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Evaluation of coriander (*Coriandrum sativum* L., 2n=22) genotypes under limited moisture stress conditions

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Abstract

Limited moisture stress is the major constraint in coriander (*Coriandrum sativum* L) productivity. To generate information on the effect of limited moisture stress on various traits which contribute for yield would be helpful in developing tolerant coriander genotypes. An experiment was conducted on a set of 20 elite coriander genotypes under normal and limited moisture stress conditions. The result revealed that plant height, umbels per plant and biological yield per ten plants are most important yield component character in limited moisture condition. On the basis of overall performance (SSI and seed yield under stress) UD-728,RCr -435 and RCr 480 may be identified as limited moisture tolerant genotypes, while on the basis of STI and TOL values, Local, RCr-480 and Hisar Anand may be identified as genotype for stress condition. The characters SSI, STI and TOL could be taken as important criteria for breeding coriander genotypes suitable for stress environments.

Key words : Coriander, stress susceptibility index, stress tolerance index, stress tolerance.

Introduction

Yield potential of a variety is combined effect of genotype and environment interaction (G×E). Among different seed spices, coriander (*Coriandrum sativum* L., 2n=22) is an important cultivated seed spice crop. At present global warming and scarcity of water are important factor for the coriander production. In India, majority of crops are still depended on rainfall and conserved soil moisture. Drought is very common adverse environmental factor, limiting crop production in most of the tropical and subtropical regions of India, thus compromising productivity.

Material and methods

The present investigation was carried out at Research Farm, SKN College of Agriculture, Jobner with 20 elite genotypes of coriander which were randomly 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 the good and healthy crop in normal environment, 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 irrigations were given. In each environment/replication, each genotype was sown in a plot size 2.0 x 0.9 m^2 consisting of three rows. The row to row and plant to plant distance was 30 cm and 10 cm, respectively. Observation were recorded on ten characters viz., days to 50 per cent flowering, plant height (cm), branches $plant^{-1}$, umbels $plant^{-1}$, umbellets $umbel^{-1}$, seeds $umbel^{-1}$, 1000-seed weight (g), biological yield ten $plants^{-1}$(g), volatile oil content (%) and seed yield ten $plants^{-1}$(g) in each entry and in each replication in both the two sowing conditions. 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).

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

Where,

Y_D = Mean of the genotype in limited moisture environment

Y_P = Mean of the genotype in normal environment

D = Stress (limited moisture) intensity =

$$1 - \left(\frac{\text{Mean } Y_D \text{ of all genotype}}{\text{Mean } Y_P \text{ of all genotypes}} \right)$$

Stress tolerance index (STI) = $[(Y_P) \times (Y_D) / (Y_P)^2]$

Stress tolerance (TOL) = $(Y_P - Y_D)$

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 minimization of yield

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losses 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 results obtained from the analysis of variance studies showed highly significant differences among all the genotypes in all the sowing environments indicating the influence of sowing condition on genotype and traits. Further it was observed that all the characters respond to limited moisture stress in different way in different genotypes. Stress susceptibility index was used to estimate susceptibility of genotypes to stress because it adjusts for variation in yield due to differences in genotypic yield potential and environmental stress intensity. But stress susceptibility (<1) is synonymous to higher stress resistance. In the present study the differences in performance of genotypes in two environments indicates the effect of limited moisture stress on different character was not uniform, thus the some of characters were influenced more while other less. It is well established that yield is a complex trait controlled by several characters. Thus, a selection based on yield as such will not be much effective. Therefore, in order to determine the stress susceptibility index was worked out based upon the values and the direction of desirability of different characters used in the study. Limited moisture tolerance ranking was done for genotypes and based on the ranks for different traits an overall ranking based on all the characters was done for each genotype to identify, those having good tolerance for limited moisture so that these can be used subsequently in the breeding programme aimed at development of limited moisture tolerance genotypes in coriander of stress susceptible index (SSI). Based on seed yield, stress (limited moisture) susceptibility index ranged from 0.1369 (local) to 2.7087 (RCr-436). Thirteen genotypes *viz.,* UD-728, J.Cor-375, DH-206, K-Selection, ND-Cor-2, ICS-1, ICC-170, RD-154, Hisar Anand, RCr-20, RCr-480, RCr-684 and Local had stress (limited moisture) susceptibility index less than one whereas, rest of the genotypes had stress (limited moisture) susceptibility index (SSI) value more than one.

A perusal of (Table 1) showed that UD-728 followed by RCr-480 and RCr-435 ranked as the best genotype on the basis of overall ranking. Since simple and reliable method for screening genotypes for limited moisture are necessary to identify tolerant genotypes, various screening parameters have been assumed by different workers (Pancholi, 1992).

Fisher and Maurer (1978) have described a susceptibility index that provides a measure of stress resistance based on minimization of yield loss under stress as compared to optimum condition, rather than on yield level under stress *per se*. Thus using formulae of Fischer and Maurer (1978) are attempt was made to assess the susceptibility index of various genotype used in this study. This stress susceptibility index gives an estimate of relative stress injury because it accounts for variation in yield potential and stress intensity (Bruckner and Frohberg, 1987). According to Fischer and Maurer (1978) low stress susceptibility index (S<1) is synonymous with higher stress tolerance.

Guttieri *et al.*(2001) using SSI criterion suggested that SSI more than 1 indicates above-average susceptibility and SSI less than 1 indicates below-average susceptibility to drought stress.

In the present investigation all the genotype for each of the traits was ranked for the SSI index values. Any genotype having lower SSI was given a higher rank (*i.e.* better suited for stress environment). The ranks of all the traits were then pooled over all the traits and the overall rank determined. A genotype with the lowest total of rank values was considered best for stress environment.

In limited moisture condition, a perusal of (table 2) showed that UD-728 followed by RCr-480 and RCr-435 ranked as good genotype on the basis of overall ranking. Stress susceptible index for seed yield of coriander genotypes revealed that thirteen genotype *viz.,* Local had, RCr-480, Hisar Anand, ICS-1, UD-728, K-Selection, N.D.-Cor-2, RD-154, RCr-20, J.Cor.-375, RCr-684, DH-206 and LCC-17 had SSI value < 1 and may be termed as tolerant genotypes, while rest of the genotypes had SSI value > 1 termed as susceptible genotype. Thus, on the basis of mean performance of SSI values genotype *viz.,* UD-728, RCr-480 and RCr-435 were tolerant to limited moisture condition.

On the basis of STI and TOL values (table 2) genotype Local, RCr-480 and Hisar Anand ranked as good genotypes which were tolerant to limited moisture condition. In the present investigation, correlation and path analysis indicated that biological yield showed significant association and high positive direct effects on seed yield. Biological yield had high estimates of PCV, GCV, heritability and genetic advance as percentage of mean in both environments. Hence, it is suggested that major emphasis should be given should be given on biological yield. Based upon the mean seed yield and SSI value, the genotype UD-728, RCr-480 and RCr-435 were tolerant to limited moisture conditions.

Table1. Stress (limited moisture) and susceptibility index (SSI) of different genotypes, yield and its contributing characters.

Variable	Days to 50% flowering		Plant height (cm)		Branches Plant^{-1}		Umbels plant^{-1}		Umbellets umbel^{-1}		Seeds umbel^{-1}		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	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	0.1198	1	0.2596	4	3.9817	9	0.3111	5	0.4295	5	1
UD-796	0.4222	3	0.7442	6	1.1037	12	1.7809	20	1.0540	13	1.4769	16	0.7980	11	4.0051	10	1.1666	14	1.0835	14	17
UD-797	0.7383	12	1.4458	16	1.4633	16	0.1915	2	0.8143	6	0.6506	8	1.3705	17	0.3026	4	1.2204	15	1.8174	16	15
J.Cor-340	0.8562	13	1.5445	19	0.9003	10	0.4878	3	1.5506	20	1.4247	15	0.1264	2	1.8913	7	2.1810	19	1.9375	19	19
J.Cor-375	0.8916	15	0.9448	10	0.3613	6	0.5747	5	1.3188	17	0.6191	6	0.4720	7	5.2957	11	1.2933	16	0.7801	10	12
DH-206	0.4292	4	0.8520	8	0.5004	8	1.5841	18	0.8015	5	0.7409	11	0.3557	12	-0.6877	3	0.9333	11	0.9266	12	8
K-Selection	1.1365	16	0.4495	3	1.4992	18	1.2286	14	1.1168	14	0.2856	5	0.4237	6	2.7872	8	0.3870	7	0.4562	6	10
ND Cor-2	0.6207	9	1.0221	12	1.3923	14	1.0174	9	0.9906	12	0.6773	9	0.5431	10	-0.7963	2	0.3733	6	0.4771	7	7
JCS-1	0.3001	1	1.2173	16	1.1333	13	0.1130	1	0.9267	9	0.1572	3	2.3093	20	0.3982	5	0.8959	10	0.3769	4	4
LCC-170	0.5662	7	0.7424	5	1.3997	15	0.5883	6	0.9873	11	0.6430	7	0.1305	3	0.4728	6	0.9851	12	0.9963	13	6
LCC-212	0.5697	8	1.0924	13	2.3048	19	0.6933	8	1.5071	19	1.8493	18	0.3763	13	-0.9457	1	1.3151	17	1.6913	17	18
RD-154	2.6938	19	0.6796	4	0.3499	4	1.3634	17	1.1253	15	2.8079	20	0.3643	5	0.4728	6	0.8571	9	0.6191	8	13
Hisar Anand	0.6468	11	1.1715	15	0.3409	3	1.0190	10	1.3872	18	0.1218	2	0.5608	8	0.4728	6	0.4341	8	0.3715	3	5
RCr-20	2.1517	17	1.2485	17	0.1461	2	1.1522	12	0.9439	10	1.9556	19	0.0404	1	7.5652	12	0.2612	2	0.7223	9	11
RCr-435	0.3715	2	0.4305	2	0.3481	5	0.5782	4	0.5533	1	1.0586	12	1.3862	16	0.3982	5	1.1206	13	1.1657	16	3
RCr-436	0.5627	6	2.2199	20	3.1052	20	1.7793	19	1.1681	16	1.0633	13	0.5130	9	-0.9457	1	3.2153	20	2.7087	20	20
RCr-446	3.9603	20	0.8231	7	0.7993	9	1.3607	16	0.7975	4	1.3350	14	2.2626	18	0.3982	5	0.2808	4	1.1025	15	14
RCr-480	0.8581	14	0.9341	9	0.4994	7	1.2410	15	0.5582	2	0.2416	4	1.2177	15	0.3982	5	0.0433	1	0.2607	2	2
RCr-684	2.2191	18	0.9933	11	1.4849	17	0.6359	7	0.8734	8	1.4834	17	1.0923	14	-0.7963	2	1.3221	18	0.9001	11	16
Local	0.6292	10	1.1383	14	1.0117	11	1.2029	13	0.8167	7	1.0357	10	2.2984	19	0.4728	6	0.2720	3	0.1369	1	9

Table 2. Stress tolerance index (STI) and stress tolerance (TOL) of different genotypes for seed yield

Genotypes	Yield under normal condition (Y_P)	Yield under limited moisture condition (Y_D)	Stress tolerance index (STI)		Stress tolerance (TOL)		Overall rank
			STI	Rank	TOL	Rank	
UD-728	37.00	33.33	0.90	5	3.67	5	6
UD-796	46.67	35.00	0.75	13	11.67	14	15
UD-797	51.67	30.00	0.58	16	21.67	17	18
J.Cor-340	56.67	31.33	0.55	17	25.34	19	19
J.Cor-375	50.00	41.00	0.82	9	9.00	10	10
DH-206	48.33	38.00	0.79	10	10.33	13	13
K-Selection	31.67	28.33	0.89	6	3.34	4	7
ND Cor-2	36.33	32.33	1.34	1	40.00	6	5
ICS-1	38.33	35.00	0.91	4	3.00	3	4
LCC-170	29.00	22.33	0.77	12	6.67	8	12
LCC-212	41.00	25.00	0.61	15	16.00	16	17
RD-154	35.00	30.00	0.86	7	5.00	7	8
Hisar Anand	35.00	32.00	0.91	4	3.00	3	3
RCr-20	44.00	36.67	0.83	8	7.33	9	9
RCr-435	48.33	35.33	0.73	14	13.00	15	16
RCr-436	40.00	15.00	0.38	18	25.00	18	19
RCr-446	38.00	28.33	0.75	13	9.67	12	14
RCr-480	44.33	41.67	0.94	3	2.66	2	2
RCr-684	43.33	34.00	0.78	11	9.33	11	11
Local	31.67	30.67	0.97	2	1.00	1	1

$STI = [(Y_P) \times (Y_D) / (Y_P)^2]$, $TOL = (Y_P - Y_D)$

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