Chapter **2**

Literature and Citations

Coriander is one of the important seed spices which are acclaimed throughout the world for its enormous uses of seed as well as leaf. Besides being used as spice coriander has several medicinal values and recently gaining momentum as one of the premier value added export items in the global market. Quality is much important so far as food preparation is concerned. High essential oil and oleoresin content in fruit are the main characters on which quality is based and price for used as spice. The review of the available literatures pertaining to this aspect is presented in this chapter.

2.1 Evaluation of growth and yield parameters

Singh *et al.* (2006) reported that ina collection of 35 lines of coriander, Coriandrum sativum from Bihar, India, showed significant variability for plant height, number of primary branches per plant, number of secondary branches per plant, days to 50% flowering, days to maturity, number of umbels per plant, number of umbellets per umbel, number of grains per umbellet, 1000-grain weight, essential oil content, harvest index and grain per plant

ISBN: 978-93-85822-48-3

Phurailatpam *et al.* (2016) evaluated nineteen cultivars of coriander from diverse sources. The highest plant height was found in Pant Haritma (97.27 cm) which was at par with RCr 435, ACr 209, JD 1, Co 4, RCr 20 and Sadhana. Highest seed yield plant-1 were observed in JD 1 (10.78 g) which was at par with Sudha, Sindhu and RCr 41.The lowest yield plant-1 were observed in RCr 20 (1.81gm). The minimum time taken for 50% flowering was observed in Sudha and RCr 41 (42.67 days) which were at par with that of Sindhu. The maximum time taken for 50% flowering was by RCr 20 (68.67 days).

Malik and Tehlan (2013) studied on various growth parameters, seed yield and essential oil content. The significant differences were obtained for all the parameters. Plant height ranged from 96.7 to 121.6, number of branches 6.1 to 10.3, umbels per plant 51.4 to 65.9, umbellate per umbel 3.8 to 6.0 and seeds per umbel 27.6 to 36.1. On the basis of mean seed yield of three years (2009-10 to 2011-2012) at Hisar, the maximum seed yield was recorded as 2104 kg/ha in DH-233 followed by DH -220(2053 kg/ha) showing an increase of 19.68 & 16.78 % higher seed yield over Hisar Anand (check), respectively.

Arif *et al.* (2014) revealed that number of basal leaves ranges from 3 to 23.2. Meena *et al* (2010) reported seeds/umbel ranges from 43.97 to 56.27. Singh *et al* (2011) reported that test weight ranges from 9.78 to 11.78, days to flowering ranges from 73 to 80.

According to Singh and Prasad (2006) thirty-five genotypes of Coriandrum sativum exhibited genetic variation for plant height, number of primary branches per plant, number of secondary branches per plant, days to 50% flowering, days to maturity, number of umbels per plant, number of umbellets per umbel, number of grains per umbellet, 1000-grain weight,

ISBN: 978-93-85822-48-3

essential oil content and harvest index in a trial conducted in Bihar, India during 1998-99.

Rajagopalan *et al.* (1996) evaluated thirteen Coriander cultivars for seed and essential oil yield during 1990-91 and 1991-92 at the Tamil Nadu Agricultural University, Coimbatore, India. Seed yield was in the range 359.2-683.4 kg/ha; Co.3 recorded the highest seed yield. Although no significant differences in essential oil content or yield were observed between the cultivars/accessions, JC.81 produced the highest essential oil yield (3.95 kg/ha)..

Datta (2006) analysed 15 coriander genotypes (ATP-77, UD-686, DH-48, UD-20, Pant Haritima, UD-684, UD-685, RCr-41, RCr-20, DH-38, Rajendra Swati, ATP-102, UD-14, UD-303 and Local cultivar) in West Bengal during 2000 and 2001. Different morphological and yield characters were studied. Among the different genotypes, UD-14 produced the highest yield (12.28 q/ha), followed by UD-686 (9.59 q/ha) Rajendra Swati (8.94 q/ha), DH-38 (8.30 q/ha) RCr-41 (8.09 q/ha) and ATP-77 (8.06 q/ha).

Datta and Choudhuri (2006) reported that experiment conducted on seventeen germplasm lines of coriander (Coriandrum sativum L.) showed significant variation for most of the characters studied. Genotypes RCr-41 produced the highest seed yield (15.06 q/ha) followed by DH-246 (14.26 q/ha). Considering all the characters, genotype RCr-41 was found as the most suitable variety under terai zone of West Bengal.

Sarada and Giridhar (2009) observed that promising genotypes varied significantly with respect to plant growth and yield. The yield data emphasized the fact that the genotype LCC-174 recorded maximum yield (845.1 kg/ha) followed by LCC-225 (812.7 kg/ha) which are significantly superior to popular variety Sadhana (649.5 kg/ha). The promising types i.e.

ISBN: 978-93-85822-48-3

LCC-174 and LCC-225 are of medium duration and mature within 85 to 90 days.

According to Hiwale *et al.* (2009) an experiment was conducted to study the performance of different varieties of coriander for growth and yield under Marathwada condition at Department of Horticulture, M.A.U., Parbhani (M.S.) during 2007-08. The variety V4 Japani exhibited maximum height of plant. The variety V5 Surbhi was superior in case of maximum number of primary and secondary branches. Highest yield per hectare was recorded in variety V5 Surbhi followed by V7 DWD-3, while lowest yield was found in variety V6 Gawran.

Meena *et al.*(2010) conducted a field experiment with 30 diverse genotypes (Local Coriander-LC-4, Surabhi, Kashmiri Dhania-PD-4, Local Lucknow-LL-4, Pusa Sugandha, Local Dhania-LD-5, Local Dhania-LD-4, Kalmi Dhania-KD-6, Kashmiri Dhania-PD-1, Local Dhania-LL-3, Local Coriander-LC-2, Coriander Kalmi-CK-2, Coriander Kalmi-CK-1, Local Katuai, Kashmiri Dhania-PD-2, Local Lucknow-LL-2, Pant Haritama, Coriander Kalmui-CK-4, Local Coriander-LC-1, Local Lucknow-LC-5, Kalmi Dhania-3- KD-3, Kalmi Dhania-4-KD-4, Kashmiri Dhania-PD-3, Kashmiri Dhania-PD-5, Local Lucknow-LL-1, Local Coriander -LC-3, Coriander Kalmi-CK-3, Kalmi Dhania-2-KD-2 and Kalmi Dhania-5-KD-5 in randomized block design with three replications. Analysed data revealed that among all the genotypes Local Lucknow-LL-4, Coriander Kalmi-CK-2, Kalmi Dhania-KD-6, Local Dhania-LD-5 and Kashmiri Dhania-PD-2) gave promising results.

Tehlan *et al.*(2009) evaluated the performance of 12 coriander varieties/accessions received from various co-ordinating centres under All India Co-ordinated Research Project on Spices for various growth parameters and seed yield during 2002-03 to 2004-05 at the Vegetable

ISBN: 978-93-85822-48-3

Research Farm, CCS Haryana Agricultural University, Hisar. The significant differences were obtained for all the growth and yield parameters. Maximum seed yield was recorded as 1839 kg/ha in DH-234, which was statistically superior over all other cultivars except DH-205. The variety DH-234 gave 23.1% higher seed yield over Hisar Anand (Check) followed by DH-205 (14.5%).

2.1.1 Range of characters

Characters	Range	Reference
Days to flowering	42.67-68.67	Phurailatpam *et al.* (2016)
	73 to 80	Singh *et al.* (2011)
Days to maturity	176-200	Arif *et al.* (2014)
	139.33-142.33	Singh *et al*. (2011)
	103.10-121.60	Meena *et al.* (2010)
	103-119	Moniruzzaman *et al.* (2013)
	93.9-108.1	Giridhar *et al.* (2014)
Plant height	59.47-97.27	Phurailatpam *et al.* (2016)
	96.7 - 121.6	Malik and Tehlan (2013)
	54.6-121.6	Meena *et al.* (2014)
	60.40-100.40	Moniruzzaman *et al.* (2013)
Number of basal leaves	3 - 23.2	Arif *et al.* (2014)
	3.85-5.81	Chaulagain *et al.* (2011)
	5-9	Tomar *et a.l* (2014)
Number of primary branch	9.40-11.40	Phurailatpam *et al.* (2016)
	5.37-8.23	Datta and Choudhari (2006)
	1.4-8.6	Bhandari and Gupta (1993)
	4.4-11.5	Meena *et al.* (2014)
	6.10-8.02	Rahman(2000)
	3.2-5.4	Giridhar *et al.* (2014)
Number of secondary branch	17.20-30.00	Phurailatpam *et al.* (2016)
	10.10-16.75	Datta and Choudhari (2006)
	7.9-25.4	Meena *et al.* (2014)
	7.40-15.41	Moniruzzaman *et al.* (2013)
Number of umbels/plant	14.67-39.20	Phurailatpam *et al.* (2016)
	51.4 - 65.9	Malik and Tehlan (2013)
	33.3-76.9	Meena *et al.* (2014)
Number of umbellets/umbel	3.8 - 6.0	Malik and Tehlan (2013)
	4.1-6.8	Meena *et al.* (2014)
	7.33-10.80	Singh *et al.* (2011)
Number of seeds/umbel	27.6 - 36.1	Malik and Tehlan (2013)
	43.97 to 56.27	Meena *et al.* (2010)

ISBN: 978-93-85822-48-3

	18.3-41.9	Meena *et al.* (2014)
	23.27-35.57	Datta and Choudhari (2006)
	28.00-46.00	Maurya (1989)
Test weight	9.78 to 11.78	Singh *et al* (2011)
	9.33-13.82	Datta and Choudhari (2006)
	9.93-13.48	Meena *et al.* (2010)
	11.77-21.96	Singh *et al.* (2012)
Seed yield/plant	1.81-10.78	Phurailatpam *et al.* (2016)
	4.6-13.5	Meena *et al.* (2014)
	7-18	Tomar *et al.* (2014)

2.2 Evaluation of quality parameters

Saxena *et al.* (2015) revealed that essential oil content range from 0.11% to 0.34% and the oleoresin content ranges from 5.39 to 15.53%.

Kalra *et al.* (1999) studiedsixteen coriander genotypes for 2 years during 1994-96 to assess the oil yield potential of these diverse genotypes in the subtropical climate of north India. C-1 had the highest seed yield, oil yield as well as high resistance against stem gall (*Protomyces macrosporus*), a major threat to coriander cultivation.

Rajagopalan *et al.* (1996) evaluated thirteen Coriandrum sativum cultivars/accessions for seed and essential oil yield during 1990-91 and 1991-92 at the Tamil Nadu Agricultural University, Coimbatore, India. Although no significant differences in essential oil content or yield were observed between the cultivars/accessions, JC.81 produced the highest essential oil yield (3.95 kg/ha)..

Malik and Tehlan (2013) studied on various growth parameters, seed yield and essential oil content. The significant differences were obtained for all the parameters. Although no significant differences in essential content were observed between the cultivars; DH-220 produced the highest essential oil content (0.39%).

Doshi *et al.* (2014) assessed Coriander varieties for quality traits viz., essential oil, non volatile ether extracts and crude fiber under south eastern Rajasthan conditions (Zone V). The variation observed among the varieties

ISBN: 978-93-85822-48-3

was significant for all the traits studied. Among all RKD-18 (Raj Pratap Dhania-1) was found to have high essential oil.

Ebrahimia *et al.* (2010) reported that essential oil content of the dried seeds was varied from 0.1 to 0.36 %. Thirty-Four different compounds were identified in essential oil of all accessions. Linalool (40.9−79.9%), neryl acetate (2.3−14.2%), γ-terpinene (0.1 −13.6%) and α-pinene (1.2−7.1%) were identified as main components in the oil of Coriander accessions. Almost all studied accessions contain more that 60% linalool showing high quality of Coriander seeds produced in Iran and suitability of the accessions for use as initial genetic materials for breeding of homogenous and talent Coriander cultivars.

2.3 Correlation and path analysis

Sanker and Khader (1991) evaluated 30 cultivars of coriander at Tamil Nadu Agricultural University. Seven morphometric traits, including fruit yield, were measured and genetic parameters estimated. Primary branches and umbels per plant recorded the highest genotypic coefficient of variation, heritability and genetic advance. Yield, however, was only correlated with number of secondary branches, associated mainly with this character's indirect influence through secondary umbels. Secondary umbel also had the highest direct effect on yield and was thus considered the most significant feature for selection.

Information on genetic variability, heritability and genetic advance is derived from data on 13 characters in 19 indigenous and exotic genotypes grown in 1988-89 by Shridar *et al.* (1990). Considerable variation was noted for secondary branches, days to 50% flowering, 1000-seed weight and seed yield per plant.

Tripathi *et al.* (2000) reported that among the forty strains/genotypes of coriander there was little variability and scope for improvement through

ISBN: 978-93-85822-48-3

selection for number of umbellet per umbel, primary branches per plant and plant height. Correlation studies indicated that plant height, number of secondary branches, days to flowering, days to maturity and number of umbels were the major yield components whereas number of primary branches, number of umbellet per umbel and number of seeds per umbel, being negatively correlated with yield were less important..

Singh *et al.* (2006) reported that in a collection of 35 lines of coriander, the heritability estimate was high for number of secondary branches per plant, days to 50 per cent flowering, days to maturity, number of umbels per plant, 1000-grain weight, essential oil content and low for number of umbellets per umbel and number of grains per umbellet. Grain yield per plant had positive and significant correlation with plant height, number of primary branches per plant, number of secondary branches per plant, number of umbels per plant, number of umbellets per umbel, number of grains per umbellet and harvest index. Path co-efficient analysis revealed that number of secondary branches per plant, days to maturity and number of umbellets per umbel were the most important characters for selection of high yielding genotypes, as they had high direct positive effects as well as positive association with grain yield per plant.

Singh and Prasad (2006) revealed that grain yield per plant was positively and significantly associated with plant height, number of primary branches per plant, number of secondary branches per plant, number of umbels per plant, number of umbellets per umbel, number of grains per umbellets, essential oil content and harvest index. Maximum direct contribution to grain yield per plant was made by harvest index followed by primary branches per plant, days to maturity, number of secondary branches per plant, essential oil content, number of umbellets per umbel and 1000-grain weight. Harvest index showed high indirect effect via

ISBN: 978-93-85822-48-3

primary branches per plant. Primary branches per plant made a high indirect contribution via harvest index.

Dyulgerov and Dyulgerova (2013) reported that a vastly genetic variability for the studied traits between accessions was found. Traits such as fruit weight per umbel, 1000-fruits weight and fruit weight per plant have major contributions to the induced genetic diversity.

Dyulgerov and Dyulgerova (2014) reported that high broad sense heritability estimates ranged from 55.88 % for fruit weight per umbel to 94.41 % for number of primary branches per plant, while fruit yield showed 82.80 % heritability. High heritability and genetic advance were recorded for the number of umbels per plant. Fruit yield exhibited significantly positive correlation with the number of umbels per plant (r = 0,858) and fruit weight per plant (r =0,789). Therefore, the results suggest that the number of umbels per plant may be considered as important characters in breeding programs aiming to coriander yield improvement.

Bhandari and Gupta (1993) studied on genetic variation, yield correlations and heritability that derived from data on 12 yield components in 29 USA and 171 Indian Coriandrum sativum genotypes. The highest direct contribution to seed yield was made by umbellets/plant.

Mandal and Hazra (1993) reported that the yield correlations derived from data on 5 yield-related characters in 25 coriander (Coriandrum sativum) germplasms grown at Kalyani.

Gurbuz (2001) was conducted an experiment in Ankara, Turkey in 1997 and 1998 to study correlation and path analysis among yield components in 25 winter resistant lines of coriander (C. sativum). The highest correlations were found between single plant yield and single plant weight, branch number and number of branches with seeds. Path analysis indicated the highest direct and positive effect of single plant weight on

ISBN: 978-93-85822-48-3

single plant yield. Plant height had the highest negative effect on single plant yield.

According to Yadav (1999) coriander germplasm collection from Jabalpur, Madhya Pradesh, were evaluated at Raigarh in 1996-97. Wide variation of yield components was found, indicating the suitability of the germplasm for breeding programmes.

Datta (2006) analysed 15 coriander genotypes which revealed that primary branches per plant, secondary branches per plant, umbellets per umbel and seeds per umbel were positively and significantly correlated with yield.

Vijayalatha and Chezhiyan (2004) reported that correlation and path analysis studies were conducted in Coimbatore, Tamil Nadu, India, with ninety genotypes of coriander for 8 traits related to yield and quality. The traits such as plant height, number of primary branches, number of umbels, number of umbellets and essential oil exhibited positive and significant association at phenotypic and genotypic levels with yield. The positive direct effect of essential oil and number of umbellets was the highest on yield. This indicated that the yield in coriander was influenced by these traits and therefore selection should be exercised based on these traits..

Al *et al.*(2013) conducted an experiment on three coriander cultivars namely Russian, Balady (Egyptian), and Selected were used. The quantitative genetic studied characters were linear growth, plant height, number of primary branches/plant, number of total branches/plant, and fruit yield of plant. Analysis of variance, broad-sense heritability, genetic advance, genotypic and phenotypic correlation coefficients was estimated. Broad-sense heritability estimates were high in the three varieties ranging between 80.4% to 99.8%. Correlation coefficients among all studied traits

ISBN: 978-93-85822-48-3

were positive. Selected cultivar showed the best fruit yield in both studied seasons, 66.73 g/plant and 70.87 g/plant, respectively.

Singh *et al.* (2011) revealed that seed yield was significantly and positively correlated with its component characters like the number of primary branches plant-1 (rg=0.750** and rp=0.581**), number of secondary branches plant-1 (rg=0.471* and rp=0.431*), number of umbels/plant (rg=0.932** and rp=0.801**), number of umbellets/plant (rg=0.806** and rp=573**), number of seeds/umbel (rg=667** and rp=0.569**) and umbel diameter (rg=851** and rp=0.703**) both at the genotypic and phenotypic levels. Thus, the data revealed that the highest positive correlation (0.932) was appeared between number of umbels/plant and seeds yield (gm) whereas the lowest positive correlation (0.031) was expressed between number of umbellets/ plant and 1000-seeds weight.

Beena *et al.* (2013) revealed that seed yield/ plant exhibited a positive and significant correlation with number of fruits/ umbel. Number of fruits/umbellet expressed a positive significant correlation with number of fruits/umbel and 1000 seed weight. Days to 50 per cent flowering had the highest positive direct effect on seed yield/plant followed by number of umbellets/ umbel, number of fruits/umbel.

Sharma and Sharma (1989) observed significant variability for plant height, branches/plant, days to flowering and maturity in a collection of 200 lines of coriander genotypes. The heritability estimate was high for 1000-grain weight, days to flowering and maturity. Grain yield/plant had positive and significant correlation with plant height, branches, umbels, and umbellets/plant, grains/umbellet,and straw yield/plant. Path coefficient analysis revealed that branch/plant, umbellets/plant, 1000-grain weight, were the most important characters for selection of high yielding

ISBN: 978-93-85822-48-3

genotypes, as they had direct positive effect as well as positive (except 1000-grain weight) association with grain yield/plant.

Meena *et al* (2014) Coriander (*Coriandrum sativum* L.) observed that the highest genotypic and phenotypic variance was observed for number of umbels per plant, plant height and days to harvesting. High genotypic and phenotypic coefficients of variances were observed for seed yield. High heritability coupled with high genetic advance as percentage of mean was observed for test weight, plant height and number of seed per umbel indicating the important of additive gene effects for these traits. Number of umbels per plant (0.25*) and test weight (0.31*) exhibited positive and significant correlations with seed yield. Path coefficient analysis revealed that secondary branches per plant had highest direct effect on seed yield followed by number of umbels per plant, test weight, days to 50% flowering and plant height.

Meena *et al* (2014) reported that a field experiment was carried out during *Rabi* season of the year 2011-2012 on the experimental field of Department of Horticulture, Dr. PDKV, Akola, Maharashtra (India) on twenty four genotypes of coriander using Randomized Block Design with three replications. This study revealed that number of umbels per plant (0.25) and test weight (0.31) was associated significantly and positively with seed yield per plant. The perusal of path coefficient analysis shown days to 50% flowering (2.08) had highest direct effect on seed yield followed by number of seed per umbel (1.01), number of secondary branches (0.52), number of umbel per plant (0.49), test weight (0.28), plant height (0.23), leaf area (0.11) and chlorophyll content (0.11). Therefore, greater emphasis should be given on these characters while selecting for higher yield and related traits.

ISBN: 978-93-85822-48-3

Arif *et al.* (2014) revealed that coefficient of variation (CV %) was higher for number of basal leaves (74.26), largest basal leaf length (33.89), plant height (33.24) and DtSE (22.42). Moderate variability was recorded for days to flower start (20.62) and 1000 seed weight (13.70). Pearson correlation revealed strong association between different traits i.e. days to start of flowering (DtFs) days to harvesting (DtH), number of basal leaves (NBL), length of basal leaves and 1000 seed weight had direct positive effect on each other. Positive correlation was observed between days to harvesting and number of basal leaves, length of basal leaves and days to stem elongation

Shridar *et al.* (1990) gave an information on genetic variability, heritability and genetic advance that derived from data on 13 characters in 19 indigenous and exotic genotypes grown in 1988-89. Considerable variation was noted for number of leaves, secondary branches, fresh weight of plant, days to 50% flowering, 1000-seed weight and seed yield per plant..

Jain *et al.* (2003) reported that correlation and path analyses for seed yield and yield components (number of days to 50% flowering, height up to the base of the main umbel, total plant height, number of branches per plant, number of umbellets per umbel, number of umbellets per plant, number of seeds per umbel and 1000-seed weight) were conducted for 106 genotypes of coriander (Coriandrum sativum) and 7 controls (selected from the germplasm collection maintained in Jobner, Rajasthan, India) grown during the rabi season of 2001. Seed yield was positively and significantly correlated with all the traits except number of days to 50% flowering. Total plant height was positively associated with number of umbels per plant, height up to the base of the main umbel, number of branches per plant, number of umbellets per umbel, number of seeds per umbel, and 1000-

ISBN: 978-93-85822-48-3

seed weight. Path analysis revealed that total plant height had the greatest positive direct effect on seed yield, followed by number of umbels per plant and 1000-seed weight. The number of days to 50% flowering had a significant negative correlation with seed yield. The results suggest that selection for greater total plant height, number of umbels per plant and 1000-seed weight, earliness, and less height up to the base of the main umbel will be effective for the improvement of the seed yield of coriander

Mengesha and Alemaw (2010) conducted an experiment at Kokate and Wondo Genet, Southern Ethiopia, using 49 accessions arranged in randomised complete block design in two replications during the main season of 2007-08. 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 of seed yield (910-3099 kg ha-1), essential oil (0.25-0.85%) and fatty oil (11.11-16.53%) content was obtained. Overall, highest value of genetic coefficient of variation, broad sense heritability and genetic advance as percent of mean was obtained for longest basal leaf length, days to start 50% flowering, umbels number/plant, umbellets number/umbel, seed number/umbellets, seed number/plant, seed yield/ha and essential oil content.

Rajput and Singh (2003) studies on variability in twenty genotypes of *Coriandrum sativum* L. indicated higher estimates of genotypic coefficient of variation, phenotypic coefficient of variation, heritability and genetic advance for seed yield, umbels/plant, seeds/umbel and plant height, suggesting probable role of additive gene effects on character expression. Superior genotypes for different, traits identified in the study could be exploited for inter varietal hybridization (reciprocal recurrent selection method) for evolving a high yielding variety with other desirable traits.

ISBN: 978-93-85822-48-3

Fufa (2013) evaluated nineteen coriander land races were evaluated at Sinana during 2010 to see the correlation among yield components, seed and oil yield. The result of the correlation analysis revealed that seed yield per plant was positively correlated with all traits except with the number of umbels per plant and oil content. On the other hand, oil content showed negative correlation with all traits studied except days to emergence. This implies that the high yielding cultivars do not necessarily have high oil content.

2.4. Selection index

The set of characters identified as selection indices by different workers based on genetic variability parameters, correlation and path coefficient analysis frame are under review.

Different set of characters as selection indices in coriander

Sl.No.	Characters to be considered in selection	References
1.	Umbellets/umbel	Sanker and Khader (1991) Bhandari and Gupta (1993)
2.	Number of secondary branches per plant, days to maturity and number of umbellets per umbel	Singh *et al.* (2006)
3.	Harvest index , primary branches per plant, days to maturity, number of secondary branches per plant, essential oil content, number of umbellets per umbel and 1000-grain weight	Singh and Prasad (2006)
4.	Single plant weight	Gurbuz (2001)
5.	Essential oil and number of umbellets	Vijayalatha and Chezhiyan (2004)
6.	Days to 50 % flowering, number of umbellets per umbel, number of fruits per umbel.	Beena *et al.* (2013)
7.	Secondary branch per plant, no.umbels per plant, test weight, days to 50% flowering and plant height	Meena *et al.* (2014)
8.	Branch/plant, umbellets/plant, 1000-grain weight	Sharma and Sharma, (1989)

ISBN: 978-93-85822-48-3

9.	50% flowering, number of seed per umbel, number of secondary branches, number of umbel per plant, test weight , plant height , leaf area and chlorophyll content	Meena *et al.* (2014)
10	Plant height, number of umbels per plant and 1000-seed weight	Jain *et al.* (2003)

2.5. Determination of genetic divergence through multivariate analysis

Patel *et al.* (2000) revealed that forty-eight genotypes of Coriandrum sativum were collected from different villages in an important and major coriander growing district-Guna (Madhya Pradesh). Data were recorded on 10 different characters. D-square values between pairs of genotypes ranged from 2.50 to 96.96. By using D^2 analysis the genotypes were grouped into nine clusters. The clustering was at random and without any relationship between genetic diversity and geographic diversity. Seed yield per plant had highest contribution towards genetic divergence followed by secondary branches and umbels per plant.

Twenty four varieties were evaluated to study genetic divergence *Meena et al. (2014)* Tocher's method of hierarchical cluster analysis was applied to group the varieties. Varieties were grouped into four clusters. Intra-cluster distance was highest in cluster III followed by cluster II, IV and I. The maximum inter-cluster distance was between clusters III and I are 17.91 and 3.86 respectively. The varieties in cluster I were Hisar Sugandh, Hisar Anand, RCr-20, RCr-435, RCr-436, RCr-446, RCr-684, Swathi, Sadhana, Sindhu, Sudha, Rajendra Swati, GCr-1, GCr-2, CO-1, CO-2, CO-3, CO-4. The variety falling in cluster II is JD-1.The varieties falling in cluster III were NRCSS ACr-1, RCr-41and Azad Dhania-1. The varieties falling in cluster IV were Hisar Surubhi and Pant Haritma. Among the 10 characters studied for genetic divergence, days to 50% flowering contributed the maximum accounting for 49.64% of total divergence, followed by test weight (17.03%).

ISBN: 978-93-85822-48-3

Bertini *et al.* (2010) conducted experiment onfive genotypes for divergence analysis revealed that the genotype 1, from the coastal region of Caucaia was the most divergent and can be used at crossings with other genotypes for obtaining segregating populations. The genotypes that had lower genetic distance were Verdao SF177 and genotype from Juazeiro (semi-arid zone). The results of the group showed no relationship to the different geographical locations of genotypes evaluated.

Fifteen Indian accessions of coriander, consisting of 8 land races and 7 cultivars were used to study genetic divergenceSingh *et al.* (2002). The study revealed that D2 values ranges from 37.4 (between the genotypes C-2 and DH-5) to 1309 (between the genotypes C-1 and RCr-20). The genotypes clubbed into 8 clusters. The genetic diversity was found to be independent of the geographical diversity of the genotypes. The study suggested that improvement in this crop would be possible by exercising selection for oil yield, seed yield and their associated traits viz. oil content and umbellets per umbel. The results of D2 values and cluster means permitted rational selection of 5-33 and C-1, RCr-41 and PD-1, potent genorypes with complementary characters in morphological fitnesses for yield and its associated traits, for effective cross hybridization programme.

Seventy germplasm lines of coriander of diverse eco-geographical origin were undertaken in present investiga-tion to determine the genetic divergence following multivariate analysis for seed yield and its 9 component traits Singh *et al.* (2005). They are group into 9 clusters. Seventy percent of total genotypes (49/70) were grouped in 4 clusters (V, VI, VIII and IX), while apparent diversity was noticed for 30 percent genotypes (21/70) that diverged into 5 clusters (I, II, III, IV, and VII). The maximum inter cluster distance was between I and IV (96.20) followed by III and IV (91.13) and I and VII (87.15). The cluster VI was very unique

ISBN: 978-93-85822-48-3

having genotypes of high mean values for most of the com-ponent traits. The cluster VII had highest seeds/umbel (35.3 ± 2.24), and leaves/plant (12.93 ± 0.55), earliest flowering (65.05 ± 1.30) and moderately high mean values for other characters.

Mengesha *et al.* (2011) evaluated 49 Ethiopian using Mahalanobi's distance (D^2) analysis based on 15 characters. The accessions were grouped in to eight clusters. Cluster II and III were the largest each with 12 accessions, followed by clusters I and V each consisting of seven accessions. The highest inter-cluster distance (480.5) was observed between clusters I and VIII, followed by clusters V and VIII (462.2), and then clusters II and VIII (336.1). Maximum contribution toward total genetic divergence was possessed by thousand seed weight (15.67%), followed by basal leaf number (13.48%), plant height (10.29%), seeds umbellet-1 (9.81%) and umbel number plant-1 (7.84%).

The genetic divergence of 25 land races was assessed usingprincipal component and cluster analysis based on 8 characters (Fufa, 2013). The accessions were grouped into five clusters. Cluster I was the largest consisting 19 accessions. High inter cluster distance (47.42) was observed between cluster IV, cluster II and IV (47.33) and cluster I and IV (41.47) indicating the presence of substantial genetic diversity in genetic makeup of the accessions included in these clusters. Accessions 16 and 8 having positive values for principal component 1 and 2 were of considerable breeding interest because of their good combination for the studied yield related traits.

ISBN: 978-93-85822-48-3