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Variability and character association studies in coriander (*Coriandrum sativum* L.)

Taslima Gauhar[1], R. K. Solanki[2], R. K. Kakani[2] and Manoj Choudhary

[1]MJRP College of Agriculture & Research (Mahatma Jyoti Rao Phoole University, Jaipur - 302 001 (Rajasthan)

[2]ICAR-Central Arid Zone Research Institute, Jodhpur, Rajasthan

Abstract

Eighty germplasm lines of coriander *(Coriandrum sativum* L.*)* were evaluated in Augmented Block Design to estimate variability and character association. Analysis of variance revealed significant variability for most of the traits. Higher estimates of phenotypic coefficient of variance along with genotypic coefficient of variance as well as broad sense heritability, genetic advance and genetic advance as percentage of mean were observed for number of basal leaf, plant height up to main umbel, umbel plant^{-1}, number of leaflets, longest basal leaf, test weight, seeds umbel^{-1}, primary branches plant^{-1}, plant height up to top of the plant, secondary branches plant^{-1}, umbellate umbel^{-1}, days to 50% flowering and seed yield. The association analysis at both genotypic and phenotypic level revealed that the seed yield plant^{-1} was significantly and positively correlated with secondary branches plant^{-1} and umbel plant^{-1}. Associations of seed yield plant^{-1} with longest basal leaf, numbers of leaflets, days to stem initiation, plant height up to main umbel, umbellate umbel^{-1} were also positive but found non-significant.

Key words : Coriander, character association, genetic advance, heritability, variability.

Introduction

Coriander *(Coriandrum sativum* L., 2n = 22) is a crop native to the Mediterranean region, belongs to *Apiaceae* family and is considered an annual herb and a major seed spice, since both its leaves and seeds are used as a condiment and for culinary purpose. Fresh coriander leaves are more commonly known as cilantro. The stems, leaves and fruits all have a pleasant aroma, which makes them used for flavoring continental curries and soups. The fruits are extensively employed as a condiment in the preparation of curry powder, pickling, spices, sausages and seasoning and are also used to flavour pastry, biscuits, buns cakes and liquors, particularly gin. Coriander seeds are also known for their medicinal properties and are considered carminative, diuretic, antibilious, refrigerant and aphrodisiac. Coriander is consequently a frequent ingredient in the preparation of Ayurvedic medicines and is a traditional home therapy for a variety of ailments. In India, it is pre-dominantly grown in the states of Rajasthan, Andhra Pradesh, Madhya Pradesh, Gujarat, Tamil Nadu and Karnataka. The essential oil is the most important in determining the quality of spices. Dried ripe coriander seeds have 6.3-8.0% moisture and contain essential oil 0.3-2.06%, fatty oil 13-18%, and crude protein 11.5-21.3%, fat 17.8-19.15%, crude fiber 28.4-29.1% and ash 4.9-6.0% (Coskuner and Karababa, 2006). Ehancement in seed yield is the prime objective of breeding programmes. Yield is a highly complex character controlled by a large number of genes and greatly influenced by the environment. Thus, direct selection for yield may not be very effective. Several morphological traits and environmental conditions influences the yield directly or indirectly. A study on variability available in the material is essential for varietal development programme. Correlation studies are the basic requirement for any selection programme which is helpful in determining the components of complex traits like yield. The present study was undertaken at ICAR-NRCSS, Ajmer to estimate the variability present in genotypes of coriander and to evaluate the extent of association among yield and yield contributing traits.

Material and methods

The experimental material for the present study consisted of 80 germplasm lines and five checks *viz.*, RCr-435, RCr-684, Hissar-Anand, APHU-D-1 and ACr-2. The experiment was laid out in an Augmented Block Design with 8 blocks, each block having 10 test entries and 5 checks. Each entry was sown in single row of 2m length with row to row spacing of 50 cm and plant to plant spacing 10 cm. All recommended agronomic practices and plant protection measures were timely followed. Observations were recorded on different morphological characters and seed yield per plant. Five plants were randomly selected

*Corresponding author email: taslimagohar242@gmail.com

and tagged from each plot before flowering to record the data on plant height (cm), primary branches plant^{-1}, secondary branches plant^{-1}, umbels plant^{-1}, umbellates umbel^{-1}, seeds umbel^{-1}, 1000-seed weight (g), seed yield plant^{-1} (g), while data on days to 50% flowering was recorded on whole plot basis. These quantitative characters were further used to estimate phenotypic and genotypic coefficient of variation, broad sense heritability, expected genetic advance at 5 per cent selection intensity and correlation coefficient following the standard statistical methods (Singh and Choudhary, 1979) using Indostat software.

Results and discussion

The analysis of variance (Table 1) revealed that significant amount of variability was present in the genotypes studied for almost all morphological traits. Variability parameters were assessed (Table 2). Genotypic Coefficient of Variation (GCV) expresses the true genetic potential indicating presence high genetic variability for the target traits thus selection may be more effective. Higher GCV (Genotypic coefficient of variation) was recorded for number of basal leaf (40.97), plant height up to main umbel (29.49), seed yield plant^{-1} (26.09), umbel plant^{-1} (25.14), number of leaflets (23.42). Similarly, high PCV (Phenotypic Coefficient of Variation) was recorded for number of basal leaf (47.40), number of leaflets (44.51), longest basal leaf (33.93), plant height up to main umbel (29.80), seed yield plant^{-1} (29.78), umbel plant^{-1} (25.62), test weight (22.28). Less difference between estimates of genotypic and phenotypic coefficient of variation indicates that these traits are least affected by the environment. The present finding confirm with the earlier reports of Jain *et al.,* 2002; Meena *et al*., 2010; Singh and Singh 2013 and Sharma *et al.,* 2016.

The estimates of heritability (in broad sense) expressed in percentage was high for the characters *viz.,* number of basal leaf, plant height up to main umbel, umbel plant^{-1}, plant height up top of the plant, seeds umbel^{-1}, primary branches plant^{-1}, seed yield plant^{-1} and number of basal leaf, indicating that these characters are less influenced by environment and direct selection for these yield contributing traits would be effective for future improvement in yield. Similar results were reported by Jain *et al.,* 2002, Mengesha *et al.,* 2010, Abou El-Nasr *et al.,* 2013, Al-Kordy *et al.,* 2013, Singh and Singh, 2013 and Agasimani *et al.,* 2015.

Genetic advance as percentage of mean for the characters ranged from 4.85 (days to germination) to 72.96 (number of basal leaf). High magnitude of genetic advance as percentage of mean was estimated for number of basal

Table 1. Analysis of variance for different characters in Coriander.

Sources of variation	Block (Eliminating check + Var.)	Entries (Ignoring Block)	Checks	Germplasm	Checks vs. Germplasm	Error
Degree of Freedom	7	84	4	79	1	28
Days to germination	3.47**	0.76	0.66	0.77	0.50	0.46
Longest basal leaf	11.46*	6.77*	19.67**	5.71	35.12**	3.42
Number of basal leaf	1.7	4.91**	6.67**	4.92**	5.28*	0.93
Number of leaflets	0.25	1.24*	6.53**	0.87	9.20**	0.56
Days to stem initiation	52.68	56.30*	135.53**	51.46*	121.83*	28.55
Days to 50% flowering	93.18**	76.34**	183.12**	70.80**	86.40*	16.52
Plant height (main umbel)	15.92**	325.82**	418.65**	320.38**	369.54**	4.69
Plant height (top of the plant)	45.41**	200.32**	284.77**	193.14**	429.60**	5.47
Primary branches per plant	0.72*	2.63**	17.28**	1.92**	0.79	0.21
Secondary branches per plant	5.46	14.37**	139.93**	7.69	35.52**	4.41
Umbel per plant	36.34**	207.60**	935.86**	172.81**	43.35**	4.56
Umbellate per umbel	0.43*	0.79**	3.65**	0.51**	11.52**	0.13
Seeds per umbel	17.38	165.22**	1982.35**	73.65**	115.37**	7.63
Test weight	2.44	12.86**	74.37**	9.66**	18.21*	2.72
Seed yield per plant	2.41	18.99	80.77*	12.33	268.59**	2.17

* = Significant at 5 % and ** = significant at 1% level of significance

Table 2. Overall mean values of genotypes, their ranges, genotypic and phenotypic coefficient of variation, heritability in broad sense, genetic advance and genetic advance as % of mean for different characters in coriander.

Characters	Mean	Range (min-max) (adjusted values)	Genotypic coefficient of variation (GCV%)	Phenotypic coefficient of variation (PCV%)	Heritability in broad sense (%)	Genetic advance	Genetic advance as % of mean
Days to germination	11.31	9.65 - 12.65	4.147	7.303	32.24	0.5488	4.8509
Longest basal leaf (cm)	6.61	1.58 - 13.54	19.219	33.931	32.08	1.4832	22.4262
Number of basal leaf	4.04	1.61 - 19.73	40.979	47.409	74.71	2.9515	72.9655
Number of leaflets	1.98	0.77 - 3.97	23.421	44.515	27.68	0.5045	25.3841
Days to stem initiation	45.66	33.20 - 58.80	8.805	14.644	36.14	4.9793	10.9046
Days to 50% flowering	63.95	50.15 - 79.75	9.496	11.639	66.56	10.2063	15.9598
Plant height (main umbel) (cm)	50.59	23.68 - 96.00	29.495	29.804	97.93	30.4213	60.1301
Plant height (top of the plant)	90.31	60.18 - 119.66	12.705	13.013	95.30	23.0767	25.5503
Primary branches per plant	6.30	3.01 - 9.81	17.390	18.896	84.69	2.0778	32.9674
Secondary branches per plant	13.31	7.85 - 20.45	11.422	19.478	34.38	1.3374	13.7970
Umbel per plant	43.32	16.57 - 71.25	25.144	25.623	96.29	22.0209	50.8273
Umbellate per umbel	4.84	3.30 - 6.50	10.713	13.080	67.08	0.8761	18.0741
Seeds per umbel	38.52	17.64 - 57.52	17.743	19.137	85.96	13.0528	33.8858
Test weight (g)	12.38	6.84 - 18.53	17.866	22.289	64.25	3.5541	28.5017
Seed yield per plant (g)	10.25	4.32 - 19.96	26.09	29.78	76.72	4.8295	47.0770

Table 3. Effect of intercropping of seed spices with vegetables on gross return, net return and BCR during 2011-12, 2012-13 and pooled

Characters	Level	Days to germination	Longest basal leaf	No. of basal leaf	No. of leaflets	Days to stem initiation	Days to 50% flowering	Plant height (main umbel)	Plant height (top of the plant)	Primary branches plant^{-1}	Secondary branches plant^{-1}	Umbel plant^{-1}	Umbellate umbel^{-1}	Seeds umbel^{-1}	Test weight	Seed yield plant^{-1}
Days to germination	P	1	-0.11	-0.07	-0.11	-0.03	-0.03	-0.19	-0.089	-0.03	-0.01	0.05	0.01	0.02	0.09	-0.13
	G	1	-0.11	-0.06	-0.11	-0.030	-0.027	-0.19	-0.087	-0.01	0.01	0.07	0.01	0.04	0.09	0.01
Longest basal leaf	P		1	0.59**	0.41**	0.48**	0.55**	0.59**	0.51**	0.48**	0.49**	0.12	0.35*	0.25*	-0.23*	0.13
	G		1	0.59**	0.38**	0.47**	0.64**	0.60**	0.53**	0.49**	0.48**	0.10	0.33*	0.26*	-0.21*	0.14
Number of basal leaf	P			1	0.35**	0.47**	0.50**	0.48**	0.35**	0.36**	0.33**	0.03	0.45*	0.21	-0.35**	-0.08
	G			1	0.34**	0.47**	0.49**	0.49**	0.36**	0.36**	0.34**	0.02	0.45*	0.21	-0.34**	-0.09
Number of leaflets	P				1	0.68**	0.62**	0.62**	0.46**	0.45**	0.33**	0.31**	0.44*	0.27*	-0.62**	0.21
	G				1	0.67**	0.62**	0.65**	0.48**	0.45**	0.30**	0.30**	0.41*	0.26*	-0.60**	0.14
Days to stem initiation	P					1	0.75**	0.58**	0.48**	0.53**	0.53**	0.28**	0.47*	0.25*	-0.49**	0.12
	G					1	0.74**	0.59**	0.49**	0.53**	0.37**	0.27*	0.47*	0.25*	-0.48**	0.12
Days to 50% flowering	P						1	0.71**	0.60**	0.61**	0.48**	0.24*	0.43*	0.27*	-0.54**	-0.01
	G						1	0.73**	0.61**	0.61**	0.47**	0.23*	0.42*	0.26*	-0.32**	0.06
Plant height 1 (main umbel)	P							1	0.66**	0.73**	0.48**	0.19	0.41*	0.25*	-0.34**	0.04
	G							1	0.65**	0.74**	0.52**	0.19	0.43*	0.23*	-0.35**	0.13
Plant height 2 (top of the plant)	P								1	0.72**	0.51**	0.42**	0.37*	0.20	-0.23*	0.19
	G								1	0.73**	0.55**	0.43**	0.40*	0.18	-0.24*	0.37**
Primary branches plant^{-1}	P									1	0.71**	0.41**	0.34*	0.13	-0.12	0.12
	G									1	0.70**	0.40**	0.37*	0.09	-0.11	0.29**
Secondary branches plant^{-1}	P										1	0.31**	0.33*	0.06	-0.07	0.27**
	G										1	0.28**	0.33*	0.04	-0.06	0.30**
Umbel plant^{-1}	P											1	0.18	0.20	-0.25*	0.48**
	G											1	0.18	0.22*	-0.24*	0.66**
Umbellate umbel^{-1}	P												1	0.46**	-0.41**	0.07
	G												1	0.47**	-0.38**	0.01
Seeds umbel^{-1}	P													1	0.66**	0.06
	G													1	-0.56**	0.02
Test weight	P														1	-0.08
	G														1	-0.02
Seed yield plant^{-1}	P															1
	G															1

Test of significance at 0.05% was 0.21 & at 0.01% was 0.278

leaf, plant height up to main umbel and umbel plant^{-1} seed yield plant^{-1}.

Character association studies reflected strong association of dependent trait ie., seed yield with important yield contributing traits (Table 3). The phenotypic correlation coefficient was higher than their genotypic correlation coefficient counterparts in most of the characters. This implies that the non genetic causes affected values of genotypic correlation because of the influence of the environmental factors. The association analysis at both genotypic and phenotypic level revealed that the seed yield plant^{-1} was significant and positively correlated with secondary branches plant^{-1} (r_g=0.30**), (r_p=0.27**) and umbel plant^{-1} (r_g=0.68**), (r_p=0.48**) respectively. While the associations of seed yield plant^{-1} with longest basal leaf, number of leaflets, days to stem initiation, plant height up to main umbel, umbellate umbel^{-1} was found positive but non- significant (Table-3). Similar results were reported by Pandey *et al.,* 2012, Nair *et al.,* 2013, Mengesha *et al.,* 2013.

Conclusion

In coriander ample variability exits for number of basal leaf, plant height up to main umbel, seed yield plant^{-1}, umbel plant^{-1} and number of leaflets. The heritability estimates for the highly variable traits was also high along with genetic gain as per cent of mean; suggesting that genotypic selection of superior plant types based on these traits will be responsive to achieve genetic gain. The association studies reflected that seed yield is highly correlated with secondary branches and umbel plant^{-1}, therefore indirect selection based on these two traits may help in increasing yield potential in coriander.

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