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Laboratory screening of coriander genotypes for drought tolerance

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ABSTRACT : Coriander fruits are an important spice of many countries of europe, northern africa, west, central and south Asia. In india it is cultivated in a area of 3.40 lakh hectares with an annual production of 2.23 lakh tonnes. Among the various environmental stresses, drought id common phenomenon in tropical countries. Choice of suitable accessions under rainfed situation is of prime importance in order to enhance the productivity of coriander. Application of physiological parameters to sort out drought tolerant accessions forms important criteria in screening suitable accessions for rainfed situation. With this view laboratory screening of coriander genotypes was taken up during the year 2007. The laboratory study involving an array 50 genotypes have clearly demonstrated that the genotypes are endowed with a wide degree of variation in respect of their sensitivity to induced moisture stress. Among the criteria considered for screening the variability manifested by the genotypes are of comparatively greater order for germination (27.5 to 0 %) and root length (0.68 to .25 cm) as against shoot length (5.47 to 2.00 cm) and vigour index (168.93 to 11.93).

Key Words : Screening, Coriander, Genotypes, Tolerance

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Coriander commonly known as "Dhania" (*Coriandrum sativum L.*) belongs to family Apiaceae. Coriander fruits are an important spice of many countries of Europe, Northern Africa, West, Central and South Asia. In India, it is cultivated in 3.40 lakh hectares with an annual production of 2.23 lakh tonnes (Anonymous, 2006).

Using six different PEG concentrations and 11 sorghum cultivars, Saint-Clair (1976) concluded that increasing concentrations of the osmoticum resulted in poorer germination. The osmotic potential of a colloidal solution can mimic the soil water potential and soil water potential is a most important parameter in controlling seed germination under normal farming conditions. Predicting field emergence using polyethylene glycol (PEG) as a water stress. Hadas (1977) found good correlation between field emergence and time needed to attain germination in a solution of PEG 6000 (MW) from -0.01 to -1.28 MPa water potential.

Jayawardhana *et al.* (1989) concluded that PEG solutions inhibit germination of sorghum seeds. Germination was decreased significantly at the lowest potential of -1.0 MPa. Polyethylene glycol was a satisfactory osmoticum for studying the direct effect of water potential on germination. Sorghum seed germinability under moisture stress imposed by PEG 6000 at -0.2 to -1.0 MPa was studied by Dighe and Rajurkar (1981). Their results pointed out that germination energy declined with increases in osmotic concentrations, where germination energy is defined as the cumulative germination counts divided by the time interval.

Working with sorghum and other annual crops, Dart *et al*. (1992) used PEG 6000 and found that sorghum is more resistant to water potential and temperature increases than soybean and sunflower. The maximum germination of sorghum seed occurred in a range of 27 to 37º C at -1.2 MPa after 3 days. Germination under drastic conditions of water stress was inhibited, but was restored with an increase of water availability (Silva Ligia *et al.*, 2001).

The seeds germinated well until -0.3 MPa water potential. Germination percentage reduced from -0.5 MPa while the speed of germination was reduced from -0.3 MPa. The limit of tolerance to water stress in PEG-6000 of *C. quercifolius* seeds was

between -0.7 and -0.9 MPa (Viégas *et al*., 2005).

Leila Radhouane (2007) reported that mean germination per cent of pearl millet (*Pennisetum glaucum* (L.) R. Br) for all provenances of Tunisia decreased about 73 per cent in -2.0 MPa compared to control (0 MPa) treatment. Decreases in the external osmotic potential induced decreased shoot growth while a slight increase in root length associate with the -1.0 MPa treatments was observed for some ecotypes. This reflects an adaptive response involving an increase in root length to reach deeper water in the soil.

RESEARCH PROCEDURE

The present investigation was carried out for screening of coriander genotypes for drought tolerance using PEG 6000 at Department of Spices and Plantation Crops laboratory, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore.

PEG 6000 at a concentration of -0.15 MPa as arrived in the standardization studies was employed for screening the accessions used for screening of 50 genotypes with 2 replications in Completely Randomised Design.

For preliminary screening, 50 genotypes were taken and they were lightly pressed to separate inter mericarps and soaked in water for 16 hours (Padmapriya *et al.*, 2007). Twenty seeds of the each accession were counted placed in separate petri dishes. All the petri dishes were kept uniformly in a germination chamber. One mL solution of PEG 6000 (-0.15 MPa) was added to the petri dishes separately at regular intervals of 24 hours. The petri dishes were kept uniformly in a germination chamber.

Observations recorded :

Germination percentage **:**

The number of seedlings emerged were counted fifteen days after sowing in each of the accession tested and the mean was expressed in percentage. Germination percentage was calculated as below :

$$\text{Germination percentage} = \frac{\text{No. of seeds germinated}}{\text{No. of seeds sown}} \times 100$$

Shoot length **:**

The height of the seedling was measured from the collar region to the top in each of the accessions and the mean value was expressed in centimeter (cm).

Root length **:**

Root length was measured from the collar region to the tip of the primary root in each of the accessions and the mean was expressed in centimeter (cm).

Vigour index (%) **:**

The vigour index was worked out as per the method of Abdul-Baki and Anderson (1970).

VI=Germination percentage × (Shoot length+Root length)

RESEARCH ANALYSIS AND REASONING

The data on the laboratory screening of coriander genotypes for drought tolerance is presented in Table 1.

With regard to germination percentage the genotypes exhibited a wide degree of variation from 0 to 27.50 per cent. The germination was significantly on the higher side in CS 127 (27.50 %) and was on par with CS 161 (25.00 %) and CS 18 (22.50 %) and followed by CS 202, CS 208 and CO (CR) 4 with a germination of 17.50, 17.50 and 15.00 per cent, respectively. Out of 50 genotypes, 27 genotypes failed to germinate.

The shoot length of the genotypes ranged from 2.00 to 5.47 cm. The shoot length was significantly higher in CS 127 (5.47 cm) and was on par with CS 161, CS 202, CS 208 and CS 18 with a shoot length of 4.83, 4.67, 4.66 and 4.35 cm, respectively. In CO (CR) 4 shoot length of 4.25 cm was recorded. The lowest shoot length was recorded in CS 134 (2.00 cm).

The root length of the seedlings among the genotypes showed significant deviation ranging from 0.25 to 0.68 cm. The root length was significantly on the higher side in CS 127 (0.68 cm) and was on par with CS 161 (0.64 cm), CS 202 (0.62 cm), CS 18 (0.61 cm) and CS 208 (0.61 cm), respectively. The lowest root length was recorded in CS 154 (0.25 cm) but genotype CO (CR) 4 recorded root length of 0.53 cm.

Vigour index was significantly differed among the genotypes. Vigour index ranged from 11.93 to 168.93. High vigour index was noticed in the CS 127 (168.93) and CS 161 (138.90) and were closely followed by CS 18, CS 202 and CS 208 with vigour index of 119.28, 92.23 and 92.13, respectively. Genotype CO (CR) 4 recorded vigour index of 71.63. The lowest vigour index of 11.93 was recorded by genotype CS 134.

Discussion :

The artificial induction of drought was done using Poly Ethylene Glycol (PEG) as has been followed earlier in hot pepper and egg plant (Krishnasamy and Irulappan, 1994). The artificial induction of drought using Poly Ethylene Glycol however is dependent on the concentration and varies with the crop and genotype. Under such circumstances, the study involved in itself a preliminary standardization of the concentration of PEG 6000. Based on the results attained for germination percentage and vigour index, a concentration of -0.15 MPa has been fixed as optimum for coriander for further studies involving screening for drought tolerance under laboratory condition.

Under laboratory studies, the criteria considered for screening are limited to germination and seedling morphology as followed in hot pepper and egg plants (Krishnasamy and Irulappan, 1994).

In general, water stress is critical to seed germination and

Table 1 : Effect of PEG 6000 on germination, shoot length, root length and vigour index of coriander genotypes

Genotypes	Germination percentage	Shoot length (cm)	Root length (cm)	Vigour index
CO 3	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)
CO (CR) 4	15.00 (4.00)	4.25 (2.29)	0.53 (1.23)	71.63 (8.52)
CS 18	22.50 (4.85)	4.35 (2.31)	0.61 (1.27)	112.88 (10.67)
CS 31	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)
CS 33	5.00 (2.45)	2.95 (1.99)	0.35 (1.16)	16.50 (4.18)
CS 37	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)
CS 73	5.00 (2.45)	3.95 (2.22)	0.30 (1.14)	21.23 (4.71)
CS 78	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)
CS 79	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)
CS 90	5.00 (2.45)	3.60 (2.14)	0.41 (1.19)	20.03 (4.59)
CS 97	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)
CS 103	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)
CS 113	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)
CS 118	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)
CS 121	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)
CS 122	5.00 (2.45)	2.45 (1.86)	0.31 (1.14)	13.78 (3.84)
CS 126	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)
CS 127	27.50 (5.34)	5.47 (2.54)	0.68 (1.29)	168.93 (13.04)
CS 131	10.00 (3.32)	2.39 (1.84)	0.38 (1.17)	27.53 (5.34)
CS 134	5.00 (2.45)	2.00 (1.73)	0.39 (1.18)	11.93 (3.60)
CS 138	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)
CS 143	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)
CS 150	5.00 (2.45)	2.10 (1.76)	0.44 (1.20)	12.70 (3.70)
CS 153	5.00 (2.45)	3.25 (2.06)	0.33 (1.15)	17.88 (4.34)
CS 154	5.00 (2.45)	3.96 (2.23)	0.25 (1.12)	21.00 (4.69)
CS 161	25.00 (5.10)	4.83 (2.41)	0.64 (1.28)	138.90 (11.83)
CS 164	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)
CS 168	5.00 (2.45)	2.90 (1.97)	0.35 (1.16)	16.23 (4.15)
CS 169	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)
CS 173	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)
CS 177	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)
CS 178	7.50 (2.92)	3.26 (2.06)	0.26 (1.12)	26.60 (5.25)
CS 183	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)
CS 184	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)
CS 185	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)
CS 188	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)
CS 195	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)
CS 196	10.00 (3.32)	3.64 (2.15)	0.32 (1.15)	39.55 (6.37)
CS 201	5.00 (2.45)	2.45 (1.86)	0.32 (1.15)	13.83 (3.85)
CS 202	17.50 (4.30)	4.67 (2.38)	0.62 (1.27)	90.23 (9.66)
CS 208	17.50 (4.30)	4.66 (2.38)	0.61 (1.27)	92.13 (9.65)
CS 210	5.00 (2.45)	3.85 (2.20)	0.48 (1.22)	21.65 (4.76)
CS 213	10.00 (3.32)	3.20 (2.05)	0.32 (1.15)	36.78 (6.15)
CS 220	7.50 (2.92)	3.95 (2.22)	0.38 (1.17)	32.50 (5.79)
CS 221	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)
CS 222	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)
CS 224	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)
CS 225	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)
CS 233	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)
CS 267	5.00 (2.45)	2.95 (1.99)	0.33 (1.15)	16.38 (4.17)
Mean	4.60 (2.37)	1.63 (1.62)	0.19 (1.09)	20.98 (4.69)
S Ed.	0.2907	0.1171	0.0210	0.7431
CD (0.05)	0.5839**	0.2352**	0.0421**	1.4928**

** = Significant at 1% level of significance, (Values in the parenthesis are square root transformed)

seedling growth phase (Levitt, 1980). The sensitivity of different vegetable crops to different levels of moisture stress as revealed from the seed germination and seedling growth have been well established (Ross and Hegarty, 1979). The present laboratory study involving an array of 50 genotypes have clearly demonstrated that the genotypes are endowed with a wide degree of variation in respect of their sensitivity to induced moisture stress. Among the criteria considered for screening, the variability manifested by the genotypes are of comparatively greater order for germination (27.50 to 0 %) and root length (0.68 to 0.25 cm) as against shoot length (5.47 to 2.00 cm) and vigour index (168.93 to 11.93).

Though study has brought out that the scope for selection is very high on variation registered in the population in respect of the sensitivity of genotypes from among the 50 genotypes tested based on the higher values obtained in respect of germination, root length, shoot length and vigour index which were later subjected to a critical performance study under field conditions. Such differential sensitivity of genotypes to moisture stress has been reported in many crops (Singh and Afria, 1985; Singh, 1990).

In giant foxtail seed, either a brief exposure to -0.3 MPa PEG solution, a slow hydration in humid air or drying after partial hydration has been reported to improve germination in a similar fashion (Taylorson, 1986). Certain physiological and biochemical changes are reported to occur during osmo-conditioning that allow seeds to develop a higher germination potential (radical thrust) or the ability to remove the seed coat restraint (Khan, 1993). This might be the basis for an improvement in the rate of germination and emergence recorded in the present experiments.

The inhibited germination recorded in other genotypes tested at -0.15 MPa osmotic potential may be related to the moisture deficit in the seeds below the threshold level for germination. These results are in conformity with the earlier findings in hot pepper and egg plants (Krishnasamy and Irulappan, 1994).

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