatmal.

It is indispensable vegetable cum spice crop in every home of the tropical countries. It is used for its pungency, colour and taste. Green chillies are rich in vitamin A, E and C and seed contains traces of starch (Hosmani, 1993). The fruits of chilli also contain a fixed oil, red colouring matter which is non pungent and yields 20 to 25% alcoholic extract. Red chilli fruit contains dry matter 22.02%, Ascorbic acid 131.06 mg/100g (fresh weight), oleoresin 66.53 ASTA units, colouring matter 67.38 ASTA units, capsaicin 0.34% (dry weight), crude fibre 26.75% and total ash 6.69%. The food value of green chilli (per100 g of edible portion) are moisture (85.70g), protein (2.90g), fat (0.60g), minerals (1g), fibre (6.80g), carbohydrates (3g), calcium (30mg), magnesium (24mg), riboflavin (0.39mg), oxalic acid (67mg), nicotinic acid (0.90mg), phosphorous (80mg), iron (1.20mg), sodium (6.50mg), copper (1.55mg), chlorine (15mg), thiamine (0.19mg), vitamin A (292I.U.) and vitamin C (111mg), (Bose *et al.* 2002).

Chillies are widely used throughout the tropics and are major ingredients of curry powder in the culinary preparations. Extracts of chillies are used in the production of ginger beer and beverages. Chillies are also rich in 'rutin' which is of immense pharmaceutical needs. It is specially used for its pungency, spicy taste, besides the appealing colour it adds to the food. It is used in pickles, sauces, ketchup, essences, oleoresins and it is an inevitable ingredient in Indian dishes. Capsaicin has significant physiological action which is used in many pharmaceutical preparations like ointments for cold, throat infection, chest congestion etc. It is also used in cosmetics like prickly heat powders and skin ointments. Capsanthin which is colouring principle in chilli is used as colouring agent for preparation of jams and sauces. Due to its wide utility, demand of chilli is increasing day by day (Janaki, 2016).

However, the statistics for area and production of green chilli is lacking through lot of area is under green chilli production. The productivity of crop is low and there is need for development of new varieties and hybrids with high productivity. A critical estimate and study of genetic variability is pre-requisite for initiating appropriate breeding procedure for effective selection of superior genotype. The partitioning of total variability into heritable and non-heritable components by using suitable design will enable the breeders to know whether the superiority of selection is inherited by the progenies. Since, natural genetic variation for most of the yield contributing characters is considerably high in chillies. There is an urgent need of information on the nature and magnitude of variation available in the material and part played by environment in expression of different characters (Amit, 2014).

Genetic diversity is an important factor for any heritable improvement. Knowledge of genetic diversity, its nature and degree is useful for selecting desirable genotypes from a germplasm for the successful breeding programme. The value of germplasm collection depends not only on the number of accessions but also depend upon the magnitude of genetic diversity present in those accessions. The wide genetic diversity that exists in the available genotypes provides ample scope for further improvement. Yield being a complex quantitative character, direct selection for yield may not result in successful improvement. Information on character association and direct and indirect effects of component traits on yield would greatly help in formulating the selection criteria and using them effectively in crop improvement programme. Therefore, it is necessary to partition the observed

variability into heritable and non-heritable components by calculating genetic parameters such as genotypic and phenotypic coefficient of variation, heritability and genetic advance (Vanitha, 2017).

Co-efficient of variation is useful in the assessment of genetic variability for the particular characters. Heritability denotes the proportion of phenotypic variation due to genotypes thus help the breeders to select the elite variety for a character. Genetic advance denotes the improvement in the mean genotypic values of selected families over base population and thus helps the breeder to select the progenies in the earlier generation itself (Murmu, 2017).

Correlation and path coefficient analysis gives an insight into the genetic variability present in population. Correlation coefficient analysis measure the mutual relationship between various plant characters and determines the component characters on which selection can be based for improvement in yield. Path analysis splits the correlation coefficients into direct and indirect effects of a set of dependent variables on the independent variable thereby aids in the selection of elite genotype. All the above mentioned parameters are the pre-requisites to formulate the sound and successful breeding programme (Bijalwan, 2016).

A wide range of genetic variability and large number of distinct forms distributed all over country provides the maximum opportunity for genetic improvement not only for high yield but also for better quality, resistance to various biotic and abiotic stresses and consumer acceptability (Maurya, 2015).

Keeping in view the above facts, the present investigation was undertaken to estimate magnitude of components of variation, heritability and genetic advance in 18 genotypes of chilli.

Hence, present investigation entitled ‘Genetic diversity in chilli (*Capsicum annum* L.) was undertaken with following objectives.

1. To estimate variability parameters, correlation and path analysis for yield and its components.
2. To measure genetic divergences between and among different genotypes and group them into suitable cluster.
3. To identify diverse parameter for hybridization.



CHAPTER - II



Review of Literature

CHAPTER-II

REVIEW OF LITERATURE

Chilli is one of the most important and popular vegetable cum spice crop. Number of workers had studied various aspects in chilli, the available literature on these aspects is reviewed under appropriate heads and subheads.

2.1 Growth parameter

2.1.1. Plant height

Dixit *et al.* (2003) stated five varieties of chilli. In this Pusa Jwala showed the maximum plant height (95.98 cm).

Choudhari and Samadia (2004) conducted research on variability of thirty chilli genotype and revealed that high degree of heritability was observed among thirty genotypes regarding plant height (48.21 cm).

Jagdeesha and Wali (2005) investigated eighteen divergent lines of chilli and F₁ hybrids for variability in phenotypic characters. They reported that the maximum plant height (62.80 cm) was observed in F₁ of cross B-kaddi x Co-2, followed by F₁ of cross B-kaddi x KDC-1 (62.70 cm)

Singh *et al.* (2005) studied thirty one local chilli cultivars for variability in phenotypic characters. They revealed that high values of genotypic variance was (497.29) was observed for plant height, while phenotypic variance was (614.29), values for plant height was ranged from 40.90 to 133.43 cm. Mean plant height was (89.80 cm)

Kameswari *et al.* (2006) evaluated yield performance of four varieties of chilli for two years. The result revealed that the genotype CA-960 recorded the maximum plant height (87.34 cm) in year 2000 while the local genotype recorded the maximum plant height (69.25 cm) in the year 2001. Less variation was observed in plant height of LCA-324 (61.60 cm) in the year 2000 while (61.15 cm) in the year 2001.

Gogate *et al.* (2006) analyzed eleven clusters of chilli for genetic divergence. Result showed that cluster VII was notified for the highest plant height (84.96 cm) which included two genotypes viz; ACG 291 and ACG 349. Cluster II

showed lowest plant height (54.20 cm) which included three genotypes ACS 98-4, ACS 2000-02 and ACS 2000-09.

Dutonde *et al.* (2006) studied genetic variability and heritability in forty genotype of chilli. They revealed that plant height was observed in the range of 45 to 114.67 cm with mean plant height 76.69 cm. The genetic coefficient of variance was noted as 21.65 while phenotypic coefficient of variance was 22.31 for plant height. Plant height showed heritability of 94.20 per cent.

Babar (2008) reported that plant height in Parbhani Tejas was 62.33 cm at 120 days after transplanting.

Ajjapplavara and Channagoudra (2009) conducted study on genetic variability and genetic advance for eighteen different quantitative characters in thirty six genotypes. Result showed that genotype VN-2 recorded the maximum plant height (76.83 cm) followed by LCA-300 (76 cm). Mean plant height was 59.89 cm.

Meena *et al.* (2016) conducted field experiment on twenty genotypes of chilli and reported that maximum plant height is 37.43 cm and minimum is 28 cm.

Janaki *et al.* (2016) studied sixty three genotypes of chilli was assessed using Mahalanobis D^2 analysis revealed that maximum mean plant height in cluster VI (107.35 cm).

Sahu *et al.* (2016) conducted experiment on nineteen genotypes of chilli. He reported that highest fruit plant height is 2014/CHIVAR-5 (83.85 cm) and minimum is Kashi Anmol-2 (45.47 cm).

2.1.2 Number of branches per plant

Smitha *et al.* (2006) conducted experiment on fourty genotypes of chilli the divergence analysis using Mahalanobis D^2 statistic indicated that cluster H was agronomically superior for number of branches per plant.

Babar (2008) reported that number of branches in Parbhani Tejas was 5.06 at 120 days after transplanting.

Ajjapplavara and Channagoudra (2009) conducted research on genetic variability and genetic advance for eighteen different characters in thirty six genotypes. Study revealed that the maximum number of branches per plant (5.53) was

observed in the genotype LCA-312 and lowest number of branches per plant (3.14) was observed in genotypes Dyavnoor Kaddi and Pant C-1.

Maurya *et al.* (2015) concluded field experiment on thirty genotypes of chilli and reported that maximum number of branches per plant is 12.00.

Meena *et al.* (2016) conducted field experiment on twenty genotypes of chilli and reported that maximum number of branches per plant is 6.67 and minimum is 3.00.

Janaki *et al.* (2016) studied sixty three genotypes of chilli was assessed using Mahalanobis D^2 analysis revealed that maximum mean number of branches per plant in cluster IV (3.95).

Sahu *et al.* (2016) conducted experiment on nineteen genotypes of chilli. He reported that highest number of branches per plant is 2014/CHIVAR-2 (15.33) and minimum is LCA-334 (11).

2.1.3 Plant Spread

Smitha *et al.* (2006) conducted experiment on fourty genotypes of chilli the divergence analysis using Mahalanobis D^2 statistic indicated that cluster GLC-4 was agronomically superior for plant spread.

Maurya *et al.* (2015) concluded field experiment on thirty genotypes of chilli and reported that mean canopy width is 52.70 cm.

2.1.4 Stem girth

Sahu *et al.* (2016) conducted experiment on nineteen genotypes of chilli they analysis of variance revealed that mean sum of square due to genotypes were highly significant for all characters. He reported that highest stem girth is 2012/CHIVAR-8 (5.67 cm) and minimum is 2014/CHIVAR-4 (4.17 cm).

2.1.5 Number of leaves per plant

Gogoi and Gautam (2002) studied genetic variability for various characters in fifty two genotypes of chilli and reported that number of leaves were within range of 96.7 to 202.83 with a mean of 146.35.

2.2 Reproductive growth parameters:

2.2.1 Days to first flowering

Gund (2007) reported that the genotype SKAUC 101 (44.17) was earliest to flower while BC-40-2 (54.87) was late to flower.

Sahu *et al.* (2016) conducted experiment on nineteen genotypes of chilli. He reported that highest days to first flowering is Indira Mirch-1 (69.33) and minimum is 2012/CHIVAR-8 (40.33).

2.2.2 Days to 50% flowering

Babar (2008) reported that days to 50% flowering in Parbhani Tejas were 64.70 days after transplanting.

Ajjaplavara and Channagoudra (2009) conducted study on genetic variability and genetic advance for eighteen different quantitative characters in thirty six genotypes. They observed that the genotype GPC-82 recorded the maximum number of days to 50% flowering and KDC-1 showed 50% flowering in 38 days followed by 39.67 days in Byadgi and Lokur local. Mean for 50% flowering was 41.82 days.

Maurya *et al.* (2015) concluded field experiment on thirty genotypes of chilli and reported mean days to 50% flowering is 46.67.

Meena *et al.* (2016) conducted field experiment on twenty genotypes of chilli and reported that days to 50% flowering is 55.33 and minimum is 33.92.

Janaki *et al.* (2016) studied sixty three genotypes of chilli was assessed using Mahalanobis D^2 analysis revealed that maximum mean days to 50% flowering in cluster VI (28.50).

Sahu *et al.* (2016) conducted experiment on nineteen genotypes of chilli. He reported that highest days to 50% flowering is 2012/CHIVAR-2 (64.33) and minimum is 2012/CHIVAR-6 (47).

2.2.3 Days 50% Fruit set

Babar (2008) observed that the genotypes BSS-353 (73.33 days), BSS-414 (71.33 days), Maina (70.46 days) were found late for number of days to 50% fruit

set, while ARCH-438 (60.66days) was earlier. He reported that days to 50% fruit set in Parbhani Tejas were 39.66.

2.2.4 Days to first picking

Babar (2008) observed that the genotype AKC-406 (58.36 days) was earliest to first fruit picking followed by BSS-353 (59.50 days). It was 63.66 days in Parbhani Tejas.

Meena *et al.* (2016) conducted field experiment on twenty genotypes of chilli and reported that maximum days to first harvest is 95.96 and minimum is 72.92.

Sahu *et al.* (2016) conducted experiment on nineteen genotypes of chilli. He reported that highest days to first picking is Indira Mirch-1 (97.67) and minimum is 2012/CHIVAR-8 (80.33)

2.2.5 Days to last picking

Sahu *et al.* (2016) conducted experiment on nineteen genotypes of chilli. He reported that highest days to last picking is 2014/CHIVAR-9 (175) and minimum is 2012/CHIVAR-8 (165).

2.2.6 Number of picking

Sahu *et al.* (2016) conducted experiment on nineteen genotypes of chilli. He reported that highest number of picking is 2014/CHIVAR-9 (6.33) and minimum is 2012/CHIVAR-2 (4.83).

2.3 Fruit parameters

2.3.1 Fruit length

Munshi and Behra (2000) studied genetic variability, heritability and genetic advance for different yield contributing characters thirty germplasms of chilli and reported that the length of fruit was maximum (12.35 cm) in Mathania local-1 followed by 10.52 cm in Mathania local-2 and minimum (2.16 cm) in Orissa local-1.

Mishra *et al.* (2001) studied genetic parameter of variability for fruit characters and the relationship among them in a lot of nine cultivars of chilli. They reported that the cultivar Utkal Rashmi was observed for the maximum length of fruit

(7.24 cm) while G-2 for minimum length of fruit (3.34 cm). Mean length of fruit was observed as (4.29 cm).

Singh *et al.* (2005) conducted an experiment on path analysis of component traits of yield in chilli in twenty seven genotypes. Genotype C-8304 showed the maximum value for fruit length (10.83cm) while Chanchal showed lowest value (2.29 cm).

Gogate *et al.* (2006) analyzed variance in fifty five genotypes of chilli which was clustered into eleven clustered on the basis of D^2 values and reported that average fruit length was maximum (9.90 cm) in cluster X which included only one genotype ACG-215 while minimum (6.48 cm) in cluster VI which included two genotypes ACG-245 and ACS 92-3.

Kameswari *et al.* (2006) studied yield performance of chilli for subsequent two years and reported that local genotype recorded maximum length of fruit (11.28 cm) in the year 2000 and LCA 324 (8.5 cm) in 2001.

Smitha *et al.* (2006) conducted experiment on fourty genotypes of chilli the divergence analysis using Mahalanobis D^2 statistic indicated that cluster H (11.95 cm) was agronomically superior for fruit length.

Lakshmi and Naidu (2008) studied five genotypes for variability and correlation, mean length of fruit was 7.47 cm which was ranged from 5.88 to 9.75 cm.

Ajjapplavara and Channagoudra (2009) conducted study on genetic variability and genetic advance for eighteen different quantitative characters in thirty six genotypes. They studied that genotype DH-5 recorded the maximum length of fruit (11.25 cm) while Kadrolli local recorded lowest length of fruit (1.41cm). Mean length of fruit was 7.07cm.

Munshi *et al.* (2000) studied genetic variability in different characters of chilli and reported that the maximum value for length of fruit was observed as 12.84 cm, while minimum value 5.96 cm.

Maurya *et al.* (2015) concluded field experiment on thirty genotypes of chilli and reported that maximum fruit length is 6.86 cm.

Meena *et al.* (2016) conducted field experiment on twenty genotypes of chilli and reported that maximum fruit length is 8.03 cm and minimum is 5.03 cm.

Janaki *et al.* (2016) studied sixty three genotypes of chilli was assessed using Mahalanobis D^2 analysis revealed that maximum mean fruit length in cluster VII (9.92 cm).

Sahu *et al.* (2016) conducted experiment on nineteen genotypes of chilli. He reported that highest fruit length is 2012/CHIVAR-3 (12.53 cm) and minimum is 2014/CHIVAR-8 (6 cm).

2.3.2 Fruit girth

Smitha *et al.* (2006) conducted experiment on fourty genotypes of chilli the divergence analysis using Mahalanobis D^2 statistic indicated that cluster H was agronomically superior for fruit girth. Highest fruit girth is 0.86 cm.

Kumari *et al.* (2010) studied ninety four genotypes of chilli. He reported that maximum fruit girth is LCA-448 (4.6 cm) and minimum is LCA-404 (1.25 cm).

Meena *et al.* (2016) conducted field experiment on twenty genotypes of chilli and reported that fruit girth is 1.60cm and minimum is 0.70 cm.

Janaki *et al.* (2016) studied sixty three genotypes of chilli was assessed using Mahalanobis D^2 analysis revealed that maximum mean fruit girth in cluster VIII (3.18 cm).

Sahu *et al.* (2016) conducted experiment on nineteen genotypes of chilli. He reported that highest fruit girth is 2012/CHIVAR-4 (8.97 cm) and minimum is Kashi Anmol-2 (3.43 cm).

2.3.3 Length of Pedicel

Shirshat *et al.* (2007) conducted experiment on seventy two genotypes of chilli and estimates that phenotypic coefficient of variation was higher than genotypic coefficient of variation for all characters indicating the influence of environment on these characters. Maximum length of pedicel is 3.10 cm and minimum length of pedicel is 1.83 cm.

Meena *et al.* (2016) conducted field experiment on twenty genotypes of chilli and reported that maximum length of pedicel is 3.30 cm and minimum is 2.57 cm.

Murmu *et al.* (2017) conducted experiment on twenty four genotypes of chilli concluded that among these genotype maximum length of pedicel in AC-573 (3.42 cm) and minimum in (2.07 cm).

2.4 Yield parameter

2.4.1 Number of fruits per plant

Munshi and Behra (2000) reported that the maximum number of fruits was recorded as (137.51) while the minimum (24.93).

Mishra *et al.* (2001) studied and reported that the maximum number of fruits (58.53) per plant was observed in G-3 while minimum (21.86) in Bhusimal local.

Dixit *et al.* (2003) tested five varieties of chilli. In Pusa Jwala showed the maximum number of fruits per plant (550.25).

Singh *et al.* (2005) conducted an experiment on path analysis of component traits of yield in chilli in twenty seven genotypes and reported that number of fruits per plant was observed within range 50.82 to 48 with mean of 90.42.

Gogate *et al.* (2006) reported that the highest value for number of fruits per plant was (352.16) recorded in cluster VIII which included two genotypes ACG 349 while lowest (50.33) in cluster XI which included only one genotype ACS 96-54.

Dutonde *et al.* (2006) studied genetic variability and heritability in forty genotypes of chilli and reported that the number of fruits per plant was ranged from 74.40 to 327.30 with mean value 192.13.

Smitha *et al.* (2006) conducted experiment on forty genotypes of chilli the divergence analysis using Mahalanobis D^2 statistic indicated that cluster H (144) was agronomically superior for number of fruits per plant.

Lakshmi and Naidu (2008) studied five genotypes for variability and correlation and reported highest number of fruits (423.39) per plant and lowest 157.69.

Ajjapplavara and Channagoudra (2009) started that genotype Pant C-1 showed the maximum number of fruits per plant (157.83) followed by KDC-1 (156) while lowest (37.20) number of fruits were observed in AD-7. Mean number of fruits per plant was (71.94).

Roby and Sreelathakumary (2010) reported number of fruits per plant was ranged from 152.87 to 675.87 from their study for variability among ten genotypes.

Maurya *et al.* (2015) concluded field experiment on thirty genotypes of chilli and reported that maximum number of fruits per plant is 89.61.

Meena *et al.* (2016) conducted field experiment on twenty genotypes of chilli and reported that maximum number of fruits per plant is 39.67 and minimum is 26.67.

Janaki *et al.* (2016) studied sixty three genotypes of chilli was assessed using Mahalanobis D^2 analysis revealed that maximum mean number of fruits per plant in cluster VI (480).

Sahu *et al.* (2016) conducted experiment on nineteen genotypes of chilli. He reported that highest number of fruits per plant is 2012/CHIVAR-5 (211.32) and minimum is 2014/CHIVAR-2 (42.05).

2.4.2 Fruit yield per plant

Dixit *et al.* (2003) tested five varieties of chilli. In this Pusa Jwala was superior which recorded the maximum yield of 5.57 kg per meter square and yield per plant (698.12 gm) and less yield per plant (512.12 gm)

Sreelathakumary and Rajamony (2004) studied thirty five diverse chilli genotypes. The genotype CA-8 showed the maximum (273.13 gm) yield per plant followed by CA-20 (271.63 gm).

Varkey *et al.* (2005) studied forty five genotypes of chilli. The genotypes Arka Lohit from Karnataka recorded the maximum number of fruits while the genotype Surkta from Punjab recorded the highest fresh green fruits yield per plant (384.20 gm).

Suseela and Bharatalakshmi (2010) carried field experiment on seven chilli varieties for three consecutive years 1998-1999, 1999-2000 and 2000-2001. Mean yield per plant was maximum (369.30 gm) in LCA-333. The same variety showed the maximum yield (328.40 gm) in the year 1998-1999 and 402.3 gm in 1999-2000. The genotype LCA-334 showed maximum yield (388 gm) in the year 2000-2001.

Chattopadhyay *et al.* (2014) conducted experiment on thirty four genotypes of chilli and reported that Chaitali Pointed and BC CH Sel-4 possess high yield.

Meena *et al.* (2016) conducted field experiment on twenty genotypes of chilli and reported that maximum fruit yield per plant is 320.88g and minimum is 85.40 g.

Janaki *et al.* (2016) studied sixty three genotypes of chilli was assessed using Mahalanobis D² analysis revealed that maximum mean fruit yield per plant in cluster VI (204.18 g)

Sahu *et al.* (2016) conducted experiment on nineteen genotypes of chilli. He reported that highest fruit yield per plant is 2014/CHIVAR-3 (564 g) and minimum is 2014/CHIVAR-2 (153.33).

2.4.3 Weight of 10 green fruits

Lakshmi and Naidu (2008) studied five genotypes for variability and correlation. They concluded that mean weight of 100 fruits was 259.56 gm which was ranged from 157.69 to 423.39 gm.

Ajjapplavara and Channagoudra (2009) revealed that weight of ten green fruits was the maximum (96.69 gm) in Byadgi while lowest (18.73 gm) in PMR-57. Mean weight of ten green fruits was (39.80 gm).

2.4.4 Fruit yield per plot

Sahu *et al.* (2016) conducted experiment on nineteen genotypes of chilli. He reported that highest fruit yield per plot is 2012/CHIVAR-5 (24.06 kg) and minimum is 2014/CHIVAR-2 (5.52 kg).

2.4.5 Fruit yield per hectare

Saraye (2001) studied six hybrid chilli cultivars, Indam-5, Indam-6, Indam-9, Indam-12, Indam Jwala and Star 6601. These were assessed at Reduit and Richelieu crop research stations in Mauritius trials were set up both during the winter and summer season of the 2000 and 2001. The cultivars Indam-5, Indam-6, Indam-42 and Star 6601 recorded high yield (27-40 tons per ha). The genotype Indam-42 recorded higher yield (40 tons per ha). Higher yield was obtained during summer months at both the research stations.

Senapati and Sarkar (2002) investigated performance of twenty chilli genotypes in respect of fruit yield in three environments for their stability analysis EC 126473 and EC 119746 were found stable in fruit yield and dry chilli recovery.

Mohanty (2003) investigated that eight varieties of chilli were evaluated over two years, cultivars X-235 emerged as the superior with a green fruit yield (144.36 q/ha) and the maximum number of fruits per plant (233.99)

Nehru *et al.* (2003) evaluated sixteen chilli genotypes during 1995-96, 1996-97 and 1997-98 in Bangalore. They studied six characters and Ceylon was found to be most stable genotype for yield.

Gund (2007) evaluated ten genotypes of chilli for variability in different morphological and reproductive characters. He concluded that genotype ACS-2002-6 had given the highest yield (124.15 q/ha) followed by BC-25 (114.68 q/ha) while Phule Jyoti was lowest in yield (86.49 q/ha)

Babar (2008) observed that variation was ranged from 38.75-65.56 q. The genotype Maina (65.56) was highest yielding followed by Utkal Yellow (61.56 q), while AKC-406 (38.75 q) recorded lowest yield of green fruits per hectare.

Sahu *et al.* (2016) conducted experiment on nineteen genotypes of chilli. He reported that highest fruit yield per hectare is 2014/CHIVAR-3 (182.78q) and minimum is 2014/CHIVAR-2 (49.69).

2.5 Quality Parameter

2.5.1 Number of seeds per fruit

Mishra *et al.* (2001) studied genetic parameter on genetic variability for fruit characters and the relations among those characters in lot of nine cultivars of chilli. Number of seeds per fruit was ranged from 32.60 to 52.53.

Choudhari and Samadia (2004) studied variability in thirty chilli genotypes. They recorded that the maximum number of seeds per fruit was 117.33 while minimum was 39.73.

Singh *et al.* (2005) conducted experiment on genetic variability in thirty one local chilli genotypes and concluded that the mean number of seeds per fruit was 67.54 which ranged from 6.64 to 99.58.

Rani *et al.* (2005) studied variability in chilli among seventy nine genotypes. Genotypic coefficient of variance for number of seeds per fruit was 703.83 while phenotypic variance was 775.69.

Maurya *et al.* (2015) concluded field experiment on thirty genotypes of chilli and reported that maximum number of seeds per fruit is 44.94.

Janaki *et al.* (2016) studied sixty three genotypes of chilli was assessed using Mahalanobis D^2 analysis revealed that maximum mean number of seeds per fruit in cluster VIII (152.50)

2.5.2 Weight of 100 seeds

Choudhari and Samadia (2004) evaluated thirty genotypes of chilli for variability and character association and reported that weight of hundred seeds was within range of 0.12 to 0.62 g.

Kumari *et al.* (2010) studied ninety four genotypes of chilli. He reported that maximum weight of 100 seeds is LCA-422 (0.49 g) and minimum is LCA-434 (0.15 g).

Maurya *et al.* (2015) concluded field experiment on thirty genotypes of chilli and reported that maximum weight of 100 seeds 0.442 g.

2.5.3 Colour of seeds

Sarkar (2006) observed that colour of seed variation was ranged from yellow, light yellow and dark yellow.

2.5.4 Ascorbic acid

Choudhari and Samadia (2004) evaluated thirty genotypes of chilli for variability and character association. They recorded mean ascorbic acid contents as 151.38 mg per 100 g with range of 70.83 to 237.30 mg per 100 g.

Rani *et al.* (2005) studied seventy nine genotypes of chilli for genetic variability. Result showed that genotypic variance for ascorbic acid content was 167.22, while phenotypic variance was noted as 1773.95. Heritability was recorded as 93.98 percent.

Singh *et al.* (2005) conducted experiment on path analysis of components traits of yield in chilli in twenty seven genotypes and they estimated that the genotype Jwala contains the maximum ascorbic acid (191.05 mg per 100g)

Dutonde *et al.* (2006) reported that ascorbic acid content showed wide variability 47.86 to 142.38 mg per 100 g. Mean ascorbic acid content was 88.84 mg per 100g.

Gogate *et al.* (2006) analyzed variance in fifty five genotype of chilli which was clustered into eleven clusters on the basis of D^2 values they said the highest ascorbic acid content (186.45 mg per 100 g) was recorded in cluster XI which comprised of only one genotype ACS 96-54. While lowest ascorbic acid content (11.40 mg per 100 g) was observed in cluster IV which included eleven different genotypes.

Shirshat *et al.* (2007) conducted experiment on seventy two genotypes of chilli and estimates that phenotypic coefficient of variation was higher than genotypic coefficient of variation for all characters indicating the influence of environment on these characters. Maximum ascorbic acid content 195.48 mg/100 gm.

Munshi *et al.* (2010) carried experiment on genetic variability among thirty genotype of chilli and revealed that ascorbic acid content was ranged from 78.30 to 188 mg per 100 g.

Tilahun *et al.* (2013) studied on determine capsaicin and ascorbic acid contents of chilli variety by High Performance Liquid Chromatography. He concluded that all chilli types can be used as potential source of capsaicin, especially the CF₁ accession likewise, Bayadagi kaddi can be used as source of vit C for enhancing the nutritive value of human diets. He concluded that maximum Ascorbic acid content is Bayadagi Kaddi (189.4 mg /100 g) and minimum is CA-97 (55.3 mg/100 g).

Janaki *et al.* (2016) studied sixty three genotypes of chilli was assessed using Mahalanobis D^2 analysis revealed that maximum mean ascorbic acid content in cluster VII (223.22 mg/100 g)

2.5.5 Capsaicin content

Ajjapplavara *et al.* (2009) conducted experiment on thirty six genotypes of chilli. He concluded that mean capsaicin content 0.15%.

Kumari *et al.* (2010) studied ninety four genotypes of chilli. He reported that maximum capsaicin content is LCA-454 (0.44%) and minimum is Byadigi (0.1%)

Tilahun *et al.* (2013) studied on determine capsaicin and ascorbic acid contents of chilli variety by High Performance Liquid Chromatography. He concluded that maximum capsaicin content is CA-97(2.975 mg/g) and minimum is Bayadagi Kaddi (0.292 mg/g).

Janaki *et al.* (2016) studied sixty three genotypes of chilli was assessed using Mahalanobis D² analysis revealed that maximum mean capsaicin percentage in cluster VI (0.45%)

2.5.6 Pericarp thickness

Murmu *et al.* (2017) conducted experiment on twenty four genotypes of chilli concluded that among these genotype maximum pericarp thickness in Hyb-3(2)-3 (3.36 cm) and minimum in BCC-54 (1.41 cm).

2.6 Insect and Disease reaction

2.6.1 Pest

2.6.1.1 White fly infestation

Shrinivas *et al.* (2013) conducted experiment on seventy eight genotypes of chilli. He reported that maximum white fly infestation on cluster VII (1.56) and minimum on cluster VIII (0.15).

2.6.2 Disease

2.6.2.1 Leaf curl incidence

Acharya and Rajput (2003) have reported that in chilli the cross between Punjab Lal and Pusa Sadabahar was highly resistant to leaf curl complex.

Somshankar *et al.* (2006) observed in five progenies he cross VN-2 x Jwala was highly resistant to leaf curl complex.

Ajjapplavara and Channagoudra (2009) reported that leaf curl incidence was lowest (30.71%) in AD-8 and maximum (62.13%) in genotype Byadgi dabbi. Mean leaf curl incidence was 48.10 %. High heritability was observed (94.52%) for leaf curl incidence with GCV 19.44 % and PCV 19.99 %.

Shrinivas *et al.* (2013) conducted experiment on seventy eight genotypes of chilli they concluded that superior genotypes Vandithadam-I and Kumarapuram-I shown best results on less incidence of leaf curl disease. Maximum incidence of leaf curl on cluster IV (71.41) and minimum on cluster VIII (3.10).

2.7 Heritability

Patel *et al.* (2003) investigated that though all the characters of chilli except number of fruits per plant were largely influenced by specific combining ability variance. The parents ACS 91-1, ACS 98-9, BC 40-2, Punjab Guchedar and RHRC-16-5 were identified as good general combiners for green fruit yield and contributing characters.

2.8 Correlation

Munshi *et al.* (2000) carried experiment on genetic variability among thirty genotype of chilli for association between yield and yield attributes. The yield per plant was positively correlated with number of fruits per plant and fruit weight. Significant negative association of days to first fruit harvest with number of fruits per plant and yield per plant was observed. Fruit weight showed significant negative correlation with number of fruits per plant and positive correlation with fruit length.

Verma *et al.* (2004) investigated twelve germplasm of chilli for eleven quantitative characters. They stated that number of fruits per plant was significantly and positively correlated with the plant height, plant canopy and number of branches per plant.

Choudhari and Samadia (2004) evaluated thirty genotypes of chilli for variability and character association. A significant positive correlation of economic traits like green fruit yield per plant, fruit weight, fruit diameter, number of seeds per fruit and weight of seeds per fruit with red ripe fruit yield was recorded suggesting that selection for these characters could lead to increase in yield.

Singh *et al.* (2005) conducted experiment in a Randomized Block Design and morphological and biochemical observations were recorded in twenty seven genotypes of chilli. Strong correlation of yield with number of fruits per plant and number of branches per plant was observed. Number of fruits per plant showed positive and significant correlation with number of branches per plant.

Rani and Veeraragavathatham (2006) studied correlation of different yield contributing characters with yield in fifteen genotypes of chilli. They revealed that all the characters like wise plant height, number of branches per plant, days to first flowering, length of fruit, girth of fruit, fruit weight had positive and significant correlation with yield. Percent disease index was negatively correlated with yield. This suggests that lowest incidence of anthracnose would result in more marketable fruit yield.

Bhardwaj *et al.* (2007) studied twenty seven genotypes of chilli for fruit yield and nine other related characters. Fruit yield was positively associated with number of branches per plant and number of fruits per plant.

Kaur and Singh (2009) revealed that fruit yield per plant had significant positive correlation with number of fruits per plant (0.6130). Significant but negative correlation was present between fruit yield and weight (-0.3394) and plant height (-0.2823).

Bijalwan *et al.* (2014) conducted experiment on sixteen genotypes in chilli. He concluded that correlation coefficient at genotypic and phenotypic levels indicated that fruit yield positively and significantly, correlated with fruit weight at edible maturity, number of fruits per plant, fruit length, number of branches per plant and ascorbic acid content.

Amit K *et al.* (2014) conducted experiment on twenty three genotypes of chilli. He concluded that high phenotypic coefficient variation and genotypic coefficient variation were recorded for number of fruits per plant, fruit yield. It revealed that the characters viz, plant height, fruit length, number of fruits per plant, fruit weight and fruit yield.

2.9 Path coefficient analysis:

Murmu *et al.* (2017) conducted experiment on twenty four genotypes of chilli concluded that among these genotype Hy-3(2)-2 one of the most promising one showed maximum yield per plant, fruit length and fruit girth.

Bijalwan *et al.* (2014) conducted experiment on sixteen genotypes in chilli. Path coefficient analysis revealed that the highest positive direct effect on fruit yield per plant was exerted by fruit weight at edible maturity followed by number of fruits per plant and fruit length.

CHAPTER - III

Material and Methods

CHAPTER - III

MATERIAL AND METHODS

The materials used and the methods followed during the course of present investigation are briefly described here under.

3.1 Experimental material

For the present investigation eighteen genotypes of Chilli were collected from different sources. The origin and source of all the genotypes included in the investigation are given in Table 1.

3.2 Location of the experiment

The field experiment was carried out at Horticulture Research Scheme (Vegetable) and Department of Horticulture, College of Agriculture, VNMKV, Parbhani, during the *Kharif* season, 2017-18.

3.3 Weather conditions during the crop period

Parbhani comes under sub-tropical semi-arid region and is situated at 408.50 m above the sea level. Geographically it is situated between 19⁰ 16'N latitude and 76⁰ 47' longitude. The monthly mean meteorological data recorded during the crop growth period (August, 2017 to February, 2018) at meteorological observatory, College of Agriculture, VNMKV, Parbhani, Maharashtra are presented in Appendix-I.

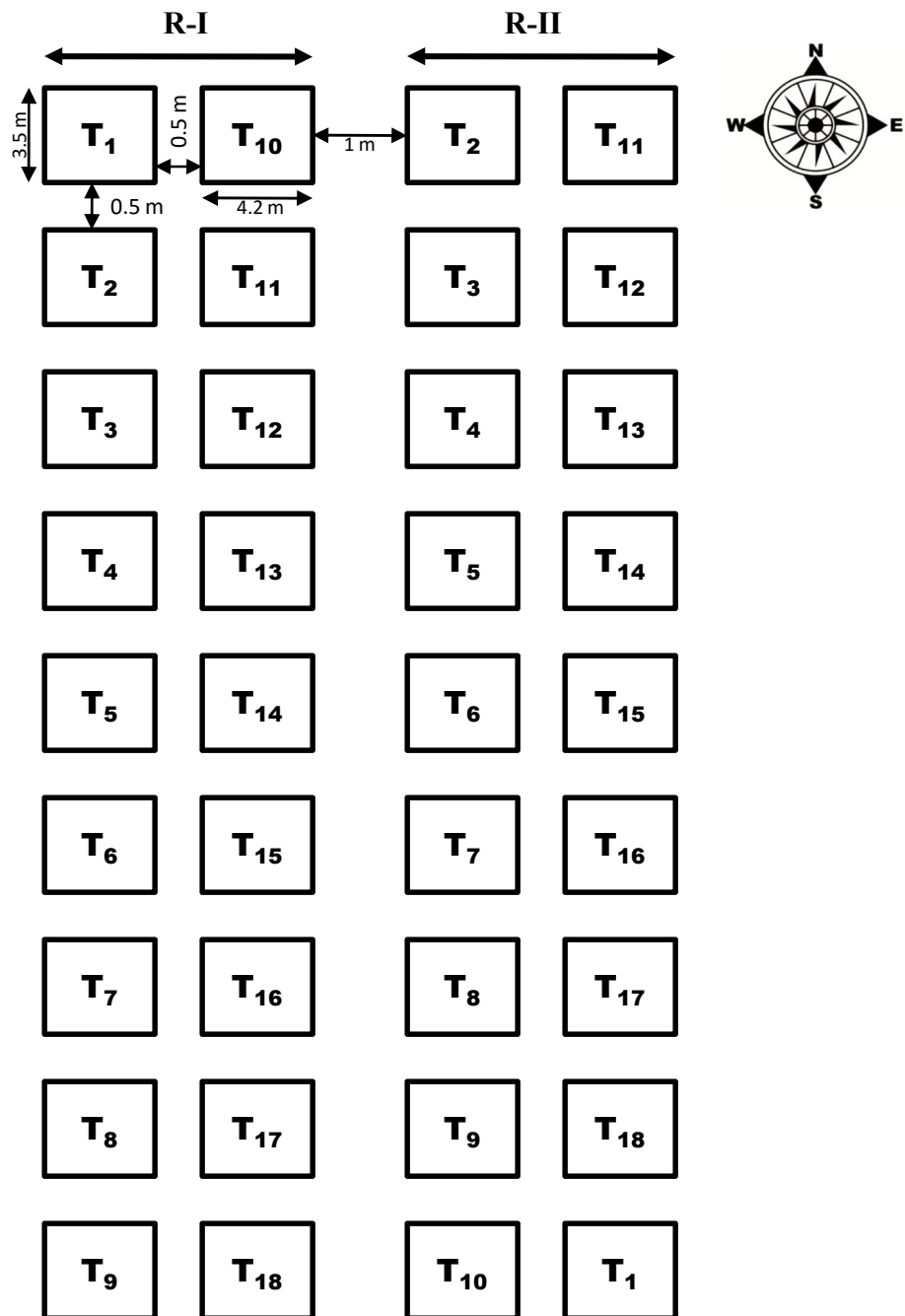
The annual precipitation of Parbhani, which comes under, assured rainfall zone with expected annual rainfall of 800-900 mm. The weekly meteorological data pertaining to rainfall, temperature and relative humidity prevailed during crop growth period from July 2017 to February 2018 were recorded at Central Meteorological Observatory, VNMKV, Parbhani. The total rainfall received during the crop growth period was (739.6 mm) over 16 rainy days. The average maximum temperature of 30.2°C and average minimum temperature of 16.9°C was recorded. Morning and evening mean relative humidity was 80% and 45%, respectively. The mean maximum BSS during crop growth period was 7.1 hrs. and mean evaporation during crop growth period was 4.4 mm.

Table 1. Details of genotypes used for genetic diversity study

Sr. No	Treatment symbol	Genotypes	Source
1.	T ₁	Pusa Sadabahar	VNMKV, Parbhani
2.	T ₂	Pusa Jwala	VNMKV, Parbhani
3.	T ₃	Parbhani Mirchi	VNMKV, Parbhani
4.	T ₄	Parbhani Tejas	VNMKV, Parbhani
5.	T ₅	Phule Jyoti	VNMKV, Parbhani
6.	T ₆	Konkan Kirti	VNMKV, Parbhani
7.	T ₇	Teja	VNMKV, Parbhani
8.	T ₈	G-4	VNMKV, Parbhani
9.	T ₉	Byadgi 341	VNMKV, Parbhani
10.	T ₁₀	Byadgi	VNMKV, Parbhani
11.	T ₁₁	KSP-1194	VNMKV, Parbhani
12.	T ₁₂	Agni Jwala	VNMKV, Parbhani
13.	T ₁₃	ARCH-930	VNMKV, Parbhani
14.	T ₁₄	Chilli Pragati	VNMKV, Parbhani
15.	T ₁₅	Garima	VNMKV, Parbhani
16.	T ₁₆	Seetha	VNMKV, Parbhani
17.	T ₁₇	Ajooba	VNMKV, Parbhani
18.	T ₁₈	Pride	VNMKV, Parbhani

3.4 Experimental details

The experiment with 18 genotypes of chilli was laid out in a Randomized Block Design (RBD) with two replications. The plan of layout of experimental plot is presented in Fig 1. General view of experimental plot is pictured in Plate 1 and photos of eighteen genotypes are pictured in Plate 2 to Plate 3.



Name of the crop: Chilli

Design: Randomized Block Design (RBD)

No. of treatments: 18

No. of replications: 2

Season : Kharif (2017-18)

No. of plants/treatment: 49

Net plot size: 4.2 × 3.5 m

Plant spacing: 60 × 50 cm

Date of sowing: 07/07/2017

Date of transplanting: 11/08/2018

Fig. 1. Plan of Layout.



Plate 1. General View of Experimental Field

3.5 Cultivation details

3.5.1 Nursery

Seeds of each genotype were sown in separate beds on 7th July, 2017 and covered with soil, water was sprinkled regularly. The seeds germinated within a week after sowing and the seedlings were transplanted to main field 35 days after sowing.

3.5.2 Main field

The land was thoroughly ploughed and brought to fine tilth. Finally, it was leveled and divided into plots as per the layout.

Approximately 1000 kg of farmyard manure was applied to the entire area of the experiment. Nitrogen, phosphorus and potash were applied @ 100, 50 and 50 kg/ha respectively. Nitrogen was applied in the form of urea (46.2%), phosphorous in the form of single super phosphate (16% P₂O₅) and potash in the form of muriate of potash (60.1% K₂O). Entire dose of phosphorus, potash and half dose of nitrogen were applied as basal dose at the time of transplanting. Remaining half dose of nitrogen is applied in two splits viz., 25th day and 50th day after transplanting.

3.5.3 Transplanting

Healthy and uniform seedlings were selected for this purpose. Seedlings were transplanted in the plots with a spacing of 60 x 45cm.

3.5.4 After care

Gap filling was done within a week after transplanting. Irrigation was given at 7-10 days intervals depending on requirement during crop period uniformly. Weeding was done at 15 days interval six times after transplanting to maturity.

Application of 0.05% Dimethoate (Rogar 2.5ml/lit) were given at 10 days interval for the control of various type of pests. Spraying of Imidacloprid (0.5ml/lit) 17.8 SL for control of sucking pests. Copper oxychloride (Blitox) 3g /lit to control wilting of chilli crop.

Harvesting of fruits was done on 8-10 days interval in the morning hours.

3.6 Observations recorded

A technique of random sampling was adopted and five plants were selected from each treatment in all replication for detailed studies on vegetative growth, flowering and yield characters.

3.6.1. Growth character:

3.6.1.1. Plant height (cm)

The height of plant was measured from ground level to the apical bud at 120 days after transplanting.

3.6.1.2. Number of branches per plant

The total number of branches on main stem at the time of final harvest was recorded.

3.6.1.3. Plant spread (cm)

Plant spread was measured at 120 days after transplanting. It was measured in 5 randomly selected plants with the help of meter scale in two directions i.e. North-South and East-West.

3.6.1.4. Stem girth (cm)

The average diameter of stem was calculated from the randomly selected five plant of each genotype with Vernier caliper and values were averaged and recorded in centimeter.

3.6.1.5. Number of leaves per plant

Number of leaves per plant was recorded by taking actual count from the observational plant in each genotype at harvesting.

3.6.2 Reproductive growth characters:

3.6.2.1 Days to flower initiation

The period from the date of transplanting to the date of first flowering and expressed in number of days.

3.6.2.2 Days to 50% flowering

The number of days taken to 50% of plant population in each genotype for producing the first flower from planting was recorded.

3.6.2.3 Days to 50% fruit set

The number of days taken to 50% of plant population in each genotype for producing the first fruit set from planting was recorded.

3.6.2.4 Days to first picking

The number of days required for first picking of fruits were counted in each genotype from the date of transplanting.

3.6.2.5 Days to last picking

The number of days required for final picking of fruits were counted in each genotype from the date of transplanting.

3.6.2.6 Number of picking

Number of picking was recorded by counting from transplanting to last picking in each replication.

3.6.2.7 Fruiting span

The number of days beginning from first fruit harvest till the final picking was counted as the duration of fruiting or fruiting span.

3.6.3 Fruit parameter

3.6.3.1 Fruit length (cm)

The average length of fruit was calculated from randomly selected five fruits of each genotype with Vernier caliper and value were averaged and recorded in centimeter.

3.6.3.2 Fruit girth (cm)

The average diameter of fruit was calculated from the randomly selected five fruits of each genotype with Vernier caliper and values were averaged and recorded in centimeter.

3.6.3.3 Fruit pedicel length (cm)

The average pedicel length of fruit was calculated from the randomly selected five fruits of each genotype with Vernier caliper and values were averaged and recorded in centimeter

3.6.4 Yield parameter

3.6.4.1. Number of fruits per plant

The total number of fruits per plant was counted from each observational plant in each genotype from first to last picking. The mean of total number of fruits per plant was recorded.

3.6.4.2. Fruit yield per plant (kg)

Fruit yield per plant was recorded from the observational plants under each genotype and the average was worked out.

3.6.4.3. Weight of 10 green fruits (g)

Weight of 10 green fruits collectively was measured on electronic weighing balance and recorded. Same fruit samples used for recording weight of fruit.

3.6.4.4 Fruit Yield per plot (kg)

Yield per plot was calculated from yield per plant for each genotype in kilogram.

3.6.4.5 Fruit Yield per hectare (qt)

Yield of fruits per hectare was calculated in quintal from yield per plot by multiplying with hectare factor. Thus, the yield of fruit in quintal per hectare was calculated.

3.6.5 Quality characters

3.6.5.1 Number of seeds per fruit

Five fruits from each observational plant were selected to count number of seeds per fruit. Number of seeds per fruit was calculated by actual count. Mean was recorded.

3.6.5.2 Weight of 100 seeds

100 seeds from each observational plant were collected and weighed on electronic balance. Mean Weight of 100 seeds was worked out.

3.6.5.3 Colour of seed

Colour of seed recorded by visually observed as yellow, light yellow and dark yellow.

3.6.5.4 Ascorbic acid content (mg/100g of fruit)

Ten ml of the HPO_3 extract of sample was titrated against standard dye up to a pink end point. Titration was done to determine preliminary determination of the titre. In the next determination, most of the dye required was added and then titrated accurately. The aliquot of sample taken should be such that the titre should not exceed 3 to 5 ml.

$$\text{Mg of ascorbic acid per 100 ml} = \frac{\text{Tire} \times \text{Dye factor} \times \text{Volume made up} \times 100}{\text{Aliquot of extract taken for estimation} \times \text{Volume of sample taken for estimation}}$$

3.6.5.5 Capsaicin content

The capsaicin content of fruits was estimated by colorimetric method described by Balasubramanian *et al.* (1982).

0.5 g dry chilli powder was weighed into glass-Stoppard test tube; 10ml dry acetone was added into the test tube and kept overnight for extraction. Next day samples were centrifuged at 10000 rpm for 10 min to get clear supernatant. 1ml of the supernatant was taken into a test tube and evaporated to dryness in a hot water bath. Then, the residue was dissolved in 5ml of 0.4% of NaOH solution and 3 ml of 3% phosphomolybdic acid was added. The contents were shaken and left undisturbed for 1 hr. After 1 hr, the solution was quickly filtered into centrifuge tubes to remove any floating debris, and then centrifuged at 5000 rpm for 15 min. The clear blue coloured

Solution was directly transferred into the cuvette and absorbance was read at 650 nm along with a reagent blank.

A standard graph was prepared using 0-200 μg pure capsaicin. Simultaneously 0.2, 0.4, 0.6, 0.8 and 1ml of working standard solution were taken into new test tubes and proceeded as mentioned above.

Percent capsaicin calculated using the formula mentioned below

$$\text{Capsaicin content (\%)} = \frac{\mu\text{g capsaicin} \times 100 \times 100}{1000000 \times 1 \times 0.5}$$

3.6.5.6 Pericarp thickness (mm)

Pericarp thickness of five randomly selected uniform fruits from each plot was measured in millimeters, at the time of peak harvest, with the help of Vernier caliper. The average pericarp thickness was calculated by taking average value.

3.6.6 Insect and Disease reaction

Number of affected plants from each genotype was recorded by taking actual count at fifteen days interval from 30 DAT. Affected plants were tagged for easiness in counting. Percentage of affected plants was worked out by using following formula.

The per cent insect and disease incidence was calculated as per cent disease Index (P.D.I).

$$\text{P. D. I.} = \frac{\text{Number of affected plants per plot}}{\text{Total number of plants per plot}} \times 100$$

Total number of plants = Affected plants + Healthy plants

3.6.6.1 Pest

3.6.6.1.1 White fly infestation

The total number of plant affected by whitefly (*Bemisia tabaci* Genn.) the affected plants are recorded and expressed as per cent.

The Per cent Pest infestation was calculated using the formula.

$$\text{Pest infestation (\%)} = \frac{\text{Number of infected plants}}{\text{Total number of plants}} \times 100$$

3.6.6.2 Disease

3.6.6.2.1 Leaf curl incidence

The total number of plant affected by leaf curl the affected plants are recorded and expressed as per cent (Joshi and Choudhary 1981).

The Per cent Disease Incidence (PDI) was calculated using the formula.

$$\text{LCV incidence (\%)} = \frac{\text{Number of infected plants}}{\text{Total number of plants}} \times 100$$

Reaction	Percent
Resistant	5-9%
Moderately resistant	10-19%
Moderately susceptible	20-39%
Susceptible	40-69%
Highly susceptible	70-100%

The table given by Bliss (1937) was referred for transformation of pest and disease index into Arc sine values for further analysis of data.

3.7 Statistical analysis

The mean values of all the traits under consideration were used for statistical analysis. The data were subjected to following statistical analysis.

1. Analysis of variance
2. Estimation of mean and range
3. Genetic divergence analysis
4. Estimation of genetic variability parameters
5. Heritability and genetic advance
6. Correlation
7. Path analysis

3.7.1 Analysis variance

Analysis of variance was performed to test the significance of difference between the lines for all the characters as per the method described by Panse and Sukhatme (1985). The analysis of variance is set out under ANOVA Table.

$$Y_{ij} = m + G_j + E_{ij}$$

Where,

$$Y_{ij} = \text{observed value of } j^{\text{th}} \text{ genotype in } i^{\text{th}} \text{ replication.}$$

$$m = \text{general mean}$$

G_j = effect of j^{th} genotypes

E_{ij} = uncontrolled variation associated with j^{th} genotype in i^{th} replication.

Sr. No.	Source of variation	D.F.	Mean sum of squares		Variance ratio 'F' observed	Table 'F'
			Observed	Expected		
1.	Replication	(r-1)	RMS	$\sigma^2_e + \sigma^2_r$		
2.	Treatment	(t-1)	TRMS	$\sigma^2_e + r\sigma^2_g$		
3.	Error	(r-1) (t-1)	EMS	σ^2_e		
	Total	(rt-1)				

Where,

r = Number of replications

t = Number of treatments

σ^2_e = Error variance

σ^2_g = Genotype variance

σ^2_r = Replication variance

The mean squares were tested against error variance by usual 'F' test. The standard error of difference for comparing any two genotypic means was estimated by formula.

$$\text{Standard Error (SE)}_{\pm} = \sqrt{\text{EMSS}/r}$$

Where,

EMSS = Error mean sum of squares

r = Number of replications

$$\text{Critical difference (CD)} = \text{SE} \times \sqrt{2 \times t}$$

Where,

t = Table value of 't' as error d.f. at 5 or 1 per cent level of significance

3.7.2 Estimation of mean and range

The mean values of all the treatments for the characters under study were worked out by dividing the total by corresponding number of observations.

$$\text{Mean } (\bar{X}) = \frac{1}{n} \sum_{i=1}^n X_i$$

Where,

$\bar{X}$ = Mean of character

X_i = i^{th} observation of population

n = Number of observation per replication

Range = The lowest and highest values of mean of each character represented by range.

3.7.3 Genetic divergence analysis

The genetic divergence between genotypes was estimated using Mahalanobis's D^2 statistics (1936). The distance D from the sample was computed using the formula.

$$D^2p = d^1 S^{-1} d$$

Where,

D^2p = Square of distance considering 'p' variables

d = Vector observed differences of the mean values of all the characters
($x_{i1} - x_{i2}$)

S^{-1} = Inverse of variance and covariance matrix

3.7.3.1 Clustering of genotypes using D^2 values

All the genotypes used were clustered into different groups following Tocher's method (Rao, 1952). The intra and inter-distance were also computed the criterion used in clustering to the same cluster should at least on the average, show a smaller D^2 values than those belonging to different clusters.

The device suggested by Tocher (Rao, 1952) was started with two closely associated populations and find a third population which had the smallest average of D^2 from the first two. Similarly, the fourth was chosen to have a smallest average D^2 value from the first three and so on. The permissible increase in D^2 value shown by a population to the nearest population. If at any stage increase in average D^2 value exceeded the average of already included, because of the addition of new genotypes, then that genotype was deleted. The genotypes that are included already in that group were considered as the first cluster. This procedure was repeated till D^2 values of the other genotypes were exhausted omitting those that were already included in the former cluster and grouping them into different cluster.

3.7.3.2 Intra and inter cluster distances

Based on D^2 values, average intra and inter cluster distances were calculated as per Euclidean method.

3.7.3.3 Intra cluster distance

The average intra cluster distances were calculated by the formula given by Singh and Chaudhary (1985).

$$\text{Square of intra cluster distance} = \sum D_i^2 / n$$

Where,

$$\sum D_i^2 = \text{Sum of distance between all possible combinations.}$$

$$n = \text{Number of all possible combinations}$$

3.7.3.4 Inter cluster distance

The average inter cluster distances were calculated by the formula (Singh and Chaudhary, 1985).

$$\text{Square of inter cluster distance} = \Sigma D_i^2 / n_i n_j$$

Where,

ΣD_i^2 = Sum of distances between all possible combinations ($n_i n_j$) of the entries included in the cluster study.

n_i = Number of entries in cluster i

n_j = Number of entries in cluster j

3.7.3.5 Contribution of individual characters towards genetic divergence

The character contribution towards genetic divergence was computed using method given by Singh and Chaudhary (1985). In all the combination, each character is ranked on the basis of $d_i = y_i^j - y_i^k$ values.

Where,

d_i = Mean deviation

y_i^j = Mean value of the j^{th} genotype for the i^{th} character and

y_i^k = Mean value of the k^{th} genotype for the i^{th} character.

Rank 'I' is given to the highest mean difference and rank 'p' is given to the lowest mean difference

Where,

P is the total number of characters.

Finally, number of times that each character appeared in the first rank is computed and per cent contribution of characters towards divergence was estimated.

3.5.4 Estimation of genetic variability parameters

Various parameters of genetic variability were calculated by using appropriate formulae.

3.5.4.1 Phenotypic and genotypic variances

The genotypic and phenotypic variance were calculated by using the respective mean squares from variance table (Burton 1952).

Genotypic variance (σ^2_g)

$$\sigma^2_g = \frac{\text{TRMSS} - \text{EMSS}}{r}$$

Error variance = $\sigma^2_e - \text{EMSS}$

Phenotypic variance (σ^2_p)

$$\sigma^2_p = \sigma^2_g + \sigma^2_e$$

Where,

TRMSS = Treatment mean sum of squares

EMSS = Error mean sum of squares

r = Number of replication

3.5.4.2 Phenotypic and genotypic coefficient of variation

The genotypic and phenotypic coefficients of variance (GCV and PCV) were calculated according to method suggested by Burton (1952).

Genotypic coefficient of variation (GCV)

$$\text{GCV (\%)} = \frac{\sqrt{\sigma^2_g}}{\bar{x}} \times 100$$

Phenotypic coefficient of variation (PCV)

$$\text{PCV (\%)} = \frac{\sqrt{\sigma^2_p}}{\bar{x}} \times 100$$

Where,

σ^2_g = Genotypic variance

σ^2_p = Phenotypic variance

$\bar{x}$ = General or grand mean of character

GCV and PCV were classified into 0-10 %: Low, 10-20 %: Moderate, 20 % and above: High as suggested by Sivasubramanian and Menon (1973).

3.7.5 Heritability and genetic advance

1. Heritability (Broad sense) was calculated according to the method suggested by Allard (1960).

$$\text{Heritability (h}^2\text{) (\%)} = \frac{\sigma^2_g}{\sigma^2_p} \times 100$$

σ^2_g = Genotypic variance

σ^2_p = Phenotypic variance

Heritability was classified as suggested by Robinson *et al* (1966) and described as 0-30 %: Low, 30 -60 %: Moderate, 60 % and above; High.

2. The genetic advance (at 5 per cent selection intensity) was calculated for each character using the formula suggested by Johnson *et al.* (1955).

$$\text{Genetic advance} = h^2 \times k \times \sqrt{\sigma^2_p}$$

Where,

h^2 = heritability (Broad sense)

K = Selection difference at 5 per cent selection intensity, the value of $K = 2.06$

σ_p = Phenotypic standard deviation

3. The expected genetic advance (EGA) in percentage of mean was calculated as

$$EGA = \frac{GA}{\bar{x}} \times 100$$

Where,

GA = Genetic advance

$\bar{x}$ = General or grand mean of character

The genetic advance as *per cent* of mean was categorized into 0-10 %: Low, 10-20 %: Moderate, 20 % and above: High as suggested by Johnson *et al.* (1955).

3.7.6 Correlation

In order to study the extent of association between different traits the genotypic and phenotypic simple correlation coefficient were worked out from the respective variance and covariances. The formula as suggested by Johnson *et al.* (1955) were used for calculating simple correlation coefficient as given below.

1. Genotypic correlation coefficient ($r_{g_{xy}}$)

$$(r_{g_{xy}}) = \frac{\text{Cov}(g_x \times g_y)}{\sqrt{\sigma^2_{g_x} \times \sigma^2_{g_y}}}$$

Where,

$\text{Cov}(g_x, g_y)$ = Genotypic covariance between character x and y

$\sigma^2_{g_x}$ and $\sigma^2_{g_y}$ = Genotypic variance of character x and y, respectively.

Similarly,

2. Phenotypic correlation coefficient ($r_{p_{xy}}$)

$$(r_{p_{xy}}) = \frac{\text{Cov}(p_x \cdot p_y)}{\sqrt{\sigma^2_{p_x} \cdot \sigma^2_{p_y}}}$$

Where,

$Cov(p_x \cdot p_y)$ = Phenotypic covariance between character x and y

$\sigma^2 p_x$ and $\sigma^2 p_y$ = Phenotypic variance of character x and y, respectively.

Significance of correlation coefficient was determined from the Fisher and Yates table at 5 and 1 per cent level of significance. The 'r' values were compared against (n-2) degrees of freedom.

3.7.7 Path analysis

The genotypic correlation coefficient between yield and its components were further partitioned into direct and indirect effects with the help of path coefficient analysis originally suggested by Wright (1921) and further outlined by Dewey and Lu (1959).

The first step in path analysis is to prepare the path diagram based on cause and effect relationship in the present study, path diagram was prepared by taking yield as effect i.e. the function of various components like X_1 , X_2 , X_3 and these components show following type of association with each other (Fig 2).

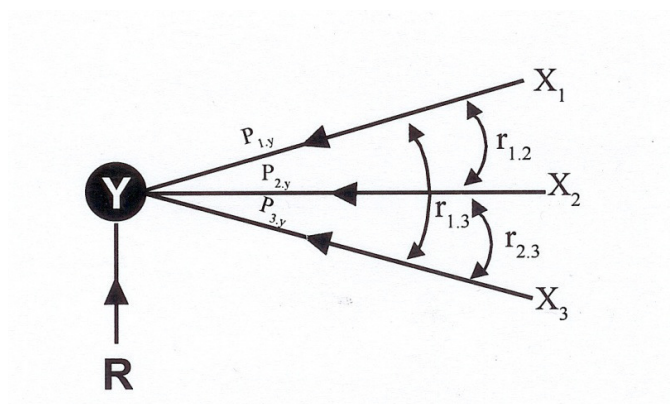


Fig. 2 Path diagram

In path diagram the grain yield is the result of X_1 , X_2 , X_3 and same other undefined factors designated by R. the double arrowed lines indicates mutual association as measured by correlation coefficient (r_{ij}) and the single arrowed line present direct influence as measured by path coefficient (P_{ij}).

Direct and indirect contribution of eight variable to grain yield were calculated by solving a set of simultaneous equations of the form as per Dewey and Lu (1959).

$$r_{ny} = p_{ny} + r_{n2}p_2y + r_{n3}p_3y + \dots\dots\dots$$

Where,

r_{ny} = represents correlation coefficient between one component and grain yield

r_{n2} = represents correlation coefficient between that character and each of other components

p_{ny} = represents path coefficient between that characters and grain yield.

Matrix – A

Martrix-B

$$\begin{array}{ccc} \left[\begin{array}{c} r_{1,y} \\ r_{2,y} \\ \vdots \\ r_{n,y} \end{array} \right] & \left[\begin{array}{c} p_1 \\ p_2 \\ \vdots \\ p_n \end{array} \right] & \left[\begin{array}{cccc} r_{1,1} & r_{1,2} & \dots & r_{1,n} \\ r_{2,1} & r_{2,2} & \dots & r_{2,n} \\ \vdots & \vdots & \ddots & \vdots \\ r_{n,1} & r_{n,2} & \dots & r_{n,n} \end{array} \right] \end{array}$$

The B matrix was inverted (B^{-1}) and path coefficient (p_{ij}) were obtained as

$$P_{ij} = A \times B^{-1}$$

The coefficient $p_1, p_2, \dots, p_n$ are estimate of direct effect of character while the indirect effects of i^{th} character on grain yield character through j^{th} character is $r_{ij}p_{ij}$.

The residual factor i.e. variation in yield uncounted by these associations was calculated from the following formula.

$$\text{Residual factor (Rx)} = \sqrt{1-R^2}$$

Where,

$$R^2 = (P_{1y}, r_{1y} + p_{2y}, r_{2y} + \dots + P_{ny}, r_{ny})$$

Where,

$$P_{1y}, P_{2y}, \dots, P_{ny}, = \text{Path values}$$

$$r_{1y}, r_{2y}, \dots, r_{ny}, = \text{Correlation coefficient}$$

CHAPTER - IV

Results

CHAPTER -IV

RESULTS

In Chilli, genetic diversity studies were conducted on eighteen genotypes. The data were subjected to biometrical analysis and results obtained were presented below under the following headings:

- 4.1 Analysis of variance
- 4.2 Mean performance of genotypes
- 4.3 Genetic divergence analysis
- 4.4 Variability, heritability and genetic advance
- 4.5 Correlation studies
- 4.6 Path coefficient analysis
- 4.7 Reaction of Chilli genotypes to pest and disease

4.1 Analysis of variance

The analysis of variance indicated that highly significant differences among the genotypes for all the characters were studied *viz.*, plant height, number of branches per plant, plant spread, stem girth, number of leaves per plant, days required for flower initiation, days required for 50% flowering, days required for 50% fruit set, days required for first picking, days required for last picking, number of picking, fruiting span, fruit length, fruit girth, pedicel length, weight of 10 green fruits, number of fruits per plant, fruit yield per plant, fruit yield per plot, fruit yield per hectare, number of seeds per fruit, 100 seeds weight, ascorbic acid, capsaicin, pericarp thickness, white fly infestation and leaf curl virus incidence. The analysis of variance was Table 2.

Table 2. Analysis of variance in Chilli genotype

Sr.No.	Characters	Replication	Genotypes	Error	SE $\pm$	CD@1%	CD@5%
1	Plant height (cm)	19.36	21.93**	6.98	1.86	7.65	5.57
2	Number of branches / plant	0.13	0.33**	0.12	0.25	1.04	0.75
3	Plant Spread (NS) (cm)	1.52	97.53**	10.66	2.30	9.46	6.89
4	Plant Spread (EW) (cm)	11.67	81.18**	11.43	2.39	9.80	7.13
5	Stem girth(cm)	0.04	0.15**	0.04	0.15	0.61	0.44
6	Number of leaves / plant	1906.77	3809.94**	1162.30	24.10	98.80	71.92
7	Days to flower initiation	18.77	36.73**	11.71	2.42	9.92	7.22
8	Days to 50% flowering	4.00	36.47**	4.94	1.57	6.44	4.68
9	Days to 50% fruit set	8.02	28.72**	9.08	2.13	8.73	6.35
10	Days to first picking	2.77	25.47**	8.18	2.02	8.29	6.03
11	Days to last picking	44.44	97.30**	23.26	3.41	13.98	10.17
12	Number of picking	0.03	1.63**	0.14	0.27	1.10	0.80
13	Fruiting span	13.44	79.64**	20.50	3.20	13.12	9.55
14	Fruit length (cm)	1.75	4.63**	1.54	0.87	3.60	2.62
15	Fruit girth(cm)	0.03	0.26**	0.09	0.21	0.87	0.63
16	Pedicel length(cm)	0.08	0.22**	0.09	0.24	0.88	0.64
17	Weight of 10 green fruits(g)	0.08	21.06**	3.89	1.39	5.71	4.16
18	Number of fruits / plant	100.50	375.03**	77.96	6.24	25.59	18.62
19	Fruit yield / plant(kg)	0.001	0.009**	0.02	0.03	0.13	0.10
20	Fruit yield / plot(kg)	1.34	22.48**	3.51	1.32	5.43	3.95
21	Fruit yield / hectare (q)	10.76	1923.93**	257.11	11.33	46.47	33.83
22	Number of seeds / fruit	3.36	792.60**	51.24	5.06	20.74	15.10
23	100 Seeds weight (g)	0.001	0.33**	0.08	0.20	0.85	0.62
24	Ascorbic acid (mg/100g)	11.05	195.09**	67.85	5.82	23.87	17.37
25	Capsaicin (%)	0.001	0.020**	0.001	0.028	0.118	0.086
26	Pericarp thickness (mm)	0.11	0.30**	0.05	0.16	0.68	0.49
27	White fly (%)	1.85	96.07**	16.55	2.87	11.79	8.58
28	Leaf curl (%)	16.29	52.16**	14.42	2.68	11.000	8.01

* and ** Significance at 5% and 1,% levels respectively

4.2 Mean performance of genotypes

The data for mean performance of the genotypes are furnished and presented in Table 3, 4 and 5.

4.2.1 Mean performance of chilli genotypes for Fruit yield and its associated traits.

Data on mean performance for fruit yield and its associated traits of chilli genotypes are presented in Table 3.

4.2.1.1 Plant height (cm)

The mean value for plant height exhibited a range from 57.00 cm to 67.90 cm. The genotype Pusa Sadabahar was recorded the highest plant height of 67.90 cm followed by Parbhani Mirchi (67.10 cm), while the genotype Chilli Pragati recorded was significantly lowest plant height of 57.00 cm. Nine genotypes were recorded significantly higher values than the grand mean of 62.32 cm.

4.2.1.2 Number of branches per plant

The mean value for number of branches exhibited a range from 3.90 to 5.50. The genotype Pusa Jwala was recorded the highest number (5.50) branches followed by in Agni Jwala (5.10), while the genotype Chilli Pragati was recorded the lowest number (3.90) of branches followed by in Byadgi (4.10). Eleven genotypes were recorded significantly higher values than the grand mean of 4.73.

4.2.1.3 Plant spread (cm)

The mean value for plant spread North- South was exhibited a range from 24.00 cm to 46.40 cm. The genotype KSP-1194 was recorded the highest plant spread N-S of 46.40 cm followed by in Garima (43.50 cm), while the genotype Pusa Sadabahar was recorded significantly lowest plant spread N-S of 24.00 cm. Twelve genotypes were recorded significantly higher values than the grand mean of 35.79 cm.

The mean value for plant spread East-West exhibited a range from 24.80 cm to 44.90 cm. The genotype KSP-1194 was recorded the highest plant spread E-W of 44.90 cm followed by in Garima (43.20 cm), while the genotype Pusa Sadabahar was recorded significantly lowest plant spread E-W of 24.80 cm. Ten genotypes were recorded significantly higher values than the grand mean of 34.35 cm.

4.2.1.4 Stem girth (cm)

The mean value for stem girth was exhibited a range of 3.31 cm to 4.41 cm. The genotype Pride was recorded the highest stem girth of 4.41 cm followed by in Pusa Jwala (4.09 cm), while the genotype Konkan Kirti was recorded the lowest stem girth of 3.31 cm followed by in Agni Jwala (3.36 cm) and ARCH-930 (3.44 cm). Twelve genotypes were recorded significantly higher values than the grand mean of 3.83 cm.

4.2.1.5 Number of leaves per plant

The mean value for number of leaves exhibited a range from 138 to 300. The genotype Parbhani Mirchi was recorded the highest number (300) of leaves followed by in Garima (261), while the genotype Parbhani Tejas was recorded the lowest number (138) branches followed by in Byadgi-341 (146). Nine genotypes were recorded significantly higher values than the grand mean of 209.16.

4.2.1.6 Days to flower initiation

The mean value for days to flower initiation was ranged from 54.00 days to 68.00 days. The genotype Teja was produced the first flower earlier in 54.00 days followed by in KSP-1194 (55.00), Phule Jyoti (55.00), G-4 (57.00), Parbhani Tejas (57.00), and Agni Jwala (57.00). While the genotype Ajooba was recorded the highest of 68.00 days to flower initiation followed by in Pride (66.00), Pusa Jwala (65.00) and Seetha (64.00). Ten genotypes were found to flower earlier than the grand mean of 60.38 days.

4.2.1.7 Days to 50% flowering

The mean value for days to 50% flowering was ranged from 62 days to 76 days. The genotype Teja was produced the 50% flower earlier in 62.00 days followed by in KSP-1194 (64.00), Phule Jyoti (64.00), G-4 (65.00), Parbhani Tejas (65.00), and Agni Jwala (65.00). While the genotype was Ajooba recorded later 76.00 days to 50% flowering followed by in Pride (76.00), Pusa Jwala (73.00) and Seetha (72.00). Ten genotypes were found to flower earlier than the grand mean of 68.33 days.

4.2.1.8 Days to 50% fruit set

The mean value for days to 50% fruit set was ranged from 72 days to 85 days. The genotype Teja was produced the 50% fruit earlier in 72.00 days followed by in KSP-1194 (72.00), Phule Jyoti (73.00), G-4 (73.00), Parbhani Tejas (73.00), and Agni Jwala (74.00). While the genotype Ajooba was recorded later 85.00 days to 50% fruit followed by Pride (82.00), Pusa Jwala (80.00) and Seetha (80.00). Eleven genotypes were found to fruit earlier than the grand mean of 76.58 days.

4.2.1.9 Days to first picking

The mean value for days to first picking ranged from 78 days to 89 days. The genotype Teja was first picked earlier in 78.00 days closely followed by in KSP-1194 (78.00), Phule Jyoti (78.00), G-4 (78.00), Parbhani Tejas (79.00), and Agni Jwala (79.00). While the genotype Ajooba was recorded later 89.00 days to first picking followed by in Pride (86.00), Pusa Jwala (86.00) and Seetha (86.00). Eleven genotypes were found to first picking earlier than the grand mean of 81.83 days.

4.2.1.10 Days to last picking

The mean value for days to last picking was ranged from 113 days to 135 days. The genotype Pusa Sadabahar was harvested later 135 days to last picking followed by in Chilli Pragati (133 days). The genotype KSP-1194 was recorded of 113 minimum days to last picking followed by in Teja (113). Ten genotypes were found to harvest later than the grand mean of 123.77 days.

4.2.1.11 Number of picking

The mean value for number of picking was exhibited a range from 3.00 to 5.00. The genotype Pusa Sadabahar was recorded significantly superior number of harvests of 5.00, whereas; the genotype Agni Jwala was recorded the lowest number of harvests of 3.00. Seven genotypes were recorded significantly higher values than the grand mean of 4.00.

4.2.1.12 Fruiting span

Significant variation was observed with respect to fruiting span which ranged from 32.00 to 50.00. The maximum number of fruiting span was recorded in ARCH-930 (50.00) whereas; minimum number of fruiting span was recorded in Parbhani Mirchi (32.00)

4.2.1.13 Fruit length (cm)

The mean value for fruit length was exhibited a range of 9.33 cm to 14.32 cm. The genotype Chilli Pragati was recorded the highest fruit length of 14.32 cm followed by in Konkan Kirti (13.78 cm). While the genotype Pride recorded the lowest fruit length of 9.33 cm followed by in G-4 (9.88 cm). Eight genotypes were recorded significantly higher values than the grand mean of 11.83 cm.

4.2.1.14 Fruit girth (cm)

The mean value for fruit girth was exhibited a range of 1.80 cm to 3.27 cm. The genotype Garima was recorded the highest fruit girth of 3.27 cm followed by in KSP-1194 (3.04 cm), while the genotype Parbhani Tejas was recorded the lowest fruit girth of 1.80 cm followed by in Byadgi-341 (1.86 cm) and Agni Jwala (2.45 cm). Ten genotypes were recorded significantly higher values than the grand mean of 2.64 cm.

4.2.1.15 Pedicel length (cm)

The mean value for pedicel length was exhibited a range of 2.47 cm to 3.53 cm. The genotype Seetha was recorded the highest pedicel length of 3.53 cm followed by in Byadgi (3.51 cm). While the genotype Byadgi-341 was recorded the lowest pedicel length of 2.47cm followed by in Parbhani Tejas (2.47 cm). Nine genotypes were recorded significantly higher values than the grand mean of 2.99 cm.

4.2.1.16 Weight of 10 green fruits (g)

The mean value for average ten fruit weight was exhibited a range from 20.47 g to 30.87 g. The genotype Teja was recorded the highest average ten fruit weight of 30.87 g followed by in G-4 (29.93 g), whereas; the genotype Garima was recorded significantly lowest average ten fruit weight of 20.47 g. Eight genotypes were recorded significantly higher values than the grand mean of 24.37 cm.

4.2.1.17 Number of fruits per plant

The mean value for number of fruits per plant was exhibited a range from 105.28 to 151.84. The genotype Pusa Jwala was recorded significantly superior number of fruits per plant (151.84) followed by in Garima (142.70). Whereas the genotypes Parbhani Mirchi was recorded the lowest number of fruits per plant

(105.28) followed by in Pride (109.12). Ten genotypes were recorded significantly higher values than the grand mean of 127.16.

4.2.1.18 Fruit yield per plant (kg)

The data presented in Table 3 showed that fruit yield per plant was ranged from 0.22 to 0.47 kg. The maximum fruit yield per plant was observed in genotype Pusa Jwala (0.47 kg) followed by in Garima (0.38) and Konkan Kirti (0.38 kg). whereas; minimum fruit yield per plant was observed in genotype Parbhani Mirchi (0.22 kg) followed by in Pride (0.22 kg) and Parbhani Tejas (0.23 kg). The overall mean of fruit yield per plant was 0.31 kg. Nine out of 18 genotypes shown more fruits yield per plant than mean value.

4.2.1.19 Fruit yield per plot (kg)

The investigation revealed that fruit yield per plot was ranged from 10.88 to 23.25 kg. The maximum fruit yield per plot was observed in genotype Pusa Jwala (23.25 kg) followed by genotypes Garima (18.65 kg) and Konkan Kirti (18.62 kg). The minimum fruit yield per plot was observed in genotype Parbhani Mirchi (10.88 kg) followed by genotypes Pride (10.89kg) and Parbhani Tejas (11.70 kg). The overall mean fruit yield per plot was 15.22 kg. Nine out of 18 genotypes shown more fruits yield per plot than mean value.

4.2.1.20 Fruit yield per hectare (q)

The investigation revealed that fruit yield per hectare was ranged from 100.82 q to 215.25 q. The maximum fruit yield per hectare was recorded in Pusa Jwala (215.25 q) followed by genotype Garima (172.73 q). While, minimum fruit yield per hectare was recorded in Parbhani Mirchi (100.82 q) followed by genotype Pride (100.85 q). The overall mean fruit yield per hectare was 140.97 q. Nine out of 18 genotypes shown more fruits yield per plot than mean value.

4.2.1.21 Number of seeds per fruit

The mean value for number of seeds per fruits was exhibited a range from 25.50 to 92.00. The genotype Byadgi-341 was exhibited the highest number of seeds per fruit (92.00) followed by in Byadgi (84.50), whereas; the genotypes Seetha was recorded the lowest number of seeds per fruits (25.50) followed by in Chilli Pragati (27.00). Ten genotypes were recorded significantly higher values than the grand mean of 57.08.

4.2.1.22 100 Seeds weight (g)

The mean value for 100 seeds weight was exhibited a range from 4.07 to 5.32 g. The genotype Byadgi-341 was recorded the highest 100 seeds weight of 5.32 g followed by in Konkan Kirti (5.32 g) and G-4 (5.20 g), whereas; the genotype Pride was recorded the lowest 100 seeds weight of 4.07 g followed by in KSP-1194 (4.14 g). Eight genotypes were recorded significantly higher values than the grand mean of 4.72 g.

Table3. Mean performance of Chilli genotypes for Fruit yield and its associated traits.

Sr. No.	Genotypes	Plant height (cm)	Number of branches/ plant	Plant spread (NS) (cm)	Plant Spread (EW) (cm)	Stem girth (cm)	Number of leaves/ plant	Days to flower initiation	Days to 50% flowering	Days to 50% fruit set	Days to first picking	Days to last picking	Number of picking	Fruiting span
1	Pusa Sadabahar	67.9	4.2	24.0	24.8	3.93	259	64	72	80	86	135	5	49
2	Pusa Jwala	61.2	5.5	38.8	36.7	4.09	236	65	73	80	86	131	5	45
3	Parbhani Mirchi	67.1	4.2	25.5	24.8	3.94	300	64	71	79	84	116	5	32
4	Parbhani Tejas	64.9	4.9	25.5	25.7	3.77	138	57	65	73	79	115	3	36
5	Phule Jyoti	66.3	4.9	39.9	39.2	3.79	162	55	64	73	78	127	3	49
6	Konkan Kirti	61.7	5.0	42.5	39.9	3.31	186	57	65	75	80	129	3	49
7	Teja	58.5	4.9	36.1	33.0	3.91	241	54	62	72	78	113	3	35
8	G-4	58.1	4.9	36.1	33.0	3.90	181	57	65	73	78	121	3	43
9	Byadgi 341	64.1	4.9	25.5	25.7	3.86	146	63	70	76	81	119	4	38
10	Byadgi	63.1	4.1	39.5	36.5	3.99	215	59	66	75	80	127	4	47
11	KSP-1194	63.5	5.0	46.4	44.9	4.05	186	55	64	72	78	113	3	35
12	Agni Jwala	62.9	5.1	42.8	40.9	3.36	225	57	65	74	79	118	3	39
13	ARCH-930	57.6	5.0	30.3	28.6	3.44	222	59	67	75	80	130	4	50
14	Chilli Pragati	57.0	3.9	33.8	32.4	3.50	171	63	70	79	84	133	5	49
15	Garima	65.3	4.6	43.5	43.2	3.92	261	60	67	76	81	128	4	47
16	Seetha	62.3	4.5	36.1	34.9	3.89	184	64	72	80	86	128	5	42
17	Ajooba	61.1	4.9	36.6	35.6	3.98	244	68	76	85	89	124	5	35
18	Pride	58.9	4.7	41.4	38.7	4.41	203	66	76	82	86	121	5	35
	Mean	62.32	4.73	35.79	34.35	3.83	209.16	60.38	68.33	76.58	81.83	123.77	4	41.94
	SE $\pm$	1.86	0.25	2.30	2.39	0.15	24.10	2.42	1.57	2.13	2.02	3.41	0.27	3.20
	CD@5%	5.57	0.75	6.89	7.13	0.44	71.92	7.22	4.68	6.35	6.03	10.17	0.80	9.55

Contd...

Sr. No.	Genotypes	Fruit length (cm)	Fruit girth (cm)	Pedicle length (cm)	Weight of 10 green fruits (g)	Number of fruits / plant	Fruit yield/ plant (kg)	Fruit yield /plot (kg)	Fruit yield / hectare (q)	Number of seeds/ fruit	100 Seeds weight (g)
1	Pusa Sadabahar	11.22	2.83	3.35	24.60	117.63	0.26	12.84	118.94	76.50	4.62
2	Pusa Jwala	11.35	2.87	2.99	21.81	151.84	0.47	23.25	215.25	68.00	5.17
3	Parbhani Mirchi	11.12	2.83	3.33	22.60	105.28	0.22	10.88	100.82	51.50	4.50
4	Parbhani Tejas	10.44	1.80	2.47	22.40	112.78	0.23	11.70	108.39	46.50	4.51
5	Phule Jyoti	11.68	2.78	3.11	25.37	114.45	0.24	11.91	110.34	49.00	5.15
6	Konkan Kirti	13.78	2.46	3.09	24.46	149.16	0.38	18.62	172.25	30.00	5.32
7	Teja	10.08	2.56	2.74	30.87	120.34	0.27	13.34	123.52	80.50	4.35
8	G-4	9.88	2.46	2.74	29.93	121.08	0.27	13.42	124.23	59.00	5.20
9	Byadgi 341	10.24	1.86	2.47	29.02	115.56	0.25	12.28	113.78	92.00	5.32
10	Byadgi	12.25	2.77	3.51	28.72	127.71	0.30	14.84	137.39	84.50	5.13
11	KSP-1194	13.09	3.04	2.88	24.61	129.15	0.31	15.38	142.48	63.50	4.14
12	Agni Jwala	13.76	2.45	3.09	24.36	140.27	0.37	18.18	168.30	56.00	4.61
13	ARCH-930	12.05	2.98	2.72	22.87	131.54	0.34	16.93	156.81	33.50	4.47
14	Chilli Pragati	14.32	2.70	2.79	21.22	139.60	0.35	17.35	160.68	27.00	4.74
15	Garima	13.36	3.27	3.24	20.47	142.70	0.38	18.65	172.73	73.50	4.53
16	Seetha	13.50	2.76	3.53	20.79	131.19	0.34	16.91	156.55	25.50	4.31
17	Ajooba	11.60	2.54	3.29	21.36	129.55	0.34	16.65	154.16	56.00	4.95
18	Pride	9.33	2.59	2.59	23.20	109.12	0.22	10.89	100.85	55.00	4.07
	Mean	11.83	2.64	2.99	24.37	127.16	0.31	15.22	140.97	57.08	4.72
	SE $\pm$	0.87	0.21	0.21	1.39	6.24	0.03	1.32	11.33	5.06	0.2
	CD@5%	2.62	0.63	0.64	4.16	18.62	0.10	3.95	33.83	15.10	0.62

4.2.2 Mean performance of Chilli genotype for Quality parameters

Data on mean performance for quality parameter of chilli genotypes are presented in Table 4.

4.2.2.1 Ascorbic acid (mg/100g)

The mean value for Ascorbic acid content was exhibited a range from 56.25 to 100 mg/100 g. The genotypes Pusa Sadabahar was recorded significantly highest Ascorbic acid content of 100mg/100 g, whereas; the genotype Parbhani Mirchi was recorded the lowest Ascorbic acid content of 56.25mg/100 g. Nine genotypes were recorded significantly higher values than the grand mean of 82.70 mg/100 g.

4.2.2.2 Capsaicin (%)

The mean value for capsaicin content was exhibited a range from 0.230 to 0.565 per cent. The genotype Konkan Kirti was recorded significantly highest capsaicin content of 0.565 per cent, whereas; the genotype Pride was recorded significantly lowest capsaicin content of 0.230 per cent. Four genotypes were recorded significantly higher values than the grand mean of 0.296 per cent.

4.2.2.3 Pericarp thickness (mm)

The mean value for pericarp thickness was exhibited a range of 1.42 to 2.49 mm. The genotype Ajooba was recorded the highest pericarp thickness of 2.49 mm followed by in Pusa Sadabahar (2.46 mm), while the genotype G-4 was recorded the lowest pericarp thickness of 1.42 mm followed by in Konkan Kirti (1.45 mm). Seven genotypes were recorded significantly higher values than the grand mean of 1.90 mm.

4.2.2.4 Colour of seed

The data presented in Table 4 revealed that colour of seed was observed yellow in genotypes Pusa Sadabahar, Teja, Pride; light yellow in genotypes Pusa Jwala, Parbhani Mirchi, Phule Jyoti, G-4, Byadgi-341, KSP-1194, Agni Jwala, Chilli Pragati, Garima, Seetha and Ajooba while dark yellow was observed in genotypes Parbhani Tejas, Konkan Kranti, ARCH-930 and Byadgi

Table 4. Mean performance of Chilli genotype for Quality parameters

Sr. No.	Genotypes	Ascorbic acid (mg/100g)	Capsaicin (%)	Pericarp thickness (mm)	Colour of Seed
1	Pusa Sadabahar	100.00	0.265	2.46	Yellow
2	Pusa Jwala	93.75	0.315	1.75	Light yellow
3	Parbhani Mirchi	56.25	0.245	1.86	Light yellow
4	Parbhani Tejas	78.12	0.475	2.09	Dark yellow
5	Phule Jyoti	75.00	0.290	1.63	Light yellow
6	Konkan Kirti	81.25	0.565	1.45	Dark yellow
7	Teja	88.72	0.480	2.18	Yellow
8	G-4	81.25	0.285	1.42	Light yellow
9	Byadgi 341	93.75	0.240	1.46	Light yellow
10	Byadgi	87.50	0.245	2.36	Dark yellow
11	KSP-1194	87.50	0.245	1.77	Light yellow
12	Agni Jwala	78.12	0.265	1.83	Light yellow
13	ARCH-930	87.50	0.240	2.41	Dark yellow
14	Chilli Pragati	71.87	0.240	1.57	Light yellow
15	Garima	81.25	0.230	1.59	Light yellow
16	Seetha	84.37	0.245	1.55	Light yellow
17	Ajooba	87.50	0.235	2.49	Light yellow
18	Pride	75.00	0.230	2.42	Yellow
	Mean	82.70	0.296	1.90	-
	SE $\pm$	5.82	0.02	0.16	-
	CD@5%	17.37	0.08	0.49	-

4.2.3 Mean performance of Chilli genotypes for pest and disease reaction

Data on mean performance for pest and disease reaction of chilli genotypes are presented in Table 5.

4.2.3.1 White fly infestation (%)

The data presented in Table 5. revealed that white fly infestation was ranged from 22.45 to 46.94 per cent with a mean value of 37.41 % infestation. The minimum white fly infestation was observed in the genotype Pusa Sadabahar (22.45 %) while, maximum white fly infestation was recorded in the genotype Byadgi (46.94 %).

4.2.3.2 Leaf curl virus incidence (%)

The investigation was revealed that grand mean value of leaf curl virus incidence was 28.23 per cent with a range of 16.32 in Pusa Sadabahar genotype to 36.73% in Teja genotype.

Table 5. Mean performance of Chilli genotypes for pest and disease reaction

Sr.No.	Genotypes	White fly (%)	Leaf curl (%)
1.	Pusa Sadabahar	22.45	16.32
2.	Pusa Jwala	28.57	18.37
3.	Parbhani Mirchi	32.65	28.57
4.	Parbhani Tejas	26.53	26.53
5.	Phule Jyoti	34.69	24.49
6.	Konkan Kirti	36.73	26.53
7.	Teja	44.90	36.73
8.	G-4	42.86	30.61
9.	Byadgi 341	44.90	32.65
10.	Byadgi	46.94	28.57
11.	KSP-1194	44.90	32.65
12.	Agni Jwala	38.77	30.61
13.	ARCH-930	42.86	32.65
14.	Chilli Pragati	36.73	30.61
15.	Garima	34.69	28.57
16.	Seetha	36.73	32.65
17.	Ajooba	42.86	24.49
18.	Pride	36.69	26.53
	Mean	37.41	28.23
	SE $\pm$	2.87	2.68
	CD@5%	8.58	8.01

4.3 Genetic divergence (D^2 statistic)

The quantitative assessment of genetic divergence was made by adopting Mahalanobis D^2 statistic for yield and its contributing characters.

4.3.1 Grouping of genotypes into different clusters (D^2 analysis)

The D^2 values between any two genotypes was calculated as the sum of squares of the differences between the mean values of all the twenty eight characters and used for the final grouping of the genotypes.

Procedure suggested by Tocher (Rao,1952) has been used to group eighteen genotypes into five clusters by treating the estimated D^2 values as the square of the generalized distance. Based on D^2 values, the eighteen genotypes were grouped into five highly divergent clusters (Table 6 and Fig 3)

One of the genotypes were so divergent in all the characters, hence single genotype formed a separate cluster. Thus cluster V were solitary with one genotype in cluster. Cluster I and III was biggest with accommodated five genotypes in each cluster respectively.

Table 6. Cluster classification of Chilli genotypes

Cluster	No. of genotypes	Genotypes
I	5	Chilli Pragati, Seetha, KSP-1194, G-4, Phule Jyoti.
II	3	Parbhani Tejas, Byadgi 341, Pride.
III	5	ARCH-930, Ajooba, Byadgi, Teja, Pusa Sadabahar.
IV	4	Agni Jwala, Garima, Pusa Jwala, Konkan Kirtri.
V	1	Parbhani Mirchi.

4.3.2 Cluster means of characters

The cluster mean for the twenty eight characters were studied in chilli genotypes revealed considerable differences among all the clusters Table 7.

The highest plant height was recorded in cluster V (67.10 cm), while lowest plant height was recorded in cluster I (61.44 cm). The maximum number of branches was recorded in cluster IV (5.05), Whereas; minimum number of branches was recorded in cluster V (4.20).

The highest plant spread (North-South) was recorded in cluster IV (41.90 cm), while lowest plant spread was recorded in cluster V (25.50 cm). The highest plant spread (East-West) was recorded in cluster IV (40.16 cm), where as lowest plant spread was recorded in cluster V (24.80 cm).

The maximum stem girth was recorded in cluster II (4.02 cm), whereas; minimum stem girth was recorded in cluster IV (3.67 cm). The highest number of leaves was recorded in cluster V (299.50), while lowest number of leaves was recorded in cluster II (162.00).

The highest number of days for flower initiation was recorded in cluster V (63.50), while lowest in cluster I (58.60). The highest number of days to 50% flowering was recorded in cluster V (70.50), while lowest in cluster I (66.80). The highest number of days to 50% fruit set was recorded in cluster V (79.00), while lowest in cluster I (75.10).

The highest number of days to first picking was recorded in cluster V (84.00), while lowest number of days to first picking was recorded in cluster I (80.50). The highest number of days to last picking was recorded in cluster IV (126.25), while lowest number of days to last picking was recorded in cluster V (116.00).

The highest number of picking was recorded in cluster V (5), while lowest number of picking was recorded in cluster IV (3.75). The maximum fruiting

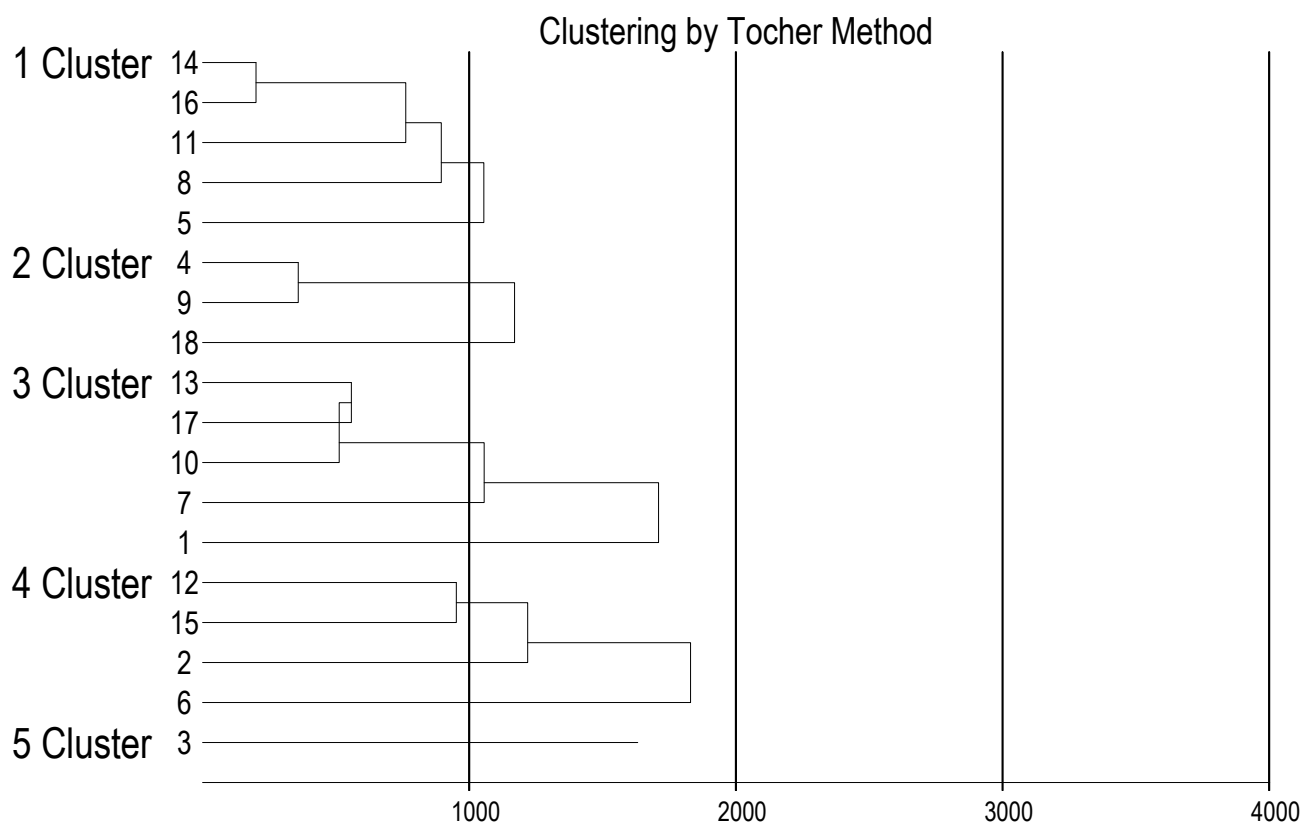


Fig. 3 Dendrogram showing clustering pattern in divergence of chilli genotypes

span was recorded in cluster IV (45.00), while minimum fruiting span was recorded in cluster V (32.00).

The maximum fruit length was recorded in cluster IV (13.06cm), Whereas; minimum fruit length was recorded in cluster II (10.00cm). The maximum fruit girth was recorded in cluster V (2.83 cm), Whereas; minimum fruit girth was recorded in cluster II (2.08 cm). The maximum pedicel length was recorded in cluster V (3.33 cm), Whereas; minimum pedicel length was recorded in cluster II (2.51cm).

The maximum weight of 10 green fruits was recorded in cluster III (25.73 g), Whereas; minimum weight of 10 green fruits was recorded in cluster V (22.60 g). The highest number of fruits per plant was recorded in cluster IV (135.06), while lowest number of fruits per plant was recorded in cluster V (109.13).

The maximum fruits yield per plant was recorded in cluster IV (0.401 kg), whereas; minimum fruits yield per plant was recorded in cluster V (0.222 kg). The maximum fruits yield per plot was recorded in cluster IV (19.68 kg), whereas; minimum fruits yield per plot was recorded in cluster V (10.89 kg). The maximum fruits yield per hectare was recorded in cluster IV (182.19 q), Whereas; minimum fruits yield per hectare was recorded in cluster V (100.82 q).

The highest number of seeds per fruit was recorded in cluster III (66.20) while lowest number of seeds per fruit was recorded in cluster V (51.50). The maximum 100 seeds weight was recorded in cluster IV (4.91g) whereas; minimum 100 seeds weight was recorded in cluster V (4.50 g). The maximum pericarp thickness was recorded in cluster III (2.37 mm) Whereas; minimum pericarp thickness was recorded in cluster I (1.59 mm).

The maximum ascorbic acid was observed in cluster III (90.25 mg/100 g), while; minimum ascorbic acid content recorded in cluster V (56.25 mg/100 g). The maximum capsaicin per cent was recorded in cluster IV (0.343 %), Whereas, minimum capsaicin per cent was found in cluster V (0.245 %).

The maximum white fly per cent infestation was observed in cluster III (40.00 %), while; minimum white fly infestation was recorded in cluster V (32.65 %). The maximum leaf curl incidence was recorded in cluster I (30.20 %), Whereas; minimum leaf curl incidence was found in cluster IV (26.02%)

Table 7. Mean values of clusters in Chilli genotypes

Cluster	Plant height (cm)	Number of branches / plant	Plant Spread (NS) (cm)	Plant Spread (EW) (cm)	Stem girth (cm)	Number of leaves/ plant	Days to flower initiation	Days to 50% flowering	Days to 50% fruit set	Days to first picking	Days to last picking	Number of picking	Fruiting span	Fruit length (cm)	Fruit girth (cm)
I	61.44	4.64	38.46	36.88	3.83	176.50	58.60	66.80	75.10	80.50	124.10	3.8	43.60	12.19	2.75
II	62.63	4.83	30.80	30.03	4.02	162.00	61.67	69.83	76.67	82.00	118.17	4	36.17	10.00	2.08
III	61.70	4.62	33.30	31.70	3.85	236.00	60.60	68.30	77.10	82.20	125.50	4.2	43.30	11.44	2.74
IV	62.78	5.05	41.90	40.16	3.67	226.63	59.63	67.13	76.00	81.25	126.25	3.75	45.00	13.06	2.76
V	67.10	4.20	25.50	24.80	3.94	299.50	63.50	70.50	79.00	84.00	116.00	5	32.00	11.12	2.83

Contd....

Cluster	Pedicle length (cm)	Weight of 10 green fruits (g)	Number of fruits / plant	Fruit yield per plant (g)	Fruit yield per plot (kg)	Fruit yield per hectare (q)	Number of seeds per fruit	100 Seeds weight (gm)	Ascorbic acid (mg/100g m)	Capsaicin (%)	Pericarp thickness (mm)	White fly (%)	Leaf curl (%)
I	3.01	24.48	129.11	306.06	15.00	138.86	44.80	4.71	80.00	0.261	1.59	39.18	30.20
II	2.51	24.87	111.21	237.33	11.63	107.68	64.50	4.63	82.29	0.315	1.99	35.37	28.57
III	3.12	25.73	130.14	304.53	14.92	138.17	66.20	4.71	90.25	0.293	2.37	40.00	27.75
IV	3.10	22.78	135.06	401.56	19.68	182.19	56.88	4.91	83.59	0.343	1.66	34.69	26.02
V	3.33	22.60	109.13	222.22	10.89	100.82	51.50	4.50	56.25	0.245	1.86	32.65	28.57

4.3.3 Average intra and inter cluster distances

Data presented in Table 8. indicated that the mean intra and inter cluster D^2 values among the five clusters.

The intra cluster D^2 value was ranged from 0.00 (Cluster V) to 44.59 (Cluster IV). The cluster IV had the maximum D^2 value (44.59).

The inter cluster D^2 values of the five clusters revealed that highest inter cluster generalized distance (123.16) was between cluster II and cluster V, while the lowest (43.39) was between cluster I and cluster II.

The nearest and distant clusters from each of the cluster based on D^2 values were presented in Table 9.

Cluster I was nearest to cluster II (43.39) and distant from cluster V (119.16). Cluster II was exhibited close proximity with cluster I (743.39) and maximum divergence with cluster V (123.16).

Cluster III was nearest to cluster I (61.72), while it was farthest from cluster II (73.39). Cluster IV showed close proximity with cluster III (63.46) and maximum divergence with cluster V (119.34). Cluster V was exhibited intimate relation with cluster III (71.92) and wide diversity with cluster II (123.16).

Table 8. Average intra (bold) and inter-cluster D^2 values for five clusters in 18 Chilli genotypes.

Clusters	I	II	III	IV	V
I	33.67	43.39	61.72	64.89	119.16
II		35.90	73.39	87.87	123.16
III			38.56	63.46	71.92
IV				44.59	111.34
V					0.00

Table 9. The nearest and farthest clusters from each cluster based on D^2 values in Chilli genotypes.

Cluster No.	Nearest cluster with D^2 values	Farthest cluster with D^2 value
I	II (43.39)	V (119.16)
II	I (43.39)	V (123.16)
III	I (61.72)	II (73.39)
IV	III (63.46)	V (111.34)
V	III (71.92)	II (123.16)

4.3.4 Relative Contribution of different characters towards divergence

The per cent contribution of each character towards divergence is presented in Table 10.

Data presented in Table 10 showed that the maximum number of seeds per fruit (41.93%) content was contributed towards divergence followed by yield per plot (37.37 %), days to last picking (7.19 %), fruit length (5.23%), plant spread N-S (3.57 %), plant spread E-W (1.96%), plant height (0.92), number of branches per plant (0.67), yield per hectare (0.65), fruit girth (0.38), days to 50% flowering (0.13). The rest of the characters *viz.*, stem girth, number of leaves per plant, days to flower initiation, days to 50% fruit set, days to first picking, number of picking, fruiting span, pedicel length, weight of 10 fruits, number of fruits per plant, fruits yield per plant, 100 Seeds weight, ascorbic acid, capsaicin, pericarp thickness, white fly and leaf curl did not contribute to the total divergence.

Table 10. Percent contribution of different characters towards diversity in Chilli genotypes.

Sr. No.	Characters	Times ranked 1 st	Percent contribution
1	Plant height (cm)	1	0.92 %
2	Number of branches per plant	1	0.67 %
3	Plant spread NS (cm)	3	3.57 %
4	Plant spread EW (cm)	2	1.96 %
5	Stem girth (cm)	0	0.00 %
6	Number of leaves per plant	0	0.00 %
7	Days to flower initiation	0	0.00 %
8	Days to 50% flowering	1	0.13 %
9	Days to 50% fruit set	0	0.00 %
10	Days to first picking	0	0.00 %
11	Days to last picking	5	7.19 %
12	Number of picking	0	0.00 %
13	Fruiting span	0	0.00 %
14	Fruit length(cm)	4	5.23 %
15	Fruit girth (cm)	1	0.38 %
16.	Pedicel length cm)	0	0.00 %
17.	Weight of 10 green fruits (g)	0	0.00 %
18.	Number of fruits per plant	0	0.00 %
19	Yield per plant (kg)	0	0.00 %
20	Yield per plot (kg)	25	37.37 %
21	Yield per hectare (q)	1	0.65 %
22	Number of seeds per fruit	28	41.93 %
23	100 Seeds weight (g)	0	0.00 %
24	Ascorbic acid (mg/100gm)	0	0.00 %
25	Capsaicin (%)	0	0.00 %
26	Pericarp thickness (mm)	0	0.00 %
27	White fly (%)	0	0.00 %
28	Leaf curl (%)	0	0.00 %

4.4 Variability, Heritability (h^2) and Genetic advance

The results with regard to mean, overall range, phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV), heritability in broad sense (h^2) and expected genetic advance as per cent of mean (GA) for all the twenty eight characters were furnished in Table 11 and Fig 4 and 5.

4.4.1 Plant height (cm)

The data presented in Table 11 revealed that moderate phenotypic and low genotypic variances (14.45 and 7.47) were recorded and coupled with low PCV and GCV of 6.10 and 4.38 per cent respectively. This trait showed high heritability (51.70 %), low genetic advance (4.05) and low GA as per cent mean (6.50).

4.4.2 Number of branches per plant

The data presented in Table 11 showed that the character recorded low phenotypic and genotypic variances of 0.23 and 0.10, respectively with moderate PCV (10.17) and low GCV (6.75) values, high heritability (44.10 %), low genetic advance (0.43) and low GA as per cent mean (9.23).

4.4.3 Plant spread (cm)

North –South- The data presented in Table 11 revealed that high phenotypic and genotypic variances (54.10 and 43.43) were recorded and coupled with high PCV and moderate GCV of 20.54 and 18.41 per cent, respectively. This trait showed high heritability (80.30 %), moderate genetic advance (12.16) and high GA as per cent mean (33.98).

East-West- The data presented in Table 11 was revealed that high phenotypic and genotypic variances (46.31 and 34.87) were recorded and coupled with moderate PCV and GCV of 19.80 and 17.18 per cent, respectively. This trait showed high heritability (75.30 %), moderate genetic advance (10.55) and high GA as per cent mean (30.72).

4.4.4. Stem girth (cm)

The data presented in Table 11 was revealed that low phenotypic and genotypic variances (0.09 and 0.05) were recorded and coupled with low PCV and GCV of 8.21 and 6.05 per cent respectively. This trait showed high heritability (54.30 %), low genetic advance (0.35) and low GA as per cent mean (9.19).

4.4.5. Number of leaves per plant

The data presented in Table 11 revealed that high phenotypic and genotypic variances (2486.12 and 1323.81) were recorded and coupled with high

PCV and moderate GCV of 23.83 and 17.39 percent, respectively. This trait showed high heritability (53.20 %), high genetic advance (54.69) and high GA as percent mean (26.14).

4.4.6. Days to first flowering

The data presented in Table 11 revealed that high phenotypic and moderate genotypic variances (24.22 and 12.51) were recorded and coupled with low PCV and GCV of 8.15 and 5.85 per cent, respectively. This trait showed high heritability (51.60 %), low genetic advance (5.23) and low GA as per cent mean (8.67).

4.4.7. Days to 50% flowering

The data presented in Table 11 revealed that high phenotypic and moderate genotypic variances (20.70 and 15.76) were recorded and coupled with low PCV and GCV of 6.65 and 5.81 per cent, respectively. This trait showed high heritability (76.10 %), low genetic advance (7.13) and moderate GA as per cent mean (10.44).

4.4.8. Days to 50% fruit set

The data presented in Table 11 revealed that moderate phenotypic and low genotypic variances (18.90 and 9.81) were recorded and coupled with low PCV and GCV of 5.67 and 4.09 per cent, respectively. This trait showed high heritability (51.90 %), low genetic advance (4.65) and low GA as per cent mean (6.07).

4.4.9. Days to first picking

The data presented in Table 11 revealed that moderate phenotypic and low genotypic variances (16.83 and 8.64) were recorded and coupled with low PCV and GCV of 5.01 and 3.59 per cent, respectively. This trait showed high heritability (51.30 %), low genetic advance (4.33) and low GA as per cent mean (5.30).

4.4.10. Days to last picking

The data presented in Table 11 revealed that high phenotypic and high genotypic variances (60.28 and 37.02) were recorded and coupled with low PCV and GCV of 6.27 and 4.91 per cent, respectively. This trait showed high heritability (61.40 %), low genetic advance (9.82) and low GA as per cent mean (7.93).

4.4.11. Number of picking

The data presented in Table 11 revealed that low phenotypic and genotypic variances (0.89 and 0.74) were recorded and coupled with high PCV and

GCV of 23.57 and 21.56 per cent, respectively. This trait showed high heritability (83.60%), low genetic advance (1.62) and high GA as per cent mean (40.61).

4.4.12. Fruiting span

The data presented in Table 11 revealed that high phenotypic and genotypic variances (50.07 and 29.56) were recorded and coupled with moderate PCV and GCV of 16.87 and 12.96 per cent, respectively. This trait showed high heritability (59.10 %), low genetic advance (8.60) and high GA as per cent mean (20.52).

4.4.13. Fruit length (cm)

The data presented in Table 11 revealed that low phenotypic and genotypic variances (3.09 and 1.54) were recorded and coupled with moderate PCV and GCV of 14.85 and 10.50 per cent, respectively. This trait showed high heritability (50.00 %), low genetic advance (1.81) and moderate GA as per cent mean (15.30).

4.4.14. Fruit girth (cm)

The data presented in Table 11 revealed that low phenotypic and genotypic variances (0.18 and 0.08) were recorded and coupled with moderate PCV and GCV of 16.07 and 11.27 per cent, respectively. This trait showed high heritability (49.20 %), low genetic advance (0.43) and moderate GA as per cent mean (16.27).

4.4.15. Pedicel length (cm)

The data presented in Table 11 revealed that low phenotypic and genotypic variances (0.16 and 0.06) were recorded and coupled with moderate PCV and low GCV of 13.39 and 8.68 per cent, respectively. This trait showed high heritability (42.00 %), low genetic advance (0.34) and moderate GA as per cent mean (11.59).

4.4.16. Weight of 10 green fruits (g)

The data presented in Table 11 revealed that moderate phenotypic and low genotypic variances (12.47 and 8.58) were recorded and coupled with moderate PCV and GCV of 14.49 and 12.02 per cent, respectively. This trait showed high heritability (68.80%), low genetic advance (5.00) and high GA as per cent mean (20.53).

4.4.17. Number of fruits per plant

The data presented in Table 11 revealed that high phenotypic and genotypic variances (226.49 and 148.53) were recorded and coupled with moderate PCV and low GCV of 11.83 and 9.58 per cent, respectively. This trait showed high

heritability (65.60%), high genetic advance (20.33) and moderate GA as per cent mean (15.98).

4.4.18. Yield per plant (kg)

The data presented in Table 11 revealed that low phenotypic and genotypic variances (0.001 and 0.009) were recorded and coupled with high PCV and moderate GCV of 24.79 and 19.44 per cent, respectively. This trait showed high heritability (61.50%), low genetic advance (0.09) and high GA as per cent mean (31.39).

4.4.19. Yield per plot (kg)

The data presented in Table 11 revealed that moderate phenotypic and low genotypic variances (12.99 and 9.48) were recorded and coupled with high PCV and GCV of 23.68 and 20.22 per cent, respectively. This trait showed high heritability (73.00 %), low genetic advance (5.41) and high GA as per cent mean (35.59).

4.4.20. Yield per hectare (q)

The data presented in Table 11 revealed that high phenotypic and genotypic variances (1090.52 and 833.41) were recorded and coupled with high PCV and GCV of 23.42 and 20.47 per cent, respectively. This trait showed high heritability (76.4 %), high genetic advance (51.98) and high GA as per cent mean (36.87).

4.4.21. Number of seeds per fruit

The data presented in Table 11 revealed that high phenotypic and genotypic variances (421.92 and 370.68) were recorded and coupled with high PCV and GCV of 35.98 and 33.72 per cent, respectively. This trait showed high heritability (87.90 %), high genetic advance (37.17) and high GA as per cent mean (65.12).

4.4.22. 100 seeds weight (g)

The data presented in Table 11 revealed that low phenotypic and genotypic variances (0.21 and 0.12) were recorded and coupled with low PCV and GCV of 9.68 and 7.42 per cent, respectively. This trait showed high heritability (58.8 %), low genetic advance (0.55) and moderate GA as per cent mean (11.71).

4.4.23. Ascorbic acid (mg/100g)

The data presented in Table 11 revealed that high phenotypic and genotypic variances (131.87 and 63.61) were recorded and coupled with moderate PCV and low GCV of 13.86 and 9.64 per cent, respectively. This trait showed high heritability (48.80%), moderate genetic advance (11.42) and moderate GA as per cent mean (13.81).

4.4.24. Capsaicin (%)

The data presented in Table 11 revealed that low phenotypic and genotypic variances (0.01 and 0.01) were recorded and coupled with high PCV and GCV of 35.39 and 32.60 per cent, respectively. This trait showed high heritability (84.90 %), low genetic advance (0.18) and high GA as per cent mean (61.87).

4.4.25. Pericarp thickness (mm)

The data presented in Table 11 revealed that low phenotypic and genotypic variances (0.18 and 0.12) were recorded and coupled with high PCV and moderate GCV of 22.29 and 18.52 per cent, respectively. This trait showed high heritability (69.00 %), low genetic advance (0.60) and high GA as per cent mean (31.70).

4.4.26. White fly infestation (%)

The data presented in Table 11 revealed that high phenotypic and genotypic variances (56.31 and 39.76) were recorded and coupled with high PCV and moderate GCV of 20.05 and 16.85 per cent, respectively. This trait showed high heritability (70.60 %), moderate genetic advance (10.91) and high GA as per cent mean (29.17).

4.4.27 Leaf curl incidence (%)

The data presented in Table 11 revealed that high phenotypic and moderate genotypic variances (33.29 and 18.87) were recorded and coupled with low PCV and moderate GCV of 2.44 and 15.38 per cent, respectively. This trait showed high heritability (56.70 %), low genetic advance (6.73) and high GA as per cent mean (23.86).

Table 11. Estimation of variability, heritability and genetic advance as percent of mean in Chilli genotypes

Sr. No.	Characters	Range		Mean	Variance		PCV (%)	GCV (%)	h ² (%)	Genetic Advance	GA as per cent of mean
		Min.	Max.		σ^2 (p) (Phenotypic)	σ^2 (g) (Genotypic)					
1	Plant height (cm)	57.00	67.90	62.32	14.45	7.47	6.10	4.38	51.7	4.05	6.50
2	Number of branches/ plant	3.90	5.50	4.73	0.23	0.10	10.17	6.75	44.1	0.43	9.23
3	Plant spread NS	24.00	46.40	35.79	54.10	43.43	20.54	18.41	80.3	12.16	33.98
4	Plant spread EW	24.80	44.90	34.35	46.31	34.87	19.80	17.18	75.3	10.55	30.72
5	Stem girth(cm)	3.31	4.41	3.83	0.09	0.05	8.21	6.05	54.3	0.35	9.19
6	Number of leaves / plant	137.50	299.50	208.58	2486.12	1323.81	23.83	17.39	53.2	54.69	26.14
7	Days to flower initiation	54.00	67.50	60.16	24.22	12.51	8.15	5.85	51.6	5.23	8.67
8	Days to 50% flowering	61.50	76.00	68.00	20.70	15.76	6.65	5.81	76.1	7.13	10.44
9	Days to 50% fruit set	74.50	84.50	76.33	18.90	9.81	5.67	4.09	51.9	4.65	6.07
10	Days to first picking	77.50	88.50	81.58	16.83	8.64	5.01	3.59	51.3	4.33	5.30
11	Days to last picking	113.00	134.50	123.52	60.28	37.02	6.27	4.91	61.4	9.82	7.93
12	Number of picking	3	5	4	0.89	0.74	23.57	21.56	83.6	1.62	40.61
13	Fruiting span	32.00	50.00	41.94	50.07	29.56	16.87	12.96	59.1	8.60	20.52
14	Fruit length (cm)	9.33	14.32	11.83	3.09	1.54	14.85	10.50	50.0	1.81	15.30
15	Fruit girth(cm)	1.80	3.27	2.64	0.18	0.08	16.07	11.27	49.2	0.43	16.27
16.	Pedicle length (cm)	2.47	3.53	2.99	0.16	0.06	13.39	8.68	42.0	0.34	11.59
17.	Weight of 10 green fruits (gm)	20.47	31.37	24.42	12.47	8.58	14.49	12.02	68.8	5.00	20.53
18.	Number of fruits / plant	109.12	151.84	126.62	226.49	148.53	11.83	9.58	65.6	20.33	15.98
19	Yield / plant (kg)	222.21	474.42	310.74	0.001	0.009	24.79	19.44	61.5	0.09	31.39
20	Yield / plot (kg)	10.89	23.25	15.22	12.99	9.48	23.68	20.22	73.0	5.41	35.59
21	Yield / hectare (q)	100.82	215.25	140.98	1090.52	833.41	23.42	20.47	76.4	51.98	36.87
22	Number of seeds / fruit	25.50	92.00	57.08	421.92	370.68	35.98	33.72	87.9	37.17	65.12
23	100 Seed weight (gm)	4.07	5.32	4.72	0.21	0.12	9.68	7.42	58.8	0.55	11.71
24	Ascorbic acid (mg/100gm)	56.25	100.00	82.70	131.47	63.61	13.86	9.64	48.8	11.42	13.81
25	Capsaicin (%)	0.230	0.565	0.296	0.01	0.01	35.39	32.60	84.9	0.18	61.87
26	Pericarp thickness (mm)	1.42	2.46	1.90	0.18	0.12	22.29	18.52	69.0	0.60	31.70
27	White fly (%)	22.45	46.94	37.41	56.31	39.76	20.05	16.85	70.6	10.91	29.17
28	Leaf curl (%)	16.32	36.73	28.23	33.29	18.87	2.44	15.38	56.7	6.73	23.86

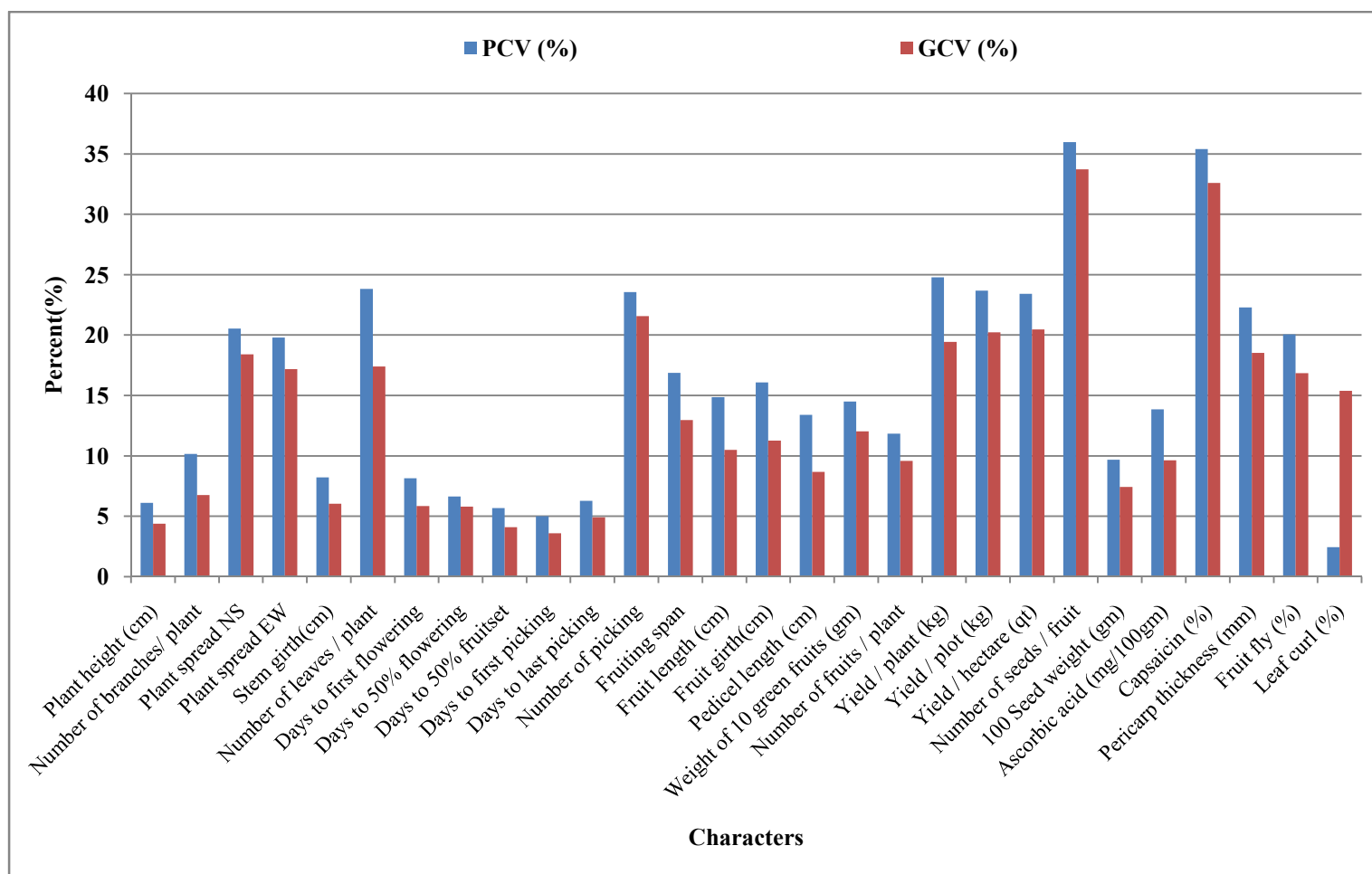


Fig. 4. PCV and GCV for 28 quantitative traits in chilli genotype

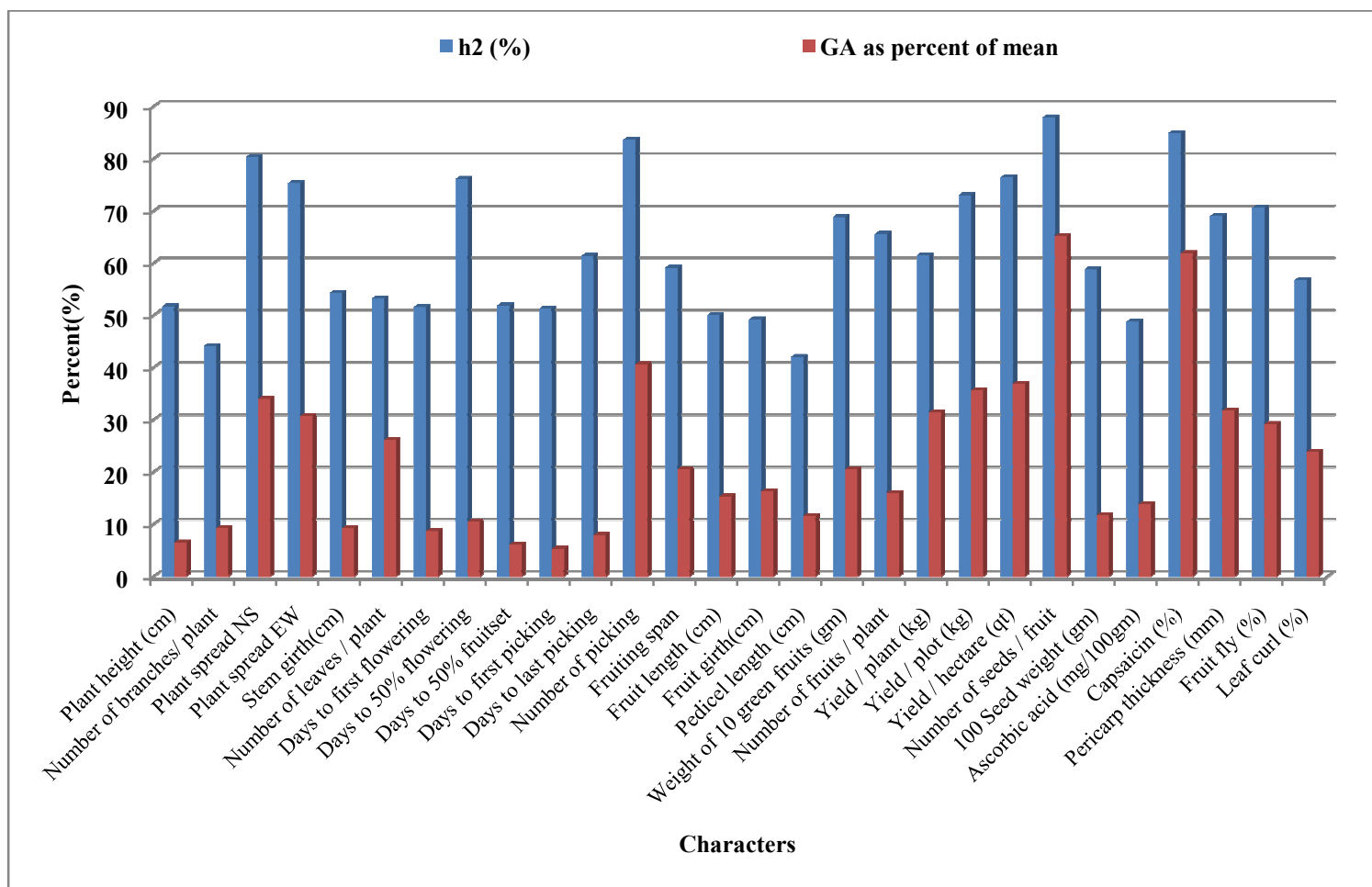


Fig. 5. Heritability (h^2) and genetic advance as per cent mean for 28 quantitative traits in chilli



Plate -2 a) : - Variability in the fruits of Chilli genotypes (Pusa Sadabahar to Byadgi- 341)



Plate- 2 b):- Variability in the fruits of Chilli genotypes (Byadgi to Pride)

4.5 Correlation studies

The genotypic correlation (G) and phenotypic (P) coefficients were worked out for eighteen characters in eighteen chilli genotypes. Data on phenotypic and genotypic correlation between fruit yield per plant (kg) as dependent variable and its attributes as independent variables *viz.*, plant height (cm), number of branches per plant, plant spread N-S(cm), plant spread E-W (cm), stem girth (cm), number of leaves per plant, days to 50 % flowering, days to 50% fruit set, days to last picking, fruit length (cm), fruit girth (cm), pedicel length, number of fruits per plant, fruit yield per hectare (q), ascorbic acid (mg/100g) and capsaicin (%) were established and resultant data was presented in Table 12 and 13 and Fig 6.

In the present study, it was found that genotypic correlation coefficient were slightly higher in magnitude than phenotypic correlation coefficient indicating strong inherent relationship between the characters and the same was less influenced by environmental variations.

Table 12. Genotypical correlation coefficient for different fruit yield contributing characters in Chilli.

Characters	Plant Height (cm)	Number of branches per plant	Plant spread NS (cm)	Plant spread EW (cm)	Stem girth (cm)	Number of leaves per plant	Days to 50% flowering	Days to 50% fruit set	Days to last picking	Fruit length (cm)	Fruit girth (cm)	Pedicle length (cm)	Number of fruits per plant	Yield per hectare (q)	Ascorbic acid (mg/100gm)	Capsaicin (%)	Pericarp thickness (mm)	Yield per plant (kg)
Plant height (cm)	1.0000	-0.2972*	-0.4048**	-0.1558	0.0565	0.5225**	-0.1042	-0.0003	-0.0758	-0.0490	0.0585	0.3553**	-0.3478**	-0.4303**	-0.0273	-0.0189	-0.1525	-0.5619**
Number of branches / plant		1.0000	0.4268**	0.4420**	-0.0301	-0.0091	-0.2286*	-0.4335**	-0.2675*	-0.1669	-0.2221*	-0.4225**	0.5222**	-0.4892**	0.4968**	0.4248**	-0.2910*	0.4704**
Plant spread NS (cm)			1.0000	1.1054**	-0.0151	0.0577	-0.2497*	-0.2239*	-0.0688	0.4759**	0.4485**	0.1800	0.6785**	0.4537**	-0.0468	0.0396	-0.2807*	0.1963
Plant spread EW (cm)				1.0000	0.0399	-0.00397	-0.2498*	-0.2077*	-0.1060	0.5640**	0.5219**	0.3658**	0.6710**	0.5124**	-0.0198	-0.0427	-0.3567**	0.5905**
Stem girth(cm)					1.0000	0.3282**	0.6402**	0.4163**	-0.2356*	-0.8370**	0.1642	-0.0679	-0.6242**	-0.4006**	-0.0380	-0.3660**	0.3650**	-0.6263**
Number of leaves per plant						1.0000	0.4484**	0.6080**	0.1337	-0.0988	0.6691**	0.9912**	-0.0144	0.2871*	-0.1772	-0.3362**	0.6131**	0.3269**
Days to 50% flowering							1.0000	1.2333**	0.4505**	-0.2165*	0.2450*	0.1372	-0.0326	0.0480	0.1221	-0.5578**	0.3293**	0.1160
Days to 50% fruit set								1.0000	0.5007**	0.0233	0.3224*	0.4035**	-0.0411	0.2511*	-0.1046	-0.5371**	0.4220**	0.2270*
Days to last picking									1.0000	0.4852**	0.4302**	0.6460**	0.5111**	0.4858**	0.3737**	-0.2579*	-0.0323	0.6643**
Fruit length (cm)										1.0000	0.3576**	0.5316**	1.0022**	0.8163**	-0.2043*	-0.1099	-0.4889**	0.8016**
Fruit girth(cm)											1.0000	0.9852**	0.3761**	0.4632**	-0.1547	-0.5895**	0.1027	0.4414**
Pedicle length (cm)												1.0000	0.3277**	0.4006**	0.0336	-0.2529*	0.1620	0.1963
Number of fruits per plant													1.0000	1.2033**	0.3125**	0.1100	-0.2928*	1.1316**
Yield per hectare (q)														1.0000	0.4613**	0.0370	-0.2651*	1.2672**
Ascorbic acid (mg/100gm)															1.0000	0.0271	0.2557*	0.2616*
Capsaicin (%)																1.0000	-0.1149	0.0610
Pericarp thickness (mm)																	1.0000	-0.3246**
Yield per plant (kg)																		1.0000

* Significant at 5 per cent level, ** Significant at 1 per cent level

Table 13. Phenotypical correlation coefficient for different fruit yield contributing characters in Chilli.

Characters	Plant Height (cm)	Number of branches per plant	Plant spread NS (cm)	Plant spread EW (cm)	Stem girth (cm)	Number of leaves per plant	Days to 50% flowering	Days to 50% fruit set	Days to last picking	Fruit length (cm)	Fruit girth (cm)	Pedicle length (cm)	Number of fruits per plant	Yield per hectare (q)	Ascorbic acid (mg/100g)	Capsaicin (%)	Pericarp thickness (mm)	Yield per plant (kg)
Plant height (cm)	1.0000	-0.0973	-0.1372	-0.1188	0.1761	0.0214	0.0142	-0.0662	-0.0561	0.0586	0.0122	0.4608**	-0.2685**	-0.1877	-0.0442	-0.0816	0.0292	-0.1261
Number of branches per plant		1.0000	0.2551*	0.2338*	-0.0639	-0.2420*	-0.1682	-0.1747	-0.2814*	-0.2092*	-0.1820	-0.3701**	0.1530	0.2623*	0.2233*	0.2762*	-0.0518	0.2827*
Plant spread NS (cm)			1.0000	0.8967**	0.0932	-0.0745	-0.2145*	-0.1431	-0.0009	0.3846**	0.4111*	0.1906	0.4201**	0.4623**	-0.0033	-0.0262	-0.1553	0.4432**
Plant spread EW (cm)				1.0000	0.0589	-0.0222	-0.1786	-0.1215	0.0574	0.4048**	0.3919**	0.1312	0.4269**	0.4186**	-0.0027	-0.0321	-0.1358	0.3806**
Stem girth (cm)					1.0000	0.1272	0.3414**	0.3468**	-0.1991	-0.4633**	0.1410	0.0721	-0.3298**	-0.2756*	0.2023*	-0.3278*	0.2610*	-0.1511
Number of leaves per plant						1.0000	0.1765	0.2499*	0.0797	0.0598	0.5479**	0.3155**	0.1288	0.1084	-0.0161	-0.1487	0.2571*	0.0808
Days to 50% flowering							1.0000	0.8122**	0.2825*	-0.1386	-0.0543	0.2118*	-0.0954	0.0790	-0.0117	-0.4138**	0.2794*	0.0283
Days to 50% fruit set								1.0000	0.3649**	-0.0807	0.0431	0.2866*	0.0533	0.0694	0.0638	-0.3591**	0.2847	0.0865
Days to last picking									1.0000	0.3373**	0.3862*	0.2765*	0.4482**	0.4589**	0.2156*	-0.1474	0.0339	0.3528**
Fruit length (cm)										1.0000	0.4362**	0.4433**	0.5444**	0.5108**	-0.0490	-0.0517	-0.2653*	0.5309**
Fruit girth (cm)											1.0000	0.3477**	0.3071**	0.3237**	-0.0411	-0.3105**	0.0755	0.3436**
Pedicle length (cm)												1.0000	0.1833	0.1844	-0.0383	-0.2491*	0.0283	0.2929*
Number of fruits per plant													1.0000	0.8026**	0.2543**	0.1488	-0.3229**	0.8651**
Yield per hectare (q)														1.0000	0.1980	0.0254	-0.2212*	0.8189**
Ascorbic acid (mg/100gm)															1.0000	0.0394	0.2168	0.3117**
Capsaicin (%)																1.0000	-0.1205	0.0008
Pericarp thickness (mm)																	1.0000	-0.2025*
Yield per plant (kg)																		1.0000

* Significant at 5 per cent level, ** Significant at 1 per cent level.

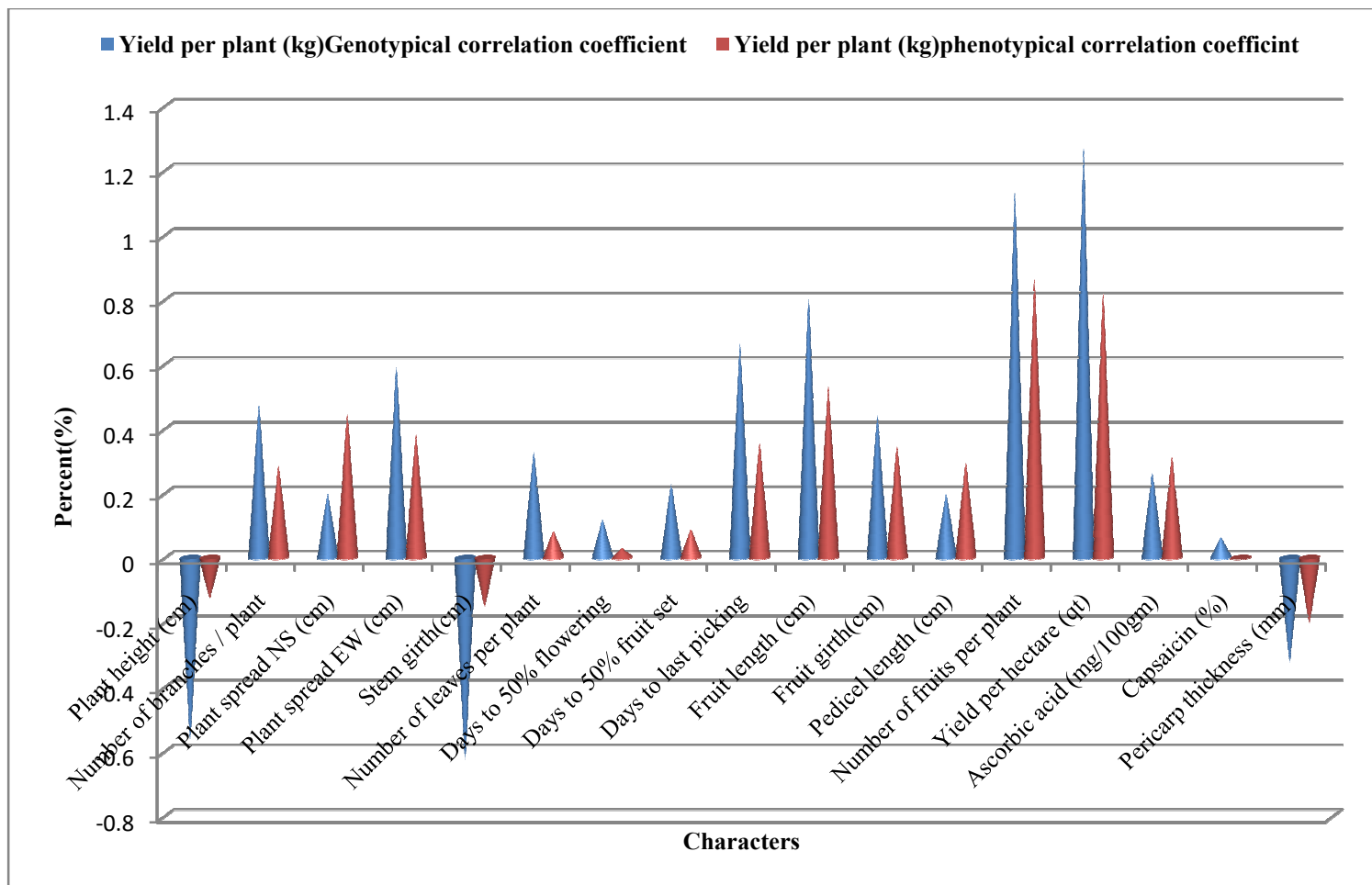


Fig. 6. Genotypic and phenotypic correlation coefficient for 17 characters in chilli

4.5.1 Plant height (cm)

Plant height were exhibited positive significant correlation with stem girth (0.1761P, 0.0565G), number of leaves per plant (0.0214 P, 0.5225 G), fruit girth (0.0122 P, 0.0585 G), pedicel length (0.4608 P, 0.3553 G).

Negative significant correlation was noticed with number of branches per plant (-0.0973 P, -0.2972 G), plant spread N-S (-0.1372 P, -0.4048 G), plant spread E-W (-0.1188 P, -0.1558 G), days to 50% fruit set (-0.0662 P, -0.0003), days to last picking (-0.0561 P, -0.0758 G), yield per hectare (-0.1877 P, -0.43033 G), yield per plant (-0.1261 P, -0.5619 G).

Ascorbic acid (-0.0273 G) and capsaicin (-0.0189 G) was recorded negative and significant association with plant height at genotypic level.

4.5.2 Number of branches per plant

Number of branches per plant were recorded positive, significant correlation with plant spread N-S (0.2551 P, 0.4268 G), plant spread E-W (0.2338 P, 0.4420 G), number of fruits per plant (0.1530 P, 0.5222 G), yield per plant (0.2827 P, 0.4704 G).

Negative and significant correlation was observed with stem girth (-0.0639 P, -0.0301 G), number of leaves per plant (-0.2420 P, -0.0091 G), days to 50% flowering (-0.1682 P, -0.2286 G), days to 50% fruit set (-0.1747 P, -0.4335 G), days to last picking (-0.2814 P, -0.2675 G), fruit length (-0.2092 P, -0.1669 G), fruit girth (-0.1820 P, -0.2221 G), pedicel length (-0.3701 P, -0.4225 G), pericarp thickness (-0.0518 P, -0.2910 G).

Ascorbic acid (0.4968 G) and capsaicin (0.4268 G) was recorded positive and significant association with number of branches per plant at genotypic level.

4.5.3 Plant spread N-S (cm)

Both phenotypic and genotypic correlation were exhibited significant positive correlation with plant spread E-W (0.8967 P, 1.1054 G), fruit length (0.3846 P, 0.4759 G), fruit girth (0.4111 P, 0.4485 G), pedicel length (0.1906 P, 0.1800 G), number of fruits per plant (0.4201 P, 0.6785 G), yield per hectare (0.4623 P, 0.4537 G), yield per plant (0.4432 P, 0.1963 G).

Both phenotypic and genotypic correlation were exhibited significant negative correlation with days to 50% flowering (-0.2145 P, -0.2497 G), days to 50%

fruit set (-0.1431 P, -0.2239 G), days to last picking (-0.0009 P, -0.0688 G), pericarp thickness (-0.1553 P, -0.2808 G).

Ascorbic acid (-0.0468 G) were recorded significant negative association at genotypic level. Whereas, capsaicin (0.0396 G), was recorded positive significant association with plant spread N-S at genotypic level

4.5.4 Plant spread E-W (cm)

Both phenotypic and genotypic correlation were exhibited significant positive correlation with stem girth (0.0589 P, 0.0399 G), fruit length (0.4048 P, 0.5640 G), fruit girth (0.3919 P, 0.5219 G), pedicel length (0.1312 P, 0.3658 G), number of fruits per plant (0.4269 P, 0.6710 G), yield per hectare (0.4186 P, 0.5124 G), yield per plant (0.3806 P, 0.5905 G).

Both phenotypic and genotypic correlation were exhibited significant negative correlation with number of leaves (-0.0222 P, -0.0397 G), days to 50% flowering (-0.1786 P, -0.2498 G), days to 50% fruit set (-0.1215 P, -0.2077 G), pericarp thickness (-0.1358 P, -0.3567 G).

Ascorbic acid (-0.0198 G) and capsaicin (-0.0427 G) was recorded negative and significant association with plant spread E-W at genotypic level.

4.5.5 Stem girth (cm)

Both phenotypic and genotypic correlation were exhibited significant positive correlation with number of leaves per plant (0.1272 P, 0.3282 G), day to 50% flowering (0.3414 P, 0.6402 G), days to 50% fruit set (0.3468 P, 0.4163 G), fruit girth (0.1410 P, 0.1642 G), pericarp thickness (0.2610 P, 0.3650 G).

Both phenotypic and genotypic correlation were exhibited significant negative correlation with days to last picking (-0.1991 P, -0.2356 G), fruit length (-0.4633 P, -0.8370 G), number of fruits per plant (-0.3298 P, -0.6242 G), yield per hectare (-0.2756 P, -0.4006 G), yield per plant (-0.1511 P, -0.6263 G).

Ascorbic acid (-0.0380 G) and capsaicin (-0.3660 G) was recorded negative and significant association with stem girth at genotypic level.

4.5.6 Number of leaves per plant

Both phenotypic and genotypic correlation were exhibited significant positive correlation with days to 50% flowering (0.1762 P, 0.4484 G) days to 50% fruit set (0.2499 P, 0.6080 G), day to last picking (0.0797 P, 0.1337), fruit girth (0.5479 P, 0.6691 G), pedicel length (0.3155 P, 0.9912 G), yield per hectare (0.1084

P, 0.2871 G), pericarp thickness (0.2571 P, 0.6131 G), yield per plant (0.0808 P, 0.3269 G).

Ascorbic acid (-0.1772 G) and capsaicin (-0.3362 G) was recorded negative and significant association with number of leaves per plant at genotypic level.

4.5.7 Days to 50% flowering

Both phenotypic and genotypic correlation were exhibited significant positive correlation with days to 50% fruit set (0.8122 P, 1.2333 G), days to last picking (0.2825 P, 0.4505 G), pedicel length (0.2118 P, 0.1372 G), yield per hectare (0.0790 P, 0.0480 G), pericarp thickness (0.2794 P, 0.3293 G), yield per plant (0.0283 P, 0.1160 G).

Both phenotypic and genotypic correlation were exhibited significant negative correlation with fruit length (-0.1386 P, -0.2165 G), number of fruits per plant (-0.0954 P, -0.0326 G).

Ascorbic acid (0.1221 G) was recorded significant positive association at genotypic level. Whereas, capsaicin (-0.5578 G), was recorded negative significant association with days to 50% flowering at phenotypic level.

4.5.8 Days to 50% fruit set

Both phenotypic and genotypic correlation were exhibited significant positive correlation with days to last picking (0.3649 P, 0.50078 G), fruit girth (0.0431 P, 0.3224 G), pedicel length (0.2866 P, 0.4035 G), yield per hectare (0.0694 P, 0.2511 G), pericarp thickness (0.2847 P, 0.4220 G), yield per plant (0.0865 P, 0.2270 G),

Ascorbic acid (-0.1046 G) and capsaicin (-0.5371 G) was recorded negative and significant association with days to 50% fruit set at genotypic level.

4.5.9 Days to last picking

Both phenotypic and genotypic correlation were exhibited significant positive correlation with fruit length (0.3373 P, 0.4852 G), fruit girth (0.0386 P, 0.4302 G), pedicel length (0.2765 P, 0.6460 G), number of fruits per plant (0.4482 P, 0.5111 G), yield per hectare (0.4589 P, 0.4858 G), yield per plant (0.3528 P, 0.6643 G).

Ascorbic acid (0.3737 G) were recorded significant positive association at genotypic level. Whereas, capsaicin (-0.2579 G), was recorded negative significant association with days to last picking at phenotypic level.

4.5.10 Fruit length (cm)

Both phenotypic and genotypic correlation were exhibited significant positive correlation with fruit girth (0.4362 P, 0.3576 G), pedicel length (0.4433 P, 0.5316 G), number of fruits per plant (0.5444 P, 1.0022 G), yield per hectare (0.5108 P, 0.8163 G), yield per plant (0.5309 P, 0.8016 G) where as; pericarp thickness (-0.2653 P, -0.4889 G) was significant but negatively correlated with fruit length at genotypic level.

Ascorbic acid (-0.2043 G) and capsaicin (-0.1099 G) was recorded negative and significant association with fruit length at genotypic level.

4.5.11 Fruit girth (cm)

Both phenotypic and genotypic correlation were exhibited significant positive correlation with pedicel length(0.3477 P, 0.9852 G), number of fruits per plant (0.3071 P, 0.3761 G), yield per hectare (0.3237 P, 0.4632 G), pericarp thickness (0.0755 P, 0.1027 G), yield per plant (0.3436 P, 0.4414 G).

Ascorbic acid (-0.1547 G) and capsaicin (-0.5895 G) was recorded negative and significant association with fruit girth at genotypic level.

4.5.12 Pedicel length (cm)

Both phenotypic and genotypic correlation were exhibited significant positive correlation with number of fruits per plant (0.1833 P, 0.3277 G), yield per hectare (0.1844 P, 0.4006 G), pericarp thickness (0.0283 P, 0.1620 G), yield per plant (0.2929 P, 0.1963 G)

Ascorbic acid (0.0336 G) was recorded significant positive association at genotypic level. Whereas, capsaicin (-0.2529G), was recorded negative significant association with days to pedicel length at phenotypic level.

4.5.13 Number of fruits per plant

Both phenotypic and genotypic correlation were exhibited significant positive correlation with yield per hectare (0.8026 P, 1.2033 G), yield per plant (0.8651 P, 1.1316 G).

Both phenotypic and genotypic correlation were exhibited significant negative correlation with pericarp thickness (-0.3229 P, -0.2928 G),

Ascorbic acid (G) and capsaicin (0.3125 G) and capsaicin (0.1100 G) was recorded negative and significant association with number of leaves per plant at genotypic level.

4.5.14 Yield per hectare (q)

Both phenotypic and genotypic correlation were exhibited significant positive correlation with yield per plant (0.8189 P, 1.2672 G) where as; pericarp thickness (-0.2212 P, -0.2651 G) was significant but negatively correlated with fruit yield per hectare at both genotypic and phenotypic level.

Ascorbic acid (0.4613 G) and capsaicin (0.0370 G) has recorded positive and significant association with yield per hectare at genotypic level.

4.5.15 Ascorbic acid (mg/100g)

Both phenotypic and genotypic correlation were exhibited significant positive correlation with pericarp thickness (0.2168 P, 0.2557 G), yield per plant (0.3117 P, 0.2616 G).

Capsaicin (0.0271 G) has recorded positive and significant association with ascorbic acid at genotypic level.

4.5.16 Capsaicin (%)

Both phenotypic and genotypic correlation were exhibited significant positive correlation with yield per plant (0.0008 P, 0.0610 G) Where as; pericarp thickness (-0.1205 P, -0.1149 G) was significant but negatively correlated with capsaicin at both genotypic.

4.5.17 Pericarp thickness (cm)

Pericarp thickness showed negative and significant correlation was noticed with yield per plant (-0.2025 P, -0.3246 G).

4.5.18 Fruit yield per plant (kg)

Fruit yield per plant was recorded positive significant correlation with characters number of branches per plant (0.2827 P, 0.4704 G), plant spread N-S (0.4432 P, 0.1963 G), plant spread E-W (0.3806 P, 0.5905 G), number of leaves per plant (0.0808 P, 0.3269 G), days to 50% flowering (0.0283 P, 0.1160 G), day to 50% fruit set (0.0865 P, 0.2270 G), days to last picking (0.3528 P, 0.6643 G), fruit length

(0.5309 P, 0.8016 G), fruit girth (0.3436 P, 0.4414 G), number of fruits per plant (0.8651 P, 1.1316 G), pedicel length (0.2929 P, 0.1963 G), yield per hectare (0.8189 P, 1.2672 G) and it was noticed significant negative correlation with plant height (-0.1261 P, -0.5619 G), pericarp thickness (-0.2025 P, -0.3246 G).

Ascorbic acid (0.2616 G) and capsaicin (0.0610 G) was recorded positive and significant association with fruit yield per plant at genotypic level.

4.6 Path coefficient analysis

Path analysis was carried out at phenotypic and genotypic level considering fruit yield per plant (kg) as dependent variable and its attributes as independent variables viz., plant height (cm), number of branches per plant, plant spread N-S (cm), plant spread E-W (cm), stem girth (cm), number of leaves per plant, days to 50 % flowering, days to 50% fruit set, days to last picking, fruit length (cm), fruit girth (cm), pedicel length, number of fruits per plant, fruit yield per hectare (q), ascorbic acid (mg/100g) and capsaicin (%). Each component has two path actions viz., direct effect on yield and indirect effect through components which are not revealed by correlation studies and data presented in Table 14 and 15 and Fig. 7 and Fig. 8.

Table 14. Genotypic (G) path coefficient analysis indicating direct and indirect effects of components characters on fruit yield per plant in 18 genotypes of chilli

Characters	Plant Height (cm)	Number of branches per plant	Plant spread NS (cm)	Plant spread EW (cm)	Stem girth (cm)	Number of leaves per plant	Days to 50% flowering	Days to 50% fruit set	Days to last picking	Fruit length (cm)	Fruit girth (cm)	Pedicle length (cm)	Number of fruits per plant	Yield / hectare (q)	Ascorbic acid (mg/100g)	Capsaicin (%)	Pericarp thickness (mm)	Yield / plant
Plant height (cm)	0.1931	-0.0574	-0.0782	-0.0301	0.0109	0.1009	-0.0201	-0.0001	-0.0146	-0.0095	0.0113	0.00686	-0.0672	-0.0831	-0.0053	-0.0037	-0.0294	-0.5619
Number of branches per plant	-0.0060	0.0200	0.0086	0.0089	-0.0006	-0.0002	-0.0046	-0.0087	-0.0054	-0.0033	-0.0045	-0.0850	0.0105	0.0098	0.0100	0.0085	-0.0058	0.4704
Plant spread NS (cm)	-0.3434	0.3620	0.8482	0.9375	-0.0128	0.0489	-0.2118	-0.1899	-0.0584	0.4036	0.3804	0.1527	0.5755	0.3848	-0.0397	0.0336	-0.2381	0.4963
Plant spread EW (cm)	0.0956	-0.2714	-0.6786	-0.6139	-0.0245	0.0244	0.1534	0.1275	0.0651	-0.3462	-0.3204	-0.2246	-0.4119	-0.3145	0.0121	0.0262	0.2190	0.5905
Stem girth(cm)	-0.0147	0.0078	0.0039	-0.0104	-0.2597	-0.0852	-0.1663	-0.1081	0.0612	0.2174	-0.0426	0.0176	0.1621	0.1040	0.0099	0.0950	-0.0948	-0.6263
Number of leaves per plant	-0.0224	0.0004	-0.0025	0.0017	-0.0141	-0.0429	-0.0193	-0.0261	-0.0057	0.0042	-0.0287	-0.0426	0.0006	-0.0123	0.0076	0.0144	-0.0263	0.3269
Days to 50% flowering	0.0066	0.0145	0.0158	0.0158	-0.0405	-0.0283	-0.0632	-0.0780	-0.0285	0.0137	-0.0155	-0.0087	0.0021	-0.0030	-0.0077	0.0353	-0.0208	0.1160
Days to 50% fruit set	0.0001	0.1448	0.0748	0.0694	-0.1390	-0.2031	-0.4119	-0.3340	-0.1672	-0.0078	-0.1077	-0.1348	0.0137	-0.0839	0.0349	0.1794	-0.1409	0.2270
Days to last picking	0.0171	0.0603	0.0155	0.0239	0.0531	-0.0301	-0.1075	-0.01128	-0.2253	-0.1093	-0.0969	-0.1455	-0.1151	-0.1094	-0.0842	0.0581	0.0073	0.6643
Fruit length (cm)	0.0217	0.0740	-0.2110	-0.2501	0.3711	0.0438	0.0960	-0.0103	-0.2151	-0.4434	-0.1586	-0.2357	-0.4443	-0.3619	0.0906	0.0487	0.2168	0.8016
Fruit girth(cm)	0.0325	-0.1234	0.2491	0.2898	0.0912	0.3715	0.1361	0.1790	0.2389	0.1986	0.5553	0.5471	0.2089	0.2572	-0.0859	-0.3274	0.0570	0.4414
Pedicle length (cm)	0.0063	-0.0075	0.0032	0.0065	-0.0012	0.0176	0.0024	0.0072	0.0115	0.0094	0.0175	0.0178	0.0058	0.0071	0.0006	-0.0045	0.0029	0.1946
Number of fruits per plant	-0.6504	0.9765	1.2687	1.2547	-1.1671	-0.0269	-0.0610	-0.0769	0.9557	1.8739	0.7033	0.6127	1.8698	2.2500	0.5844	0.2057	-0.5476	1.1316
Yield / hectare (q)	0.3165	-0.3599	-0.3338	-0.3769	0.2947	-0.2112	-0.0353	-0.1847	-0.3574	-0.6005	-0.3407	-0.2947	-0.8852	-0.7356	-0.3393	-0.0272	0.1950	1.2672
Ascorbic acid (mg/100g)	-0.0086	0.1551	-0.0148	-0.0062	-0.0120	-0.0560	0.0386	-0.0331	0.1182	-0.0646	-0.0489	0.0106	0.0988	0.1458	0.3162	0.0086	0.0808	0.2616
Capsaicin (%)	0.0041	-0.0911	-0.0085	0.0092	0.0785	0.0717	0.1197	0.1152	0.0553	0.0236	0.1265	0.0543	-0.0236	-0.0079	0.0058	-0.2145	0.0246	0.0610
Pericarp thickness (mm)	-0.0522	-0.0996	-0.0961	-0.1221	0.1249	0.2098	0.1127	0.1444	-0.0111	-0.1673	0.0352	0.0554	-0.1002	-0.0907	0.0875	-0.0393	0.3423	-0.3246

Residual effect =0.0002

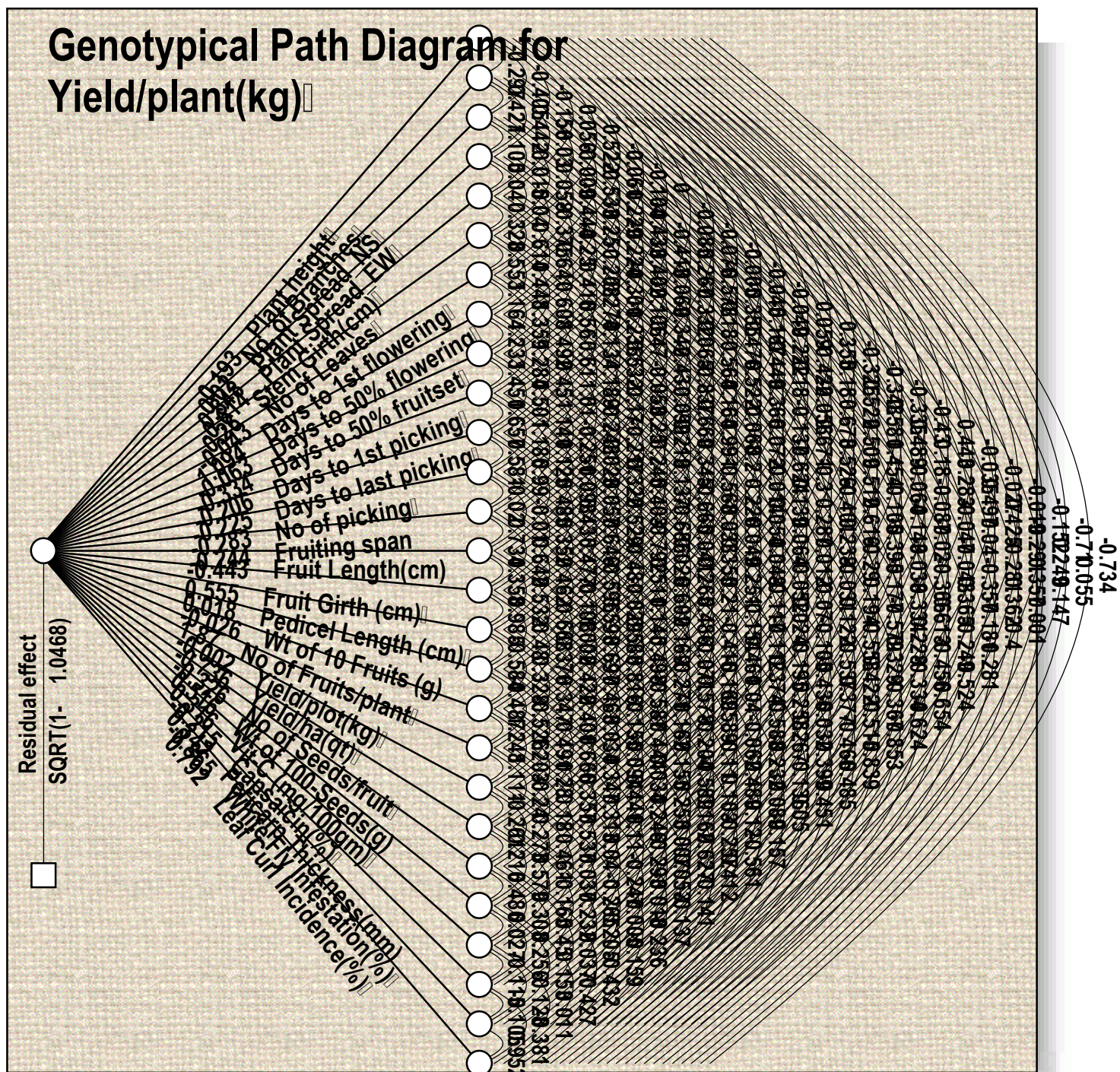


Fig. 7 Genotypic path diagram representing direct and indirect effects for fruit yield per plant

Table 15. Phenotypic (P) path coefficient analysis indicating direct and indirect effects of components characters on fruit yield per plant in 18 genotypes of Chili

Characters	Plant Height (cm)	Number of branches per plant	Plant spread NS (cm)	Plant spread EW (cm)	Stem girth (cm)	Number of leaves per plant	Days to 50% flowering	Days to 50% fruit set	Days to last picking	Fruit length (cm)	Fruit girth (cm)	Pedicle length (cm)	Number of fruits per plant	Yield per hectare (q)	Ascorbic acid (mg/100g)	Capsaicin (%)	Pericarp thickness (mm)	Yield / plant
Plant height (cm)	-0.599	0.0058	0.0082	0.0071	-0.0105	-0.0013	-0.0008	0.0040	0.0034	-0.0035	-0.0007	-0.2760	0.0161	0.0112	0.0026	0.0049	-0.0018	-0.1261
Number of branches per plant	-0.0107	0.1103	0.0281	0.0258	-0.0071	-0.0267	-0.0186	-0.0193	-0.0310	-0.0231	-0.0201	-0.0408	0.0169	0.0289	0.0246	0.0305	-0.0057	0.2827
Plant spread NS (cm)	-0.0321	0.0596	0.2337	0.2095	0.0218	-0.0174	-0.0501	-0.0334	-0.0002	0.0899	0.0961	0.0445	0.0982	0.1080	-0.0008	-0.0061	-0.0363	0.4432
Plant spread EW (cm)	0.0319	-0.0628	-0.2407	-0.2685	-0.0158	0.0059	0.0479	0.0326	-0.0154	-0.1087	-0.1052	-0.0352	-0.1146	-0.1124	0.0007	0.0086	0.0375	0.3806
Stem girth(cm)	-0.0015	0.0005	-0.0008	-0.0005	-0.0083	-0.0011	0.0028	-0.0029	0.0017	0.0039	-0.0012	-0.0006	0.0027	0.0023	-0.0017	0.0027	-0.0022	-0.1511
Number of leaves per plant	-0.0055	0.0616	0.0190	0.0056	-0.0324	-0.2547	-0.0449	-0.0636	-0.0203	-0.0152	-0.1395	-0.0803	-0.0328	-0.0273	0.0041	0.0379	-0.0655	0.0808
Days to 50% flowering	-0.0012	0.0146	0.0186	0.0155	-0.0296	-0.0153	-0.0867	-0.0704	-0.0245	0.0120	0.0047	-0.0184	0.0083	-0.0068	0.0010	0.0359	-0.0242	0.0283
Days to 50% fruit set	0.0150	0.0397	0.0325	0.0276	-0.0788	-0.0568	-0.1844	-0.2271	-0.0829	-0.0183	-0.0098	-0.0651	-0.0121	-0.0158	-0.0145	0.0815	-0.0647	0.0865
Days to last picking	0.0157	0.0787	0.0003	-0.0160	0.0557	-0.0223	-0.0790	-0.1020	-0.2796	0.0946	-0.1080	-0.0773	-0.1253	-0.1283	-0.0603	0.0412	-0.0095	0.3528
Fruit length (cm)	-0.0043	0.0155	-0.0285	-0.0300	0.0343	-0.0044	0.0103	0.0060	-0.0250	-0.0741	-0.0323	-0.0329	-0.0403	-0.0379	0.0036	0.0038	0.0197	0.5309
Fruit girth(cm)	-0.0047	-0.0705	0.1593	0.1518	0.0546	0.2123	-0.0210	0.0167	0.1496	0.1690	0.3874	-0.1347	0.1190	0.1254	0.0159	-0.1203	0.0292	0.3436
Pedicle length (cm)	0.0853	-0.0685	0.0353	0.0243	0.0133	0.0584	0.0392	0.0530	0.0512	0.0820	0.0643	0.1850	0.0339	0.0341	-0.0071	-0.0461	0.0052	0.2929
Number of fruits per plant	-0.3022	0.1721	0.4727	0.4803	-0.3711	0.1449	-0.1073	0.0600	0.5043	0.6126	0.3456	-0.0201	1.1252	0.9030	0.2861	0.1674	-0.3633	0.8651
Yield per hectare (q)	-0.0039	0.0054	0.0095	0.0086	-0.0057	0.0022	0.0016	0.0014	0.0094	0.0105	0.0067	0.0038	0.0165	0.0206	0.0041	0.0005	-0.0045	0.8189
Ascorbic acid (mg/100g)	-0.0069	0.0347	-0.0005	-0.0004	0.0315	-0.0025	-0.0018	0.0099	0.0333	-0.0076	0.0064	-0.0060	0.0395	0.0308	0.1555	0.0061	0.0337	0.3117
Capsaicin (%)	0.0124	-0.0421	0.0040	0.0049	0.0499	0.0226	0.0630	0.0547	0.0224	0.0079	0.0473	-0.0379	-0.0227	-0.0039	-0.0060	-0.1523	0.0183	0.0008
Pericarp thickness (mm)	0.0075	-0.0133	-0.0398	-0.0358	0.0668	0.0658	0.0715	0.0729	0.0087	-0.0679	0.0193	0.0072	-0.0827	-0.0566	0.0555	-0.0309	0.2561	-0.2025

Residual effect =1.0000

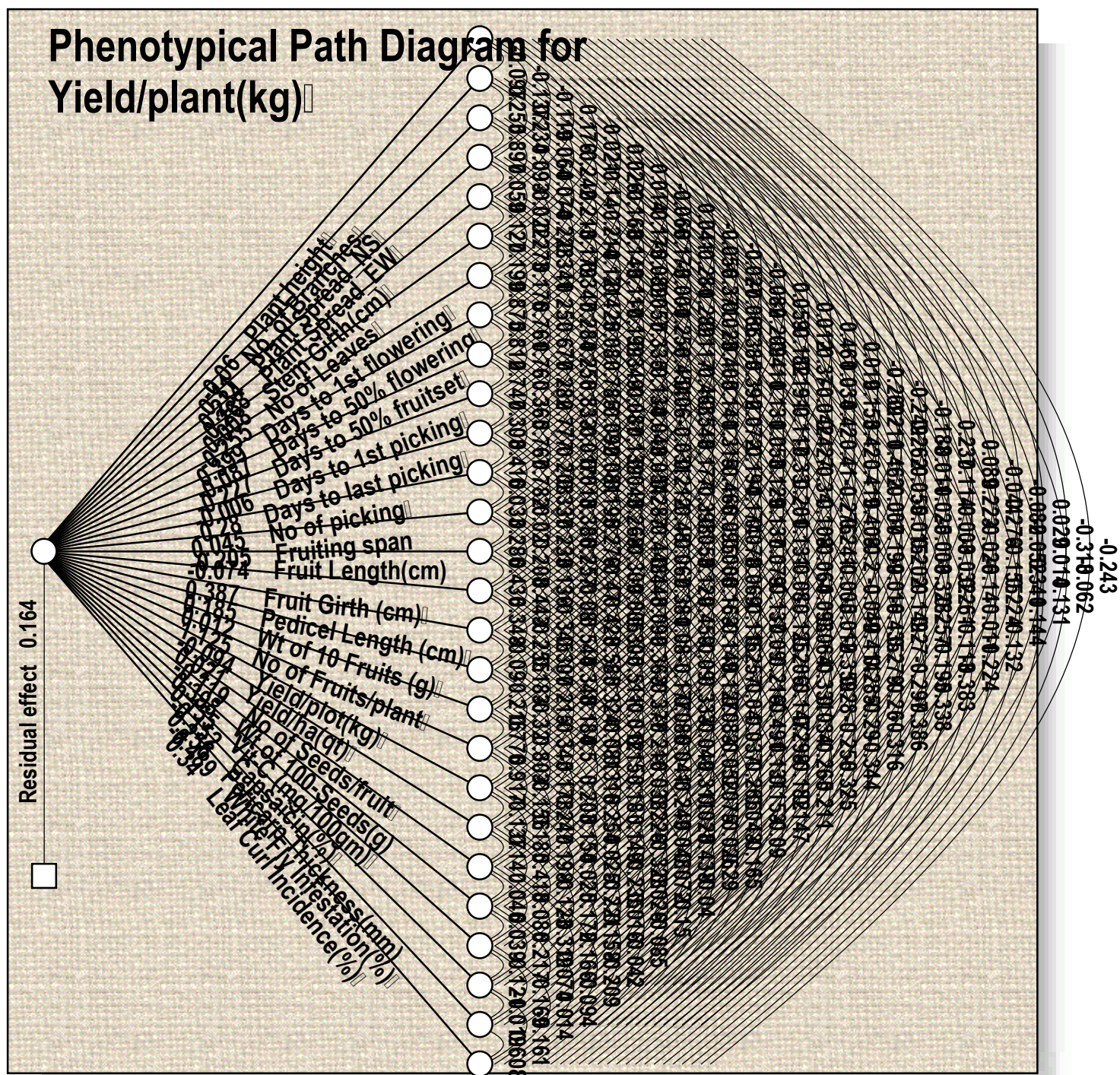


Fig. 8 Phenotypic path diagram representing direct and indirect effects for fruit yield per plant

4.6.1 Plant height (cm)

Plant height showed positive direct effect (0.1931) on fruit yield per plant. It had shown maximum positive indirect effect on fruit yield per plant through characters *viz.*, number of leaves per plant (0.1009), fruit girth (0.0113), stem girth (0.0109). While it had shown maximum negative indirect effect on fruit yield per plant *viz.*, plant spread NS (-0.0782), number of fruits per plant (-0.672), number of branches per plant (-0.0574) at genotypic level.

At phenotypic level, plant height was recorded negative direct effect (-0.599) on fruit yield per plant. It had shown maximum positive indirect effect through number of fruits per plant (0.0161), yield per hectare (0.0112), plant spread NS (0.0082). While, pedicel length (-0.2760), stem girth (-0.0105), fruit length (-0.0035) characters had shown maximum negative indirect effect on fruit yield per plant.

4.6.2 Number of branches per plant

Number of branches had a positive direct effect (0.0200) on fruit yield per plant. It showed a maximum positive indirect effect through characters *viz.*, number of fruits per plant (0.0105), ascorbic acid (0.0100) and yield per hectare (0.0098). While, it showed maximum negative indirect effect through pedicel length (-0.0850) followed by days to 50% fruit set (-0.0087), plant height (-0.0060) at genotypic level.

The character number of branches showed positive direct effect (0.1103) on fruit yield per plant. It exhibited maximum positive indirect effect on fruit yield per plant *viz.*, capsaicin (0.0305) followed by fruit yield per hectare (0.0289), and plant spread NS (0.0281). Whereas, it had shown maximum negative indirect effect on fruit yield per plant through pedicel length (-0.0408) followed by days to last picking (-0.0310), and number of leaves per plant (-0.0267) at phenotypic level.

4.6.3 Plant spread NS (cm)

Plant spread NS had a positive direct effect (0.8482) on fruit yield per plant. It showed a maximum positive indirect effect through characters *viz.*, plant spread EW (0.9375), number of fruits per plant (0.5755) and fruit length (0.4036). While, it showed maximum negative indirect effect through plant height (-0.3434) followed by pericarp thickness (-0.2381), days to 50% flowering (-0.2118) at genotypic level.

The character Plant spread NS showed positive direct effect (0.2337) on fruit yield per plant. It exhibited maximum positive indirect effect on fruit yield per plant *viz.*, plant spread EW (0.2095), yield per hectare (0.1080) and number of fruits per plant (0.0982). Whereas, it had shown maximum negative indirect effect on fruit yield per plant through days to 50% flowering (-0.0501) followed by days to pericarp thickness (-0.0363), and plant height (-0.0321) at phenotypic level.

4.6.4 Plant spread EW (cm)

Plant spread EW had a negative direct effect (-0.6139) on fruit yield per plant. It showed a maximum positive indirect effect through characters *viz.*, pericarp thickness (0.2190), days to 50% flowering (0.1534), and days to 50% fruit set (0.1275). While, it showed maximum negative indirect effect through plant spread NS (-0.6786) followed by number of fruits per plant (-0.4119) and fruit length (-0.3462) at genotypic level.

The character Plant spread EW showed negative direct effect (-0.2685) on fruit yield per plant. It exhibited maximum positive indirect effect on fruit yield per plant *viz.*, days to 50% flowering (0.0479), pericarp thickness (0.0375), and days to 50% fruit set (0.0326). Whereas, it had shown maximum negative indirect effect on fruit yield per plant through plant spread NS (-0.2407) followed by number of fruits per plant (-0.1146) and yield per hectare (-0.1124) at phenotypic level.

4.6.5 Stem girth (cm)

Stem girth had a negative direct effect (-0.2597) on fruit yield per plant. It showed a maximum positive indirect effect through characters *viz.*, fruit length (0.2174), number of fruits per plant (0.1621) and yield per hectare (0.1040). While, it showed maximum negative indirect effect through days to 50% flowering (-0.1663), days to 50% fruit set (-0.1081) and pericarp thickness (-0.0948). at genotypic level.

The character stem girth showed negative direct effect (-0.0083) on fruit yield per plant. It exhibited maximum positive indirect effect on fruit yield per plant *viz.*, fruit length (0.0039), days to 50% flowering (0.0028), and capsaicin (0.0027). Whereas, it had shown maximum negative indirect effect on fruit yield per plant through days to 50% fruit set (-0.0029), pericarp thickness (-0.0022) and ascorbic acid (-0.0017) at phenotypic level.

4.6.6 Number of leaves per plant

Number of leaves per plant had a negative direct effect (-0.0429) on fruit yield per plant. It showed a maximum positive indirect effect through characters *viz.*, capsaicin (0.0144), ascorbic acid (0.0076), and fruit length (0.0042). While, it showed maximum negative indirect effect through days to pedicel length (-0.0426), pericarp thickness (-0.0263) and days to 50% fruit set (-0.0261) at genotypic level.

The character number of leaves per plant showed negative direct effect (-0.2547) on fruit yield per plant. It exhibited maximum positive indirect effect on fruit yield per plant *viz.*, number of branches per plant (0.0616), capsaicin (0.0379) and plant spread NS (0.0190). Whereas, it had shown maximum negative indirect effect on fruit yield per plant through fruit girth (-0.1395), pedicel length (-0.0803) and number of fruits per plant (-0.0328) at phenotypic level.

4.6.7 Days to 50 per cent flowering

Negative direct effect (-0.0632) on fruit yield was exerted by days to 50 per cent flowering and it had maximum positive indirect effect on fruit yield through capsaicin (0.0353) followed by plant spread EW (0.0158), and plant spread NS (0.0158). While, characters days to 50% fruit set (-0.0780), days to last picking (-0.0285), and number of leaves per plant (-0.0283) exerted maximum negative indirect effect on fruit yield per plant at genotypic level.

At phenotypic level, days to 50 per cent flowering had shown negative direct effect (-0.0867) on fruit yield per plant. While it recorded maximum positive indirect effect *viz.*, capsaicin (0.0359) followed by plant spread NS (0.0186), and plant spread EW (0.0155). While, days to 50% fruit set (-0.0704), stem girth (-0.0296) and days to last picking (-0.0245) had shown maximum negative indirect effect on fruit yield per plant.

4.6.8 Days to 50% fruit set

The character days to 50% fruit set showed negative direct effect (-0.3340) on fruit yield per plant. It recorded maximum positive indirect effect on fruit yield through capsaicin (0.1794), number of branches per plant (0.1448) and plant spread NS (0.0748). The highest negative indirect effect was observed through days to 50% flowering (-0.4119), number of leaves per plant (-0.2031) and days to last picking (-0.1672) at genotypic level.

At phenotypic studies, days to 50% fruit set exerted negative direct effect (-0.2271) on fruit yield per plant. It had maximum positive indirect effect on fruit yield per plant via. Capsaicin (0.0815), number of branches per plant (0.0397) and plant spread NS (0.0325). While, it had shown maximum negative indirect effect through days to 50% flowering (-0.1844), days to last picking (-0.0829) and stem girth (-0.0788)

4.6.9 Days to last picking

The character days to last picking showed negative direct effect (-0.2253) on fruit yield per plant. It was recorded maximum positive indirect effect on fruit yield through number of branches per plant (0.0603), capsaicin (0.0581) and stem girth (0.0531). The highest negative indirect effect was observed through pedicel length (-0.1455), number of fruits per plant (-0.1151) and yield per hectare (-0.1094) at genotypic level.

At phenotypic studies, days to last picking exerted negative direct effect (-0.2796) on fruit yield per plant. It had maximum positive indirect effect on fruit yield per plant via. fruit length (0.0946), number of branches per plant (0.0787) and stem girth (0.0557). While, it had shown maximum negative indirect effect through number of fruits per plant (-0.1253), fruit girth (-0.1080) and days to 50% fruit set (-0.1020).

4.6.10 Fruit length (cm)

The character fruit length showed negative direct effect (-0.4434) on fruit yield per plant. It was recorded maximum positive indirect effect on fruit yield through stem girth (0.3711), pericarp thickness (0.2168) and ascorbic acid (0.0906). The highest negative indirect effect was observed through number of fruits per plant (-0.4443), yield per hectare (-0.3619) and plant spread EW (-0.2501) at genotypic level.

At phenotypic studies, fruit length exerted negative direct effect (-0.0741) on fruit yield per plant. It had maximum positive indirect effect on fruit yield per plant via. stem girth (0.0343), pericarp thickness (0.0197) and number of branches per plant (0.0155). While, it had shown maximum negative indirect effect through number of fruits per plant (-0.0403), yield per hectare (-0.0379) and pedicel length (-0.0329).

4.6.11 Fruit girth (cm)

Fruit girth had a positive direct effect (0.5553) on fruit yield per plant. It showed a maximum positive indirect effect through characters *viz.*, pedicel length (0.5471), number of leaves per plant (0.3715), and plant spread EW (0.2898). While, it showed maximum negative indirect effect through capsaicin (-0.3274) followed by number of branches per plant (-0.1234), ascorbic acid (-0.0859) at genotypic level.

The character fruit girth showed positive direct effect (0.3874) on fruit yield per plant. It was exhibited maximum positive indirect effect on fruit yield per plant *viz.*, number of leaves per plant (0.2123), fruit length (0.1690) and plant spread NS (0.1593). Whereas, it had shown maximum negative indirect effect on fruit yield per plant through pedicel length (-0.1347) followed by capsaicin (-0.1203) and number of branches per plant (-0.0705) at phenotypic level.

4.6.12 Pedicel length (cm)

Pedicel length had shown positive direct effect (0.0178) on fruit yield per plant. It had maximum positive indirect effect on fruit yield per plant through number of leaves per plant (0.0176), fruit girth (0.0175) and days to last picking (0.0115). It had maximum negative indirect effect on fruit yield per plant through number of branches per plant (-0.0075) followed by capsaicin (-0.0045), and stem girth (-0.0012) at genotypic level.

The character pedicel length was recorded positive direct effect (0.1850) on fruit yield per plant. The traits plant height (0.0853), fruit length (0.0820) and fruit girth (0.0643) through which pedicel length exhibited maximum positive indirect effect on fruit yield per plant. While, pedicel length had shown maximum negative indirect effect on fruit yield per plant through number of branches per plant (-0.0685) followed by capsaicin (-0.0461), and ascorbic acid (-0.0071) at phenotypic level.

4.6.13 Number of fruits per plant

Number of fruits per plant had a positive direct effect (1.8698) on fruit yield per plant. It showed a maximum positive indirect effect through characters *viz.*, yield per hectare (2.2500), fruit length (1.8739), plant spread NS (1.2687); While, it showed maximum negative indirect effect through stem girth (-1.1671), plant height (-0.6504) and pericarp thickness (-0.5476) at genotypic level.

The character number of fruits per plant showed positive direct effect (1.1252) on fruit yield per plant. It exhibited maximum positive indirect effect on fruit yield per plant viz., yield per hectare (0.9030), fruit length (0.6126) and days to last picking (0.5043). Whereas, it had shown maximum negative indirect effect on fruit yield per plant through stem girth (-0.3711), pericarp thickness (-0.3633) and plant height (-0.3022) at phenotypic level.

4.6.14 Yield per hectare (q)

Yield per hectare was exhibited negative direct effect (-0.7356) on fruit yield per plant and it had maximum positive indirect effect on fruit yield through plant height (0.3165) followed by stem girth (0.2947), and pericarp thickness (0.1950). While it showed maximum negative indirect effect on fruit yield per plant through number of fruits per plant (-0.8852), fruit length (-0.6005) and plant spread EW (-0.3769) at genotypic level.

The character yield per hectare showed positive direct effect (0.0206) on fruit yield per plant. It had recorded maximum positive indirect effect on fruit yield per plant through number of fruits per plant (0.0165), fruit length (0.0105) and plant spread NS (0.0095). Whereas, it had shown maximum negative indirect effect through stem girth (-0.0057), pericarp thickness (-0.0045) and plant height (-0.0039) at phenotypic level.

4.6.15 Ascorbic acid (mg/100g)

At genotypic level, the trait Ascorbic acid was exhibited positive direct effect (0.3162) on fruit yield per plant. The characters number of branches per plant (0.1551), yield per hectare (0.1458) days to last picking (0.1182) through which ascorbic acid was exerted maximum positive indirect effect on fruit yield and it had shown maximum negative indirect effect through fruit length (-0.0646), number of leaves per plant (-0.0560) and fruit girth (-0.0489).

The character ascorbic acid had shown positive direct effect (0.1555) on fruit yield per plant. It had maximum positive indirect effect on fruit yield per plant through number of fruits per plant (0.0395), number of branches per plant (0.0347) and pericarp thickness (0.0337). While, it had shown maximum negative indirect effect on fruit yield per plant via; fruit length (-0.0076), plant height (-0.0069) and pedicel length (-0.0060) at phenotypic level.

4.6.16 Capsaicin (%)

At genotypic level, the character capsaicin showed negative direct effect (-0.2145) on fruit yield per plant. Its indirect effect on fruit yield per plant through fruit girth (0.1265), days to 50% flowering (0.1197) and days to 50% fruit set (0.1152) was positive. Whereas, it was negative through number of branches per plant (-0.0911), number of fruits per plant (-0.0236) and plant spread NS (-0.0085).

At phenotypic level, capsaicin had shown negative direct effect (-0.1523) on fruit yield per plant. It had recorded maximum positive indirect effect on fruit yield per plant through days to 50% flowering (0.0630), days to 50% fruit set (0.0547) and stem girth (0.0499). While, trait number of branches per plant (-0.0421), pedicel length (-0.0379) and number of fruits per plant (-0.0227) was recorded highest negative indirect effect on fruit yield per plant.

4.6.17 Pericarp thickness (mm)

Pericarp thickness had shown positive direct effect (0.3423) on fruit yield per plant. It was exerted maximum positive indirect effect through characters viz., number of leaves per plant (0.2098), stem girth (0.1249) and days to 50% flowering (0.1127). Whereas, it shown maximum positive indirect effect through fruit length (-0.1673) followed by plant spread EW (-0.1221) and number of fruits per plant (-0.1002) at genotypic level.

At phenotypic level, pericarp thickness was exhibited positive direct effect (-0.2561) on fruit yield per plant. The traits days to 50% fruit set (0.0729), days to 50% flowering (0.0715) and stem girth (0.0668). While number of fruits per plant (-0.0827), fruit length (-0.0679) and yield per hectare (-0.0566) were recorded highest negative indirect effect on fruit yield per plant.

4.7 Reaction of chilli genotypes to pest and diseases

Eighteen chilli genotypes were screened against the incidence of white fly, and leaf curl under natural field conditions. The eighteen genotypes were classified based on their resistance level against white fly incidence, and leaf curl and presented in Table 16 and 17.

The data presented in Table 16, indicated that eleven genotypes were graded as moderately resistant (11-39 %) showing on leaves infestation and seven genotypes expressed (40-70 %) damage on leaves and were graded as susceptible.

In respect of leaf curl Pusa Sadabahar and Pusa Jwala were found moderately resistant (10-19 %) and sixteen genotypes were moderately susceptible (20-39 %). Table 17.

Table 16. Reaction of Chilli genotypes to white fly infestation

Reaction	Number of genotypes	Genotypes
Resistant (0-10%)	-	-
Moderately resistant (11-39%)	11	Pusa sadabahar, Pusa Jwala, Parbhani Mirchi, Parbhani Tejas, Phule Jyoti, Konkan kirti, Agni Jwala, Chilli Pragati, Garima, Seetha, Pride.
Susceptible (40-70%)	7	Teja, G-4, Byadgi, Byadgi 341, KSP-1194, ARCH-930, Ajooba.
Highly susceptible (>70%)	-	-

Table 17. Reaction of Chilli genotypes to leaf curl incidence

Reaction	Number of genotypes	Genotypes
Resistant (0-9%)	-	-
Moderately resistant (10-19%)	2	Pusa Sadabahar, Pusa Jwala.
Moderately Susceptible (20-39%)	16	Parbhani Mirchi, Parbhani Tejas, Phule Jyoti, Konkan Kirti, Teja, G-4, Byadgi 341, Byadgi, KSP-1194, Agni Jwala, ARCH-930, Chilli Pragati, Garima, Seetha, Ajooba, Pride.
Susceptible (40-69%)	-	-
Highly susceptible (70-100%)	-	-

CHAPTER - V

Discussion

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DISCUSSION

Chilli is the most important warm-season fruit vegetable grown throughout the world because of its wider adaptability, high yielding potential and multipurpose uses in fresh as well as processed food industries. It is indispensable vegetable cum spice crop in every home of the tropical countries.

The knowledge on the amount of variability and its heritable portion present in the source population is a pre-requisite for attempting any successful breeding programme aimed at improving the yield and other characters. It is therefore, important to generate information on the extent of variability, heritability and genetic advance for different characters under consideration.

The phenotypic variance measures the magnitude of variation arising out of difference in phenotypic values, while the genotypic variation measures the magnitudes of variation due to differences in genotypic values. The absolute values of phenotypic and genotypic variances cannot be used for comparing the magnitude of variability for different characters since the mean and units of measurement of the characters may be different. Hence, the coefficients of variation expressed at phenotypic and genotypic levels have been used to compare the variability observed among different characters. While, genotypic coefficient of variation indicates the amount of genetic variability present in the character, the heritability estimates aid in determining the relative amount of heritable portion of variation. However, heritability values alone itself provide no indication of the amount of genetic progress that would result from selecting the best individuals. Ramanujam and Tirumalachar (1967) while studying the genetic variability in red-pepper discussed the limitation of estimating the heritability in broad sense as it included both additive and non-additive genetic effects. According to them heritability estimates in broad sense would be reliable if accompanied by high genetic advance.

Yield being an important and complex character is a function of several component characters and their interaction with environment. In the integrated structure of a plant, most of the characters are inter-related and often change in one character will influence the other. Hence, direct selection based on yield alone will not be very effective.

Grafius (1964) pointed out that it would be more meaningful if the structure of yield is probed through its components rather than *per se* yield. For improving yield through breeding, it is necessary to study these components, their inter relationships with yield and their direct and indirect contributions. The phenotypic and genotypic correlations reveal the extent of association between different characters. Thus, it helps to base selection procedure to a required balance, when two opposite desirable characters affecting the principal characters are being selected. It also helps to improve different characters simultaneously (Falconer, 1981). The other genetic parameter commonly used is the path analysis given by Dewey and Lu (1959). Path analysis gives a cause and effect relationship. It critically breaks up different direct and indirect effects which finally make up correlation coefficient.

In recent years, the cognizance of genetic diversity and the evolutionary history of crop plants yielded major advances in crop improvement. Measure of genetic divergence reveals the differences in gene frequencies. Mahalanobis's generalized distance estimated by D^2 statistic (Rao, 1952) is a unique tool for discriminating populations by considering a set of parameters together. In addition to estimation of variability, cognizance of the genetic diversity of the germplasm is necessary for effective choice of parents in hybridization.

5.1 Genetic divergence studies

Assessment of divergence in the germplasm is essential to know the spectrum of diversity so that improvement in fruit yield can be normally attained through involvement of the genetically diverse parents in breeding programmes. Mahalanobis's D^2 statistics, a powerful tool has been used to quantify the genetic divergence between the genotypes and to identify diverse parents for crossing. This also helps to relate clustering pattern with the geographical origin. This technique has been employed widely to resolve divergence at inter varietal, species and subspecies levels in classifying problems in crop plants (FAO, 1997).

In present studies, eighteen germplasm lines of chilli were grouped into five clusters. The magnitude of D^2 values confirmed that there was considerable amount of diversity in the experimental material evaluated.

Statistical distance represents the extent of genetic diversity among clusters. The inter cluster distance was minimum between cluster I and II indicating close relationship and similarity for most of the characters of the genotypes included in these clusters. The maximum inter cluster distance was observed between clusters II and V indicating wider genetic diversity among the genotypes included in these groups. Selection of parents from these diverse clusters for hybridization programme would help in achieving novel recombinants. Similar results were obtained in chilli by Vanitha and Jansirani, (2017) and Kumari *et al* (2010). Cluster V displayed least intra cluster distance denoting the similarity of genotypes. While maximum intra cluster distance was recorded in cluster IV and this might be due to limited gene exchange or selection practices among the genotypes for diverse characters. Therefore, hybridization programme between the genotypes belonging to cluster II and cluster V may be undertaken for getting good segregants.

Emphasis should be laid on characters contributing maximum D^2 values for choosing the cluster for the purpose of further selection and choice of parents for hybridization. Highest contribution towards divergence in this regard was put forth by number of seeds per fruit maximum towards divergence followed by yield per plot, days to last picking, fruit length, plant spread N-S, plant spread E-W, plant height, number of branches per plant, yield per hectare, fruit girth and days to 50% flowering. Thus, these were the major traits contributing to divergence. Hence, selection for divergent parents based on these characters will be useful for heterosis breeding in chilli. Similar results were reported in chilli by, Yatung *et al.* (2014), Smitha and Basavaraja (2005), Srinivas *et al.* (2013).

Genetic divergence among eighteen genotypes revealed that the genotypes *viz.*, Pusa Sadabhar and Parbhani Mirchi were identified as genetically divergent for plant height and hence, these genotypes can be utilized in crop improvement programme as donor parents for improving plant height. The genotype Pusa Jwala and Agni Jwala were more divergent for improving number of branches per plant. The genotype KSP-1194 and Garima were more divergent for improving both plant spread North-South and East-West. The genotype Pride and Pusa Jwala were more divergent for improving stem girth. The genotype Parbhani Mirchi and Garima were more divergent for improving number of leaves per plant.

The genotype Teja and KSP-1194 which found dwarf genotypes and early fruit yielding found to be promising line for less number of days to flower initiation, days to 50 percent flowering and days to 50% fruit set, whereas; the genotype Ajooba has required highest days. The genotype Pusa Sadabhar which was found highest days to last picking and number of picking, whereas; the genotype KSP-1194 which found lowest days to last picking and genotype Agni Jwala which was found lowest days to number of picking. The maximum number of fruiting span was recorded in ARCH-930, whereas; minimum number of fruiting span was recorded in Parbhani Mirchi.

Fruit length was maximum in the genotypes of Chilli Pragati while, it was minimum in the genotype Pride. Maximum fruit girth was observed in the genotype Garima and minimum fruit girth was recorded in the genotype of Parbhani Tejas. Pedicel length was maximum in the genotypes of Seetha, while; it was minimum in the genotype Byadgi-341. The genotype Teja was recorded the highest average ten fruit weight whereas the genotype Garima was recorded significantly lowest average ten fruit weight.

Number of fruits per plant was recorded maximum in Pusa Jwala and minimum in Parbhani Mirchi. The maximum fruit yield per plant, fruit yield per plot and fruit yield per hectare was observed in genotype Pusa Jwala, whereas; minimum in Parbhani Mirchi. Number of seeds per fruit was recorded maximum in Byadgi-341 and minimum in Seetha. 100 seeds weight was recorded maximum in Byadgi-341 and minimum in Pride.

Ascorbic acid content was highest in Pusa Sadabahar and lowest in Parbhani Mirchi. Capsaicin content was highest in Konkan Kirti and lowest in Pride. Maximum pericarp thickness was observed in the genotype Ajooba and minimum pericarp thickness was recorded in the genotype of G-4. Colour of seed observed yellow in genotypes Pusa Sadabahar, Teja and Pride while; light yellow in genotypes Pusa Jwala, Parbhani Mirchi, Phule Jyoti, G-4, Byadgi-341, KSP-1194, Agni Jwala, Chilli Pragati, Garima, Seetha and Ajooba while dark yellow was observed in genotypes Parbhani Tejas, Konkan Kirti, ARCH-930, Byadgi.

White fly infestation was recorded maximum in Byadgi and minimum in Pusa Sadabahar. Leaf curl incidence was recorded maximum in Teja and minimum in Pusa Sadabahar.

Hence, apart from selecting genotypes from the clusters which have high inter-cluster distance for hybridization, one can also think of selecting parents based on extent of genetic divergence in respect to a particular character of interest. This is to mean that, if breeder's intention is to improve fruit yield, he can select parents which are highly divergent with respect to these characters.

5.2 Genetic variability

In the present study, eighteen genotypes from diverse sources were evaluated. The genotypes exhibited significant differences for all the twenty eight characters studied and a wide range of variability was observed for plant height, plant spread, number of fruits per plant, fruit yield per plant, fruit yield per plot, ascorbic acid, capsaicin, pericarp thickness and number of seeds per fruit indicating the scope for selection of suitable initial breeding material for further improvement.

The PCV and GCV values were very high particularly for number of seeds per fruit, capsaicin due to very high variability available in these traits. The PCV and GCV values were also high for number of leaves per plant, number of picking, yield per plant, yield per plot, yield per hectare, pericarp thickness suggesting that these characters can be improved through simple selection. Ajjapplavara (2009), Meena *et al.* (2016), Sahu *et al.* (2016), Murmu *et al.* (2017), Amit *et al.* (2014) also reported high PCV and GCV for these traits.

Moderate PCV and GCV values for number of branches per plant, plant spread, fruiting span, fruit length, fruit girth, pedicel length. Weight of 10 green fruits, number of fruits per plant ascorbic acid and white fly Similar types of reports were also reported in chilli by Srinivas *et al.* (2013)

5.3 Heritability and genetic advance

Heritability estimates were high for all the characters studied. This suggested the greater effectiveness of selection due to less influence of environment and improvement to be expected for these characters in future breeding programme. High estimates of heritability for these traits were also observed by Mittal *et al.* (1996), Prasad and Rai (1999), Mehata and Asati (2008).

Johnson *et al.* (1955) suggested that high heritability coupled with high genetic advance as percentage of mean were more useful than h^2 alone in predicting the resultant effect during selection of best individual genotype. Genetic advance is the measure of genetic gain under selection and expression in percentage of mean.

In these present investigation genetic advance as per cent of mean was high for plant spread, number of leaves per plant, number of picking, fruiting span, weight of 10 green fruits, yield per plant, yield per plot, yield per hectare, number of seeds per fruit, capsaicin, pericarp thickness, white fly, leaf curl. Interestingly, high h^2 was also observed for these traits, indicating that these traits were under the strong influence of additive gene action as such, simple selection based on phenotypic performance of these traits would be more effective. Similar kind of results were observed in chilli for the traits like plant height and fruit yield per plant by Sahu *et al.* (2016), Meena *et al.* (2016), Ajjaplavara and Channagoudra. (2009).

High heritability and moderate GA as percent mean values were observed for the following characters, days to 50% flowering, fruit length, fruit girth, pedicel length, number of fruits per plant, 100 seeds weight, ascorbic acid. This indicates that the influence of non-additive gene action and considerable influence of environment in the expression of these traits. These traits could be exploited through manifestation of dominance and epistatic components through heterosis (Padmini and Vadivel, 1997).

Hence, the breeder should adopt suitable breeding methodology to utilize both additive and non additive gene effects simultaneously, since varietal and hybrid development will go a long way in the breeding programmes especially in case of chilli.

5.4 Correlation studies

Yield being a complex character is governed by a large number of genes. The influence of each character on yield could be known through correlation studies with a view to determine the extent and nature of relationships prevailing among yield and yield attributing characters. The present investigation was carried out to study the association of different characters on yield and yield contributing traits in chilli both at phenotypic and genotypic levels.

5.4.1 Correlation between yield and its components

In general, it is evident from the recorded data (Table 12 and 13), genotypic correlation was higher than phenotypic correlation indicating a less influence of environmental factors and relative stability of the genotypes.

Fruit yield per plant was exhibited high significant positive association with, number of branches per plant, plant spread, number of leaves per plant, days to 50 % flowering, days to 50% fruit set, days to last picking, fruit length, fruit girth, pedicel length, fruit yield per hectare, ascorbic acid, number of fruits per plant, fruit girth, weight of 10 green fruits indicating the importance of these traits in selection for yield. Direct selection based on these traits would result in simultaneous improvement of aforesaid traits and yield in chilli. Similar results were reported in chilli for different components *viz.*, association of fruit yield with number of fruits per plant, number of branches per plant, fruit length and ascorbic acid (Bijalwan *et al.*, 2016), plant height, number of fruits per plant, fruit weight and fruit yield (Amit *et al.*, 2014), days to first flowering, seeds per fruit. Fruit length with fruit girth, number of fruits per plant with seeds per fruit (Murmu *et al.*, 2017).

In present experiment, it was observed that as the plant height increased, there was corresponding increased with stem girth, number of leaves per plant, fruit girth, pedicel length. Similar results were obtained in chilli by Amit *et al.* (2014). The significant positive correlation between plant height and number of fruits per plant was reported in chilli by earlier researchers, Amit *et al.* (2014). Plant height showed significant positive association with number of fruits per plant observed by Verma (2004).

Increase in number of branches accompanied with increase with plant spread N-S, plant spread E-W, number of fruits per fruit, yield per plant and similar results were recorded in chilli by Bijalwan and Mishra (2016). Increase in plant spread accompanied with increase with stem girth, fruit length, fruit girth, pedicel length, yield per hectare, yield per plant.

Days to 50% flowering was highly significant and positive association with days to 50% fruit set, days to last picking, pedicel length, yield per hectare, pericarp thickness, yield per plant. Similar results were noticed by Chattopadhyay *et*

al. (2014). Negative significant correlation was also noticed with most of characters except plant height.

Number of fruit per plant showed positive significant correlation with number of branches per plant, plant spread NS, plant spread EW, day to last picking, fruit length, fruit girth, pedicel length, yield per hectare, yield per plant. Chattopadhyay *et al.*(2014). Number of fruits per plant was significant positive correlated with number of branches per plant and plant height. The similar result were noticed by Amit *et al.* (2014).

Length of fruit was recorded positive significant correlation with fruit girth, pedicel length, number of fruits per plant, yield per hectare, yield per plant. Chattopadhyay *et al.* (2014). Fruit length was significantly and positively correlated with fruit weight and fruit girth by Murmu *et al.* (2017) whereas; significant negative correlation with fruit yield.

Days to last picking was recorded positive and significant correlation with days to first flowering and days to first picking by Sahu *et al* (2016)

The overall perusal of correlation analysis results in chilli indicated that traits like number of branches per plant, plant spread, number of leaves per plant, days to 50% fruit set, days to last picking, fruit length, fruit girth, and ascorbic acid significant association with fruit yield per plant. Similar results were reported in chilli by Sahu *et al.* (2016), Bijalwan and Mishra (2016), Murmu *et al.* (2017) and Chattopadhyay *et al.* (2014).

5.5 Path coefficient analysis

The estimation of correlation indicates only the extent and nature of association between yield and its components, but does not show the direct and indirect effects of different yield attributes on yield *per se*. fruit yield is dependent on several characters which are mutually associated; these will in turn impair the true association existing between a component and fruit yield. A change in any one component is likely to disturb the whole network of cause and effect. Thus, each component has two paths of action *viz.*, the direct influence on fruit yield, indirect effect through components which are not revealed from the correlation studies (Lenka and Mishra 1973).

The traits like plant height, number of branches per plant, plant spread NS, fruit girth, pedicel length, ascorbic acid, and pericarp thickness exhibited positive direct effects on fruit yield at genotypic level. Number of branches per plant, plant spread NS, fruit girth, pedicel length, number of fruits per plant, yield per hectare, ascorbic acid and pericarp thickness these traits also recorded positive direct effect with yield at phenotypic level. This suggested that direct selection based on these traits will be rewarding for crop yield improvement, similar results were also reported in chilli by Prasad and Rai (1999).

Out of eighteen characters studied, path analysis revealed that the traits like number of fruits per plant are directly contributing to yield.

Based on the mean performance it was observed that out of eighteen genotypes studied, Pusa Jwala, Garima, Konkan Kirti, Agni Jwala, Chilli Pragati and ARCH-930 genotypes were found to be promising since these genotypes possess higher *per se* value for yield contributing characters, thus ultimately resulting in higher yield.

FUTURE LINE OF WORK

It is imperative to design a chilli plant for sub-tropical semi-arid region. The following is the plant ideotype concept.

- Early maturity
- Moderate to high plant height
- More number of branches per plant
- More number of fruits per plant
- More number of seeds per fruit
- High Ascorbic acid and capsaicin percentage.

Hence, the breeder should focus his attention on to know the gene action controlling the trait, then select appropriate breeding procedure and pyramid the gene into one genotype through recombinant breeding methods or any other appropriate breeding approach methodology should be adopted.

CHAPTER - VI

Summary and Conclusion

CHAPTER VI

SUMMARY AND CONCLUSIONS

The present investigation of eighteen chilli genotypes was undertaken to study the nature and magnitude of genetic diversity available in the germplasm, to study the degree and direction of relationship between yield and its component characters and to study the direct and indirect effects of various component characters on yield.

Eighteen Chilli germplasm lines were grown in a randomized block design with two replications during *Kharif* 2017-18 at Horticulture Research Scheme (Vegetable), VNMKV, Parbhani. Observations were recorded on twenty eight characters viz., plant height (cm), number of branches per plant, plant spread NS (cm), plant spread EW (cm), stem girth (cm), number of leaves per plant, days to flower initiation, days to 50% flowering, days to 50% fruit set, days to first picking, days to last picking, fruiting span, fruit length (cm), fruit girth (cm), pedicel length (cm), weight of 10 green fruits (g), number of fruits per plant, yield per plant (kg), yield per plot (kg), yield per hectare (q), number of seeds per fruit, 100 seeds weight (g), ascorbic acid (mg/100g), capsaicin (%), pericarp thickness (mm), white fly infestation (%), leaf curl incidence (%). The data was analyzed with following standard statistical techniques.

Genetic diversity was assessed by using Mahalanobis's D^2 statistics for twenty eight characters. Grouping of genotypes into clusters using Tocher's method (Rao, 1952) resulted in formation of five clusters; maximum intra-cluster distance was shown by cluster IV. The maximum inter cluster distance was observed between cluster II and V. Therefore, the genotypes belonging to cluster II and of clusters V may be undertaken in a hybridization programme for getting good segregants.

Yield per plot, yield per plant, number of seeds per fruit, ascorbic acid, yield per hectare, leaf curl incidence content were major contributors to the genetic divergence in the germplasm. The clusters II and V showing high genetic divergence could be effectively utilized in heterosis breeding programme. If a breeding programme is used at improving nutritional characters, then cluster III showing maximum ascorbic acid and cluster IV showing maximum capsaicin can be utilized in

breeding programme. Therefore, a plant breeder may keep in mind the above aspects to obtain superior hybrids and good recombinants.

The analysis of variance revealed significant difference for twenty eight characters studied and reported that there was considerable amount of variability exist among the genotypes. Wide range of variability was observed for plant height, number of leaves per plant, fruit length, pedicel length, number of fruits per plant, number of seeds per fruit and fruit yield per plant indicating the scope for selection of suitable initial breeding material for further improvement.

High PCV and GCV estimates were recorded for plant spread, number of leaves per plant, number of picking, yield per plant, number of seeds per fruit, capsaicin, pericarp thickness. The difference between PCV and GCV values were minimum, indicating that the traits under study were less influenced by environment and these characters could be improved by following phenotypic selection.

Heritability estimates were high for all the characters studied. This suggested the greater effectiveness of selection due to less influence of environment and improvement to be expected for these characters in future breeding programme as the genetic variance is mostly due to the additive gene action.

Genetic advance as per cent of mean was high for plant spread, number of leaves per plant, number of picking, weight of 10 green fruits, yield per plant, yield per hectare, number of seeds per fruit, capsaicin, pericarp thickness. This indicated that all the above said traits were under the influence of additive gene action and simple selection process based on phenotypic performance of these traits would be effective.

Fruit yield per plant was exhibited high significant positive association with number of branches per plant, plant spread, number of leaves per plant, days to 50% flowering, days to 50% fruit set, days to last picking, fruit length, fruit girth, pedicel length, number of fruits per plant, yield per hectare, ascorbic acid, capsaicin, pericarp thickness. These characters should form selection criterion in breeding programmes. Direct selection based on these traits could result in simultaneous improvement of aforesaid traits and fruit yield in chilli. Path coefficient analysis showed that the characters plant height, number of branches per plant, plant spread NS, fruit girth, pedicel length, number of fruits per plant, ascorbic acid and pericarp thickness exhibited positive direct effects on fruit yield at genotypic level. Number of branches per plant, plant spread NS, fruit girth, pedicel length, number of fruits per

plant, yield per hectare, ascorbic acid and pericarp thickness these traits also recorded positive direct effect with yield at phenotypic level. This suggested that direct selection based on these traits will be rewarding for crop yield improvement. Positive indirect effect on fruit yield per plant through number of branches per plant, plant spread, number of leaves per plant, days to last picking, fruit length, fruit girth, number of fruits per plant, yield per hectare and ascorbic acid at genotypic and phenotypic level. This suggested that indirect selection based on number of fruits per plant will be effective in yield improvement.

Based on results obtained in the present studies following are the main attributes for yield improvement in chilli.

1. Correlation and path coefficient analysis revealed that traits *viz.*, number of fruits per plant, number of branches per plant are primary yield contributing components in chilli.
2. On the basis of the mean performance of the genotypes among the different traits studied, the following were identified as promising lines *viz.*, Pusa Sadabahar, Pusa Jwala, Byadgi-341, Ajooba.

Genetic divergence among eighteen genotypes revealed that the genotypes *viz.*, Pusa Sadabhar and Parbhani Mirchi were identified as genetically divergent for plant height and hence, these genotypes can be utilized in crop improvement programme as donor parents for improving plant height. The genotype Pusa Jwala and Agni Jwala were more divergent for improving number of branches per plant. The genotype KSP-1194 and Garima were more divergent for improving both plant spread North-South and East-West. The genotype Pride and Pusa Jwala were more divergent for improving stem girth. The genotype Parbhani Mirchi and Garima were more divergent for improving number of leaves per plant.

The genotype Teja and KSP-1194 which were found dwarf genotypes and early fruit yielding found to be promising line for less number of days to flower initiation, days to 50 percent flowering and days to 50% fruit set, whereas; the genotype Ajooba has required highest days. The genotype Pusa Sadabhar which were found highest days to last picking and number of picking, whereas; the genotype KSP-1194 which found lowest days to last picking and genotype Agni Jwala which was found lowest days to number of picking. The maximum number of fruiting span was recorded in ARCH-930 whereas; minimum number of fruiting span was recorded in Parbhani Mirchi

Fruit length was maximum in the genotypes of Chilli Pragati while, it was minimum in the genotype Pride. Maximum fruit girth was observed in the genotype Garima and minimum fruit girth was recorded in the genotype of Parbhani Tejas. Pedicel length was maximum in the genotypes of Seetha while, it was minimum in the genotype Byadgi-341. The genotype Teja was recorded the highest average ten fruit weight whereas the genotype Garima was recorded significantly lowest average ten fruit weight.

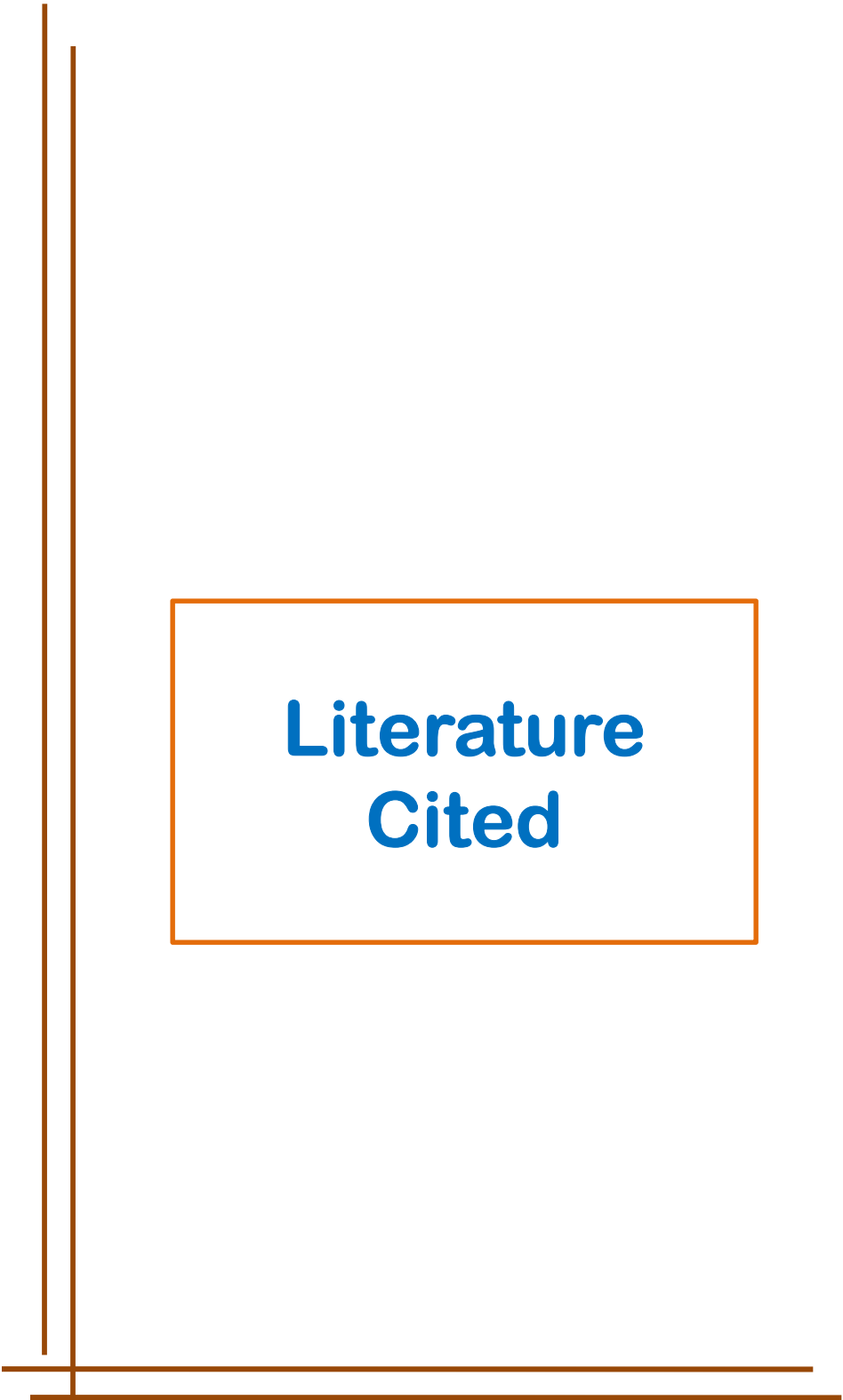
Number of fruits per plant was recorded maximum in PusaJwala and minimum in Parbhani Mirchi. The maximum fruit yield per plant, fruit yield per plot and fruit yield per hectare was observed in genotype Pusa Jwala whereas minimum in Parbhani Mirchi. Number of seeds per fruit was recorded maximum in Byadgi-341 and minimum in Seetha. 100 seeds weight was recorded maximum in Byadgi-341 and minimum in Pride.

Ascorbic acid content was highest in Pusa Sadabahar and lowest in Parbhani Mirchi. Capsaicin content was highest in Konkan Kirti and lowest in Pride. Maximum pericarp thickness was observed in the genotype Ajooba and minimum pericarp thickness was recorded in the genotype of G-4. Colour of seed were observed yellow in genotypes Pusa Sadabahar, Teja and Pride where; light yellow in genotypes Pusa Jwala, Parbhani Mirchi, Phule Jyoti, G-4, Byadgi-341, KSP-1194, Agni Jwala, Chilli Pragati, Garima, Seetha and Ajooba where; dark yellow in genotypes Parbhani Tejas, Konkan Kirti, ARCH-930, Byadgi.

White fly infestation was recorded maximum in Byadgi and minimum in Pusa Sadabahar. Leaf curl incidence was recorded maximum in Teja and minimum in Pusa Sadabahar.

3. Among eighteen chilli genotypes which were screened against the incidence of white fly and leaf curl of chilli under natural field conditions and concluded that Pusa Sadbahar and Pusa Jwala was found tolerant to fruit fly and leaf curl of chilli.
4. Overall view and result of the experiment were found that the genotype Pusa Jwala and Pusa Sadabahar was best performing in all characters in Marathwada region and yet to concern more on its breeding to develop it into a new variety.

It is concluded that the yield improvement in chilli can be achieved through selection and hybridization programme.

A decorative graphic on the left side of the page consisting of two vertical lines and two horizontal lines forming a partial frame.

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A decorative graphic consisting of several thin, parallel brown lines. Two vertical lines are on the left side, and two horizontal lines are at the bottom, forming a partial frame around the central text.

Appendix

APPENDIX- I

Appendix-I: Mean weekly weather parameters during the crop growth period (2017-2018)

Month	RF	Temperature oC		Humidity (%)		EVP (mm)	BSS (Hrs.)	WS (Kmph)
		Max	Min	RH1	RH2			
26	8.0	32.6	23.7	82	62	5.4	2.8	6.0
27	0.0	33.8	23.7	75	46	6.2	7.0	7.4
28	68.5	30.8	23.0	91	70	3.8	2.6	6.0
29	31.9	30.1	23.0	90	79	2.8	2.3	4.6
30	15.5	31.9	22.2	84	60	4.5	4.9	6.1
31	0.0	33.4	22.8	75	49	6.4	8.1	5.4
32	16.1	32.2	23.0	85	59	4.8	3.6	3.7
33	141.0	28.7	22.7	92	77	2.9	3.0	4.4
34	98.2	29.2	9.4	90	77	3.5	4.1	5.0
35	29.8	17.4	9.6	88	67	3.8	6.8	3.0
36	78.9	13.7	22.7	82	60	3.9	6.6	3.0
37	79.2	30.5	22.7	87	72	2.8	4.9	2.5
38	6.6	31.5	22.3	87	61	4.6	6.0	3.1
39	0.0	34.2	22.5	77	48	6.2	8.5	3.4
40	57.6	33.2	21.6	82	65	5.4	7.0	3.4
41	111.2	31.2	22.2	89	69	3.3	5.3	2.5
42	1.4	32.6	20.2	79	46	4.7	6.5	2.2
1	0.0	29.6	9.2	76.1	31.6	3.9	8.6	2.6
2	0.0	30.3	11.5	76.1	29.7	4.5	8.7	2.9
3	0.0	31.0	11.8	75.0	25.7	5.1	9.2	3.0
4	0.0	29.9	8.7	77.7	24.9	4.5	9.4	3.1
5	0.0	31.8	8.9	75.1	17.3	5.0	9.7	3.0
6	0.0	31.1	12.5	77.1	25.6	4.6	5.9	2.8
7	3.6	39.6	14.2	47.9	27.7	4.7	8.2	4.6

The image features a minimalist design with several thin, dark brown lines. On the left, two vertical lines and two horizontal lines at the bottom form a partial frame. A single rectangular box, outlined in a slightly thicker dark brown line, is positioned in the center-right area. Inside this box, the word "Vitae" is written in a bold, blue, sans-serif font.

Vitae

VITAE

Mr. HANMANT NANA LANGUTE

A candidate of the degree of

MASTER OF SCIENCE

In

HORTICULTURE (VEGETABLE SCIENCE)

2018

Biographical Information:

Personal data : Born at Barad, Dist.-Satara, Maharashtra on 11th August, 1993.

S/o Mr. Nana and Mrs. Jayashri.

Educational data:

1. Passed S.S.C. (Xth) from Modern High School, Barad in 2009.
2. Passed H.S.C. (XIIth) from Maloji Raje Sheti Vidhyalaya, Phaltan in 2011.
3. Received the degree of Bachelor of Science (Horticulture) from M.P.K.V. Rahuri in 2015.
4. Secured P.G. seat at College of Agriculture, Parbhani VNMKV, Parbhani, Maharashtra through MCAER-CET in 2016.
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