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GENETIC ANALYSIS OF AGRONOMIC TRAITS IN CORIANDER

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SUMMARY

Coriander (*Coriandrum sativum* L.) is an annual spice herb that belongs to the family of Umbelliferae. The investigation was undertaken to assess the extent of genotypic and phenotypic coefficient of variation, expected genetic advance, heritability, genotypic and phenotypic correlation coefficients and path analysis for direct and indirect effect of yield components on yield of coriander**.** The study was undertaken using 24 genotypes of coriander using randomized complete block design with 3 replications. 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. Therefore for breeding, greater emphasis should be given on these characters while selecting for higher yield and related traits.

Keywords: Coriander, *Coriandrum sativum* L, genetic advance, genetic variability, heritability, correlation coefficient and path analysis.

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INTRODUCTION

Coriander (*Coriandrum sativum L.*) is an important seed spices crop of family Apiaceae (Umbelliferae) and possess 2n = 22 chromosomes with cross-pollination as mode of reproduction. Western Europe and Asia are considered to be the centre of origin of this crop (Gal *et al.,* 2010). Coriander is an annual herbaceous plant extensively grown in India. Its name has been derived from Greek world "Koris" means bed-bug, because of unpleasant, fetid bug like odor of the green unripened fruits (Meena *et al.,* 2010). The area, production and productivity of coriander during 2012-2013 in India were 543 thousand hectares, 524 thousand metric tons and 1.0 MT/ha respectively (Anon, 2013). Although the king and queen of spices are Black pepper and small Cardamom, respectively, coriander is the major ingredient of curry powder comprising up to 40% by weight. It is thus extensively used in Indian Malaysian, Indonesian and Arabic cuisine. Coriander is extensively used in western countries in flavoring of processed foods, including breads, cakes, sauces, meat products, soups and

confectionery. 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). To make this crop more productive and resistant to diseases and insect pests, breeders have to launch an intensive breeding program for development of high yielding cultivars requires knowledge of the existing genetic variation and also the association of yield contributing characters.

When initiating a breeding program with any crop having genetic variation, it is important to gather information on the traits of agronomic importance in order to select and breed better varieties (Dubley and Moll, 1969). Genetic variability is an important to select characters, which are heritable. Unless and until there is large amount of variability present in the population, the breeder has little scope in breeding for high yielding varieties. The observed variability is a combined estimate of genetic and environmental causes. The estimate of heritability alone does not provide an idea of the expected gain in the next generation but it has to be considered in conjunction with genetic advance.

Yield being a quantitative trait has complex inheritance, which is subjected to environmental fluctuations, requiring indirect selection of simply highly heritable traits for its improvement (Thakur and Saini, 1995). Deb and Khaleque (2009) stated that knowledge about the association and interaction of different traits with yield greatly helps the breeder in selection work with more precession and accuracy. Relationships of different traits with yield, among different traits and their direct and indirect effects on one another provides basis for a successful breeding program (Ali *et al.,* 2003). The intensity and direction of association of the different traits with yield were estimated with genotypic and phenotypic coefficient of correlation (Mode and Robinson, 1959). The exact picture of the relative importance of direct and indirect influences of the component characters towards seed yield is determined by path analysis (Bhatt, 1973).

Correlation and path analysis have been used in breeding studies in different aromatic plants (Gurubuz, 2001). Hence, correlation studies and path analysis provide detailed information to identify important characters to be considered in improvement program through selection. Correlation and path analysis methods can be used to determine the extent of association between yield and its component and also bring out the relative importance of their direct and indirect effect and thus, give a clear understanding of their association with yield.

MATERIALS AND METHODS

The experiment material comprised 24 diverse genotypes (Table 1) were sown during rabi 2011-2012 using a randomized block design with 3 replications at Main Garden Department of Horticulture, Dr. Panjabrao Deshmukh Krishi Vidyapeeth (Dr. PDKV) Akola. The seeds of different genotypes were sown in 24 October at Main Garden Department of Horticulture, Dr. PDKV, Akola. The recommended dose of manures and fertilizer were applied at the time of field preparation. Akola is situated in subtropical region between 22° 42' N latitude and 77° 02' longitudes at an altitude of 307.42' above the mean sea level. Row to row and plant to plant spacing were maintained at 30 cm and 10 cm respectively. All the agronomic package of practices was adapted to grow a healthy crop. In each replication 5 plants randomly selected were marked for observation.

A total of 14 agronomical traits were recorded according to the descriptors of International Plant Genetic Resource Institute (IPGRI) *Diederichsen* (1996). These are plant height (cm), number of primary branches per plant, number of secondary branches per plant, leaf area (cm^2), days to 50% flowering, days to harvesting, number of umbels per plant, number of umbellets per umbel, number of seeds per umbel, test weight (g), seed yield per plant (g), seed yield per plot (kg), seed yield per ha.(q), chlorophyll content (mg/g) collected from plants in a middle rows of a plot. Variability among accessions was estimated using range, mean, least significant difference, phenotypic and genotypic variance and coefficient of variability

according to Burton and Devane (1953). Analysis of variation among the accessions, correlation and path analysis using SAS software version 9.2SAS (2008) on the mean of the traits under study.

Table 1. Lists of the coriander genotypes and their sources.

Genotypes	Sources	Genotypes	Sources
RCr-20	SKN Agriculture University, Jobner, Rajasthan	NRCSS-ACr-1	NRCSS- Ajmer, Rajasthan
RCr-41	SKN Agriculture University, Jobner, Rajasthan	Azad Dhania-1	CSAUA&T, Kanpur, Uttar Pradesh
RCr-435	SKN Agriculture University, Jobner, Rajasthan	RajendraSwathi	RRC. (RAU) Dolia, Bihar
RCr-436	SKN Agriculture University, Jobner, Rajasthan	Swathi	RRC-Lam (APAU),Gunter, AndraPradesh
RCr-684	SKN Agriculture University, Jobner, Rajasthan	Sudha	RRC-Lam (APAU),Gunter, Andra Pradesh
GCr-1	AICRP (GAU) Jagudan,Gujrat	Sindhu	RRC-Lam (APAU),Gunter, Andra Pradesh
GCr-2	AICRP-(GAU) Jagudan, Gujrat	Sadhana	RRC-Lam (APAU),Gunter, Andra Pradesh
Co-1	TNAU, Coimbatore, Tamil Nadu	Pant Haritma	GBPAUT, Pantagar, Uttrakhand
Co-2	TNAU, Coimbatore, Tamil Nadu	HissarSugandh	CCSHAU, Hisar, Haryana
Co-3	TNAU, Coimbatore, Tamil Nadu	HissarAnand	CCSHAU, Hisar, Haryana
Co-4	TNAU, Coimbatore , Tamil Nadu	HissarSurbhi	CCSHAU, Hisar, Haryana
JD-1	RRC- (JNKV), Jabalpur , Tamil Nadu	Akola Local	Local Farmer, Akola, Maharastra

RESULTS AND DISCUSSION

Analysis of variance revealed significant differences among genotypes for all traits studied indicating presence of significant variability in the materials (Table 2). The range of variance was high for days to harvesting (91.6-134.6) followed by plant height (54.6-121.6) and days to 50% flowering (41.3-70.0). In general, the phenotypic variance and phenotypic coefficient of variance were higher than the respective genotypic variance and genotypic coefficient of variance for all the traits (Table 3) indicating a considerable influence of environmental on their expression. In the present investigation, phenotypic variance ranged from 0.02 (seed yield per plot) to 210.61 (number of umbels per plant) for different characters under study. The phenotypic coefficient of variance varied from days to harvesting (11.0) to seed yield per plot (29.5) similar result have been reported by Mandal and Hazara (1989). The phenotypic coefficient of variance (PCV) expressed in terms of percentage were comparatively high for seed yield per plot followed by seed yield per plant, seed yield per hectare number of umballete per umbel, number of primary branches, number of secondary branches, number of seed per umbel, leaf area and test weight. As the estimates of phenotypic variability cannot differentiate between the effect of genetic and environmental effects, so the study of genetic variability is effective in partitioning the real genetically difference. The higher the genotypic coefficient of variance (GCV), the more the chance of improvement for those characters. In this study, GCV were comparatively higher for seed yield per plot (kg) followed by seed yield per pant, seed yield per hectare, number of primary branches, number of secondary branches, leaf area, number of umbels per plant, number of seed per umbel and test weight. The GCV is less than the corresponding PCV, indicating the role of environment in the expressive of the traits under observation. The different between GCV and PCV were more in case of primary branches per plant, number of umballets per umbel and days to harvesting.

Table 2. Analysis of variance for different quantitative character in coriander.

		Mean Squares													
Source	D.F.	Plant height (cm)	Primary branches/ plant	Secondary Branches/ plant	Leaf area (cm^2)	Days to 50 % flowering	No. of umbels per plant	No. of umballete umbel	No. of seed/ mbel	Test weight (g)	Days to harvesting	seed yield per plant (g)	seed yield Per plot (kg)	seed yield/ ha (q)	Chlorophyll content
Replications	2	2.37	0.20	0.73	0.28	1.38	6.21	0.03	0.31	0.11	0.68	0.25	0.07	3.94	0.49
Treatments	23	585.66**	5.80**	38.98**	40.82**	177.20**	623.24**	1.80**	112.67**	22.99**	456.05**	20.34**	0.74**	225.10**	78.90**
Error	46	1.112	0.46	0.43	0.32	3.50	4.30	0.06	0.32	0.034	2.82	0.19	0.08	2.12	0.46

Table 3. Range, mean, component of variance, coefficient of variance, heritability, genetic advance and genetic advance as percentage of mean for different quantitative traits in coriander.

Characters	Range		Mean	Variance		Coefficient of variance		Heritability (%)	Genetic advance as % of mean
	Min.	Max.		Genotypic	Phenotypic	Genotypic	Phenotypic		
Plant height (cm)	54.6	121.6	81.3	194.85	195.96	17.16	17.21	99.40	35.25
Primary branches/ plant	4.4	11.5	6.1	1.78	2.24	21.73	24.39	79.40	39.89
Secondary branches/ plant	7.9	25.4	14.1	12.85	13.28	25.29	25.71	96.80	51.26
Leaf area (cm^2)	11.2	25.3	14.9	13.49	13.82	24.49	24.78	97.70	49.86
Days to 50% flowering	41.3	70.0	54.5	57.90	61.40	13.94	14.36	94.30	27.90
Number of umbels per plant	33.3	76.9	55.2	206.31	210.61	26.00	26.27	98.00	53.01
Number of umbellate per umbel	4.1	6.8	5.3	0.58	153.90	10.96	13.27	90.20	28.13
Number of seed per umbel	18.3	41.9	25.2	37.45	37.77	24.26	24.37	99.10	49.76
Test weight(g)(1000seed)	8.2	18.7	13.5	7.65	7.68	20.39	20.44	99.50	41.91
Days to harvesting	91.6	134.6	112.1	151.07	0.64	14.37	11.06	98.20	22.37
Seed yield per plant(g)	4.6	13.5	9.0	6.71	6.90	28.68	29.08	97.20	58.26
Seed yield Per plot(kg)	0.2	0.8	0.5	0.02	0.02	29.03	29.50	96.80	58.84
Seed yield Per ha(q)	16.2	45.1	30.1	74.32	76.45	28.58	28.98	97.20	58.05
Chlorophyll content	30.0	49.0	38.8	26.15	26.61	13.16	15.13	98.30	26.87

The large difference between GCV and PCV indicated that environment effect to a large extent influenced the traits. The characters having high GCV possessed better potential for further gain improvement (Burton, 1952). Burton and De Vane (1953) suggested that GCV together with heritability estimate would give best option expected for selection.

Heritability estimates were high for test weight, plant height, number of seed per umbel and chlorophyll content. Johanson *et al.* (1955) reported that the heritability estimates along with genetic advance are more useful than the resultant effect for selecting the best genotypes due to the presence of additive gene effects. High estimate of genetic advance were recorded for seed yield per plot followed by seed yield per plant, seed yield per hectare, number of umbel per plant, secondary branches, leaf area and number of seed per umbel. The information on heritability alone may be misleading, when used in combination with genetic advance the utility of heritability estimate increases. In this study, high genetic advance coupled with high heritability was observed for seed yield per plant and number of umbels per plant. It indicated that additive gene effects were more important for these traits. Therefore, improvement for these traits would be more effectively done through selection in the present materials. Depending upon the variability, heritability and genetic advance estimates, it could be predicted that improvement by direct selection was possible in coriander for traits like seed yield per plot, number of umbel per plant days to harvesting and number of seed per umbel. Yield of a crop is the result of interaction of a number of inter-related characters. Therefore, selection should be based on these component characters after assessing their correlation with seed yield per plot. Character association revealed the mutual relationship between 2 characters, and it is important parameters for taking a decision regarding the nature of selection to be followed for improvement in the crop under study. The phenotypic and genotypic correlations among the yield and yield components in coriander are presented in Table 4. Significant correlations between characters suggested that these are much scope for direct and indirect selection for further improvement of coriander. In general, the estimate of genotypic correlation coefficients was higher than corresponding phenotypic ones, thereby, suggesting strong inherent association among the characters studied. In this investigation, seed yield per plot was positively significant correlated with number of umbel per plant and test weight. Therefore, these characters should be considered while making selection for yield improvement in coriander. These finding are consistent with Sanker and Khader (1991).

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Table 4. The genotypic and phenotypic (in parenthesis) correlation coefficient among 12 quantitative traits in coriander.

Characters		Plant height (cm)	Primary branches per plant	Secondary Branches per plant	Leaf area	Days to 50% flowering	Number of umbels per plant	Number of umbellete per umbel	Number of seed per umbel	Test weight (g)	Days to harvesting	Chlorophyll content	Correlation with seed yield per plant (g)
Plant height (cm)	rg	1.00	0.67	0.51	0.70	0.64	0.25	0.49	0.48	-0.42	0.66	0.56	-0.33
	rp	(1.00)	0.60**	0.50**	0.69**	0.62**	0.25 *	0.47**	0.47 **	-0.42 **	0.65 **	0.55 **	-0.33**
Primary branches per plant	rg		1.00	0.91	0.78	0.62	0.48	0.51	0.69	-0.56	0.63	0.47	-0.22
	rp		(1.00)	0.83 **	0.69 **	0.54**	0.41**	0.46**	0.60 **	-0.50**	0.56 **	0.41 **	-0.20
Secondary branches perplant	rg			1.00	0.65	0.70	0.49	0.62	0.65	-0.55	0.67	0.41	-0.21
	rp			(1.00)	0.63 **	0.67**	0.48**	0.60**	0.63**	-0.54**	0.66 **	0.40 **	-0.21
Leaf area (cm^2)	rg				1.00	0.69	0.59	0.50	0.53	-0.36	0.68	0.56	-0.08
	rp				(1.00)	0.66 **	0.58**	0.48**	0.51 **	-0.36 **	0.66 **	0.55 **	-0.08
Days to 50% flowering	rg					1.00	0.55	0.65	0.45	-0.57	0.96	0.60	-0.27
	rp					(1.00)	0.53**	0.58**	0.43 **	-0.55 **	0.92 **	0.58 **	-0.24 *
Number of umbels per plant	rg						1.00	0.52	0.61	-0.36	0.53	0.43	0.25
	rp						(1.00)	0.50**	0.60**	-0.35 **	0.52 **	0.42 **	0.25 *
Number of umballate/umbel	rg							1.00	0.68	-0.45	0.53	0.31	-0.10
	rp							(1.00)	0.64 **	-0.43**	0.50 **	0.31 **	-0.10
Number of seed per umbel	rg								1.00	-0.61	0.44	0.43	0.11
	rp								(1.00)	-0.61 **	0.44 **	0.43**	0.12
Test weight (g)	rg									1.00	-0.60	-0.35	0.31
	rp									(1.00)	-0.59**	-0.35**	0.311**
Days to harvesting	rg										1.00	0.65	-0.40
	rp										(1.00)	0.64 **	-0.39**
Chlorophyll content	rg											1.00	-0.05
	rp											(1.00)	-0.05
Seed yield per plant (g)	rg												1.00
	rp												(1.00)

*, **Significant at 5 and 1 % levels, rg= genotypic correlation; rp = phenotypic correlation

Table 5. Direct (diagonal) and indirect effect of different traits contributing to yield in coriander.

Characters	Plant height (cm)	Primary branches per plant	Secondary Branches per plant	Leaf area (cm^2)	Days to 50 % flowering	Number of umbels per plant	Number of umballets per umbel	Number of seed per umbel	Test weight (g)	Days to harvesting	Chlorophyll	Correlation seed yield per plant
Plant height (cm)	0.233	0.158	0.121	0.164	0.150	0.059	0.115	0.112	-0.099	0.155	0.131	-0.337
Primary branches per plant	-0.668	-0.988	-0.901	-0.772	-0.614	-0.477	-0.506	-0.685	0.556	-0.629	-0.466	-0.228
Secondary branches per plant	0.271	0.477	0.523	0.344	0.368	0.260	0.329	0.342	-0.292	0.354	0.215	-0.217
Leaf area (cm^2)	0.083	0.093	0.078	0.119	0.083	0.071	0.060	0.063	-0.043	0.081	0.066	-0.087
Days to 50% flower	1.808	1.744	1.975	1.959	2.804	1.5526	1.829	1.275	-1.607	2.692	1.707	-0.271
Number of umbels per plant	0.124	0.236	0.244	0.293	0.271	0.4902	0.258	0.300	-0.178	0.264	0.211	0.255
Number of umbellate per umbel	-0.584	-0.604	-0.743	-0.601	-0.770	-0.6222	-1.180	-0.809	0.531	-0.626	-0.375	-0.107
Number of seed per umbel	0.490	0.706	0.666	0.540	0.463	0.625	0.699	1.019	-0.628	0.458	0.443	0.119
Test weight (g)	-0.119	-0.158	-0.157	-0.103	-0.160	-0.102	-0.126	-0.172	0.280	-0.168	-0.099	0.316
Days to harvesting	-2.039	-1.945	-2.069	-2.093	-2.935	-1.650	-1.622	-1.373	1.836	-3.056	-2.002	-0.401
Chlorophyll	0.061	0.051	0.045	0.061	0.067	0.047	0.035	0.047	-0.039	0.07	0.110	-0.057

Residual effect = 0.236; Bold figures in main diagonal indicate direct effect

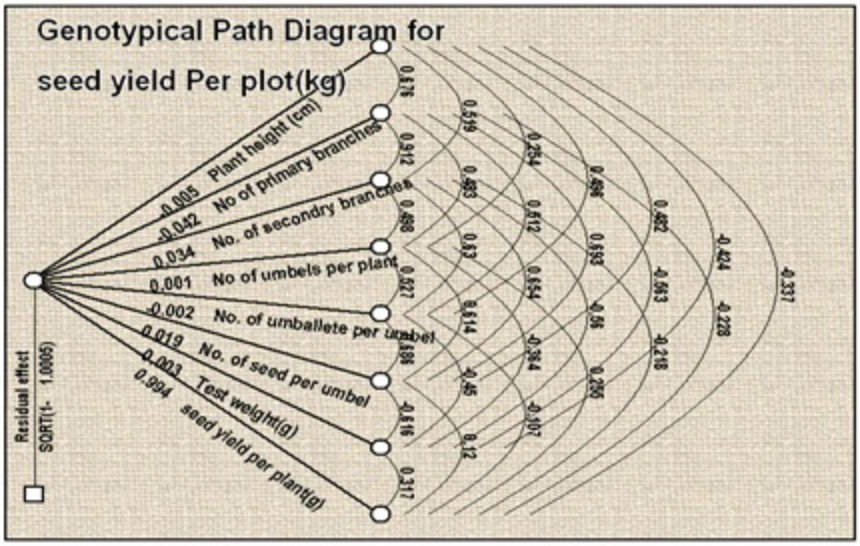

Figure 1. Genotypic path diagram for seed yield per plot of coriander.

per umbel, days to harvesting and chlorophyll content at both genotypic and phenotypic content. Similar findings were also noted by Meena *et al.* (2010), Singh *et al.* (2006), Agrihotri *et al.* (1997) and Vedamuthu *et al.* (1989).

Test weight showed positive and significant correlation with seed yield per plant. Similar result also reported by Sanjeev *et al.* (1990). Yield is the sum total of the several component characters which directly or indirectly contributed to it. The information derived from the correlation studies indicated only mutual association among the characters. Whereas, path coefficient analysis helps in understanding the magnitude of direct and indirect contribution of each character on the dependent characters like seed yield. Partitioning of correlation coefficient into direct and indirect effects provide information about the nature and magnitude of effects of other characters on seed yield. The result of the present investigation on path coefficient analysis as presented in Table 5 and Figure 1 revealed that 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). These indicate that seed yield could be improved by making selection on the basis these characters. These findings are in agreement with that Datta *et al. (*2006), Kumar (1997), Vedamuthu *et al.* (1989) and Choudhary (1987) for secondary branches per plant; Jain *et al.* (2003), Srivastava *et al.* (2000) and Kumar (1997) for number of umbel per plant and Srivastava *et al.* (2000) for number of seed per umbel.

Path coefficient analysis indicated that utility of the character like days to 50% flowering which showed highest positive direct effects on seed yield per plot. These are major yield contributing traits for enhancing the yield of coriander.

REFERENCES

Agnihotri P, Dashora SL, Sharma RK (1997). Variability correlation and path analysis in fennel. *Journal of Spices and Aromatic Crops*. 6(1): 13-15

Ali N, Javidfar F, Elmira JY, Mirza MY (2003). Relationship among yield components and selection criteria for yield improvement in winter rape seed (*Brassica napus* L.). *Pakistan Journal of Botany*. 35: 167-174.

Anonymous (2013). *Indian Horticulture Database*, National Horticulture Board, p 6.

Bhandari MS, Gupta A (1993). Association analysis in coriander. *Indian J. Genet*. 53 (1): 66-70.

Bhatt GM (1973). Significance of path coefficient analysis in determining the nature of character association. *Euphytica*. 22:338-343.

Burton GW (1952) Quantitative inheritance in grasses. Proc. *6thInt. Grassland Cong*-1: 277-282.

Burton GW, De Vane EH (1953). Estimating heritability in tall Festua (*Festuceaurandianacea*) from replicated clonal material. *Agron. J*. 45: 478-81

Choudhary CL (1987). Association of developmental characters with grain yield in coriander (Coriander sativum L.) M.Sc. (Ag.)(Un-published) *Thesis,* Sukhadia University, Udaipure, Campus-Jobner.

Datta S, Chatterjee R, Satya (2006). Correlation and path analysis studies on Coriander (Coriandrum sativum L.). *Horticulture Journal*. 19: 65-67.

Deb AC, Khaleque MA (2009). Nature of gene action in some quantitative traits in chickpea (Cicer arietinum L.). *World Journal of Agricultural Sciences*. 5(3): 361-368.

Diederichsen A (1996). Coriander (*Corianderum sativum* L). Promoting the conservation and use of underutilized and neglected crops. 3. Institute of Plant Genetics and Crop Plant Research, Gaterslbebn/International Plant Genetic Resources Institute, Rome, Italy, pp. 83.

Dubley JW, Moll RH (1969). Interpretation and use of estimates of heritability and genetic variances in plant breeding. *Crop Science Journal*. 9: 257-262.

GalG, Anwer MM, Meena SS, Mehta RS, Maeria SP (2010). Advances in Production technology of Coriander. *National Research Centre on Seed Spices Ajmer Raj*. Feb 2010, pp-1-5.

Gurubuz B (2001). Correlation and path analysis among yield components in winter resistant coriander (*Coriandrum sativum*) lines. *Indian Journal of Agricultural Science*. 71: 730-732.

Jain UK, Singh DA (2003). Correlation and path analysis for certain metric trails in coriander. *Progressive Agriculture*. 3(1): 86-88.

Johnson HW, Robinson HF, Comostock RE (1955). Estimate of genetic and environmental variability in soybeans. *Argon. J*. 47: 314-18.

Kumar S (1997). Genetic Variability in coriander, M.Sc. (Ag.) Unpublished *Thesis*, Dept. of Hort. (Veg. & Flori.), RAU, Pusa, Samstipure (Bihar).

Mandal AK, Hazara P (1989). *Statistical Methods for Agricultural Workers*. Indian Council of Agricultural Research, New Delhi. pp; - 381.

Meena ML, Kumar V, Kumar S, Yadav YC, Kumar A (2010). Genetic variability, heritability, genetic advance, correlation coefficient and path analysis in coriander. *Indian Journal of Horticulture*. 67: 242-246.

Mode CJ, Rhobinson HF (1959). Pleotropism and genetic divergence and covariance. *Biometrics* 15: 518-537.

SAS Institute Inc. (2008). *SAS/STAT ®9.2 User's Guide*. Cary, NC: SAS Institute Inc.

Sanjeev A, Sharma RK, Agrawal S (1990). Quality evaluation in coriander. *Indian Cocoa Arecanut and Spices Journal*. 13(4): 137-138.

Sankar KB, Khader MA (1991). Studies on genetic Variability in coriander. *South Indian Hort. 39***:** 312-14.

Singh Dhirendra, Jain UK, Rajput SS, KhandelwalV, Shiva KN (2006). Genetic variation for seed yield and its components and their association in coriander (*Coriandrum sativum* L.) Gerplasm. *Journal of Spices and Aromatic Crops*. 15(1): 25-29.

Srivastava SBL, Tripathi SM, Srivastava JP (2000). Genetic divergene in coriander (*Coriandrum sativum* L.). Spices and Aromatic plant: Challenges and opportunities in the new century. Contributory papers. *Centennial Conference on spices and aromatic plant, Calicut, Kerela, India*, pp. 68-70.

Thakur SR, Saini JP (1995). Variation, association and path analysis in finger millet (Eleusina coracana) under aerial moisture stress condition. *Journal of Agricultural Sciences.* 65(1):54-57.

Vedamuthu PGB, Khader MA, Rajan FS (1989). Yield components in coriander. *South Indian Horticulture*. 37 (5): 287-290.