



Stability Analysis for Seed Yield over Environments in Coriander

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ABSTRACT

Thirty five genotypes of coriander (*Coriandrum sativum* L.) were tested in four artificially created environments to judge their stability in performance of seed yield. The differences among genotypes and environments were significant for seed yield. Stability parameters varied considerably among the tested genotypes in all the methods used. The variation in result in different methods was due to non-fulfillment of assumption of different models. However, AMMI analysis provides the information on main effects as well as interaction effects and depiction of PCA score gives better understanding of the pattern of genotype – environment interaction. The sum of squares due to PCAs was also used for the computation of AMMI stability values for better understanding of the adaptability behavior of genotypes hence, additive main effects and multiplicative interaction (AMMI) model was most appropriate for the analysis of G x E interactions for seed yield in coriander. Genotypes RVC 15, RVC 19, RVC 22, RVC 25 and Panipat local showed wider adaptability while, Simpo S 33 exhibited specific adaptability to favourable conditions of high fertility. These genotypes could be utilized in breeding programmes to transfer the adaptability genes into high yielding genetic back ground of coriander.

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Introduction

The cultivation of coriander (*Coriandrum sativum* L.) is widespread in many countries. In India, the crop is grown in about 3.62 lakh hectares with annual production of about 2.88 lakh tonnes. Rajasthan and Madhya Pradesh contribute about 71.26% to national coriander basket from an area share of about 67.48 per cent. Madhya Pradesh ranks second in area and production and contribute about 0.50 lakh tones from 1.17 lakh hectares area in national coriander basket. The average yield of coriander in the state of Madhya Pradesh is 428 kg/ha which is very low as compared to its Indian average yield of 795 kg/ha and the yield of states like Gujarat (1851kg/ha), Karnataka (1091kg/ha) and Rajasthan (1183kg/ha). There is thus, urgent need to improve the yield level of this crop by systematic crop breeding programs. The breeding methods adopted for this purpose are selection, hybridization, mutation and other innovative approaches. However, the direct selection either to use as a high yielding variety or as a parent is not much effective due to existence of genotype – environment interaction. Several biometrical methods have been developed to determine the stability of genotypes. But, most commonly used method is the regression analysis technique given by Eberhart and Russell (1966). Recently, multivariate techniques such as principal component analysis (PCA) and additive main effects and multiplicative interaction (AMMI) analysis are available for analysis of genotype – environment interaction. The practical utility of these techniques have not been tested for judging the potential genotypes in coriander. In the present study, an attempt

was therefore made to determine the stability behavior of genotypes using regression analysis and multivariate analysis techniques in coriander.

Materials and Methods

Thirty five genotypes, comprising land races of coriander mostly collected from Madhya Pradesh were evaluated in four environments created by adjusting two fertility status in the soil in two subsequent years of 2008-09 and 2009-10. The soil moisture, soil temperature, ambient temperature and rainfall were quite different in two years. The experiment was laid out in randomized complete block design with three replications in each environment. Each genotype was grown in 4 row plots of 4.0 m length with row to row distance of 25 cm on November 07, 2008 and November 11, 2009 during 2008-09 and 2009-10, respectively. The plant to plant distance was maintained at 10 cm in all the environments. Fertilizer was applied as basal @ 60:30:15 kg NPK/ha and 40:20:10 kg NPK/ha in high and low fertility conditions of both the years. The full doses of phosphorus and potassium along with half dose of nitrogen was given as basal at the time of sowing while, rest of the nitrogen was top dressed during the crop growth. The fertilizers were applied as per environment while, experiment was laid out under natural rain precipitation condition. Ten competitive plants were randomly selected and tagged for recording observations on seed yield and its attributing characters in each genotype, each replication and each

environment. The consistency in seed yield performance of tested genotypes over environments was determined by stability analysis. The stability parameters namely, mean, regression coefficient and deviation from regression were computed using the formulae suggested by (Eberhart and Russell, 1966) and principal component analysis (Gauch, 1988 and Zobel et al., 1988) were computed using statistical software IRRISTAT. AMMI's stability value (ASV) was calculated in order to rank genotypes in terms of stability using the following formula suggested by Purchas (1997).

Results and Discussion

Pooled analysis of variance revealed highly significant differences due to genotypes and environments for all the characters studied indicating the existence of significant variability among the genotypes and environments. The climatic and cultural conditions created significant environmental variations even at same location. Genotype

and environment interaction was also significant for majority of characters including seed yield. It revealed that these characters were significantly influenced by the prevailing environmental conditions. On the other hand, umbel per plant, umbellate per umbel, seed yield per plant were least influenced by the environmental variations having non-significant mean sum of squares.

Stability parameters for seed yield per plant differed from genotype to genotype. It varied from 0.71 to 6.15g, 0.00 to 2.50 and 0.02 to 0.96 for mean, regression coefficient and deviation from regression, respectively (Table 1). RVC 10 followed by RVC 9, RVC 22 and RVC 5 were highest seed yielding genotypes which showed less than one estimate of regression coefficient and deviation from regression around zero thus, appeared average responsive and stable for this character. On the other hand, Simpo S 33 having greater than one estimate of regression coefficient was found responsive to favorable conditions and stable for seed yield per plant.

Table 1 Seed yield per plant over environments, Ist and IInd interaction principal component and AMMI stability values (ASV) for 35 genotypes in coriander

S. No.	Genotypes	Seed yield/plant		Regression analysis		Principal component analysis		ASV	
		Mean	Rank	bi	S2di	IPCA 1	IPCA 2	Value	Rank
1	RVC 1	2.26	26	0.13	0.01	-0.230	-0.109	3.244	30
2	RVC 2	2.50	24	0.13	0.01	-0.201	-0.175	3.046	28
3	RVC 3	3.29	20	0.04	0.00	-0.132	-0.052	2.455	21
4	RVC 4	2.40	25	0.07	0.00	-0.156	-0.118	2.680	24
5	RVC 5	5.08	4	0.07	0.01	-0.138	-0.151	2.530	22
6	Panipat local	4.86	8	0.01	0.01	-0.046	0.005	1.442	7
7	G C 3	4.34	17	0.01	0.00	-0.091	0.045	2.019	17
8	RVC 8	4.34	17	0.01	0.01	-0.046	-0.012	1.447	8
9	RVC 9	5.22	2	0.07	0.04	0.109	0.275	2.283	20
10	RVC 10	6.15	1	0.02	0.01	0.074	0.149	1.871	14
11	RVC 11	3.00	22	0.02	0.01	-0.077	-0.098	1.893	15
12	RVC 12	4.87	7	0.01	0.00	0.054	0.021	1.570	10
13	RVC 13	3.00	22	0.00	0.02	-0.018	-0.065	0.938	3
14	RVC 14	4.26	18	0.03	0.01	-0.083	-0.14	1.974	16
15	RVC 15	4.55	13	0.00	0.03	-0.038	0.178	1.242	5
16	RVC 16	4.42	15	0.00	0.00	-0.036	0.003	1.276	6
17	RVC 17	4.74	9	0.66	0.15	0.451	0.543	4.579	33
18	RVC 18	3.24	21	0.01	0.01	0.019	0.107	0.984	4
19	RVC 19	4.55	13	0.01	0.00	0.068	-0.052	1.740	12
20	RVC 20	4.65	11	0.17	0.04	0.196	0.325	3.033	27
21	RVC 21	4.70	10	0.00	0.00	0.033	0.047	1.242	5
22	RVC 22	5.09	3	0.00	0.03	-0.022	0.178	0.905	1
23	RVC 23	5.06	5	0.05	0.02	0.092	0.23	2.097	18
24	RVC 24	4.35	16	0.01	0.00	0.058	0.078	1.645	11
25	RVC 25	4.57	12	0.00	0.00	0.019	0.001	0.928	2
26	RVC 26	4.46	14	0.02	0.01	0.068	0.137	1.793	13
27	JD 1 (Check)	4.88	6	0.05	0.01	0.107	0.175	2.241	19
28	JD 1-1	4.03	19	0.03	0.03	0.047	0.208	1.529	9
29	CS 193	1.71	29	0.14	0.01	-0.187	-0.217	2.947	26
30	Moroccan	1.33	31	0.28	0.02	-0.316	-0.228	3.813	32
31	RCR 41	1.52	30	0.12	0.01	-0.226	-0.100	3.215	29
32	UD 20	0.72	32	0.28	0.01	-0.295	-0.237	3.687	31
33	Simpo S 33	1.99	28	2.50	0.96	1.264	-0.623	7.524	34
34	PMIN 5	2.56	23	0.05	0.01	-0.140	-0.087	2.535	23
35	G 5363	2.21	27	0.13	0.02	-0.181	-0.241	2.905	25

Genotype-environment interaction was further partitioned into four PCA axes. The contribution of PCA 1 axes was comparatively high in comparison to rest of the PCA axis. IPCA 1 score, ranging from -0.316 to 1.264 was lowest for Moroccan followed by UD 20, RVC 1, CS 193 and G 5363. It was highest for Simpo S 33 followed by RVC 17, RVC 20, RVC 9 and JD 1. Similarly, IPCA 2, ranging from - 0.623 to 0.543 was lowest for Simpo S 33 followed by G 5363, UD 20, Moroccan, CS 193 and JD 1. It was noted highest for RVC 17 followed by RVC 20, RVC 23, JD 1-1, RVC 15 and RVC 22. The ASV ranged from 0.905 to 7.544 among tested genotypes. It was lowest in RVC 22 followed by RVC 25, RVC 13, RVC 18, RVC 15 and RVC 16. On the other hand, highest ASV was recorded in Simpo S 33 followed by RVC 17, Moroccan, UD 20 and RVC 1. In this study, Simpo S 33 showed highest IPCA scores indicating their adaptability to specific environmental conditions i.e. high fertility environments, which was also confirmed from ASV with the last rank of 34 suggesting erratic (unstable) yield across environments. On the other hand, RVC 8, RVC 15, RVC 19, RVC 12, RVC 18, RVC 22, RVC 25 and Panipat local exhibited low IPCA scores with above average yield and comparatively low AMMI stability Values (ASV) claiming themselves as wider adaptable genotypes (Table 1). These genotypes appeared as promising for incorporation in breeding program to transfer the high yield with yield stability in coriander. The interaction pattern and adaptability of genotypes for seed yield was mainly reflected through interaction pattern and stability behavior of yield traits in coriander.

A comparison of results obtained in regression analysis, principal component analysis and AMMI stability value indicates more or less similar adaptability behavior of genotypes. The variation in result in different methods is due to non-fulfilment of assumption of different procedures. However, AMMI analysis provides the information on main effects as well as interaction effects and depiction of PCA score gives better understanding of the pattern of genotype – environment interaction. The sum of squares due to PCAs is also used

for the computation of AMMI stability values for better identification of the adaptability genotypes. Hence, additive main effects and multiplicative interaction (AMMI) model is most appropriate for the analysis of G x E interactions in coriander (Zobel et al., 1988; Vijaykumar et al., 2001, Berger et al., 2006 and Sadeghi et al., 2011).

It can be concluded from genotype x environment interaction using multivariate analysis that genotypes were mostly geographically related but responded differently to differences in environments as portion of environmental variance and G x E interaction hence, one can rely more on suitability of the environment and crop management conditions to attain the high yield in coriander. Genotypes RVC 15, RVC 19, RVC 22, RVC 25 and Panipat local showing wider adaptability or Simpo S 33 exhibiting specific adaptability be utilized in breeding programmes to transfer the adaptability genes into high yielding genetic back ground in coriander.

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