GENETIC DIVERGENCE FOR YIELD AND ITS COMPONENTS IN INDIGENOUS COLLECTION OF CORIANDER (*Coriandrumsativum* L.) GERMPLASM

JYOTHI K

B.Sc. (Hort.)

MASTER OF SCIENCE IN HORTICULTURE

(PLANTATION, SPICES MEDICINAL AND AROMATIC CROPS)

DEPARTMENT OF PLANTATION, SPICES MEDICINAL AND AROMATIC CROPS

COLLEGE OF HORTICULTURE, RAJENDRANAGAR, HYDERABAD -500 030

SRI KONDA LAXMAN TELANGANA STATE HORTICULTURAL UNIVERSITY

JULY, 2017

GENETIC DIVERGENCE FOR YIELD AND ITS COMPONENTS IN INDIGENOUS COLLECTION OF CORIANDER (*Coriandrumsativum* L.) GERMPLASM

By

JYOTHI K

B.Sc. (Hort.)

THESIS SUBMITTED TO SRI KONDA LAXMAN TELANGANA STATE HORTICULTURAL UNIVERSITY

IN PARTIAL FULFILMENT OF THE REQUIREMENTS

FOR THE AWARD OF THE DEGREE OF

MASTER OF SCIENCE IN HORTICULTURE

(PLANTATION, SPICES MEDICINAL AND AROMATIC CROPS)

DEPARTMENT OF PLANTATION, SPICES MEDICINAL AND AROMATIC CROPS

COLLEGE OF HORTICULTURE, RAJENDRANAGAR, HYDERABAD - 500 030

SRI KONDA LAXMAN TELANGANA STATE HORTICULTURAL UNIVERSITY

JULY, 2017

CERTIFICATE

Ms. JYOTHI Khas satisfactorily prosecuted the course of research and that the thesis entitled**"GENETIC DIVERGENCE FOR YIELD AND ITS COMPONENTS IN INDIGENOUS COLLECTION OF CORIANDER (*Coriandrumsativum*L.) GERMPLASM"**submitted is the result of original research work and is of sufficiently high standard to warrant its presentation to the examination.

I certify that neither the thesis nor its part thereof has been previously submitted by her for a degree of any University.

Date : **(Dr. R. PURNIMA MISHRA)**

Place: Rajendranagar, Hyderabad.**Chairman**

CERTIFICATE

This is to certify that the thesis entitled **"GENETIC DIVERGENCE FOR YIELD AND ITS COMPONENTS IN INDIGENOUS COLLECTION OF CORIANDER (*Coriandrumsativum*L.) GERMPLASM"** submitted in partial fulfillment of the requirements for the degree of Master of Science in Horticulture (Plantation, Spices, Medicinal and Aromatic crops)ofSri Konda Laxman Telangana StateHorticultural University, Rajendranagar, is a record of the bonafide research work carried out by **Ms. JYOTHI K**under our guidance and supervision.

No part of the thesis has been submitted by the student for any other degree or diploma. The published part and all assistance received during the course of the investigations have been duly acknowledged by the author of the thesis.

Thesis approved by the Student Advisory Committee

Chairman:**Dr. R. PURNIMA MISHRA**
Technicalofficer,
College of Horticulture, SKLTSHU
Rajendranagar, Hyderabad.

Member:**Dr.VEENA JOSHI**
Assisstant professor,
Dept. of Horticulture
College of Horticulture, SKLTSHU
Rajendranagar, Hyderabad.

Member:**Dr.M. SUJATHA**
Professor,
Department of Genetics
and Plant breeding,
College of Agriculture,PJTSAU
Rajendranagar, Hyderabad.

LIST OF CONTENTS

LIST OF TABLES

LIST OF ILLUSTRATIONS

LIST OF PLATES

LIST OF APPENDICE

ACKNOWLEDGEMENTS

Accomplishment of this thesis is the result of benevolence of almighty, blessings of my teachers and prayers of my well wishers. Prima facie, I am grateful to express my deepest sense of gratitude to the almighty for blessing me enough patience and strength for the accomplishment of this endeavor.

I express my profound sense of gratitude and heartfelt thanks to my Major Advisor and Chairperson **Dr. R. Purnima Mishra**, Technical officer, College of Horticulture, Rajendranagar, Hyderabad, for her inspiring, everlasting guidance and whole hearted support throughout the progress of my research work.

I am overwhelmed to avail this opportunity to express my profound sense of gratitude and regards to **Dr. M. Sujatha,** Professor, Dept. of Genetics and Plant Breeding, PJTSAU for her constant versatile inspiring guidance & constructive suggestions, throughout the course of this study and preparation of manuscript. It was my proud privilege to be associated with her.

I sincerely extend my profound gratitude and appreciation to the member of my Advisory Committee, **Dr.Veena Joshi,** Assisstant professor, College of Horticulture, Rajendranagar for her suggestions and whole hearted support during the course of my research.

It gives me an immense pleasure to thank **Dr. M. Padma (Dean of PG studies), K. Venkatalaxmi (Asst. Professor), Dr. P. Saidaiah (Asst. Professor), Dr.Rajagoud (Asst. Professor), Dr. S.S. Vijayapadma and Dr. M. Jayaprada** for their meticulous support and valuable suggestions during my research work.

I am in dearth of words to express my unboundful gratitude and genuffect love to my noble parents **Krishnappa**and **Bhagya** for their sprinkling blessings and prayers on me and I am thankful to my mother-in-law **Lakshmi** and my brother **Adarsh**for their affection and endless care.

My deepest sense of love and indebtedness to my beloved sister **Mythri** for her selfless support and tutelage throughout my lifetime, without whom none of my success would be possible.

I owe and respectfully offer thanks to my beloved well wisher and special friend**Sreehariji** for his moral support, mellifluous affection and encouragement given to me interminably.

My joy knows no bounds in expressing my cordial gratitude to my close friends **Siddu, Vinay, Shivaji, Swathi, Manju**, **Sowmya** and **Laxmi. M**, my senior friend **Renju Nair** and junior friend **Ambika** for their constant support and wishes during my studies and worries.

I would like to place on record my thanks to all friends **Aru, Shruthi, Triveni, Jeevana, Premalatha,Yusuf, Bhavana,Pushpa, Soujanya, Divya, Jyothireddy, Devisree, Amrutha, Ramchandra, my seniors ChethanBilla, Vijalakshmi, Shanti priya, Ravali, Tejaswini, Anitha,Tanuja, Sharwani** and **Ishrath**for their help and suggestions during my experiment. My pen will cease to write if I forget the help of Sai Baba, Vinod, Priyanka, Shravan and Ratnam.

I greatly acknowledge to the staffs of Central Library and Agriculture Stat. Centre, P.J.T.S.A.U, for providing me valuable references and help during my course of study. I humbly thank College of Horticulture, Rajendranagar, S.K.L.T.S.H.U, for all the support during my study period. Finally, I convey my wholehearted thanks to my well wishers requesting for their forgiveness for not mentioning them here by name.

(JYOTHI K)

DECLARATION

I,**Ms.JYOTHI K**, hereby declare that the thesis entitled**"GENETIC DIVERGENCE FOR YIELD AND ITS COMPONENTS IN INDIGENOUS COLLECTION OF CORIANDER (*Coriandrumsativum*L.) GERMPLASM"** submitted toSri Konda Laxman Telangana State Horticultural University**,** Rajendranagar,for the Degree ofMaster of Science in Horticulture ()is the result of original research work done by me. I declare that no material contained in the thesis has been published earlier in any manner.

Place: Rajendranagar **Name:** JYOTHI K

Date: **I.D.No:** RHM/15-06

LIST OF SYMBOLS AND ABBREVATIONS

^{0}C	:	Degree Celsius
σ^2g	:	Genotypic variance
σ^2p	:	Phenotypic variance
$<$	:	Less than
$\geq$	:	More than or equal
%	:	percent
&	:	And
ANOVA	:	Analysis of variance
CD	:	Critical difference
Cm	:	Centimetre
CV	:	Coefficient of variation
DAS	:	Days after sowing
Df	:	Degrees of freedom
et al.	:	et alia (and others)
etc	:	Etcetera
Fig.	:	Figure
g	:	Gram
G	:	Genotypic level
GA	:	Genetic Advance
GCV	:	Genotypic coefficient of variation
GV	:	Genetic variability
h^2	:	Heritability
H	:	High
IC	:	Indigenous Collection
i.e.	:	That is

L:Low

M	:	Moderate
MSS	:	Mean Sum of Squares
Mts	:	Meters
MT/ha	:	Metric ton per hectare
N	:	Negligible
NBPGR	:	National Bureau of Plant Genetic Resources
NHB	:	National Horticulture Board
No.	:	Number
P	:	Phenotypic level
PCV	:	Phenotypic coefficient of variation
PJTSAU	:	Professor Jayashankar Telangana State Agricultural University
PV	:	Phenotypic variability
q	:	quintal
RBD	:	Randomized Block Design
RF	:	Rainfall
rg	:	Genotypic correlation coefficient
rp	:	Phenotypic correlation coefficient
RH	:	Relative humidity
SE (m) ±	:	Standard error of mean
TNAU	:	Tamilnadu Agricultural University
VH	:	Very high
Viz.,	:	Namely

Name of the author : **JYOTHI K**

Title of the thesis : **"GENETIC DIVERGENCE FOR YIELD AND ITS COMPONENTS IN INDIGENOUS COLLECTION OF CORIANDER (*Coriandrumsativum* L.) GERMPLASM"**

Degree to which it is Submitted : MASTER OF SCIENCE IN HORTICULTURE

Faculty : HORTICULTURE

Major Field : PLANTATION, SPICES, MEDICINAL AND AROMATIC CROPS

Major Advisor : Dr.R. PURNIMA MISHRA

University : SRI KONDA LAXMAN TELANGANA STATE HORTICULTURAL UNIVERSITY

Year of submission : 2017

ABSTRACT

A field experiment was undertaken to estimate the genetic variability, divergence studies and to know correlation and path analysisin coriander. Thirty five genotypes were sown in a Randomized Block Design with three replications during *rabi* 2016-17 at College of Horticulture, Rajendranagar, Hyderabad. The objective of the experiment was to study genetic divergence, variability and also to know correlation among genotypes to use as donor parents in hybridization programmes.

The analysis of variance of RBD revealed highly significant differences among the genotypes for all the 23 characters studied.

The D^2 analysis was carried out for twenty three characters which partitioned the thirty five genotypes into seven clusters. The maximum divergence was observed between cluster VI and IV indicating that the genotype of these cluster are highly divergent. Number of umbels per plant at 60 DAS had more contribution to total divergence. Hence selection of genotype from cluster VI and IV based on number of umbels per plant at 60 DASmay be chosen in hybridization programme for getting good seggregants.

High PCV and GCV were recorded in umbels plant^{-1} (60 DAS and at harvest), umbellets umbel^{-1} at 60 DAS, number of seeds umbellet^{-1} (60 DAS and at harvest), seed yield plant^{-1} and seed yield hectare^{-1} indicating the existence of wider genetic variability for these traits in the genotypes under study and showing ample scope for

selection of these characters.

High heritability coupled with high genetic advance as percent of mean was observed in plant height at 60 DAS, number of leaves (60 DAS and at harvest), primary branches plant^{-1} (60 DAS and at harvest, secondary branches plant^{-1} (60 DAS and at harvest), number of umbels plant^{-1} (60 DAS and at harvest). Number of umbellets plant^{-1} (60 DAS and at harvest), seeds umbellet^{-1} (60 DAS and at harvest), seed yield plant^{-1}, seed yield hectare^{-1} and harvest index indicating contribution of additive gene effects in the expression of these traits. Therefore improvement can be done through direct selection to select better genotypes for coriander.

Correlation coefficient analysis revealed highly significant positive association of days to harvest index, seed yield hectare^{-1},seed umbellet^{-1}, umbellet umbel^{-1}, umbels plant^{-1}, number of primary branches and secondary branches, number of leaves, plant height registered a positive and significant correlation at both phenotypic and genotypic levels with seed yield plant^{-1} signifying the importance of these traits in selection for yield and can be identified as yield attributing characters.

Path coefficient analysis showed that the character, plant height at harvest, number of leaves at harvest, days to first flowering, umbellets plant^{-1} at 60 DAS, number of umbelletsumbel^{-1}at 60 DAS, seeds umbellet^{-1} at 60 DAS and seed yield per hectare exhibited high positive direct selection based on these trait will be rewarding for yield improvement.

In conclusion, IC-512365, IC-424455, IC- 553117and IC- 421974 for different growth components and for early yield IC-574534 were found superior genotypes and these can be used in different breeding programme for the development of superior coriander varieties for commercial cultivation.

CHAPTER I

INTRODUCTION

CHAPTER I

INTRODUCTION

Coriander of commerce is the dried fruit of *Coriandrum sativum* L., an aromatic spice crop of the family Umbelliferae or Apiaceae having a basic chromosome number 2n= 22. It is purely a cross pollinated crop. It is an important seed spice grown in tropical regions and can be successfully cultivated in areas free from severe frost during flowering and seed setting stages and crowned as an important seed spice.

Coriander was first used by the Egyptians for culinary purpose during 1550 BC and it is noted down in the Ebers papyrus. It is also mentioned in the Sanskrit as a drug implored by Hippocrates about 400 BC. Coriander is mostly used for its fragrance and aroma. It is cultivated both for leaf and seed purpose. Whole herb when tender is used for the preparation of chutney, sauces and leaves are used for flavouring curries and soups, the coriander contains coriandrol. Besides condiment, coriander also has medicinal values. The dry seeds are said to have carminative, diuretic, stomachic and aphrodisiac properties. On steam distillation, coriander seeds yield 0.2 to 1.2 per cent essential oil. The seed oil contains 19 to 21 per cent of oleoresin, which is a base for preparation of many chemicals and mainly used as a flavouring agent for liquor (Tiwari and Agarwal, 2004).

Western Europe and Asia are considered to be the centre of origin of this crop (Gal *et al.,* 2010). In India, it is cultivated practically in most of the states like Rajasthan, Madhya Pradesh, Assam, Gujarat, Odisha, Andhra Pradesh, Haryana, Tamil Nadu, Uttarakhand, Uttar Pradesh, Bihar, Telangana and Karnataka with a total production of 4.62 lakh metric tonnes of seeds over an area 5.53 lakh hectares. The area covered by coriander crop in Telangana state is 9.6 thousand hectare with a production of 4.1thousand tonnes and productivity of 0.67 t/ha (NHB, 2015-16).

Genetic diversity is an important factor for any heritable improvement. Knowledge of genetic diversity on 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 on the genetic diversity present in those accessions. Availability of genetic variability is important in selecting genotypes for making rapid improvement in yield and to select parents for hybridization programmes. Wide range of genetic variability that exists in available genotypes provide an ample scope for further improvement.

Mahalanobis D^2 statistics of multivariate analysis is recognized as a powerful tool in quantifying the degree of genetic divergence among the population and to identify suitable donors for a successful breeding programme.

Heritability is the heritable portion of phenotypic variance. It is good index of the transmission of characters from parents to offspring. The estimates of heritability help the plant breeder in selection of elite genotypes from diverse genetic populations.

Genetic advance under selection, measures the role of genetic progress as the deviation between the mean genotypic value of the base population due to selection. An improvement in yield and yield attributes of coriander is normally achieved by selecting the genotypes with desirable character combination existing in nature or by hybridization.

Correlation studies indicate the association between various yield components and their influence on yield and it is useful for fixing up these characters, which have a decisive role in influencing the yield. Path analysis is the other important tool for partitioning the correlation coefficient into direct and indirect effects of an independent variable on dependent variable. Correlation studies in combination with path analysis can provide a better insight into the cause and effect relationship between different pairs of characters.

It is therefore considered useful to select the best genotype of coriander for effective genetic improvement in this crop. Yield being a complex quantitative character, direct selection for yield may not result in any 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.

The acreage of the crop is increasing day by day but the productivity is very low. There is a scope to increase the productivity by introducing new genotypes under cultivation especially in sandy soils. The starting point of any systematic breeding programme is the collection of large germplasm in turn assessed by the genetic variability present in the germplasm. Keeping the above in view, the present investigation was planned under Hyderabad condition with the following objectives

Objectives:

1. To assess the genetic diversity among the germplasm in coriander.
2. To estimate the variability, heritability and genetic advance for yield and other components.
3. To assess the nature of association of different yield contributing characters and their direct and indirect effects on yield.

CHAPTER II

REVIEW OF LITERATURE

CHAPTER II

REVIEW OF LITERATURE

Coriander in recent years has gained a lot of importance as a condiment as well as spice crop. Now-a-days, several new genotypes of coriander are available, but their performance with respect to growth, yield and quality has differed greatly. With the increase in interest of this crop has moderated many researchers to work on various aspects including the assessment of performance among different accessions.

The literature on performance, diversity and genetic variability among the genotypes in coriander is limited. Therefore, the work on other related crops has also been reviewed on important aspects and presented in this chapter.

2.1 GROWTH PARAMETERS

Considerable difference in growth parameters like plant height, number of branches (primary and secondary), number of leaves, crop duration has been recorded by several workers in coriander and other related crops. It is presented in the following sub-headings.

2.1.1 Plant height

Gurbuz (2001) studied 25 coriander lines out of which line 20 recorded the highest plant height (125.4 cm) whereas, the lowest height was observed in line 25 (85.1 cm). Selvarajan *et al.* (2002) conducted a field experiment for three consecutive years from 1998 to 2000 in Tamil Nadu under irrigated conditions. Among the nine genotypes evaluated, the accession CS-12 registered the highest mean values for plant height (55.47 cm), followed by the accession CS-102 (49.67 cm) and least in the variety CO-3 (40.71 cm).

Datta *et al.* (2001) evaluated five ajowan introductions under Mohanpur conditions of West Bengal. The genotype RA-2 recorded higher plant height (94.13 cm), followed by RA-4 (85.95 cm) and the lowest plant height (81.00 cm) was recorded by the local control.

Among the 12 genotypes evaluated for four *rabi* seasons from 1998 to 2002 by Sarada *et al*. (2008) the maximum plant height was recorded in JF-210 (47.50 cm) and minimum height was in UM-323 (30.13 cm) in fenugreek.

Rajput and Dhirendrasingh (2003) evaluated twenty genotypes of coriander under Jobner conditions. Among them, RCr-435 recorded maximum plant height (89.60 cm) followed by UD-728 (88.30 cm) whereas, the genotype UD-310 recorded the minimum (44.00 cm) plant height. Out of a study on eleven genotypes of coriander in both *kharif* and *rabi* seasons of 2003-04 under Arabhavi conditions, the genotype RCr-41 recorded the highest plant height (49.03 cm) and the lowest height (38.74 cm) in Guntur Local during *kharif* season whereas, during *rabi* season the highest plant height was recorded in CO-1 (66.97 cm) and the lowest in Ghataprabha Local (41.47 cm) (Velayudham, 2004).

Patidar *et al.* (2004) reported that there were significant differences among the varieties of cumin with respect to plant height. Among them, improved variety RZ-19 recorded higher plant height (33.3 cm) followed by RZ-209 (32.9 cm).

Kole (2004) evaluated thirty genotypes of fenugreek among these genotypes the highest plant height was recorded in JF-17 genotype (52.63 cm) and minimum was in Sonali (32.67 cm).

Dhuhan *et al.* (2005) recorded plant height (111.30 cm) at 140 days after sowing in HM-232 while, the least plant height was recorded in HM-254 (94.3 cm), among 65 genotypes of fenugreek studied at Hissar in winter season of 1997-1998.

Giridhar and Sarada (2005) evaluated 11 coriander genotypes in black soil under rainfed conditions of Guntur region for three years from 2002-2005. Among them, LCC-216 recorded maximum plant height (65.90 cm) and was significantly superior to check Sadhana (56.20 cm). Saxena *et al.* (2005) evaluated 11 entries of coriander for four years (2000 to 2004). There were significant differences in respect of plant height among different varieties evaluated. The maximum plant height was observed in UD-743 (120.73 cm) and minimum height in LCC-128 (94.63 cm), against check variety Pant Haritma (104.96 cm).

Prabhu and Murthy (2005) evaluated 23 coriander genotypes. Among them UD-15 recorded the highest mean value in respect of plant height (23.42 cm), followed by accession UD-681 (20.53 cm). The least plant height was recorded in local accession CS-205 (14.11 cm). Bhattacharya *et al.* (2006) evaluated fenugreek cultivars under Mohanpur conditions of West Bengal wherein local cultivar recorded higher plant height (63.44 cm) followed by EC 57752 (62.11 cm) and the lowest height was observed in J.Fenu (55.00 cm).

Among investigated lines of sweet fennel by Cosge *et al.* (2008) plant height was ranged significantly from minimum (40.08 cm) to maximum (80.36 cm).

Malik and Tehlan (2013) evaluated 13 coriander cultivars/accessions during 2009-2010 to 2011-2012 at Hissar. Maximum plant (121.6 cm) was recorded in DH-223. The genotype RKD-13 recorded the lowest plant height (96.7 cm).

Moniruzzaman *et al.* (2013) evaluated 14 genotypes among them the genotype CS003 produced the tallest plant (116.10 cm) followed by the lowest plant height was found in CS005 (60.40 cm) which was found to be identical with (60.50 cm).

Dyulgerov and Dyulgerov (2013) compared yield-Related traits of two different coriander species. According to the means of the three years 2010,2011 and 2012 plant height was determined between 80.87 and 101.83 cm (average 92.50 cm) in *microcarpum* accession and between 55.17 and 99.50 cm (average 75.75 cm) in *sativum* accessions.

Giridhar *et al.* (2014) evaluated 13 potential genotypes of coriander (*Coriandrum sativum* L.) suitable for arid vertisols under Guntur conditions. The genotype LCC-237 recorded maximum plant height (68.0 cm) whereas, the genotype DH-220 recorded the minimum plant height (56.7 cm). Anil *et al.* (2015) evaluated 10 varieties of coriander under Madhya Pradesh conditions. The variety Pant Haritma recorded the highest plant height (142.3 cm) and lowest height (68.4 cm) was observed in Chhoti Dhaniya.

Nagappa *et al.* (2016) evaluated thirty genotypes of coriander, the data obtained from different stages of plant growth. Maximum plant height was achieved in the genotype LCC-322 (74.68 cm) and significantly it was superior over both the check AD-1 and Suguna.

2.1.2 Number of branches (primary and secondary)

Gurbuz (2001) in coriander noticed significantly highest number of branches per plant (24.25) in line-9 and it was minimum in line-15 (11.60). Selvarajan *et al.* (2002) found that the genotype CS-12 of coriander registered maximum number of primary (8.8 per plant) and secondary branches (18.2 per plant) whereas, minimum number of primary branches was seen in CS-203 (5.4 per plant) and the genotype CS-97 recorded minimum number of secondary branches (9.0 per plant).

Among the five Ajowan introductions, RA-2 exhibited superiority over other introductions with respect to primary branches (11.5 per plant) and secondary branches (20.53/plant) and minimum number of primary branches (6.85) and secondary (12.33) branches per plant in RA-6 (Datta *et al.*, 2001). Singh *et al.* (2002) reported that among 15 genotypes of coriander studied the highest number of branches was recorded in C-8 (23.08) and the lowest in CS-7 (6.65).

Agrawal *et al.* (2003) studied 74 fennel accessions along with check varieties RF-101 and RF-125. Among these, UF-178 recorded the more number of branches per plant (11.7) while, UF-156 was having minimum (5.0 per plant) number of branches. One of the eleven coriander genotypes studied by Velayudham (2004) *i.e.* CO-1 exhibited more primary (6.66 per plant) branches whereas, the lesser primary branches were observed in Guntur Local (5.30 per plant) during *kharif* season. During *rabi* season, maximum primary and secondary branches were noticed in RCr-41 (8.20 per plant and 16.53 per plant, respectively) and minimum in Gadag Local (5.20 per plant and 10.73 per plant, respectively) at harvest stage. Giridhar and Sarada (2005) noted that the coriander var. LCC-216 produced the maximum number of primary branches (6.5 per plant) and secondary branches (12.1 per plant) significantly superior to Sadhana (5.1 and 8.0, respectively).

Prabhu and Murthy (2005) evaluated 23 coriander genotypes, among which, UD-15 recorded the highest number of branches (6.71), followed by UD-681 (6.44) and the lowest number of branches was obtained in local accession CS-205 (4.06).

Bhattacharya *et al.* (2006) observed a non-significant difference among the cultivars of fenugreek with respect to number of primary branches per plant. But there was a significant difference with respect to the number of secondary branches per plant. The cultivar RM-10 recorded the highest number of secondary branches (9.56 per plant), while the lesser number of secondary branches (7.97 per plant) was observed in local cultivar.

Malik and Tehlan (2013) evaluated 13 coriander cultivars/accessions during 2009-2010 to 2011-2012 at Hissar. Maximum number of branches was found in the genotype DH-233 (10.3) and the genotype RKD-13 recorded minimum number of branches per plant (6.1). Moniruzzaman *et al*. (2013) evaluated 14 genotypes of coriander at Gazipur during the *rabi* season of 2007 and 2008. The maximum number of primary and secondary branches were obtained from CS004 (8.70 per plant) and CS001 (15.41 per plant), respectively.

Giridhar *et al*. (2014) evaluated of 13 potential genotypes of coriander (*Coriandrum sativum* L.) suitable for arid vertisols under Guntur conditions. The genotype UD-801 recorded maximum number of primary branches (5.4), while the genotype Hissar Anand recorded the minimum number of primary branches (3.2). The genotype UD-801 produced more number of secondary branches (16.7) whereas, lesser number of secondary branches was observed in local (9.8).

Anil *et al.* (2015) evaluated 10 varieties of coriander under Madhya Pradesh conditions. The variety Pant Haritma recorded the maximum number of branches (11.0) and minimum (5.3) in Chhoti Dhaniya.

Singh *et al.* (2015) studied trait variation among 102 fenugreek genotypes among them UM-117 recorded the maximum primary branches (8) as well as secondary branches (6) plant$^{-1.}$

2.1.3 Number of leaves

In the evaluation study on ajowan, Datta *et al.* (2001) reported that the highest number of leaves per plant was seen in RA-2 (64.13) followed by RA-4 (53.75) whereas, the lowest in RA-6 (33.38).

Velayudham (2004) studied 11 coriander genotypes in *kharif* and *rabi* season of 2003-04 under Arabhavi conditions. Among them, RCr-41 recorded maximum number of leaves (52.83 and 68.20) at harvest during both the seasons and the same value was minimum in DWD-3 (21.40 and 31.53).

Among the five cultivars of fenugreek evaluated by Bhattacharya *et al.* (2006), J.Fenu 115 exhibited superiority over other cultivars with respect to number of leaves (117.84) and the minimum number of leaves (99.13) was recorded by local cultivar.

Prabhu and Murthy (2005) studied 23 genotypes of coriander collected from different parts of the country. The study revealed that UD-15 of Jobner recorded higher number of leaves (38.49) followed by UD-681 (35.77). The local accession 812 was showing the lowest number of leaves (19.11).

Shridhar *et al.* (1990) opined that the number of leaves in *kharif* were maximum in 96/81-11 (60.00), followed by IC-67159 (57.00) and lowest in DWD-3(24.33). During *rabi* season, non-significant difference were observed.

Velayudham (2004) studied 11 coriander genotypes in *kharif* and *rabi* season of 2003-04 under Arabhavi conditions. Among them, RCr-41 recorded maximum number of leaves (52.83 and 68.20) in both the season and it was minimum in DWD-3 (21.40 and 31.53) at harvest stage of crop.

Moniruzzaman *et al.* (2013) noticed number of leaves significantly varied among 14 genotypes where the maximum number of leaves was in CS003 (8.10/plant) and minimum was recorded in CS-013(4.85/plant)

Among the five cultivars of fenugreek evaluated by Bhattacharya *et al.* (2006), J.Fenu 115 exhibited superiority over other cultivars with respect to number of leaves (117.84) whereas, local cultivar (99.13) exhibited minimum number of leaves.

2.2 Yield parameters

2.1 Days to first flowering

Five genotypes of coriander were evaluated in different regions of ceara- brazil areas Bertini *et al.* (2010), observed for the genotypes evaluated for different charcterstics like plant height diameter, days to emergence of first inflorescence and mean umbellet/umbel.

Moniruzzaman *et al*. (2013) evaluated 14 genotypes of coriander at Gazipur during the *rabi* season of 2007 to 2008. Among them, the genotype CS005 took minimum days for bolting (38.00), while CS003 took the maximum (60.00 days) days for the same.

Anil *et al.* (2015) evaluated 10 varieties of coriander under Madhya Pradesh conditions. The variety Chhoti Dhaniya recorded the earliest flower initiation (51.2 days) while, the latest flower initiation (71.3 days) was recorded in Pant Haritma.

2.2.2 Days to 50 per cent flowering

Among the nine accessions of coriander, the number of days to 50 per cent flowering was minimum in the genotype CS-208 (42.7 days) and maximum in the CS-123 (44.3 days). However, the differences were not significant (Selvarajan *et al.*, 2002). Agrawal *et al.* (2003) evaluated 74 fennel accessions along with check varieties RF-101 and RF-125. They recorded that the accessions NS-8 and UF-173 took the least number of days (110 days each genotype) for 50 per cent flowering.

The studies of Rajput and Dhirendrasingh (2003) on variability among 20 genotypes of coriander indicated that the least number of days was taken for flowering in RCr-436 (57.0 days), whereas the UD-728 took the maximum number of days (94.70) for the same. Among the 11 genotypes of coriander evaluated, the RCr-41 recorded maximum number of days taken for 50 per cent flowering (65.66 and 69.33) in *kharif* and *rabi* seasons, respectively while, the minimum was being observed in case of Guntur Local (39.00 and 42.33, respectively) (Velayudham, 2004).

LCC-170 recorded maximum number of days (49.3) whereas, the minimum was recorded by genotype LCC-192 (42.1) and the check Sadhana recorded 46.4 days for 50% flowering in coriander (Giridhar and Sarada, 2005).

According to Dhuhan *et al.* (2005), there were significant differences among the genotypes in fenugreek with respect to 50 per cent flowering. Among the cultivars studied, HM-211 took maximum number of days (85.6). The genotype HM-257 took minimum number of days to 50% flowering (75.6).

Giridhar *et al*. (2014) evaluated of 13 potential genotypes of coriander (*Coriandrum sativum* L.) suitable for arid vertisols under Guntur conditions. The genotype LCC-236 took minimum number of days to 50% flowering (51.3 days) wheras, the genotype DH-220 exhibited maximum delay for 50% flowering (63.1 days).

Anil *et al.* (2015) evaluated 10 varieties of coriander under Madhya Pradesh conditions. The variety Chhoti dhaniya recorded the earliest 50% flowering (61.1 days) while, the latest 50% flowering (82.6 days) was recorded in Pant Haritma.

2.2.3 Days taken to maturity

Yadav (1999) studied Raigarh coriander selection in Madhya Pradesh and observed that, RCS-1 and RCS-6 (104 days each) were early in maturity, while RCS-8 and RCS-11 (110 each) were late in maturity.

Velayudham (2004) conducted an experiment in *kharif* and *rabi* seasons under Arabhavi conditions with 11 genotypes. Among them, RCr-41 took maximum days for maturity in both seasons (108.33 and 121.00, respectively) as against minimum number of days for maturity observed in Ghataprabha Local (76.33 and 81.00 respectively).

Among the 11 genotypes of coriander evaluated, LCC-170 and LCC-172 recorded maximum days to maturity (86.1) whereas, the genotype LCC-192 recorded minimum days (81.6) (Giridhar and Sarada, 2005). The number of days taken for maturity varied from 99.2 in UD-118 to 82.2 in the genotype LCC-174. The check Sadhana recorded 88.4 days to maturity (Giridhar and Sarada, 2005).

Saxena *et al.* (2005) studied 11 varieties of coriander under Kumarganj conditions of Uttar Pradesh. Among them, the genotype DH-208 matured earlier in 142.66 days. Giridhar *et al*. (2014) evaluated of 13 potential genotypes of coriander (*Coriandrum sativum* L.) suitable for arid vertisols. The genotype LCC-237 took minimum number of days to maturity (93.9 days) as against the genotype Hissar Anand which recorded maximum number of days to maturity (108.1 days).

2.2.4 Umbels and seed

Variation among the cultivars of coriander and other related crops with respect to number of umbels per plant, number of umbellets per umbel and number of seeds per umbellet as reported by several workers has been reviewed in this paragraph.

Among twenty five coriander lines, line 2 recorded higher umbellets per umbel (5.83)

(Gurbuz, 2001). Selvarjan *et al.* (2002) reported that, among the different coriander genotypes, the accession CS-12 registered more number of umbels per plant (32.3) and umbellets per umbel (6.4), followed by CS-102, which registered 29.8 umbels and 6.1 umbellets. The expression of seed yield related characteristics of coriander was studied by Singh *et al.* (2002). The result revealed that, the highest umbels per branch (7.60) and umbellets per umbel (8.18) was recorded in C-6 and S-33, respectively, as against 5.1 umbels per branch in C-2 and 4.1 umbellets per umbel in Pant-1.

Rajput and Dhirendrasingh (2003) reported that among 20 genotypes of coriander evaluated, UD-728 recorded the highest number of umbels per plant (34.4) and seeds per umbel (42.2) whereas, the number of umbellets per umbel was maximum in NS-2 (6.6) and the lowest number of umbellets per umbel and seeds per umbel was observed in UD-529 (13.9), NS-1 (3.4) and UD-483 (12.1), respectively.

Agrawal *et al.* (2003) evaluated 74 fennel accessions along with check variety RF-101 and RF-125 for yield attributing characters. The accession UF-178 exhibited superiority over other accessions in respect of seeds per umbel (380.9) whereas, the highest number of umbels per plant was recorded in UF-170 (48.4) and umbellets per umbel in UF-153 (16.6).

Six fenugreek cultivars were studied by Raje *et al.* (2003) at Jobner conditions. Among them, the yield attributing characters *viz.*, number of pods per plant and number of seeds per pod were recorded at the highest in UM-117 (47.7), UM-305 and RMt-1 (17.32), respectively and lower values in CO-1 (34.8), UM-117 and RMt-143 (16.18) respectively.

According to Patidar *et al.* (2004), there were significant differences among varieties with respect to yield attributes. Among them, RZ-19 recorded higher umbels per plant (15.10) and seed per umbel (38.2) than other varieties. Velayudham (2004) reported that, among 11 genotypes of coriander evaluated in *kharif*, the highest number of umbels per plant was recorded in RCr-41 (23.80), umbellets per umbel (5.12) and seeds per umbel (28.65) in CO-3 as against the lowest umbels per plant (14.93), seeds per umbel (4.16) in Guntur Local and umbellets per umbel (4.18) in Gadag Local. During *rabi* season, the highest values for umbels per plant (32.00), seeds per umbel (5.37) were observed in RCr-41 and umbellets per umbel (5.32) in CO-3 as against the lowest values observed for umbels per plant (17.40), seeds per umbel (4.40) in Guntur Local, for umbellets per umbel in Gadag Local (4.00). Giridhar and Sarada (2005) reported that, among the 11 genotypes of coriander evaluated, LCC-216 recorded maximum number of umbels (21.5), umbellets per umbel (7.4) and seeds per umbel (25.4) significantly superior to check Sadhana (15.3, 5.4 and 19.7, respectively).

Among 11 entries of coriander evaluated at Kummarganj, the highest number of umbels (108.96) and seeds per umbellets (72.53) were recorded in UD-743 and DH-208, respectively (Saxena *et al.*, 2005). According to Bhattacharya *et al.* (2006), there were significant differences among the genotypes with respect to yield attributes in fenugreek. Among five cultivars, the cultivar RM-10 recorded the highest number of seeds per pod (15.24) and number of pods per plant (44.74).

The coriander accession UD-15 recorded significantly higher number of umbels per plant (23.92) and umbellets per umbel (6.99) over other genotypes in a study conducted by Prabhu and Murthy, 2005.

Malik and Tehlan (2013) evaluated 13 coriander cultivars/accessions during 2009-2010 to 2011-2012 at Hissar. Minimum number of umbels per plant was recorded in the genotype RKD-13 (51.4), whereas, the genotype DH-233 (65.9) recorded maximum number. The highest number of umbellets per umbel was recorded in the genotype DH-220 (6.0) and the lowest number was recorded in genotype LCC-237 (4.7). The maximum number of seeds per umbel was recorded in the genotype DH-233 (36.1) whereas, the genotype RKD-13 recorded minimum number of seeds per umbel (27.6). Regarding the seeds per umbellet, maximum number of seeds was recorded by DH-233 (6.3) whereas, the genotype LCC-236 recorded minimum number of seeds per umbellet (3.24).

Moniruzzaman *et al.* (2013) evaluated 14 genotypes of coriander at Gazipur during the *rabi* seasons of 2007 and 2008. The number of umbels per plant ranged from 12.70 (CS010) to 33.37 (CS003), while the umbellets per umbel ranged from 4.75 (CS003) to 6.67 (CS010). The maximum number of seeds were obtained from CS011 (35.63 per umbel) and (684.3 per plant) and the least number of seeds per umbel were obtained from CS005 (15.00) and per plant from CS010 (163.3).

Giridhar *et al*. (2014) evaluated of 13 potential genotypes of coriander (*Coriandrum sativum* L.) suitable for arid vertisols. The genotype LCC-237 recorded maximum number of umbels (24.4) while the genotype Local was having the minimum number of umbels (15.4). The genotype LCC-237 recorded maximum number of umbellets (7.1) and the genotype Local recorded the minimum number of umbellets per plant (5.1). The genotype LCC-237 recorded maximum number of seeds per umbel (37.5) as against the minimum number of seeds per umbel (26.8) registered in the genotype Local.

2.2.5 Seed yield

The ultimate economic value of a cultivar is determined by its yield potential. Differences in the yield among the cultivars of coriander and other related spices were observed by several workers.

Datta *et al.* (2001) evaluated six local cultivars of ajowan under alluvial zone of west Bengal. They recorded higher seed yield in the genotype RA-2 (503.32 kg ha^{-1}) as against the genotype RA-6 which recorded lower seed yield (273.5 kg ha^{-1}). Nine genotypes of coriander were evaluated by Selvarajan *et al.* (2002) under irrigated conditions of Coimbatore. The results of pooled data indicated that the accession CS-12 was the best with the highest yield (579.3 kg ha^{-1}) followed by CS-102 (561.0 kg ha^{-1}). The lowest yield was observed in the genotype CS-123 (504.1 kg ha^{-1}).

The mean performance of 15 genotypes of coriander under Lucknow conditions indicated that, genotype C-1 was the best for seed yield (1.5 t ha^{-1}) followed by the genotype RCr-41 (1.3 t ha^{-1}). Seed yield was the lowest in the genotype RCr-20 (0.08 tonnes ha^{-1}) (Singh *et al.*, 2002).

Patil (2003) evaluated eight genotypes in fenugreek and the experiment revealed that higher seed yield was noticed in genotype Belgaum Local (1375.53 kg ha^{-1}) followed by Ghataprabha Local (1076.64 kg ha^{-1}), while the least was recorded in the genotype Rajasthan-2 (225.5 kg ha^{-1}). The studies of Rajput and Singh (2003) on 20 genotypes of coriander under Jobner conditions indicated that, the highest seed yield was observed in NS-2 (8.68 q ha^{-1}) the lowest in the genotype NS-1 (2.08 q ha^{-1}).

The seed yield of cumin was found to be influenced by varieties and showed significant variations. The improved varieties, RZ-19 produced significantly higher seed yield (580 kg ha^{-1}), which was on par with var. RZ-209 (569 kg ha^{-1}) and higher than the local check (502 kg ha^{-1}) (Patidar *et al.*, 2004). Among the 11 genotypes of coriander evaluated, LCC-216 recorded maximum yield (863.2 kg ha^{-1}) followed by LCC-212 (836.1 kg/ha), on par with each other and significantly superior to check Sadhana (624.8 kg ha^{-1}) (Giridhar and Sarada, 2005).

Sarada and Giridhar (2005) studied 11 genotypes of coriander. Their study revealed that the genotypes varied significantly with respect to seed yield. The genotype LCC-174 recorded maximum yield (845.1 kg ha^{-1}) followed by LCC-225 (812.7 kg ha^{-1}) and significantly superior to the check Sadhana (649.5 kg ha^{-1}).

In a trial involving 11 entries of coriander in Uttar Pradesh, K-selection produced maximum quantity of seed (21.02 q/ha) followed by RCr-41 (20.59 q ha^{-1}) (Saxena *et al.*, 2005). Velayudham *et al.* (2004) evaluated 11 genotypes for yield during *kharif* and *rabi* seasons in the year 2003-2004. Among them, Var. CO-3 recorded the highest seed yield (7.62 q ha^{-1}, 7.89 q ha^{-1}), which was on par with CO-4 (7.36 q ha^{-1} and 5.84 q ha^{-1}, respectively) in both the seasons. Agrawal *et al.* (2003) studied 24 entries of cumin for their yield. Among them, GC-3 recorded the highest seed yield (333.33 kg ha^{-1}) followed by GC-2 (291.67 kg ha^{-1}) and the least was recorded in JC-2003 (41.66 kg ha^{-1}).

Bhattacharya *et al.* (2006) studied the seed yield of five cultivars of fenugreek under Mohanpur conditions. The highest seed yield was recorded in RM-10 (6.65 q ha^{-1}) followed by EC-57752 (6.16 q ha^{-1}). The genotype UD-15 of Jobner recorded the highest seed yield (573.33 kg ha^{-1}) followed by UD-681 (560 kg ha^{-1}) in coriander under Coimbatore conditions (Prabhu and Murthy, 2005).

Datta and Choudhuri (2006) evaluated 17 genotypes of coriander. Among them, genotype RCr-41 produced the highest seed yield (15.06 q ha^{-1}) followed by DH-246 (14.26 q ha^{-1}). Malik and Tehlan (2013) evaluated 13 coriander cultivars/accessions during the period from 2009-2010 to 2011-2012 at Hissar. On the basis of mean seed yield pooled over three years, the maximum seed yield was computed (2104 kg ha^{-1}) in DH-233 followed by DH-220 (2053 kg ha^{-1}).

Moniruzzaman *et al.* (2013) evaluated 14 genotypes of coriander at Gazipur during the *rabi* seasons of the years 2007 and 2008. The genotypes CS011 and CS007 gave the highest seed yield per plant (5.7 g and 5.57 g) as well as per hectare (1.34 and 1.05 tons).

Giridhar *et al*. (2014) evaluated of 13 potential genotypes of coriander (*Coriandrum sativum* L.) suitable for arid vertisols. The genotype LCC-237 recorded maximum seed yield (959.0 kg ha^{-1}) and the genotype Local recorded the lowest seed yield (456.2 kg ha^{-1}). Anil *et al.* (2015) tested 10 varieties of coriander under Madhya Pradesh conditions. The variety Pant Haritma gave the maximum seed yield (19.25 q ha^{-1}) and the lowest (12.36 q ha^{-1}) yield was recorded in Chhoti Dhaniya.

Among the seventy one genotypes evaluated in hill zone of Karnataka with respect to growth and yield traits, the data emphasized that maximum seed yield was obtained from genotype DCC- 37 (37.71 kg ha^{-1}) whereas, least was in DCC-44 (31.20g/plant) (Arif, 2014) .

The study consisted of eight coriander varieties The varieties viz., Hissar Sugandh, Pant Haritima, Sadhana, Swati, CO 4, Hissar Anand, CO 2 and Rajendra Swathi were studied under investigation by Bajad *et al*. (2017) the results revealed that variety Pant Haritima was found superior in seed yield (13.33 q/ha) but required more number of days for seed harvesting (131days). The yield contributing parameters like days required for seed harvesting, plant height, number of umbels (20.5), number of umbellate (5.7), number of seed (30.4) and test weight (12.23 g) were observed with maximum numerical values in variety Pant Haritima, than rest of the varieties under study. Hence, suggested pant haritma can be included in further breeding programme for improving the seed yield.

2.2.6 Thousand seed weight

There existed considerable variation among the cultivars of coriander and even in other related crops with respect to thousand seed weight. In an evaluation study, line 1 recoded higher 1000-seed weight (15.23 g) as against the lowest in line 15 (4.67) and line 8 (8.81 g), respectively Gurbuz (2001).

Velayudham (2004) studied 11 genotypes of coriander which differed significantly with respect to thousand seed weight. In *kharif* and *rabi* seasons, 1000-seed weight was recorded at maximum in CO-4 (16.40 g and 16.55 g, respectively) and minimum in RCr-41 (7.16 g and 7.30 g, respectively).

According to Bhattacharya *et al.* (2006), there were significant differences among the genotypes with respect to thousand seed weight in fenugreek. Among five cultivars, local collection recorded the highest weight (11.51 g).

2.2.7 Harvest index (%)

Velayudham (2004) studied 11 genotypes of coriander which differed significantly with respect to harvest index. In *kharif* season, the highest harvest index was recorded in CO-1 (57.05%), whereas the lowest harvest index (46.99%) was recorded with Guntur Local. In *rabi* season, the highest harvest index recorded was in DWD-3 (56.16%), while the lowest was observed in RCr-41 (40.57%).

Anil *et al.* (2015) evaluated 10 varieties of coriander under Madhya Pradesh conditions. The variety Chhoti Dhaniya recorded the highest harvest index (37.40%) and the lowest (25.86%) was observed in the genotype Halka Green.

2.3 GENETIC PARAMETERS

The existence of wide range of genetic variability in a population for economically important characters enables the improvement of crop in the desirable direction. Thus, for effective selection and utilization of genotypes for breeding programme, a thorough study of genetic variability, heritability and genetic advance is essential.

The phenotypic variability is a measure of variability due to genotype, environment and their interaction. The genetic variability is the real measure of variability concealed in a population. It indicates the relative magnitude of genetic diversity existing in the breeding population and helps to compare the genetic variability present for different characters. The determination of genetic variability and partitioning it into heritable and non-heritable components is necessary to have an insight on genetic nature of yield, yield components characters.

Heritability refers to the degree to which variability for a character is transmitted to the progeny. The heritable variation is masked by non-heritable components. Hence, it is necessary to split the overall variability into heritable and non-heritable variation using genetic parameters. The ratio of genotypic variance to the total variance in non-segregating population is known as heritability in broad sense (Hanson *et al.*, 1956) whereas; the ratio of additive variance to the total or phenotypic variance is referred to as narrow sense heritability (Lush, 1949). Thus, heritability is the heritable proportion of phenotypic variance.

Genetic advance under selection is the improvement in the mean genotypic value of selected plants over parental population which depends upon the genetic variability present in the population, heritability of the characters and the intensity of selection. Heritability estimates may not provide clear predictability of the breeding value. Therefore, estimation of heritability accompanied with genetic advance is generally more useful than heritability alone in prediction of the resultant effect, for selecting the best individuals (Johnson *et al.*, 1955). This is due to the fact that a character having high heritability may have very less phenotypic variation thus, leading to low genetic advance but, in the presence of additive gene effects high genetic advance can be expected (Johnson *et al.*, 1955).

The expression of a character in plant is a consequence of a chain of biologically integrated and inter-related events. Correlation coefficient measures mutual relationship between various plant characters and provides the way to know the association prevailing between highly heritable characters with most economic characters and gives a better understanding of the contribution of each trait in building up the genetic makeup of the crop.

Estimation of genotypic correlation between various plant characters are of immense use for selecting suitable plant types. The correlation of a character may be due to genetic linkage or pleiotropy (Harland, 1939).

Path analysis is a standardized partial regression coefficient as it measures the direct influence of one variable upon other and permits the separation of correlation coefficient into components of direct and indirect effects of a set of independent variables on a dependent variable. The concept of path coefficient analysis was originally developed by Wright (1921), but the technique was first used for plant selection by Dewey and Lu

(1959) as a means of separating direct and indirect contribution of various characters, which is not possible through correlation coefficient. If correlation coefficient is considered alone as the criterion for selection of high yield with better quality would be misleading because of their interrelationship of the components among themselves. Therefore, rapid improvement in yield and quality could be achieved if differential emphasis is laid on component characters based on the relative influence of each trait on the economic character. The use of this technique requires cause and effect situation among the variables (Singh and Choudhary, 1977).

Hence, study on components of variances and heritable components with suitable genetic parameters such as genotypic and phenotypic coefficients of variation, heritability and genetic advance are important tools for the breeders in selection of elite genotypes from diverse population.

2.3.1 GENETIC DIVERGENCE

Genetic improvement in any crop mainly depends upon the amount of genetic variability present in the population. The importance of genetic diversity in crop plants was first realized by Darwin (1859). The germplasm in often cross-pollinated crop can be considered as heterogeneous sets of groups, since each group being homozygous within it. Selecting the parents for breeding program in such crops is critical because, the success of such program depends on the segregants of hybrid derivatives between the parents, particularly when the aim is to improve the quantitative characters like yield. To help the breeder in the process of identifying the better parents, several methods of divergence analysis based on quantitative traits have been proposed to suit various objectives. Mahalanobis D^2 statistics is a powerful tool in quantifying the degree of divergence between biological populations at genetic level and provides a quantitative measure of association between geographic and genetic diversity based on generalized distance (Mahalanobis, 1936). The review of literature on genetic divergence was as follows.

Ali *et al.* (2000) evaluated twenty genotypes of coriander grown for three consecutive seasons. The pooled data for yield and its attributes were subjected to study the genetic divergence using Mahalanobis D^2 statistics. Twenty genotypes were classified into seven clusters. The cluster I contained the maximum of 13 genotypes belonging to different geographical origins. Cluster II contained two genotypes. The clusters III, IV, V, VI and VII contained one genotype each. Genotypes CS-193 and Tikamgarh Local were quite divergent and appeared promising for further improvement.

D^2 values varied between pairs of genotypes from 2.50 (between genotypes 29 and 42) to 96.96 (between genotypes 3 and 45) (Patel *et al*., 2000). On the basis of D^2 values all the 48 genotypes were grouped into nine clusters randomly, clusters I to VII included 16,7,8,8,2,3 and 2 genotypes respectively , whereas clusters VIII and IX Included only one genotype each (5 and 23 respectively). This indicated that genotypes from same Tehsil fell in different clusters and genotypes from different Tehsils were included in the same cluster. The free clustering of genotypes suggested dependence upon the directional selection pressure applied for realizing maximum yield in different Tehsils of the district. The intra cluster D values have been observed to be zero for two clusters VIII and IX as they includes only single genotype. The minimum D value was observed in cluster *V* while it was maximum in cluster *IV*. The divergence between cluster *V* and IX was maximum. The hybridization between the genotypes falling in these clusters would result in maximum hybrid vigour and eventually desirable segregants.

Srivastava *et al*. (2000) studied 40 genotypes of coriander was subjected to multivariate analysis using D^2 statistics. The characters studied were plant height, primary branches, secondary branches, days to flowering, days to maturity, number of umbel, number of umbellets per umbel, number of seeds per umbel, 1000 seed weight and seed yield. The assessment revealed considerable variability among the stock for all characters except primary branches, umbellate per umbel and 1000-seed weight. The 40 genotypes were grouped into four clusters depending on similarities of their D^2 values. Cluster number I had 12 genotypes, III retained 11. Cluster numbers II and IV captured 10 and 7 genotypes. The inter-cluster D^2 values ranged from 0.62 to 30.7, suggesting considerable diversity among the groups of the genotypes. Based on cluster means, characters such as days to flowering, days to maturity and number of secondary branches were major factors of differentiation among genotypes, which may be taken into account while selecting parents for hybridization programme. The clustering pattern of strains did not follow the geographical distribution exactly.

Singh *et al.* (2005) studied the genetic divergence and its implication in 70 germplasm lines of coriander. The 70 genotypes were grouped into 9 clusters (V,VI, VIII and IX), while apparent diversity was noticed for 30 percent genotypes (21/70) that diverged into 5 clusters (I, II, III, IV and VII). The maximum inter cluster distance was between I and IV (96.20) followed by III and IV (91.13) and I and VII (87.15). The cluster VI had highest seeds/umbel (35.3 ± 2.24), and leaves per plant (12.93 ± 0.55), earliest flowering (65.05 ± 1.30) and moderately high mean values for other characters.

Mengesha *et al.* (2011) studied the genetic divergence in 49 Ethiopian coriander (*Coriandrum sativum* L.) accessions. According to the Mahalanonbi's distance (D^2) analysis the accessions were grouped into eight clusters. Cluster II and III were the largest each with 12 accessions, followed by clusters I and V each consisting of seven accessions. The highest inter-cluster distance (480.5) was observed between clusters I and VIII (336.1). Maximum contribution toward total genetic divergence was possessed by thousand seed weight (15.67%), followed by basal leaf number (13.48%), plant height (10.29), seeds per umbellet (9.81%) and umbel number/plant (7.84%).

The genetic divergence of 25 land races was assessed using principal component and cluster analysis based on 8 characters in Ethiopia coriander. The accessions were grouped into five clusters. Cluster I was the largest consisting 19 accessions. High inter cluster distance (47.42) was observed between cluster IV, cluster II and IV (47.33) and cluster I and IV (41.47) indicating the presence of substantial genetic diversity in genetic makeup of the accessions included in these clusters. Accessions 16 and 8 having positive values for principal component 1 and 2 were of considerable breeding interest because of their good combination for the studied yield related traits. The highest intra-cluster distance (5.67) was observed in cluster I followed by cluster II (1.33). The intra cluster distance of cluster III, IV and V was zero for they contained only one accession. (Fufa, 2013).

Meena *et al*. (2014) studied twenty four varieties of coriander developed by different centres were grouped into four clusters. All varieties were grouped in four cluster that showed narrow genetics base of Indian varieties. Intra-cluster distance was highest in cluster III followed by cluster II, IV. The maximum inter-cluster distance was between clusters III and Iare17.91 and 3.86 respectively. Among the 10 characters studied for genetic divergence, 50% flowering contributed the maximum accounting for 49.64% of total divergence, followed by test weight 17.03%.The maximum. The maximum divergence of these traits would be used in breeding programme for improvement in coriander.

2.3.2 GV, PV, GCV and PCV

Shridhar *et al*. (1990) studied thirteen characters in nineteen indigenous as well in exotic genotypes considerable variation was noted for number of leaves, number of secondary branches, fresh weight of the plant, days to 50% flowering, thousand seed weight and seed yield per plant.

Among 200 genotypes evaluated, significant variability was observed for plant height and number of branches per plant. Days to flowering and days to maturity recorded moderate and low GCV and PCV, respectively and high heritability values (Sharma and Sharma., 1989 and Bhandari and Gupta, 1993).

Saha and Kole (2001) evaluated fifteen genotypes of fenugreek grown in sub-humid lateritic belt of West Bengal, India, during *rabi* 1988-99, for genetic variability. Results revealed that analysis of variance showed highly significant differences among genotypes for all the characters studied. The genotypic and phenotypic correlations for days to flowering, plant height, pods per plant, pod length, grains per pod, straw yield, biological yield and harvest index with grain yield per plant were significant and positive indicating the importance of these characters in seed yield improvement. Results of genotypic path analysis revealed high positive direct effects of branches per plant, straw yield, pod length and pods per plant on grain yield.

Krishnamoorthy and Madalageri (2002) observed higher PCV and GCV for total dry weight of plant whereas, moderate estimates were recorded for plant height, plant spread and days to harvest among fifteen genotypes studied. Kole (2004) studied the genetic variability in a population of 22 genotypes of fenugreek (*Trigonella foenum-graecum*) at Sriniketan, West Bengal, India and reported that phenotypic and genotypic coefficients of variability were high for stem weight.

Singh *et al.* (2005) reported high variability for seed yield (22.82%), number of umbels per plant (28.65%) and number of seeds per umbel (21-63%) and low variability for number of days to 50% flowering (12.39%) and number of umbellets per umbel (13.30%). Patel *et al.* (2008) reported that high genotypic and phenotypic variances were observed for days to fifty per cent flowering, days to fifty per cent maturity, plant height, plant height up to main umbel, total branches per plant, number of seeds in main umbel and seed yield per plant.

Data for 15 agronomic and quality traits were recorded and statistically tested by Mengesha and Getinet (2011). In the combined analysis of variance over locations, accessions varied significantly in all the traits except for basal leaf number, plant height and fatty oil contents. The interaction between accessions and environment was significant for nine of the 15 traits. A range from 910 kg ha^{-1} to 3099 kg ha^{-1} for seed yield and from 0.25% to 0.85% for essential oil content was obtained.

Abhay *et al.* (2011) reported that high phenotypic and genotypic coefficient of variation was observed for seed yield per plot, biological yield per plot, harvest index and pods per plant indicating the importance of additive gene effects for these traits.

Siddharth and Dodiya (2014) concluded that the estimated GCV and PCV indicated the existence of fairly high degree of variability for harvest index, seed yield per plant, number of umbels per plant, number of secondary branches per plant and pedicel length. Lower values of GCV and PCV was recorded in number of umbelletes per umbel, plant height and days to 50% flowering. These results indicated the presence of variability for seed yield and related traits in dill. In corollary to high heritability, estimates of genetic advance as per cent of mean was also observed for oil content, harvest index, pedicel length and number of umbels per plant.

The estimates of genotypic coefficient variation (GCV) and phenotypic coefficient variation (PCV) by Ghanshyam *et al.* (2014) indicated the existence of fairly high degree of variability for seed yield plant^{-1}, oil content, number of umbels plant^{-1} and harvest index. Lower values of GCV and PCV were recorded in number of umbellets umbel^{-1} indicating the important role of environment in the expression of the characters. High heritability associated with moderate genetic advance was recorded in traits like harvest index and seed yield plant^{-1}.

Geremew *et al*. (2015) studied variability, heritability and genetic advance for yield and yield related traits and oil content in Ethiopian coriander genotypes. Highest GCV and PCV were recorded for leaf number/ plant followed by plant height at flowering and seed yield/ha. Highest PCV was similarly noticed for leaf number per plant, seed yield per hectare, plant height at flowering and harvest index per plant. Heritability values were recorded highest at 50% flowering, days to emergence, days to maturity and days to start of flowering. Genetic variability as percent of mean was highest for leaf number per plant, plant height at flowering and number of secondary branches.

The phenotypic coefficient of variance (PCV) was higher than corresponding genotypic coefficient of variance (GCV) for most of the characters for fifty genotypes of the fennel. The heritability estimates were high for seed yield, plant height, umbellate per umbel, secondary branches per plant, 1000-seed weight, umbel per plant, primary branches per plant and seeds per umbellate. High genetic advance as percent of mean was recorded for seed yield, plant height, umbellate per umbel, secondary branches per plant, umbel per plant, 1000-seed weight, primary branches per plant and seeds per umbellate. The primary branches per plant secondary branches per plant and umbel per plant exhibited positive and significant correlated with the seed yield Sharma *et al.* (2015).

Wojo *et al*. (2016) studied on 36 geographically divergent Ethiopian Coriander. The accessions differed significantly for most of the characters and exhibited a relatively wide range. These characters indicated existence of variation among the tested accessions. High GCV was only observed in number of secondary branches per plant. High PCV were observed in number of primary and secondary branches per plant, number of seeds per pod and 1000-seeds weight.

In cumin Meena *et al*. (2016) recorded high estimates (>25%) of genotypic coefficient of variation (GCV) were recorded for secondary branches (25.62) followed by seed yield/plot (21.85) and umbel/plant (16.89). High heritability were obtained for primary branches (48.91%), seeds umbellate (43.39%), seed umbel (41.49%), while it was moderate for umbellate umbel (37.85 %), secondary branches (37.84%), umbel $plant^{-1}$ (37.72%) and plant height (37.55%), seed yield $plot^{-1}$ (10.61%), test weight (5.36%). High estimates of genetic advance (as percentage of mean) was realized for secondary branches (32.46%), umbel plant (21.36%), primary branches (19.19%) whereas the value moderate for seed yield $plot^{-1}$ (14.66%), seed $umbel^{-1}$ (12.23%) elucidated that they could be improved to a large extent.

2.3.2 Heritability and Genetic advance

Krishnamoorthy and Madalageri (2002) observed high heritability accompanied with high genetic advance as per cent of mean for plant height, number of branches, number of leaves per plant, plant spread, days to harvest and total dry weight of the plant among fifteen genotypes studied.

Studies conducted by Rajput and Dhirendrasingh (2003) reported that high estimates of phenotypic and genotypic coefficient of variation, heritability and genetic advance were recorded for seed yield, umbels per plant, seeds per umbel and plant height, suggesting the probable role of additive gene effects on character expression.

Singh *et al.* (2005) reported that in coriander the phenotypic coefficient of variation was greater than the genetic coefficient of variation. All traits registered high heritability estimates. Heritability and genetic advance were high for harvest index, number of primary and secondary branches per plant, number of umbels per plant and 1000-grain weight.

Singh *et al.* (2006) reported a high broad sense heritability (91.94%) and genetic advance (56.55%) for number of umbels per plant and number of seeds per umbel in coriander.

Patel *et al.* (2008) reported that high genetic advance as per cent mean was recorded for seed yield per plant, days to fifty per cent flowering, primary branches per plant and total branches per plant number of umbellets per umbel, number of seeds in main umbel test weight. Broad sense heritability and genetic advance as per cent of mean was obtained for longest basal leaf length, days to start 50% flowering, number umbel per plant, number of umbellets per umbel, number of seeds per umbelets, number of seeds per plant, seed yield per hectare seed and essential oil content (Mengesha *et al.,* 2011).

Siddharth *et al.* (2014) revealed high heritability associated with moderate genetic advance was recorded in traits like seed yield per plant and number of secondary branches per plant indicating predominance of additive gene effects for these traits. The association study among characters revealed that seed yield was positively and significantly correlated with harvest index and number of umbelletes per plant and negative and significantly correlated with number of secondary branches per plant in different coriander accessions.

Wojo *et al.* (2016) recorded high heritability values for number of seed per pod (63.1%), plant height (65.3%), biological yield per plot (80.1%), seed yield per plot (89.0%), day to maturity (80.8%), and day to flowering (71.4%). High genetic advance was observed for days to maturity, number of pod per plant, number of secondary branches per plant, biological yield and seed yield per plot.

Genetic variability, heritability was estimated among 28 germplasm for 10 characters in Ajwain (*Trachyspermum* ammi L.) by Ghanshyam (2014). Analysis of variance revealed significant differences among the germplasm lines for number of secondary branches plant^{-1}, number of umbels plant^{-1}, number of umbellets umbel^{-1}, seed yield plant^{-1}, harvest index and oil content, suggesting sufficient amount of variability.

2.3.3 Correlations

The seed yield showed a positive association with number of branches per plant, which could be used as index to select the superior genotypes (Ali *et al.*, 1993).

Singh *et al.* (2005) noticed that grain yield per plant was positively correlated at the phenotypic level with plant height, number of primary and secondary branches per plant, number of umbels per plant, number of umbellets per umbel, number of grains per umbellet and harvest index in coriander.

Singh *et al.* (2006) analysed character association and reported that number of umbels per plant and number of branches per plant were the most important traits, as they exhibited positive direct effects on seed yield in coriander

A field experiment was conducted by Fikreselassie *et al.* (2012a) at Adadi, during the years 2006 and 2007 in fenugreek. Seed yield per plant had significant association with plant height, biomass yield, number of pods and seeds per plant, thousand seed weight, days to maturity, grain filling period, pods per plant, total and podding nodes per plant, primary and secondary branches per plant, seeds per pod and days to flowering.

Beena *et al.* (2013) revealed Seed yield plant^{-1} exhibited a positive and significant correlation with number of fruits umbel^{-1}. Number of fruits umbellet^{-1} expressed a positive significant correlation with number of fruits umbel^{-1} and 1000 seed weight. Days to 50 per cent flowering had the highest positive direct effect on seed yield plant^{-1} followed by number of umbellets umbel^{-1}, number of fruits umbel^{-1} among 64 genotypes of coriander.

Singh *et al.* (2015) revealed that among 64 genotypes of coriander Seed yield plant1exhibited a positive and significant correlation with number of fruits umbel^{-1} but was negatively correlated with days to 50% flowering and 80% maturity, whereas number of fruits umbellet^{-1} expressed a positive significant correlation with number of fruits umbel^{-1} and 1000 seed weight. A positive correlation was also noted between 1000-seed weight and number of fruits umbel^{-1}.

Field experiment was conducted by Sunita *et al.* (2016) using 25 diverse genotypes of coriander during the rabi seasons of 2012–13 at Junagadh. Seed yield per plant showed significant and positive correlation with umbels per plant, harvest index, seeds per umbel, longest basal leaf length, umbellets per umbel, number of fruit bearing branches, plant height and 100-seed weight in irrigated conditions, whereas with harvest index, umbels per plant, number of fruit bearing branches and number of umbellets per umbel, under limited irrigation conditions.

2.3.4 Path analysis

Singh *et al.* (2005) conducted path analysis and noticed that the number of grains per umbellet had the greatest direct effect on grain yield per plant. Plant height, number of secondary branches per plant, number of days to maturity, number of umbellets per umbel and thousand-grain weight had negative direct effects on grain yield per plant. The number of grains per umbellet, which was the most important yield component, was positively associated with plant height, number of primary per plant and number of secondary branches per plant, number of umbellets per umbel, essential oil content and harvest index. The path analysis by Singh *et al.* (2006) indicated that number of umbels per plant and number of branches per plant were the most important traits, as these traits had positive direct effects on seed yield.

Prajapathi *et al.* (2010) evaluated sixty four genotypes of fenugreek (*Trigonella foenum-graecum*) for genetic variability, correlation and path coefficient analysis at Jagudan (Gujarat). Results of path analysis revealed that number of pods per plant, days to fifty per cent flowering and test weight had the highest positive direct effects on grain yield. An evaluation of 72 lines of fenugreek (*Trigonella foenum-graecum*) showed that the number of pods per plant, test weight and plant height were the most important traits on account of their direct and indirect effects on seed yield (Sastry and Singh, 2000).

Fikreselassie *et al.* (2012b) evaluated fenugreek accessions at Adadi, experimental station in 2006 and 2007. The path analysis at genotypic level revealed that number of seeds per plant and thousand seed weight contributed major positive direct effects on seed yield per plant. Maximum positive direct effect on protein content of the seed was exerted by thousand seed weight followed by days to flowering, number of podding nodes and total nodes per plant, number of primary branches per plant and seeds per pod.

The perusal of path analysis of twenty five genotypes in coriander evaluated by Sravanti *et al*. (2014) revealed that the traits *viz.*, dry weight of plant and harvest index had higher direct and positive contribution towards seed yield.

Path analysis revealed that the maximum direct and positive effect was due to umbels per plant, number of fruit bearing branches, seeds per umbel, harvest index, plant height, days to maturity and longest basal leaf length under irrigated condition, whereas days to 50% flowering, number of fruit bearing branches, umbellets per umbel, plant height, harvest index and longest basal leaf length in limited irrigation conditions by Sunita *et al*. (2016) in coriander.

The path coefficient studied by Meena *et al.* (2016) in cumin reflected that primary branches, secondary branches and seed per umbel traits had high direct effects on seed yield without having any undesirable negative indirect effects. Nevertheless, it was concluded that primary branches, secondary branches and seed per umbel were the important components in selection for genotypes with higher seed yield per plant .

Sunil *et al.* (2017) studied character association indicate seed yield (kg per hectare) have significant and positive correlation with plant height upto main umbel (0.325), plant height including main umbels (0.331), number of fruits per umbel (0.290), seed yield per plot (0.743) and seed yield per plant (0.361). The path coefficient analysis revealed that the highest direct effect was shown by seed yield per plot (0.6975), toward on seed yield (kg per hectare) followed by number of fruits per umbels (0.2716), seed yield per plant (0.1143), 1000-seed weight (0.060), days to 50 per cent flowering (0.0281), number of primary branches per plant (0.0734) and plant height upto main umbels.

CHAPTER III

MATERIAL AND METHODS

CHAPTER III

MATERIAL AND METHODS

The present investigation entitled "Genetic divergence for yield and its components in indigenous collection of Coriander (*Coriandrum sativum* L.)

germplasm" was conducted at the College of Horticulture, Rajendranagar during *Rabi* period October 2016 to February 2017. The materials used and the methods followed during the course of investigation are represented in this chapter.

3.1 Experimental location

The experiment was carried at the College of Horticulture, Rajendranagar Hyderabad.

3.2 Climate

Hyderabad falls under semi arid tropical climate, situated at an altitude of 542.3 m above the mean sea level. Geographically, it lies at latitude of 17.19°N and longitude of 79.23°E. The monthly mean meteorological data recorded during the crop growth period (Oct-Feb) at meteorological observatory, ARI, Rajendranagar which was presented in the appendix. At all the stages of the crop growth period the weather was congenial for the growth and development of coriander.

3.3 Experimental techniques.

3.3.1 Experimental details

The experiment was laid out in randomized block design with three replications. All the treatments were randomizely separated in each replication.

3.1 Details of the experiment are furnished below

Table 3.1: Details of layout

Design	Randomized Complete Block Design (RCBD)
No. of accessions	35
Replications	3

Spacing	30×10cm
Plot size/accession	2.0m × 1.0m
Location	College of Horticulture, Rajendranagar, Hyderabad
Season	*Rabi* (2016-17)

Table-3.2. Treatment details

List of genotypes evaluated along with their sources

Treatment	**IC No.**	**Source**	**Treatment**	**IC No.**	**Source**
T_1	IC-564150	NBPGR, New Delhi	T_{19}	IC-564148	NBPGR, New Delhi
T_2	IC-564149	NBPGR, New Delhi	T_{20}	IC-574146	NBPGR, New Delhi
T_3	IC-363965	NBPGR, New Delhi	T_{21}	IC-421974	NBPGR, New Delhi
T_4	IC-524231	NBPGR, New Delhi	T_{22}	IC-512374	NBPGR, New Delhi
T_5	IC-469788	NBPGR, New Delhi	T_{23}	IC-424455	NBPGR, New Delhi
T_6	IC-512369	NBPGR, New Delhi	T_{24}	IC-564143	NBPGR, New Delhi
T_7	IC-574156	NBPGR, New Delhi	T_{25}	IC-512368	NBPGR, New Delhi
T_8	IC-564130	NBPGR, New Delhi	T_{26}	IC-361284	NBPGR, New Delhi
T_9	IC-363969	NBPGR, New Delhi	T_{27}	IC-564091	NBPGR, New Delhi
T_{10}	IC-374688-X	NBPGR, New Delhi	T_{28}	IC-424457	NBPGR, New Delhi
T_{11}	IC-421951	NBPGR, New Delhi	T_{29}	IC-564155	NBPGR, New Delhi
T_{12}	IC-512366	NBPGR, New Delhi	T_{30}	IC-429946	NBPGR, New Delhi
T_{13}	IC-512365	NBPGR, New Delhi	T_{31}	IC-574236	NBPGR, New Delhi
T_{14}	IC-512372	NBPGR, New Delhi	T_{32}	IC-394342	NBPGR, New Delhi
T_{15}	IC-553117	NBPGR, New Delhi	T_{33}	IC-574534	NBPGR, New Delhi

T_{16}	IC-411616	NBPGR, New Delhi	T_{34}	CO-4	Coimbatore, TNAU
T_{17}	IC-564104	NBPGR, New Delhi	T_{35}	Monarch	Local, Hyderabad
T_{18}	IC-311276	NBPGR, New Delhi			

IC: Indigenous Collection

3.3.2 Cultural operations

Thirty-five genotypes were raised in Randomized block design with three replications. The seeds were sown at a spacing of 30cm×10cm in leveled land. The land was ploughed twice, harrowed and brought to a fine tilth. Farmyard manure was applied as basal dose at the rate of 15 tonnes per hectare along with full dose of phosphorus and potash and half dose of nitrogen (40:40:40 kg NPK/ha) during land preparation. The remaining half dose of nitrogen was top dressed at 30 DAS. After thorough land preparation, experiment was laid out as per the plan. The crop was sown during October 2016. After seeding emergence, thinning was done by leaving 10 cm within the row.

The crop was harvested when it attained complete maturity. Seeds were manually separated and cleaned after threshing.

3.3.2.1 Sowing of seeds

Healthy and bold coriander seeds of different genotypes were sown on 25th October 2016. The seeds were split into two and soaked in water overnight for better germination and sown directly in the prepared field at a spacing of 30x10 cm followed by light irrigation immediately once the sowing is completed.

3.3.2.2 Thinning of seedlings

The seedlings were thinned out at 30 days of sowing in order to maintain the desirable plant population.

3.3.2.3 Irrigation

First irrigation was given lightly immediately after sowing and subsequent irrigations were given at 8-10 days interval.

3.3.2.4 Intercultural operations

The plots were kept free from weed by regular weeding. Crop was irrigated at an interval of six to eight days. Necessary plant protection measures were undertaken to manage pest and diseases.

3.4 Collection of experimental data

Five plants in each plot were selected randomly and they were tagged for taking observations on various growth and yield parameters.

3.4.1 Growth parameters

3.4.1.1 Plant height

The data at 30, 60 DAS and at harvest was recorded from ground level to the tip of the main stem. The plant height measured in centimeters.

3.4.1.2 Number of leaves

Leaves at 30, 60 DAS and at harvest are recorded from tagged plants.

3.4.1.3 Number of primary and secondary branches per plant

The number of primary branches arising from the main stem are counted at 60 DAS and at harvest time and number of secondary branches arising from the primary branches are counted from each five tagged plants at 60 days and at harvest time.

3.4.2 Yield and yield parameters

3.4.2.1 Days to first flowering

Days required from sowing to anthesis of the main umbel in 100% of the plants in a plot were counted to represent days to first flowering.

3.4.2.2 Days taken to 50% flowering

Days required to 50% of the flowering from sowing to anthesis of the main umbel in 50% of the plants in a plot were counted to note down the days taken to 50% flowering.

3.4.2.3 Days to maturity (crop duration)

Days were counted from sowing to harvest. The harvesting was done when 90 percent of umbels turned dark green to light brown colour.

3.4.2.4 Number of umbels per plant

Number of umbels in each five tagged plants were counted at 60 DAS and at harvest time. The mean is recorded as number of umbels per plant.

3.4.2.5 Number of umbellets per umbel

Five umbels from each selected five plants were used and the umbellets in each umbel were counted and the average was recorded as number of umbellets per umbel.

3.4.2.6 Number of seeds per umbellet

Five umbellets each from randomly selected five umbels were used and the seeds in each umbellet were counted and the average was recorded as number of seeds per umbellet.

3.4.2.7 Thousand seed weight (g)

One thousand dried seeds from each plot were counted and weighed and the average weight (g) was recorded as thousand seed weight.

3.4.2.8 Seed yield per plant (g)

All the umbels from five selected plants of each plot were harvested, dried under shade and threshed. The average weight of cleaned seeds from five plants was recorded as seed yield per plant in grams.

3.4.2.9 Seed yield per hectare (q)

The seeds harvested from each plot were weighed (g). The sum of these seed weight and seed weight of the five plants was harvested separately for yield per plant and remaining plants were harvested and the yield was expressed seed yield per hectare.

3.4.2.10 Harvest index (%)

On the basis of seed yield and total dry matter per plant, the harvest index was worked out using the formula.

$$HI = \frac{\text{Economic yield (g)}}{\text{Biological yield (g)}} \times 100 = \frac{\text{Seed yield per plant (g)}}{\text{Total dry matter per plant (g)}} \times 100$$

3.5 STATISTICAL ANALYSIS

The data were subjected to the following analyses with the help of standard statistical procedures

1. Analysis of variance of RBD
2. Multivariate analysis (D^2 statistics)
3. Coefficient of variation, heritability in broad sense (h^2) and genetic advance (GA)
4. Correlation coefficient analysis
5. Path coefficient analysis

3.5.1. Analysis of variance for RBD

Analysis of variance for different characters was carried out using mean data in order to assess the genetic variability among genotypes as given. Cochran and Cox (1957).

The level of significance was tested at 5% and 1% using F test. The model of ANOVA used is presented below

Sources of variation	**Degrees of freedom (df)**	**Mean sum of squares (MSS)**	**Expected MSS**
Replication Between genotypes Within genotypes (Error)	(r-1) (g-1) (g-1) (r-1)	M_r M_g M_E	$g\sigma_r^2 + \sigma_e^2$ $r\sigma_g^2 + \sigma_e^2$ σ_e^2
Total	(rg-1)		

Where,

r = number of replications

g = number of treatments (genotypes)

σ_r^2 = variance due to replications.

σ_g^2 = variance due to treatments (genotypes)

σ_e^2 = variance due to error

M_r, M_g and M_E are standard mean squares due to replication, genotype and error, respectively.

3.5.2 Multivariate analysis

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

$$D^2p = d1\ S^{-1}d$$

Where,

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

d = Vector observed differences of the mean values of all the characters (xi1- xi2)

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

3.5.2.1 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. 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.

3.5.2.2 Intra and inter cluster distances

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

1. Intra cluster distance

The average intra cluster distances were calculated by the formula given by Singh and Chaudhary (1977).

Square of intra cluster distance = $\Sigma Di^2 / n$

Where,

ΣDi^2 = sum of distance between all possible combinations.

n = Number of all possible combinations

2. Inter cluster distance

The average inter cluster distances were calculated by the formula described by Singh and Chaudhary (1977).

Square of inter cluster distance = $\Sigma Di^2 / n_i n_j$

Where,

ΣDi^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

3.5.2.3 Contribution of individual characters towards genetic divergence

The character contribution towards genetic divergence was computed using the method given by Singh and Chaudhary (1977). In all the combinations, each character was ranked on the basis of $di = y_i^j - y_i^k$ values.

Where,

di = 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, the number of times that each character appeared in the first rank was computed and per cent contribution of characters towards divergence was estimated using the formula

$$\text{Percentage contribution of character x} = \frac{N \times 100}{M}$$

Where,

N = Number of genotype combinations where the character was ranked first.

M = All possible combinations of number of genotypes considered.

3.5.3.1 Estimation of genetic variability parameters

The variability among the genotypes for traits related to seed yield in Coriander were estimated as mentioned below.

1. Genotypic variance and phenotypic variance:

Phenotypic and genotypic components of variance were estimated by using the formula given by Cochran and Cox (1957).

MSS due to genotypes – MSS due to error

Genotypic variance (σ^2_g) = ---

r

Phenotypic variance = Genotypic variance (σ^2_g) + Error variance (σ^2_e)

2. Co-efficient of variability:

Both phenotypic and genotypic co-efficients of variability for all characters were estimated using the formula of Burton (1952).

$$\text{Phenotypic Co-efficient of Variability (PCV\%)} = \frac{\sqrt{\text{Phenotypic variance}}}{\text{Grand mean}} \times 100$$

$$\text{Genotypic Co-efficient of Variability (GCV\%)} = \frac{\sqrt{\text{Genotypic variance}}}{\text{Grand mean}} \times 100$$

PCV and GCV were classified as per Sivasubramanian and Menon (1973) as shown below:

Low	:	Less than 10 per cent
Moderate	:	11 – 20 per cent
High	:	20 per cent and above

3.5.3.2. Heritability in broad sense (h^2):

Broad sense heritability (h^2_{bs}) was estimated and expressed as the ratio of genotypic variance to the phenotypic variance and expressed in percentage (Lush, 1949 and Hanson *et al.*, 1956).

$$h^2 = \frac{\text{Genotypic variance}}{\text{Phenotypic variance}} \times 100$$

The range of heritability was categorized as follows (Johnson *et al*., 1955a)

Low	:	Less than 30 per cent
Moderate	:	30 – 60 per cent
High	:	60 per cent and above

3.5.3.3 Genetic advance (GA):

The expected genetic gain or advance for each character was estimated by using the following method suggested by Johnson *et al.* (1955a).

$$GA = h^2_{bs} \times \sigma_p \times K$$

Where,

h^2 = Heritability estimate in broad sense

σ_p = Phenotypic standard deviation of the trait

K = Standard selection differential which is 2.06 at 5 per cent selection intensity.

Further the Genetic advance as per cent of mean was computed by using the following formula

$$\text{GA as per cent of mean} = \frac{\text{GA}}{\text{Grand mean}} \times 100$$

The range of genetic advance as per cent of mean was classified as suggested by Johnson *et al*. (1955a).

Low	:	Less than 10 per cent

Moderate	:	10 – 20 per cent
High	:	20 per cent and above

3.5.4 Correlation coefficient analysis

To determine the degree of association of characters with yield and also among the yield components, the correlation coefficients were calculated.

Both genotypic and phenotypic coefficients of correlation between two characters were determined by using the variance and covariance components as suggested by Al-Jibouri *et al.* (1958).

$$r_g(xy) = \frac{Cov_g(xy)}{\sqrt{\sigma_g^2(x) \cdot \sigma_g^2(y)}} \qquad r_p(xy) = \frac{Cov_p(xy)}{\sqrt{\sigma_p^2(x) \cdot \sigma_p^2(y)}}$$

Where,

r_g (xy), r_p (xy) are the genotypic and phenotypic correlation coefficients respectively.

Cov_g, Cov_p are the genotypic and phenotypic covariance of xy, respectively.

$\sigma^2{}_g$ and $\sigma^2{}_p$ are the genotypic and phenotypic variance of x and y, respectively.

The calculated value of ‘r’ was compared with table ‘r’ value with n-2 degree of freedom at 5% and 1% level of significance, where, n refers to number of pairs of observation.

3.5.5 Path coefficient analysis

Path coefficient analysis was carried out using phenotypic correlation values of yield components on yield as suggested by Wright (1921) and illustrated by Dewey and Lu (1959). Standard path coefficients which are the standardized partial regressing coefficients were obtained using statistical software packages called GENRES. These values were obtained by solving the following set of 'p' simultaneous equation using the above package.

$P_{01} + P_{02}\, r_{12} + \text{---------} + P_{0P}\, r_{1P} = r_{01}$

$P_{01} + P_{12}\, r_{02} + \text{---------} + P_{0P}\, r_{2P} = r_{02}$

↓

$P_{01} + r_{1P} + P_{02}\, r_{2P} + \text{---------} + P_{0P} = r_{0P}$

Where, P_{01}, P_{02}, -------------- P_{0P} are the direct effects of variables 1,2,--------p on the dependent variable 0 and r_{12}, r_{13}, ------------ r_{1P}--------- $r_{P(P-1)}$ are the possible correlation coefficients between various independent variables and r_{01}, r_{02}, r_{03} ---- r_{0P} are the correlation between dependent and independent variables.

The indirect effects of the i^{th} variable *via* j^{th} variable is attained as (P_{oj} x r_{ij}). The contribution of remaining unknown factor is measured as the residual factor, which is calculated and given below.

$P^2ox = 1-[P^2_{01}+2P_{01}P_{02}r_{12}+2P_{01}P_{03}r_{13}+ \text{------------} + P^2_{02}+ 2P_{02}P_{03}r_{13}+ \text{--------} +P^2_{0P}]$

Residual factor = $\sqrt{(P^2_{ox})}$

The direct and indirect effects were ranked based on the scales of Lenka and Mishra (1973) as given below

Negligible	:	0.00 to 0.09
Low	:	0.10 to 0.19
Moderate	:	0.20 to 0.29
High	:	0.30 to 0.99
Very high	:	> 1.00

CHAPTER IV

RESULTS AND DISCUSSION

CHAPTER IV

RESULTS AND DISCUSSION

The present investigation was carried out with 35 genotypes of coriander (*Coriandrum sativum* L.) at College of Horticulture, Rajendranagar Hyderabad with a view to find out the extent of genetic variability, genetic advance, degree of association and relative importance of various traits on seed yield.

The magnitude of heritable variability is the most important component in any breeding material as it has a close bearing in response to selection. Therefore, occurance of adequate genetic variability is an essential pre requisite for all the crop improvement programmes. Knowledge of the amount of variability and heritability aids the crop breeder for affecting improvement in any crop by choosing suitable breeding technique. The source material for genetical improvement would be identified by studying the amount of variability available in the gene pool or germplasm. This necessitates the evaluation of the assemblage for various requirements in the single environment. Accordingly, coriander genotypes were evaluated for their genetic potential in respect of yield and yield attributes.

The objective of any breeding programme will mostly be oriented towards the improvement of the yield. Since the yield is dependent upon different growth and yield contributing characters, it is necessary to understand growth and yield contributing characters and genetic potential of yield must be probed through the study of its component characters by employing the useful biometrical tools. Some of these parameters include genotypic (GCV) and phenotypic (PCV) co-efficient of variation, heritability, and genetic advance, genotypic and phenotypic correlation and path coefficient helps to base selection procedure to a required balance when two opposite desirable characters affecting the principle characters are also being selected. It helps to improve different characters simultaneously.

The results of the experiment are presented under the following headings.

4.1 Analysis of variance

4.2 Mean performance of genotypes

4.3 Genetic divergence

4.4 Variability, heritability and genetic advance

4.5 Correlation and path analysis

4.1 ANALYSIS OF VARIANCE

The result of the analysis of variance for different quantitative characters for 35 genotypes of coriander are presented in the table 4.1 for 10 growth characters and 13 yield characters. The results indicated that there was a highly significant (P= 0.01) difference among the genotypes for all characters under study.

4.2 MEAN PERFORMANCE OF GENOTYPES

The data on the mean values for different quantitative characters are compiled in the table nos. from 4.2 to 4.6.

4.2.1 Growth attributes

4.2.1.1 Plant height (cm).

Plant height ranged from 4.34 cm to 12.06 cm with a total mean of 7.02 cm. At 30 DAS, significantly higher plant height of 12.06 cm was recorded in IC-424455 and it was on par with IC-564091 (10.44 cm) genotypes whereas the lowest plant height of 4.34 cm was recorded in IC-524231 (table 4.2). Thirteen genotypes were taller than grand mean (7.02 cm). Five are superior than CO-4 and thirteen genotypes were statistically superior by exceeding plant height at 30 DAS than that of check Monarch (6.84 cm).

Significantly highest plant height of 18.14 cm was recorded in IC-574146 at 60 DAS whereas, the lowest plant height of 9.26 cm was found in IC-524231 with a total mean of 12.90 cm (Table 4.2). Fifteen genotypes were taller than the grand mean (12.90 cm) and nineteen genotypes recorded the superior plant height than that of check Monarch (12.28cm) and twenty one genotypes recorded more than CO-4 (11.94 cm).

At harvest, the higher plant height was recorded in IC-512365 (42.16 cm), closely followed by IC-421974 (41.81 cm) with grand mean of 33.46 cm (Table 4.2) while the minimum plant height of 30.36 cm was observed in IC-363965. Ten genotypes recorded higher plant height than total mean. Ten genotypes recorded the higher plant height than the check CO-4 (33.53cm) and eighteen than monarch (32.50cm).

4.2.1.2 Number of leaves

At 30 DAS, the number of leaves ranged between 8.80 (IC-564150) and 18.76 (IC-421974) with grand mean of 11.80 (Table 4.2). Nineteen genotypes showed the maximum count than the mean value. Two genotypes significantly superior than the check CO-4 (15.13) and 12 genotypes were superior than monarch (12.53).

At 60 DAS, the number of leaves ranged between 15.76 (IC-574156) and 25.40 (IC-512369), followed by IC-421974 and IC-564148 (23.60) with grand mean of 20.06 (Table 4.2). Out of 35 genotypes, seventeen genotypes exhibited significantly higher number of leaves per plant compared to total mean. Eleven genotypes were statistically superior by exceeding number of leaves per plant than the check CO-4 (21.60) and sixteen were found significant than monarch (19.60).

At harvest, the number of leaves (28.73) were more in IC-363969, which was at par with CO-4 (28.66), IC-512365 (28.33), IC-512369 (27.26), IC-311276 (27.07) and IC-424455 (26.93). The lowest number of leaves (21.07) in IC-574156 with grand mean of 24.84 (Table 4.2). Seventeen genotypes out of thirty-five genotypes were higher than the mean value. One genotype was statistically superior by exceeding number of leaves plant^{-1} than the check CO-4 (28.66) twenty five were found to be superior than monarch (22.93).

The number of leaves is dependent largely upon the number of nodes and also on the number of branches both primaries and secondaries arising on the main shoot of the plant. When there are more branches a plant is likely to have more leaves but depending on the expansion of them the leaf area per plant may show a different trend. In the present study, the values obtained are in conformity with the observations recorded by Banerjee and Kole (2004) and Mourya *et al*. (2015) in fenugreek.

4.2.1.3 Number of primary branches

At 60 DAS, the mean values for number of branches plant^{-1} in coriander genotypes varied from 3.46 to 6.40 with a grand mean of 4.70 (Table 4.3). The genotype IC-512365 (6.40) recorded more number of primary branches plant^{-1}, which was closely followed by IC-424455 (6.20), whereas less number of branches plant^{-1} was recorded in IC-564130 (3.46). Out of 35 genotypes, twelve genotypes exhibited significantly higher number of branches plant^{-1} compared to total mean. Thirty one genotypes were statistically superior by exceeding number of primary branches plant^{-1} than the check CO-4 (4.00).

At harvest, the number of primary branches plant^{-1} varied between 4.66 to 7.73 with a mean of 5.96 (Table 4.3). Significantly higher number of branches 7.73 was recorded in IC- 512365 and it was followed by IC-574534 (7.46), IC-564130 (7.20), IC-564155 (7.00), IC-424455 (6.80), IC-394342 (6.73). The lowest number of primary branches was recorded in IC-574156 (4.66). Out of 35 genotypes, eighteen genotypes exhibited significantly higher number of primary branches plant^{-1} compared to total mean. Twelve genotypes were statistically superior by exceeding number of branches plant^{-1} than the check CO-4 (6.26) and twenty six were superior than monarch (5.96).

4.2.1.4 Number of secondary branches

At 60 DAS, the number of secondary branches ranged between 4.93 (512366) and 8.53 (IC-512365), which was on par with 8.46 (IC-421974) with grand mean of 6.36 (Table 4.3). Seventeen genotypes are significantly differing than total mean. Six genotypes performed statistically superior than the check CO-4 (7.26).

Significantly higher number of secondary branches (16.66) was recorded in IC-424455 at harvest and it was on par with IC-512365 and the minimum number of secondary branches (10.80) was found in genotype IC-564149 with a mean value

13.94 (Table 4.3). Nineteen genotypes were recorded more number of secondary branches plant^{-1} than the grand mean 13.94 (Table 4.3). Three genotypes recorded maximum number of secondary branches per plant than the check CO-4 (15.73) thirty two were superior than monarch (11.80)

The height of plant normally denotes how many nodes are born, the length of the internodes and also inherent genetic makeup of the genotypes and their interaction with the environment. Therefore, the number of primary branches born may have a positive association with the height of main axis, though not compulsory in every case. It is evident from the results that there is a slight but not strong association between the height of plant and number of primary branches and in turn with number of secondaries. The number of secondary branches are high may be attributed by closer spacing of 30×10 cm. Genotypes or accessions reaching maximum height at maturity normally were noticed to possess reasonably good number of branches and however, slightly shorter genotypes also possessed number of branches on par with the tallest accessions. This can be attributed to the reason that there would be differences in the apical dominance property that might be due to differential contents or synthesis of auxins or their suppression due to antagonising plant hormones endogenously. These results are in concurrence with the findings of those reported by Datta and Choudhuri *et al.* (2006), Anubha *et al.* (2013), Dyulgerov N and Dyulgerov B (2013), Mengesha *et al*. (2013), Arif (2014), Meena *et al*. (2014), Sravanti *et al.* (2014) in coriander and Singh *et al*. (2015) in fenugreek.

4.2.2 Yield and yield attributes

4.2.2.1 Days to first flowering

The genotype IC-574534 was found to be early with respect to days taken to first flowering with a value of 36.33 days followed by IC-421974 (39.67), IC-469788 (39.33), IC- 512365 (40.33), IC-424455 (40.67), IC-564143(42.33), IC-512372 (42.33) and IC-361284(42.33) (Table 4.4) (Fig 4.1). However, the maximum 56.33 days taken to first flowering was recorded in genotype IC-411616 followed by IC-374688-X (55.33 days). The average days for first flowering were 46.41and it ranged from 36.33 to 56.33 days. Seventeen genotypes attributed for the earliest flowering than the mean value. Fifteen genotypes have shown the earliness for first flowering than check Monarch and nineteen were recorded early flowering compared to CO-4.

4.2.2.2 Days to 50% flowering

Days taken to 50% flowering ranged between 41.67 to 60.33 days with an overall mean performance of 51.73 days (Table 4.4) (Fig 4.1). Genotype IC-574534 (41.67 days) was earliest followed by IC-(44.66), IC-421974 (45.33), IC-512365 (45.67), IC- 424455 (45.67), IC-564143 (46.67) and IC-564150 (46.33) days. However, the genotype IC-374688-X was recorded late flowering (60.33) days. Twenty one genotypes recorded significantly less number of days to 50% flowering compared to grand mean. Twenty genotypes had taken significantly lesser number of days to 50% flowering than the check Monarch (51.66).

4.2.2.3 Days to maturity

Days to maturity ranged from 81.66 to 111.67 days with an average days being 100.54 days (Table 4.4) (Fig 4.1). IC-574534 (81.66 days) was earliest followed by IC-512366 (84.33days), IC-564146 (88.00 days) and IC-564130 (88.33 days) while, the genotype IC-424455 has taken longest span to mature. Thirteen genotypes had taken less number of days to attain maturity than the grand mean and six genotypes are significantly superior than local check Monarch (92.3) and 14 genotypes recorded attained early maturity than CO-4 (101.67 days).

Early flowering might be due to minimum branches per plant resulting in low quantity of florigen (a flowering harmone) which might have been responsible for the period of reproductive phase. These genotypes can introduce diversity in crop improvement programme because the early and late type can easily fetch the market demand and give better economic returns. The days taken to complete flowering in each genotype depended on the duration of flowering which in turn decided the number of productive sinks *i.e.* flowers, Srivastav *et al.* (2000), Singh *et al.* (2005), Mengesha and Getinet (2011), Sravanti *et al.* (2014) in coriander and Patahk *et al.* (2014) in fenugreek, also observed similar differences in flowering behaviour of genotypes in coriander and fenugreek.

4.2.2.4 Number of umbels per plant

Marked variation was observed among the genotypes at 60 days in respect of number of umbels per plant (Table 4.5). It ranged from 9.80 to 26.60 with a mean value of 15.10. The highest number of umbels (26.60) in IC-512365 and lowest (9.80) was found in IC-411616. Twelve genotypes were found to be better than the mean. Eight genotypes had recorded more number of umbels plant^{-1} than check CO-4 (17.33) and twenty nine genotypes exhibited more number of umbels plant^{-1} than monarch (11.00).

Number of umbels plant^{-1} at harvest ranged between 12.46 to 31.80 with a grand mean value 18.62 (Table 4.5). The genotype IC-512365 had maximum number of umbels plant^{-1} (31.80) which was on par with IC-421951 (30.73) and minimum number of umbels plant^{-1} (12.46) was recorded in the IC-411616. A total of 8 genotypes had significantly more number of umbels plant^{-1} as compared to the local check Monarch (20.87) and nine were found significant than CO-4 (20.73).

The data pertaining to this trait are in accordance with the studies conducted by Arif (2014), Moniruzzaman *et al*. (2013), Singh *et al*. (2006), Maurya (1989) and Bhandari and Gupta (1993) in coriander.

4.2.2.5 Number of umbelletes per plant

Significant variation among the genotypes was observed for this trait at 60 DAS (Table 4.5). The genotype IC-512365 produced the maximum umbellets umbel^{-1} closely followed by IC-553117 (5.67). The lowest was found in IC-363965 (2.60) with a mean value of 4.26. Seventeen genotypes were found better than mean. Six genotypes recorded highest number of umbellets umbel^{-1} than the check Monarch (5.20) and thirteen genotypes were found superior than CO-4 (5.93).

At harvest, the number of umbelletes umbel^{-1} recorded between 4.33 to 7.86 with a mean value 6.18 (Table 4.5). Maximum number of umbellets produced in genotype IC-512365 (7.86) which was closely followed by IC-553117 (7.67), IC-574236 (9.07) and IC-363969 (7.53) and lowest in IC-564148 (4.33). Nineteen genotypes were found to superior than mean. Four genotypes found to be statistically superior than check Monarch (7.33).

Islam *et al.* (2004) did not find significant variation among genotypes used for the umbellets per umbel. The results of this study corroborates the results of Maurya (1989) and Arif (2014) in coriander .

4.2.2.6 Number of seeds per umbellet

The higher number of seeds umbellet^{-1} at 60DAS varied significantly between 4.53 (IC- 411616) to 11.13 (IC- 553117) followed by IC-564104 (11.00), IC-564143 (10.60), IC-363969 (10.07) and IC-311276 (9.87). The grand mean value of number of seeds umbellet^{-1} was 7.76 (Table 4.6). Twenty one genotypes exhibited significantly higher number of seeds umbellet^{-1} compared to total mean. Twenty four genotypes recorded more number of seeds umbellet^{-1} compared to check Monarch (6.87) and twenty nine were recorded more seeds than CO-4 (5.20).

Number of seeds umbellet^{-1} at harvest varied from 5.73 (IC-411616) to 13.33 (IC-574236) which was on followed by 13.06 (IC-553117) and 12.80 (IC-564104) with grand mean of 9.55 (Table 4.6) and the lowest was in 5.73 (IC-411616). Twenty genotypes exhibited significantly higher number of seeds umbellet^{-1} compared to total mean. Twenty genotypes recorded more number of seeds umbellet^{-1} compared to check Monarch (9.40) and 29 genotypes were found to be recorded more number than CO-4 (6.86).

Arif (2014), Meena *et al*. (2014), Moniruzzaman *et al*. (2013), Maurya (1989) and Bhandari and Gupta (1993) in coriander reported more seeds umbellet^{-1} which are in agreement with the present study.

4.2.2.7 Thousand seed weight (g)

The maximum 1000-seed weight was recorded from IC-5113117 (14.71 g) followed by IC-512374(14.54g), IC-424457 (14.34 g) and IC-564143 (13.54 g) with an average value 12.12 g (Table 4.6) (Fig 4.2). Eighteen genotypes recorded significantly more thousand seed weight compared to total mean. Lowest yield was recorded in IC-574156 (9.89 g). Seven genotypes recorded significantly higher fruit yield per plant than the check Monarch (12.98 g) and 22 genotypes were found to be recorded more seed weight than CO-4 (11.51 g).

The results pertaining to this trait are in collaboration with Datta and Choudhuri (2006) and Moniruzzaman *et al*. (2013) in coriander and Singh *et al*. (2015) in fenugreek. This variation might be due to genetic variation.

4.2.2.8 Seed yield per plant (g)

Maximum seed yield plant^{-1} was noted in IC-512365 (6.84 g) closely followed by IC- 553117 (6.20 g), IC-363969 (6.18 g) and genotype IC-574156 (2.56 g) was poor yielder. The average yield per plant was 3.82 g (Table 4.6) (Fig 4.3). The mean value of twelve genotypes showed significant values than total mean value. Thirteen genotypes had significantly maximum seed yield plant^{-1} as compared to the check Monarch (3.72 g) and eighteen genotypes recorded higher seed yield than Co-4 (3.42 g).

The present finding supports the result of Bhandari and Gupta (1993). The difference in the seed yield plant^{-1} might be due to the genotypical difference and ecological variation.

4.2.2.9 Seed yield per hectare (q)

Seed yield hectare^{-1} in quintal varied from 8.66 q to 26.83 q and the average yield in quintal per hectare was noted to be 15.72 q (Table 4.6). The Maximum seed yield 26.83 q was recorded under the genotype IC-512365 which was on par with IC-421974 (25.45q). The genotype IC-574236 (8.66 q) was poor yielder. Out of 35 genotypes, ten genotypes recorded significantly highest seed yield hectare^{-1} over the total mean. Ten genotypes significantly higher than the check CO-4 (15.36 q) and twelve genotypes superior than monarch (14.98 q).

Rajagopalan *et al*.(1996), Carubba *et al*. (2002), Datta and Choudhuri (2006), Singh *et al*. (2006) for highest seed yield in two subsequent years and Arif (2014) in coriander reported similar findings in coriander.

4.2.2.10 Harvest index (%)

The average harvest index of the plant was 42.61 per cent among the genotypes studied (Table 4.6) (Fig 4.4). The quantum of variation observed for this trait ranged from 30.67 per cent in genotype IC-574236 to 53.36 per cent in genotype IC-363969 which was at par with IC-429946 (51.66). Out of 35 genotypes, eighteen genotypes recorded significantly highest harvest index over the total mean. Eleven genotypes had significantly more harvest index compared to check CO-4 (43.96%) and eighteen genotypes recorded more than monarch (42.02).

The boldness of grain and its weight are dependent on how it was able to drag the assimilates from different sources and also perhaps due to its genetic makeup. It is the speed and steady flow of the photosynthetic products that decides over time the size of the fruits and its weight. Therefore, these quality parameters are necessarily influenced by greater values of vegetative parameters as evident from the data obtained on these parameters from various genotypes. Bold grains and in higher quantities would definitely lead to greater grain yield per plant which in turn govern corresponding top rank of a genotype in grain yield per hectare. In the present study, it is evident that genotypes had independent ranking with regard to quality parameters as against grain yield. Yield is a complex character and is influenced by several attributing parameters. Similar trends were also noted by Meena *et al*. (2014) in coriander and Anubha *et al*. (2013) in fenugreek.

The detailed analysis of yield attributing parameters, their association among themselves and their partial effects summing up to individual direct effects is carried out in the present investigation and described under correlation and path coefficient sections in the following paragraphs

4.3 GENETIC DIVERSITY

In recent times, the D^2 statistic has found favour as a tool for estimating the genetic divergence for use in plant breeding. In the present study, the D^2 analysis was utilized to assess the distance between the genotypes, to study the contribution of different characters to diversity, to identify promising genotypes and to initiate a crossing programme in a collection of 35 genotypes for 23 characters in coriander.

The high variability existing among the genotypes was confirmed by the D^2 analysis, wherein the 35 genotypes formed as many as seven clusters. Large number of clusters formed indicated that coriander is marked by considerable genetic diversity. The clustering of genotypes from same geographical regions in one cluster showed the presence of similar genetic architecture of the genotypes from the same region.

4.3.1 Genetic Divergence (D^2 statistic) for seed yield

An assessment of genetic divergence was made by adopting Mahalanobis D^2 statistic for yield and its components.

4.3.1.1 Grouping of genotypes in to various clusters

Procedure suggested by Tocher (Rao, 1952) was used to group 35 coriander genotypes into seven clusters by treating estimated D^2 values as the square of the generalized distance. The pattern of distribution of 35 genotypes into various clusters is indicated in Table 4.7. The resulting average D^2 values within (intra) and between (inter) clusters are indicated in table 4.8 (Fig 4.5). Maximum divergence was observed between cluster VI and IV (D^2=444.60). Similar results are also reported by Mengesha *et al.* (2011) in coriander.

4.3.1.2 Average intra and inter cluster distances

The mean intra and inter cluster D^2 values among the seven clusters are given in the Table 4.9 (Fig 4.6). The intra cluster distance ranged from 0.00 to 84.49 (cluster I).

Cluster I consisting of 29 genotypes, exhibited a close relation with cluster II (139.45) and distant from cluster VII (346.91). Cluster II exhibited close proximity with cluster III (73.29) and maximum divergence with cluster IV (232.87). Cluster III was nearest to cluster VII (137.59), while it was farthest from cluster IV (179.08). Cluster IV was nearest to cluster II (97.10) and distant from cluster VII (444.60). Cluster V exhibited intimate relation with cluster II (101.35) and wide diversity with cluster IV (444.60). Cluster VI was nearest to cluster II (101.35) and distant from cluster IV (444.60). Cluster VII exhibited intimate relation with cluster III (137.59) and wide diversity with cluster I (346.91).

Thus, more variability in genetic makeup of the accessions included in these clusters. The accessions belonging to the clusters separated by high statistical distance could be used in hybridization programme for obtaining a wide spectrum of variation among the segregates. The range of inter-cluster D^2 values from 73.29 (cluster II and III) to 446.40 (cluster IV and VI) obtained in the current study were higher than the inter cluster distance (13.8 to 91.3) reported by Singh *et al.* (2005), comparable to the values (7.67 to 663.93) reported by Wassihun (2006) and (336.1.1to 480.5) and Mengesha *et al.* (2011).

4.3.1.3 Performance of characters in cluster

The cluster means for each of twenty traits are presented in Table 4.10. From the data it can be seen that considerable differences exist for all the traits studied.

The genotypes of cluster III recorded highest plant height at 30 DAS (12.07 cm) followed by cluster V (8.31cm), while the genotypes of cluster II registered lowest plant height (5.68 cm) followed by cluster VI (6.24cm). The genotype of cluster II recorded highest plant height at 60 DAS (13.77 cm) followed by cluster III (13.63 cm), while minimum plant height for genotypes of cluster IV (10.23). The genotypes of cluster VII recorded highest plant height at harvest (42.16 cm) , while the genotypes of cluster V registered lowest plant height (31.35 cm) followed by cluster IV (31.82 cm).

The genotypes of cluster VI (18.77) had produced more number of leaves, while the genotypes of cluster IV (10.67) recorded lowest number followed by cluster III (10.87) at 30 DAS. The character number of leaves at 60 DAS recorded more number of leaves in cluster V (25.40) followed by cluster VI (23.67), while the genotypes of cluster VII (17.93) registered minimum mean value for number of leaves followed by cluster III (19.20). At harvest the count was highest in cluster VII (28.33) followed by (27.27), while the least count in genotypes belong to cluster IV (22.87) followed by cluster II (24.55).

The genotypes of cluster VII (6.40) has recorded more number of primary branches at 60 DAS followed by cluster III (6.20), while the genotypes of cluster VI (4.40) recorded less number of primary branches plant^{-1} followed by cluster I (4.54). The genotypes of cluster VII (7.73) has recorded more number of primary branches per plant at harvest followed by cluster III (6.80), while the genotypes of cluster VI (4.80) recorded less number of primary branches per plant followed by cluster I (5.40).

The genotypes of cluster VII (8.53) has recorded more number of secondary branches at 60 DAS followed by cluster VI (8.47), while the genotypes of cluster V (5.13) recorded less number of primary branches per plant followed by cluster IV (5.67). The genotypes of cluster III (16.67) has recorded more number of secondary branches per plant at harvest followed by cluster VII (16.40), while the genotypes of cluster V (12.30) recorded less number of primary branches per plant followed by cluster I (13.81).

The genotype of cluster VI (39.00) took minimum number of days to first flowering, while the genotype of cluster IV (52.33) recorded maximum number of days to first flowering followed by cluster V (51.33). The character days to fifty percent flowering recorded its minimum mean value for the genotypes of cluster VI (45.33), while the genotypes of cluster IV recorded maximum mean value for days to 50 percent flowering. The genotype cluster VI took minimum days to attain maturity (90.33) followed by cluster VII (96.67) while the genotypes of cluster III took maximum days to maturity (111.67)

The genotypes of cluster VII (26.60) have recorded more number of umbel plant^{-1} at 60 days, while the genotypes of cluster I (13.99) recorded less number of umbels plant^{-1} followed by cluster VI (14.13). The genotypes of cluster VII recorded highest mean value for number of umbels per plant at harvest (31.80) followed by cluster IV (30.73), while the genotypes of cluster VI (15.53) recorded lowest mean value for number of umbels per plant followed by cluster I (17.56).

The genotypes of cluster VII (6.30) recorded highest number of umbellets umbel^{-1} at 60 DAS followed by cluster II (5.67), while the genotypes of cluster I showed less number of umbellet umbel^{-1} (4.07) followed by cluster V (4.60). Highest number of umbellets umbel^{-1} at harvest was recorded in the genotypes of cluster VII (7.87) followed by cluster II (7.67).The lowest mean value was observed in cluster I (6.00) followed by cluster IV (6.27).

The maximum seeds umbellet^{-1} at 60 DAS was recorded in the genotypes of cluster II (11.13) followed by cluster III (9.47) whereas, minimum value was recorded in the genotypes of cluster V (5.20) followed by cluster VII (6.27). The genotypes of cluster II registered more seeds umbellet^{-1} at harvest (13.07) followed by cluster VII (11.13), while the genotypes of cluster V (6.27) observed less number of seeds umbellet^{-1} followed by cluster VI (8.40).

The character seed yield plant^{-1} (g) recorded its highest mean value in the genotypes of cluster VII (6.84) followed by cluster VI (5.04) whereas, the lowest mean value was recorded in the genotypes of cluster IV (3.07) followed by cluster V (3.34). The character seed yield per hectare (q) recorded its maximum mean value in the genotypes of cluster VII

(26.83) while cluster IV recorded minimum mean value for seed yield (12.72) followed by cluster V (13.49).

The genotypes of cluster II recorded highest 1000 seed weight (g) (14.71) followed by cluster IV (13.35), whereas the lowest 1000 seed weight was recorded in cluster V (10.10) followed by cluster VII (10.17). The genotypes of cluster II recorded maximum harvest index mean value (48.23) followed by cluster VII (46.60), where as the lowest value recorded in the genotypes of cluster IV (38.47). Similar results are reported by Mengesha *et al.* (2011)

Cluster mean values showed a wide range of mean values among the characters studied indicating presence of wide variation among the genotypes studied.

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

4.3.1.4 Relative contribution of characters towards diversity

Number of times each of twenty three traits appeared in first rank and its respective per cent contribution towards genetic divergence are furnished in Table 4.11. The results showed that the character number of umbel per plant at harvest contributed maximum (20.16%) towards diversity by taking 120 times first ranking, followed by Days to harvest (13.10%) by 78 times, seed yield per hectare (12.94%) by 77 times, days to first flower (10.75%) by 64 times, umbels per plant at 60 DAS (9.41%) by 56 times, number of seeds per umbellet at harvest (9.07%) by 54 times, harvest index (8.90%) each by 53 times, Seed yield per plant (4.53%) by 27 times, number of seeds per plant at 60 days (3.86%) by 23 times, plant height at 60 DAS (2.52%) by 15 times, No. of umbellets per umbel at 60 DAS (2.52%) followed by 15, number of leaves 60 DAS (0.84%) by 5 times, 1000 seed weight (0.67%) by 4 times, number of leaves at 30 days after sowing (0.50%) by 3 times and days to fifty percent flowering (0.16%) by one time.

Similar results were obtained by Mengesha *et al.* (2011) for umbels per plant and for seed yield by Patel *et al.* (2000) in coriander concluded that these characters contributed maximum towards genetic divergence. The difference in the contributing factors for genetic divergence could be attributed to differences among the genotypes under study, which in turn might be due to environmental conditions of the locations associated and interacted with genotypes. The characters contributing maximum to the D^2 value are to be given greater emphasis for deciding on the clusters for the purpose of further selection and choice of parents for hybridization.

4.4 GENETIC VARIABILITY

Estimating variability in a population is an effective tool for the breeder to design the selection procedures more accurately for identifying superior genotypes. Variability helps to choose the potential genotype, since it indicates the extent of recombination for implementing effective selection. The magnitude of phenotypic and genotypic coefficients of variation has been assessed to know the real worth of the source material.

Genotypic coefficient of variation would be a useful tool for the assessment of variability, since it depends upon the heritable portion of the total variability (Allard 1960). In the present study, the estimated genotypic variance and genotypic coefficient of variation followed a similar trend as that of phenotypic variance and phenotypic coefficient of variation reported by Singh *et al.* (2005).

Heritability estimates give a measure of transmission of characters from one generation to another, thus giving an idea of heritable portion of variability and enabling the plant breeder in isolating the elite genotype in the crop. The heritability expresses the portion of total variances that was attributed to the average effect of genes and that determines the degree of resemblance between parents and off springs. It also expresses the reliability of phenotypic values as a guide to the breeding value.

Heritability in broad sense is the portion of genotypic variance to phenotypic variance, which indicates the relative success of selection. It is useful in selection of elite genotype from diverse genetic population.

High heritability estimates are helpful in selecting superior genotypes on the basis of performance of quantitative characters. In the present study, the heritability in broad sense was found to be high for most of the characters. High heritability estimates indicated the presence of large number of fixable additive genes and hence these traits can be improved by selection.

Heritability coupled with genetic advance is an important selection parameter. Johnson *et al*. (1955a) reported that heritability along with genetic gain is more useful than the heritability alone, in predicting the resultant effect for selecting the best individuals. He categorized the heritability values, as the values greater than 60 per cent indicate the high heritability, the values ranged between 30 to 60 per cent indicate the moderate heritability, while the values less than 30 per cent indicate the low heritability. Similarly, the values greater than 20 per cent indicate high genetic advance, the values ranged between 10 to 20 per cent indicate moderate genetic advance Table 4.12 while the values less than 10 per cent indicate low genetic advance.

The simple measure of variability like mean, range and the major components of variability such as phenotypic and genotypic coefficients of variation (PCV and GCV) table 4.12 (Fig 7), heritability in broad sense (h_{bs}^2), genetic advance and genetic advance as % of mean were presented in table 4.12 (Fig 4.8). Most of the characters under study exhibited high variability as evident from the estimates of mean, range, coefficients of variation, heritability and genetic advance.

4.4.1. Plant height (cm)

Phenotypic and genotypic variances at 30 DAS were (3.54 and 1.60 respectively**)** recorded coupled with high PCV and moderate GCV of 26.79 and 18.02 per cent, respectively. This trait showed moderate heritability (45.24 %) and high GA as % mean (24.97%).

Plant height at 60 DAS, The GV and PV were 3.05 and 4.10 respectively. The estimate of GCV and PCV were moderate (13.54 and 15.69, respectively). High heritability (74.4%) was observed along with high genetic advance as per cent of mean (24.07%).

At harvest, PV and GV were 6.85 and 11.41 respectively. The estimates of PCV and GCV were moderate 10.09 and low 7.82, respectively with high heritability (60.10%), GA (4.18%) and moderate GA as % of mean (12.50%).

The estimates of PCV and GCV were distant to each other for this character which indicated that plant height was much influenced by environmental factors. Moderate PCV and low GCV for this attribute was in conformity with Nilkolay and Boryana (2014) in coriander. And further presence of high heritability was in agreement with Nilkolay *a*nd Boryana (2014) in coriander. Similar results were also found by Patahk *et al.* (2014) in fenugreek.

4.4.2 Number of leaves

The GV and PV values at 30 DAS (4.46, 5.51) and at 60 DAS (5.06 and 6.25) respectively. Moderate PCV was recorded for this trait at 30 DAS (19.88) and 60 DAS (12.45) and GCV at 30 DAS (17.90) and at 60 DAS (11.91). A high heritability was observed for 30 days (0.811) as well for 60 DAS (0.811) with high GAM 33.20 and 20.81 respectively.

High heritability coupled with high GAM observed for this trait indicated that this trait was under additive gene control and direct selection for this trait would be effective for genetic improvement. The present findings are in agreement with the Dhirendra singh *et al.* (2006), Rajput and Dhirendrasingh (2003) and Geremew *et al*. (2015) in coriander.

At harvest, the number of leaves recorded a PV of 5.55 and GV of 3.08. Values in low range were estimated for both PCV (9.48) and GCV (7.07). A moderate heritability of 55.60 per cent with low GAM (10.86%) was recorded for this trait.

The moderate heritability for this trait indicates the prevalence of additive gene action in governing the inheritance of this character, however since the GAM is in low range the expected improvement could be lesser.

4.4.3 Number of primary branches per plant

The PV and GV recorded for number of primary branches per plant at 60 DAS were 0.44 and 0.61 respectively. A moderate PCV (16.71) and GCV (14.16) were estimated for this trait. This character exhibited high heritability (71.9%) coupled with high GAM (24.74%).

The PV and GV recorded for number of primary branches per plant at harvest were 1.27 and 0.23 respectively. A moderate PCV (18.93) and low GCV (7.98) were estimated for this trait. This character exhibited high heritability (67.97%) coupled with high GAM (24.74%).

The presence of high heritability was in agreement with Nilkolay and Boryana (2014) in coriander, Patahk *et al.* (2014) in fenugreek, and Patel *et al.* (2008) in fennel. High heritability in conjunction with high GAM was observed for this trait indicating the preponderance of additive gene action governing the inheritance of this character and offers the best possibility of improvement through simple selection procedures. Moderate phenotypic coefficient of variation which indicated that selection based on phenotypic performance would be rewarded.

4.4.4 Number of secondary branches

The PV and GV recorded for number of secondary branches at 60 DAS were 1.09 and 0.741, respectively. The estimates of PCV (16.45) high and GCV (13.53) were in moderate range. A high heritability (67.6%) coupled with high GAM (22.93) was recorded for this trait.

The GV and PV recorded for number of secondary branches at harvest were 1.29 and 3.42, respectively. The estimates of PCV (13.25) moderate and GCV (8.14) was in low range. A moderate heritability (37.8%) coupled with moderate GAM (10.91) was recorded for this trait.

The present findings for high PCV at 60 days are in close harmony with Tripathi *et al.* (2000) in coriander. The high GAM observed for this trait, may be attributed to the preponderance of additive gene action and that these characters possessed a high selection value. These outcomes are in accordance with the findings of Patahk *et al.* (2014) in coriander.

The moderate estimates of PCV at harvest for this character, which indicated that selection based on phenotypic performance would be rewarding.

4.4.5 Days to first flowering

For this character, high PV and GV (25.70 and 22.47 respectively) were recorded in coriander genotypes with moderate PCV (10.92%) and GCV (10.20%) values. Days to first flowering showed high heritability (87.3 %), but genetic advance (9.12) and moderate GA as % of mean (19.65).

The PCV and GCV values are high for the trait are in consideration with the findings of Tripathi *et al*. (2000) in coriander reporting that selection might be rewarded.

4.4.6 Days to 50% flowering

This trait recorded higher phenotypic and genotypic variances (23.669 and 21.07 respectively) with low PCV (9.404%) and low GCV (8.862%), high heritability (88.80 %), genetic advance (8.89) and moderate GA as % of mean (17.20).

The PCV and GCV values were moderate and low for this trait. High heritability coupled with moderate GA as per cent of mean was also observed for this trait. These findings are in close harmony with the investigations of Shrivastava *et al.* (2000), Tripathi *et al.* (2000) and Singh *et al.* (2006) in coriander.

4.4.7 Days taken for maturity

The PV and GV (66.68 and 61.23) respectively for this trait with low PCV and GCV of 8.12 and 7.78 per cent respectively. This trait exhibited high heritability of 91.18 per cent coupled with genetic advance (15.44) and moderate GAM of 15.36 per cent. High estimates of heritability recorded for this trait indicates presence of more genetic variability and thus more scope for selection of this trait by Meena *et al.* (2014) in coriander. Moderate GAM indicated that this trait was highly influenced by environment.

4.4.8 Number of umbels per plant

PV and GV for this character at 60 DAS were 19.06 and 17.75 respectively. High values of PCV and GCV (28.90 and 27.89 respectively) were estimated for this trait. Very high heritability of 93.1 per cent was recorded with very high GAM of 55.45 per cent for this trait.

Phenotypic and genotypic variances at harvest (23.88 and 22.62 respectively) were recorded coupled with high PCV and GCV of 26.24 & 25.44 per cent, respectively. This trait showed high heritability (94.70%), genetic advance (9.5) and high GA as per cent of mean (51.21).

The estimates of PCV and GCV were high for this trait. Similar results were obtained by Meena *et al.* (2014) in coriander and Patel *et al.* (2008) in fennel. Presence of high heritability and GAM was in agreement with, Meena *et al.* (2014) in coriander and Singh and Choudhary (2008) in ajowain indicating that these characters are less influenced by environmental factors and are under the control of additive gene effect for improvement for such character would be rewarding.

4.4.9 Number of umbellets per umbel

The PV and GV for number of umbellets per umbel at 60 DAS were 0.98 and 0.77 respectively. The estimates of PCV and GCV (23.21 and 20.65 respectively) were in high range. This trait exhibited high heritability of 79.2 per cent coupled with high GAM of 37.88 per cent.

At harvest Phenotypic and genotypic variances (1.04 and 0.69, respectively) were recorded coupled with moderate PCV and GCV of 16.54 & 13.47 per cent, respectively. This trait showed high heritability (66.30%), low genetic advance (1.39) and high GA as per cent mean (22.60).

Presence of high heritability was in agreement with Meena *et al.* (2014) in coriander and Patel *et al.* (2008) in fennel.

4.4.10 Number of seeds per umbellet

This trait recorded PV and GV values at 60 DAS as 4.17 and 3.46 respectively. The estimates of PCV and GCV (26.29 and 23.97, respectively) were at high range.

This character exhibited higher heritability (83.1%) coupled with high GAM of 45.02 per cent.

Phenotypic and genotypic variances (4.88 and 4.03, respectively) were recorded coupled with moderate PCV and GCV of 19.21 & 18.66 per cent, respectively. This trait showed high heritability (64.34%), low genetic advance (6.54) and high GA as per cent mean (37.33).

High estimates of PCV and GCV recorded for this trait indicated the presence of high genetic variability as a result of which more scope for selection. Similar results were found by Jeeterwal *et al.* (2015) and Sharma *et al*. (2015) in fennel. High heritability for this character was also estimated by the earlier workers Nilkolay and Boryana (2014) and Meena *et al.* (2014) in coriander and Patel *et al.* (2008) in fennel.

4.4.11 1000 seed weight

The PV (2.14) was higher than GV (1.20). The PCV (12.07) were moderate and low (9.05) for this trait. Moderate heritability (56.2%) was associated with moderate genetic advance as per cent of mean (13.98) and low GA (1.69).

Similar results were observed for test weight by Dashora *et al.* (2011), Singh (2000), Prajapathi *et al*. (2010) in fenugreek indicating considerable effect of environment on the expression of these characters.

4.4.12 Seed yield per plant (g)

The PV and GV of 1.35 and 0.93 respectively were recorded for this trait. PCV (30.43) and GCV (25.28) were estimated at high range. This trait exhibited high heritability of 69.0 per cent coupled with very high GAM of 43.27 per cent.

High estimates of PCV and GCV recorded for this trait indicates the presence of high degree of genetic variability and thus a greater scope for selection on the basis of this character. Similar results were also reported by Meena *et al.* (2014) in coriander, Singh and Choudhary (2008) in Ajowan, Patahk *et al.* (2014) and Anubha *et al*. (2013) in fenugreek. High heritability in conjunction with high GAM was observed for this trait which indicates the preponderance of additive gene action governing the inheritance of this character and offers the best possibility of improvement through simple selection procedure. These results are in accordance with the conclusions of Singh and Choudhary (2008) in Ajowain.

4.4.13 Seed yield per hectare (q)

The PV and GV were 17.80 and 16.69 respectively. The estimates of GCV (25.89) and PCV (26.83) were high for this trait. The estimate of heritability (93.8%) was high with high genetic advance as per cent of mean (51.84), low GA (8.15) for this trait.

High PCV and GCV indicates fairly high degree of variability for seed yield. The same was also observed by Dashora *et al*. (2011) and Rakesh and Korla (2003) in fenugreek suggesting less environmental effects on this character, which was confirmed by its high heritablility.

4.4.14 Harvest index

The PV and GV were (24.45 and 22.35 respectively) for this trait. The estimates of GCV and PCV were moderate (11.09 and 11.60, respectively). High heritability (91.4%) coupled with high genetic advance as per cent of mean (21.84%) and GA (9.31) was observed for the trait.

Similar results indicating high heritability coupled with high genetic advance as percent of mean were observed by Mathur *et al.* (1971), Godara *et al*. (1995) in coriander and Singh and Choudhary (2008) in ajowain.

The study revealed that PCV was higher than the corresponding GCV for all the characters indicating that all characters had interacted with environment to some degree. High PCV and GCV were recorded for number of umbels (at 60 DAS and at harvest), number of umbellets per umbel at 60 DAS, number of seeds per umbellet at 60 DAS and at harvest, seed yield per plant, seed yield per hectare and harvest index indicating the existence of wider genetic variability for these traits in the genotypes under study. On the other hand, moderate to low variability was recorded for plant height, number of primary branches per plant, number of secondary branches per plant, number of leaves, days to first flowering, days taken to 50% flowering, days to maturity and 1000 seed weight.

High heritability coupled with high genetic advance as per cent of mean indicates the operation of additive gene action as observed in case of plant height at 60 DAS, number of leaves at (30 DAS and at harvest), number of primary branches per plant, number of secondary branches at 60 DAS, number of umbels per plant (at 30 DAS and at harvest), umbellets per umbel (60 DAS and at harvest), number of seeds per umbellet (60 DAS and at harvest), seed yield per plant (g), seed yield per hectare (q), harvest index and hence, direct selection based on these traits in genetically diverse material could be effective for desired improvement. Moderate genetic advance as per cent of mean with high or moderate heritability indicates the action of both additive and non-additive genes as computed in case of plant height (at 30 DAS and at harvest), number of secondary branches per plant, number of leaves at 60 DAS, days to first flowering, days taken to 50% flowering, days taken to maturity and thousand seed weight (g) and therefore selection based on these traits may not be of great advantage.

4.5 CORRELATION COEFFICIENT ANALYSIS

Correlation provides a measure of genetic association between the characters and reveals the traits that might be useful as an index of selection. All the changes in the components need not, however be expressed by changes in the yield. This is due to varying degrees of positive and negative correlations between yield and its components and among the components themselves. A study of association of these characters helps in selection of genotypes and also suggests the advantage of a selection scheme for more than one character at a time, which could be explained that improvement of one character results in improvement of all positively related characters. In the present study, the simple correlation coefficients between yield and its components and their inter correlations among the components were estimated.

The phenotypic (P) and genotypic correlation (G) coefficients were worked out for twenty three characters in coriander and the results are presented in Table 4.13. In general, it was observed that genotypic correlation coefficients were higher than that of phenotypic correlation coefficients. This could be interpreted on the basis that there was a strong inherent genotypic relationship between the characters studied, but their phenotypic expression was impeded by the influence of environmental factors.

4.5.1 Plant height (cm)

Plant height at 30 DAS showed positive and significant correlations with plant height at 90 DAS (0.198 G) at genotypic level, days to maturity(0.277 P, 0.357G), number of umbels at 60 DAS (0.237 P, 0.364 G), umbellets at 60 DAS (0.228P, 0.319G), umbellets per umbel at harvest (0.231P, 0.361G) and negative significant correlation with first flowering (-0.259P, -0.405G), days to 50% flowering (-0.319P, -0.372G), 1000 seed weight (-0.196P, -0.401G).

Plant height at 60 DAS recorded significant positive association with plant height at harvest (0.271 G), number of secondary branches at harvest (0.257G), number of seeds per umbellet at 60DAS(0.200G) only at genotypic level, seed yield per plant (0.203P, 0.273G), seed yield per hectare (0.208P, 0.621G), harvest index (0.341P, 0.417G) at both genotypic and phenotypic levels. However, the trait had significant negative correlation with days to first flowering (-0.2523P, -0.275P), days taken to 50% flowering (-0.252P, -0.291G).

Plant height at harvest recorded significant positive association with number of leaves at harvest (0.398P, 0.644G), number of primary branches at 60DAS (0.348P, 0.570G), number of primary branches at harvest (0.394P, 0.692G), number of secondary branches at 60DAS (0.377P, 0.652G), number of secondary branches at harvest (0.406P, 0.780G), number of umbels at 60 DAS (0.350P, 0.441G), number of umbels at harvest (0.206P, 0.267G), number of umbellets at 60 DAS (0.337P, 0.521G), number of umbellate at harvest (0.293P, 0.439G), seed yield plant $^{-1}$ (0.441P, 0.718G), seed yield hectare^{-1} (0.535P, 0.702G), harvest index (0.236P, 0.341G) at both genotypic and phenotypic levels. However, the trait had significant negative correlation with days to first flowering (-0.406P, -0.326P), days taken to 50% flowering (-0.410P, -0.325G) and days to harvest (-0.262G) only at genotypic level.

Positively significant association of plant height was also reported by Anubha *et al.* (2013), Mengesha *et al.* (2013), Meena *et al.* (2014), and Sravanthi *et al.* (2014)

for grain yield plant^{-1}, Mourya *et al.* (2015) for number of branches plant^{-1}, Dhirendra *et al.* (2006) and Sravanthi *et al.* (2014) for branches plant^{-1}, number of umbels plant^{-1}, number of umbellets umbel^{-1} in coriander and for thousand seed weight, grain yield per plant and harvest index by Mourya *et al.* (2015) and plant height was found to have positively significant correlation for days to maturity as observed by Prajapathi *et al.* (2010) in fenugreek.

4.5.2 Number of leaves

The data pertaining to number of leaves at 30 DAS are positive and significantly correlated for number of leaves at 60 DAS and at harvest (0.688P, 0.843G) and (0.488P, 0.633G) respectively, secondary branches at 60 DAS (0.254P, 0.283G), seed yield per plant (0.195G) at genotypic level seed yield per hectare (0.287P, 0.332G) and negatively and significantly correlated with number of seed per umbellet at 60 DAS (-0.198P, -0.218G).

Number of leaves at 60 DAS recorded positive and significant effect for leaves at harvest (0.527P, 0.769G) and secondary branches at 60 DAS (0.242P), seed yield per hectare (0.198P) only at phenotypic level and seed yield per plant (0.255G) at genotypic level only. At harvest number of leaves are significantly and positively correlated for secondary branches at 60 DAS and at harvest (0.348P, 0.491G), and (0.284P, 0.646G) respectively, umbels at 60 DAS (0.216P, 0.301G), seed yield per plant (0.332P, 0.550G), seed yield per hectare (0.319P, 0.412G), harvest index (0.237P, 0.311G) and umbellets per umbel at 60 DAS (0.236P) at phenotypic level. Primary branches at 60 DAS varying only at genotypic level (0.605G).

4.5.3 Number of primary branches

The character exhibited significant and positive correlation at 60 DAS with number of primary branches per plant at harvest (0.362P, 1.02G), secondary branches plant^{-1} at 60 DAS (0.400P, 0.620G), number of secondary branches plant^{-1} at harvest (0.291P, 0.490G), number of umbels at 60 DAS (0.413P, 0.318G), number of umbellet umbel^{-1} at 60DAS (0.439P, 0.531G), number of umbellets umbel^{-1} at harvest (0.298P, 0.434G), seed yield per plant (0.233P, 0.345G), seed yield hectare^{-1} (0.291P, 0.393G). Number of umbellets per umbel at harvest (0.2449G) only at genotypic level.

Negative positive correlation is observed for days to first flowering (-0.321P, -0.491G), days to fifty percent flowering (-0.411P, -0.509G).

The character exhibited positive and significant correlation at harvest for number of primary branches per plant at harvest for secondary branches per plant at 60DAS (0.282P, 1.005G), secondary branches at harvest (0.298P, 1.05G), number of umbellet per umbel at 60DAS (0.245P, 0.630G), seed yield per hectare (0.213P, 0.625G) and umbellets per umbel at harvest (0.391G),seed yield per plant (0.648G), 1000 seed weight (0.241G), harvest index (0.414G) and negative and significantly correlated for days to maturity (-0.208P, -0.439G).

Similar positive association of number of primary branches per plant was also reported by Banerjee and Kole (2004) and Mourya *et al*. (2015) in fenugreek for grain yield per plant, Nilkolay and Boryana (2014) for number of umbels per plant, fruit weight per plant and umbellets per umbel at genotypic level by Sharma *et al*. (2015) in fennel.

4.5.4 Number of secondary branches

Number of secondary branches per plant at 60 DAS recorded positive and significant correlation effect with secondary branches per plant at harvest (0.471P, 0.974 G), number of umbellets per umbel at 60 DAS (0.345P, 0.545G), number of umbellets at harvest (0.263P, 0.407G), number of seeds per umbellet at harvest (0.231P, 0.289G), seed yield per plant (o.278P, 0.498G), seed yield per hectare (0.4593P, 0.561G) and number of seeds per umbellet at 60 DAS (0.229G), thousand seed weight (0.1930G), harvest index (0.209) only at genotypic level. Whereas, negative and significant correlation is noticed for days to first flowering (-0.197P, -0.252G) and days to fifty percent flowering (-0.213G) at genotypic level.

At harvest, secondary branches per plant recorded positive and significant correlation for seed yield per plant (0.262P, 0.552G), seed yield per hectare (0.3091P, 0.5408G) and at only genotypic level umbels per plant at 60DAS (0.2434G), umbellet per umbel (0.246G), number of seeds at 60DAS (0.212G), number of seeds at harvest (0.191G). Similar results are reported by Dhirendra singh *et al.* (2006) and Ali *et al.* (1993) in coriander and Sharma *et al*. (2015) in fennel for seed yield per hectare.

4.5.5 Days to first flowering

Association of days to first flowering was exhibited positive and significant with days to 50% flowering (0.941P, 0.983G), days to maturity (0.2407P, 0.2738G) and negatively correlated for umbellets per umbel at harvest (-0.2495P, -0.3183G), seed yield per hectare (-0.293P, -0.315G) and seed yield per plant (-0.253G) at genotypic level only at 5% LOS.

4.5.6 Days to 50% flowering

This trait had significant and positive correlation with days taken to maturity (0.299P, 0.342G), and negatively correlated for umbellets at 60 DAS(-0.2495P, -0.290G), see yield per hectare (-0.233P, -0.252G), whereas seed yield per plant (-0.2061G) and umbellets per umbel at harvest (-0.2061G) at genotypic level. These findings are in agreement with the earlier findings of Shridhar *et al.*(1990) Dhirendrasingh *et al.* (2006) and Sravanthi *et al*. (2014) in coriander, Patahk *et al*. (2014) in fenugreek, for positive correlation with seed yield. Negative association of this trait with seed yield was in accordance with the results of Anubha *et al.* (2013) and Kailashchandra *et al.* (2000) in fenugreek.

4.5.7 Days taken to maturity

Days to maturity has recorded positive significant correlation with number of seeds at harvest (0.205G) at genotypic level and non significant results were obtained with respect to seed yield per plant. Similar findings were reported by Yogendra *et al*. (2013) and Meena *et al*. (2010) in fenugreek.

4.5.8 Number of umbels per plant

Number of umbels per plant at 60 DAS has shown positive and significant relation for this trait with umbels at harvest (0.843P, 0.897G), umbellets at 60DAS (0.325P, 0.391G), umbellets per umbel at harvest (0.282P, 0.322G) , number of seeds at 60 DAS (0.282P, 0.305G), seed yield per plant (0.302P, 0.390G), seed yield per hectare (0.285P, 0.304G) and secondary branches at 60 DAS (0.243G) and seeds per umbellet at harvest (0.220G) only at genotypic level.

Number of umbels at harvest found significant and positive correlation with umbellets per umbel at 60 DAS (0.348P, 0.423G) and at harvest (0.331P, 0.419P), number of seeds per umbellet at 60 (0.286G, 0.248P) and at harvest (0.215P, 0.284G) and seed yield per plant (0.277 P, 0.323G)

Similar results are reported by Shridhar *et al.* (1990), and Dhirendra singh *et al.* (2006), in coriander and Kailashchandra *et al.* (2000) fenugreek. Meena *et al*. (2014) in coriander observed positive correlation of number of umbels per plant with seed yield per plant.

4.5.9 Number of umbellets per umbel

At 60 DAS, number of umbellets per umbel at 60 DAS has recorded significant and positive correlation with number of umbellets per umbel at harvest (0.8072P, 0.995G), number of seeds per umbellet at 60 DAS (0.3020P, 0.953G) and at harvest (0.331P, 0.380G), seed yield per plant (0.315P, 0.466G), seed yield per hectare (0.301P, 0.360G) and1000 seed weight (0.199P) at phenotypic level.

Number of umbellets per umbel at harvest varied positively significant with number of seeds per umbellet at 60 DAS (0.278P, 0.344G), number of seeds per umbellet at harvest (0.311P, 0.406G), seed yield per plant (0.208P, 0.438G), seed yield per hectare (0.194P, 0.256G).

Mengesha *et al*. (2013), Jindla *et al*. (1985) also reported a positive association of days to flowering, plant height, umbels plant^{-1}, umbellets umbel^{-1} and seed umbel^{-1} with seed yield in coriander. Singh and Mittal (2003) similary reported positive and significant association of number of umbel plant^{-1} with seed yield per plant in sweet fennel. Hence, selection of coriander plants having these features will facilitate coriander seed yield improvement.

4.5.10 Number of seeds per umbellet

Number of seeds per umbellet at 60 DAS showed highly significant and positive correlation with number of, seed yield per plant (0.247P, 0.3359G) thousand seed weight (0.262P, 0.335G) at both genotypic and phenotypic levels and seeds per umbellet at harvest 0.864P at phenotypic level.

Number of seeds at harvest found significant and positive correlation with harvest index (0.2491P, 0.334G) and seed yield per plant (0.292G), only at genotypic level. Similar results were obtained by Dhirendra singh *et al*. (2006) in coriander where number seeds are positively correlated with seed yield per plant at phenotypic level and significant and positive association with seed yield per plant at both genotypic and phenotypic levels. Similar results are reported by Singh *et al.* (2005) and Sravanthi *et al*. (2014) for seed yield per plant in coriander.

4.5.11 Harvest index

Harvest index showed positive and significant correlation with seed yield per plant (0.623P, 0.776G) at both phenotypic and genotypic level.

4.5.12 Seed yield per plant

This trait had significant positive association with plant height at (60 DAS and at harvest), number of leaves plant^{-1} (at harvest), number of primary branches plant^{-1} at 60 DAS), secondary branches plant^{-1} (60 DAS and at harvest), umbels plant^{-1} (60 DAS and a harvest), umbellets plant^{-1}(60 DAS and at harvest), Seeds umbellet $^{-1}$, seed yield hectare^{-1} and harvest index at phenotypic level and genotypic level. These findings are in conformity with the earlier observations by Anubha *et al*. (2013) and Meena *et al*. (2014).

A positive correlation between desirable characters is favorable to the plant breeder because it helps in simultaneous improvement of both the characters. In the present study, genotypic correlation coefficients were found to be higher for most of the traits considered, indicating a strong inherent association between various characters and were masked by environmental component with regard to phenotypic expression.

The results on character association indicated significant positive association of yield with plant height, number of primary branches, number of secondary branches, number of umbels per plant, number of umbellets per umbel, number of seeds per umbellet, seed yield per hectare, 1000 seed weight indicated that the adequate knowledge of interrelationship between seed yield per plant and its components themselves is useful for selection and simultaneous improvement in these characters.

4.6 Path coefficient analysis

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

Path analysis was carried out at phenotypic and genotypic level considering seed yield per plant as dependent variable and its components *viz.,* plant height at 30 DAS, 60 DAS and at harvest, number of leaves plant^{-1} at 30, 60 DAS and at harvest, number of primary branches at 60 DAS and at harvest, number of secondary branches at 60 DAS and at harvest, days to first flowering, days to 50% flowering, days to harvest, number of umbels at 60 DAS and at harvest, number of umbellets at 60 DAS and at harvest, number of seeds per umbellet at 60 DAS and at harvest, seed yield per hectare, 1000 seed weight and harvest index (%).

Each component has two path actions *viz.,* direct effect on yield and indirect effect through components which are not revealed by correlation studies. The results are represented in Table (4. 14) (Fig 9 and 10).

4.6.1 Direct effects and indirect effects

4.6.1.1 Plant height (cm)

Plant height at 30 DAS showed low direct effect (0.105 P) on seed yield per plant at phenotypic level and negligible direct negative effect (-0.173) at genotypic level.

Plant height at 60 DAS showed negligible direct negative effect (-0.048P) on seed yield at phenotypic level and moderate direct negative effect (-0.2484G) at genotypic level.

This trait at harvest showed low positive direct effect at phenotypic level (0.108P) and negligible positive direct effect (0.040 G) at genotypic level on seed yield per plant. Similar results were obtained by Meena *et al*. (2014) and Sravanthi *et al*. (2014) in coriander for positive direct effect of plant height on seed yield per plant. Banerjee and Kole (2004) also reported negative indirect effects exerted by plant height on pod yield per plant via number of seed per pod in fenugreek and Pushpa *et al*. (2010) in fenugreek for plant height at maturity.

4.6.1.2 Number of leaves

Number of leaves at 30 DAS has recorded negligible negative direct effect (-0.079P) at phenotypic level and moderate positive direct effect (0.272G) at genotypic level. The trait at 30 DAS had moderate positive indirect effect on seed yield per plant through number of leaves at 60 DAS and at harvest.

At 60 DAS number of leaves has reported low positive direct effect (0.097P) at phenotypic level whereas high negative direct effect (-0.924G) at genotypic level. At harvest, number of leaves has recorded low positive direct effect (0.133P) at phenotypic level and very high positive direct effect on seed yield (1.180G) at phenotypic level. Number of leaves at 60 DAS had shown low positive indirect effect via primary branches at 60 DAS (0.173G), primary branches at harvest (0.122G) at genotypic level and seed yield per hectare negligible and low indirect effect (0.0194P, -0.176G) at phenotypic and genotypic level was noted.

Number of leaves at harvest recorded moderate positive indirect effect via primary branches at 60 DAS (0.1501G), very high and negligible effect at harvest (0.714G , 0.0236P), high and low effect through secondary branches at 60 DAS and at harvest (0.579G, 0.046P & 0.763G, 0.037P respectively) high effect umbels at 60 DAS (0.356G) and at harvest (0.1893) moderately, moderate effect through umbellets at 60 DAS (0.279G), high and low effect through seed yield per hectare (0.487G, 0.042P) and harvest index (0.367G) at genotypic level

4.6.1.3 Number of primary branches

Number of primary branches at 60 DAS had low direct positive effect at phenotypic level (0.168P) and low negative direct effect (-0.488G) at genotypic level on seed yield per plant. Similarly negligible indirect effect *viz.*, primary branches at harvest (0.0612 P) and high negative indirect effect (-0.502G) at phenotypic and genotypic level .

Number of primary branches per plant at harvest reported negligible direct effect on (-0.083P) seed yield per plant at phenotypic level and high direct positive effect (0.305G) at genotypic level.

4.6.1.4 Number of secondary branches

At 60 DAS, number of secondary branches per plant has recorded very low and high direct negative effect (-0.032P, -0.921G) respectively, on seed yield per plant at phenotypic and genotypic level.

Number of secondary branches per plant at harvest exhibited negligible positive direct effect and high negative direct effect (0.0012P, -0.312G) at phenotypic and genotypic level respectively, on seed yield per plant.

4.6.1.5 Days to first flowering

Days to first flowering showed low and very high direct positive effect (0.118P, 2.442G) on seed yield per plant at phenotypic and genotypic level.

The trait exhibited high positive indirect effect on seed yield per plant through days taken to maturity (0.668), low positive effect for days to 50% flowering (0.1082G) at genotypic level.

4.6.1.6 Days to 50% flowering

Days to 50% flowering had recorded negligible and very high negative (0.002P, -2.4764G) direct effect on seed yield per plant at phenotypic and genotypic level. At the genotypic level, high negative indirect effect *via* days taken to maturity (-

0.848) and low positive indirect effects *via* harvest index (-0.189), high indirect effect for seed yield per hectare (0.624) on seed yield per plant, umbels at 60 DAS and at harvest (0.720 and 0.498) at high level.

4.6.1.7 Days to maturity

Days to maturity exhibited low negative and high positive (-0.153P, 0.469G) direct effect at phenotypic and genotypic level on seed yield per plant. At genotypic level negative indirect effect was recorded *via*., umbels at harvest (0.038), seed yield per hectare (0.0128) and thousand seed weight (-0.0615).

4.6.1.8 Number of umbels per plant

Number of umbels per plant at 60 DAS, high negative (0-0.309P) and negative (-0.176G) direct effect at phenotypic and genotypic level**.** At harvest high positive (0.344P) and moderate negative (-0.268G) direct was observed for phenotypic and genotypic path matrix on seed yield per plant. It exerted low positive indirect effects *via* umbellets per umbel at 60 DAS (0.119) and at harvest (0.114) and fresh weight (0.124), and negligible positive indirect effect via seeds per umbellet at harvest (0.074), seed yield per hectare. Similar results were obtained by Mourya *et al*. (2015) in fenugreek for grain yield per plant for exertion of direct effects on grain yield per plant.

4.6.1.9 Number of umbellets per umbel

Number of umbellets per umbel at 60 DAS recorded low positive (0.183P) and very high positive (1.25G) direct effect at phenotypic and genotypic levels on dependent variable respectively. It showed low positive indirect effects through umbellets at harvest (0.147), and negligible positive direct effect on seeds per umbellet at 60DAS, seeds per umbellet at harvest (0.060), seed yield per hectare (0.055), thousand seed weight (0.036) and harvest index (0.017).

Number of umbellets per umbel at harvest found negative low direct effect (-0.126P) and very high negative (-1.041G) at phenotypic and genotypic level. It showed negligible negative indirect effects through number of seeds at harvest (0.039) and seed yield per plant (-0.024).

4.6.1.9 Number of seeds per umbellet

Number of seeds per umbellet at 60 DAS recorded low positive (0.193P) and high positive (0.296G) direct effect at phenotypic and genotypic levels on dependent variable respectively.

Number of seeds per umbellet at harvest found negative low direct effect (-0.052P) and high positive (0.279G) at phenotypic and genotypic level on dependent variable. However, it exerted a negligible positive indirect effect *via* umbels per plant at harvest (0.058) and low negative indirect effect *via* 1000 seed weight (-0.013) at genotypic level only. Similar results were obtained by Patahk *et al*. (2014) in fenugreek for grain yield per plant for exertion of direct effects on grain yield per plant.

4.6.1.10 Thousand seed weight

Thousand seed weight recorded negligible negative direct (-0.090P) at phenotypic level and high positive direct effect (0.383G) on seed yield per plant. It also showed the positive indirect effect through the number of primary branches at 60 DAS (0.032), number of umbels per plant at at harvest (0.014), number of umbellets per umbel at 60 DAS (0.036P),and number of seeds at 60 DAS (0.050P, 0.107G), at genotypic and phenotypic level and number of seeds at harvest (0.093P) at phenotypic level. Similar reports were found by Singh *et al*. (2005) in coriander and Mourya *et al*. (2015) in fenugreek for grain yield per plant for exertion of direct effects on grain yield per plant.

4.6.1.11 Seed yield per hectare

Seed yield per hectare reported high (0.333P) and very high (1.649G) positive direct effect on seed yield per plant at phenotypic and genotypic level.

4.6.1.12 Harvest index

Harvest index recorded high positive direct effect (0.365P) at phenotypic level and high negative direct effect (-0.597G) on seed yield per plant.

It also showed the positive indirect effect through the plant height, number of leaves at harvest, number of seeds at 60 DAS and seed yield per hectare genotypic and phenotypic level. It also showed the positive indirect effect through the test weight at genotypic level. These results are in accordance with findings of Singh *et al.* (2005), Abhay *et al.* (2011), Saha and Kole (2001), in coriander and fenugreek.

In plant breeding, it is very difficult to have complete knowledge of all component traits of yield. The residual effect permits precise explanation about the pattern of interaction of other possible components of yield. In other words, residual effect measures the role of possible independent variables which were not included in the study of dependent variable.

The path analysis indicated that plant height at harvest, number of leaves (at 30 DAS and at harvest), number of secondary branches per plant at harvest, days to first flowering, days to maturity, number of umbellets per umbel at 60 DAS, number of seeds per umbellet at 60 DAS and seed yield per hectare had direct positive effects on fruit yield per plant at phenotypic and genotypic levels.

Based on the results of path analysis, the present study revealed that major emphasis should be laid on selection process with more number of leaves, number of umbels per plant, number of umbellets per umbel, number of seeds per umbellet, days taken to maturity and harvest index and there should be economic balance among these traits to get higher seed yield per plant.

In view of the above, in addition to the phenotypic diversity, the mean performance, seed yield was considered in selecting the germplasm lines for further studies. Accordingly, genetically divergent and horticulturally superior lines with optimal or intermediate level of diversity *viz.,* IC-512365, IC-424455, IC-553117, IC-421974 germplasms and for early yield IC-574534 germplasm can be used as parents in future breeding programmes following direct selection.

CHAPTER V

SUMMARY AND CONCLUSIONS

CHAPTER V

SUMMARY AND CONCLUSIONS

In the present investigation entitled "Genetic divergence for yield and its components in indigenous collection of Coriander (*Coriandrum sativum* L.) germplasm", thirty five coriander germplasm lines were evaluated in a Randomized Block Design with three replications at the PG Research Block, College of Horticulture, Sri Konda Laxman Telangana State Horticultural University, Rajendranagar during *rabi,* 2016-17 for twenty three characters *viz.,* plant height at 30, 60 DAS, at harvest (cm), number of leaves at 30, 60 DAS, at harvest, number of primary and secondary branches per plant at 60 DAS, at harvest, days to first flowering, days to 50% flowering, days to maturity, number of umbels per plant at 60 DAS, at harvest, number of umbellets per umbel at 60 DAS, at harvest, number of seeds per umbellet at 60 DAS, at harvest, seed yield per plant (g), seed yield per hectare (q), 1000 seed weight (g) and harvest index (%).The mean data was analyzed following standard statistical techniques with the objective of studying the nature and magnitude of genetic diversity available in the germplasm, the degree and direction of relationship between yield and its component characters and the direct and indirect effects of various component characters on yield. The genetic analysis to assess the variability, heritability, genetic advance as per cent of mean, magnitude of association between characters, their inter dependence, direct and indirect effect of traits on yield, existence of genetic diversity and relative contribution to divergence were estimated.

Mahalanobis D^2 analysis established the presence of wide genetic diversity between 35 genotypes by the formation of seven clusters. The maximum intra cluster distance was shown by cluster I. High inter cluster distance was observed between cluster IV and V and minimum between cluster II and III. Therefore, the genotypes belonging to cluster I and of clusters IV and V may be considered for inclusion in any hybridization programme for getting good seggregants. The mode of distribution of genotypes from different eco- geographical regions into various clusters was at random indicating that geographical distribution and genetic diversity were not related. Therefore, the selection of genotypes to widen the diversity or to generate new gene combinations should be based on genetic diversity rather than ecological geographic diversity.

Number of umbels per plant at harvest contributed maximum towards divergence followed by days to harvest, seed yield hectare^{-}1, days to first flowering, number of umbels plant^{-1} at 60 DAS, number of seeds umbellet^{-1} at harvest, harvest index, seed yield plant^{-1}, number of seeds umbellet^{-1} at 60 DAS, number of umbellets umbel^{-1} at 60 DAS, plant height at 60 DAS, 1000 seed weight, number of leaves at 60 DAS and days to fifty percent flowering. Therefore, a plant breeder may consider the above aspects while developing superior varieties and hybrids.

The genotypic and phenotypic coefficient of variations were high for umbels plant^{-1} (60 DAS and at harvest), umbellets umbel^{-1} at 60 DAS, number of seeds umbellet^{-1} (60 DAS and at harvest), seed yield plant^{-1} and seed yield hectare^{-1} indicating the existence of wider genetic variability for these traits in the genotypes under study and showing ample scope for selection of these characters.

High heritability coupled with high genetic advance as percent of mean was observed in plant height at 60 DAS, number of leaves (60 DAS and at harvest), primary branches plant^{-1} (60 DAS and at harvest, secondary branches plant^{-1} (60 DAS and at harvest), number of umbels plant^{-1} (60 DAS and at harvest). Number of umbellets plant^{-1}, seeds umbellet^{-1} (60 DAS and at harvest), seed yield plant^{-1}, seed yield hectare^{-1} and harvest index indicating contribution of additive gene effects in the expression of these traits. Therefore improvement can be done through direct selection to select better genotypes for coriander.

Correlation study indicated that genotypic correlation coefficients were higher than phenotypic correlation coefficients indicating lesser phenotypic expression under the influence of environment. Harvest index, seed yield hectare^{-1}, seed umbellet^{-1}, umbellet umbel^{-1}, umbels plant^{-1}, number of primary branches and secondary branches, number of leaves, plant height registered a positive and significant correlation at both phenotypic and genotypic levels with seed yield plant^{-1} signifying the importance of these traits in selection for yield and can be identified as yield attributing characters.

Path coefficient analysis showed that the character, plant height at harvest, number of leaves at harvest, days to first flowering, umbellets at 60 DAS, number of umbellets umbel^{-1} at 60 DAS, seeds umbellet^{-1} at 60 DAS and seed yield per hectare exhibited high positive direct selection based on this trait will be rewarding for yield improvement.

In conclusion, IC-512365, IC- 424455, IC- 553117 and IC- 421974 for different growth components and for early yield IC-574534 were found superior genotypes and these can be used in different breeding programme for the development of superior coriander varieties for commercial cultivation.

FUTURE LINE OF WORK

1. From the present study, IC-512365, IC- 424455, IC- 553117, IC- 421974 and for early yield IC-574534 genotypes were found superior with respect to yield and majority of the yield components which can be used as a parental lines in breeding programmes for direct selection.
2. High yielding genotypes of present study can be evaluated in different geographical locations.
3. The genotypes can be screened further for pest and disease incidence.

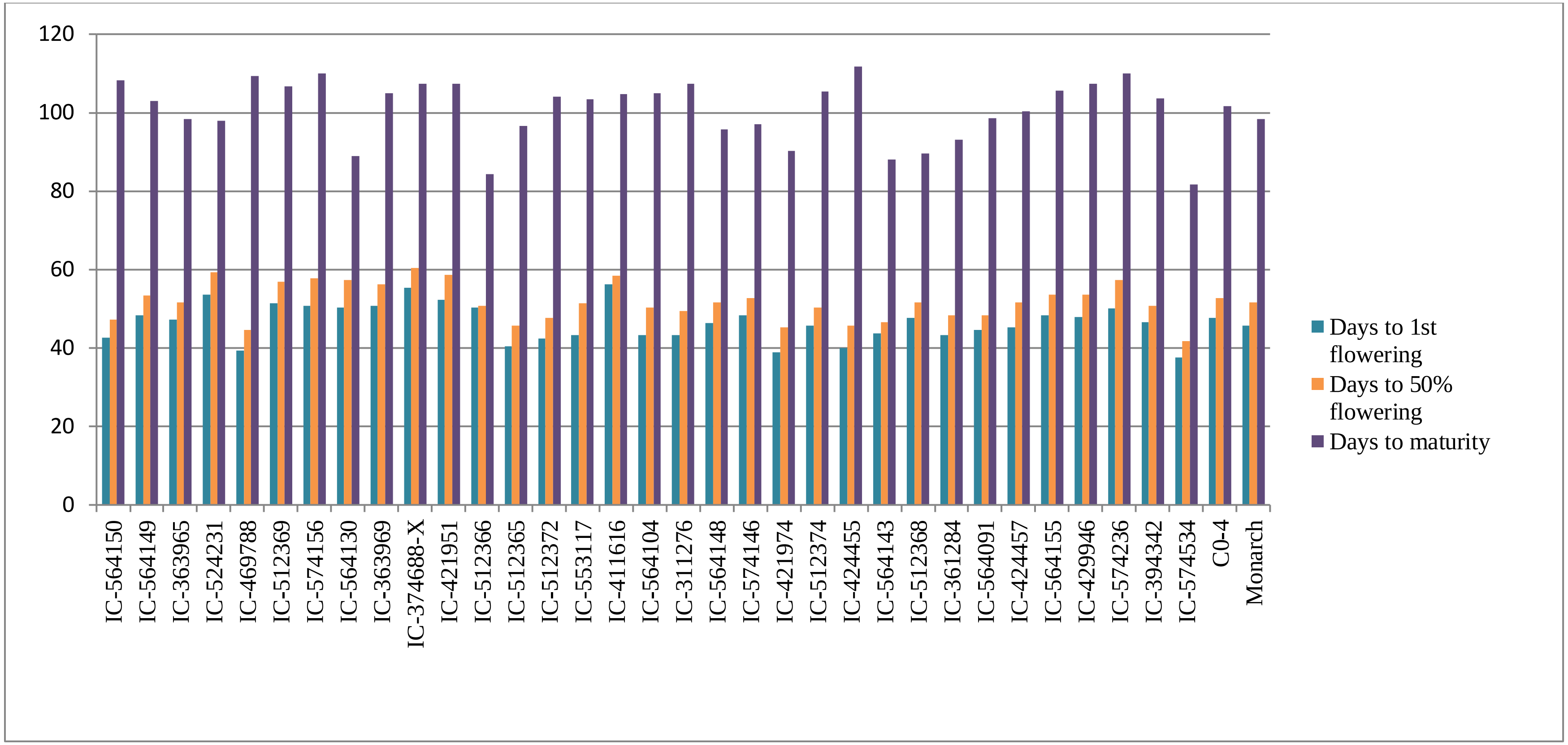


Fig 4.1: Mean values of days to first flowering, days to 50% flowering and days to maturity in 35 coriander genotypes.

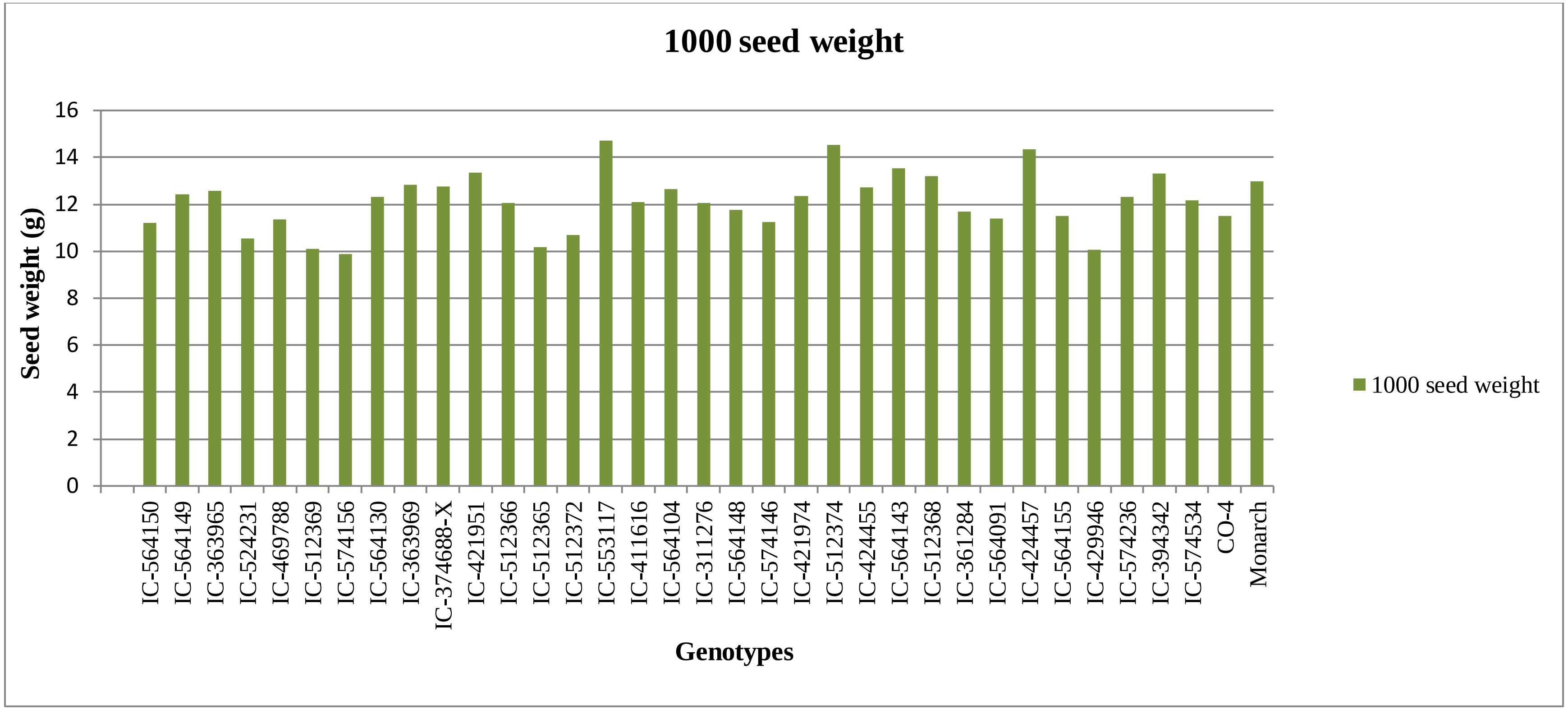


Fig 4.2: Mean values of 1000 seed weight in 35 coriander genotypes.

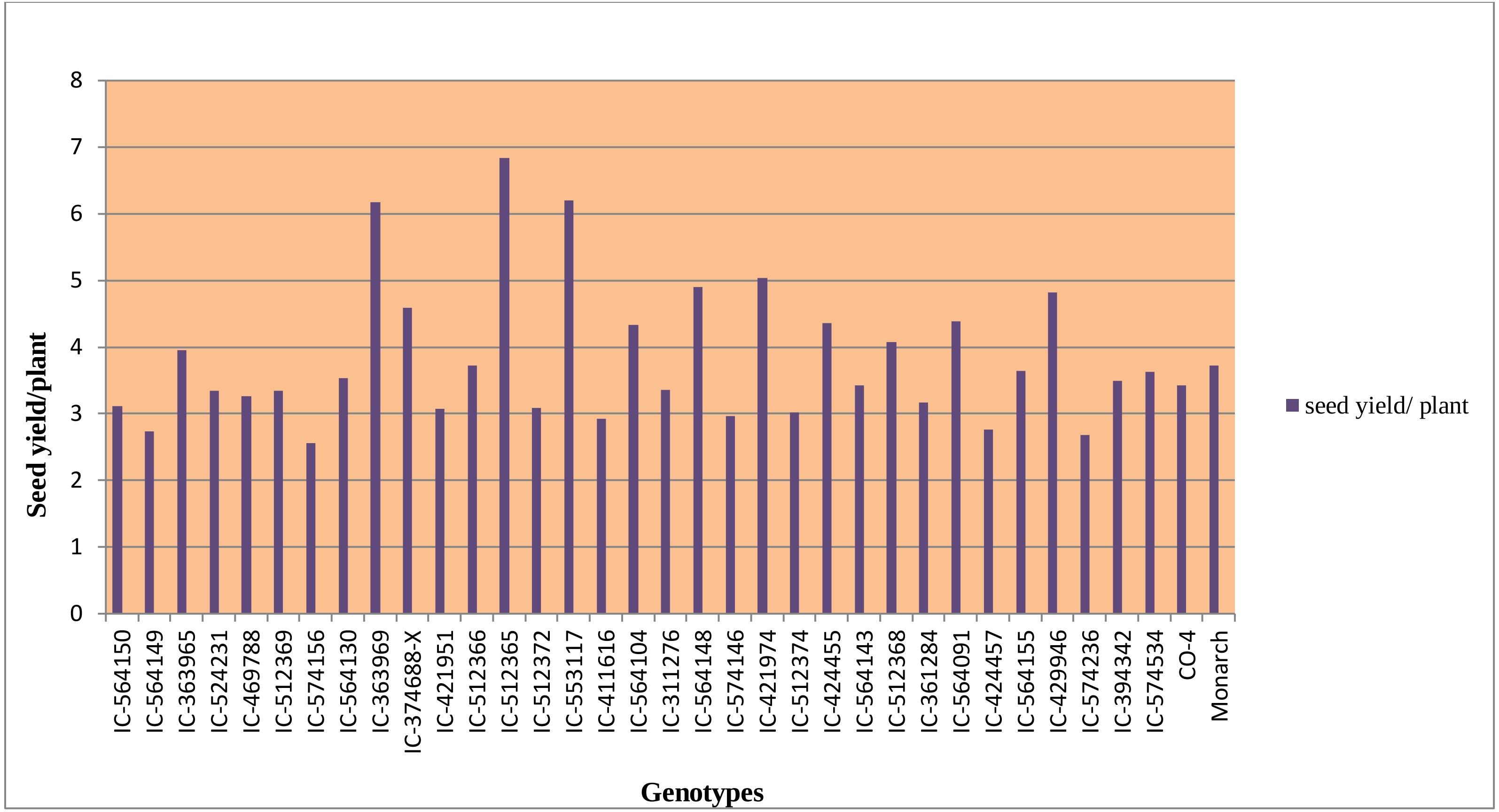


Fig 4.3: Mean values of seed yield per plant in 35 coriander genotypes.

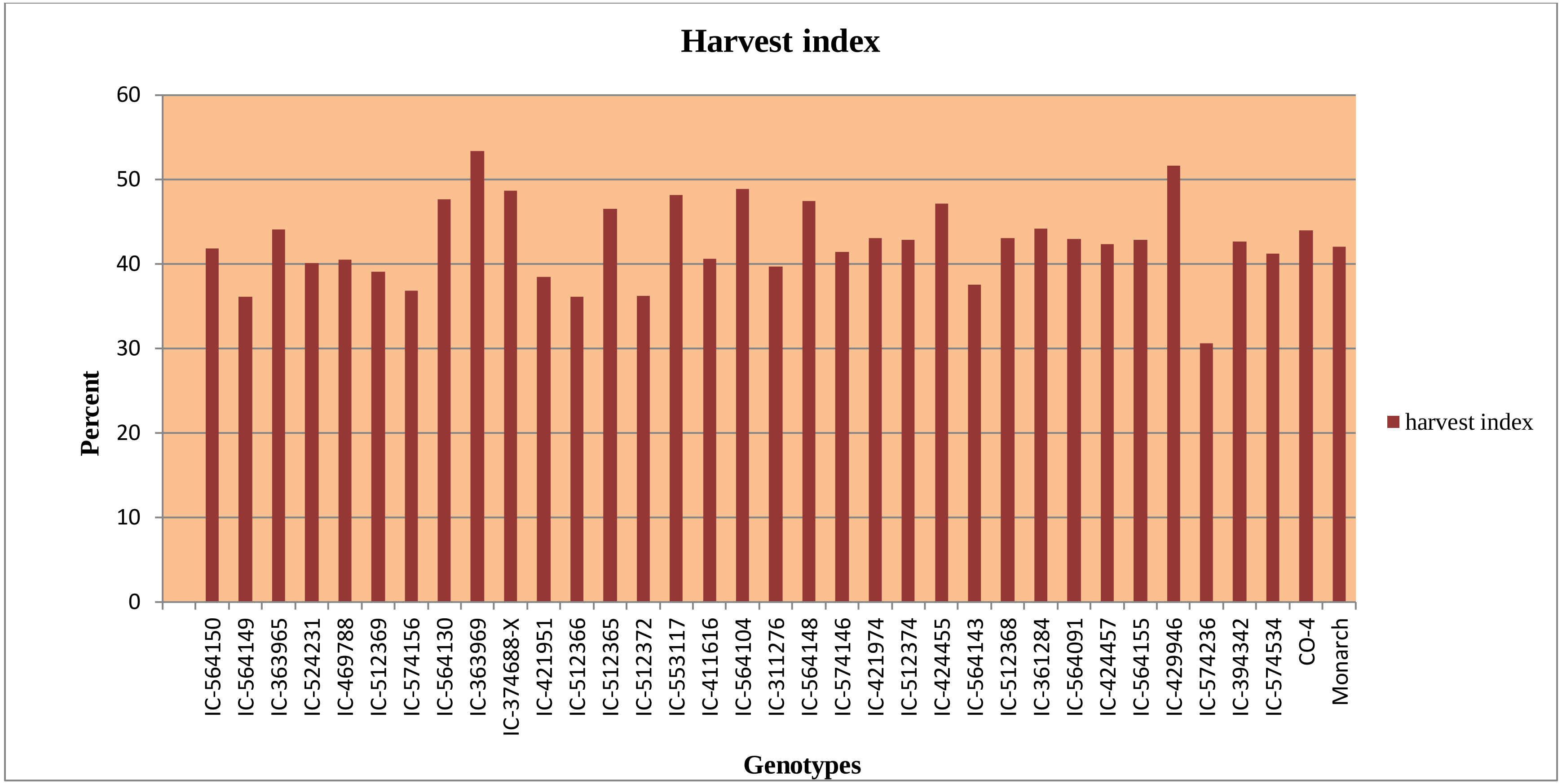
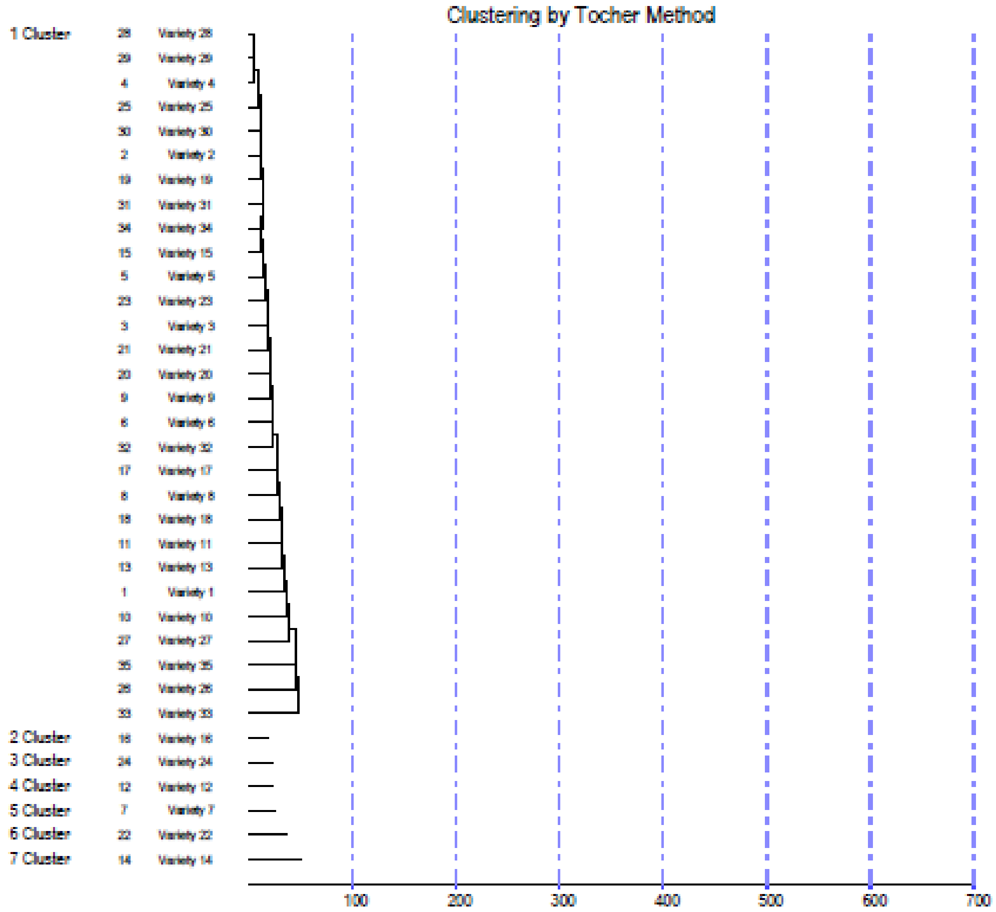
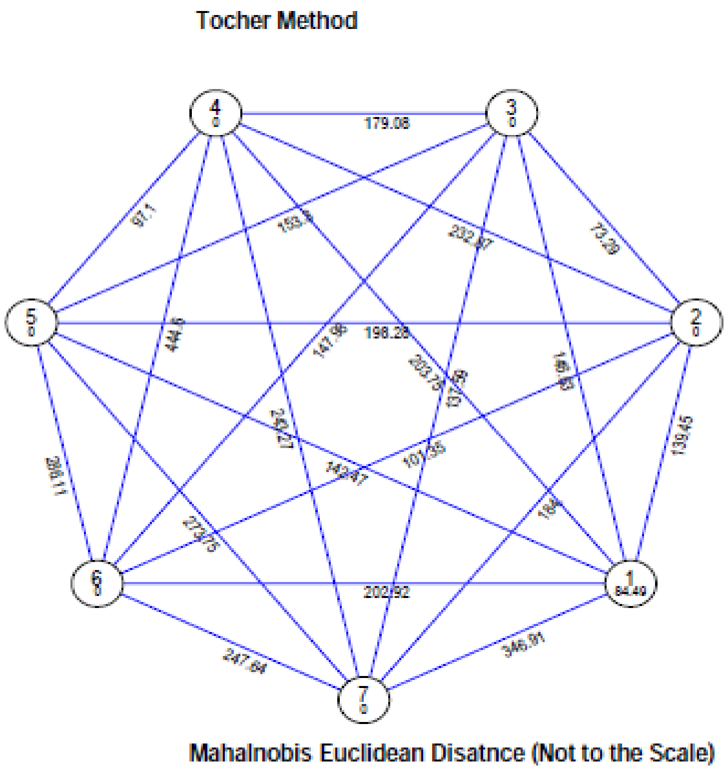


Fig 4.4: Mean values of harvest index in 35 coriander genotypes. Fig 4.5: Clustering pattern in coriander genotypes based on morphological characters



Clustering by Tocher Method
1 Cluster
28 Variety 28
29 Variety 29
4 Variety 4
25 Variety 25
30 Variety 30
2 Variety 2
19 Variety 19
31 Variety 31
34 Variety 34
15 Variety 15
5 Variety 5
23 Variety 23
3 Variety 3
21 Variety 21
20 Variety 20
9 Variety 9
6 Variety 6
32 Variety 32
17 Variety 17
8 Variety 8
18 Variety 18
11 Variety 11
13 Variety 13
1 Variety 1
10 Variety 10
27 Variety 27
35 Variety 35
26 Variety 26
33 Variety 33
2 Cluster
16 Variety 16
3 Cluster
24 Variety 24
4 Cluster
12 Variety 12
5 Cluster
7 Variety 7
6 Cluster
22 Variety 22
7 Cluster
14 Variety 14
100
200
300
400
500
600
700

Fig 4.6: Average intra and inter-cluster D^2 values for seven clusters in coriander genotypes. (Tocher's method)



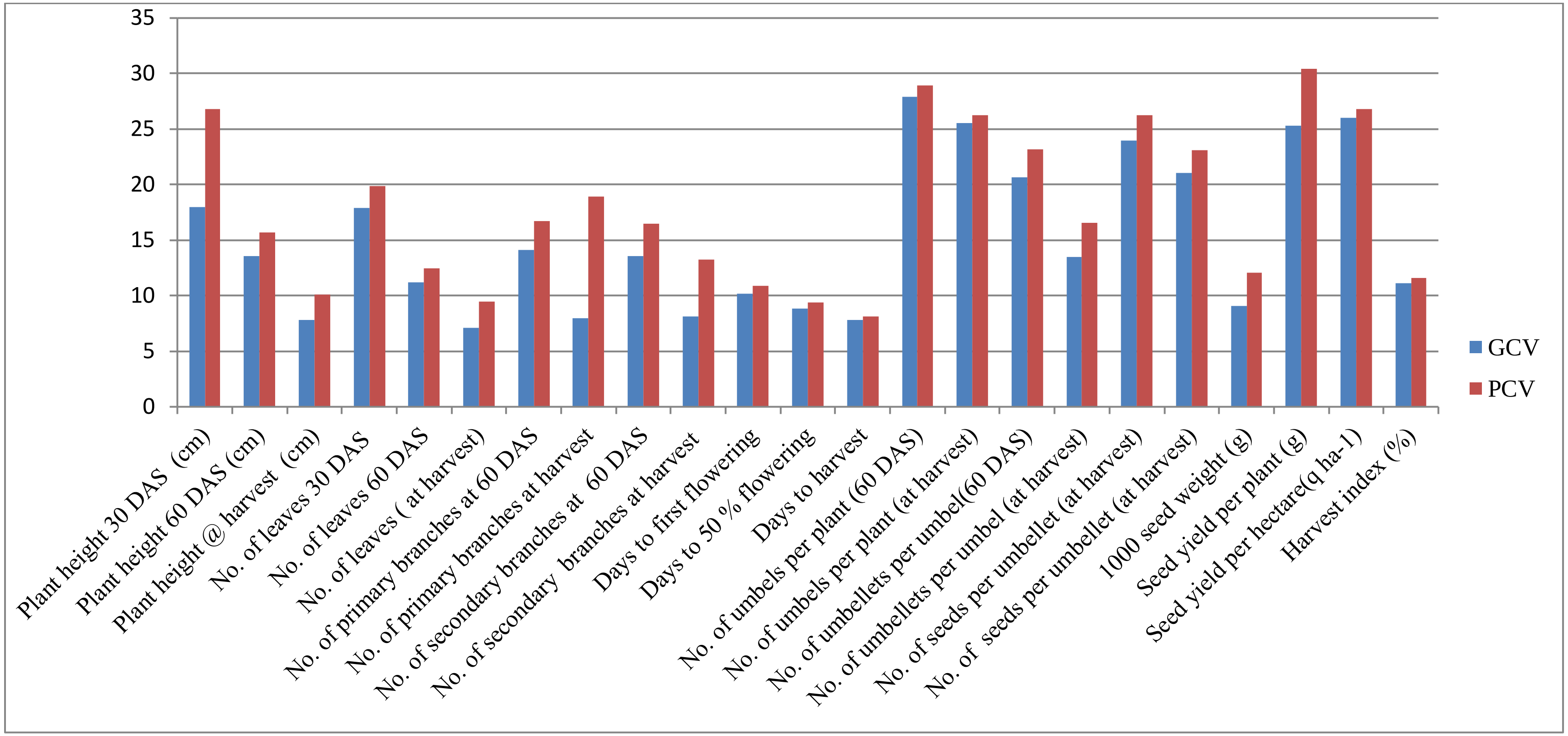


Fig 4.7: Estimates of PCV and GCV for twenty three characters in coriander genotypes

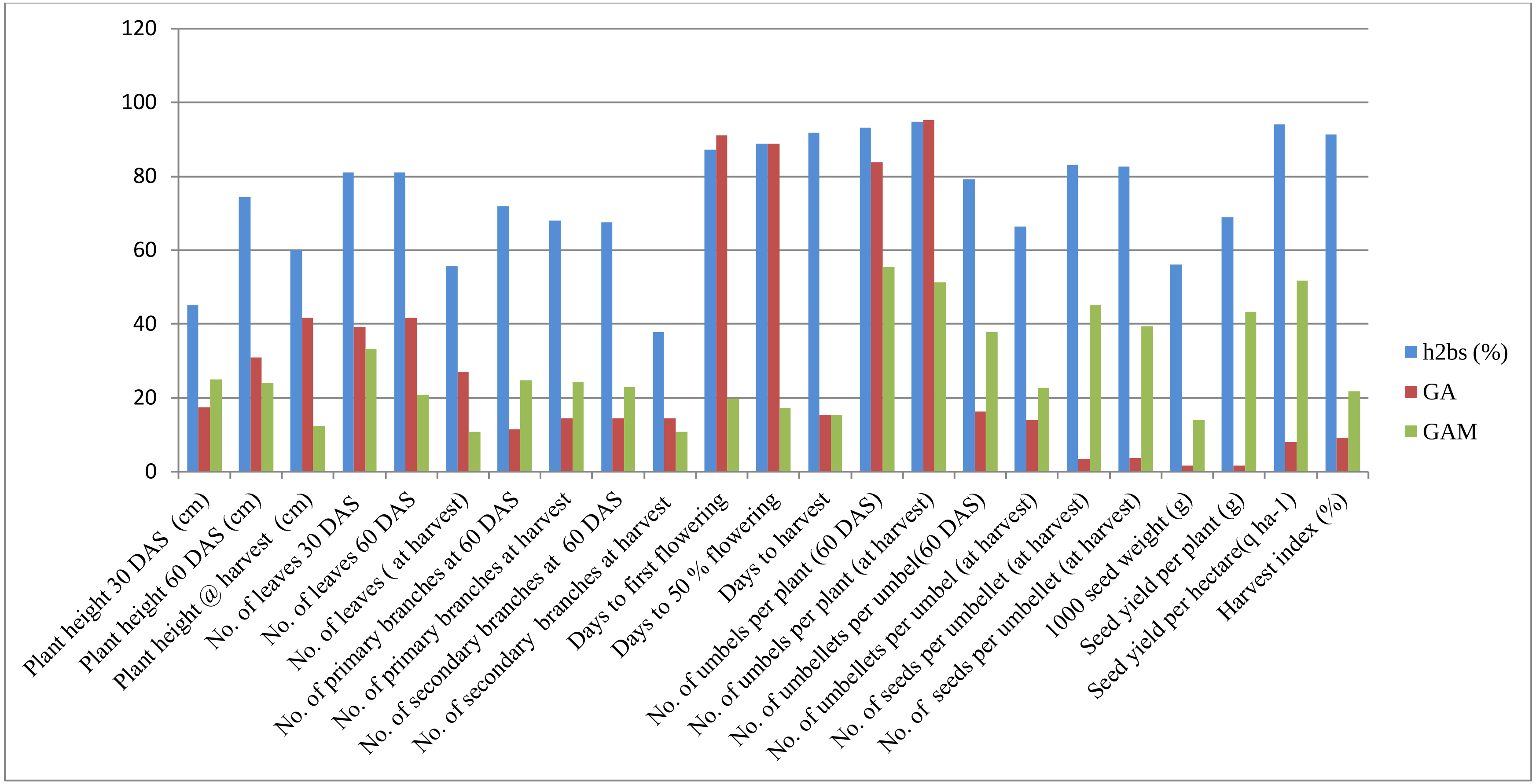


Fig 4.8: Estimates of heritability, genetic advance and genetic advance as percent of mean for twenty three characters in coriander genotypes

ig 4.9: Phenotypical path diagram for seed yield per plant

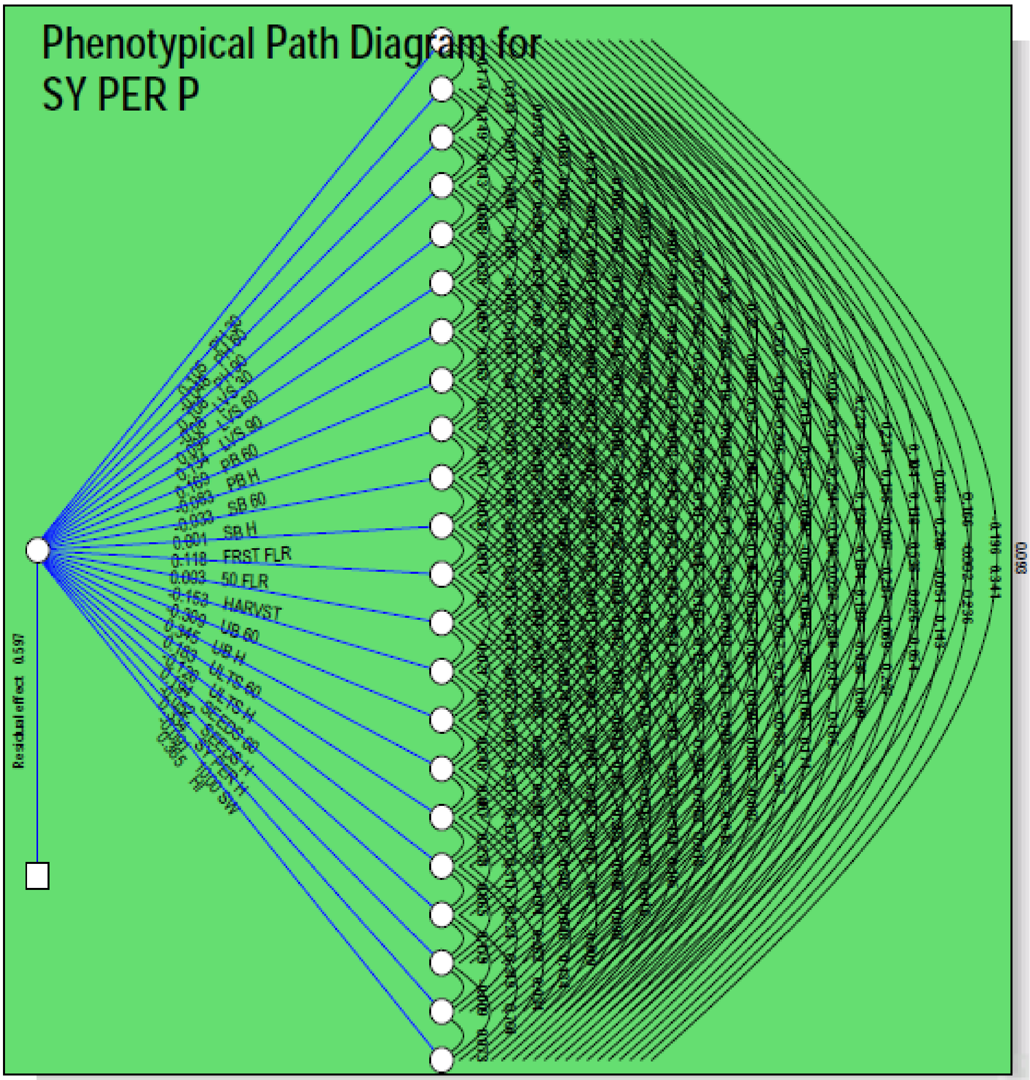
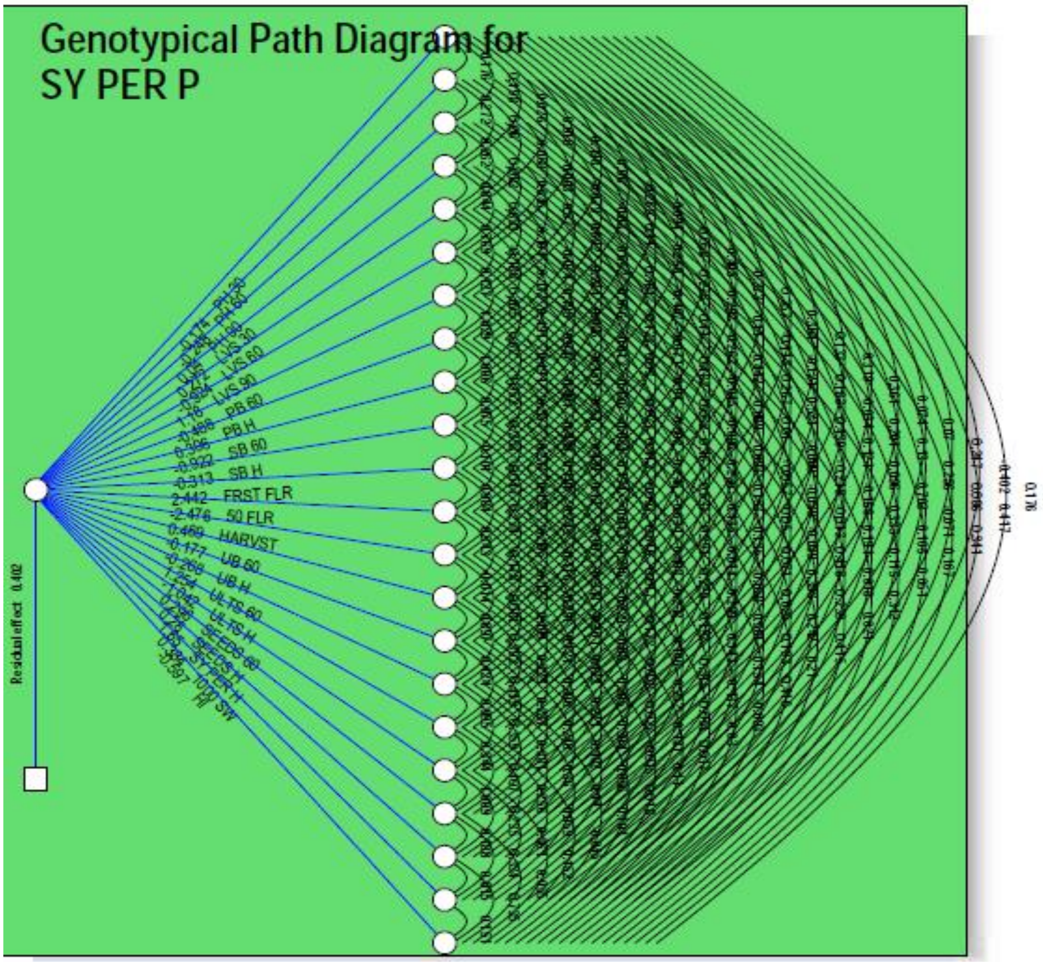


Fig 4.10: Genotypical path diagram for seed yield per plant



Genotypical Path Diagram for
SY PER P
PH 30
PH 60
PH 90
LVS 30
LVS 60
LVS 90
PB 60
PB H
SB 60
SB H
-0.922
-0.313
2.442 FRST FLR
-2.476 50 FLR
0.469 HARVST
-0.177 UB 60
-0.268 UB H
1.254 ULTS 60
ULTS H
SEEDS 60
SEEDS H
SY PER H
100 SW
HI
Residual effect 0.402

4.1View of promising genotypes at flowering stage

IC-512365

IC-553117

4.1 Contd..

IC-424455

IC-421974

4.1 Contd..

IC-574534

3.1 General view of the experimental plot at flowering stage

Table 4.1: ANOVA for yield and yield components in Coriander.

S. No	Character	Mean sum of squares		
		Replications (df =2)	Treatments (df=34)	Error (df =68)
1	Plant height 30 DAS (cm)	9.56	6.75**	1.94
2	Plant height 60 DAS (cm)	13.47	10.21**	1.05
3	Plant height @ harvest (cm)	10.15	25.13**	4.55
4	No. of leaves 30 DAS	1.42	14.44**	1.04
5	No. of leaves 60 DAS	9.68	16.38**	1.18
6	No. of leaves (at harvest)	8.42	11.72**	2.46
7	No. of primary branches (60 DAS)	0.02	1.50**	0.17
8	No. of primary branches (at harvest)	0.76	1.73**	1.04
9	No. of secondary branches at (60 DAS)	1.69	2.57**	0.35
10	No. of secondary branches (at harvest)	22.08	5.99**	2.12
11	Days to first flowering	20.06	70.59**	3.25
12	Days to 50 % flowering	4.15	65.70**	2.65
13	Days to harvest	42.20	189.15**	5.44
14	No. of umbels per plant (60 DAS)	9.21	54.57**	1.31
15	No. of umbels per plant (at harvest)	3.05	69.14**	1.25
16	No. of umbellets per umbel (60 DAS)	5.28	2.53**	0.20
17	No. of umbellets per umbel (at harvest)	9.00	2.43**	0.35
18	No. of seeds per umbellet (60 DAS)	0.93	11.10**	0.70
19	No. of seeds per umbellet (at harvest)	1.83	12.95**	0.85
20	1000 seed weight	1.52	4.55**	0.94
21	Seed yield per plant (g)	0.974	3.22**	0.41
22	Seed yield per hectare(q)	15.27	51.19**	1.11
23	Harvest index	8.95	69.15**	2.10

Significant at 1% level= **

4.2 Mean values of plant height and number of leaves (30, 60 DAS and @ harvest) in 35 coriander genotypes.

Sl. No	Genotypes	Plant height (cm)			Number of leaves		
		30 DAS	60 DAS	@ Harvest	30 DAS	60 DAS	@ Harvest
1	IC-564150	7.35	14.18	32.12	8.80	16.80	22.06
2	IC-564149	7.33	12.84	30.40	12.06	21.73	24.20
3	IC-363965	5.72	13.5	30.36	13.4	22.46	25.66
4	IC-524231	4.34	9.26	32.35	11.60	20.13	24.80
5	IC-469788	9.49	11.3	31.68	12.53	22.33	25.73
6	IC-512369	8.31	11.71	31.35	17.26	25.40	27.26
7	IC-574156	6.42	11.92	32.61	9.33	15.76	21.07
8	IC-564130	6.29	12.86	34.39	13.06	21.66	26.46
9	IC-363969	6.88	14.71	38.4	11.53	20.86	28.73
10	IC-374688-X	6.36	11.97	32.69	9.86	19.20	24.46
11	IC-421951	6.64	10.23	31.82	10.66	17.93	22.86
12	IC-512366	6.29	11.70	34.3	11.86	20.53	24.86
13	IC-512365	7.85	12.74	42.16	11.73	19.20	28.33
14	IC-512372	7.32	13.42	33.12	8.93	18.40	24.33
15	IC-553117	5.68	13.76	33.06	13.06	22.80	25.73
16	IC-411616	6.46	10.77	31.18	9.13	16.06	21.73
17	IC-564104	6.81	12.27	30.99	9.13	16.93	22.93
18	IC-311276	7.13	11.62	33.59	13.06	22.26	27.07
19	IC-564148	6.04	15.13	33.81	12.73	23.60	24.66
20	IC-574146	6.22	18.14	35.74	10.26	17.40	23.73
21	IC-421974	6.24	13.18	41.81	18.76	23.66	26.66
22	IC-512374	5.74	16.55	32.68	13.53	21.00	25.66
23	IC-424455	12.06	15.62	39.63	10.86	19.46	26.93
24	IC-564143	6.07	10.78	32.97	9.00	19.40	22.53
25	IC-512368	6.30	14.66	32.63	12.06	19.33	24.40
26	IC-361284	8.49	14.20	30.78	13.73	19.20	22.70
27	IC-564091	10.44	15.00	32.55	11.46	18.56	24.00
28	IC-424457	6.23	11.60	32.46	13.86	20.66	25.20
29	IC-564155	5.90	10.63	31.72	13.00	22.06	26.46
30	IC-429946	9.06	13.26	31.74	11.66	19.60	23.53
31	IC-574236	7.10	11.86	31.94	10.26	21.93	25.40
32	IC-394342	5.62	12.52	32.46	9.80	17.66	22.40
33	IC-574534	6.41	13.38	35.52	9.06	16.93	25.46
34	CO-4	8.32	11.94	33.53	15.13	21.60	28.66
35	Monarch	6.84	12.28	32.50	12.53	19.60	22.93
	Mean	**7.02**	**12.90**	**33.46**	**11.80**	**20.06**	**24.85**
	S.Em±	0.80	0.59	1.23	0.58	0.62	0.90
	CD@ 5%	2.26	1.66	3.47	1.66	1.77	2.55

4.3 Mean performance of primary branches and secondary branches (60 DAS and at harvest) in 35 coriander genotypes.

Sl.No	Genotypes	No. of primary branches per plant		No. of secondary branches per plant	
		At 60 DAS	@ harvest	At 60 DAS	@ harvest
1	IC-564150	4.46	5.93	6.46	12.60
2	IC-564149	3.93	5.13	5.80	10.80
3	IC-363965	4.60	6.06	6.73	14.56
4	IC-524231	4.40	5.60	6.26	13.80
5	IC-469788	4.20	5.06	5.46	11.80
6	IC-512369	4.40	4.80	5.13	12.30
7	IC-574156	4.20	4.66	5.66	14.40
8	IC-564130	3.46	7.20	5.80	14.73
9	IC-363969	4.07	6.00	6.20	14.8
10	IC-374688-X	4.13	6.40	6.83	15.86
11	IC-421951	4.73	5.40	5.67	12.93
12	IC-512366	4.46	6.00	4.93	12.33
13	IC-512365	6.40	7.73	8.53	16.40
14	IC-512372	4.46	5.53	5.53	12.93
15	IC-553117	5.40	6.26	7.50	14.26
16	IC-411616	5.60	6.46	5.80	12.33
17	IC-564104	5.13	6.06	6.27	13.40
18	IC-311276	4.40	5.46	6.40	14.73
19	IC-564148	4.20	5.80	6.53	15.00
20	IC-574146	4.40	5.90	6.73	15.00
21	IC-421974	5.73	6.33	8.46	15.13
22	IC-512374	5.40	6.40	6.86	15.33
23	IC-424455	6.20	6.80	7.73	16.66
24	IC-564143	5.60	6.46	5.93	14.33
25	IC-512368	4.40	4.86	5.40	13.30
26	IC-361284	4.26	5.80	6.46	11.86
27	IC-564091	4.53	5.53	6.46	14.13
28	IC-424457	4.60	5.20	6.26	13.73
29	IC-564155	5.13	7.00	7.33	14.06
30	IC-429946	4.03	4.86	5.2	13.10
31	IC-574236	4.67	6.06	7.93	15.23
32	IC-394342	5.40	6.73	6.53	14.93
33	IC-574534	5.73	7.46	5.53	13.73
34	CO-4	4.00	6.26	7.26	15.73
35	Monarch	3.73	5.33	5.06	11.80
	Mean	**4.70**	**5.96**	**6.36**	**13.94**
	S.Em±	0.24	0.59	0.34	0.84
	CD@ 5%	0.67	1.66	0.97	2.34

4.4 Mean values of days to first flowering, days to 50% flowering and days to maturity in 35 coriander genotypes.

Sl.No	Genotypes	Days to 1st flowering	Days to 50% flowering	Maturity
1	IC-564150	42.67	46.33	108.33
2	IC-564149	48.33	53.33	103.00
3	IC-363965	47.33	51.66	98.33
4	IC-524231	53.67	59.33	98.00
5	IC-469788	39.33	44.66	109.33
6	IC-512369	51.33	56.33	106.67
7	IC-574156	50.67	56.66	110.00
8	IC-564130	50.33	57.33	88.33
9	IC-363969	50.67	56.33	105.00
10	IC-374688-X	55.33	60.33	107. 33
11	IC-421951	52.33	58.67	107. 33
12	IC-512366	50.33	50.67	84. 33
13	IC-512365	40.33	45.67	96. 67
14	IC-512372	42.33	47.67	104.00
15	IC-553117	43.33	51.33	103.33
16	IC-411616	56.33	58.33	104. 67
17	IC-564104	43.33	50.33	105.00
18	IC-311276	43.33	49.33	107.33
19	IC-564148	46.33	51.67	95. 67
20	IC-574146	48.33	52.67	97.00
21	IC-421974	39.00	45. 33	90. 33
22	IC-512374	45.67	50. 33	105. 33
23	IC-424455	40.67	45. 67	111. 67
24	IC-564143	42.00	46.67	88.00
25	IC-512368	47.00	51.67	89. 67
26	IC-361284	42.33	48.33	93.00
27	IC-564091	42.67	48.33	98.66
28	IC-424457	44.33	51.67	100.33
29	IC-564155	49.33	53.7	105.66
30	IC-429946	48.67	53.67	107.33
31	IC-574236	51.67	57.33	110.00
32	IC-394342	45.66	50.67	103.66
33	IC-574534	36.33	41.67	81.66
34	CO-4	47.66	52.67	101. 67
35	Monarch	45.67	51.66	92.33
	Mean	**46.41**	**51.73**	**100.54**
	S.Em±	1.04	0.94	1.34
	CD@ 5%	2.93	2.65	3.80

4.5 Mean values of days to umbels per plant and umbellets per umbel at 60 DAS and @ maturity in 35 coriander genotypes.

Sl.No	Genotypes	No. of umbels per plant		No. of umbelltes per umbel	
		At 60 DAS	@ harvest	At 60 DAS	@ harvest
1	IC-564150	17.87	25.40	4.86	6.93
2	IC-564149	13.80	15.80	3.87	6.20
3	IC-363965	10.13	15.26	2.60	4.46
4	IC-524231	13.00	16.20	2.86	5.40
5	IC-469788	13.00	18.80	3.60	6.26
6	IC-512369	22.13	25.26	4.60	6.66
7	IC-574156	12.26	14.26	3.46	5.53
8	IC-564130	10.86	14.00	3.13	5.26
9	IC-363969	17.13	20.86	5.40	7.53
10	IC-374688-X	18.60	20.73	3.80	5.13
11	IC-421951	23.33	30.73	4.20	6.26
12	IC-512366	17.20	21.33	4.26	6.46
13	IC-512365	26.60	31.80	6.30	7.87
14	IC-512372	11.86	15.26	4.06	6.26
15	IC-553117	14.33	20.40	5.66	7.33
16	IC-411616	9.80	12.46	4.07	6.20
17	IC-564104	15.00	19.40	4.73	7.00
18	IC-311276	13.66	15.40	3.20	5.33
19	IC-564148	11.00	13.26	2.80	4.33
20	IC-574146	11.46	16.60	4.06	6.20
21	IC-421974	14.13	15.53	5.13	6.87
22	IC-512374	14.33	18.06	5.07	5.67
23	IC-424455	22.40	18.73	5.40	7.13
24	IC-564143	21.86	25.33	3.86	6.06
25	IC-512368	20.33	24.60	3.73	5.66
26	IC-361284	12.46	15.46	4.86	6.73
27	IC-564091	15.00	16.73	5.00	6.93
28	IC-424457	13.00	15.06	3.06	4.93
29	IC-564155	11.73	13.66	4.26	6.40
30	IC-429946	13.40	15.00	3.13	5.00
31	IC-574236	10.27	15.40	5.27	7.60
32	IC-394342	12.20	14.13	5.33	6.73
33	IC-574534	16.13	19.20	4.13	5.40
34	CO-4	17.33	20.73	4.33	5.93
35	Monarch	11.00	20.86	5.20	7.33
	Mean	**15.10**	**18.62**	**4.26**	**6.18**
	S.Em±	0.66	0.64	0.26	0.34
	CD@ 5%	1.86	1.82	0.73	0.96

4.6 Mean values of number of seeds per umbellet (60 DAS and @ harvest), 1000 seed weight, seed yield per plant, seed yield per hectare harvest index in 35 coriander genotypes.

Sl.No	Genotypes	Seeds umbellet^{-1}		1000 seed weight	SY/P	SY/ha	HI
		60 DAS	@ harvest				
1	IC-564150	9.40	11.66	11.21	3.12	14.49	41.83
2	IC-564149	9.13	11.40	12.44	2.73	12.89	36.19
3	IC-363965	4.53	6.00	12.57	3.95	15.20	44.06
4	IC-524231	5.33	7.20	10.55	3.34	14.12	40.1
5	IC-469788	4.90	7.00	11.35	3.26	14.76	40.55
6	IC-512369	5.2	6.26	10.10	3.34	13.49	39.08
7	IC-574156	8.27	10.20	9.89	2.56	11.57	36.86
8	IC-564130	8.13	9.86	12.32	3.54	18.25	47.72
9	IC-363969	10.07	11.26	12.83	6.17	17.52	53.36
10	IC-374688-X	7.13	9.13	12.75	4.59	19.16	48.70
11	IC-421951	8.86	10.86	13.35	3.07	12.72	38.47
12	IC-512366	7.87	9.80	12.07	3.73	12.39	36.19
13	IC-512365	9.20	11.13	10.17	6.84	26.83	46.59
14	IC-512372	8.00	8.86	10.68	3.09	12.66	36.23
15	IC-553117	11.13	13.06	14.71	6.20	23.25	48.23
16	IC-411616	4.53	5.733	12.09	2.93	13.60	40.61
17	IC-564104	11.00	12.80	12.66	4.33	20.23	48.88
18	IC-311276	9.87	12.00	12.06	3.36	13.98	39.73
19	IC-564148	8.67	10.26	11.77	4.90	19.36	47.48
20	IC-574146	6.27	7.93	11.26	2.96	13.73	41.47
21	IC-421974	6.26	8.40	12.36	5.04	25.45	43.04
22	IC-512374	9.06	10.66	14.54	3.02	14.69	42.91
23	IC-424455	9.47	10.93	12.72	4.36	22.86	47.14
24	IC-564143	10.60	11.00	13.54	3.42	14.54	37.56
25	IC-512368	8.80	10.80	13.19	4.07	14.25	43.13
26	IC-361284	8.53	10.00	11.70	3.17	15.15	44.22
27	IC-564091	8.60	9.93	11.39	4.39	14.40	42.94
28	IC-424457	7.07	8.53	14.34	2.76	11.94	42.32
29	IC-564155	7.27	9.73	11.50	3.64	13.58	42.89
30	IC-429946	7.00	8.60	10.07	4.82	20.32	51.66
31	IC-574236	9.07	13.33	12.33	2.68	8.66	30.67
32	IC-394342	5.93	7.46	13.30	3.49	13.47	42.70
33	IC-574534	4.60	6.06	12.16	3.63	12.19	41.20
34	CO-4	5.20	6.86	11.51	3.42	15.36	43.96
35	Monarch	6.87	9.40	12.98	3.72	14.98	42.02
	Mean	**7.76**	**9.54**	**12.12**	**3.82**	**15.72**	**42.61**
	S.Em±	0.48	0.53	0.55	0.37	0.60	0.83
	CD@ 5%	2.26	1.66	3.47	1.66	1.77	2.55

Table 4.7: Cluster classification of 35 genotypes in coriander.

Cluster	No. of genotypes	Genotypes
I	29	IC-361284, IC-564091, MONARCH, CO-4, IC-424457, IC-564149, IC-311276, IC-564155, IC-394342, IC-512372, IC-524231, IC-512374, IC-363965, IC-574146, IC-564148, IC-564130, IC-469788, IC-429946, IC-411616, IC-574156, IC-564104, IC-374688-X, IC-512366, IC-564150, IC-393969, IC-512368, IC-574534, IC-564143, IC-574236
II	1	IC-553117
III	1	IC-424455
IV	1	IC-421951
V	1	IC-512369
VI	1	IC-421974
VII	1	IC-512365

Table 4.8. Average intra (bold) and inter-cluster D^2 values for 7clusters in 35 genotypes of coriander .

Clusters	I	II	III	IV	V	VI	VII
I	**84.49**	139.45	146.63	203.75	142.47	202.92	346.91
II		**0.00**	73.29	232.87	198.28	101.35	184.00
III			**0.00**	179.08	153.30	147.98	137.59
IV				**0.00**	97.10	444.60	243.27
V					**0.00**	286.11	273.75
VI						**0.00**	247.64
VII							**0.00**

Table 4.9. The nearest and farthest clusters from each cluster based on D^2 values in coriander genotypes.

Cluster No.	Farthest cluster with D^2 values	Nearest cluster with D^2 value
I	VII (346.91)	II (139.45)
II	IV(232.87)	III(73.29)
III	IV(179.08)	VII (137.59)
IV	VI(446.60)	V (97.10)
V	VI(286.11)	IV(97.10)
VI	IV(446.60)	II (101.35)
VII	V(273.75)	III (137.59)

Table 4.10: Mean values of clusters for nineteen characters in 35 coriander genotypes.

cluster	Plant height (30 DAS)	Plant height 60 DAS	Plant height at harvest	No. of leaves 30 DAS	No. of leaves 60 DAS	No. of leaves at harvest	No. of primary branches at 60 DAS	No. of primary branches a harvest
I	6.86	12.98	32.80	11.46	19.78	24.55	4.54	5.91
II	5.68	13.77	33.07	13.07	22.80	25.73	5.40	6.27
III	12.07	13.63	39.63	10.87	19.47	26.93	6.20	6.80
IV	6.64	10.23	31.82	10.67	17.93	22.87	4.73	5.40
V	8.31	11.71	31.35	15.60	25.40	27.27	4.40	4.80
VI	6.24	13.19	41.81	18.77	23.67	26.67	5.73	6.33
VII	7.84	12.74	42.16	11.73	19.20	28.33	6.40	7.73

Continued…..

cluster	Days to first flowering	Days to 50 % flowering	Days to harvest	No. of umbels per plant (60 DAS)	No. of umbels per plant (at harvest)	No. of umbellets per umbel (60 DAS)	No. of umbellets per umbel (at harvest)	No. of seeds per umbellet (60DAS)	No. of seeds per umbellet (at harvest)	1000 seed weig
I	46.82	51.97	100.10	13.99	17.56	4.07	6.00	7.64	9.43	12.1
II	43.33	51.33	103.33	14.33	20.40	5.67	7.67	11.13	13.07	14.7
III	40.67	45.67	111.67	22.40	18.73	5.40	7.13	9.47	10.93	12.7
IV	52.33	58.67	107.33	23.33	30.73	4.20	6.27	8.87	10.87	13.3
V	51.33	57.00	106.67	22.13	25.27	4.60	6.67	5.20	6.27	10.1
VI	39.00	45.33	90.33	14.13	15.53	5.13	6.87	6.27	8.40	12.3
VII	40.33	45.67	96.67	26.60	31.80	6.30	7.87	9.20	11.13	10.1

Table 4.11: Percent contribution of different characters towards genetic divergence in 35 genotypes of coriander.

	Source	Times Ranked 1st	Contribution (%)
1	Plant height 30 DAS (cm)	0	0.0000
2	Plant height 60 DAS (cm)	15	2.521
3	Plant height @ harvest (cm)	0	0.000
4	No. of leaves 30 DAS	3	0.5042
5	No. of leaves 60 DAS	5	0.8403
6	No. of leaves (at harvest)	0	0.0000
7	No. of primary branches (60 DAS)	0	0.0000
8	No. of primary branches (at harvest)	0	0.0000
9	No. of secondary branches at (60 DAS)	0	0.0000
10	No. of secondary branches (at harvest)	0	0.0000
11	Days to first flowering	64	10.75
12	Days to 50 % flowering	1	0.1681
13	Days to harvest	78	13.1092
14	No. of umbels per plant (60 DAS)	56	9.4118
15	No. of umbels per plant (at harvest)	120	20.1681
16	No. of umbellets per umbel (60 DAS)	15	2.521
17	No. of umbellets per umbel (at harvest)	0	0.0000
18	No. of seeds per umbellet (60 DAS)	23	3.8655
19	No. of seeds per umbellet (at harvest)	54	9.0756
20	1000 seed weight	4	0.6723
21	Seed yield per plant (g)	27	4.5378
22	Seed yield per hactare(q)	77	12.94
23	Harvest index	53	8.9076

Table 4.12: Estimates of variability, heritability, and genetic advance as percent of mean for twenty three characters in coriander genotypes.

Characters	Range	Mean	GV	PV	GCV	PCV	h^2_{bs} (%)	GA	GAM
Plant height 30 DAS (cm)	4.24-12.06	7.02	1.60	3.54	18.02	26.79	45.24	1.75	24.97
Plant height 60 DAS (cm)	9.26-18.14	12.90	3.05	4.10	13.54	15.69	74.44	3.10	24.07
Plant height @ harvest (cm)	30.36-42.16	33.46	6.85	11.41	7.82	10.09	60.12	4.18	12.50
No. of leaves 30 DAS	8.80-18.76	11.80	4.46	5.51	17.90	19.88	81.07	3.92	33.20
No. of leaves 60 DAS	15.76-25.40	20.06	5.06	6.25	11.21	12.45	81.08	4.17	20.81
No. of leaves (at harvest)	21.06-28.73	24.84	3.08	5.55	7.07	9.48	55.62	2.70	10.86
No. of primary branches at 60 DAS	3.46-6.40	4.70	0.44	0.62	14.16	16.71	71.88	1.16	24.74
No. of primary branches at harvest	4.66-7.73	5.96	0.23	1.27	7.98	18.93	67.97	1.45	24.37
No. of secondary branches at 60 DAS	4.93-8.53	6.36	0.74	1.10	13.53	16.45	67.64	1.45	22.92
No. of secondary branches at harvest	10.80-16.66	13.94	1.29	3.42	8.14	13.25	37.79	1.44	10.91
Days to first flowering	36.33-56.33	46.42	22.47	25.70	10.21	10.92	87.34	9.12	19.65
Days to 50 % flowering	41.67-60.33	51.73	21.01	23.66	8.86	9.40	88.79	8.89	17.20
Days to harvest	81.66-111.66	100.54	61.23	66.68	7.78	8.12	91.83	15.44	15.36
No. of umbels per plant (60 DAS)	9.80-26.60	15.10	17.75	19.06	27.89	28.91	93.13	8.37	55.45
No. of umbels per plant (at harvest)	12.46-31.80	18.62	22.63	23.88	25.54	26.24	94.74	9.53	51.21
No. of umbellets per umbel(60 DAS)	2.60-6.30	4.26	0.77	0.98	20.65	23.21	79.23	1.62	37.88
No. of umbellets per umbel (at harvest)	4.33-7.86	6.18	0.69	1.05	13.47	16.54	66.33	1.39	22.60
No. of seeds per umbellet (60 DAS)	4.53-11.13	7.76	3.46	4.17	23.97	26.29	83.12	3.49	45.02
No. of seeds per umbellet (at harvest)	5.73-13.33	9.54	4.03	4.88	21.03	23.14	82.58	3.76	39.38
1000 seed weight (g)	9.89-14.71	12.13	1.21	2.14	9.05	12.07	56.21	1.69	13.98
Seed yield per plant (g)	2.56-6.84	3.82	0.93	1.35	25.28	30.43	69.03	1.65	43.27
Seed yield per hectare(q ha^{-1})	8.66-26.83	15.72	16.69	17.80	25.98	26.83	94.00	8.15	51.84
Harvest index (%)	30.67-53.36	42.61	22.35	24.45	11.09	11.60	91.40	9.31	21.84

Table 4.13: Phenotypic (P) and genotypic (G) correlation coefficients among yield and yield attributes in 35 genotypes of Coriander.

characters		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1	P	1	.174	0.134	0.038	-0.033	0.158	0.005	-0.051	-0.003	0.027	-0.259**	-0.319**	0.277**	0.237*	0.085	0.228*	0.232*	0.101	0.085	0.166	-0.196*	0.093	0.151
	G	1	.177	0.198*	0.026	0.018	0.0198	0.060	0.271**	0.094	-0.059	-0.405**	-0.373**	0.358**	0.364**	0.133	0.319**	0.361**	0.073	0.070	-0.024	-0.401**	0.176	0.049
2	P		1	0.148	0.012	-0.045	0.065	-0.0251	0.019	0.131	0.1411	-0.252**	-0.253**	-0.081	-0.114	-0.109	0.156	0.020	0.154	0.118	0.208*	-0.002	0.341**	0.203*
	G		1	0.272**	0.060	-0.068	-0.03	-0.079	-0.030	0.110	0.258	-0.276**	-0.291**	-0.102	-0.113	-0.121	0.183	-0.034	0.200*	0.129	0.255*	0.086	0.417**	0.273**
3	P			1	0.143	0.043	0.398**	0.348**	0394**	0.373**	0.406**	-0.326**	-0.325**	-0.189	0.350**	0.206*	0.337**	0.293**	0.127	0.096	0.535**	-0.051	0.236*	0.441**
	G			1	0.262**	0.082	0.645**	0.570**	0.692**	0.652**	0.781**	-0.407**	-0.410**	-0.262**	0.442**	0.268**	0.521**	0.439**	0.121	0.096	0.702**	0-071	0.341**	0.718**
4	P				1	0.688**	0.488**	-0.124	-0.145	0.254**	0.0435	-0.092	-0.034	-0.141	-0.049	-0.086	-0.003	-0.049	-0.198*	-0.183	0.287**	0.026	0.1427	0.172
	G				1	0.844**	0.633**	0.104	-0.074	0.284**	.076	-0.123	-0.071	-0.182	-0.045	-0.081	0.009	-0.009	-0.218	-0.167	0.332**	0.105	0.166	0.195*
5	P					1	0.527**	-0.164	-0.080	0.242*	0.068	0.018	0.054	-0.018	-0.054	-0.063	-0.108	-0.723	-0.074	0.022	0.198*	0.068	0.054	0.140
	G					1	0.770**	-0.190*	-0.132	0.196*	0.086	-0.013	0.030	-0.010	-0.052	-0.097	-0.092	-0.057	-0.039	-0.013	0.191*	0.115	0.050	0.255*
6	P						1	0.059	0.154	0.349**	0.284**	-0.128	-0.107	0.026	0.217*	0.117	0.091	0.146	-0.033	-0.003	0.319**	-0.038	0.237*	0.332**
	G						1	0.127	0.605**	0.491**	0.647**	-0.159	-0.136	-0.037	0.301	0.160	0.236*	0.152	-0.049	-0.039	0.412**	0.017	0.311**	0.550**
7	P							1	0.363**	0.40**	0.291**	-0.321**	-0.412**	-0.046	0.318**	0.173	0.439**	0.298**	0.052	0.017	0.297**	0.189	0.009	0.233*
	G							1	1.02	0.620**	0.491**	-0.492**	-0.600**	-0.340**	0.413**	0.244*	0.537**	0.434**	0.135	0.071	0.393**	0.239*	0.020	0.345**
8	P								1	0.283**	0.298**	-0.145	-0.182	-0.208*	0.151	0.059	0.245*	0.166	0.019	0.050	0.213*	0.168	0.164	0.158
	G								1	1.006	1.051	-0.357**	-0.440**	-0.439**	0.174	0.093	0.630**	0.391**	0.014	-0.058	0.625**	0.241*	0.414*	0.648**
9	P									1	0.471**	-0.197*	-0.129	0.156	0.077	-0.004	0.345**	0.264**	0.127	0.231*	0.459**	0.035	0.171	0.278**
	G									1	0.974**	-0.252**	-0.213*	0.180	0.119	-0.127	0.545**	0.407**	0.229*	0.289**	0.561**	0.193*	0.209*	0.498**
10	P										1	-0.038	-0.005	0.041	0.152	0.108	0.141	0.025	0.072	0.084	0.309**	0.086	0.2668**	0.262**
	G										1	-0.101	-0.046	0.132	0.243*	-0.006	0.246*	0.017	0.212*	0.191*	0.540*	0.154	0.416**	0.552**
11	P											1	0.914**	0.240*	-0.144	-0.117	-0.249*	-0.190	-0.178	-0.121	-0.293**	-0.035	-0.086	-0.182
	G											1	0.984**	0.274**	-0.165	-0.115	-0.318**	-0.229*	-0.171	-0.105	-0.315**	-0.137	-0.093	-0.253*

1.Plant height@ 30 DAS , **3.** Plant height @ harvest **5**. No. of leaves @ 60 DAS **7**.Primary branches @ 60 DAS **9.** Secondary branches @ 60 DAS
2. Plant height @60 DAS **4.** No. of leaves @ 30 DAS **6**. No. of leaves @ harvest **8.** Primary branches @ harvest **10.** Secondary branches @ harvest
** : Significant at 1%, * : Significant at 5%.

Table 4.13(Contd….)

12	**P**												**1**	**0.299****	**-0.171**	**-0.116**	**-0.273****	**-0.1988***	**-0.114**	**-0.05**	**-0.233***	**-0.063**	**-0.015**	**-0.157**
	G												**1**	**0.342****	**-0.178**	**-0.127**	**-0.290****	**-0.201***	**-0.079**	**-0.008**	**-0.252***	**-0.051**	**-0.029**	**-0.206***
13	**P**													**1**	**-0.021**	**-0.071**	**0.084**	**0.076**	**0.145**	**0.169**	**-0.016**	**-0.123**	**0.017**	**-0.075**
	G													**1**	**-0.014**	**-0.081**	**0.010**	**0.120**	**0.132**	**0.205***	**-0.027**	**-0.131**	**0.016**	**-0.138**
14	**P**														**1**	**0.8434****	**0.325****	**0.282****	**0.282****	**0.188**	**0.285****	**0.019**	**0.105**	**0.302****
	G														**1**	**0.898****	**0.391****	**0.322****	**0.305****	**0.220***	**0.304****	**-0.014**	**0.110**	**0.390****
15	**P**															**1**	**0.348****	**0.331****	**0.248***	**0.215***	**0.175***	**0.042**	**0.015**	**0.277****
	G															**1**	**0.423****	**0.419****	**0.286****	**0.248****	**0.182**	**0.056**	**0.018**	**0.323****
16	**P**																**1**	**0.807****	**0.302****	**0.331****	**0.194***	**0.047**	**-0.098**	**0.315****
	G																**1**	**0.995****	**0.359****	**0.380****	**0.360****	**0.139**	**0.101**	**0.466****
17	**P**																	**1**	**0.278****	**0.311****	**0.194***	**0.047**	**-0.008**	**0.208***
	G																	**1**	**0.344****	**0.046**	**0.256***	**0.058**	**-0.045**	**0.439****
18	**P**																		**1**	**0.864****	**0.223***	**0.262****	**0.133**	**0.247****
	G																		**1**	**1.009**	**0.234***	**0.361****	**0.152**	**0.335****
19	**P**																			**1**	**0.178**	**0.249***	**0.034**	**0.177**
	G																			**1**	**0.118**	**0.334****	**0.054**	**0.292****
20	**P**																				**1**	**-0.009**	**0.749****	**0.718****
	G																				**1**	**0.015**	**0.735****	**0.897****
21	**P**																					**1**	**0.073**	**0.014**
	G																					**1**	**0.151**	**0.070**
22	**P**																						**1**	**0.623****
	G																						**1**	**0.776****

11. Days to first flowering, **12** .Days to 50%flowering, **13**. Days to maturity, **14.** Umbels plant^{-1} @60 DAS, **15**.Umbels pantl $^{-1}$ at 60 DAS **16**.Umbellets umbel^{-1} at 60 DAS, **17.** Umbellet umbel^{-1} @ harvest, **18.** Seeds umbellet^{-1} at 60 DAS, **19.** Seeds umbellet^{-1} @harvest, **20.** Seed yield ha^{-1} **21.** 1000seed weight **22.** Harvest index and **23**. Seed yield plant^{-1}

Character		PH (cm)	No. of leaves	Primary branches	Secondary branches	DTFF	DTFPF	DTM

Table 4.14: Direct and indirect effects of various yield and its components on seed yield in coriander genotypes. Path using genotypic correlation (Residual Effect: 0.59) Path using phenotypic correlations: (Residual effect: 0.40)

			30DAS	60DAS	At H	30DAS	60DAS	At H	30DAS	60DAS	30DAS	60DAS			
PH (cm)	30 DAS	P	**0.1054**	0.0184	0.014	0.004	-0.003	0.016	0.0005	-0.005	-0.0003	0.0028	-0.027	-0.033	0.029
		G	**-0.1738**	-0.0307	-0.0344	-0.0045	-0.0032	-0.0344	-0.0104	0.0468	-0.0163	0.0101	0.0704	0.0648	-0.0621
	60 DAS	P	-00084	**-0.0480**	-0.0071	-0.0006	0.0022	-0.0031	0.0012	-0.0010	-0.0063	-0.006	0.0121	0.0121	0.0039
		G	-0.0438	**-0.2484**	-0.0675	-0.0149	0.0168	0.0007	0.0196	0.0074	-0.0274	-0.0640	-0.0683	0.0725	0.0272
	90 DAS	P	0.0145	0.0161	**0.1084**	0.0155	0.0047	0.0432	0.0377	0.0427	0.0409	0.0441	-0.0354	-0.0353	-0.0206
		G	0.0079	0.0109	**0.0401**	0.0105	0.0033	0.0258	0.0228	0.0277	0.0261	0.0313	-0.0163	-0.0164	-0.0105
No. of leaves	30 DAS	P	-0.0031	-0.0009	-0.0114	**-0.0799**	-0.0550	-0.0391	0.0099	0.0116	-0.0203	-0.0035	0.0074	0.0027	0.0113
		G	0.0070	0.0163	0.0715	**0.0724**	0.2299	0.1725	0.0284	0.0200	0.0773	0.0208	-0.0334	-0.0192	-0.0497
	60 DAS	P	-0.0032	-0.0044	0.0042	0.0671	**0.0975**	0.0514	-0.0161	-0.0078	0.0236	0.0067	0.0017	0.0052	-0.0018
		G	-0.0170	0.0624	-0.0757	-0.7801	**-0.9243**	-0.7109	0.1737	0.1223	-0.1802	-0.0793	0.0121	-0.0280	0.0096
	90 DAS	P	0.0212	0.0087	0.0532	0.0653	0.0705	**0.1336**	0.0079	0.0205	0.0466	0.0379	-0.0171	-0.0143	0.0035
		G	0.2336	-0.0034	0.7610	0.7474	0.9076	**1.1801**	0.1501	0.7142	0.5796	0.7631	-0.1871	-0.1601	-0.1431
PB	60 DAS	P	0.0008	-0.0042	0.0588	-0.0209	-0.0278	0.0100	**0.1689**	0.0612	0.0676	0.0492	-0.0543	-0.0695	-0.0078
		G	-0.0293	0.0385	-0.2786	0.0510	0.0918	0.0621	**-0.4885**	-0.5027	-0.3028	-0.2397	0.2401	0.2490	0.0165
	@ H	P	0.0042	-0.0017	-0.0328	0.0121	0.0067	-0.0128	-0.0302	**-0.0833**	-0.0235	-0.0248	0.0121	0.0150	0.0174
		G	-0.0822	-0.0092	0.2117	-0.0225	-0.0404	0.1850	0.3146	**0.3058**	0.3076	0.3216	-0.1090	-0.1343	-0.1343
SB	60 DAS	P	0.0001	-0.0043	-0.0123	-0.0083	-0.0079	-0.0114	-0.0130	-0.0092	**-0.0326**	-0.0154	0.0064	0.0042	-0.0051
		G	-0.0864	-0.1016	-0.6011	-0.2616	-0.1797	-0.4528	-0.5715	-0.9273	**-0.9219**	-0.8987	0.2330	0.1965	-0.1668
	@H	P	0.0000	0.0002	0.0005	0.0001	0.0001	0.0003	0.0004	0.0004	0.0006	**0.0012**	0.0000	0.0000	0.0001
		G	0.0182	-0.0805	-0.2442	-0.0239	-0.0268	-0.2022	-0.1534	-0.3289	-0.3048	**-0.3126**	0.0317	0.0146	-0.0414
DTFF		P	-0.0308	-0.0299	-0.0386	-0.0109	0.0021	-0.0152	-0.0380	-0.0172	-0.0234	-0.0045	**0.1184**	0.1082	0.0285
		G	-0.9893	-0.6716	-0.9938	-0.2992	-0.0320	-0.3873	-1.2003	-0.8708	-0.6174	-0.2473	**2.4423**	2.4030	0.6688
DTFPF		P	-0.0009	-0.0007	-0.0009	-0.0001	-0.0001	-0.0003	-0.0011	-0.0005	-0.0004	0.0000	0.0025	**0.0028**	0.0008
		G	0.9234	0.7228	1.0158	0.1747	-0.0750	0.3359	1.2625	1.0878	0.5279	0.1159	-2.4366	**-2.4764**	-0.8482
DTM		P	-0.0426	0.0124	0.0291	0.0216	0.0028	-0.0040	0.0071	0.0320	-0.0239	-0.0063	-0.0369	-0.459	**-0.1533**
		G	0.1676	-0.0514	-0.1232	-0.0856	-0.0049	-0.0171	-0.0159	-0.2061	0.0849	0.0621	0.1285	0.1607	**0.4692**

Table 4.14 (Contd….)

character		Umbels		Umbellets		seeds		SY/ha (q)	1000 seed weight	HI
		At 60 DAS	At harvest	At 60 DAS	At harvest	At 60 DAS	At harvest			
PH 30 DAS	P	0.0250	0.0091	0.0240	0.0244	0.0106	0.0038	0.0175	-0.0207	0.0098
	G	-0.0633	-0.0231	-0.0555	-0.0627	-0.0128	-0.0122	-0.0429	0.0698	-0.0307
PH 60 DAS	P	0.055	0.0053	-0.0075	-0.0010	-0.0074	-0.0057	0.0100	0.0001	-0.0164
	G	0.0281	0.0302	-0.0455	0.0085	-0.0499	-0.0322	-0.0635	-0.0214	-0.1037
PH @H	P	0.0380	0.0224	0.0365	0.0319	0.0319	0.0105	0.0580	-0.0055	0.0256
	G	0.0177	0.0107	0.0209	0.0176	0.0048	0.0038	0.0281	-0.0028	0.0137
No. of leaves 30 DAS	P	0.0039	0.0069	0.0003	0.0039	0.0159	0.0147	-0.0229	-0.0021	-0.0114
	G	-0.0123	-0.0243	0.0027	-0.0025	-0.0594	-0.0457	0.0906	0.0287	0.0454
At 60 DAS	P	-0.0053	-0.0061	-0.0106	-0.0071	-0.0073	0.0022	0.0194	0.0067	0.0053
	G	0.0479	0.0890	0.0856	0.0527	0.0364	0.0124	0.1768	-0.1067	-0.0468
At harvest	P	0.0290	0.0156	0.0133	0.0195	-0.0044	-0.0003	0.0427	-0.0050	0.0317
	G	0.3561	0.1893	0.2790	0.1800	-0.0585	-0.0462	0.4870	0.0207	0.3678
PB at 60 DAS	P	0.0538	0.0293	0.0742	0.0505	0.0089	0.0029	0.0502	0.0320	0.0015
	G	-0.2018	-0.1196	-0.2624	0.2124	-0.0660	-0.0348	-0.1922	-0.1168	-0.0101
PB @ harvest	P	-0.0126	-0.0050	-0.0204	-0.0138	-0.0016	-0.0042	-0.0178	-0.0140	-0.0137
	G	0.0531	0.0286	0.1929	0.1197	0.0043	-0.0178	0.1912	0.0739	0.1268
SB @ 60DAS	P	-0.0025	0.0001	-0.0113	-0.0086	-0.0041	-0.0075	-0.0150	-0.0011	-0.0056
	G	-0.1104	0.0117	-0.5033	-0.3761	-0.2114	-0.2668	-0.5175	-0.1779	-0.1932
SB @ harvest	P	0.002	0.000	0.0002	0.0000	0.0001	0.0001	0.0004	0.0001	0.0003
	G	-0.0761	0.0021	-0.0770	-0.0054	-0.0664	-0.0599	-0.1691	-0.0483	-0.1301
DTFF	P	-0.0170	-0.0139	-0.0295	-0.0225	-0.0211	-0.0143	-0.0348	-0.0041	-0.0103
	G	-0.4032	-0.2825	-0.7774	-0.5599	-0.4192	-0.2578	-0.7697	-0.3349	-0.2283
DTFPF	P	-0.005	-0.0003	-0.008	-0.0006	-0.0003	-0.0001	-0.0006	-0.0002	0.0000
	G	0.4402	0.3154	0.7201	0.4985	0.1970	0.0200	0.6242	0.1267	0.0739
DTM	P	0.0032	0.0110	-0.0130	-0.0118	-0.0222	-0.0260	0.0026	0.0190	-0.0027
	G	0.0067	-0.0382	0.0511	0.0567	0.0619	0.0962	-0.0128	-0.0615	0.0080

Table 4.14 (Contd….)

Table 4.14 (Contd….)

Character			PH At 30 DAS	PH 60DAS	PH At H	No. of leaves 30DAS	No. of leaves 60DAS	No. of leaves At H	Primary branches 60DAS	Primary branches @H	Secondary branches 60DAS	Secondary branches At H	DTFF	DTFPF	DTM
Uumbels	60 DAS	P	-0.0734	0.0352	-0.1084	0.0152	0.0168	-0.0671	-0.0986	-0.0469	-0.0240	-0.0472	0.0445	0.0530	0.0064
		G	-0.0643	0.0200	-0.0780	0.0080	0.0092	-0.0533	-0.0729	-0.0307	-0.0211	-0.0430	0.0291	0.0314	0.0025
	@H	P	0.0296	-0.0377	0.0710	-0.0299	-0.0217	0.0403	0.0597	0.0206	-0.0015	0.0037	-0.404	-0.0403	-0.0246
		G	-0.0357	0.0326	-0.0716	0.0239	0.0258	-0.0430	-0.0657	-0.0251	0.0034	0.0018	0.0310	0.0342	0.0219
Umbellets	60 DAS	P	0.0418	0.0287	0.0618	-0.0007	-0.0199	0.0182	0.0806	0.0450	0.0633	0.0260	-0.0457	-0.0502	0.0155
		G	0.4003	0.2298	0.6538	0.0123	-0.1161	0.2964	0.6735	0.7910	0.6845	0.3088	-0.3919	-0.3646	0.1366
	@H	P	-0.0292	-0.0025	-0.0371	0.0062	0.0091	-0.0185	-0.0377	-0.0210	-0.033	-0.0032	0.0240	0.0252	-0.0097
		G	-0.3760	0.0355	-0.4573	0.0094	0.0594	-0.1589	-0.4529	-0.4077	-0.4249	-0.0181	0.2388	0.2097	-0.1260
SEEDS	60 DAS	P	0.0195	0.0299	0.0248	-0.0384	-0.0145	-0.0064	0.0102	0.0037	0.0246	0.0140	-0.0345	-0.0221	-0.281
		G	-0.0218	-0.0595	0.0359	-0.0647	-0.0117	-0.0147	0.0401	0.0042	0.0680	0.0629	-0.0509	-0.0236	0.0391
	@H	P	-0.0159	-0.0062	-0.0051	0.0096	-0.0012	0.0001	-0.0053	-0.0026	-0.0121	-0.0041	0.0063	0.0028	-0.0089
		G	-0.0196	0.0363	0.0269	-0.0470	-0.0038	-0.0110	0.0199	-0.0163	0/0810	0.0537	-0.0295	-0.0023	0.0574
SY/ha		P	0.0554	0.0694	0.1785	0.0857	0.0663	0.1065	0.0993	0.0711	0.1532	0.1031	-0.0979	-0.0778	-0.0056
		G	0.4076	1.2537	1.1386	0.5487	0.3155	0.6809	0.6491	1.0315	0.9262	0.8923	-0.5200	0.4159	-0.0450
1000 SW		P	0.0178	0.0002	0.0046	-0.0024	-0.0063	0.0034	-0.0172	-0.0153	-0.0032	-0.0079	0.0032	0.0057	0.0112
		G	-0.1541	0.0331	-0.0272	0.0405	0.0443	0.0067	0.0918	0.0927	0.0740	0.0592	-0.0526	-0.0996	-0.0503
HI		P	0.0339	0.1246	0.0863	0.0021	0.0197	0.0867	0.0039	0.0601	0.0625	0.0974	-0.0316	-0.0055	0.0064
		G	-0.1054	-0.2494	-0.2039	-0.0995	-0.0303	-0.1862	-0.0124	-0.2477	-0.1252	-0.2486	0.0558	0.0178	-0.0101
Seed yield/plant		P	0.1510	0.2031	0.4415	0.1726	0.1409	0.3329	0.2336	0.1589	0.2780	0.2622	-0.1827	-0.1575	-0.0750
		G	0.0497	0.2730	0.7183	0.1954	0.2554	0.5504	0.5454	0.6481	0.4985	0.5522	-0.2534	-0.2061	-0.1384

character		Umbels At 60 DAS	Umbels At harvest	Umbellets At 60 DAS	Umbellets At harvest	Seeds At 60 DAS	Seeds At harvest	SY/ha (q)	1000 seed weight	HI
Umbels at 60 DAS	P	**-0.3092**	-0.2608	-0.1007	-0.0874	-0.0872	-0.0581	-0.0882	-0.0059	-0.0325
	G	**-0.1766**	-0.1585	-0.0692	-0.0570	-0.0540	-0.0390	-0.0537	0.0026	-0.0194
Umbels atharvest	P	0.2906	**0.3445**	0.1199	0.1141	0.856	0.0743	0.0605	0.0145	0.0054
	G	-0.2407	**-0.2682**	-0.1136	-0.1125	-0.0769	-0.0666	-0.0489	-0.0151	-0.0048
Umbellet at 60 DAS	P	0.0597	0.0638	**0.1833**	0.1479	0.0553	0.0608	0.0553	0.0366	0.0179
	G	0.4911	0.5312	**1.2539**	1.3477	0.4505	0.4773	0.4514	0.1753	0.1270
Umbellet at harvest	P	-0.0357	-0.0418	-0.1019	**-0.1263**	-0.0351	-0.0393	-0.0245	-0.0060	0.0011
	G	-0.3362	-0.4369	-1.0364	**-1.0416**	-0.3586	-0.4237	-0.2671	-0.0610	0.0470
Seeds at 60 DAS	P	0.0546	0.0481	0.0584	0.0538	**0.1935**	0.1673	0.0433	0.0507	0.0258
	G	0.0906	0.0850	0.1065	0.1021	**0.2965**	0.2992	0.0696	0.1071	0.0452
Seeds at harvest	P	-0.0099	-0.0113	-0.0174	-0.0163	-0.0453	**-0.0524**	-0.0094	-0.0131	-0.0018
	G	0.0618	0.0695	0.1065	0.1138	0.2825	**0.2799**	0.0527	0.0935	0.0153
Seed yield per hectare	P	0.0951	0.0586	0.1007	0.0648	0.0746	0.0596	**0.3336**	-0.0030	0.2349
	G	0.5022	0.3007	0.5940	0.4232	0.3874	0.3107	**1.6499**	0.0250	1.2130
1000 seed weight	P	-0.0017	-0.0038	-0.0181	-0.0043	-0.0238	-0.0226	0.0008	**-0.0908**	-0.0066
	G	-0.0057	0.0216	0.0536	0.0225	0.1386	0.1282	0.0058	**0.3837**	0.0581
Harvest index	P	0.0384	0.0057	0.0357	-0.0032	0.0488	0.0124	0.2572	0.0267	**0.3652**
	G	-0.0657	-0.0107	-0.0605	0.0270	-0.0910	-0.0326	-0.4392	-0.0904	**-0.5974**
Seed yield/plant	P	0.3025	0.2772	0.3153	0.2081	0.2472	0.1779	0.7183	0.0148	0.6236

	G	0.3902	0.3230	0.4661	0.4399	0.3359	0.2923	0.8971	0.0702	0.7764

PH-Plant height, **PB-** Priamary branches plant^{-1}, **SB-** Secondary branches plant^{-1}, **DTFF-** Days to first flowering, **DTFPPF-** Days to fifty per cent flowering, **DTM-** days to maturity, SY/ha-Seed yield hectare^{-1}, **DAS-** Days After Sowing

Table 4.15: Classification of character/s showing high, moderate and low PCV and GCV in coriander genotypes.

Sl. No			
1	High	PCV	Plant height at 30 DAS, number of umbels per plant at 60 DAS, number of umbels per plant at harvest, number of umbellets per umbel at 60 DAS, number of seeds per umbellet at 60 DAS and at harvest, seed yield per plant and seed yield per hectare.
		GCV	Number of umbels per plant at 60 DAS, number of umbellets per umbel at 60 DAS, number of seeds per umbellet at 60 DAS and at harvest, seed yield per plant and seed yield per hectare.
2	Moderate	PCV	Plant height at 60 DAS, Plant height at harvest, no. of leaves at 30 DAS, no. of leaves at 60 DAS, no. of primary branches(at 60 DAS and harvest), days to first

			flowering, no. of umbellets per umbel at harvest, 1000 seed weight and harvest index.
		GCV	Plant height at 30 DAS, Plant height at 60 DAS and no. of leaves at 30 DAS, no. of leaves at 60 DAS, no. of primary branches at 60 DAS, no. of secondary branches 60 DAS, days to first flowering and harvest index.
3	Low	PCV	No. of leaves at harvest, days to 50% flowering and days to harvest.
		GCV	Plant height at harvest, no. of leaves at harvest, no. of primary branches at harvest, no. of secondary branches at harvest, days to 50% flowering, days to harvest and 1000 seed weight.

Table 4.16: Classification of character/s showing high, moderate and low heritability and genetic advance as percent of mean (GAM) in coriander genotypes.

Sl. No			
1	High	Heritability	Plant height at harvest (cm), number of primary branches (60 DAS and at harvest), days to first flowering, days to 50 % flowering, days to harvest, number of umbels per plant, no. of umbellets per umbel, number of seeds per umbellet, seed yield per plant (g), Seed yield per hectare and Harvest index
		GAM	Plant height at 30 DAS, plant height at 60 DAS, no. of leaves at 30 DAS, no. of leaves at 60 DAS, no. of primary branches (at 60 DAS and harvest), no. of secondary branches at 60 DAS, number of umbels

			per plant (at 60 DAS and harvest), number of umbellets per umbel (at 60 DAS and harvest), number of seeds per umbellet (at 60 DAS and at harvest), seed yield per plant, seed yield per hectare and harvest index.
2	Moderate	Heritability	Plant height at 30 DAS, no. of leaves at harvest, no. of secondary branches at harvest and 1000 seed weight
		GAM	Plant height at harvest, no. of leaves at harvest, no. of secondary branches at harvest, days to first flowering, days to 50% flowering, days to harvest and 1000 seed weight.
3	Low	Heritability	_____
		GAM	______

Plan of layout **N**

$\mathbf{R_1}$	$\mathbf{R_2}$	$\mathbf{R_3}$
T_{8}	T_{11}	T_{9}
T_{12}	T_{9}	T_{5}
T_{16}	T_{3}	T_{19}
T_{26}	T_{35}	T_{31}
T_{2}	T_{17}	T_{30}
T_{15}	T_{12}	T_{6}
T_{27}	T_{5}	T_{2}
T_{1}	T_{18}	T_{33}
T_{10}	T_{19}	T_{26}
T_{31}	T_{33}	T_{1}
T_{14}	T_{7}	T_{32}
T_{3}	T_{28}	T_{29}
T_{28}	T_{6}	T_{18}
T_{11}	T_{14}	T_{16}
T_{17}	T_{16}	T_{35}
T_{30}	T_{1}	T_{15}
T_{4}	T_{20}	T_{3}
T_{29}	T_{31}	T_{20}
T_{13}	T_{32}	T_{4}
T_{21}	T_{15}	T_{22}
T_{24}	T_{27}	T_{21}
T_{32}	T_{2}	T_{27}
T_{22}	T_{26}	T_{14}
T_{7}	T_{25}	T_{24}
T_{18}	T_{23}	T_{10}
T_{33}	T_{29}	T_{7}
T_{25}	T_{4}	T_{11}
T_{9}	T_{13}	T_{25}
T_{34}	T_{10}	T_{17}
T_{20}	T_{8}	T_{34}
T_{6}	T_{24}	T_{28}
T_{35}	T_{22}	T_{12}
T_{5}	T_{21}	T_{23}
T_{23}	T_{30}	T_{13}
T_{19}	T_{34}	T_{8}
2mx1m	2mx1m	2mx1m

LITERATURE CITED

LITERATURE CITED

Abhay, D, Maloo, S.R. and Dashora, L.K. 2011. Variability, correlation and path analysis in fenugreek (*Trigonella foenumgraecum* L.) under water limited conditions. *Journal of Spices and Aromatic Crops*. 20(1): 38-42.

Agrawal, S, Dhivendrasingh. And Rajput, S. S. 2003, Evaluation of fennel (*Foeniculum vulgare* Mill.) germplasm for production and quality.

Journal of Medicinal and Aromatic Plant Sciences. 12(2): 174-178.

Ali, S.A, Misra, A.K, Yadav, L.N and Mayura, K.N. 1993. Variability an correlation studies in coriander (*Coriandrum sativum* L.). *International journal of Tropical Agriculture*. 11(1): 40-42.

Ali, S. A, Chaurasia, S. C, Jaiswal, R. K. and Singh, A.P. 2000**.** Genetic divergence in coriander (*Coriandrum sativum* L.). *Research on Crops*. 1(3): 382-385

*Al-Jibouri, H.A., Miller, P.A. and Robinson, H.F. 1958. Genotypic and environmental variation and correlation in upland cotton cross of interspecies origin. *Agronomy Journal*. 50: 633-637.

Allard, R.W. 1960. *Principles of Plant Breeding*. John Willey and Sons Inc. London. 83-108.

Anil, G, Dilip, B. and Tambi, N.K. 2015. Evaluation of coriander varieties for growth, economics and yield. *Annals of Plant and Soil Research*. 17(2): 224-26.

Anubha, J, Balraj Singh, Solanki K.R, Saxena, N.S. and Kale, K.R. 2013. Genetic variability and character association in fenugreek (*Trigonell foenum- graecum* L.). *International Journal of Seed Spices*. 3(2): 22-28.

Arif, A. 2014. Evaluation of coriander (*Coriandrum sativum* L.) genotypes in hill zone of Karnataka. *The Asian Journal Of Horticulture*. 9 (1) : 174-177.

Bajad, G.B, Dahale, M.H and Nandeshwar, V.N. 2017. Performance of Different Coriander Varieties for Seed Yield. Journal of Krishi Vigyan. 5 (2): 132:137.

Banerjee. and Kole, C.P. 2004. Genetic variability, correlation and path analysis in fenugreek (*Trigonell foenum-graecum* L.). *Journal of Spices and Aromatic Crops*. 13(1): 44-48.

Beena, N, Sengupta, S.K and Naidu, A.K. 2013. Association and path coefficient analysis for seed yield and yield components in Ethiopian coriander accessions. *Asian Journal of Horticulture*. 8(2): 403-408.

Bertini, C.H, De Pinheiro, M, Nobrega, Duerte, G.M and Mi De, J.L. 2010. Agronomic performance and genetic divergenceof coriander genotypes. *Revista Ciencia Agronomica*. 41(3): 409-416.

Bhandari, M.M. and Gupta, A. 1993. Association analysis in coriander. Indian Journal of Genetics. 53(1): 66-70.

Bhattacharya, M, Chatterjee, R.P.S, Sharangi, A.B. and Pariari, A. 2006. Growth and yield of different cultivars of fenugreek (*Trigonella foenum-graecum* L.) as influenced by dates of sowing. *The Orissa Journal of Horticulture*. 34(1): 69-71.

Burton, G.W. 1952. Quantitative inheritance in grass. *Proceedings of the 6th International Grassland Congress.* 1: 277.

Carubba, A,la. R. Torre, I. Calabrese, R. la Torre and Kock. O. 2002. Cultivation trials of coriander (*Coriandrum sativum* L.)in a semi-arid Mediterranean environment. *Acta Horticulture*. 576: 237-242.

Cochran, W.G. and Cox, G.M. 1957. Experimental Designs.127-131.

Cosge, B.A, Ipek and Gurbuz, B. 2008. Some phenotypic selection criteria to improve seed yield and essential oil percentage of sweet fennel (*Foeniculum vulgare* mill. var. d*ulce*). *Tarim Bilimleri Dergis.* 15: 127-133.

Cox, T.S. and Murphy, J.P. 1990. Effect of parental divergence of F_2 heterosis in winter wheat crosses. *Theoretical and Applied Genetics*. 79: 241-250.

Darwin, C. 1859. On the Origin of Species by Means of Natural Selection, or the Preservation of Favoured Races in the Struggle for Life, 1st edition. John Murray, London.

Dashora, A, Maloo, S.R, and Dashora, L.K. 2011.Variability, correlation and path coefficient banalysis in fenugreek. (*Trigonella foenum-graecum* L.) under water limited conditions. *Journal of Spices and Aromatic Crops.*20(1): 38-42.

Datta, S, Chatterjee, R, Medda, P.S. and Chattopadhyay, P.K. 2001. Evaluation of ajowan (*Trachyspermum ammi* L.). Introductions for growth, yield and quality. *Journal of Spices and Aromatic Crops*. 10(1): 37-39.

Datta, S. and Choudhuri, P. 2006. Evaluation of coriander germplasm under terai zone of West Bengal. *Haryana Journal of Horticulture Sciences*. 35(3-4): 348-49.

Dewey, D.R. and Lu, H.K. 1959. A correlation and path-coefficient analysis of components of crested wheat grass production. *Agronomy Journal*. 51: 515-518.

Dhuhan, D, Partap, P.S, Rana, M.K. and Baswana, K.S. 2005. Effect of rhizobium inoculation and greens leaf cutting on test weight and seed yield of fenugreek genotypes. *Haryana Journal of Horticulture Sciences*. 34(1-2): 156-60.

Dhirendra singh, Jain, S. K, Rajput, S. S, Khandewal, V. And Shiva, K. N. 2006. Genetic variation for seed yield and its components and their association in coriander (*Coriandrum sativum* L.) germplasm. *Journal of Spices and Aromatic crops* **15**(1): 25-29.

Dyulgerov, N and Dyulgerov, B. 2013. Correlation and path coefficient analysis of productivity elements in coriander (*Coriandrum sativu.* L.). *Journa of central European agriculture.* 14(4): 1512:1517.

Fikreselassie, M, Zeleke, H. and Alemayehu, N. 2012a. Genetic variability of Ethiopian fenugreek land races. *Journal of Plant Breeding and Crop Science*.

4(3): 39-48.

Fikreselassie, M, Zeleke, H. and Alemayehu, N. 2012b. Correlation and path analysis in Ethiopian fenugreek land races. *Journal of Plant Breeding and Crop Science*. 2(3): 132-42.

Fufa, M. 2013. Genetic divergence in Ethiopian coriander (*Coriandrum sativum* L.*)* accessions. *Advances in Crop Science and Technology*. 1: 4.

Gal, G, Anwer, M.M, Meena, S.S, Mehta, R.S and Maeria, S.P. 2010. Advances in production technology of coriander. National Research centre on Seed Spices Ajmer Rajasthan. 1-5

Geremew, A. Firew, M and Amsalu, A. 2015. Variability, heritability and genetic advance for some yield and yield related traits and oil content in Ehtiopian coriander (*Coriandrum sativum* L.) genotypes. *International Journal of Plant Breeding and Genetics*. 9(3): 116-125.

Ghanshyam, N.S, Dodiya, Sharma, S.P, Jain, H.K & Dashora.A. 2014. Assessment of genetic variability, correlation and path analysis for yield and its components in ajwain (*Trachyspermum ammi* L.). *Journal of Spices and Aromatic Crops*. 24 (1): 43–46.

Giridhar, K. and Sarada, C. 2005. Identification of coriander (*Coriandrum sativum* L.) genotypes for vertisols of Andhra Pradesh. *National Symposium on Current Trends in Onion, Garlic, Chillies and Seed Spices-Production, Marketing and Utilization, SYMSAC-II*, 25-27 November. NRCOG, Rajgurunagar, pp. 92.

Giridhar, K, Surya Kumari, A, Rajani, C, Sarada. and L. Naram Naidu. 2014. Identification of potential genotypes of coriander (*Coriandrum sativum* L.) suitable for rainfed vertisols. *Applied Biological Research*. 16(2): 155-60.

Godara, B.R. 1995. Assessment of variability and path analysis in coriander (*coriandrum sativum* L.) germplasm. *M.Sc Ag Thesis*, Rajasthan Agricultural university, Bikaner.

Gurbuz, B. 2001, Correlation and path analysis among yield components in winter resistant coriander (*Coriandrum sativum* L.) lines. *Indian Journal of Agriculture Science*. 71(11): 730-32.

Hanson, C.H, Robinson. and Comstock, R.E. 1956. Biometrical studies of yield in segregating populations of Korean Lespedeza. *Agronomy Journal*. 48: 268-375.

Harland, S.C. 1939. The genetics of cotton. Jornathan cape, London.

Islam, M. S, Rahman Mazumder, M. A,. Hossain, M. M, Kundu, R and Bhuyan, M. A. J. 2004. Performance of some coriander genotypes for grain yield and its attributes. *Bangladesh Journal of Agrcultural Research*. 29 (1): 59-66.

Jeeterwal, R.C, Divakara Sastry.E.V, Rajput,S.S and Singh, D. 2015. Genetic variability, character association, path coefficient and divergence analysis in inbreds of fennel (*Foeniculum vulgare Mill.*). *International Journal of Seed Spices*. 5(2): 26-31.

Jindla, L. N, Singh, T. H, Allahrang and Bansal, M, L.1985. Stability for seed yield and its components in coriander (*Coriandrum sativum* L.). *Indian Journal of Genetics and Plant Breeding*. 45: 358-361.

Johnson, H.W, Robinson, H.F. and Comstock, R.E. 1955. Estimates of genetic and environmental variability in soyabean. *Agronomy Journal*. 47: 314-18.

Kailashchandra, D. S. E. V and Singh, D. 2000. Genetic variation and character association of seed yield and its component characters in fenugreek. *Agricultural Science Digest*. 20(2): 93-95.

Kole, A.B.P.C. 2004. Genetic variability, correlation and path analysis in fenugreek (*Trigonella foenum-graecum* L.). *Journal of Spices and Aromatic Crops*. 13(1): 44-48.

Krishnamoorthy, V. and Madalageri, M.B. 2002. Variability and correlation studies in ajowan (*Trachyspermum ammi*). *Journal of Medicinal and Aromatic Plant Science*. 24(2): 364-70.

Lenka, D. and Mishra, B. 1973. Path coefficient analysis of yield in rice varieties. *Indian Journal of Agriculture Science.* 43: 376-379.

Lush, J.L. 1949. Heritability of quantitative characters in farm animals. *Proceedings of 85th Congress on Genetics, Heriditas* (Supplement), pp. 356-75.

Mahalonobis, P.C. 1936. On the generalized distance in statistics. *Proceedings of the National academy of Sciences*. 19: 201:208.

Malik, T.P. and Tehlan S.K. 2013. Performance of coriander (*Coriandrum sativum* L.) varieties for growth and seed yield. *International Journal of Seed Spices.* 3(2): 89-90.

Mathur, S.C, Anwar, M and Bhargava, P.D. 1971. Studies on splitting of phenotypic and genotypic complexes and their correlation in coriander (*Coriandrum sativum* L.). *Rajasthan journal of Agricultural Sciences*. 2: 63:71.

Meena, R.S, Kakani, R.K, Anwer, M.M, Panwar, A, Sharada, C and Meena Shiv Ram. 2010. Variability studies in fenugreek (*Trigonella foenum-graceum* L.). *International Journal of Seed Spices*. 1(1): 44-46.

Meena, K.Y, Kale S.V. and Meena P.O. 2014. Correlation coefficient and path analysis in coriander. *International Journal of Scientific and Research Publications*. 4(6): 2250-3153.

Meena, R.S, Solanki, R.K and Alka Panwar. 2016. Quantitative genetic analysis for variability studies in cumin (*Cuminum cyminum* L.). *International Journal of Seed Spices*. 6(1): 90-92.

Mengesha, B, Getinet, A and Bizuayehu, T. 2011. Genetic divergence in Ethiopian coriander accessions and its implication in breeding of desired plant types. *African Crop Science Journal*. 19(1):39 – 47.

Mengesha, B and Getinet, A. 2013. Variability in Ethiopian coriander accessions for agronomic quality traits. *African Crop Science Journal*. 18(2): 43-49.

Moniruzzaman, M, Rahman, M.M, Hossain, M.M, Sirajul Karim, A.J.M. and Khalig, Q.A. 2013. Evaluation of coriander (*Coriandrum sativum* L.) genotypes for seed yield and yield contributing characters. *Bangladesh Journal of Agricultural Research*. 38(2): 189-202.

Maurya, K.R. 1989. Growth, yield and quality component in coriander genotypes. *Indian journal of horticulture*. 46(1): 107-110.

Mourya, P.B, Yadav, K.B, Pandey, P.V. and Yadav S.P. 2015. Correlation and path analysis in Fenugreek (*Trigonella foenumgraecum* L.). *Research of Environmental Life Science*. 8(4): 569-70.

Nagappa. M.K, Lakshminarayana reddy, M, and Dorajeerao, A.V.D. 2016. Growth and seed yield among certain coriander accessions. *Plant archieves.* 16(2): 1019-1024.

National Horticulture Data Base. 2015-16. National Horticulture Board, Ministry of Agriculture, Government of India.

Nilkolay, D. and Boryana, D. 2014. Heritability and correlation coefficient analysis for fruit yield and its components in coriander (*Coriandrum sativum* L.). *Turkish Journal of Agricultural and Natural Sciences*. 1: 618-22.

Patahk, R.A, Patil, I.A, Joshi, K.H. and Patil, A.D. 2014. Genetic variability, correlation and coefficient analysis in fenugreek (*Trigonella foenum-graecum* L.). *Trends in Biosciences.* 7(4): 234-37.

Patel, K.C, Tiwari, A.S and Kushwaha, H.S. 2000. Genetic divergence in coriander. *Agricultural Science Digest..* 20(1): 13-16.

Patel, D.G, Patel, P.S. and Patel, I.D. 2008. Studies on variability of some morphological characters in fennel. *Journal of Spices and Aromatic Crops*. 17(1): 29-32.

Patidar, M, Balaram, B, Singh, M.P. and Singh, G. 2004. Influence of varities, sheep manure and nitrogen on yield of cumin (*Cuminum cyminum* L.). *Journal of Spices and Aromatic Crops.* 13(2): 126-28.

Patil, P,B. 2003. Evaluation of fenugreek (*Trigonella foenum graecum* L.) genotypes. *M.Sc. (Hort.) Thesis, University of Agriculture Sciences,* Dharwad.

Prabhu, T. and Murthy, G. 2005. Evaluation of short duration coriander accessions under irrigated conditions for growth, yield and quality of greens and grains. *South Indian Horticulture.* 53(1-6): 397-401.

Prajapthi, D.B, Ravindrababu, Y and Prajapthi, B.H. 2010. Genetic variability and character association in fenugreek (T*rigonella foenum-graecum* L.). *Journal of Spices and Aromatic Crops*. 19(1 &2): 61:64.

Pushpa, T. N, Chandregowda, M, Gouda, M. A. P, Srikantaprasad,D and Anupa, T. 2010. Genetic evaluation of fenugreek (*Trigonella foenum-graceum* L.)

For growth and seed yiled attributes. *Journal of Asian Horticulture.* 6(2): 33-37.

Rajagopalan, A, Manavalan, R.S.A, Khader, M.D.A, Azhakiya, R.S and Khair, M.D.A. 1996. Evaluation of coriander cultivars for yieldand quality. *Indian Cocoa, Arecanut and Spice Journal*. 20(1): 13-14.

Raje, R.S, Singhania, D.L. and Singh, D. 2003. Evaluation of early generation progenies (F_2) of fenugreek (*Trigonella foenum-graecum*) crosses for seed yield and yield related characters. *Journal of Spices and Aromatic Crops*. 12(2): 127-34.

Rajput, S.S. and Dhirendrasingh. 2003. Variability in coriander (*Coriandrum sativum* L.) for yield and yield components. *Journal of Spices and Aromatic Crops*. 12(2): 162-64.

Rakesh,V and Korla, B.N. 2003. Genetic variability in fenugreek (*Trigonella foenum-graecum* L.) grown under mid-hills of Himachal Pradesh. *Journal of Spices and Aromatic Crops*. 12: 60:62.

Rao, C.R. 1952. Advance Statistical Methods in Biometrics. John Willey and Sons Inc. New York.

Saha, A. and Kole, P.C. 2001. Genetic variability in fenugreek grown in sub-humid lateritic belt of West Bengal. *Madras Agriculture Journal*. 88(4/6): 345-48.

Sarada, C, Giridhar, K and Hariprasad, R.N. 2008. studies on character association in fenugreek (*trigonella foenum-graceum* L.). *Journal of Spices and Aromatic Crops*. 17(2): 82-84.

Sastry, K. and Singh, A. 2000. Estimation of variability for grain yield and its component characters in fenugreek (*Trigonella foenum-graecum* L.). *Journal of Spices Aromatic Crops*. 18(1/2): 60-64.

Saxena, R.P, Pandey, V.P, Datta, J. and Gupta, R.K. 2005. Performance of coriander entries at Kumarganj, Faizabad. National Sympрsium on Current Trends in Onion, Garlic, Chillies and Seed Spices – Production and Utilization, SYMSAC-II, 25-27 November, *NRCOG*, Rajgurunagar, pp. 55-56.

Sharma, K.C. and Sharma, R.K. 1989. Variation and character association of grain yield and its component character in coriander. *Indian Journal of Genetics*. 49(1): 135-39.

Sharma, L.K, Meena, R.S and Panwar, A. 2015. Genetic variability on yield and its yield attributing characters in fennel (*Foenicum vulgare Mill*.). *International Journal of Seed Spices*. 5(1): 95-97.

Shridhar, Sulikeri, G.S. and Madalageri, B.B. 1990a. Genetic variability in coriander (*Coriandrum sativum* L.). *Karnataka Journal of Agricultural Sciences*. 3(3-4): 266-69.

Siddhharth, K.S and Dodiya, N.S. 2014. Assessment of genetic variability, correlation for yield and its Components characters in dill (*anethum graveolens* L.). *International Journal of Plant Sciences*. 9 (1): 234-36.

Singh, D.P and Mittal, S.A. 2003. Stabilty analysis foe seed yield, its contributing traits and oil content in coriander (*Coriandrum sativum* L.). *Journal of Spices and Aromatic Crops*. 12(2): 165-170.

Singh, R.K. and Chaudhary, B.D. 1977. Biometrical methods in quantitative genetic analysis. Kalyani Publishers New Delhi. 252.

Singh H.P, Patra, N.K, Kalra, A, Singh, H.B, Kumar, B, Singh, S.P. and Singh, A.K. 2002. Genetic distance in coriander (*Coriandrum sativum* L.) for essential oil yield and yield traits. *Journal of Spices and Aromatic Crops*. 11(2): 101-05.

Singh, S.P, Rajendraprasad. and Singh, S.K. 2005. Path co-efficient analysis of seed yield in coriander. *International Journal of Agricultural Sciences*. 1(1): 58- 61.

Singh, Jain, S.K, Rajput, S.S, Khandewal, V. and Shiva, K.N. 2006. Genetic variation for seed yield and its components and their association in coriander (*Coriandrum sativum* L.) germplasm. *Journal of Spice and Aromatic Crops*. 15(1): 25-29.

Singh, D and Choudhary, S.P. 2008. Evaluation of ajowain (*Trachyspermum ammi* L.). *Journal of Spice and Aromatic Crops.*17(2): 167-171.

Singh, B, Singh, K.P and Sengupta, S.K. 2015. Correlation analysis of traits in elite genotypes of coriander. *Sabrao Journal of Breeding and Genetics*. 47(1): 70-78.

Singh, K.P, Singh, B, Tomar, B.S, and Naidu, A.K. 2015. Trait variation in fenugreek. *Sabrao Journal of Breeding and Genetics*. 47 (4): 413-423.

Sivasubramanian, S. and Madhava Menon, P. 1973. Genotypic and phenotypic variability in rice. *Madras Agricultural Journal*. 60: 1093-1096.

Selvarajan, M, Chezhiyan, N, Muthulakshmi, P. and Ramar, A. 2002. Evaluation of coriander genotypes for growth and yield. *South Indian Horticulture*. 50(4-6): 458-62.

Sravanthi, B.B, Sreeramu, B.S, Narsimha, S.B, Umesha, K. and Rajasekhar, R. 2014. Correlation coefficient and path analysis in coriander (*Coriandrum sativum* L.). *International Journal of Applied Biology and Pharmaceutical Technology*. 5(4): 60-62.

Shridhar. 1990. Studies on variability in coriander (*Coriandrum sativum* L.) and response of leaf type to nutrition. *M.Sc. (Agri.) Thesis*, Univ. Agric. Sci., Dharwad.

Srivastava, J.P. Kamaluddin, Srivastava, S.B.L. and Tripathi, S.M. 2000. Path analysis in coriander (*Coriandrum sativum* L.). Spices and aromatic plants: challenges and opportunities in the new century Contributory papers Centennial conference on spices and aromatic plants, Calicut, Kerala, India, 20-23-September, 2000; 71-74.

Sunita, K, Sharma, L.K, Kulkarni, G. U and Sondarva Jyoti . 2016. Association studies in coriander (*Coriandrum sativum* L.) under irrigated and limited irrigation conditions. 17(3): 622-627.

Sunil Kumar, J.P, Singh, Dhirendra Singh, Chander, M, Mangaldeep, S and Hariom, S. 2017. Character Association and Path Analysis in Coriander (*Coriandrum sativum* L.) for Yield and Its Attributes. *International journal of pure applied biosciences***.** 5 (1): 812-818.

Tiwari, R.S. and Agarwal, A. 2004. *Production Technology of Spices*. International Book Distributing Co., India, pp. 254-270.

Tripathi, S.M, Kamaluddin, Srivasttava, S.B.L and Srivastava, J.P. 2000. Variabilty heritability and correlation studies in coriander (*Coriandrum sativum* L.). *Journal of Spices and Aromatic Plants- Challenges and opportunities in new century*. 30-34.

Velayudham, A. 2004. Evaluation and effects of organics with bio-inoculants in coriander var. C0-3. *M.Sc. (Hort.) Thesis*, *University Agriculture Sciences*, Dharwad.

Wassihun, L. 2006. Agro morphological characterisation of sorghum (*Sorghum bicolar* L.) landraces from Metekel Zone Benishangul Gumuz region. M.Sc. Thesis. Hawasa University, Awassa, Ethiopia. 102pp.

Wojo, A.A, Alamerew, S, Nebiyu, A & Menamo, T. 2016. Genotype and phenotype variability studies in fenugreek (*Trigonella foenum-graecum* L.) accessions in

Kaffa Zone, South West Ethiopia. *Journal of Spices and Aromatic Crops*. 25 (2): 159–168.

*Wright, S. 1921. Correlation and causation. *Journal of Agriculture Research.* 20: 667-587.

Yadav, R. K. 1999. Variability in a collection of coriander (*Coriandrun sativum* L.) germplasm. *Journal of Spices and Aromatic Crops*. 8(1): 99.

Yogendra, Y, Premshanker, Y, Pandey V.P and Adesh, K. 2013. Genetic variability, Correlation, Path coefficient analysis studies in fenugreek (*Trigonella foenum-graecum* L.). *The Asian Journal of Horticulture*. 8(2): 456-459.

***Original paper not seen.**

APPENDICE

APPENDIX

Monthly meteorological data recorded at ARI, Rajendranagar during October 2016 to February 2017.

Month	Temperature (^{0}C)		Relative Humidity (%)		Rainfall (mm)	Rainy days	Sun Shine (hrs)	Wind Speed (km/hr)	Evaporation (mm)
	Maximum	Minimum	Morning	Evening					
October 2016	30.2	18.2	91	48	1.0	0	7.1	0.0	3.7
November 2016	30.3	12.8	88.3	33.5	0.0	0.0	8.2	0.0	3.6
December 2016	29.00	11.3	90.1	37.4	0.1	0.0	8.0	1.4	3.7
January 2017	29.3	12.2	86.9	33.4	0.0	0.0	8.0	1.4	3.7
February 2017	32.7	13.6	79.3	26.8	0.0	0.0	9.6	3.6	5.2