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EVALUATION OF GENETIC DIVERSITY AND RELATIONSHIPS AMONG CORIANDER GENOTYPES BY USING CORRELATION AND PATH ANALYSIS

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Abstract

The present investigation was undertaken to study the relationship between seed yield and its contributing characters by using 30 diverse genotypes of coriander (*Coriandrum sativum* L.). Experiment was conducted at the Experimental Farm, Lovely Professional University, Jalandhar during *Rabi* 2017-2018. Observations of twelve different characters were recorded on five randomly selected plants from each replication and mean were used for statistical analysis. Analysis of variance revealed highly significant differences among the genotypes for all the characters. The presence of highly significant differences established the existence of large variability among genotypes. High GCV observed for harvest index, seed yield per plant, 100- seed weight and days to 50% flowering. PCV values were higher for 100- seed weight, harvest index and seed yield per plant. Both GCV and PCV were low for days to maturity. Broad-sense heritability was high for seed yield per plant and harvest index. A high estimate of genetic gain was noted for number of basal leaves, longest basal leaf length, number of fruit bearing branches, seeds per umbel, seed yield per plant, 100-seed weight and harvest index. Phenotypic and genotypic correlation studies revealed that the seed yield per plant was positively and significantly correlated with harvest index, 100-seed weight, number of fruit bearing branches and umbellets per plant. Path analysis revealed that the maximum direct and positive effect was due to harvest index followed by seeds per umbel, 100-seed weight, umbellets per plant.

Key words: GCV, PCV, genetic diversity.

Introduction

Coriander (*Coriandrum sativum* L.) is an important seed spice crop belonging to the family Apiaceae with a diploid chromosome number 2n=22 (Darvhankar *et al.,* 2013). The unripe fruits smell of bed bugs and thus character is responsible for determination of the name coriander from the Greek world "Koris" meaning bed bug. The ripe fruits are pleasantly aromatic. Two types of coriander namely small seeded and large seeded are cultivated. The large seeded types (3-5 mm diameter) belong to the group var. Vulgare while the small seeded (1.5-3 mm diameter) belong to var. microcarpum. In India large seeded varieties were mostly cultivated but they are being with small seeded ones, in recent years. In India coriander occupied an area of 530.50 million hectares giving a total production of 482.00 metric tonnes during 2013-14. The major coriander growing states are Andhra Pradesh, Tamil Nadu, Karnataka, Rajasthan, Gujarat, Madhya Pradesh, Utter Pradesh, Haryana and Bihar. Rajasthan is the leading state in area and production of coriander followed by Andhra Pradesh.

Coriander is extensively used in western countries in flavoring of processed foods, including breads, cakes, sauces, meat products, soups and confectionery (Darvhankar *et al.,* 2015). Coriander also forms an important ingredient for several alcoholic beverages, particularly gin. Coriander seeds are also used as tonic, carminative, diuretic, stomachic and as an aphrodisiac. Oleoresin from coriander is used as a flavoring agent, as an ingredient in pharmaceutical formulation and in perfumery (Singh *et al.,* 2006). A native of eastern Mediterranean region, coriander is now widely cultivated in many other parts of the world for its leaves, seeds and essential oil production. It is commonly grown in India, Bangladesh, Russia, Central Europe, Morocco and China. Coriander (*Coriandrum sativum* L.) also called Dhania (Hindi) Khophir (Gujarati), Dhane (Bengali), Dhaniyalu (Telugu), Dhana (Marwari), Kustumbari (Sanskrit), Kothamali (Tamil) is an annual herbaceous plant are

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belongs to the family Apiaceae.

The basic rationale in any crop improvement programme is the increase in yield potential of the crop. Seed yield is a complex and polygenic trait, and in order to study it properly, different factors affecting the seed yield must be considered and evaluated with regard to their contribution to seed yield (Darvhankar *et al.,* 2016). For a particular crop, information on the nature and magnitude of variability present in the population due to genetic and non-genetic causes is an important pre-requisite for commencing any systematic breeding programme (Baraskar *et al.,* 2014). Estimation of variability parameter under different dates or environments also provides useful information regarding pattern of changing variability under varied condition. By using such valuable information, breeding programme can become more systematic and sound.

The development of improved and stable genotype is one of the main objectives of plant breeders. Generally, multilocational traits are conducted over several years to find out stability of various genotypes. Economy with efficiency could be exercised by testing many genotypes in contrasting environments created by manipulating agronomic differential like planting time, row spacing, dose of fertilizers, irrigation etc at single location.

Matrials and methods

Plant material: The material for the present investigation comprised of 30 diverse genotypes of coriander of which 26 were collected from NRC on seed spices Ajmer (Rajasthan) and four were collected from Jalandhar. These 30 lines of coriander grown in randomized block design with three replications, at Experimental Farm, Lovely Professional University, Jalandhar Punjab. Each genotype was sown in single line of five meter bed with a spacing of 30 cm between lines and 10 cm between plants. Recommended crop management practices were followed for raising a healthy crop. Before sowing, fertilizer (25 N: 50 P: 0 K) was applied in furrows as basal dose. Life saving irrigation was applied as when required.

Data Collection: The biometrical observations were recorded for twelve different characters *viz.*, days to 50% flowering, plant height, number of basal leaves, longest basal leaf length, number of fruit bearing branches, umbels per plant, umbellets per plant, seeds per umbel, seed yield per plant, 100-seed weight, days to maturity and harvest index.

Statistical analysis

Variance analysis: The analysis of variance was performed following the standard procedures given by Panse and Sukhatme (1985).

Variability parameters: The phenotypic and genotypic coefficient of variation (PCV and GCV) was computed as per method described by Burton and DeVane (1953). Heritability (broad sense; hereafter denoted only heritability) estimate was computed by dividing the genotypic variance with phenotypic variance and then multiplying by 100 as suggested by Warner (1952). correlation coefficient at genotypic and phenotypic level was computed according to (Al-Jibouri *et al.,* 1958). Path coefficient analysis was done by formula suggested by (Dewey and Lu 1959). In present investigation, path coefficient analysis was carried out by taking seed yield per plant as dependent variable and other observed traits as independent variables in each of the environments and also for the pooled basis.

Results and discussion

Analysis of variance and per-se performance: Analysis of variance was carried out for 12 different characters in coriander. Result revealed highly significant differences among the genotypes for all the characters. The presence of highly significant differences established the existence of large variability among genotypes included in the experimental material. (table 1)

The analysis of variance showed highly significant mean square due to genotypes for all the characters. This indicates the significance in the expression of character and hence many genotypes behaved differently in different conditions (Darvhankar *et al.,* 2016). Wide range of variation was observed for all the characters umbellets per plant, harvest index, umbels per plant, days to 50% flowering, plant height and number of fruit bearing branches. Wide range of variation present in the material indicated the further scope of improvement. (Singh *et al.,* 2006 and Meena *et al.,* 2010)

Variability parameters:

Phenotypic and genotypic coefficient of variation: The highest PCV observed for harvest index (26.85%) followed by seed yield per plant (26.18%), 100-seed weight (22.10%), number of fruit bearing branches (17.37%), number of basal leaves (14.57%), seeds per umbel (11.85%), longest basal leaf length (10.35%), days to 50% flowering (7.80%), umbellets per plant (7.67%), umbels per plant (6.47%), days to maturity (3.27%) and plant height (2.81%). In case of GCV, the highest estimate was observed for harvest index (19.55%) followed by seed yield per plant (17.34%), number of basal leaves (10.32%), 100-seed weight (9.20%), number of fruit bearing branches (8.31%), seeds per umbel (6.55%), longest basal leaf length (4.65%), umbellets per plant

Table 1: Mean and range of different characters in coriander

Characters	Mean	Range
Days to 50% flowering	30.20	27.67-33.67
Plant height (cm)	77.33	74.58-80.23
Number of basal leaves	6.86	4.56-8.56
Longest basal leaf length (cm)	5.92	5.27-6.80
Number of fruit bearing branches	20.89	15.95-25.05
Umbels per plant	48.52	44.93-52.73
Umbellets per plant	247.39	214.67-267.87
Seeds per umbel	24.88	19.98-28.87
Seed yield per plant (g)	13.08	7.14-17.64
100-seed weight (g)	1.10	0.71-1.39
Days to maturity	101.38	98.33-107.00
Harvest index (%)	59.26	28.24-78.56

Table 2: Genotypic coefficient of variation, heritability and genetic advance as per cent of mean for twelve characters in coriander

Characters	GCV (%)	PCV (%)	H^2	GA	GA (%)
Days to 50% flowering	3.38	7.80	18.78	4.85	46.05
Plant height (cm)	1.30	2.81	21.4	4.44	5.74
Number of basal leaves	10.32	14.57	19.08	2.79	40.67
Longest basal leaf length (cm)	4.65	10.35	20.20	1.26	21.28
No. of fruit bearing branches	8.31	17.37	22.92	6.92	33.12
Umbels per plant	2.77	6.47	18.40	6.50	13.39
Umbellets per plant	3.49	7.67	20.71	38.94	15.74
Seeds per umbel	6.55	11.85	30.59	6.08	24.43
Seed yield per plant (g)	17.34	26.18	43.87	7.05	53.89
100-seed weight (g)	9.20	22.10	17.33	0.50	45.45
Days to maturity	1.46	3.27	19.98	6.83	6.73
Harvest index (%)	19.55	26.85	53.03	32.69	55.16

(3.49%), days to 50% flowering (3.38%), umbels per plant (2.77%), days to maturity (1.46%) and plant height (1.30%) (table 2).

Heritability: High estimates of broad sense heritability were obtained for harvest index (53.03%) and seed yield per plant (43.87%). Whereas moderate heritability was recorded for seeds per umbel (30.59%), number of fruit bearing branches (22.92%) and plant height (21.40%). And it was low for umbellets per plant (20.71%), longest basal leaf length (20.20%),days to maturity (19.98%), number of basal leaves (19.08%),days to 50% flowering (18.78%), umbels per plant (18.40%) and 100-seed weight (17.33%) (table 2).

Genetic advance expressed as per cent of mean: The highest genetic advance expressed as per cent of mean was found for harvest index (55.16),seed yield per plant (53.89),days to 50% flowering (46.05), 100-seed weight (45.45), number of basal leaves (40.67), number of fruit bearing branches (33.12),seeds per umbel (24.43) and longest basal leaf length (21.28), whereas it was low for umbellets per plant (15.74), umbels per plant (13.39), days to maturity (6.73) and low for plant height (5.74) (table 2).

The estimates of phenotypic and genotypic coefficient of variability indicated that the values of phenotypic coefficient of variation were always higher than genotypic coefficient of variation, indicating the influence of environmental factors. But the difference between phenotypic and genotypic coefficient of variation were not substantial. Narrow difference between phenotypic and genotypic coefficient of variation in most of the characters indicated that they were comparatively stable to environmental variation. (Majumdar *et al.*, 1969). This also suggested that genetic factors were pre-dominantly responsible for the expression of these attributes and selection could be made effectively on the basis of phenotypic performance. However in certain cases like days to maturity and number of basal leaves has considerable difference between PCV and GCV. This clearly indicated the significant role of environmental factors in the expression of above said traits. It is a well known fact that forced maturity may result due to sudden rise of temperature.

The coefficient of variation does not offer full scope to estimate the heritable variation. The relative amount of heritable portion of variation is assessed with the help of heritability estimate and genetic advance expressed as percentage of mean (genetic gain). The success of selection depends on the breeding value of a genotype recognized from its phenotypic expression.

Moderate to high heritability estimates indicated that the characters were least influenced by the environmental effects. This also suggested that the phenotypes were the true representative of their genotypes for these traits and selection based on phenotypic value could be reliable. In a crop improvement programme the highly heritable characters may be selected early in the programme and selection with low heritability may be postponed till they are close to complete homozygosis (Sakai, 1951).

Correlation coefficient: The genotypic and phenotypic correlation co-efficient of component characters with seed yield were estimated (table 3) to study how seed yield was influenced by its component characters. The seed yield per plant had significant

Table 3: Genotypic (r_g) and phenotypic (r_p) correlation coefficient for twelve characters in coriander

Character		Days to 50% flowering	Plant height (cm)	No. of basal leaves	Longest basal leaf length(cm)	No. of fruit bearing branches	Umbeles per plant	Umbellets per plant	Seeds per umbel	100 seed weight (g)	Days to maturity	Harvest index (%)
Seed yield (g)	rg rp	-0.190 -0.049	-0.216 -0.011	0.447** 0.041	0.757** 0.139	0.340** 0.250*	-0.053 0.170	0.381** 0.294*	0.483** 0.230	1.000** 0.516**	-0.204 0.621**	0.890** 0.621**
Days to 50% flowering	rg rp		0.375** -0.075	-0.430** -0.014	-0.250* -0.124	0.562** 0.186	-0.881** -0.132	0.293* 0.194	0.392** 0.220	-0.660** -0.163	-0.990** 0.029	-0.370** -0.111
Plant height (cm)	rg rp			-0.067 0.063	0.949** 0.030	0.359** 0.057	-0.767** -0.022	0.201 0.159	0.010 -0.088	-0.490** -0.218	0.116 0.032	0.331** 0.131
No. of basal leaves	rg rp				-0.460** -0.001	0.403** 0.092	0.588** 0.009	1.020** 0.219	0.528** -0.037	0.271* 0.017	-0.159 -0.223	0.099 0.017
Longest basal leaf length (cm)	rg rp					-0.253* 0.009	0.027 -0.062	0.411** 0.199	0.398** 0.229	0.273* -0.013	0.294* 0.086	0.601** 0.258*
No. of fruit bearing branches	rg rp						-0.309* 0.032	0.377** 0.103	0.778** 0.158	0.311* 0.109	-0.197 0.074	0.178 0.088
Umbeles per plant	rg rp							0.043 0.050	-0.780** -0.380**	0.231 0.162	-0.154 -0.033	-0.100 -0.065
Umbellets per plant	rp rp								0.249 0.356**	0.012 -0.013	-0.127 0.078	0.342** 0.314**
Seeds per umbel	rg rp									0.253* 0.068	-0.081 0.009	0.104 0.128
100-seed weight (g)	rg rp										-0.092 0.106	0.761** 0.532**
Days to maturity	rg rp											0.228 0.144

and positive correlations both at genotypic and phenotypic levels with number of fruit bearing branches (rg=0.340, rp=0.250), umbellets per plant (rg=0.381, rp=0.294), 100 seed weight (rg=1.000, rp=0.516) and harvest index (rg=0.890, rp=0.621). The seed yield per plant had non-significant and negative correlation both at genotypic and phenotypic levels with days to 50% flowering (rg=-0.190, rp=-0.049), plant height (rg=-0.216, rp=-0.011). This character showed non-significant and positive correlation both at phenotypic levels with number of basal leaves (rp=0.041), longest basal leaf length (rp=0.139) and seeds per umbel (rp=0.230).

In general, the values of genotypic correlation were higher than their corresponding phenotypic correlation in the present investigation. This indicated that though there was high degree of association between two variables at genotypic level, its phenotypic expression was deflated by the influence of environment. The study of genotypic correlation gives an idea of the extent of relationship between different variables. This relationship among yield contributing characters as well as their associations with yield provides information for exercising selection pressure for bringing genetic improvement in seed yield.

In present investigation, (table 4.3) seed yield per plant showed significant and positive correlation with longest basal leaf length, umbels per plant, umbellets per plant, 100-seed weight and harvest index was significant and positive correlation in timely sown condition. This indicated that importance of these traits as compliment of seed yield. Significant and positive correlation of seed yield with these contributing characters was earlier reported by Rao *et al.* (1981), Singh *et al.* (2006) Bhandari and Gupta (1991) and Mandal and Hazra (1993).

Path analysis: The data (table 4) revealed that harvest index (0.591) had the highest direct positive effect towards the seed yield. Other traits having seeds per umbel (0.523), 100-seed weight (0.362), umbellets per plant (0.259), umbels per plant (0.184), days to 50% flowering (0.055), number of fruit bearing branches (-0.144), number of basal leaves (-0.238), days to maturity (-0.239) and plant height (-0.309) had direct effect with negative sign.

Path analysis provides information about the cause and effect situation in understanding the cause of association between two variables. It permits the examination of direct effect of various characters on yield

Table 4: Genotypic path coefficient analysis showing direct (diagonal and bold) and indirect effect of different characters on seed yield in coriander

Character	Days to 50% flowering	Plant height (cm)	No. of basal leaves	Longest basal leaf length (cm)	No. of fruit bearing branches	Umbels per plant	Umbellets per plant	Seeds per umbel	100 seed weight (g)	Days to maturity	Harvest index (%)	Genotypic correlation with seed yield
Days to 50% flowering	**0.055**	-0.115	0.104	-0.053	-0.080	-0.162	0.076	0.205	-0.237	0.237	-0.218	-0.190
Plant height (cm)	0.021	**-0.309**	0.016	0.202	-0.051	-0.141	0.052	0.005	-0.178	-0.027	0.195	-0.216
No. of basal leaves	-0.024	0.020	**-0.238**	-0.098	-0.057	0.108	0.264	0.276	0.098	0.038	0.058	0.447**
Longest basal leaf length (cm)	-0.013	-0.293	0.110	**0.213**	0.036	0.005	0.106	0.208	0.098	-0.070	0.355	0.757**
No. of fruit bearing branches	0.031	-0.110	-0.095	-0.054	**-0.144**	-0.057	0.097	0.407	0.112	0.047	0.105	0.340**
Umbeles per plant	-0.049	0.237	-0.140	0.005	0.044	**0.184**	0.011	-0.408	0.083	0.036	-0.059	-0.053
Umbellets per plant	0.016	-0.062	-0.242	0.087	-0.054	0.008	**0.259**	0.130	0.004	0.030	0.202	0.381**
Seeds per umbel	0.021	-0.003	-0.125	0.085	-0.112	-0.144	0.064	**0.523**	0.091	0.019	0.061	0.483**
100 seed weight (g)	-0.036	0.152	-0.064	0.058	-0.044	0.042	0.003	0.132	**0.362**	0.052	0.450	0.97**
Days to maturity	-0.055	-0.035	0.037	0.062	0.028	-0.028	0.033	-0.042	-0.033	**-0.239**	0.134	-0.204
Harvest index (%)	-0.020	-0.102	-0.023	0.128	-0.025	-0.018	0.088	0.054	0.275	-0.054	**0.591**	0.890**

Residual effect: 0.610

as well as their indirect effects via other component traits. Therefore, it provides basis for selection of superior genotypes from the diverse breeding populations.

In the present study, the path coefficient analysis revealed that the harvest index, days to 50% flowering, longest basal leaf length, umbels per plant, umbellets per plant, seeds per umbel and 100-seed weight exhibited high and positive direct effects on seed yield per plant. Thus, these characters turned-out to be the major components of seed yield and direct selection for these traits would be rewarding for yield improvement. Similar results were reported Singh *et al.* (2006), Meena *et al.* (2010), Darvhankar *et al.* (2013) and Darvhankar *et al.* (2016). The residual effect was of low magnitude suggesting that the majority of the yield attributes have been included in the path analysis.

It can also be concluded that the characters which are most important for correlation studies are also important for path analysis. Thus, it can be suggested that correlation and path analysis study should be consider together for rapid gain for final improvement in seed yield.

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