EVALUATION OF CORIANDER (*Coriandrum sativum* L.) GENOTYPES FOR GROWTH, YIELD AND QUALITY UNDER CENTRAL DRY ZONE OF KARNATAKA

NANDAKUMAR, K

MH2TAE093

DEPARTMENT OF PLANTATION. SPICES. MEDICINAL AND AROMATIC CROPS

COLLEGE OF HORTICULTURE, MUDIGERE

UNIVERSITY OF AGRICULTURAL AND HORTICULTURAL SCIENCES,

SHIVAMOGGA

July, 2017

EVALUATION OF CORIANDER (*Coriandrum sativum* L.) GENOTYPES FOR GROWTH, YIELD AND QUALITY UNDER CENTRAL DRY ZONE OF KARNATAKA

NANDAKUMR, K

MH2TAE093

Thesis submitted to the

UNIVERSITY OF AGRICULTURAL AND HORTICULTURAL SCIENCES,
SHIVAMOGGA

In partial fulfillment of the requirements
for the award of the degree of

Master of Science (Horticulture)
in

DEPARTMENT OF PLANTATION, SPICES, MEDICINAL AND AROMATIC CROPS

Mudigere **July, 2017**

DEPARTMENT OF PLANTATION, SPICES, MEDICINAL AND AROMATIC CROPS
COLLEGE OF HORTICULTURE, MUDIGERE
UNIVERSITY OF AGRICULTURAL AND HORTICULTURAL SCIENCES, SHIVAMOGGA

CERTIFICATE

This is to certify that the thesis entitled **'EVALUATION OF CORIANDER (*Coriandrum sativum* L.) GENOTYPES FOR GROWTH, YIELD AND QUALITY UNDER CENTRAL DRY ZONE OF KARNATAKA'** submitted in partial fulfillment of the requirements for the award of the degree of **MASTER OF SCIENCE (HORTICULTURE) in PLANTATION, SPICES, MEDICINAL AND AROMATIC CROPS** to the College of Horticulture, Mudigere, University of Agricultural and Horticultural Sciences, Shivamogga is a bonafide record of research work carried out by **Mr. NANDAKUMAR, K, ID NO. MH2TAE093** (harinandu887@gmail.com) during the period of study in this university under my guidance and supervision and no part of this thesis has previously formed the basis for the award of any other degree, diploma, associateship, fellowship or any other similar titles.

Mudigere
July, 2017

(MAJOR ADVISOR)

APPROVED BY:

Chairman: **(CHANDRAPPA, H)**

Co-chairman: **(RAVIRAJA SHETTY, G.)**

Members: 1. **(HEMANTH KUMAR, P.)**

2. **(HARISH BABU, B. N.)**

ACKNOWLEDGEMENT

In the journey of bringing out my master degree thesis to find its daylight, I find it a herculean task to search the names of all those people from the bottom cores of my memory. However, it is a pleasant experience for me to make honest efforts to acknowledge the help of several personalities.

At the very outset, I extend lion's share of my heartfelt gratitude, profound indebtedness and veneration to **Dr. H. Chandrappa,** Professor and Head of the Department (PMA), College of Horticulture, Hiriyur and esteemed chairman of my advisory committee for his stead fast support persistent encouragement and through provoking suggestions during my intimate association for two years, whose generous, precious guidance and frank remarks made me to rectify my weakness without which I couldn't completed my thesis. I could never forget the freedom given to me by him during M.Sc. studies. I thank him in million for his consistent inspiration and adroit guidance at several occasions.

I am deeply indebted to **Dr. Raviraja Shetty, G.,** Assistant Professor and Head, Department of Plantation, Spices, Medicinal and Aromatic Crops, College of Horticulture, Mudigere man of versatile personality, motivator of all, perfect planner, a good interpreter. I am most thankful to him for his excellent encouragement, keen interest throughout the course of this investigation.

I extend heartfelt thanks to the members of my Advisory Committee **Dr. Harish Babu, B. N.,** Assistant professor, Department of crop improvement and Biotechnology, College of Horticulture, Hiriyur and **Mr. Hemanth Kumar, P.** Assistant Professor, Department of Floriculture and Landscape Architecture, College of Horticulture, Hiriyur, for their inspiring guidance, valuable suggestion, extravagant support, sensible criticism in ameliorating this manuscript mammoth help and timely cooperation rendered me in the completion of this programme.

Dr. Chandrappa, H., Associate directorate of research, (ADR), Mr. Lalyanaik Senoir farm superdent, **Dr. Rajanna sir** Assistant professor of Entomology, Prakash sir, Hanumanaik sir, **Dr. Kumar naik** (Agronomist), **Subramani sir**, **Mr. Nataraj, Ms. Priyamadam, Ms. Dhanalakshmi madam (breeder), Uday sir (breeder) and bindu madam, pallavi madam**, all members form ZHRS, Hiriyur. Who gave gratitude support during course of investigation. Furthermore, it was a great support and inspiration to be supervised by Mr. Ravi C.S., **Senoir Farm Superdent and Dr. Ganapathi, M.,** Assistant Professor and Department of Crop physiology, College of Horticulture, Mudigere.

I avail myself of this opportunity to express my sincere gratitude with great reverence to the staff members **Mr. Vasudev.,** Assistant Professor, College of Horticulture, Hiriyur, **Dr. Ashok, L. B.,** Assistant professor of Soil science, College of Horticulture, Hiriyur, **Dr. Basavalighaiya.,** Assistant professor of Agronomy, College of Horticulture, Hiriyur, **Ms. Sowmya kumari,** Assistant professor of Plantation, Spices, Medicinal and Aromatic crops, **Ms. Vaishnavi** Assistant professor of Plantation, Spices, Medicinal and Aromatic crops, and Ms.Hazhiram khanam Assistant professor of Crop physiology, College of Horticulture, Hiriyur **Ms. Monisha** for their constant support and help during the course of my investigation.

I truly think that my parents are really those different earthy reflections of that almighty. I bow my head to the feet of their foresight, sacrifices, love and blessings always showered on me, be it good or bad moments. May I be worthy to live up to their desires and expectations. It is my pleasure to express gratitude and respect to my father **Mr. Krishnanaik, S.**, mother **Devibai,** my elder brother **Harish naik,** elder sister **Gowthami, Chandranaik** and **Ravinaik** all my relatives for their bound less affection, words of encouragement, selfless sacrifice and unshakable confidence respond in me that had a direct effect in completing this work.

Sicerely acknowledge the kind co- operation of my near and dear batch mates PG friends Sandesh, Tejaswigowda, Harish, Santhosh, Rama, manjesh, nirupadi, ambresh, yoga ,Rp(Prasad), Laxmi, madhusree, latha, rohini for their timely help, constant moral support, motivation and thesis work. My thank go in particular to my all friends (wisteriazz) who were always there with their constant support, motivaton and help when I really needed.

My sincere and special thanks to all the respected teaching staff members juniors of College of Horticulture, Hiriyur and College of Horticulture, mudigere.

My sincere and heart full thanks to library staffs Ramachandra, Yoganna, Manu anna and Shahnaz and Girish anna for their constant help and support during my M.Sc. programme.

I avail this opportunity to express my heartfelt thanks to Latha aunty, for their kind help during my Research program

Last but not least my heartfelt thanks to all my PG and UG friends who had boosted me while doing my M.Sc. Programme. I offer my thanks to all those who have helped me directly or indirectly to reach this tough goal.

Finally, I thank god for bestowing me with divine spirit, essential strength and necessary succor to find my way towards a glorious career amidst several hurdles and struggles.... Any omission in this short manuscript doesn't mean lack of gratitude.

MUDIGERE

JULY- 2017

Nandakumar. K

(NANDAKUMAR, K)

Evaluation of Coriander (*Coriandrum sativum* L.) Genotypes for Growth, Yield and Quality Under Central Dry Zone of Karnataka

(NANDAKUMAR, K)

ABSTRACT

An experiment was conducted to evaluate 20 coriander genotypes in Randomized Complete Block Design with three replications to study their performance with respect to growth, yield and quality at Zonal Agricultural and Horticultural Research Station, Babbur farm, Hiriyur during of 2016-17 in winter season. Significant differences were observed among genotypes for all the characters under the study. The results revealed that, Rcr-475 recorded maximum plant height (70.27 cm), number of primary branches per plant (7.33), number of umbels per plant (28.13), number of umbellets per umbel (5.50), number of seeds per umbellet (5.70), seed yield per plant (6.37 g), seed yield per hectare (16.83 q), highest test weight (14.53 g) and plant spread (645 cm^2). The genotype DCC-4 took minimum number of days for first flowering (39.33 days) and maximum essential oil content (0.8%) was recorded in Acr-1and Rcr-728. High heritability coupled with genetic advance over mean were observed for most of the growth, yield as well as quality characters that indicated predominance of additive gene action for these traits. Correlation studies showed positive association with respect to seed yield per plant with number of primary branches per plant, plant height, plant spread and test weight. Path analysis revealed that, number of primary branches per plant had highest direct positive effect on seed yield followed by plant height suggesting that these parameters may be considered as prime traits during selection to fetch higher seed yield. Genotypes *viz.,* Rcr-475, Rcr-446, Rcr-41, Co-4, Rcr-20 and Acr-1 were found as the best performing genotypes from the study.

Department of Plantation, Spices,
Medicinal and Aromatic Crops
College of Horticulture, Mudigere
UAHS, Shivamogga
July, 2017

Nandakumar. K
Nandakumar, K
(harinandu887@gmail.com)

H. Chandrappa
(drchandrah56@gmail.com)

ಕರ್ನಾಟಕದ ಕೇಂದ್ರಿಯ ಒಣವಲಯದಲ್ಲಿ ಕೊತ್ತಂಬರಿಯ ವಂಶವಾಹಿಗಳ ಬೆಳವಣಿಗೆ, ಇಳುವರಿ ಮತ್ತು ಗುಣಮಟ್ಟದ ಮೌಲ್ಯಮಾಪನ

(ನಂದಕುಮಾರ, ಕೆ)

ಸಾರಾಂಶ

ಕೊತ್ತಂಬರಿಯ ಇಪ್ಪತ್ತು ವಂಶವಾಹಿಗಳ ಬೆಳವಣಿಗೆ, ಇಳುವರಿ ಮತ್ತು ಗುಣಮಟ್ಟವನ್ನು ತಿಳಿದುಕೊಳ್ಳಲು ಅಧ್ಯಯನವೊಂದನ್ನು 2016–17ರ ಚಳಿಗಾಲದ ಅವಧಿಯಲ್ಲಿ, ಕೃಷಿ ಮತ್ತು ತೋಟಗಾರಿಕಾ ಸಂಶೋಧನ ಕೇಂದ್ರ, ಬಬ್ಬೂರು ಫಾರಂ, ಹಿರಿಯೂರಿನಲ್ಲಿ ಕೈಗೊಳ್ಳಲಾಯಿತು. ಈ ಅಧ್ಯಯನದಲ್ಲಿ ವಂಶವಾಹಿಗಳನ್ನು ಮೂರು ಪ್ರತಿಕೃತಿ ಜೊತೆಗೆ ಯಾಧೃಚ್ಚಿಕ್ ಬ್ಲಾಕ್ ವಿನ್ಯಾಸದಲ್ಲಿ ಮೌಲ್ಯಮಾಪನವನ್ನು ಮಾಡಲಾಯಿತು. ಅಭ್ಯಸಿಸಿದ ಎಲ್ಲಾ ಗುಣಗಳಲ್ಲಿಯೂ ಗಮನಾರ್ಹ ವ್ಯತ್ಯಾಸಗಳನ್ನು ಕಂಡುಕೊಳ್ಳಲಾಯಿತು. ಗರಿಷ್ಟ ಗಿಡದ ಎತ್ತರ (70.27 ಸೆಂ. ಮೀ.), ಗರಿಷ್ಟ ರೆಂಬೆಗಳ ಸಂಖ್ಯೆ (7.33 ಪ್ರತಿ ಗಿಡಕ್ಕೆ), ಅಧಿಕ ಸಂಖ್ಯೆಯ ಹೂಕೊಡೆಗಳು (28.13 ಪ್ರತಿ ಗಿಡಕ್ಕೆ), ಅಧಿಕ ಸಂಖ್ಯೆಯ ಹೂಗಳು (5.50 ಪ್ರತಿ ಹೂಕೊಡೆಗೆ), ಬೀಜದ ಇಳುವರಿ (6.37 ಗ್ರಾಂ. ಪ್ರತಿ ಗಿಡಕ್ಕೆ), ಬೀಜದ ಇಳುವರಿಯು (16.83 ಕ್ವಿಂಟಾಲ್ ಪ್ರತಿ ಹೆಕ್ಟೇರಿಗೆ), ಗರಿಷ್ಟ ಬೀಜಶೋಧನೆಯ ತೂಕ (14.53 ಗ್ರಾಂ.) ಹಾಗೂ ಹೆಚ್ಚು ಗಿಡದ ಹರಡುವಿಕೆಯು (645 ಚ. ಮೀ.) ಆರ್‌ಸಿಆರ್–475 ವಂಶವಾಹಿಯಲ್ಲಿ ದಾಖಲಿಸಿದೆ. ಮೊದಲ ಹೂಬಿಡಲು ವಂಶವಾಹಿ ಡಿಸಿಸಿ–4 ಕಡಿಮೆ ದಿನಗಳನ್ನು ತೆಗೆದುಕೊಂಡಿದೆ (39.33 ದಿನಗಳು). ವಂಶವಾಹಿ ಎಸಿಅರ್–1 ಮತ್ತು ಆರ್‌ಸಿಆರ್–728 ಗರಿಷ್ಟ ಎಣ್ಣೆಯ ಪ್ರಮಾಣವನ್ನು (ಶೇ. 0.8) ದಾಖಲಿಸಿದೆ. ಅಧಿಕ ಅನುವಂಶಿಯತೆ ಜೊತೆಗೆ ಹೆಚ್ಚು ಅನುವಂಶಿಕ ಮುಂಗಡದ ಸರಾಸರಿಯು ಗಿಡದ ಬೆಳವಣಿಗೆ, ಇಳುವರಿ ಮತ್ತು ಗುಣಮಟ್ಟದಲ್ಲಿ ಕಂಡುಬಂದಿದ್ದು, ಅಧಿಕ ಸಂಯೋಜನೆಯ ಅನುವಂಶಿಕ ಘಟಕದ ಪ್ರಮುಖ ಪಾತ್ರವನ್ನು ಸೂಚಿಸಿವೆ. ಆದ್ದರಿಂದ ಈ ಮೇಲ್ಕಂಡ ಗುಣಗಳು ಆಯ್ಕೆಗೆ ಸೂಕ್ತವಾಗಿವೆ. ಪರಸ್ಪರ ಸಹಯೋಗ ಅಧ್ಯಯನದ ಮೂಲಕ ತಿಳಿದು ಬಂದಿರುವುದೇನೆಂದರೆ, ಪ್ರತಿ ಗಿಡದ ಕವಲುಗಳ ಸಂಖ್ಯೆ, ಗಿಡದ ಎತ್ತರ, ಗಿಡದ ಹರಡುವಿಕೆ, ಬೀಜಶೋಧನೆಯ ತೂಕವು ಒಟ್ಟಾರೆ ಇಳುವರಿಯೊಂದಿಗೆ ಧನಾತ್ಮಕ ಸಹಯೋಗ ಹೊಂದಿರುವುದು ಕಂಡುಬಂದಿದೆ. ಮಾರ್ಗ ಗುಣಾಂಕದ ಅಧ್ಯಯನದ ಮೂಲಕ ತಿಳಿದು ಬಂದಿರುವುದೇನೆಂದರೆ, ಪ್ರತಿಗಿಡದ ಮೊದಲನೆಯ ರೆಂಬೆಗಳ ಸಂಖ್ಯೆಯು ಮತ್ತು ಗಿಡದ ಎತ್ತರವು ಬೀಜದ ಇಳುವರಿಗೆ ನೇರ ಸಕಾರಾತ್ಮಕ ಪರಿಣಾಮ ಬೀರಿದೆ. ಒಟ್ಟಾರೆ ಈ ಅಧ್ಯಯನದಿಂದ ಆರ್‌ಸಿಆರ್–475, ಆರ್‌ಸಿಆರ್–446, ಆರ್‌ಸಿಆರ್–41, ಆರ್‌ಸಿಆರ್–20, ಕೊ–4 ಮತ್ತು ಎಸಿಆರ್–1 ವಂಶವಾಹಿಗಳು ಇಳುವರಿ ಹಾಗೂ ಗುಣಮಟ್ಟದಲ್ಲಿ ಅತ್ಯುತ್ತಮವೆಂದು ಗುರುತಿಸಲಾಗಿದೆ.

Nandakumar. K

ನಂದಕುಮಾರ, ಕೆ

(harinandu887@gmail.com)

ಪ್ಲಾಂಟೇಶನ್, ಸಾಂಬಾರ, ಔಷಧಿಯ ಮತ್ತು
ಸುಗಂಧ ದ್ರವ್ಯ ಬೆಳೆಗಳ ವಿಭಾಗ,
ತೋಟಗಾರಿಕಾ ಮಹಾವಿದ್ಯಾಲಯ, ಮೂಡಿಗೆರೆ
ಕೃಷಿ ಮತ್ತು ತೋಟಗಾರಿಕಾ ವಿಶ್ವವಿದ್ಯಾಲಯ, ಶಿವಮೊಗ್ಗ
ಜುಲೈ–2017

ಹೆಚ್. ಚಂದ್ರಪ್ಪ

(drchandrah56@gmail.com)

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

LIST OF APPENDICES

INTRODUCTION

I INTRODUCTION

Coriander (*Coriandrum sativum* L.) belonging to the family Apiaceae (Umbelliferae), is an annual herb native to the Eastern Mediterranean region and Southern Europe. It is one of the most important annual seed spice produced in the country. On steam distillation, coriander seeds yield 0.2 to 1.2 per cent essential oil. The seeds also contain 19 to 21 per cent of fatty oil (oleoresin), which is a base for preparation of many chemicals and chiefly used as a flavoring agent for liquor (Tiwari and Agarwal, 2004). The content of essential oil in ripe fruit is comparatively low (typically, less than 1 %); the oil contains mainly of linalool (50 to 60 %) as an active principle and about 20 per cent terpenes (pinenes, α-terpinene, myrcene, camphene, phellandrenes, limonene and cymene).

Coriander is a tropical crop which can be successfully cultivated in the *Rabi* season in areas free from severe frost during the flowering and seed setting stages. Dry and cool weather favours higher seed production. However, in India the season of sowing varies with different regions. In Karnataka, the season of sowing is from May to July during *kharif* and from October to January during *Rabi* season (Farooqi *et al.*, 2005).

Coriander is commercially grown in India, Morocco, Romania, Russia, Mexico, Argentina, Hungary, Poland, Bulgaria and USA. In India, it is mainly grown in the states of Rajasthan, Gujarat, Tamil Nadu, Andhra Pradesh and Chhattisgarh. In a limited extent, it is also grown in Karnataka, Uttar Pradesh, Orissa, Bihar and Punjab (Vashishtha and Malhotra, 2005). In India the domestic marketing centers of coriander are Jodhpur, Pratapgarh, Nembhaheda, Bhawanimandi, Jhalarapatan, Ramganjmandi, Kota and Jaipur. In India, coriander is grown in an area of 522.66 thousand hectares with the production of 461.71 thousand MT and productivity is 1.13 MT per hectare (Anon, 2015).

In Karnataka, coriander is mainly grown under rainfed conditions both in *kharif* and *rabi* season in an area of 2.65 thousand hectare with a production of 0.82 MT (Anon, 2015). The average yield of coriander is low in India. One of the reasons for low yield is lack of genotypes suited to a particular region. Apart from selection of suitable genotypes, optimum sowing season, nutritional requirement and resistance to biotic stresses are important factors for accomplishing the higher yield in coriander.

Very limited scientific information is available on germplasm evaluation of coriander under central dry zone of karnataka, though farmers are using their own genotypes for cultivation.

The genetic potential of genotype largely determines productivity of crop in a particular region with agro climatic conditions, cropping system and scientific practices adopted. Since the crop is grown mainly as sole crop in *Rabi* season under *rainfed* or protective irrigation, moisture availability, short duration high yielding genotype for the particular zone/ region is boon to farmer to realize higher yield and returns.

Evaluation of different coriander genotypes and identification of high yielding genotypes for a particular agro-climatic region will be more beneficial for realizing high yield and income assessing to growers. Further, assessing the molecular markers study for different yield traits are very important in developing high yielding, suitable genotypes.

There is great potential for the commercial production of coriander seeds under central dry zone. However, there is no systematic study on the performance of different genotypes. Considering the importance of this crop, there is a prime need to evaluate some of the genotypes to find out the suitable variety for central dry region.

Keeping all these aspects in view, the present investigation was carried out at Zonal Agricultural and Horticultural Research Station, Babbur farm, Hiriyur, central dry zone of Karnataka with the following broad objectives.

Objectives:

1. To evaluate coriander genotypes for growth, yield and quality parameters
2. To assess the genetic variability for growth, yield and quality parameters in coriander genotypes
3. To study the correlation and path analysis for yield and yield parameter

REVIEW OF LITERATURE

II REVIEW OF LITERATURE

Coriander has gained a lot of importance as a condiment as well as spice crop in recent years for its uses. Coriander is used as green leaf vegetable for flavouring and to increase the taste of various curries and soups. It is also important ingredient used in manufacturing confectionaries flavouring, beverages, pickles and the extraction of essential oil. It is also used in pharmaceutical industry for manufacture of drugs and perfumes.

Though coriander is cultivated in large area and large numbers of cultivars are being grown in different parts of the country, the productivity is low. Development of high yielding varieties associated with its good quality will go a long way to withstand competition in the international market as well as for domestic use. Similarly in Karnataka, the productivity of coriander is also low because it is extensively cultivated under rain fed conditions by using the locally available cultivars.

The non availability of the high yielding genotypes in a particular agro-climatic condition is one of the factors responsible for the low yield. The scientific information on both performance and genetic variability among the coriander genotypes is limited. Hence an attempt has been made to review the available scientific information on coriander and other related crops and presented under the following headings.

2.1 Evaluation of coriander for growth parameters

2.2 Evaluation of coriander for yield parameters

2.3 Evaluation of coriander for quality parameters

2.4 Assessment of coriander for genetic parameters

2.1 GROWTH PARAMETERS

Considerable difference in growth parameters like plant height, number of branches per plant (primary and secondary), 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

Jindla *et al.* (1985) evaluated seven coriander genotypes under Jobner conditions. They observed maximum plant height in cv. PCO-4 (120.01 cm) followed by PCO-2 (106.6 cm) and minimum in cv. PCO-5 (84.0 cm).

Sharma and Bhati (1988) conducted a comparative trial of 16 varieties of coriander and noticed significant differences in plant height at the time of harvest. The cv. UD-41recorded maximum height (75.46 cm) and minimum height was in cv. CS-6 (54.20 cm).

Maurya (1989) conducted a field experiment for two consecutive years from 1982-84 under Dholi conditions comprising 10 genotypes for evaluation. The genotype GC-35 recorded the highest mean values for plant height (93.00 cm), whereas the lowest plant height was recorded in the genotype CS-2 (68.00 cm).

Shridhar *et al.* (1990 a) studied comparative performance in 19 genotypes of coriander for two seasons (*kharif* and *rabi*) under Dharwad conditions. In *kharif* season, the genotype IC-33728 recorded the highest plant height (46.20 cm) as against the lowest (32.33 cm) in var. 14/18-14. While, in *rabi* season, cv. 96/81-11 was the tallest (47.13 cm), whereas var. DWD-5 was dwarf plant (30.40 cm).

Rajagopalan *et al.* (1996) evaluated 13 coriander cultivars during *rabi* season from 1990 to 1992 at Coimbatore. Maximum plant height was recorded in JC-147 (38.8 cm) and minimum in CS-287 (32.9 cm) at the time of harvest.

Gurbuz (2001) studied 25 coriander lines of coriander, out of which the line number 20 recorded the highest plant height (125.4 cm) whereas, the lowest height was observed in line number 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 the least in the variety CO-3 (40.71 cm).

Rajput and DhirendraSingh (2003) evaluated 20 genotypes of coriander under Jobner conditions. Among them, genotype RCr-435 recorded maximum plant height (89.60 cm), followed by UD-728 (88.30 cm) whereas, the genotype UD-310 recorded the minimum plant height (44.00 cm).

Velayudham (2004) studied 11 coriander genotypes in both *kharif* and *rabi* seasons of 2003-04 in Arabhavi, 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).

Giridhar and Sarada (2005) evaluated 11 coriander genotypes in black soils under rain fed conditions of Guntur region for three years from 2002-2005. Among them, cv. LCC-216 recorded maximum plant height (65.90 cm) and was significantly superior to Sadhana (56.20 cm) a local check variety.

Saxena *et al.* (2005) evaluated 11 entries of coriander for four years (2000 to 2004). Among them, the maximum plant height was observed in accession number

UD-743 (120.73 cm) and minimum height was in accession number LCC-128 (94.63 cm), against check variety Pant Haritima (104.96 cm).

Prabhu and Murthy (2005) evaluated 23 coriander genotypes. Among them, the accession number UD-15 recorded the highest mean value in respect of plant height (23.42 cm), followed by accession number UD-681 (20.53 cm). The least plant height was recorded in local accession CS-205 (14.11 cm).

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

Moniruzzaman *et al.* (2013) evaluated 14 genotypes of coriander among which, the genotype CS003 was the tallest plant (116.10 cm) and the lowest plant height was found in genotype CS005 (60.40 cm) which was found to be identical with CS009 (60.50 cm).

Phurailatpam *et al.* (2014) observed that highest plant height found in Pant Haritima (92.27cm) cultivar and the cultivar JD-1 shows highest seed yield (10.78g) per plant.

2.1.2 Other crops

Datta *et al.* (2001) evaluated five ajowan introductions under Mohanpur conditions of West Bengal. The genotype RA-2 recorded highest 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.

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

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

Bhattacharya *et al.* (2006) evaluated fenugreek cultivars under Mohanpur conditions of West Bengal wherein, local cultivar recorded highest plant height (63.44 cm), followed by EC 57752 (62.11 cm) and the lowest height was observed in cultivars J.Fenu (55.00 cm).

Banerjee and Kole (2004) evaluated 30 genotypes of fenugreek and among these genotypes, the highest plant height was recorded in genotype JF-17 (52.63 cm) and minimum was in Sonali (32.67cm).

2.1.3 Number of branches (primary and secondary) per plant

Gurbuz (2001) in coriander noticed significantly highest numbers of branches per plant in line-9 (24.25) and it was minimum in line-15 (11.60).

Selvarajan *et al.* (2002) found that the accession CS-12 of coriander registered maximum number of primary branches per plant (8.8) and secondary branches per plant (18.2), whereas, minimum number of primary branches per plant were seen in CS-203 (5.4) and the accession CS-97 recorded minimum number of secondary branches per plant (9.0).

Singh *et al.* (2002) reported that among 15 genotypes of coriander studied, the highest number of branches per plant was recorded in C-8 (23.08) and the lowest in CS-7 (6.65).

Co-1, one of the 11 coriander genotypes studied by Velayudham (2004) exhibited more primary branches per plant (6.66) whereas, the lesser primary branches were observed in Guntur Local (5.30) during *kharif* season. During *rabi* season, maximum primary and secondary branches per plant were noticed in RCr-41 (8.20 and 16.53, respectively) and minimum in Gadag Local (5.20 and 10.73, respectively) at harvest stage.

Giridhar and Sarada (2005) noted that the coriander genotype LCC-216 produced maximum number of primary branches and secondary branches per plant (6.5 and 12.1, respectively) which was significantly superior to Sadhana (5.1 and 8.0, respectively).

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

Malik and Tehlan (2013) evaluated 13 coriander cultivars during 2009-2010 to 2011-2012 at Hissar. Maximum number of branches were 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 accessions 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.

2.1.4 Other crops

Datta *et al.* (2001) evaluated five Ajowan cultivars. The cultivar RA-2 exhibited superiority over other cultivars with respect to primary branches per plant (11.5) and secondary branches per plant (20.53). The genotype RA-6 recorded minimum number of primary (6.85) and secondary branches per plant (12.33).

Agrawal *et al*. (2003) studied 74 fennel accessions along with check varieties RF-101 and RF-125. Among these, UF-178 recorded more number of branches per plant (11.7) while, UF-156 was having minimum number of branches per plant (5.0).

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 lowest number of secondary branches (7.97 per plant) were observed in local cultivar.

2.1.5 Plant spread

The mean data of four years from Guntur condition showed that, all the genotypes of fenugreek varied significantly with respect to growth parameters. JF-210 (604 cm) and JF-204 (572 cm) recorded significantly higher plant spread than the check Lam Sel-l (426 cm) as reported by Sarada and Giridhar (2005).

2.2 Yield parameters

2.2.1 Days to first flowering

Sharma and Bhati (1988) conducted accession trial on coriander. The day to 50 per cent flowering was less in case of accession CS-4 (66.71days) while, it was maximum in accession UD-41 (92.89 days).

Maurya (1989) evaluated 10 coriander genotypes along with check variety RD-41. He opined that the genotype RD-42 took the least number of days (46.67 days) for 50 per cent flowering whereas, maximum days (80.67) was recorded in line 5365.

Agrawal *et al.* (1990) reported that among the 15 entries of coriander studied, the entry CS-6 flowered in 71.76 days, while the entry UD-374 took 97 days.

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

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 accession CS-208 (42.7 days) and maximum in the CS-123 (44.3 days). However, the differences were not significant (Selvarajan *et al.*, 2002).

The studies of Rajput and Singh (2003) on variability among 20 genotypes of coriander indicated that, the least number of days were taken for flowering in genotypes RCr-436 (57.0 days), whereas the UD-728 took the maximum number of days (94.70 days) for the same.

Among the 11 genotypes of coriander evaluated, the genotypes RCr-41 recorded maximum number of days taken for 50 per cent flowering (65.66 and 69.33 days) in *kharif* and *rabi* seasons respectively. While the minimum was being observed in genotype Guntur Local (39.00 and 42.33 days, respectively) (Velayudham, 2004).

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

Phurailatpam *et al*. (2014) evaluated genotypes for yield attributing characters. Among different genotypes, minimum time taken for 50 per cent flowering in genotype Sudha and RCr-41(42.67 days).

2.2.3 Other crops.

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.

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

2.2.4 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, selection RCS-8 and RCS-11 matured late (110 days each).

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

Among the 11 genotypes of coriander evaluated, the genotype LCC-170 and LCC-172 recorded maximum days to maturity (86.10 days) whereas, the genotype LCC-192 recorded minimum days (81.6 days) (Giridhar and Sarada, 2005).

The number of days taken for maturity varied from 99.2 in UD-118 to 82.2 days in the genotype LCC-174. The local check Sadhana recorded 88.4 days for maturity (Sarada and Giridhar, 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.

<u>*2.2.5 Umbels and seed*</u>

Variations 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 25 coriander lines, line number 2 recorded higher umbellets per umbel (5.83) (Gurbuz, 2001).

Selvarajan *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 results revealed that, the highest umbels per branch (7.60) and umbellets per umbel (8.18) were 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 Singh (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 were observed in UD-529 (13.9), NS-1 (3.4) and UD-483 (12.1), respectively.

According to Patidar *et al.* (2004), there were significant differences among varieties of coriander 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, and 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 local 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).

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 (2006).

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

Moniruzzaman *et al.* (2013) evaluated 14 accessions 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).

2.2.6 Other crops

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 Bhattacharya *et al.* (2006) there were significant differences among the cultivars 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).

2.2.7 Dry matter production

Easwarareddy *et al.* (1988) carried out an investigation consisting of six coriander cultivars and observed that the cultivars CS-4 and CO-2 had more dry weight (22.36 g and 20.65 g, respectively) due to production of higher plant height and more branches per plant.

Shridhar (1989) studied 19 genotypes of coriander during *kharif* season and opined that the genotype 96/81-11 produced the highest dry matter (7.98 g and 15.4 g) per plant at both *kharif* and *rabi* seasons, respectively. Whereas, the genotype IC-67153 registered minimum dry matter (5.83 g) in *rabi* season.

Hariprasadrao and Srinivasarao (2001) noted the highest fresh weight (20.25 t/ha) in case of the genotype EC-232666 at flowering stage in coriander and the lowest values were recorded in genotype EC-232671 (10.58 t/ha).

Velayudham (2004) reported that the coriander genotype CO-2 recorded higher dry weight of plant (8.02 g) at harvest stage and lowest in Gadag Local (5.45 g) during *kharif* season. While, in *rabi* season, RCr-41 recorded maximum dry weight (8.61 g) and the lowest weight was in Guntur Local (5.50 g).

2.2.8 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.

Nine accessions 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) followed by CS-102 (561.0 kg/ha). The lowest yield was observed in the accession CS-123 (504.1 kg/ha).

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

The studies of Rajput and Singh (2003) on 20 genotypes of coriander under Jobner conditions indicated that, the highest seed yield was observed in genotype NS-2 (8.68 q /ha) and the lowest in the genotype NS-1 (2.08 q/ha).

Among the 11 genotypes of coriander evaluated, LCC-216 recorded maximum yield (863.2 kg /ha) followed by genotype LCC-212 (836.1 kg/ha) and were on par with each other and significantly superior to local check Sadhana (624.8 kg/ha) (Giridhar and Sarada, 2005).

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

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) (Saxena *et al.*, 2005).

Velayudham *et al.* (2006) evaluated 11 genotypes for yield during *kharif* and *rabi* seasons in the year 2003-2004. Among them, the variety CO-3 recorded the highest seed yield (7.62 q /ha, and 7.89 q /ha, respectively) which was on par with variety CO-4 (7.36 q /ha and 5.84 q/ha, respectively) in both the seasons.

The genotype UD-15 of Jobner recorded the highest seed yield (573.33 kg /ha) followed by UD-681 (560 kg /ha) in coriander under Coimbatore conditions (Prabhu and Murthy, 2006).

Datta and Choudhuri (2006) evaluated 17 genotypes of coriander. Among them, genotype RCr-41 produced the highest seed yield (15.06 q /ha), followed by DH-246 (14.26 q /ha).

Among the 71 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) whereas least was in DCC-44 (31.20 g/plant), (Arif 2012) .

Malik and Tehlan (2013) evaluated 13 coriander cultivars 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) in cultivars DH-233, followed by DH-220 (2053 kg/ha).

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

2.2.9 Other crops

Datta *et al.* (2001) evaluated six local cultivars of ajowan under alluvial zone of west Bengal. They recorded highest seed yield in the cultivars RA-2 (503.32 kg /ha) as against the cultivars RA-6 which recorded lowest seed yield (273.5 kg /ha).

Patil (2003) evaluated eight genotypes in fenugreek and the experiment revealed that highest seed yield was noticed in genotype Belgaum Local (1375.53 kg /ha) followed by Ghataprabha Local (1076.64 kg /ha), while the least was recorded in the genotype Rajasthan-2 (225.5 kg /ha).

The seed yield of cumin was found to be influenced by varieties and showed significant variations. The improved variety, RZ-19 produced significantly highest seed yield (580 kg /ha), which was on par with variety RZ-209 (569 kg /ha) and higher than the local check (502 kg /ha) (Patidar *et al.*, 2004).

Agrawal *et al.* (2006) studied 24 entries of cumin for their yield. Among them, the GC-3 recorded the highest seed yield (333.33 kg /ha) followed by GC-2 (291.67 kg /ha) and the least was recorded in JC-2003 (41.66 kg /ha).

Bhattacharya *et al.* (2006) studied the seed yield of five cultivars of fenugreek under Mohanpur conditions. The highest seed yield was recorded in cultivar RM-10 (6.65 q/ha) followed by EC-57752 (6.16 q /ha).

2.2.10 Test weight of seed (g)

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

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

2.2.11 Other crops

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

2.2.12 Harvest Index

Maurya (1989) studied 10 genotypes of coriander, which differed significantly with respect to harvest index. The highest harvest index was recorded in genotypes RD-44 (46.44%), whereas the lowest (28.25%) was recorded in genotypes RD-41 (check).

Shridhar (1989) studied 19 genotypes of coriander, which differed significantly with respect to harvest index. In *kharif* season, the highest harvest index was recorded in genotypes DWD-2 (0.52), whereas the lowest harvest index of 0.09 was recorded with genotypes IC-67168. In *rabi* season, harvest index did not vary significantly among genotypes. However, the lowest was observed in genotypes Pant-C-1 and the highest in genotypes DWD-6 (0.57).

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 genotype 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 genotypes DWD-3 (56.16%), while, the lowest was observed in RCr-41 (40.57%).

2.3. Quality parameters (Essential oil content of seed)

The primary quality determinant of the spice is the content and composition of its volatile oil or essential oil. Essential oils are complex mixture of volatile secondary substances produced by plants. These are usually accumulated in specialized secretary structures. Essential oils are isolated from plant material by steam hydrodistillation and hydrodiffusion. The quality and yield of essential oil depends on environmental influences such as climate, soil conditions, botanical varieties, methods of harvesting and production (Sanjeev *et al.*, 1994). Small coriander seeds are characterized by relatively high volatile oil content, whereas the bold seed types are reported to possess low oil content. However, exception to these are not uncommon as the bold seeded Indian varieties like CS-4 and CS-6 contain higher oil compared with the small seeded variety like RCr-41 (Kumar *et al.*, 1977).

In the quality attributes of ten genotypes of coriander, Maurya (1989) found the highest oil content of 0.52 per cent in genotypes RD-44 followed by 0.40 per cent in RD-42, whereas minimum oil content was observed in CS-2 (0.19%).

Agrawal *et al.* (1993) evaluated the coriander varieties for essential oil purpose and reported that the yield of essential oil was maximum in local variety and CS-287 (0.37% each). It was minimum in genotypes DH-5 and UD-436 (0.18% each).

In an investigation to evaluate the collection of coriander varieties for essential oil, it was found that the content of essential oil of Indian genotypes ranged from 0.2 to 0.4 per cent and a good crop yielded around 6-8 kg per hectare of essential oil (Kalra *et al.*, 1999).

In a study regarding the quality attributes of fifteen genotypes of coriander, Singh *et al.* (2002) found that the highest oil content of 0.40 per cent was in S-33 followed by 0.10 per cent in genotypes RCr-20, whereas oil yield was more in genotypes RCr-41 (4.18 kg/ha).

Prabhu and Balkrishnamurthy (2006) evaluated coriander accessions for quality studies. The study revealed that the accession UD-243 recorded the highest essential oil (0.34%), whereas the lowest oil content was noticed in local accession 812 (0.19%).

In a Study on evaluation of coriander genotypes at northern Karnataka by Velayudham *et al*. (2006), 11 genotypes were evaluated for quality during *kharif* and *rabi* seasons. The cultivars CO-3 and RCr-41 recorded the highest oil yield of 5.83 kg/ha and 5.84 kg per hectare, respectively.

In an investigation on evaluation of 12 genotypes of coriander, Divya (2007) noticed the highest essential oil content in CIMPO-S-33 (0.73%) followed by Sindhu and CO-4 (0.43%) and the lowest in Ghataprabha Local (0.30%). The yield of essential oil per hectare was highest in CIMPO-S-33 (5.03 kg/ha) and the lowest was in Ghataprabha Local (1.47 kg/ha).

Tehlan *et al.* (2007) in their experiments on evaluation of coriander varieties described Hisar Surbhi (DH-246), a very promising variety of coriander which is high yielding having good oil content (0.425%).

Sunilkumar (2010) in a study on evaluation of coriander varieties observed that the variety CIMPO-S-33 registered highest essential oil content of 0.74 per cent followed by RCr-41 (0.61%), CO-4 (0.55%) and Swathi (0.49%) while the lowest was in Ghataprabha Local (0.23%). The essential oil yield per hectare was highest in CIMPO-S-33 (3.98 kg/ha) followed by RCr-41 (3.70 kg/ha) and the lowest was in Ghataprabha Local (1.21 kg/ha).

In an experiment to evaluate the coriander genotypes, it was reported that Indian corianders are poor in essential oil content (0.2 to 0.8%) as compared to European types (1.4 to 1.7%). Among the genotypes evaluated, CS-101 recorded maximum oil content (0.54 %) followed by UD-685 (0.47%) and CS-136 (0.43%) and these genotypes can be used successfully for further breeding programmes. They also reported that variation in the synthesis of essential oil might have been due to the promotive or inhibiting mechanism through physiological and biochemical reactions in the genotypes (Palanikumar and Rajamani, 2012).

2.4 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 and yield attributing 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 it would be misleading because of the 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, 1979).

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

2.4.1 GV, PV, GCV and PCV

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 15 genotypes of fenugreek grown in sub-humid lateritic belt of West Bengal, India, during *rabi* 1998-99, 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 15 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.* (2006) 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 per cent 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 50 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 Alemaus (2010). 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 to 3099 kg /ha 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.

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 per hectare. 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 per cent flowering, days to emergence, days to maturity and days to start of flowering. Genetic variability as per cent of mean was highest for leaf number per plant, plant height at flowering and number of secondary branches.

2.4.2 Heritability and genetic advance

In an investigation with 12 genotypes of coriander, medium heritability and high genetic advance was noticed for number of umbels and seed yield per plant and also 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).

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 15 genotypes studied.

Rajput and Singh (2003) reported that high estimates of genotypic coefficient of variation, phenotypic 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 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 test 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.

Patel *et al.* (2008) reported that high genetic advance as per cent mean was recorded for seed yield per plant, days to 50 per cent flowering, primary branches per plant and total branches per plant, number of umbellets per umbel, number of seeds in main umbel and test weight. Broad sense heritability and genetic advance as per cent of mean was obtained for longest basal leaf length, days to start 50 per cent flowering, number of umbel per plant, number of umbellets per umbel, number of seeds per umbellets, number of seeds per plant, seed yield per hectare, seed and essential oil content (Mengesha and Alemaus, 2010).

2.4.3 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.

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.

Singh *et al.* (2008) reported that the high heritability coupled with high genetic advance and coefficient of variability was for plant height, inter-nodal distance, seed yield per plant, test weight and umbels per plant. Branches per plant, leaves per plant, umbels per plant and seeds per plant exhibited positively significant genotypic correlation among themselves and all were positively and significantly associated with seed yield per plant. A positive significant correlation with seed yield per plant and its main components viz., seeds per plant and umbels per plant were also noticed. Considering the direct and indirect selection parameters of major contributors, a plant ideotype has been discussed to enhance seed yield on one hand and leafy vegetable on the other.

A field experiment was conducted by Fikreselassie *et al.* (2012 a) at Adadi, during 2006 and 2007 in fenugreek. Seed yield per plant had significant association with plant height, biomass yield, number of pods and seeds per plant, test 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.

Seed yield per plant exhibited a positive and significant correlation with number of seeds per umbel. Number of seeds per umbellet expressed a positive significant correlation with number of seeds per umbel and test weight. Days to 50 per cent flowering had the highest positive direct effect on seed yield per plant followed by number of umbellets per umbel, number of seeds per umbel and chlorophyll content at 60 DAS Krishnan (2013).

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

Singh (2015 b) revealed that among 64 genotypes of coriander, seed yield per plant exhibited a positive and significant correlation with number of seeds per umbel but was negatively correlated with days to 50 per cent flowering and 80 per cent maturity, whereas number of seeds per umbellet expressed a positive significant correlation with number of seeds per umbel and test weight. A positive correlation was also noted between test weight and number of seeds per umbel.

2.4.4 Path analysis

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).

Singh *et al.* (2005) conducted path analysis in coriander 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 branches per plant and number of secondary branches per plant, number of umbellets per umbel, essential oil content and harvest index.

Singh *et al.* (2006) evaluated of 360 lines of coriander (*Coriandrum sativum* L.) at Jobner (Rajasthan) and indicated a high variability for seed yield, umbels per plant and seeds per umbel and low variability for days to 50 per cent flowering and umbellets per umbel. High broad sense heritability and genetic advance were obtained for umbels per plant and seeds per umbel. Correlation and path coefficient analysis indicated that umbels per plant and branches per plant were the most important traits as they exerted positive direct effect on seed yield and negative effect on number of umbellets per umbel.

The path analysis by Singh *et al.* (2006) indicated that number of umbels per plant and number of branches per plant was the most important traits, as these traits had positive direct effects on seed yield.

Prajapati *et al*. (2010) evaluated 64 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 50 per cent flowering and test weight had the highest positive direct effects on grain yield.

Fikreselassie *et al.* (2012 b) 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 test weight contributed major positive direct effects on seed yield per plant. Maximum positive direct effect on protein content of the seed was exerted by test 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 25 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.

Awas *et al.* (2014) studied the correlation and path coefficient analysis for seed yield and oil content in Ethiopian coriander genotypes at Adami Tulu Agricultural Research Center during 2011/12 in *rabi* season. Seed yield per plant was highly and positively correlated with umbel number per plant, biomass yield per plant and number of seeds per plant, was highly negatively correlated with days to start of flowering, days to 50 per cent flowering and plant height at flowering at both genotypic and phenotypic level.

MATERIAL AND METHODS

III MATERIAL AND METHODS

The field experiment was conducted at Zonal Agricultural and Horticultural Research station (ZAHRS), Babbur farm, Hiriyur taluk, Chitradurga District, Karnataka under protective irrigation to "Evaluate the coriander (*Coriandrum sativum* L.) genotypes for growth, yield and quality attributes under central dry zone of Karnataka" during *rabi* season 2016-2017.

The details of the material used and methods adopted for the study including the techniques and statistical analysis for conducting the experiment and observations recorded during the course of the investigation are described in this chapter under the following headings.

3.1 Geographical location of the experiment site

Zonal Agricultural and Horticultural Research Station (ZAHRS), Babbur farm, Hiriyur is situated in central dry zone of Karnataka state at 13° 57′ 32" Northern latitude, 70°37′ 38" East longitude and at an altitude of 606.1 meter above mean sea level.

3.2 Climate

Hiriyur, which comes under Zone-4 region of agro-climatic zones of Karnataka, is benefited by both South-West and North-East monsoons. The mean rainfall of this area is about 313.4 mm, which is distributed over a period of six to seven months (June to December) with a peak during June & July. The meteorological data pertaining to the year of crop growth period *i.e*., November to February 2016-2017 is furnished in Appendix-II and it was obtained from the meteorological observatory of same station.

3.3 Design and layout of the experiment

The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. The treatments in each replication were allotted randomly according to definite laws of probability. The plan and layout of the experimental plot is given in figure-1 (plate no.1).

3.3.1 Details of Experiment

Location	: Zonal Agricultural and Horticultural Research Station, Babbur farm, Hiriyur
Total genotypes	: 20
Design	: Randomized Complete Block Design
Replications	: 3
Season	: *Rabi* 2016-17
Spacing	: 30 x 22.5 cm
Number of plants / plot	: 44
Fertilizer dose	: 35:35:35 kg/ha. (NPK)
Date of sowing	: 3rd Nov 2016
Gross plot size	: 2.0 × 1.5 m = 3.0 m^2

Table 1: Collection of genotypes from different sources.

Sl. No.	Genotypes	Source
1	Rcr-684	SKNA, Rajasthan
2	Rcr-728	
3	Rcr-446	
4	Rcr-20	
5	Rcr-436	
6	Rcr-41	
7	Rcr-480	
8	Rcr-475	
9	Rcr-435	
10	Co-1	TNAU, Coimbatore
11	Co-2	
12	Co-3	
13	Co-4	
14	Gco-1	GAU, Gujarat
15	Gco-2	
16	Acr-1	NRC, Ajmer
17	Dcc-1	HRES, Devihosur
18	Dcc-2	
19	Dcc-3	
20	Dcc-4	

The above mentioned genotypes are collected from

HRES- Horticultural Research and Extension Station, Devihosur

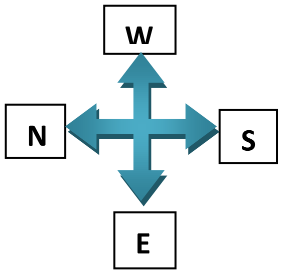
SKNA-Sri Karana Narendra Agriculture University, Jobner, Rajastan

TNAU- Tamilu Nadu Agriculture University, Coimbatore

GAU- Gujarath Agriculture University, Gujarat

NRC- National Research Center for Seed Spice, Ajmer, Rajastan

3.3.2 Treatment details:



Replication- I	Replication- II	Replication- III
T_{15}	T_{19}	T_{10}
T_{16}	T_{2}	T_{3}
T_{12}	T_{9}	T_{16}
T_{13}	T_{12}	T_{17}
T_{14}	T_{15}	T_{18}
T_{10}	T_{14}	T_{15}
T_{5}	T_{13}	T_{14}
T_{11}	T_{20}	T_{2}
T_{1}	T_{7}	T_{4}
T_{17}	T_{1}	T_{20}
T_{2}	T_{5}	T_{12}
T_{9}	T_{10}	T_{19}
T_{18}	T_{6}	T_{5}
T_{20}	T_{18}	T_{7}
T_{19}	T_{17}	T_{9}
T_{7}	T_{3}	T_{13}
T_{8}	T_{16}	T_{11}
T_{3}	T_{8}	T_{1}
T_{6}	T_{4}	T_{8}
T_{4}	T_{11}	T_{6}

2m

1.5m

Fig.1 Plan and layout of the experimental plot

Plate 1. General view of experimental plot

3.4 Soil characteristics

The experiment was conducted in medium black soil. The soil samples were collected from each replication and the composite samples were used and analyzed for physical and chemical composition of the soil. The data is presented in Appendix I.

3.5 Cultural practices

3.5.1 Preparation of experimental plot

The experimental area was ploughed and was brought to a fine tilth. Well decomposed farm yard manure @ 12.0 tonnes per hectare, was applied and mixed well in the soil before final harrowing. The experimental site was divided into required number of plots of 2m ×1.5m size. The main and sub-irrigation channels were laid out, taking into consideration the gradient of the site. After the layout of the plots, the treatments were assigned to the different plots in each replication by using random table (Fig. 1).

3.5.2 Fertilizer application

The recommended dose of nutrients (35:35:35 kg NPK/ha) was applied in the form of Urea (76.08 kg/ha), Single superphosphate (194.44 kg/ha) and Muriate of potash (58.33 kg/ha). Full dose of Single superphosphate, potash and 50 per cent of recommended nitrogen were applied at the time of sowing and the remaining dose of nitrogen was top dressed at 30 days after sowing (DAS). These fertilizers were applied in rows and covered with soil and irrigation was given immediately.

3.5.3 Sowing of seeds

Healthy and bold coriander seeds of different genotypes were sown on 3rd November 2016 under Hiriyur condition. Before sowing, the seeds were split into two equal halves to reduce the seed rate and seeds were directly sown in the field at recommended spacing of 30 cm between rows apart and the plots were irrigated immediately after sowing.

3.5.4 Thinning of seedlings

Thinning operation was taken up after 20-25 days after sowing, when seedlings were fully emerged out in the field. All the excess seedlings in a row were thinned out by maintaining a spacing of 22.5 cm between two plants in a row.

3.6 After care

3.6.1 Weeding and irrigation

The plots were kept weed-free by hand weeding at 30 and 60 day after sowing. Irrigation was given at an interval of four to five days during the whole cropping period considering the weather conditions and crop requirement.

3.6.2 Plant protection

Fusarium wilt was noticed in some of the genotypes and it was controlled by dissloving 2g carbendazim in one liter of water and sprayed on the crop twice during the period of crop growth. For the management of powdery mildew, the crop was sprayed with wettable sulphur at 2g per liter of water.

3.6.3 Harvesting

The whole plants were harvested when the seeds turned to brown colour and dried under sun for 3-4 days and seeds were separated from the plants.

3.6.4 Extraction of essential oil

The coriander oil from the dried coriander seeds was extracted by hydro-distillation using hydro-distillation unit (Clevenger, 1928). For distillation, dry coriander seeds of a known quantity (500 g) were ground in grinder to a coarse powder which is immersed in water for 30 minutes for easy extraction of essential oil and taken in the round bottom flask and added with 1000 ml water (half the capacity of the flask) and distilled for three and half hours. During the distillation, care was taken to keep the condenser cool. The temperature for boiling was maintained at 60^0C during oil extraction. The liberated oil was condensed and collected in the graduated portion of the distillation unit. The quantity of oil was recorded after completion of distillation. The essential oil collected was separated from water and stored in glass vials.

3.7 Observations recorded

Observations on growth and yield parameters were recorded using five plants in each plot at random and tagged, avoiding border row plants.

3.7.1 Growth parameters

3.7.1.1 Plant height (cm)

The height of the plant was measured in centimeter from the ground level to the top most nodes in the main stem at 30 and 60 DAS and at the time of harvest.

3.7.1.2 Number of primary branches

The number of primary branches, in each plant were counted and recorded at 30 and 60 day after sowing and also at the time of harvest.

3.7.1.3 Number of secondary branches

The number of secondary branches, in each plant were counted and recorded at 30 and 60 day after sowing and also at the time of harvest.

3.7.1.4 Plant spread (cm^2)

Spread of plants was calculated by measuring canopy spread in North – South and East – West directions on five labelled plants and, the multiplied product of both the values was expressed in cm^2.

3.8 Yield and yield parameters

3.8.1 Days taken for first flowering

Days were counted from the date of Sowing to appearance of the first flower in each treatment plot and recorded as number of days taken for first flowering.

3.8.2 Days to 50 per cent flowering

The days were counted from the date of sowing till 50 per cent of the plants in a plot flowered and recorded as days to 50 per cent flowering.

3.8.3 Number of umbels per plant

The number of umbels in each of five plants were counted at harvest. The mean was recorded as number of umbels per plant.

3.8.4 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.

3.8.5 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.

3.8.6 Test weight /dry weight of thousand seeds (g)

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

3.8.7 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.

3.8.8 Seed yield per plot (g)

All the plants in each plot were harvested, dried under shade and threshed to spread the seeds from the umbel. The average of cleaned seed weight of each plot was recorded in grams.

3.8.9 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 as seed yield per hectare.

3.8.10 Days to maturity (crop duration)

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

3.8.11 Dry matter production (qha^{-1})

Five separate test plants in each plot were uprooted at harvest and recorded their fresh weight immediately and the same plants were oven dried at 60^0C until they attained constant weight and recorded the dry weight of the plant in grams and it converted into in quintals.

3.8.12 Harvest index (%)

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

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

3.8.13 Essential oil content (%)

Essential oil obtained by hydro-distillation of 500 g of coriander seed powder of each variety was measured and expressed as volume by weight basis.

3.9 Statistical analysis and interpretation

The data recorded on various characters were subjected to Fishers method of analysis of variance as given by Panse and Sukatme (1957) was applied for analysis and interpretation of data. The level of significance used in "F" and "t" test was at p=0.05 and critical difference (CD) values were worked out wherever "F" test was significant.

3.9.1 Analysis of variance (ANOVA)

The data was analyzed by the methods outlined by Sundarraj *et al.* (1972) using the mean values of 12 characters to find out the significance of genotypes. The model of analysis of variance table adopted is given below.

Sources of variation	**Degrees of**	**MSS**	**F-ratio**
Replication	(r –1)	M_1	MSSt / MSSe
Treatment	(k – 1)	M_2	
Error	(k-1) (r-1)	M_3	
Total	kr – 1	$M_1+M_2+M_3$	

Where,

r = Number of replications

k = Number of genotypes

M_1 – Replication mean sum of square

M_2 – Treatment mean sum of square

M_3 – Error mean sum of square

3.10 Genetic variability

3.10.1 Estimation of variance components

Phenotypic and genotypic components of variances were estimated from ANOVA with the help of the formula suggested by Singh and Choudhary (1979).

$$GV = \frac{M_2 - M_3}{r}$$

$$PV = \frac{M_2 - M_3}{r} + M_3$$

Where, M_2 – Treatment mean sum of square

M_3 – Error mean sum of square

r – Number of replications

3.10.2 Coefficient of variability

Genotypic and phenotypic coefficients of variation were computed according to Burton and Devane (1953) based on the estimate of genotypic and phenotypic variance as follows:

$$GCV = \frac{\sqrt{GV}}{X} \times 100$$

$$PCV = \frac{\sqrt{PV}}{X} \times 100$$

Where

GV – Genotypic variance

PV – Phenotypic variance

x = Grand mean

PCV and GCV were classified as per (Subramaniyan and Memon, 1973)

0-10% - Low

10-20% - Moderate

20% and above - High

3.10.3 Heritability (h^2 broadsence)

Heritability in broad sense for all the characters were computed as the ratio of genetic variance to phenotypic variance as suggested by Hanson *et al.* (1956) and expressed in percentage.

$$\text{Heritability} = \frac{\text{GV}}{\text{PV}} \times 100$$

Where

GV = Genotypic variance

PV = Phenotypic variance

Heritability percentage was categorized as per Robinson *et al.* (1949).

0-30% - Low

30-60% - Moderate

60% and above – High

3.10.4 Genetic advance (GA)

Genetic advance for each character was worked out by adopting the formula given by Johnson *et al.*, (1955).

GA = h^2 □ □p

□ k Where,

h^2 = Heritability

k = Selection differential which is equal to 2.06 at 5 per cent intensity of selection (Lush, 1949)

□p = Phenotypic standard deviation

3.10.5 Genetic advance over mean (GAM)

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

$$\text{GAM} = \frac{\text{GA}}{X} \times 100$$

Where

GA = Genetic advance

x = General mean of the character

0-10% - Low

10-20% - Moderate

20% and above – High

3.11 Association analysis

3.11.1 Simple correlation

The correlation coefficients among all possible character combinations at phenotypic (rp) and genotypic (rg) level were estimated employing formula by Al-Jibourie *et al.* (1958).

$$\text{Genotypic correlation } r_{xy}\ (G) = \frac{\text{Cov (G)}}{\sqrt{\text{V (G) x V (G)}}}$$

$$\text{Genotypic correlation } r_{xy}\ (P) = \frac{\text{Cov (P)}}{\sqrt{\text{V (P) x V (P)}}}$$

Where

Cov_{xy} (G) = Genotypic coefficient of variance between x and y

Cov_{xy} (P) = Phenotypic coefficient of variance between x and y

V_x (G) = Genotypic variance of character x

V_x (P) = Phenotypic variance of character x

Vy (G) = Genotypic variance of character y

Vy (P) = Phenotypic variance of character y

Test of significance of correlation was tested by comparing the ‘r’ value with obtained value.

3.11.2 Path coefficient analysis

The path coefficient analysis was performed as given by Wright (1921), Dewey and Lu (1959). The following set of simultaneous equations were formed and solved for estimating direct and indirect effects.

r1y = a + r12b + r13c +------------- + r11i

r2y = r21a + b + 423c +………..
+ r21 i r3y = r31a + r32b + c
+……….. + r31i rny=rn1a +
r12b + 413c +……… + I

Where,

r1y to rny = Correlation coefficients between causal factors 1 to n on dependent character Y

r12, r21, 431, rni = Correlation coefficient among the causal factor 1 to n a, b, c, ……i = Direct effects of characters a to i on dependent character Y Residual effect (R) = 1 – (a^2 + b^2 + c^2 +……+ i^2 + 2abr12 + 2acr13 +…..)

EXPERIMENTAL RESULTS

IV EXPERIMENTAL RESULTS

The present investigation entitled "Evaluation of coriander (*Coriandrum sativum* L.) genotypes for growth, yield and quality under central dry zone of Karnataka" was carried out at Zonal Agricultural and Horticultural Research Station, Babbur farm, Hiriyur during *rabi* season 2016-17 using 20 coriander genotypes collected from different research stations.

The results obtained from the study are presented here under with the following headings.

4.1 Evaluation of coriander genotypes for growth, yield and quality parameters

4.2 Analysis of variance

4.3 Genetic variability, heritability and genetic advance

4.4 Character association

4.5 Path coefficient analysis

4.1 Growth, yield and quality parameters.

4.1.1 Plant height (cm)

The data pertaining to the plant height of different genotypes of coriander at various growth stages are presented in table 2.

The genotypes differed significantly for plant height at all the growth stages. Among the different genotypes, the genotype Rcr-475 recorded significantly highest plant height of (18.64, 58.73 and 70.27 cm) and followed by the genotype Rcr-446 (15.90, 55.48 and 62.93 cm) at 30, 60 DAS and at harvest, respectively. However, these two genotypes are on par with each other. The minimum plant height of (8.13, 34.93 and 37.47 cm) was recorded by DCC-4 at 30, 60 DAS and at harvest, respectively.

4.1.2 Number of primary branches per plant

Significant differences were recorded among the genotypes with respect to number of primary branches per plant at 30, 60 DAS and at harvest table 2.

Significantly maximum number of primary branches per plant was recorded by genotype Rcr-475 coriander at 30, 60 DAS and at harvest (5.25, 5.90 and 7.33, respectively) followed by Rcr-446 (4.90, 5.87 and 6.80, respectively). However, these two genotypes were on par with each other. The genotype DCC-4 recorded minimum number of primary branches per plant (3.33, 3.40 and 4.13, respectively) at harvest.

Table 2. Performance of coriander (*Coriandrum sativum* L.) genotypes for growth parameters

Genotypes	Plant height (cm)			Number of primary branches plant^{1}			Number of secondary branches plant^{1}			Plant spread (cm^{2})
	30DAS	60 DAS	At harvest	30 DAS	60 DAS	At harvest	30 DAS	60 DAS	At harvest	
T_1-Rcr-684	8.87	48.13	52.67	4.87	5.40	6.07	2.73	8.13	10.60	525.00
T_2-Rcr-728	8.35	36.40	42.80	4.27	5.07	5.97	4.20	9.93	11.73	451.00
T_3-Rcr-446	15.90	55.48	62.93	4.90	5.87	6.80	4.69	10.50	13.40	596.00
T_4-Rcr-20	9.32	44.53	46.93	4.60	4.73	5.20	4.00	9.13	10.73	467.00
T_5-Rcr-436	9.50	36.13	40.00	4.00	4.20	4.40	3.80	9.87	10.00	388.33
T_6-Rcr-41	10.00	36.20	58.87	4.33	5.80	6.53	4.00	8.67	13.13	581.00
T_7-Rcr-480	9.63	42.73	44.80	4.80	5.53	6.13	3.40	9.93	10.53	487.00
T_8-Rcr-475	18.64	58.73	70.27	5.25	5.90	7.33	4.80	11.30	13.90	645.00
T_9-Rcr-435	10.89	39.00	40.93	4.60	5.00	6.07	3.73	8.67	11.47	435.33
T_{10}-Co-1	10.48	41.20	45.40	4.60	5.00	5.20	3.73	10.27	10.47	548.67
T_{11}-Co-2	9.37	40.93	41.13	4.30	4.60	5.20	4.63	9.47	10.07	486.00
T_{12}-Co-3	11.08	50.47	52.47	4.00	4.20	4.40	4.67	9.73	11.93	575.00
T_{13}-Co-4	10.02	49.07	54.60	4.60	5.33	6.27	4.33	9.53	11.07	582.00
T_{14}-Gco-1	10.56	54.00	58.67	4.90	5.00	6.27	4.00	9.07	10.60	449.33
T_{15}-Gco-2	11.86	51.33	55.87	4.80	5.53	6.07	4.27	10.33	13.27	557.33
T_{16}-Acr-1	10.10	44.40	49.20	4.85	5.47	7.07	3.33	9.60	12.47	569.67
T_{17}-Dcc-1	9.18	45.20	46.00	4.53	4.67	4.80	3.60	9.13	9.47	389.33
T_{18}-Dcc-2	10.01	45.07	45.13	4.87	4.67	4.60	3.53	9.13	10.40	439.33
T_{19}-Dcc-3	9.97	38.53	39.33	4.00	4.13	4.47	3.53	8.47	9.27	392.67
T_{20}-Dcc-4	8.13	34.93	37.47	3.33	3.40	4.13	2.40	7.00	8.33	380.67
S. Em ±	0.65	3.00	3.03	0.28	0.41	0.52	0.34	0.53	0.96	45.05
C.D @ 5%	1.87	10.10	8.90	1.20	1.30	1.54	0.99	1.51	2.84	132.6

4.1.3 Number of secondary branches per plant

The data on number of secondary branches per plant produced at 30, 60 DAS and at harvest was found to be significant in different genotypes and are presented in table 2.

Significantly maximum number of secondary branches per plant was recorded in genotype Rcr-475 coriander at 30, 60 DAS and at harvest (4.80, 11.30 and 13.90, respectively) followed by Rcr-446 (4.69, 10.50 and 13.40, respectively). However, these two genotypes were on par with each other. The genotype DCC-4 recorded minimum number of secondary branches per plant (2.40, 7.0 and 8.33, respectively) at harvest.

4.1.4 Plant spread (cm^2)

Significant differences were recorded among the study of genotypes with respect to plant spread at harvest table 2.

Among the different genotypes, plant spread was significantly maximum in the genotype Rcr-475 (645 cm^2) followed by Acr-1 (596 cm^2). However, these two genotypes were on par with each other. The minimum plant spread was recorded in the genotype DCC-4 (380.67 cm^2).

4.1.5 Days taken to first flowering

The data pertaining to number of days for first flowering in different coriander genotypes is presented in the table 3. The genotype DCC-4 (39.33 days) took significantly least number of days for first flowering whereas, the genotype Rcr-41 (58.67 days) took maximum number of days for first flowering followed by genotype Rcr-728 (53.00 days).

4.1.6 Days taken to 50 per cent flowering

Significant differences were recorded among the study of genotypes with respect to days to 50 per cent of flowering table 3.

The genotype DCC-3 and DCC-4 (43.67 days) took significantly minimum number of days to 50 per cent of flowering. Whereas, the genotype Rcr-41 (63.67 days) took significantly maximum number of days to 50 per cent flowering, followed by Acr-1 (59.67days). However, these two were on par with each other. The data pertaining to number of days to 50 per cent flowering in different coriander genotypes is presented in the table 3.

4.1.7 Number of umbels per plant

Among the different genotypes, significantly highest number of umbels per plant was recorded in the genotype Rcr-475 (28.13) followed by Rcr-446 (27.87). However, these two were on par with each other, it was lowest in the genotypes Acr-1 (13.20). The data pertaining to number of umbels per plant in different coriander genotypes is presented in the table 3.

Table 3. Performance of coriander (*Coriandrum sativum* L.) genotypes for yield parameters

Genotypes	Days to first flowering	Days to 50 % flowering	Days to maturity	Umbels $plant^{-1}$	Umbellet $umbel^{-1}$	Seeds $umbellete^{-1}$	Seed yield (g) $plant^{-1}$	Seed yield (g $plot^{1}$)	Seed yield (qha^{-1})	Dry matter (q ha^{-1})	Test weight (g)	Harvest index (%)	Essential oil (%)
T_1-Rcr-684	47.00	53.67	101.67	18.40	4.80	5.14	4.03	300.00	10.00	3.66	9.57	52.41	0.5
T_2-Rcr-728	53.00	59.00	98.33	21.07	4.53	5.30	5.29	390.50	13.01	3.96	9.37	41.92	0.8
T_3-Rcr-446	47.33	54.33	110.00	27.87	5.47	5.52	6.20	497.50	16.58	6.89	14.10	47.36	0.4
T_4-Rcr-20	46.67	52.00	96.33	21.67	4.94	4.61	3.55	295.00	9.83	5.34	14.27	39.93	0.3
T_5-Rcr-436	39.67	44.00	96.00	18.19	5.03	4.80	5.27	317.50	10.58	5.57	11.73	48.62	0.4
T_6-Rcr-41	58.67	63.67	110.00	25.00	5.33	5.39	6.07	487.00	16.23	8.22	9.73	42.54	0.3
T_7-Rcr-480	45.00	48.67	99.33	22.60	4.77	4.48	5.37	421.00	14.03	7.69	12.60	41.12	0.4
T_8-Rcr-475	45.33	51.00	102.00	28.13	5.50	5.70	6.37	505.00	16.83	6.74	14.53	48.59	0.6
T_9-Rcr-435	52.33	56.00	100.67	22.07	4.37	4.43	5.13	364.50	12.15	4.40	11.47	53.83	0.4
T_{10}-Co-1	39.67	45.00	99.33	17.20	4.63	3.93	4.90	393.00	13.10	7.40	10.00	39.84	0.4
T_{11}-Co-2	42.33	46.33	99.00	18.93	4.81	4.83	5.07	360.50	12.01	5.72	10.43	46.99	0.4
T_{12}-Co-3	41.67	46.33	97.33	18.60	5.39	5.17	5.31	341.00	11.36	5.77	10.77	47.92	0.6
T_{13}-Co-4	44.33	47.33	99.33	23.00	5.06	5.33	5.77	444.00	14.80	8.06	12.97	41.72	0.5
T_{14}-Gco-1	48.67	54.67	98.67	17.93	4.83	4.13	3.53	357.00	11.90	5.42	11.20	39.44	0.4
T_{15}-Gco-2	42.00	46.00	99.67	17.10	5.00	5.03	3.73	326.50	10.88	7.33	12.10	48.50	0.4
T_{16}-Acr-1	52.67	59.67	108.33	18.13	5.03	5.30	5.33	387.00	12.90	4.10	10.77	56.52	0.8
T_{17}-Dcc-1	39.67	45.33	94.33	17.00	4.97	5.15	2.93	301.50	10.05	3.36	8.63	46.58	0.2
T_{18}-Dcc-2	39.67	45.00	94.33	16.57	4.83	4.53	2.80	334.00	11.13	4.50	10.00	38.36	0.3
T_{19}-Dcc-3	40.00	43.67	94.00	15.94	4.10	3.83	2.73	299.50	9.98	3.86	9.10	41.43	0.2
T_{20}-Dcc-4	39.33	43.67	95.00	13.20	3.97	3.80	2.67	279.50	9.31	2.80	8.07	48.81	0.1
S. Em ±	1.83	2.08	3.41	1.73	0.26	0.40	0.75	21.48	0.72	1.54	0.85	2.38	0.04
C.D @ 5%	5.32	6.06	10.00	5.10	0.76	1.16	2.2	63.27	2.10	4.51	2.50	6.93	0.12

4.1.8 Number of umbellets per umbel

The data pertaining to number of umbellets per umbel in different genotypes of coriander is presented in the table 3. Significantly maximum umbellets per umbel was recorded in the genotype Rcr-475 (5.50) followed by Rcr-446 (5.47). These were on par with each other. While, the minimum was found in the genotype DCC-4 (3.97).

4.1.9 Number of seeds per umbellet

Among the different genotypes, significantly maximum number of seeds per umbellet was recorded in the genotype Rcr-475 (5.70) followed by Rcr-446 (5.52) and were on par with each other, the minimum was found in the genotypes DCC-4 (3.80). The data pertaining to number of seeds per umbellet in different coriander genotypes is presented in the table 3.

4.1.10 Days taken to maturity

Significant differences were recorded among the study genotypes with respect to days to maturity table 3.

Significantly maximum days taken for maturity was recorded in the genotype Rcr-446 (110 days) and Rcr-41(110 days) and followed by the genotype Acr-1(108.33 days) these were on par with each other. While, it was minimum in the genotype DCC-3 (94.00 days) followed by DCC-1 and DCC-2 (94.33 days).

4.1.11 Dry matter production (q)

The data pertaining to dry matter production of different genotypes of coriander is presented in the table 3. The maximum dry matter production (8.22 q) was recorded in the genotype Rcr-41, followed by Co-4 (8.06 q) and these two were on par with each other. The genotype DCC-4 has recorded a low dry matter production (2.80 q).

4.1.12 Seed yield per plant (g)

Significant differences were recorded among the study genotypes with respect to seed yield per plant table 3.

The genotype Rcr-475 (6.37g) recorded significantly highest seed yield per plant followed by Rcr-446 (6.20 g). However, these genotypes are on par with each other. The genotype DCC-4 (2.67 g) followed by DCC-3 (2.73 g) has recorded as lowest seed yield per plants.

4.1.13 Seed yield per plot (g)

Among the genotypes, significantly maximum seed yield per plot was recorded in the genotype Rcr-475 (505 g) followed by Rcr-446 (497 g). However, these genotypes are on par with each other. The genotype DCC-4 has recorded minimum seed yield of (279.5 g) per plot table 3.

4.1.14 Seed yield per hectare (q)

The data pertaining to seed yield per hectare in different genotypes of coriander is presented in the Table 3. Among the genotypes, significantly highest seed yield was registered by the genotype Rcr-475 (16.83 q) followed by Rcr-728 (16.58 q). However, these genotypes were on par with each other. The genotype DCC-4 has recorded the lowest seed yield (9.31 q ha^{-1})

4.1.15 Test weight (g)

Significant differences were recorded among the studied genotypes with respect to test weight table 3.

Among the different coriander genotypes, significantly highest test weight was recorded in the genotypes Rcr-475 (14.53 g) followed by Rcr-20 (14.27 g). However, these genotypes were on par with each other. While, it was lowest in the genotype Rcr-436 (8.07 g).

4.1.16 Harvest index (%)

The data pertaining to harvest index in different genotypes of coriander is presented in the table 3.

Significantly maximum harvest index was recorded in the genotype Acr-1 (56.52 %) followed by Rcr-435 (53.83 %). However these genotypes were on par with each other. While, it was minimum in the genotype DCC-2 (38.36 %).

4.1.17 Essential oil content (%)

Among the different genotypes, significantly highest essential oil content was recorded in Acr-1and Rcr -728 (0.8%) followed by Rcr-475 (0.6%) and Co-3 (0.6%). While, it was lowest in the genotype DCC-4 (0.1%). The data on essential oil content in coriander seeds of different genotypes is presented in the table 3.

4.2 Analysis of variance

Analysis of variance showed significant differences among the genotypes for all the characters studied both at five and one per cent level of significance. The mean sum of squares due to genotypes for different characters is presented in the table 4 and 5.

4.3 Genetic variability, heritability and genetic advance

The genetic parameters *viz.*, mean, range, phenotypic and genotypic coefficients of variation, heritability (broad sense) estimates and predicted genetic advance as per cent of mean for all the characters studied are presented in table 6.

Table 4. Analysis of variance (mean sum of square) for growth parameters in different genotypes of coriander (*Coriandrum sativum* L.)

Source	d. f	Plant height (cm)	Number of primary branches	Number of secondary branches	Plant spread (cm^2)	Days to first flowering	Days to 50% flowering
Replication	2	34.17	0.99	5.88	6628.06	20.850	0.71
Treatment	19	341.31**	3.09**	8.92**	42893.17**	100.96**	109.67**
Error	38	29.02	0.876	2.97	6538.856	10.60	13.75
S.Em ±		3.03	0.52	0.96	45.05	1.83	2.08
C.D @ 5%		8.90	1.54	2.80	133.65	5.38	6.12
C.D @ 1%		11.9	2.07	3.80	179.02	7.20	8.21

Where,

d.f. - Degrees of freedom, *** - Significance at 5%** **** - Significance at 1 %,**

Table 5. Analysis of variance (mean sum of square) for yield parameters in different genotypes of coriander (*Coriandrum sativum* L.)

Source	d.f	Umbels plant^{-1}	Umbellet umbel^{-1}	Seeds umbellete^{-1}	Days taken for maturity	Seeds plant^{-1}	Seeds plot^{-1}	Seed yield (q ha^{-1})	Dry matter (qha^{-1})	Test weight (g)	Harvest index (%)	Essential oil (%)
Replication	2	13.28	1.65	0.02	45.26	1.26	4985.5	5.223	22.650	1.99	81.67	0.018
Treatment	19	46.35**	0.50*	1.00*	70.05*	4.38**	10699.9**	14.99**	67.934**	10.685**	160.55**	0.035**
Error	38	9.54	0.21	0.513	36.72	1.80	1511.9764	1.65	7.51	2.32	17.89	0.004
S.Em ±		1.73	0.26	0.40	3.41	0.75	21.88	0.72	1.54	0.85	2.38	0.037
C.D @ 5%		5.1	0.76	1.18	10.01	2.21	64.27	2.12	4.5	2.51	6.99	0.11
C.D @ 1%		6.8	1.027	1.68	18.41	2.97	86.08	2.85	6.06	3.37	936	0.14

Where,

d.f. - Degrees of freedom, *** - Significance at 5 %,** *** * - Significance at 1%**

4.3.1 Plant height (cm) at harvest

The plant height at harvest was in the range of 37.4 to 70.27 cm with a mean of 48.8 cm. The genotypic and phenotypic variances were 104.09 and 133.12, respectively. The genotypic and phenotypic coefficients of variation were 20.89 and 23.63 per cent, respectively. The heritability for the trait was 78.20 per cent with a genetic advance of 18.58 and genetic advance over mean of 38.06 per cent.

4.3.2 Number of primary branches per plant

The number of primary branches per plant at harvest was in the range of 4.13 to 7.3 with a mean of 5.7. The genotypic and phenotypic variances were 0.74 and 1.61, respectively. The genotypic and phenotypic coefficients of variation were 15.05 and 22.25 per cent, respectively. The heritability for the trait was 45.79 per cent with a genetic advance of 1.19 and genetic advance over mean of 20.98 per cent.

4.3.3 Number of secondary branches per plant

The number of secondary branches per plant at harvest was in the range from 8.3 to 13.90 with a mean of 11.04. The genotypic and phenotypic variances were 1.98 and 4.95, respectively. The genotypic and phenotypic coefficients of variation were 12.76 and 20.1 per cent, respectively. The heritability for the trait was 40.06 per cent with a genetic advance of 1.83 and genetic advance over mean of 16.6 per cent.

4.3.4 Plant spread (cm^2)

The plant spread ranged from 380.6 to 645 cm^2 with an average of 517.6 cm^2. The genotypic and phenotypic variances were 12118.10 and 18656, respectively. The genotypic and phenotypic coefficients of variation were 21.76 and 26.38 per cent, respectively. The heritability for the trait was 64.95 per cent with a genetic advance of 182.76 and genetic advance over mean of 35.30 per cent.

4.3.5 Number of days for first flowering

The number of days to first flowering was in the range of 39.3 to 58.6 with a mean of 45.5. The genotypic and phenotypic variances were 30.12 and 40.72, respectively. The genotypic and phenotypic coefficients of variation were 12.06 and 14.02 per cent, respectively. The heritability of 73.95 per cent with a genetic advance of 9.72 and genetic advance over mean of 21.36 per cent was observed for this trait.

4.3.6 Number of days for 50 per cent flowering

The average number of days to 50 per cent flowering was 50.2 with a minimum of 43.36 days to a maximum of 63.6 days in the coriander genotypes used for present study. The genotypic and phenotypic variances were 31.97 and 45.72, respectively. The genotypic and phenotypic coefficients of variation were 11.24 and

13.45 per cent, respectively. The trait exhibited 69.92 per cent heritability with a genetic advance of 9.74 and genetic advance over mean of 19.37 per cent.

4.3.7 Number of umbels per plant

Number of umbels per plant was in the range of 13.2 to 28.1 with a mean of 19.9. The genotypic and phenotypic variances were 12.27 and 21.81, respectively. The genotypic and phenotypic coefficients of variation were 17.57 and 23.4 per cent, respectively. A high heritability of 56.26 per cent with a genetic advance of 5.41 and genetic advance over mean of 27.16 per cent was observed for this trait.

4.3.8 Number of umbellets per umbel

The mean number of umbellets per umbel was 4.87 with a range of 3.96 to 5.50. The genotypic and phenotypic variances were 0.097 and 0.313, respectively. The genotypic and phenotypic coefficients of variation were 6.41 and 11.4 per cent, respectively. A high heritability of 31.17 per cent with a genetic advance of 0.35 and genetic advance over mean of 7.37 per cent was observed for this trait.

4.3.9 Number of seeds per umbellet

The mean number of seeds per umbellet was 4.89 with a range of 3.8 to 5.7. The genotypic and phenotypic variances were 0.16 and 0.67, respectively. The genotypic and phenotypic coefficients of variation were 8.35 and 17.04 per cent, respectively. The broad sense heritability for this trait was 24.06 per cent coupled with a genetic advance of 0.407 and high genetic advance over mean of 8.44 per cent.

4.3.10 Days taken to maturity

Days for maturity are varied from 94.6 to 110.0 with a mean of 99.98. The genotypic and phenotypic variances were 11.10 and 47.83, respectively. The genotypic and phenotypic coefficients of variation were 3.33 and 6.91 per cent, respectively. A high heritability of 23.26 per cent with a genetic advance of 3.309 and genetic advance over mean of 3.31 per cent was observed for this trait.

4.3.11 Seed yield per plant (g)

Seed yield per plant was in the range of 2.6 to 6.20 g with a mean of 4.31 g. The genotypic and phenotypic variance was 0.862 and 2.66, respectively. The genotypic and phenotypic coefficient of variation was 21.54 and 37.86 per cent respectively. The broad sense heritability of 32.36 per cent with a genetic advance of 1.08 of and genetic advance over mean of 25.24 per cent was observed for this trait.

4.3.12 Seed yield per plot (g)

Seed yield per plot was in the range of 279.5 to 505 g with a mean of 245.91 g. The genotypic and phenotypic variances were 3062.67 and 4574.64, respectively.

Table 6. Estimates of mean, range and genetic parameters for growth and yield traits in coriander (*Coriandrum sativum* L.) genotypes

Sl No	Characters	Mean± S.Em	Range	GV	PV	GCV (%)	PCV (%)	h^2 (bs) (%)	GA	GAM
Growth parameters										
1	Plant height	48.8± 3.03	37.4-70.27	104.09	133.12	20.89	23.63	78.20	18.586	38.06
2	Number of primary branches	5.7± 0.520	4.13- 7.30	0.74	1.6162	15.05	22.25	45.79	1.199	20.98
3	Number of secondary branches	11.041± 0.69	8.3-13.90	1.9853	4.9554	12.76	20.1	40.06	1.837	16.60
4	Plant spread	517.6± 45.05	380.6-645	12118.1	18656	21.26	26.38	64.95	182.76	35.30
Yield parameters										
5	Days to first flowering	45.5± 1.83	39.3-58.6	30.12	40.72	12.06	14.02	73.95	9.72	21.36
6	Days to 50% flowering	50.2±2.080	43.6-63.6	31.97	45.72	11.24	13.45	69.92	9.74	19.37
7	Umbels/plant	19.9± 1.730	13.2-28.1	12.27	21.81	17.57	23.40	56.26	5.41	27.16
8	Umbellate/umbell	4.87± 0.260	3.96-5.50	0.097	0.3132	6.41	11.40	31.17	0.35	7.37
9	Seeds/umbellet	4.893±0.400	3.8-5.70	0.162	0.6756	8.35	17.04	24.06	0.407	8.44
10	Days taken to maturity	99.98± 3.41	94.6-110	11.10	47.83	3.33	6.91	23.26	3.309	3.31
11	Seed yield/plant	4.31±0.750	2.6- 6.20	0.862	2.66	21.54	37.86	32.36	1.088	25.24
12	Seed yield/plot	245.91± 21.8	279.5- 505	3062.67	4574.64	22.5	27.50	66.95	93.28	37.93
13	Seed yield/ha	8.28± 0.720	9.3-16.80	4.44	6.10	25.45	29.81	72.84	3.7071	44.74
14	Dry matter(qha^{-1})	32.34± 1.54	2.8- 8.22	20.13	27.65	13.87	16.25	72.83	7.88	24.38
15	Test weight(g)	11.07± 0.85	8.06- 14.50	2.788	5.10	15.08	20.41	54.57	2.5408	22.95
16	Harvest index (%)	28.72± 2.44	38.86-56.52	47.55	24.01	25.44	28.16	70	0.177	45.65
Quality parameters										
17	Essential oils (%)	0.38± 0.037	0.1-0.8	0.0105	0.015	26.47	31.63	70.05	0.17	45.65

The genotypic and phenotypic coefficients of variation were 22.50 and 27.50 per cent, respectively. The broad sense heritability of 66.95 per cent coupled with a genetic advance of 93.28 and genetic advance over mean of 37.93 per cent was observed for this trait.

4.3.13 Seed yield per hectare (q)

The mean of seed yield per hectare was 8.28 with a range of 9.31 to 16.83 q. The genotypic and phenotypic variances were 4.44 and 6.10, respectively. The genotypic and phenotypic coefficients of variation were 25.45 and 29.81 per cent, respectively. The broad sense heritability of 72.84 per cent with a genetic advance of 3.70 and genetic advance over mean of 44.74 per cent was observed for this trait.

4.3.14 Dry matter production (g)

The mean dry matter production recorded in the present coriander genotypes was 32.34 g with a range of 2.8 to 8.22 g. The genotypic and phenotypic variances were 20.13 and 27.65, respectively. The genotypic and phenotypic coefficients of variation were 13.87 and 16.25 per cent, respectively. A high heritability of 72.83 per cent coupled with a genetic advance of 7.88 and genetic advance over mean of 24.38 per cent was observed for this trait.

4.3.15 Test weight (g)

The mean test weight was 11.07 g with a range of 8.06 to14.5 g. The genotypic and phenotypic variances were 2.78 and 5.10, respectively. The genotypic and phenotypic coefficients of variation were 15.08 and 20.41 per cent, respectively. The broad sense heritability of 54.57 per cent with a genetic advance of 2.54 and genetic advance over mean of 22.95 per cent was observed for this trait.

4.3.16 Harvest index (%)

The harvest index was in the range of 38.36 to 56.52 per cent with a mean of 28.72 per cent. The genotypic and phenotypic variances were 47.55 and 24.01, respectively. The genotypic and phenotypic coefficients of variation were 65.44 and 28.16 per cent, respectively. The high heritability value of 70 per cent coupled with a genetic advance of 0.177 and high genetic advance over mean of 45.65 per cent was observed for this trait.

4.3.17 Essential oil content (%)

The essential oil content was in the range of 0.1 to 0.8 per cent with a mean of 0.38 per cent. The genotypic and phenotypic variances were 0.0105 and 0.015, respectively. The genotypic and phenotypic coefficients of variation were 26.47 and 31.63 per cent, respectively. The high heritability value of 70.05 per cent coupled with a genetic advance of 0.17 and high genetic advance over mean of 45.65 per cent was observed for this trait.

4.4 Character association

The correlations were estimated among 16 characters to determine the nature of association existing between them table 7. Only phenotypic correlation coefficients were taken under for this association analysis.

4.4.1 Correlation of seed yield with other traits

Among the characters studied, the characters *viz*., plant height at harvest (0.237), number of primary branches per plant (0.359), plant spread (0.279), number of seeds per plant (0.269), test weight (0.254) showed positive significant correlation with seed yield per plant. Besides exhibiting a positive non significant association with secondary branches per plant (0.224), days to first flowering (0.170), days to 50 per cent flowering (0.217), umbellets per umbel (0.118), dry matter (0.116), seeds per umbellet (0.073), days taken to maturity (0.047), seed yield per plot (0.180), seed yield per hectare (0.178), harvest index (0.043) and essential oil (0.140), respectively.

4.4.2 Plant height at harvest (cm)

Plant height at harvest showed a highly significant positive association with number of primary branches (0.590), days to first flowering (0.935), days to 50 per cent flowering (0.281), number of seed per umbellet (0.341), days taken for maturity (0.316), seed yield per plot (0.392) and seed yield per ha (0.396). However, it exhibited non significant positive correlation with number of secondary branches (0.504), plant spread (0.557), number of umbels per plant (0.175), number of umbellet per umbel (0.196), test weight (0.011), and negative non-significant correlation with dry matter (-0.237), essential oil content (-0.053) and harvest index (-0.080).

4.4.3 Number of primary branches

Number of primary branches showed a highly significant positive association with days to first flowering (0.620), days to 50 per cent flowering (0.590), number of umbellet per umbel (0.214), number of seeds per umbellet (0.295), days taken for maturity (0384), seed yield per plot (0.392) and seed yield per hectare (0.543). Whereas, it exhibited negative association with days to first flowering (-0.288). However, it exhibited a non-significant positive correlation with plant spread (0.230), number of umbels per plant (0.138), number of umbellet per umbel (0.236), test weight (0.110) and essential oil content (0.061). Besides having a negative non-significant correlation with dry matter (0.228) and harvest index (0.097).

4.4.4 Number of secondary branches

Number of secondary branches showed a highly significant positive association with plant spread (0.302), essential oil content (0.376). However, it exhibited a non-significant positive correlation with days to first flowering (0.177),

Table 7. Estimates of phenotypic correlation coefficients for yield and yield attributing traits in coriander genotypes

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17 (r.P)
1	**1.000**	0.590**	0.139	0.142	0.935**	0.281*	0.175	0.196	0.341**	0.316*	0.392*	0.396**	-0.237	0.069	-0.080	0.053	**0.237***
2		**1.000**	0.504**	0.243	0.620**	0.460**	0.138	0.236	0.295*	0.384**	0.392**	0.543**	-0.228	0.110	-0.097	0.061	**0.359****
3			**1.000**	0.302*	0.177	0.504**	-0.120	0.005	-0.164	0.109	0.073	0.247	-0.193	-0.054	0.006	0.376**	**0.224**
4				**1.000**	0.159	0.557**	0.060	0.191	-0.052	0.152	0.288*	0.238	-0.252	0.029	0.243	0.298*	**0.279***
5					**1.000**	0.192	0.234	0.087	0.384**	0.284*	0.441**	0.457**	-0.271*	0.055	-0.077	-0.033	**0.170**
6						**1.000**	-0.264	0.214	0.026	0.206	0.123	0.188	-0.150	0.011	0.159	0.260*	**0.224**
7							**1.000**	0.205	0.243	0.077	0.541**	0.330**	0.083	0.449**	0.0195	-0.014	**0.269***
8								**1.000**	0.287*	0.219	0.259*	0.056	0.197	0.082	-0.119	0.002	**0.118**
9									**1.000**	0.040	0.130	0.140	0.094	0.066	0.019	-0.437**	**0.073**
10										**1.000**	0.377**	0.197	0.014	0.096	0.037	-0.077	**0.047**
11											**1.000**	0.664**	-0.128	0.410**	0.285*	0.080	**0.180**
12												**1.000**	0.916	0.331**	0.353**	0.130	**0.178**
13													**1.000**	0.105	0.376**	-0.155	**0.116**
14														**1.000**	0.265*	0.018	**0.244***
15															**1.000**	0.090	**0.043**
16																**1.000**	**0.140**
																	1.000

Critical r value 1%= 0.301 5%=0.231 *& indicates significant @ 5% and 1% level respectively**
rP - Phenotypic correlation with seed yield per plant

1. Plant height (cm)
2. Number of primary branches
3. Number of secondary branches
4. Plant spread (cm^2)
5. Days to first flowering
6. Days to 50% flowering
7. Number of umbels per plant
8. Number of umbellate per umbel
9. Number of seed per umbellet
10. Days taken for maturity
11. Seed yield per plot(g)
12. Seed yield per (ha)
13. Dry matter production(qha^{-1})
14. Test weight (g)
15. Harvest index (%)
16. Essential oil content (%)
17. Seed yield per plant (g)

days to 50 per cent flowering (0.139), number of umbellets per umbel (0.005), days taken for maturity (0.109), seed yield per plot (0.073), seed yield per hectare (0.247) and harvest index (0.006). Besides showing a negative non-significant correlation with number of umbels per plant (0.120), number of seed per umbellet (0.164), dry matter (0.193) and test weight (0.054).

4.4.5 Plant spread (cm^2)

Plant spread at harvest showed a significant positive association with plant spread (0.288), seed yield per hectare (0.238), essential oil content (0.298) and significant negative association with seed yield per plot (-252). However, it exhibited a non-significant positive correlation with days to first flowering (0.159), days to 50 per cent flowering (0.142), number of umbels per plant (0.060), number of umbellet per umbel (0.191), days taken for maturity (0.152), test weight (0.029) and harvest index (0.230), besides having a negative non-significant correlation with number of seed per umbellet (-0.052).

4.4.6 Days to first flowering

Days to first flowering showed a highly significant positive association with days to 50 per cent flowering (0.935), number of umbels per plant (0.234), number of seed per umbellet (0.384), days taken for maturity (0.284), seed yield per plot (0.441) and seed yield per hectare (0.457). However, it exhibited non-significant positive correlation with number of umbellets per umbel (0.087), test weight (0.055) and in addition it exhibited a negative significant correlation with dry matter (-0.271). It exhibited non-significant negative correlation with harvest index (-0.077) and essential oil content (-0.033).

4.4.7 Days to 50 per cent flowering

Days taken for 50 per cent flowering showed a highly significant positive association with essential oil content (0.260). Whereas, it exhibited a non-significant positive correlation with number of umbellets per umbel (0.241), test weight (0.011), harvest index (0.080), number of seeds per umbellet (0.026), days taken for maturity (0.206), seed yield per plot (0.123) and seed yield per hectare (0.188). Besides showing a negative non- significant correlation with umbels per plant (-0.264) and dry matter (-0.150).

4.4.8 Number of umbels per plant

Number of umbels per plant showed a highly significant positive association with number of seeds per umbellet (0.243), seed yield per plot (0.541), seed yield per hectare (0.330), and test weight (0.449). It exhibited a non- significant positive correlation with number of umbellets per umbel (0.205), days taken for maturity (0.077), dry matter (0.083), and harvest index (0.0195) in addition to its negative non-significant correlation with essential oil content (0.0.014).

4.4.9 Number of umbellet per umbel

Number of umbellet per umbel showed significant positive association with number of seed per umbellet (0.287), seed yield per plot (0.259). It exhibited non-significant positive correlation with days taken for maturity (0.219), seed yield per hectare (0.056), dry matter (0.197), test weight (0.082), essential oil content (0.002). However, it also exhibited negative non-significant correlation with harvest index (0.119).

4.4.10 Number of seeds per umbellet

Number of seeds per plant showed significant positive association with days taken for maturity (0.040), seed yield per plot (0.130), seed yield per hectare (0.140), dry matter (0.094), test weight (0.066), harvest index (0.019). Further, this trait also exhibited negative significant correlation with essential oil content (0.437).

4.4.11 Days taken for maturity

Days taken for maturity showed significant positive association with seed yield per plot (0.377). However showed non-significant positive association with seed yield per hectare (0.197), dry matter (0.014), test weight (0.096), and harvest index (0.037). Further, this trait also exhibited negative non significant correlation with essential oil content (0.077).

4.4.12 Seed yield per plot (g)

Seed yield per plot showed significant positive association with seed yield per hectare (0.664), test weight (0.410), and harvest index (0.285). But exhibited a non significant positive with essential oil content (0.077). Besides its negative non-significant correlation with dry matter (0.128).

4.4.13 Seed yield per hectare (q)

Seed yield per hectare showed significant positive association with dry matter (0.916), test weight (0.331) and harvest index (0.353). However it shows non-significant positive association with essential oil content (0.130).

4.4.2.14 Dry matter production (g)

Dry matter production showed significant positive association with harvest index (0.376). However, it shows non-significant positive association with test weight (0.105) but negative non significant correlation with essential oil content (-0.155).

4.4.15 Test weight (g)

Test weight showed significant positive association with harvest index (0.265). However, it showed non-significant positive association with essential oil content (0.0188).

4.4.16 Harvest index (%)

Harvest index showed non-significant positive association with essential oil content (0.090).

4.4.17 Essential oil content (%)

Essential oil content of seed showed significant positive association with secondary branches (0.376), plant spread (0.298), days taken to first flowering (0.260), negative significant correlation with number of seeds per umbellet (-437). However, it showed non-significant positive association with plant height (0.053), number of primary branches (0.061), number of umbellets per umbel (0.002), harvest index (0.090), test weight (0.018) and seed yield per ha (0.130).

4.5 Path coefficient analysis

The path analysis for seed yield per plant was performed with 13 independent characters viz., plant height at harvest, number of primary branches, plant spread, days for first flowering, days to 50 per cent flowering, number of umbels per plant, number of umbellets per umbel, number of seed per umbellet, days taken for maturity, seed yield per plant, seed yield per plot, seed yield per hectare, dry matter production, test weight of seed, harvest index and essential oil of the seed. The results of path analysis are presented in the table 8.

4.5.1 Plant height (cm) at harvest

Plant height at harvest and number of primary branches had a direct positive effect (0.618) and (0.662) on seed yield per plant and also an indirect positive effect through, plant spread (0.039), number of umbels per plant (0.050), seed yield per plot (0.039), seed yield per hectare (0.008) and test weight (0.009). However, this trait exhibited an indirect negative effect on seed yield per plant through first flowering (-0.624), 50 per cent flowering (-0.007), number of umbellet per umbel (-0.026), number of seeds per umbellet (-0.013), days taken for maturity (-0.046), dry matter (-0.011), harvest index (-0.005) and essential oil content (-0.006).

4.5.2 Number of primary branches per plant

The trait, number of primary branches per plant had a direct positive effect (0.662) on seed yield per plant and also a positive effect on seed yield per plant indirectly through various other independent traits *viz*., plant spread (0.066), days to 50 per cent flowering (0.364), number of umbels per plant (0.039), seed yield per plot (0.039), seed yield per hectare (0.110), test weight (0.014) and essential oil content (0.007). Nevertheless, this trait has exhibited an indirect negative effect on seed yield per plant through plant height (-0.011), number of secondary branches (-0.103), days to first flowering (-0.414), number of umbellets per umbel (-0.032), number of seeds

Table 8. Estimates of direct (diagonal) and indirect effects (of diagonal) of growth, yield and quality on seed yield at phenotypic level in coriander genotypes

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17 (r.P)**
1	**0.618**	0.364	0.086	0.087	0.578	0.173	0.108	0.121	0.211	0.195	0.242	0.244	-0.146	0.043	-0.049	-0.033	**0.237***
2	0.391	**0.662**	0.334	0.161	0.411	0.304	0.091	0.156	0.196	0.254	0.259	0.359	-0.151	0.073	-0.064	0.040	**0.359****
3	-0.028	-0.103	**-0.205**	-0.062	-0.036	-0.103	0.024	-0.001	0.033	-0.022	-0.015	-0.050	0.039	0.011	-0.001	-0.077	**0.224**
4	0.039	0.066	0.083	**0.274**	0.043	0.153	0.016	0.052	-0.014	0.042	0.079	0.065	-0.069	0.008	0.066	0.082	**0.279***
5	-0.624	-0.414	-0.118	-0.106	**-0.667**	-0.128	-0.156	-0.058	-0.256	-0.189	-0.294	-0.305	0.181	-0.037	0.051	0.022	**0.170**
6	-0.007	-0.011	-0.012	-0.013	-0.004	**-0.024**	0.006	-0.005	-0.000	-0.005	-0.003	-0.004	0.003	-0.000	-0.003	-0.006	**0.217**
7	0.050	0.039	-0.034	0.017	0.067	-0.075	**0.286**	0.058	0.069	0.022	0.155	0.094	0.024	0.128	0.005	-0.004	**0.269***
8	-0.026	-0.032	-0.000	-0.026	-0.012	-0.029	-0.028	**-0.137**	-0.039	-0.030	-0.035	-0.007	-0.027	-0.011	0.016	-0.000	**0.118**
9	-0.013	-0.011	0.006	0.002	-0.015	-0.011	-0.009	-0.011	**-0.039**	-0.001	-0.005	-0.005	-0.003	-0.002	-0.000	0.017	**0.073**
10	-0.046	-0.056	-0.016	-0.022	-0.041	-0.030	-0.013	-0.032	-0.006	**-0.146**	-0.055	-0.028	-0.002	-0.014	-0.005	0.011	**0.047**
11	0.039	-0.039	-0.007	-0.028	0.044	-0.012	0.054	-0.025	-0.013	-0.037	**0.098**	0.066	-0.012	-0.041	-0.028	-0.008	**0.180**
12	0.080	0.110	-0.050	-0.048	0.093	-0.038	0.067	-0.011	-0.028	-0.040	-0.135	**0.203**	-0.018	0.067	-0.071	-0.026	**0.178**
13	-0.011	-0.011	-0.009	-0.012	-0.013	-0.007	0.004	0.009	0.004	0.000	0.006	0.004	**0.048**	0.005	0.018	-0.007	**0.116**
14	0.009	0.014	-0.007	0.003	0.007	0.001	0.058	0.010	0.008	0.012	0.053	0.042	0.013	**0.129**	0.034	0.002	**0.244***
15	-0.005	-0.006	0.000	0.015	-0.005	-0.010	0.001	-0.007	0.001	0.002	0.018	0.023	0.024	0.017	**0.065**	0.005	**0.043**
16	-0.006	0.007	0.045	0.036	-0.004	-0.031	-0.001	0.000	-0.053	-0.009	0.009	0.015	-0.018	0.002	0.011	**0.121**	**0.140**
Partial R^2	**0.134**	**0.238**	**-0.019**	**0.076**	**-0.114**	**-0.005**	**0.077**	**-0.016**	**-0.002**	**-0.007**	**0.018**	**0.036**	**0.005**	**0.031**	**0.002**	**0.017**	

Residual effect- 0.8040

1. Plant height (cm)
2. Number of primary branches
3. Number of secondary branches
4. Plant spread (cm^2)
5. Days to first flowering
6. Days to 50% flowering
7. Number of umbels per plant
8. Number of umbellate per umbel
9. Number of seed per umbellate
10. Days taken for maturity
11. Seed yield per plot (g)
12. Seed yield per (ha)
13. Dry matter production(qha^{-1})
14. Test weight (g)
15. Harvest index (%)
16. Essential oil content (%)
17. Seed yield per plant (g)

per umbellet (-0.011), days taken for maturity (-0.056), dry matter (-0.011) and harvest index (-0.006).

4.5.3 Number of secondary branches per plant

The trait, number of secondary branches per plant had a direct negative effect (0.205) on seed yield per plant and also a positive effect on seed yield per plant indirectly through various other independent traits *viz*., Number of primary branches (0.334), plant spread (0.083), days to 50 per cent flowering (0.086), number of seeds per umbellet (0.006) and harvest index (0.000). Nevertheless, this trait has exhibited an indirect negative effect on seed yield per plant through plant height (-0.012), days to first flowering (-0.118), number of umbels per plant (-0.034), number of umbellets per umbel (-0.00), days taken for maturity (-0.016), seed yield per plot, (-0.007), seed yield per hectare (-0.050), dry matter (-0.009) and test weight (0.007).

4.5.4 Plant spread (cm^2)

Plant spread had a direct positive effect (0.274) on seed yield per plant and also an indirect positive effect through number of primary branches (0.161), days to 50 per cent flowering (0.087), number of umbels per plant (0.017), test weight (0.003), harvest index (0.015) and essential oil content (0.036). But it exhibited an indirect negative effect through plant height (-0.013), number of secondary branches (-0.062), days to first flowering (-0.106), number of umbellets per umbel (-0.026), days taken for maturity (-0.022), seed yield per plot (-0.028), seed yield per hectare (-0.048) and dry matter (-0.012).

4.5.5 Number of days for first flowering

Number of days for first flowering had a direct negative effect (-0.667) on seed yield per plant and also an indirect positive effect on seed yield per plant through various other independent traits *viz*., number of primary branches (0.411), plant spread (0.043), days to 50 per cent flowering (0.578), number of umbels per plant (0.067), seed yield per plot (0.044), seed yield per hectare (0.093) and test weight (0.007). However, it exhibited an indirect negative effect on plant height (-0.004), number of primary branches (-0.036), number of umbellet per umbel (-0.012), number of seed per umbellets (-0.015), days taken for maturity (-0.041), dry matter (-0.013), harvest index (-0.005) and essential oil content (-0.004).

4.5.6 Number of days to 50 per cent flowering

Number of days to 50 per cent flowering had a direct negative effect (-0.024) on seed yield per plant and also an indirect positive effect through plant height (0.173), number of primary branches (0.304), plant spread (0.153) and test weight (0.001). Nevertheless, this trait exhibited an indirect negative effect on days to first flowering (-0.128), number of umbels per plant (-0.075), number of umbellets per umbel (0.029), number of seeds per umbellet (-0.011), days taken for maturity (-0.030), seed yield per plant(-0.012), seed yield per plot (-0.012), seed yield per hectare (-0.038), dry matter (-0.007), harvest index (-0.010) and essential oil content (-0.031).

4.5.7 Number of umbels per plant

This trait showed a direct positive effect (0.286) on seed yield per plant and also an indirect negative effect on seed yield per plant through days to first flowering (-0.156), number of umbellet per umbel (-0.028), number of seeds per umbellet (-0.009), days taken for maturity (-0.013) and essential oil content (-0.001). But it exhibited an indirect positive effect on seed yield per plant through plant height (0.006), number of primary branches (0.091), number of secondary branches (0.024), plant spread (0.016), days to 50 per cent flowering (0.108), dry matter (0.004), seed yield per plot (0.054), seed yield per hectare (0.067), test weight (0.058) and harvest index (0.001).

4.5.8 Number of umbellets per umbel

Number of umbellets per umbel has exhibited a direct negative effect (-0.137) on seed yield per plant and also an indirect negative effect on seed yield per plant through plant height (-0.005), number of secondary branches (-0.001), days to first flowering (-0.058), number of seeds per umbellet (-0.011), days taken for maturity (-0.032), seed yield per plot (-0.025), seed yield per hectare (-0.011) and harvest index (-0.007). However, it exhibited an indirect positive effect on seed yield per plant through number of primary branches (0.156), plant spread (0.052), days to 50 per cent flowering (0.121), number of umbels per plant (0.058), dry matter (0.009), test weight (0.010) and essential oil content (0.0000).

4.5.9 Number of seeds per umbellet

Number of seeds per umbellet had a direct negative effect (-0.039) on seed yield per plant and also an indirect positive effect through number of primary branches (0.196), number of secondary branches (0.033), days to 50 per cent flowering (0.211), number of umbels per plant (0.069), dry matter (0.004), test weight (0.008) and harvest index (0.001). But it exhibited an indirect negative effect on seed yield per plant through plant height (-0.00), plant spread (-0.014), days to first flowering (-0.256), number of umbellets per umbel (-0.039), days taken for maturity (-0.006), seed yield per plot (-0.013), seed yield per hectare (-0.028) and essential oil content (-0.053).

4.5.10 Days taken for maturity

Days taken for maturity had a direct negative effect (-0.146) on seed yield per plant and also an indirect positive effect through number of primary branches (0.254) plant spread (0.042), days to 50 per cent flowering (0.195), number of umbels per plant (0.022), dry matter (0.00), test weight (0.012) and harvest index (0.002). However, it exhibited an indirect negative effect on seed yield through plant height (-0.005), number of secondary branches (-0.022), days to first flowering (-0.189), number of umbellets per umbel (-0.030), number of seeds per umbellet (-0.001), seed yield per plot (-0.037), seed yield per hectare (-0.040) and essential oil content (-0.009).

4.5.11 Seed yield per plot

This trait has shown a direct positive effect (0.098) on seed yield per plant and also an indirect negative effect on seed yield per plant through plant height (-0.003), number of secondary branches (-0.015), days to first flowering (-0.294), number of umbellets per umbel (-0.035), number of seeds per umbellet (-0.005) and days taken for maturity (-0.055). But it exhibited an indirect positive effect through number of primary branches (0.259), plant spread (0.079), days to 50 per cent flowering (0.242), number of umbels per plant (0.155), dry matter (0.006), test weight (0.053), seed yield per hectare (0.135), harvest index (0.018) and essential oil content (0.009).

4.5.12 Seed yield per hectare (q)

Seed yield per hectare had a direct positive effect (0.203) on seed yield per plant and also an indirect positive effect through number of primary branches (0.359), plant spread (0.065), days to 50 per cent flowering (0.244), number of umbels per plant (0.094), dry matter (0.004), test weight (0.042), seed yield per hectare (0.004), harvest index (0.023) and essential oil content (0.015). Nevertheless, this trait has exhibited an indirect negative effect on seed yield through number of secondary branches (-0.050), days to first flowering (-0.305), number of umbellets per umbel (-0.007), number of seed per umbellet (-0.005), days taken for maturity (-0.028) and seed yield per plot (-0.066).

4.5.13 Dry matter production (g)

This trait had a direct positive effect (0.048) on seed yield per plant and also an indirect positive effect through plant height (0.003), number of secondary branches (0.039), days to first flowering (0.181), number of umbels per plant (0.024), test weight (0.013) and harvest index (0.024). However, it exhibited an indirect negative effect on seed yield through number of primary branches (-0.151), plant spread (-0.069), days to 50 per cent flowering (-0.146), number of umbellets per umbel (-0.027), number of seeds per umbellet (-0.003), days taken for maturity (-0.002), seed yield per plot (-0.012), seed yield per hectare (-0.018) and essential oil content (-0.018).

4.5.14 Test weight (g)

Test weight recorded direct positive effect (0.129) on seed yield per plant and also an indirect positive effect through number of primary branches (0.073), number of secondary branches (0.011), plant spread (0.008), days to 50 per cent flowering (0.043), seed yield per plot (0.041), number of umbels per plant (0.128), dry matter (0.005), harvest index (0.017) and essential oil content (0.002). However, it exhibited an indirect negative effect on seed yield through plant height (-0.00) days to first flowering (-0.037), number of umbellets per umbel (-0.011), number of seeds per umbellet (-0.002), days taken for maturity (-0.014) and seed yield per hectare (-0.067).

4.5.15 Harvest index (%)

This trait had a direct positive effect (0.065) on seed yield per plant and also an indirect positive effect through plant spread (0.066), days to first flowering (0.051), number of umbels per plant (0.005), number of umbellets per umbel (0.016), dry matter (0.018), test weight (0.034) and essential oil content (0.011). However, it exhibited an indirect negative effect on seed yield through plant height (-0.003), number of primary branches (-0.064), number of secondary branches (-0.001), days to 50 per cent flowering (-0.049), number of seeds per umbellet (-0.00), days taken for maturity (-0.005), seed yield per plot (-0.028) and seed yield per hectare (-0.071).

4.5.16 Essential oil content (%)

Essential oil content had direct positive effect (0.121) on seed yield per plant and also an indirect positive effect through number of primary branches (0.040), plant spread (0.082), days to first flowering (0.022), number of seeds per umbellet (0.017), days taken for maturity (0.011), test weight (0.002) and harvest index (0.005). However, it exhibited an indirect negative effect on seed yield through plant height (-0.006), number of secondary branches (-0.077), days to 50 per cent flowering (-0.033), number of umbels per plant (-0.004), number of umbellet per umbel (-0.000), seed yield per plot (-0.008), seed yield per hectare (-0.026), and dry matter (-0.007).

DISCUSSION

V DISCUSSION

The coriander is an important annual seed spice grown in Karnataka state. The present investigation was carried out to study the Evaluation of different coriander genotypes with respect to growth, yield and quality during *rabi* season of 2016-2017 at Zonal Agricultural and Horticultural Research station (ZAHRS), Babbur farm, Hiriyur taluk, Chitradurga (Dist) coming under the central dry zone of Karnataka. The results obtained from the present study are discussed here under.

5.1 Weather condition and crop growth

5.1.1 Weather condition

The weather data indicate that the total rainfall of 313.4 mm was received during the year 2016 (Appendix II). The rainfall received at time of sowing helped for better germination and crop growth. During the experimental period, there were not much variations in the maximum and minimum atmospheric temperature. During the crop growth, the maximum temperature (33.32^{0} C) and minimum temperature (13.40^{0} C) were recorded during the month of February and January, respectively. The relative humidity (83%) during the month of December favored the crop growth and seed set.

5.1.2 Crop growth

Crop growth and yield performance of the coriander genotype under protective irrigation condition was better with higher biomass and yield with minimum incidence of pests and diseases.

5.1.3 Performance of coriander varieties for growth, yield and quality

Choosing a variety for particular agro climatic condition is of great significance as it shows considerable variability in various characters when they are grown under a particular ecological situation. Yield and quality of crop largely depends on the vigor of plant as indicated by the various growth parameters such as plant height, number of branches, number of umbels, number of umbellets, plant spread and number of days taken for flowering etc. Better growth is normally reflected through higher yield and quality. The growth is normally governed by the genetic constitution of the particular variety and environmental condition under which the crop is raised. Selection of better genotype can be of immense value to the breeder for further improvement and development of the crop.

As coriander is an important annual seed spice crop, it needs a great deal of critical evaluation of the available genotypes for selection of the improved genotypes with high yield potential for specific agro-climatic conditions.

Therefore, the present investigation was undertaken in order to evaluate the morphological traits of the collected coriander genotypes and to select the promising ones for higher seed yield and quality under protective irrigation. Therefore, attempts were made in the present study to select suitable and high yielding coriander genotypes during *rabi* season in the central dry zone.

5.1.4 Plant height (cm)

In the present study, the plant height varied significantly among the genotypes. Genotype Rcr-475 was found to be vigorous in growth habit with respect to plant height at 30, 60, DAS and at harvest (18.64, 58.73 and 70.27 cm respectively) whereas, it was minimum in the genotype DCC-4 (8.13, 34.93 and 37.47 cm, respectively) indicating its poor vigor. Variations in plant height were mainly due to genetic factors of the respective genotype as well as influence of the growing environmental conditions which in turn increases vegetative growth leading to synthesis of more carbohydrates and their utilization for food production and effective absorption of the nutrients resulting in increased yield. Such variations were also observed by Giridhar and Sarada (2005), Moniruzzaman *et al.* (2013), Malik and Tehlan (2013) and Phurailatpam *et al.* (2014).

5.1.5 Number of primary branches per plant

Number of primary branches per plant was maximum in the genotype Rcr-475 at 30, 60, DAS and at harvest (5.25, 5.90 and 7.33, respectively) while, the genotype DCC- 4 has recorded the minimum (3.33, 3.40 and 4.13, respectively) number of branches per plant. This might be due to the increased vegetative growth and crop duration, which facilitates accumulation of more photosynthates leading to production of more number of primary branches per plant. Similar variation for number of branches in different coriander genotypes were reported by Giridhar and Sarada (2005), Moniruzzaman *et al.* (2013) and Malik and Tehlan (2013).

5.1.6 Number of Secondary branches per plant

Number of secondary branches per plant was maximum in the genotype Rcr-475 at 30, 60, DAS and at harvest (4.80, 11.30 and 13.90, respectively) while, the genotype DCA- 55 has recorded the minimum (2.40, 7.0 and 8.33, respectively) number of branches per plant. This might be due to the increased vegetative growth and crop duration, which facilitates accumulation of more photosynthates leading to production of more number of secondary branches per plant. Similar variation for number of branches in different coriander genotypes was reported by Giridhar and Sarada (2005), Moniruzzaman *et al.* (2013) and Malik and Tehlan (2013).

5.1.7 Plant spread (cm^2)

Plant spread was minimum in the genotype DCC-4 (380.67 cm^2) while, the genotype Rcr-475 has recorded the maximum (645 cm^2) plant spread. Such variations could be attributed to genetic constituents of the particular variety and its response to environmental conditions of particular region which favors good growth leading to production of more number of spreading branches. This resulted in the accumulation of more photosynthates in view of increase in the bearing area. These results are in conformity with results of the Sarada and Giridhar (2005) who recorded maximum plant spread.

5.1.8 Days to first flowering

The genotype DCC-4 (39.33 days) has recorded less number of days for first flowering (39.33 days) whereas, genotype Rcr-41 was late flowering type. Hence, it took maximum days to first flowering (58.67 days). Growth is also one of the important characters, which determines the earliness of the variety which is controlled by the genetic factors. Similar results were reported by Moniruzzaman *et al*. (2013) and Malik and Tehlan (2013).

5.1.9 Days to 50 per cent flowering

The genotype Dcc-3 and Dcc-4 has recorded less number of days to 50 per cent flowering (43.67 days) whereas genotype Rcr-41 was late flowering type as it took maximum days to 50 percent flowering (63.67 days). Growth is also one of the important characters, which determines the earliness of the variety which is controlled by the genetic factors. These results are in accordance with the results reported by Moniruzzaman *et al*. (2013) and Malik and Tehlan (2013).

5.1.10 Number of umbels per plant

Number of umbels per plant was maximum (28.13) in the genotype Rcr-475 while, the genotype Acr-1 has recorded the minimum (13.20) number of umbels per plant. This variation in the yield could be attributed to genotypic character and response of the particular genotype to the specified environment conditions. Similar trend of variations for number of umbels per plant in different genotypes were also reported by Moniruzzaman *et al*. (2013) and Malik and Tehlan (2013).

5.1.11 Number of umbellets per umbel

Number of umbellets per umbel was maximum (5.50) in the genotype Rcr-475 while, the genotype DCC-4 has recorded the minimum (3.97) number of umbellets per umbel. This variation in the yield could be attributed to genotype character, genotypic response to environment conditions and growth attribute of the genotype. Similar variation for number of umbels per plant in different genotypes was reported by Moniruzzaman *et al*. (2013), Malik and Tehlan (2013).

5.1.12 Number of seeds per umbellet

Number of seeds per umbellet was maximum (5.70) in the genotype Rcr-475 while, the genotype Rcr-436 has recorded the minimum (3.80) number of seeds per umbellet. This variation in the seed per umbellet could be attributed to genotypic character, genotypic response to environmental conditions and also to growth attributes of the genotype. Similar findings were also reported by Moniruzzaman *et al*. (2013) and Malik and Tehlan (2013).

5.1.13 Days taken to maturity

The genotype Rcr-446 took more number of days to mature (110 days) while, the genotype DCC-3 (94 days) matured little early. This may be due to its early flowering nature of the particular genotype and crop duration. Similar trend of early maturity in coriander was observed by Moniruzzaman *et al.* (2013) and Malik and Tehlan (2013).

5.1.14 Dry matter production (q ha^{-1})

The maximum dry matter production was recorded in the genotype Rcr-41(8.22 q/ha) whereas the lowest value for this trait was recorded in the genotype DCC-4 (2.80 q /ha) (Table-5). The total dry matter production of whole plant is the integral part of crop growth rate over the entire growing period and it is also positively correlated with yield. The dry matter accumulation efficiency differs with different genotypes. If the dry matter is more, it is evident that the photosynthetic system is efficient. In the present study, the total dry matter production of whole plant varied significantly due to genotypes. The present findings are in consonance with the findings of Arif *et al.* (2011), Velayudham *et al.* (2004) and Maurya *et al.* (1989).

5.1.15 Seed yield per plant (g)

Significant variations for seed yield were observed among the genotypes and ranged from 2.67-6.37g per plant. The maximum seed yield per plant (6.37 g) was recorded in the genotype Rcr-475 whereas the genotype DCC-4 has recorded lowest seed yield per plant (2.67g). The difference in yield might be due to genotypic differences and agro-climatic conditions. Similar trend of genetic variations and ecological differences were also reported by Phurailpattam *et al.* (2016), Moniruzzaman *et al*. (2013) and Malik and Tehlan (2013).

5.1.16 Seed yield per plot (g)

Significant variations for seed yield were observed among the genotypes and it ranged from 279.50-505.05 g per plot. The maximum seed yield per plot (505 g) was recorded in the genotype Rcr- 475 whereas, the genotype DCC-4 has recorded lowest seed yield per plot (279.5 g). It is clear that, the factors mainly responsible for the differences in the seed yield among the genotypes were due to the differences in the

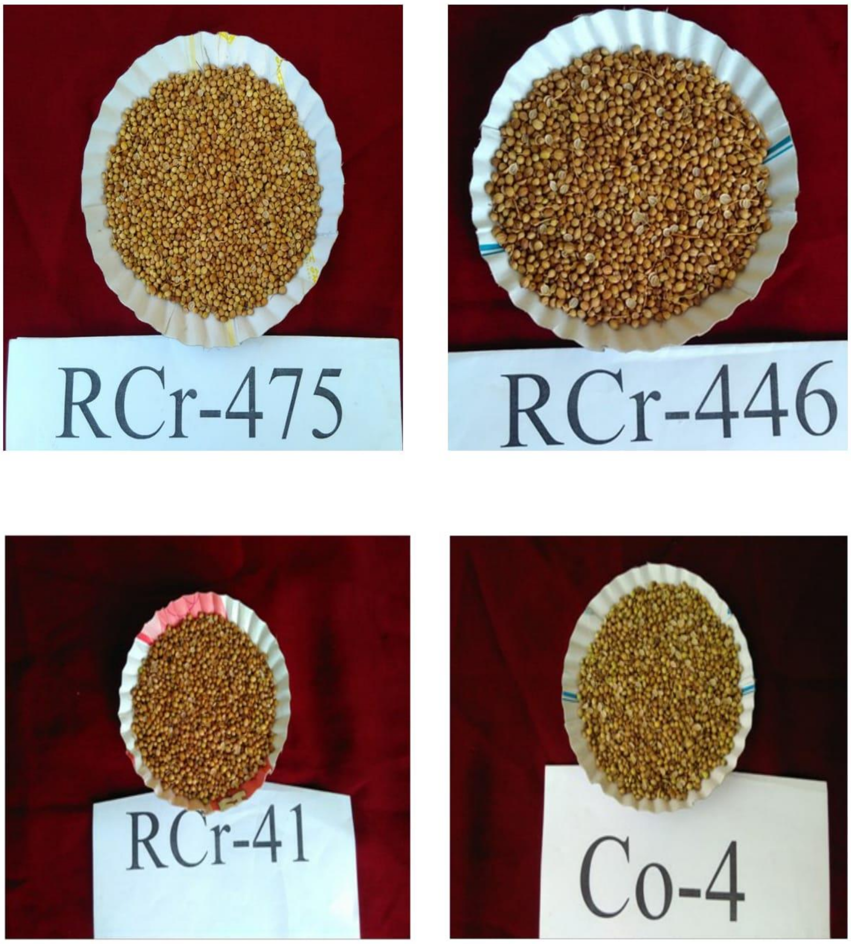


Plate 2. Best performing coriander genotypes

yield attributes like umbels per plant, umbellets per umbel, seeds per umbellets, number of seeds per umbel and test weight. The difference in the yield might be due to genotypic differences and agro-climatic conditions. The same genetic variations and ecological differences were also reported by Phurailpattam *et al.* (2016). These results are in agreement with the findings of Moniruzzaman *et al.* (2013) and Malik and Tehlan (2013) (Plate no 2).

5.1.17 Seed yield per hectare (q)

Significant variations for seed yield were observed among the genotypes and ranged from 9.31-16.80 q per hectare. The maximum total yield (16.83 q/ha) was recorded in the genotype Rcr-475 whereas, the genotype DCC-4 has recorded lowest value for this trait (9.31 q/ha). The difference in yield might be due to genotypic differences and also the prevailing agro-climatic conditions. Similar trend in genetic variations and ecological differences were also reported by Phurailpattam *et al.* (2016). These results are in agreement with the findings of Moniruzzaman *et al.* (2013) and Malik and Tehlan (2013).

5.1.18 Test weight (g)

Test weight was also found to be one of the important yield components in deciding the seed yield per hectare. The genotype Rcr-475 (14.53 g) has recorded the highest test weight. This may be mainly due to genetic factor of the respective genotype as well as influence of the growing environmental conditions. Lowest test weight (8.07 g) was recorded in genotype Rcr-436.The present findings are in consonance with the findings of Gurbuz *et al.* (2001) and Velayudham *et al.* (2004).

5.1.19 Harvest index (%)

Harvest index was found to be maximum (56.52 %) in the genotype Acr-1 while the genotype DCC-2 (38.36 %) had lowest harvest index. Seed yield is more compare to its dry matter yield due to its remobilization of photosythates to the sink. Similar variation in harvest index among the varieties was reported by several workers (Maurya, 1989; Shridhar, 1989; Velayudham, 2004).

5.1.20 Essential content (%)

Essential oil content was found to be maximum (0.8 %) in the genotype Acr-1, and Rcr-728, while the genotype DCC-4 had lowest essential oil content (0.1%). Essential oil content is found to be significantly varied among the genotypes studied. This could be attributed to the lower starch content. Starch being a primary metabolite, may affect the accumulation of secondary metabolites like oil. This is in confirmation with the studies of earlier workers Agarwal *et al.*, 1990; Rajagopalan *et al.*,1996; Singh *et al.*, 2002; Prabhu and Balakrishnamurthy 2006; Velayudham *et al.*, 2006. These results are in conformity results of the (Palanikumar and Rajamani, 2012).

5.2 Genetic variability, heritability and genetic advance

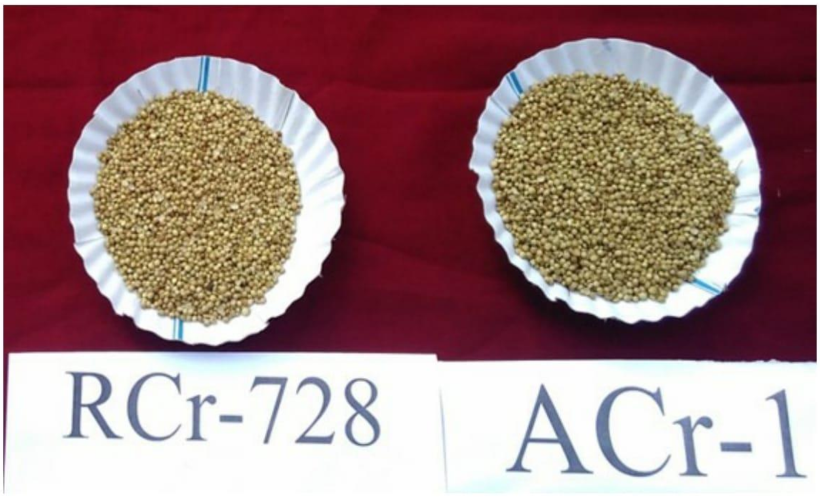
The results of the analysis of variance for different quantitative characters for 20 genotypes of coriander are presented in table 4 and 5. The result indicated that there is highly significant difference among genotypes for all the characters of growth and yield parameters. This indicated the presence of high degree of variation within the genotypes. Similarly, highly significant variations for all characters studied were reported by Sharma and Sharma (1989), Sridhar *et al.* (1990 b), Ali *et al.* (1993), Bhandari and Gupta (1993), Mengesha and Alemaus (2010) in coriander.

The magnitude of variance, as such does not reveal the relative amount of variability as ascertained through co-efficient of variation. PCV was higher than GCV for all the characters studied. The characters like plant height at harvest, number of umbellets per umbel, number of seeds per umbellet, test weight, seed yield per plant, seed yield hectare, maturity and harvest index showed very narrow differences between phenotypic and genotypic co-efficient of variation indicating less influence of environment in the expression of these characters (Table 6). Thus, selection for these characters would be more effective. The other characters *viz.*, primary branches at harvest, number of secondary branches at harvest, number of umbels per plant, seeds per umbellet and essential oil showed moderate differences between GCV and PCV indicating more sensitivity of these characters to environmental factors. Thus, response to selection would be poor. These results are confirmed by Mengesha and Alemaus (1993), Kole (2004) and Krishnamoorthy and Madalageri (2002) in coriander, fenugreek and ajowan.

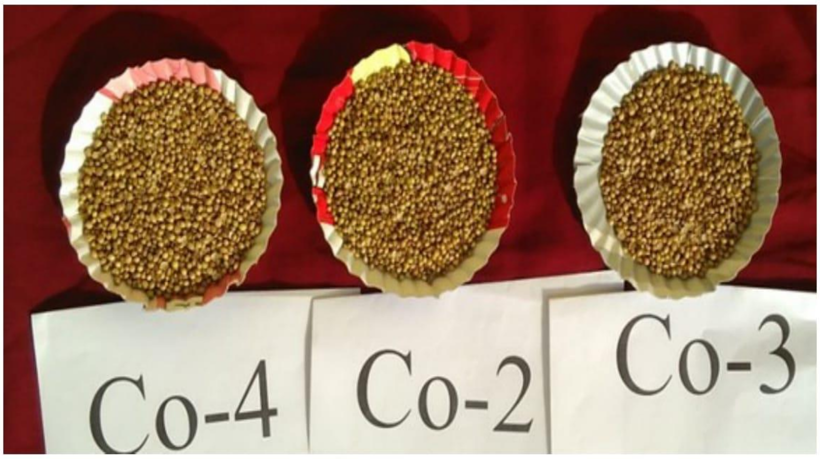
High value of PCV was recorded for seed yield per plant, essential oil, seed yield per ha, seed yield per plot, and plant spread which indicates that maximum amount of variability is present in genotypes for these characters. These results are in conformity with Singh *et al.* (2005) in coriander.

High value of GCV was recorded for seed yield per plant, essential oil and seed yield per ha due to genetic character, indicating that selection for yield attributing characters would be more effective. Similar results were obtained by Rajput and Dhirendrasingh (2003) and Abhay *et al.* (2011) in coriander and fenugreek, respectively.

High PCV with equal GCV was recorded for plant height at harvest, dry matter production, days taken for first flowering, days taken for 50 per cent flowering, number of umbellet per umbel, test weight, seed yield per plant, seed yield per hectare indicating maximum variability existing in the genotypes for these characters and offers good scope for improvement by simple selection through these characters. Similar results were obtained by Rajput and Dhirendrasingh (2003) and Patel *et al.* (2008) in coriander and ajowan, respectively.



A. Small seeded coriander genotypes



B. Bold seeded coriander genotypes

Plate 3. Variability in seed size of different coriander genotypes

However, the effectiveness of selection for any character depends not only on the amount of phenotypic and genotypic variability, but also on the estimates of broad sense heritability.

Heritability value indicates the heritable properties of variation. Burton and Devane (1952) had suggested that genotypic co-efficient of variation together with heritability estimates would give the best picture of the amount of progress to be expected by selection. In the present study, heritability ranged from 24.06 (seeds per umbellet) to 78.20 (plant height at harvest). High heritability was noticed for the characters like plant height at harvest, days to first flowering, seed yield per hectare, maturity, dry matter production, seed yield per plot, harvest index, essential oil content, days to 50 per cent flowering and test weight. Similarly, high heritability estimates were reported by Singh *et al.*(2006) and Rajput and Singh (2003), indicating that these characters are less influenced by environmental factors and are under the control of additive gene effect and improvement for such characters through simple selection would be rewarding.

High genetic advance was observed for plant spread, seed yield per plot and plant height at harvest as these characters were controlled by additive gene action; selection for these characters will improve the yield. These results are in conformity with the findings of Singh *et al.* (2006) in coriander.

Low genetic advance was observed for number of umbellets per umbel, seeds per umbellet, harvest index and essential oil indicating that these characters were governed by non additive gene action and selection for these characters is not useful. Similar results are reported by Fikreselassie *et al.* (2012b) in fenugreek.

High genetic advance as per cent of mean was observed for number of primary branches at harvest, plant spread, harvest index, essential oil and seed yield per plant and per hectare. This indicates that, the characters were governed by additive genes and selection will be rewarding for improvement of such traits. Similar results are reported by Mengesh and Alemaus (2010) and Singh *et al.* (2006) in coriander.

Moderate genetic advance as per cent of mean was observed for plant height, number of primary branches at harvest, days to first flowering, maturity, number of umbellets per umbel, dry matter, seed yield per plant and test weight which indicates that the characters were governed by non additive genes and hence may be useful for Heterosis breeding.

Heritability estimates along with genetic gain (genetic advance as per cent of mean) is more useful than heritability alone in predicting the resultant effect for selecting the best individuals (Johnson *et al.*, 1955). Genetic advance is the measure of improvement that can be achieved by practicing selection in a population.

High heritability with low genetic advance indicates the importance of non-additive gene action, while high heritability with high genetic advance indicates the additive gene effects.

In the present study, high genetic advance over per cent of mean coupled with high heritability was observed for the characters like plant height at harvest, plant spread, harvest index, essential oil, dry matter, number of umbellets per umbel, seed yield per plant and seed yield per hectare. Thus, these characters were under additive gene effect and could be improved by simple selection procedure. Number of primary branches, secondary branches, umbels per plant, days to first flowering, days to 50 per cent flowering have shown high heritability coupled with low genetic advance over mean which indicate the presence of certain degree of non additive gene effects.

The high heritability is being exhibited due to favorable influence of environment rather than genotype and selection for such trait may not be rewarding. The findings are in accordance with results reported by Singh *et al.* (2008), Rajput and Singh (2003) and Mengesh and Alemaus (2010) in coriander and fenugreek.

5.3 Correlation analysis

Yield is a complex trait and direct selection for this trait based on heritability estimates alone will not be rewarding. Seed yield is dependent on various other component traits like plant height, number of branches, seed weight *etc*. Knowledge on the relationship between these traits helps in achieving the improved yield. Phenotypic correlation coefficient is an important appliance for the breeder which helps in selection of a complex trait through the selection of simpler traits. In this respect, several studies reported significant relationships among the different pairs of the assorted characters of coriander.

In view of this, phenotypic correlation analysis was carried out for 17 different characters in 20 coriander genotypes (Table7) which revealed existence of significant association among many of these traits. Numerous studies reported significant correlations among the different pairs of the various characters of coriander.

Among the characters studied, the characters *viz*., plant height at harvest, number of branches per plant, plant spread, days to maturity, number of umbels per plant, number of umbellet per umbel, number of seeds per umbellet, seed yield per plant, seed yield per plot and seed yield per hectare showed positive significant correlation with seed yield per plant indicating selection or improvement in these traits may also help in possible improvement in the seed yield in coriander. These results are in conformity with those of Beena *et al* (2013), in coriander.

Plant height at harvest showed a highly significant positive association with number of primary branches, days to first flowering, days to 50 per cent flowering, number of seeds per umbellet, days taken for maturity, seed yield per plot and seed yield per hectare. The results indicated that, selection for these characters would lead to improvement in seed yield. Similar results were reported by Singh *et al.* (2008) in coriander.

Number of primary branches showed a highly significant positive association with number of secondary branches per plant, days to first flowering, days to 50 per cent flowering, number of seeds per umbellet, days taken for maturity, seed yield per plot and seed yield per hectare. Similar results were reported by Sing *et al.* (2006) and Ali *et al.* (1993) in coriander.

Number of secondary branches showed a highly significant positive association with plant spread and essential oil content. Similar results were reported by Singh *et al.* (2006) and Ali *et al.* (1993) in coriander. Besides showing a negative non-significant correlation with number of umbels per plant (0.120), number of seeds per umbellet (0.164), dry matter (0.193) and test weight (0.054). Similar results are reported by Singh *et al.* (2006) and Ali *et al.* (1993) in coriander.

Plant spread recorded a significant positive association with umbels per plant, seed yield per (ha) and essential oil content. It indicates that, improvement in plant spread may possibly improve number of umbels per plant and seed yield and as a result plant spread may also contribute towards yield improvement in coriander. Similar results were reported by Sarada and Giridhar (2005) in coriander.

Days to first flowering showed a highly significant positive association with days to 50 per cent flowering, number of umbels per plant, number of seed per umbellet, days taken for maturity, seed yield per plot and seed yield per hectare. Similar results were reported by Singh *et al.* (2006) and Singh *et al.* (2005) in coriander.

Days taken for 50 per cent flowering showed a highly significant positive association with essential oil content. Similar results were reported by Singh *et al.* (2006) and Singh *et al.* (2005) in coriander.

Number of umbels per plant showed a highly significant positive association with number of seeds per umbellet, seed yield per plot, seed yield per hectare and test weight. Number of umbels increases the seed yield in coriander. So, the relationship between those traits is important for increasing the seed yield. Similar results are reported by Shridhar *et al.*(1990 b) and Singh *et al.* (2006) in coriander.

Number of umbellet per umbel showed significant positive association with number of seeds per umbellet (0.287) and seed yield per plot (0.259). There is dairect relationship present between the seed yield and umbels. Similar results are reported by Mengesha and Alemaus (2010) and Singh *et al.* (2008) in coriander.

Number of seeds per plant showed significant positive association with days taken for maturity (0.040), seed yield per plot (0.130), seed yield per hectare (0.140), dry matter (0.094), test weight (0.066) and harvest index (0.019). It indicates that weight of seed, accumulation of photosythates and harvest index contributing to seed yield per plant. Similar results are reported by Singh *et al.* (2005) in coriander.

Days taken for maturity showed significant positive association with seed yield per plot (0.377). Similar results are reported by Singh *et al.* (2008) and Abhay *et al.* (2011) in coriander and fenugreek respectively.

Seed yield per plot showed significant positive association with seed yield per (ha) (0.664), test weight (0.410) and harvest index (0.285). Similar results were reported by vedamuthu and Rajan (1990), Shridhar *et al.* (1990b) and Singh *et al.*(2006).

Seed yield per hectare showed significant positive association with dry matter (0.916), test weight (0.331), harvest index (0.353). Similar results were reported by vedamuthu and Rajan (1990), Shridhar *et al.* (1990b) and Singh *et al.* (2006).

Dry matter production, test weight and essential oil (%) content showed significant positive association with harvest index. Similar results were reported by Singh *et al.* (2008) and Singh *et al.* (2005) in coriander.

Harvest index showed non significant positive association with essential oil content (0.090).These results are in accordance with findings of Singh *et al.* (2005), Abhay *et al.* (2011), and Saha and Kole (2001) in coriander and fenugreek

5.4 Path analysis

Correlation coefficient analysis just facilitates us to know the nature and degree of relationship among characters. Still, direct contribution of every component towards yield and their indirect contributions through other components are unknown. In this context, the path analysis facilitates in partitioning the correlation coefficients into direct and indirect effects of the component characters on yield which would be very useful for accurate selection. If the correlation between yield and any of its component traits is due to the direct effect, it reveals a true relation between them and selection for that character will be effective in order to improve yield. But if the correlation is mainly due to indirect effect of another component character, the breeder has to select the latter character through which the indirect effect is used.

In the present investigation, the results of path analysis (Table 8) reflected that, the yield related traits *viz.*, plant height at harvest, number of primary branches, plant spread, umbels per plant, seed yield per plant, seed yield per plot, seed yield per hectare, dry matter production, test weight, harvest index and essential oil have shown direct positive effect on seed yield.

Among these traits, primary branches and plant height had highest direct positive effect on seed yield followed by umbels per plant. These results are in line with the findings of Singh *et al.* (2005). This indicates that if other characters are kept constant, an increase in number of primary branches per plant and plant height attachment will increase the seed yield significantly. However, the traits like days taken for first flowering, secondary branches, 50 per cent flowering and umbellets per umbel had direct negative effect on seed yield. Among these traits, days taken for first flowering had highest negative effect on seed yield. This results in reduced vegetative growth which leads to reduce number of branches per plant ultimately lowering the seed yield per plant.

5.4.1 Plant height at harvest (cm)

Plant height at harvest had a direct positive effect on seed yield per plant and also an indirect positive effect through number of primary branches, plant spread, number of umbels per plant and test weight. It indicates that this trait have influence on growth and yield of coriander either directly or indirectly through other traits. Similar results are reported by Singh *et al.* (2008) in coriander.

5.4.2 Number of primary branches per plant

The trait, number of primary branches per plant had a direct positive effect on seed yield per plant and also a positive effect on seed yield per plant indirectly through various other independent traits *viz.*, plant spread, days to 50 per cent flowering, number of umbels per plant, test weight and essential oil content. These results are in accordance with findings of Singh *et al.* (2005) in coriander.

5.4.3 Number of secondary branches per plant

The trait, number of secondary branches per plant had a direct negative effect on seed yield per plant and also a positive effect on seed yield per plant indirectly through various other independent traits *viz.*, number of primary branches, plant spread, days to 50 per cent flowering, number of seeds per umbellet and harvest index. It has a very low effect on yield due to environmental effect but it influence directly or indirectly on yield. These results are in accordance with findings of Singh *et al.* (2005) in coriander and Solanki *et al.* (2014) in dill.

5.4.4 Plant spread (cm^2)

Plant spread had a direct positive effect on seed yield per plant and also an indirect positive effect through number of primary branches, days to 50 per cent flowering, number of umbels per plant, test weight, harvest index and essential oil content. It indicates that as the plant spread influences the number of umbels this increases the yield. These results are in agreement with findings of Vedamuthu and Rajan (1990), Shridhar *et al.* (1990b) and Singh *et al.* (2006).

5.4.5 Number of days for first flowering

Number of days for first flowering had a direct negative effect on seed yield per plant and also an indirect positive effect on seed yield per plant through various other independent traits *viz.*, number of primary branches, plant spread, days to 50 per cent flowering, number of umbels per plant and test weight. These results are in accordance with findings of Awas *et al.* (2014) and Singh *et al.* (2006) in Ethiopian coriander.

5.4.6 Number of days to 50 per cent flowering

Number of days to 50 per cent flowering had a direct negative effect on seed yield per plant and also an indirect positive effect through plant height, number of primary branches, plant spread and test weight. Therefore, selection of early hybrids or early varieties might result in more production through increased number of seeds per plant. These results are in accordance with findings of Awas *et al.* (2014) and Singh *et al.* (2006) in Ethiopian coriander.

5.4.7 Number of umbels per plant

This trait is having a direct positive effect on seed yield per plant and also it exhibited an indirect positive effect on seed yield per plant through plant height, number of primary branches, number of secondary branches, plant spread, days to 50 per cent flowering, dry matter, test weight and harvest index. These results are in accordance with findings of Singh *et al.* (2006) in coriander.

5.4.8 Number of umbellets per umbel

It exhibited direct negative effect on seed yield per plant and indirect positive effect on seed yield per plant through number of primary branches, plant spread, days to 50 per cent flowering, number of umbels per plant, dry matter, test weight and essential oil content and also an indirect negative effect on seed yield per plant through plant height, number of secondary branches, days to first flowering, number of seeds per umbellet, days taken for maturity, seed yield per plot, seed yield per hectare and harvest index. These results are in accordance with findings of Awas *et al.* (2014), Singh *et al.* (2006) and in coriander.

5.4.9 Number of seed per umbellate

Number of seeds per umbellet had a direct positive effect on seed yield per plant and indirect positive effect through number of primary branches, number of secondary branches, days to 50 per cent flowering, number of umbels per plant, dry matter, test weight and harvest index. These results are in accordance with findings of Singh *et al.* (2006), Abhay *et al.* (2011) and Saha and Kole (2001) in coriander and fenugreek.

5.4.10 Days taken for maturity

Days taken for maturity attachment had a direct negative effect on seed yield per plant and also an indirect positive effect through number of primary branches plant spread, days to 50 per cent flowering, number of umbels per plant, dry matter, test weight and harvest index. Similar results are reported by Singh *et al.* (2006) and Awas *et al* (2014) in coriander.

5.4.11 Seed yield per plot (g)

This trait has shown a direct positive effect on seed yield per plant through number of primary branches, plant spread, days to 50 per cent flowering, number of umbels per plant, dry matter, test weight, harvest index and essential oil content. These results are in accordance with findings of Singh *et al.* (2005), Abhay *et al.* (2011) and Saha and Kole (2001) in coriander and fenugreek.

5.4.12 Seed yield per ha (q)

Seed yield per hectare had a direct positive effect on seed yield per plant and indirect positive effect through number of primary branches, plant spread, days to 50 per cent flowering, number of umbels per plant, dry matter, test weight, harvest index, essential oil content. These results are in accordance with findings of Singh *et al.* (2005), Abhay *et al.* (2011) and Saha and Kole (2001) in coriander and fenugreek.

5.4.13 Dry matter production (g)

This trait had a direct positive effect on seed yield per plant and also an indirect positive effect through plant height, number of secondary branches, days to first flowering, number of umbels per plant, test weight, harvest index. Since dry matter is an important factor which has a key role in growth and yield, it certainly have influence on growth and yield of coriander either directly or indirectly through other traits. Similar results are reported by Abhay *et al.* (2011) and Saha and Kole (2001) in coriander and fenugreek.

5.4.14 Test weight (g)

Test weight of seed had direct positive effect on seed yield per plant and also an indirect positive effect through number of primary branches, number of secondary branches, plant spread, days to 50 per cent flowering, number of umbels per plant, dry matter, harvest index and essential oil content. Similar results are reported by Singh *et al.* (2005) in coriander.

5.4.15 Harvest index (%)

This trait had a direct positive effect on seed yield per plant and also an indirect positive effect through plant spread, days to first flowering, number of umbels per plant, number of umbellet per umbel, dry matter, test weight and essential oil content. These results are in accordance with findings of Singh *et al.* (2005), Abhay *et al.* (2011) and Saha and Kole (2001) in coriander and fenugreek.

5.4.16 Essential oil content (%)

Essential oil content showed a direct positive effect on seed yield per plant and also an indirect positive effect through number of primary branches, plant spread, days to first flowering, number of seed per umbellet, days taken for maturity, test weight and harvest index. These results are in agreement with findings of Vedamuthu and Rajan (1990), Shridhar *et al.* (1990b) and Singh *et al.* (2006) (Plate no 4).

Conclusion

1. DCC-1, DCC-2, DCC-3, DCC-4, Rcr-20 and Rcr-446 were found to be the best genotypes in terms of their early maturity.
2. Rcr-475, Rcr-446, Rcr-41 and Co-4 were found to be best with respect to seed yield of coriander (Plate no 3).
3. Rcr-728 and Acr-1 were found to be best with respect to essential oil of coriander.

Future line of work

1. The genotypes *viz*., Rcr-475, Rcr-446, Rcr-41, Co-4, Rcr-20 and Acr-1 can be evaluated in different multi locations during different seasons to know the stability of yield.
2. Screening of genotypes for important pest and diseases.
3. Molecular marker characterization of the coriander genotypes.

Plate 4. Essential oil extracted from seeds of different coriander genotypes

SUMMARY

VI SUMMARY

The present investigation "Evaluation of coriander (*Coriandrum sativum* L.) genotypes for growth, yield and quality under central dry zone of Karnataka" was carried out during the year 2016-17 at Zonal Agricultural and Horticultural Research station, Babbur farm, Hiriyur taluk. The study consisted of 20 coriander genotypes which were procured from different research stations with the following main objectives:

To evaluate coriander genotypes for growth, yield and quality parameters

To assess the genetic variability for growth, yield and quality parameters in coriander genotypes

To study the correlation and path analysis for yield and yield parameters

Observations were recorded on five randomly selected plants for 17 characters (inclusive of one qualitative trait *viz*., plant height**,** number of primary branches per plant**,** number of secondary branches per plant**,** plant spread**,** days to first flowering, days to 50 per cent flowering, number of umbels per plant, umbellets per umbel, seeds per umbellet, number of seeds per plant, seed yield per plot, seed yield per hectare, test weight, dry matter, days taken to maturity, harvest index and essential oil respectively.

Among the different genotypes, Rcr-475 recorded the maximum plant height at 30, 60 DAS and at harvest (18.64, 58.73 and 70.27 cm respectively) while, it was minimum in case of DCC-4 (8.13, 34.93 and 37.47 cm respectively). The maximum number of primary branches per plant was produced by genotype Rcr-475 at 30, 60 DAS and at harvest (5.25, 5.90 and 7.33, respectively. The minimum number of primary branches per plant at 30, 60, 90 DAS and at harvest were produced in genotype DCC-4 (3.33, 3.40 and 4.13, respectively).

The maximum number of secondary branches per plant was produced by genotype Rcr-475 at 30, 60 DAS and at harvest (4.80, 11.30 and 13.90, respectively). The minimum number of secondary branches per plant at 30, 60 DAS and at harvest were produced in genotype DCC-4 (2.73, 7.0 and 8.33, respectively). Plant spread was maximum in the genotype Rcr-475 (645 cm^2) at harvest while, the genotype DCC-4 has recorded the minimum (380.67cm^2) plant spread.

Though the number of days taken to first and 50 per cent flowering exhibited high variability among the genotypes studied, the genotype DCC-4 and DCC-3 (39.33 and 43.67 days, respectively) took significantly least number of days for first and 50 per cent of flowering and Rcr-41 took maximum number of days for first and 50 per cent flowering (58.67 and 63.67 days, respectively).

Highest number of umbels per plant was recorded in the genotype Rcr-475 (28.13) compared to all genotypes studied while it was lowest in the genotype Acr-1 (13.20).

Maximum umbellets per umbel was recorded in the genotype Rcr-475 (5.50) compared to all the genotypes studied, while it was minimum in the genotype DCC-4 (3.97).

Maximum number of seeds per umbellet was recorded in the genotype Rcr-475 (5.70) compared to all genotypes studied while it was minimum in the genotypes Rcr-436 (3.80).

The maximum days taken for maturity was recorded in the genotype Rcr-446 (110 days) and Rcr-41(110 days) while, it was minimum in the genotype DCC-3 (94 days) followed by DCC-1 and DCC-2 (94.33 days).

The maximum dry matter production (8.22 q) was recorded in the genotype Rcr-475 followed by Co-4 (8.06 q). However, the genotype DCC-4 has recorded (2.80 q) as a low dry matter production.

The genotype Rcr-20 (6.37 g) recorded highest seed yield per plant followed by Co-1 (6.20 g) whereas, the genotype DCC-4 (2.67 g) followed by DCC-3 (2.73 g) has recorded as low seed yield per plants.

Among the genotypes, the maximum seed yield per plot was recorded in the genotype Rcr-475 (591g) followed by Rcr-446 (497 g). However, the genotype DCC-4 has recorded minimum seed yield of 279.5 g per plot.

The highest seed yield was registered by the genotype Rcr-475 (16.83 q) followed by Rcr-728 (16.58 q). However, the genotype DCC-4 has recorded the lowest seed yield (9.31 q/ha).

Among the different coriander genotypes, Rcr-475 has recorded the highest test-weight (14.53g) followed by Rcr-20 (14.27 g) while it was lowest in the genotype Rcr-436 (8.07 g).

The maximum Harvest index was recorded in the genotype Acr-1 (56.52 %) followed by Rcr-435 (53.83 %) while it was minimum in the genotype DCC-2 (38.36 %).

Among the genotypes, the highest essential oil content was recorded in Acr-1and Rcr-728 (0.8 %), while it was lowest in the genotype DCC-4 (0.1%).

The analysis of variation revealed the existence of highly significant differences among the genotypes for the all the traits studied. A high range of variation and high heritability coupled with high genetic advance was recorded for most of the traits. It revealed the broad genetic base and less environmental influence indicating the predominance of genetic factor controlling variability for these traits. Hence, simple and early generation selection schemes would be effective for improvement and there is ample scope for isolation of promising lines from present gene pool for yield improvement.

The results on association studies revealed that, seed yield per plant showed significant positive association with plant height at harvest, number of branches per plant, plant spread, number of umbels per plant, essential oil and harvest index. It can be concluded that, these traits should be given due importance while practicing selection for increasing yield.

Path analysis revealed that, primary branches had highest direct positive effect on seed yield followed by plant height. This indicates that if other characters are kept constant, an increase in number of primary branches and plant height will increase the yield significantly. Other yield attributing traits like plant spread, umbels per plant, dry matter, and harvest index exhibited direct positive effect on seed yield.

REFERENCES

VII REFERENCES

AGRAWAL, S. AND SHARMA, R. K., 1990, Variability in quality aspects of seed spices and future strategy. *Indian Cocoa, Arecanut and Spices J*., **13**(4): 127-129.

AGRAWAL, S., SHARMA, R. K. AND BHATT, B. N., 1990, Quality evaluation in coriander. *Indian Cocoa, Arecanut and Spices J*., **13**(4): 137-137.

AGRAWAL, S., SINGH, D. AND RAJPUT, S. S., 2003, Evaluation of fennel (*Foeniculum vulgare* Mill L.) germplasm for production and quality. *Spices and Arom. Crops*., **12**(2): 174-178.

AGRAWAL, S., SINGH, D., KHANDELWAL, V. AND JAIN, O, K., 2006, Correlation between seed yield, volatile oil content and it's constituent in cumin. *J. Med. Arom. Plant Sci*., **28**: 547-549.

ALI, S. A., MISRA, A. K., YADAV, L. N. AND MAYURA, K. N., 1993. Variability and correlation studies in coriander (*Coriandrum sativum* L.). *Int. J. Trop. Agri*., **11**(1): 40-42.

AL–JIBOURIE, H.A., MILLER, P.A. AND ROBINSON, H.V., 1958, Genotypic and environmental variance and co- variances in a upland cotton cross of interspecific origin. *Agron. J*., **50**: 633-536.

ANONYMOUS, 2012, Cultivation of coriander for spice and quality seed. *Spice India*., **25**(4): 7-15.

ANONYMOUS, 2015, Statistics of Horticulture crops. Department of Horticulture, Government of Karnataka.

ARIF, 2012, Studies on genetic variability for herbage and seed yield in coriander (*Coriandrum sativum* L.) under hilly zone of Karnataka. *M. Sc. (Agri.) Thesis*, Univ. Hort. Sci., Bagalkot, Karnataka (India).

AWAS, G., MEKBIB, F. AND AYANA, A., 2014, Correlation and path coefficient analysis study among seed yield and oil content in Ethiopian coriander (*Coriandrum sativum* L.) genotypes. *Int J.Plant Breed Genet*., **8**: 224-240

BANERJEE, A. AND KOLE, P.C., 2004, Genetic variability, correlation and path analysis in fenugreek (*Trigonella foenum-graecum* L.). *J. Spices and Arom. Crops*., **13**(1) 44-48.

BHANDARI, M. M. AND GUPTA, A., 1993, Association analysis in coriander. *Indian J. Genet*., **53**(1): 66-70.

BHATTACHARYA, M., CHATTERJEE, R., PAN, 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. *Orissa J. Hort*., **34**(1): 69-71.

BURTON, G.W. AND DEVANE, E. M., 1953, Estimating heritability in tall fescue (*Festuca arundianacea* L.) from replicated clonal material. *Agron. J*., **45**:

478-481.

CLEVENGER, J. P., 1928, Content of essential oil in plants. *Ame. Perfumer*., **23**: 467.

DASHORA, A., MALOO, S. R. AND DASHORA, L. K., 2011, Variability, correlation and path coefficient analysis in fenugreek (*Trigonella foenum graecum* L.) under water limited conditions. *J. Spices and Arom. Crops*., **20**(1): 38-42.

DIVYA, N., 2007, Studies on evaluation of varieties and nutrition in coriander (*Coriandrum sativum* L.). *M. Sc. (Agri.) Thesis*, Univ. Agric. Sci., Dharwad, Karnataka (India).

DATTA, S., CHATTERJEE, R., MEDDA, P. S. AND CHATTOPADHYAY, P. K., 2001, Evaluation of ajowan (*Trachyspermum ammi* L.). Introduction for growth, yield and quality. *J. Spices and Arom*., *Crops*., **10**(1): 37-39.

DATTA, S. AND CHOUDHURI, P., 2006, Evaluation of coriander germplasm under terai zone of West Bengal. *Haryana J. Hort. Sci*., **35**(4): 348-349.

DEWEY, D.H. AND LU, K.H., 1959, Correlation and path coefficient analysis of components of crested wheat grass seed production. *Agron. J*., **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 J. Hort. Sci*., **34**(1-2): 156-16.

EASWARAREDDY, S., VENKATESWARLU, K. AND NARAYANAREDDY, Y., 1988, Studies on the sowing time and efficacy of certain coriander cultivars in biomass production. *Indian Cocoa, Arecanut and Spices J*., **11**(3): 110-112.

FAROOQI, A. A., SREERAMU, B. S. AND SRINIVASAPPA, K. N., 2005, Cultivation of spice crops. Universities Press (India) Private Limited, Hyderabad.

FIKRESELASSIE, M., ZELEKE, H. AND ALEMAYEHU, N., 2012a, Genetic variability of Ethiopian fenugreek land races. *J. Plant Breed crop Sci*., **4**(3): 39-48.

FIKRESELASSIE, M., ZELEKE, H AND ALEMAYEHU, N, 2012b, Correlation and path analysis in Ethiopian fenugreek land races. *J. Plant Breed crop Sci*., **2**(3): 132-142

GIRIDHAR, K. AND SARADA, C., 2005, Identification of coriander (*Coriandrum sativum* L.) genotypes for *vertisols* of Andhra Pradesh. *Nat. Symp. Cur. Trends in Onion, Garlic, Chillies and Seed Spices-Production, Marketing and Utilization, SYMSAC-II*, 25-27 November, NRCOG, Rajgurunagar, pp. 92.

GEREMEW, A., FIREW, M. AND AMSALU, A., 2015, Variability, Heritability and Genetic Advance for Some Yield and Yield Related Traits and Oil Content in Ethiopian Coriander (*Coriandrum sativum* L.) Genotypes. *Int. J. Plant Breed Genetics*., **9**: *116-125.*

GURBUZ, B., 2001, Correlation and path analysis among yield components in winter resistant coriander (*Coriandrum sativum* L.) lines. *Indian J. Agric. Sci*., **71**(11): 730-732.

HANSON, C. H., ROBINSON AND COMSTOCK, R. E., 1956, Biometrical studies of yield in segregating populations of Korean Lespedeza, *Agron. Jl*., **48:** 268-375.

HARLAND, S.C., 1939, The Genetics of Cotton. Janardhan Publication, London, pp. 35-39.

HARIPRASADRAO, N. AND SRINIVASRAO, G., 2001, Studies on the performance of exotic and indigenous coriander (*Coriandrum sativum* L.) genotypes for greens. *Andhra Agric. J*., **48**(3-4): 324-326.

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 J. Genet. Plant Breed*., **45**: 358-361.

*JOHNSON, H.W., ROBINSON, H.F. AND COMSTOCK, R.E., 1955, Estimates of genetic and environmental variability in soyabean. *Agron. J*., **47:** 314-318.

KALRA, A., PATRA, N. K., SINGH, H. P., MENGI, M., NAQVI, A. A. AND KUMAR, S., 1999, Evaluation of coriander (*Coriandrum sativum* L.) collections for essential oil. *Indian J. Agric. Sci*., **69**: 657-659.

KRISHNAMOORTHY, V. AND MADALAGERI, M. B., 2002, Variability and corre-lation studies in ajowan (*Trachyspermum ammi*). *J. Med. Arom. Pl. Sci*., **24**(2): 364-370.

KUMAR, C. R., SARWAR, M. AND DIMRI, B. P., 1977, Bulgarian coriander in Indian and its future prospects in export trade. *Indian Perfumer*., **21**(3): 146-150.

*LUSH, J. L., 1949, Heritability of quantitative characters in farm animals. *Proceedings of 85th Congress on Genetics, Heriditas* (Supplement)., pp. 356-375.

MALIK, T. P., AND TEHLAN, S. K., 2013, Performence of coriander (*Coriandrum sativum*L.) varieties for growth and seed yield. *Int. J. Seed Spices*, **3**: 89-90.

MAURYA, K. R., 1989, Growth, yield and quality component in coriander genotypes. *Indian J. Hort*., **46**(1): 107-110.

MENGESHA. B. AND ALEMAUS, G., 2010, Variability in ethiopian coriander accessions for agronomic quality traits. *African Crop Sci. J*., **18**(2): 43-49.

MEHTA, K. G. AND PATEL, R. H., 1983, Variability in fennel (*Foeniculum vulgare* P. Miller) under North Gujurat conditions. *J. Plantation Crops*., **11**(1): 21-23.

MONIRUZZAMANI, M., RAHMAN, M. M., HOSSAIN, M. M., SIRAJUL, K. A. J. M., AND. KHALIQ, Q. A., 2013, Evaluation of coriander (*Coriandrum sativum* L.) genotypes for seed yield and yield contributing characters. *Bangladesh. J. Agril. Res*., **38**(2): 189-202.

PALANIKUMAR, M. AND RAJAMANI, K., 2012, Evaluation of coriander (*Coriandrum sativum* L.) genotypes for fresh, dry biomass yield and oil content under different seasons. *J. Crop Res*., **44**(1&2): 194-202.

*PANSE, V. G. AND SUKHATME, P. V., 1957, *Statistical Methods for Agriculture Workers*. Indian Council of Agric. Res. Pub., New Delhi, pp. 152-174.

PATEL, D. G., PATEL, P. S. AND PATEL, I. D., 2008, Studies on variability of some morphological characters in ajowan. *J. Spices and Arom. 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.). *J. Spices and Arom. Crops*., **13**(2): 126-128.

PATIL, P, B., 2003, Evaluation of fenugreek (*Trigonella foenum grace* L.) genotypes. M.Sc. *(Hort.) Thesis*, Univ. Agric. Sci., Dharwad.

PHURAILATPAM, A. K., GEETHA, K. A., MEENA, R. S., MAITI, S., 2016, Evaluation of coriander (*Coriandrum sativum L.*) cultivars for yield and yield contributing character in Gujarat. *J. Spices and Aromatic crops*., **25**(1): 7 -12.

PRAJAPATI, D. B., RAVINDRABABU, Y. AND PRAJAPATI, B. H., 2010, Genetic variability and character association in fenugreek (Trigonella foenum-graecum L.) *J. Spices and Arom. Crops*., **19** (1 & 2): 61–64

PRABHU, T. AND BALAKRISHNAMURTHY, G., 2006, Evaluation of coriander (*Coriandrum sativum* L.) accessions under irrigated conditions for growth, yield and quality. *Proc. Nat. Sem. Emerging Trends in Production, Quality, Processing and Export of Spices*., 28-29 March, Coimbatore pp 13.

RAJAGOPALAN, A., AZHAKIYAMANAVALAN, R. S. AND ABDUL-KHADER, M. D., 1996, Evaluation of coriander cultivars for yield. *Indian Cocoa, Arecanut and Spices J*., **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. *J. Spices and Arom. Crops*., **12**(2): 127-134.

RAJPUT, S. S., AND DHIRENDRASINGH, 2003, Variability in Coriander (*Coriandrum sativum* L.) for yield and yield components. *J. Spices and Arom. Crops*, **12**(2): 162-164.

ROBINSON, H.F., COMSTOCK, R.E. AND HARVEY, P.H., 1949, Estimates of heritability and degree of dominance in corn. *Agron. J*., **4**: 353-359.

SAHA, A. AND KOLE, P. C., 2001, Genetic variability in fenugreek grown in sub-humid lateritic belt of West Bengal. *Madras Agri. J*., **88**(6): 345-348.

SANJEEV, A., CHOUDHARY, G. R. AND SHARMA, R. K., 1994, Quality evaluation in coriander. *Indian Cocoa, Arecanut and Spices J*., **18**(2): 45-47.

SARADA, C., AND GIRIDHAR, K., 2005, Elite genotypes of coriander (*Coriandrum sativum* L.) suitable for rainfed cultivation in Andhra Pradesh. *Nat. Symp. Cur. Trends in Onion, Garlic, Chillies and Seed Spices-Production, Marketing and Utilization, SYMSAC-II*, 25-27 November, NRCOG, Rajgurunagar, pp. 93.

SASTRY, K. AND SINGH, A., 2000, Estimation of variability for grain yield and its component characters in fenugreek (*Trigonella foenum-graecum* L.), *J. Spices, Arom. Crops*., **18**(2): 60-64.

SAXENA, R. P., PANDEY, V. P., DATTA, J. AND GUPTA, R. K., 2005, Performance of coriander entries at Kumarganj, Faizabad. *Nat. Symp. Cur. Trends in Onion, Garlic, Chillies and Seed Spices-Production, Marketing and Utilization, SYMSAC-II*, 25-27 November, NRCOG, Rajgurunagar, pp. 55-56.

SELVARAJAN, M., CHEZHIYAN, N., MUTHULAKSHMI, P. AND RAMAR, A., 2002, Evaluation of coriander genotypes for growth and yield. *South Indian Hort*., **50**(4-6): 458-462.

SHARMA, R. K., AND BHATI, D. S., 1985, Performance of fennel varieties. *Indian Cocoa, Arecanut and Spices J*., **9**(1): 16.

SHARMA, R. K., AND BHATI, D. S., 1988, Performance of coriander varieties under irrigated condition. *Indian Cocoa*, *Arecanut and Spices J*., **11**(3): 96-97.

SHARMA, K.C. AND SHARMA, R. K., 1989, Variation and character association of grain yield and its component character in coriander. *Indian J. Genet*., **49**(1): 135-139.

SHIVASUBRAMANIAN, S. AND MENON, M., 1973, Heterosis and inbreeding depression in rice. *Madras Agric. J*., 606 –1139.

SHRIDHAR, 1989, Studies on variability in coriander (*Coriandrum sativum* L.) and response of leaf type to nutrition. *M.Sc. (Agri.) Thesis*, Univ. Agric. Sci., Dharwad.

SHRIDHAR, SULIKERI, G. S. AND HULAMANI, N. C., 1990 a, Performance of coriander (*Coriandrum sativum* L.) genotypes. *Karnataka J. Agric Sci*., **3** (3-4): 213-217.

SHRIDAR, SULIKERI, G. S. AND MADALAGERI, M. B., 1990 b, Genetic variability in coriander (*Coriandrum sativum* L.). *Karnataka J. Agric. Sciences*., **3** (3-4): 266-269.

SINGH, R.H. AND CHOUDHARY, R.D., 1979, *Biometrical methods in Quantitative Genetics Analysis*., Kalyani Publishers, Ludhiana.

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. *J. Spices and Arom. Crops*., **11**(2): 101-105.

SINGH, U. B. AND JAIN, M. K., 1970, Studies on yield and quality variation in coriander. *Indian J. Agron*., **15**: 223-226.

SINGH, S. P., RAJENDRA PRASAD. AND SINGH, S. K., 2005, Path co-efficient analysis of seed yield in coriander. *Int. J. Agric. Sciences*., **1**(1): 58-61.

SINGH, S.P., PRASAD, R. AND SINGH, R.K., 2015b, Association analysis in coriander. *Int. J. Agri Sci*., **1**(1): 84-86.

SINGH, D., U.K. JAIN, S.S. RAJPUT, V. KHANDELWAL AND K.N. SHIVA, 2006. Genetic variation for seed yield and its components and their association in coriander (*Coriandrum sativum* L.) germplasm. *J. Spices and Arom. Crops*., **15**: 25-29.

SINGH, D., JAIN, S. K., RAJPUT, S. S., KHANDEWAL, V. AND SHIVA, N., 2006, Genetic variation for seed yield and its components and their association in coriander (*Coriandrum sativum* L.) germplasm. *J. Spice and Arom. Crops*., **15**(1): 25-29.

SINGH, S. P., KATIYAR, R. S., RAI, S. K., YADAV, H. K., TRIPATHI, S. M., NIGAM, H. K. AND SRIVASTAVA, J. P., 2008, Studies on genetic variability and character association in coriander (*Coriandrum sativum* L.) grown on sodic soil. *J. Medi. Arom. Plant. Sci*., **30**(2): 164-167.

SRAVANTHI, B., SREERAMU, B. S. B., NARSIMHA, S. B., UMESHA, K. AND RAJASEKHAR REDDY, B., 2014, Correlation coefficient and path analysis in coriander (*Coriandrum sativum* L.) genotypes. *Int. J. Appl Biol and Pharma. Technol*., **5**: 60-62.

SUNILKUMAR, H. T., 2010, Evaluation of genotypes and nutritional studies in coriander (*Coriandrum sativum* L.). *M.Sc.(Agri.) Thesis,* Univ. Agric. Sci., Dharwad, Karnataka (India).

*SUNDARRAJ, N., NAGARAJU, S., VENKATA RAMU, M.N. AND JAGANATH, M.K., 1972. *Design and analysis of field experiments.* Univ. Agric. Sci., Bangalore, India.

TEHLAN, S. K., THAKRAL, K. K., PARTAP, P. S. AND MALIK, T. P., 2007, Hisar Surbhi : a high yielding variety of coriander. *Haryana J. Hort. Sci*., **36**(3): 410-411.

TIWARI, R. S. AND AGARWAL, A., 2004, *Production Technology of Spices*. International Book Distributing Co., India, pp. 254-270.

VASHISTHTHA AND MALHOTRA, 2005, Crop improvement on seed spices. *Nat. Symp. Cur. Trends in Onion, Garlic, Chillies and Seed Spices-Production, Marketing and Utilization, SYMSAC-II*, 25-27 November, NRCOG, Rajgurunagar, pp. 30-36.

VELAYUDHAM, A., 2004, Evaluation and effects of organics with bio-inoculants in coriander var. Co 3. *M.Sc (Hort.) Thesis*, Univ. Agric. Sci., Dharwad.

VELAYUDHAM, A., HANAMSHETTI, S. I., MADALGERI, M. B. AND WALI, M. C., 2006, Evaluation of coriander genotypes during 2003-04 *kharif* and *rabi* seasons. *Proc. Nat. Sem. Emerging Trends in Production, Quality, Processing and Export of Spices*., 28-29 March, Coimbatore p. 11.

VENKATAREDDY, P., SRIRAMARAO T., NARASIMHARAO, S. B. S. AND NARISIRDDY, A., 1986, Genetic variability in coriander. *Indian Cocoa, Arecanut and Spices J*., **10**(3): 90-92.

WEBBER, C.R. AND MOORTHY, B.R., 1952, Heritability and non-heritability relationship and variability of oil content and agronomic characters in F_2 generation of soyabean crosses. *Agron. J*., **44**: 202-209.

WRIGHT, S., 1921, Correlation and causation. *J. Agril. Res*., **20**: 667-587.

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

APPENDICES

VIII APPENDICES

APPENDIX-I

Chemical properties and fertility status of the experimental site

Soil (chemical) properties	Characterization
P^H	6.58
Electrical Conductivity (dSm^{-1})	0.43
Organic Carbon (%)	0.19
Available Nitrogen (kg/ha)	383.0
Available Phosphorous P_2O_5 (kg/ ha)	33.0
Available Potassium K_2O (kg/ha)	309.0

APPENDIX-II

Monthly mean meteorological data recorded during experimental period (2016-2017) at ZAHRS, Babbur farm, Hiriyur.

Month	Temperature (ºC)		Relative humidity (%)		Rainfall (mm)	Rainy days
	Maximum	Minimum	Morning	Evening		
Jan	30	17	80	48	4.6	01
Feb	34	19	75	31	0.0	0
March	35	22	70	32	0.0	0
April	39	26	80	39	2.2	0
May	36	26	81	49	75.6	03
June	31	24	86	67	90.8	10
July	29	23	84	71	85.8	09
August	29	23	87	70	3.8	01
Sept	29	23	86	71	6.8	02
Oct	32	21	81	55	13.8	02
Nov	32	16	73	45	0.0	0
Dec	30	15	83	42	28.8	03
Jan	30.2	13.4	79	48	0.0	01
Feb	33.2	14.4	77	59	0.0	0
March	35.8	21.0	81	59	1.20	0
Total	**485.2**	**303.8**	**1203.0**	**786.0**	**313.4**	**32**

APPENDIX -III

List of symbols and abbreviations

Symbols	Abbreviations
%	Per cent
$^{-1}$	Per plant
@	At
/	Per
˚C	Degree centigrade
Cm	Centimeters
cm^2	Centimeter square
M	Meter
m^2	Meter square
Mm	Millimeter
et al	And other
G	Gram
i.e.	That is
Ha	Hectare
Kg	Kilogram
Q	Quintal
T	Tons
Mg	Milligrams
T	Treatment
No.	Number
S.Em	Standard Error Mean
SD	Standard Deviation
CD	Critical difference
Viz,	As follows
DAS	Days after Sowing