



Evaluation of Coriander (*Coriandrum sativum* L.) Genotypes under Normal and Limited Moisture Stress Condition

Arvind Singh^{1*}, Dharendra Singh¹, O.P. Khedar² and Dayanand³

¹ S.K.N. Agriculture University Jobner 303 329, India

² Rajasthan Agricultural Research Institute, Durgapura, Jaipur 302 018, India

³ K.V.K. Abusar, Jhunjhunu 333 001, India

Received: September 2017

Abstract: Yield potential of a variety is combined effect of genotype and environment interaction. Among different seed spices, coriander is an important cultivated seed spice crop. In India, majority of this crop is still under limited irrigation and conserved moisture. Drought is very common adverse environmental factor limiting crop production in most of the tropical and subtropical regions of India. To generate information on the effect of moisture stress on various traits which contribute towards yield would be helpful in developing tolerant coriander genotypes. The results revealed that plant height; umbels per plant and biological yield per plant are most important yield components under limited moisture condition. On the basis of overall performance (stress susceptibility index, SSI), seed yield under stress and stress tolerance index (STI) values, UD-728, RCr-480 and Hisar Anand were identified as potential genotypes for stress condition. The indices, SSI and STI, could be taken as important criteria for breeding of coriander genotypes suitable for stress environments.

Key words: Genetic advance, heritability, stress susceptibility index, stress tolerance index, variability.

Coriander (*Coriandrum sativum* L., $2n = 22$) is an important seed spice crop belonging to family Apiaceae and is highly cross-pollinated. It is probably one of the earliest seed spices known to mankind (Pruthi, 1976). Coriander is cultivated in two specific agro-ecological conditions viz., irrigated and rainfed (conserved moisture). It thus often suffers from limited water availability. Drought is very common adverse environmental factor limiting crop production in most of the tropical and subtropical regions of India, thus limiting the productivity.

Materials and Methods

The present investigation was carried out at Research Farm S.K.N. College of Agriculture, Jobner with 20 elite coriander genotypes selected from the germplasm collection of AICRP on Spices located at S.K.N. College of Agriculture, Jobner. The experimental material was evaluated in Randomized Block Design with 3 replications in two environments namely, (i) normal and (ii) limited moisture

condition. In normal condition all the standard horticultural practices were followed to raise good and healthy crop, whereas in limited moisture condition one irrigation was given at the time of sowing and one light irrigation after 8 days was given to ensure proper germination. After that no irrigation was given and also no precipitation was received.

Observations were recorded on ten characters viz., days to 50% flowering, plant height (cm), branches per plant, umbels per plant, umbellates per umbel, seeds per umbel, 1000-seed weight (g), biological yield per ten plants (g), volatile oil content (%) by hydro-distillation method (Clevenger, 1928) and seed yield per plants (g).

Coefficients of variations were calculated by the formulae suggested by Burton (1952) whereas heritability in broad sense was estimated as per formula given by Johnson *et al.* (1955).

Stress susceptibility index (SSI) was calculated for yield and other attributes over limited moisture (stress) and normal (non-stress) environment as per formula given by Fisher and Maurer (1978).

*E-mail: arvindfageria84@gmail.com

$$SSI = (1 - Y_D/Y_P)/D$$

where, Y_D =Yield of the genotype in limited moisture environment; Y_P =Yield of the genotype in normal environment:

$$D = \text{Stress (limited moisture) intensity} \\ = 1 - \frac{\text{Mean } Y_D \text{ of all genotypes}}{\text{Mean } Y_P \text{ of all genotypes}}$$

$$\text{Stress tolerance index (STI)} = \frac{(Y_P) \times (Y_D)}{(Y_P)^2}$$

where, Y_P = Yields of genotypes under normal condition; Y_D = Yields of genotypes under limited moisture condition.

The SSI values were used to characterize the relative tolerance of genotypes based on minimum yield loss compared to normal environmental conditions. The differences between genotypes for different characters were tested for significance by using standard techniques for analysis of variance.

Results and Discussion

The analysis of variance revealed that significant variability was present in the genotypes for most of the characters under normal (Table 1) and limited moisture condition (Table 2). This suggested that the material had adequate variability and response to selection may be accepted in the breeding program for seed yield or any of its supporting characters. These results are in agreement with the findings of Mathur *et al.* (1971) in coriander under normal and moisture stress conditions.

Changes in the means of character under limited moisture condition in comparison to normal condition were recorded. Mean values were higher in normal condition in comparison to limited moisture condition for plant height, seeds per umbel, 1000-seed weight, biological yield and seed yield per plant. This indicated clearly the adverse effect of moisture stress on the expression of some characters by the genotypes. The mean values of days to 50% flowering, branches per plant, umbels per plant, umbellate per umbel and volatile oil content varied little across environmental conditions. However, volatile oil content had higher mean value in limited moisture condition in comparison to normal condition.

In both the environments high estimates of variation were observed for all the traits except umbels per plant. Thus, selection may be more effective for these characters because the response to selection is directly proportional to the variability present in the experimental material. Similar results were reported by Patel and Aglodia (2007) in coriander.

Comparison among the characters indicated that GCV and PCV values varied little across environments for days to 50% flowering, branches per plant, 1000 seed weight, volatile oil content and seed yield. For characters plant height, umbellate per umbel, seeds per umbel and biological yield the GCV and PCV values were of higher magnitude in limited moisture stress condition.

The heritability estimates along with the genetic advance are more meaningful. If

Table 1. Mean, range, estimate of variances, coefficients of variation, heritability (broad sense) and genetic advance for yield and other attributes (normal condition)

Characters	Mean	Range	Estimates of variance			Coefficients of variation			Heritability % (bs)	GA as %age of mean
			σ^2_e	σ^2_g	σ^2_p	Environment	Genotypic	Phenotypic		
Days to 50% flowering	68.70	54.00-88.00	10.41	97.27	107.68	4.70	14.36	15.10	90.33	28.11
Plant height (cm)	59.99	51.43-67.20	27.09	11.38	38.47	8.68	5.62	10.34	29.58	6.30
Branches per plant	6.27	4.43-8.43	0.25	0.94	1.19	7.97	15.49	17.42	79.08	28.38
Umbels per plant	18.14	14.20-24.47	8.60	2.51	11.11	16.16	8.53	18.37	22.59	8.55
Umbellates per umbel	5.47	4.60-6.10	0.20	0.04	0.27	8.15	4.96	9.54	27.05	5.31
Seeds per umbel	39.37	27.63-52.53	16.31	36.25	52.56	10.26	15.29	18.42	68.97	26.17
1000-seed weight (g)	13.59	9.22-17.52	0.19	5.30	5.49	3.24	17.32	17.62	96.61	35.07
Volatile oil content (%)	0.29	0.17-0.42	0.0007	0.003	0.0037	9.078	18.97	21.03	81.37	35.25
Biological yield (g)	89.28	60.00-122.67	109.82	253.98	363.79	11.74	17.85	21.36	69.81	30.72
Seed yield (g)	41.32	29.00-56.67	37.16	42.80	79.96	14.75	15.83	21.64	53.53	23.86

Table 2. Mean, range, estimate of variances, coefficients of variation, heritability (broad sense) and genetic advance for yield and other attributes (limited moisture condition)

Characters	Mean	Range	Estimates of variance			Coefficients of variation			Heritability % (bs)	GA as %age of mean
			σ^2_e	σ^2_g	σ^2_p	Environment	Genotypic	Phenotypic		
Days to 50% flowering	73.17	56.00-90.67	13.13	86.72	99.85	4.96	12.73	13.66	86.85	24.43
Plant height (cm)	47.64	32.20-56.23	25.28	28.67	53.95	10.55	11.24	15.42	53.14	16.88
Branches per plant	5.80	3.97-7.73	0.24	0.96	1.20	8.41	16.90	18.88	80.15	31.18
Umbels per plant	14.45	9.87-17.37	5.74	2.31	8.05	16.58	10.51	19.63	28.69	11.60
Umbellates per umbel	4.43	3.73-5.20	0.90	0.16	0.25	6.82	9.04	11.32	63.77	14.87
Seeds per umbel	31.91	18.77-44.50	17.24	42.79	60.03	13.01	20.50	24.28	71.28	35.66
1000-seed weight (g)	11.43	8.68-16.67	0.99	4.06	4.16	2.75	17.63	17.85	97.63	4.10
Volatile oil content (%)	0.33	0.23-0.48	0.0007	0.0045	0.0051	7.77	20.42	21.85	87.34	39.31
Biological yield (g)	70.15	29.33-106.67	78.86	221.06	299.93	12.66	21.19	24.69	73.71	37.48
Seed yield (g)	31.78	15.00-41.67	26.89	29.79	56.68	16.32	17.19	23.69	52.55	25.64

heritability of a character is high (>60%), selection for such a characters should be fairly easy. This is because of relatively smaller contribution of environment to the phenotype, but for a character with a low heritability (<40%), selection may be considerably difficult or virtually impractical due to masking effect of environment on the genotypic effect.

In present investigation broad sense heritability was observed to be high for days to 50% flowering followed by branches per plant, seeds per umbel, 1000-seed weight, volatile oil content and biological yield in normal and for most of the characters except plant height, seed yield and umbels per plant in limited moisture condition, which is in agreement with earlier reports of Patel and Agalodia (2007). Further, while the estimates of heritability changed very little between the environments for traits such as branches per plant, 1000-seed weight, biological yield and seed yield, the changes were considerable for plant height and umbellate per umbel with higher estimates in the stress environment (Table 3).

Heritability estimates alone do not provide information on the amount of genetic progress that would result from the selection of the best genotype. Therefore, genetic advance as percentage of mean was calculated in order to determine the relative merits of different characters that can be further utilized in the selection programme.

In normal condition high magnitude of genetic advance as percentage of mean was obtained for 1000-seed weight, volatile oil

content and biological yield which are in agreement with earlier reports of Patel and Agalodia (2007) for volatile oil content and 1000-seed weight. Moderate genetic advance as percentage of mean was observed for days to 50% flowering, branches per plant, seeds

Table 3. Stress tolerance index (STI) of different genotypes for seed yield

Genotypes	Yield under normal condition (Y_P)	Yield under limited moisture condition (Y_D)	Stress tolerance index (STI)	
			STI	Rank
UD-728	37.00	33.33	0.90	5
UD-796	46.67	35.00	0.75	13
UD-797	51.67	30.00	0.58	16
J.Cor-340	56.67	31.33	0.55	17
J.Cor-375	50.00	41.00	0.82	9
DH-206	48.33	38.00	0.79	10
K-Selection	31.67	28.33	0.89	6
ND Cor-2	36.33	32.33	1.34	1
ICS-1	38.33	35.00	0.91	4
LCC-170	29.00	22.33	0.77	12
LCC-212	41.00	25.00	0.61	15
RD-154	35.00	30.00	0.86	7
Hisar Anand	35.00	32.00	0.91	4
RCr-20	44.00	36.67	0.83	8
RCr-435	48.33	35.33	0.73	14
RCr-436	40.00	15.00	0.38	18
RCr-446	38.00	28.33	0.75	13
RCr-480	44.33	41.67	0.94	3
RCr-684	43.33	34.00	0.78	11
Local	31.67	30.67	0.97	2

Table 4. Stress (limited moisture) susceptibility index (SSI) of different genotypes yield and its contributing characters

Variable	Days to 50% flowering		Plant height (cm)		Branches per plant		Umbels per plant		Umbellate per umbel	
Genotypes	SSI	Rank	SSI	Rank	SSI	Rank	SSI	Rank	SSI	Rank
UD-728	0.4661	5	0.2173	1	0.1220	1	1.0779	11	0.7355	3
UD-796	0.4222	3	0.7442	6	1.1037	12	1.7809	20	1.0540	13
UD-797	0.7383	12	1.4458	18	1.4833	16	0.1915	2	0.8143	6
J.Cor-340	0.8502	13	1.5445	19	0.9003	10	0.4878	3	1.5505	20
J.Cor-375	0.8916	15	0.9448	10	0.3613	6	0.5747	5	1.3188	17
DH-206	0.4292	4	0.8520	8	0.5004	8	1.5841	18	0.8015	5
K-Selection	1.1365	16	0.4495	3	1.4992	18	1.2286	14	1.1168	14
ND Cor-2	0.6207	9	1.0221	12	1.3923	14	1.0174	9	0.9906	12
JCS-1	0.3001	1	1.2173	16	1.1333	13	0.1130	1	0.9267	9
LCC-170	0.5662	7	0.7424	5	1.3997	15	0.5883	6	0.9873	11
LCC-212	0.5697	8	1.0924	13	2.3048	19	0.6933	8	1.5071	19
RD-154	2.6938	19	0.6786	4	0.3499	4	1.3634	17	1.1253	15
Hisar Anand	0.6468	11	1.1715	15	0.3409	3	1.0190	10	1.3872	18
RCr-20	2.1517	17	1.2465	17	0.1461	2	1.1522	12	0.9439	10
RCr-435	0.3715	2	0.4305	2	0.3481	5	0.5732	4	0.5533	1
RCr-436	0.5627	6	2.2199	20	3.1052	20	1.7793	19	1.1681	16
RCr-446	3.9603	20	0.8231	7	0.7993	9	1.3507	16	0.7975	4
RCr-480	0.8581	14	0.9341	9	0.4994	7	1.2410	15	0.5582	2
RCr-684	2.2191	18	0.9933	11	1.4849	17	0.6359	7	0.8734	8
Local	0.6292	10	1.1383	14	1.0117	11	1.2029	13	0.8167	7

Variable	Seeds per umbel		1000-seed weight (g)		Volatile oil content (%)		Biological yield (g)		Seed yield (g)		Overall rank
Genotypes	SSI	Rank	SSI	Rank	SSI	Rank	SSI	Rank	SSI	Rank	
UD-728	0.1198	1	0.2596	4	3.9817	9	0.3111	5	0.4295	5	1
UD-796	1.4769	16	0.7980	11	4.0051	10	1.1666	14	1.0835	14	17
UD-797	0.6506	8	1.9705	17	0.3026	4	1.2204	15	1.8174	18	15
J.Cor-340	1.4247	15	0.1264	2	1.8913	7	2.1810	19	1.9375	19	19
J.Cor-375	0.6191	6	0.4720	7	5.2957	11	1.2933	16	0.7801	10	12
DH-206	0.7409	11	0.8557	12	-0.6877	3	0.9333	11	0.9266	12	8
K-Selection	0.2856	5	0.4237	6	2.7872	8	0.3870	7	0.4562	6	10
ND Cor-2	0.6773	9	0.6431	10	-0.7963	2	0.3733	6	0.4771	7	7
JCS-1	0.1572	3	2.3093	20	0.3982	5	0.8959	10	0.3769	4	4
LCC-170	0.6430	7	0.1305	3	0.4728	6	0.9851	12	0.9963	13	6
LCC-212	1.8493	18	0.8763	13	-0.9457	1	1.3151	17	1.6913	17	18
RD-154	2.8079	20	0.3643	5	0.4728	6	0.8571	9	0.6191	8	13
Hisar Anand	0.1218	2	0.5608	8	0.4728	6	0.4341	8	0.3715	3	5
RCr-20	1.9558	19	0.0404	1	7.5652	12	0.2612	2	0.7223	9	11
RCr-435	1.0586	12	1.6862	16	0.3982	5	1.1206	13	1.1657	16	3
RCr-436	1.0633	13	0.6130	9	-0.9457	1	3.2153	20	2.7087	20	20
RCr-446	1.3350	14	2.2626	18	0.3982	5	0.2808	4	1.1025	15	14
RCr-480	0.2416	4	1.2177	15	0.3982	5	0.0433	1	0.2607	2	2
RCr-684	1.4834	17	1.0923	14	-0.7963	2	1.3221	18	0.9001	11	16
Local	1.0357	10	2.2984	19	0.4728	6	0.2720	3	0.1369	1	9

per umbel and seed yield per plant which is in agreement with the reports of Bhandari and Gupta (1991) for seeds per umbel. Low magnitude genetic advance as percentage of mean was observed for plant height, umbels per plant and umbellate per umbel. These results are in accordance with the earlier report of Jain *et al.* (2002) in coriander. However, in limited moisture condition characters such as volatile oil content, biological yield, seeds per umbel and branches per plant had high heritability along with high genetic advance which indicated that these characters may respond to selection more effectively. The character, days to 50% flowering, had high heritability with moderate genetic advance as percentage of mean. Comparison of the genetic advance estimates between the environments indicated that minimum changes in the estimates were observed for traits like branches per plant and seed yield. However, the changes were considerable for plant height, umbellates per umbel, seeds per umbel, 1000-seed weight and biological yield while with respect to plant height, umbellates per umbel, seeds per umbel and biological yield, the estimates increased in stress in comparison to normal environment. The estimate was lower in 1000-seed weight in stress in comparison to normal environment. Seed yield per plant had moderate heritability and genetic advance as percentage of mean. Plant height, umbellets per umbel and 1000-seed weight had high heritability and low genetic advance as percentage of mean. Umbels per plant had low heritability with low genetic advance as percentage of mean. On the basis of STI values (Table 3), genotypes ND Cor-2, Local, RCr-480, UD-728 and Hisar Anand were more tolerant than other genotypes. However, based on overall SSI rank genotypes UD-728, RCr-480, RCr-435, JCS-1 and Hisar Anand were tolerance to limited (Table 4) moisture condition.

Conclusion

The study has shown variation for water stress tolerance while identifying certain tolerant genotypes but being poor in yield they may be used for breeding programs to improve the tolerance of high yielding types.

References

- Bhandari, M.M. and Gupta, A. 1991. Variation and association analysis in coriander. *Euphytica* 58: 1-4.
- Burton, G.W. 1952. Quantitative inheritance in grasses. In *Proceedings of the 6th International Grass Land Congress* 1: 277-283.
- Clevenger, J.F. 1928. Apparatus for the determination of volatile oil. *The Journal of American Pharmaceutical Association* 17: 345-349
- Fischer, R.A. and Maurer, R. 1978. Drought resistance in spring wheat cultivars I grain yield response. *Australian Journal of Agriculture Research* 14: 742-754.
- Jain, U.K., Singh, D. and Jain, S.K. 2002. Assessment of genetic variability in coriander. *Annals of Plant Soil Research* 4: 329-330.
- Johnson, H.W., Robinson, H.F. and Comstock, R.E. 1955. Estimates of genetic and environmental variability in soybean. *Agronomy Journal* 47: 314-318.
- Mathur, S.C., Anwar, M. and Bhargava, P.D. 1971. Studies on splitting of phenotypic and genotypic complexes and their correlation in coriander (*Coriandrum sativum* L.). *Rajasthan Journal of Agricultural Science* 2: 63-71.
- Patel, V.R. and Agalodia, A.V. 2007. Genetic variability studies in coriander (*Coriandrum sativum* L.). In *National Seminar on Production, Development, Quality and Exports of Seed Spice-Issues and Strategies* held at National Research Centre on Seed Spices, Tabaji, Ajmer, Rajasthan, 16 p.
- Pruthi, J.S., 1976. *Spices and Condiments*. National Book Trust of India, New Delhi, pp. 9.

