Indian J. Plant Physiol., Vol. 8, No. 3 (N.S.) pp. 319-322 (July-Sept., 2003)

SHORT COMMUNICATION

EVALUATION OF CASTOR (*RICINUS COMMUNIS* L.) GENOTYPES FOR MOISTURE STRESS

K. MANJULA, P.S. SARMA, RAMESH THATIKUNTA* AND T. NAGESHWAR RAO

Department of Plant Physiology, College of Agriculture, Acharya N.G. Ranga Agricultural University, Rajendranagar 500030

Received on 20 Sept., 2001, Revised on 20 Aug., 2003

Castor, which is chiefly grown on dry lands, suffers from low productivity in Andhra Pradesh. To identify genotypes that suit dry land situations, screening based on seed germination, seedling vigour index, proline accumulation and nitrate reductase activity was taken up. Moisture stress of –3, –6 and –9 bars was provided to seeds germinating in petri plates or test tubes using polyethylene glycol solution and the response compared with control. Stress level of –6 bar was found appropriate for screening of genotypes. The genotype GCH 4 showed superiority in most of the parameters examined and recommended for cultivation in dry lands.

Key words **: PEG induced stress, *Ricinus communis***

Castor (*Ricinus communis* L.) is an important non-edible oilseed crop. In Andhra Pradesh the crop is cultivated over an area of 1.71 lakh ha primarily on dry lands, where moisture is a limiting factor for maintenance of adequate crop stands, crop growth and full expression of its genetic potential because of which the yield of the crop hovers around a low of 333 kg/ha as compared to all India average of 1197 kg/ha (Damodaram and Hegde 2002). In dry situations, germination and early seedling growth determine crop stand and seed yield (Gelmond 1978). There is a need to identify genotypes that perform well under such conditions. The present study was therefore undertaken to evaluate genotypes for their performance under water stress in terms of seed germination, seedling vigour, nitrate reductase activity and proline accumulation.

Eight castor genotypes viz. GCH 4, DCH 177, DCH 32, PCH 8, Bhagya, Aruna, Jyothi and Kranthi were taken for the study. Twenty seeds of each genotype were placed in petri dishes of 10 cm diameter. Polyethyleneglycol (PEG), 7.78, 15.55 and 23.33 g was dissolved in distilled water and made up to 100 ml to give –3, –6, and –9 bars respectively. Ten ml of PEG solution was used to impose water stress, while distilled water was added to control treatments. The petri dishes were kept under room temperature and observed for germination. The experiment was conducted during May to August 1999. To study the seedling growth, germinated castor seeds were transferred on to the filter paper boats placed in sterile test tubes containing 20 ml of different concentrations of PEG solutions. Seedling vigour index (SVI) was computed for seedlings grown for fifteen days following the procedure of Jayaraj and KavithaRaju (1992). Proline and nitrate reductase activity (NRA) were estimated in leaf tissues of fifteen days old seedlings following the procedures of Bates *et al.* (1973) and Klepper *et al.* (1971) respectively. Data from eight castor genotypes X four PEG concentrations were analyzed in mixed factorial experiment laid out in CRD.

The seed germination was decreased under water stress. The germination irrespective of genotypes was 79.0 and 14.8% in –3 and –9 bars as compared to 81.9% in control (Table 1). Significant variation in seed germination were observed under PEG induced water stress. At –3 bars stress, GCH 4 and DCH 177 showed superior germination of 84.6 and 81.3%. DCH 177 was observed to be on par with DCH 32, Bhagya and Aruna. Three other genotypes PCH 8, Jyothi and Kranthi showed lower germination (76.4 to 75%). At –6 bars, GCH 4,

*Corresponding author.

Table 1. Effect of PEG induced stress (-3, -6, -9 bars) on seed germination (%) and seedling vigour index (SVI) in castor genotypes.

Genotype	Seed germination (%)					SVI				
	0	-3	-6	-9	Mean	0	-3	-6	-9	Mean
GCH 4	86.9 (70.1)	84.6 (67.7)	65.2 (53.9)	22.0 (28.0)	64.7 (54.9)	16.0	14.8	11.0	1.9	10.9
DCH 177	85.0 (67.2)	81.3 (64.4)	63.2 (52.6)	20.4 (26.9)	62.5 (52.8)	13.9	12.9	8.5	2.0	9.3
DCH 32	80.2 (63.5)	79.2 (62.9)	54.2 (47.4)	15.0 (22.8)	57.1 (49.1)	12.2	10.2	5.9	1.4	7.4
PCH 8	80.1 (63.5)	75.3 (60.2)	42.3 (42.3)	0.0 (SNG)	49.4 (49.4)	11.0	9.7	4.9	0.0	6.4
Bhagya	81.8 (64.8)	79.9 (63.3)	61.6 (51.7)	18.9 (25.8)	60.5 (51.4)	15.5	14.3	9.9	2.4	10.5
Aruna	81.6 (64.6)	80.4 (63.9)	60.1 (60.8)	17.2 (24.5)	59.8 (50.9)	13.3	10.9	7.1	1.8	8.3
Jyothi	80.1 (63.5)	76.4 (60.9)	47.6 (43.6)	14.2 (22.5)	54.7 (47.6)	11.6	9.8	5.5	0.9	6.9
Kranthi	79.8 (63.3)	75.0 (60.0)	31.9 (34.4)	0.0 (SNG)	46.7 (39.4)	12.6	10.9	3.7	0.0	6.8
Mean	81.9 (65.1)	79.0 (62.9)	53.3 (46.9)	14.8 (21.1)		13.3	11.7	7.1	1.3	
CD (P = 0.05) Genotypes (G)					1.89					0.39
Treatments (T)					1.34					0.28
G X T					3.78					0.79

Figures in parenthesis indicate transformed values; SNG : Seeds not germinated.

DCH 177 and Bhagya proved superior. PEG concentration of –9 bars drastically decreased the per cent germination. Such decline in seed germination may be due to the inability of seeds to imbibe water at low osmotic potentials (Karan Singh and Afria 1985).

Seedling vigour index (SVI) decreased under moisture stress induced by PEG as compared to control. The mean SVI was 11.7, 7.1 and 1.3 under –3, –6 and –9 bars of moisture stress respectively. For control SVI was 13.3 (Table 1). At –3 bar GCH 4 and Bhagya were at par (14.0 – 14.3 SVI). Differences among genotypes were evident at higher PEG stress. At –6 bars, GCH 4 showed significantly higher SVI, followed by Bhagya and DCH 177. Seedling growth was not promoted at stress of –9 bar. Singh and Singh (1983) reported that decline in SVI was due to fall in mobilization of reserves to seedlings thus preventing their growth under stress.

Proline content increased under moisture stress. The mean proline content was 329.3, 468.5 and 401.8 μg g^{-1}fw in –3, –6 and –9 bars as compared to 200.3 μg g^{-1}fw in control (Table 2). Genotypes showed variation in proline content in response to PEG induced stress. PEG X Genotype interaction showed GCH 4 followed by DCH 177 and Bhagya to be superior at –3 bar. GCH 4 maintained superiority at –6 bar. Proline accumulation confers adaptive mechanism to water stress (Aspinall and Paleg 1981), acts as nitrogen storage compound (Handa *et al.* 1986) and helps in stress tolerance either by rehydration of protoplasm or by providing energy for recovery of plants (Khidse *et al.* 1982). Tolerance to water stress with increased proline

Table 2. Effect of PEG induced stress (-3, -6, -9 bars) on proline content (μg g^{-1}fw) and nitrate reductase activity (mg NO_2 g^{-1}fw h^{-1}) in castor genotypes.

Genotype	Proline					Nitrate reductase				
	0	-3	-6	-9	Mean	0	-3	-6	-9	Mean
GCH 4	243.8	583.7	961.6	1041.7	707.7	11.8	5.8	3.7	2.9	6.1
DCH 177	293.5	503.5	519.2	534.6	462.7	5.9	2.1	1.8	0.9	2.7
DCH 32	153.4	241.3	400.0	0.0	198.1	4.2	1.7	1.6	0.0	1.9
PCH 8	116.4	139.4	209.6	0.0	116.4	1.9	1.9	1.0	0.0	1.2
Bhagya	259.2	494.4	562.1	646.6	490.6	6.8	6.1	2.1	1.9	4.3
Aruna	222.2	352.1	736.2	991.7	575.6	11.8	1.3	1.0	0.9	3.8
Jyothi	179.5	181.6	209.2	0.0	142.6	0.9	0.7	0.6	0.0	0.5
Kranthi	113.5	138.2	150.3	0.0	105.8	1.8	1.5	0.9	0.0	1.1
Mean	200.3	329.3	468.5	401.8		5.6	2.6	1.6	0.8	
CD (P = 0.05) Genotypes (G)					4.53					0.29
Treatments (T)					3.20					0.21
G X T					9.06					0.58

content was also observed in groundnut (Koti *et al.* 1994) and sunflower (Garcia *et al.* 1992).

Nitrate reductase activity (NRA) decreased in response to moisture stress. The average NRA was 2.6, 1.6 and 0.8 mg NO_2g^{-1}fw h^{-1} as compared to 5.6 mg NO_2 g^{-1}fw h^{-1} in control. Genotypes under study differed in their response to water stress (Table 2). Bhagya followed by GCH 4 and DCH 177 were superior at –3 bars. GCH 4 proved superior to Bhagya at –6 bars and at –9 bars. The decrease in NRA was due to the decreased rate of enzyme synthesis at low water potentials (Morilla *et al.* 1973) and may also be due to redox mediated inactivation of enzyme (Neeru Munjal *et al.* 1998). The decrease in NRA under water stress was also reported in groundnut (Sharma *et al.* 1990). In the present study at –3 bar PEG induced moisture stress, GCH 4 and DCH 177 possessed superior germination. At –6 bars stress, GCH 4 was superior to other castor genotypes in respect of SVI, proline content and NRA. GCH 4 appeared superior for cultivation in dry lands.

REFERENCES

Aspinall, B. and Paleg, L. G. (1981). Proline accumulation-physiological aspects. In: B. Aspinall and L.G. Paleg (eds.), The Physiology and Biochemistry of Drought Resistance in Plants, pp. 205-241. Academic Press, Sydney.

Bates, L.S., Waldren, R.P and Teare, I.D. (1973). Rapid determination of free proline for water stress condition. *Plant soil.* **39** : 205-207.

Damodaram, T. and Hegde, D.M. (2002). Castor. In : T. Damodaram and D.M. Hegde (eds.), Oilseed Situation. A Statistical Compendium, pp. 210-229. Directorate of Oilseed Research, Rajendranagar, Hyderabad.

Garcia, A.L., Galinda, A.L. and Soldatini, G.F. (1992). Biochemical effects of water and salt stress induced by sodium chloride and polyethylene glycol in sunflower seedlings. *Agric. Mediterranea.* **122** : 322-327.

Gelmond, H. (1978). Problems in crop seed germination. In : U.S. Gupta (ed.), Crop Physiology. Oxford and IBH Publishing Company, New Delhi.

Handa, S., Handa, A.K., Hasegawa, P.M. and Bressan, R.A. (1986). Proline accumulation and adaptation of cultured plant cells to water stress. *Plant Physiol.* **80** : 938-945.

Jayaraj, T. and KavithaRaju, T.V. (1992). Influence of harvesting stage on seed vigour in groundnut cultivars. *Seed Res.* **20** : 41-43.

Khidse, S.R., Bhale, N.L. and Barikar, S.T. (1982). Effects of water stress on proline accumulation in sorghum. *J. Maharashtra Agri. Univ.* **7** : 195-196.

Klepper, L., Flesher, D. and Hageman, R. H. (1971). Generation of reduced nicotinamide adenine dinucleotide for nitrate reduction in young leaves. *Plant Physiol.* **48** : 580-590.

Koti, RV., Chetti, M.B., Manjunath. and Ameragowda, A. (1994). Effect of water stress at different growth stages on biophysical characters and yield in groundnut (*Arachis hypogaea* L.) genotypes. *Karnataka J. Agric. Sci.* **7** : 158-162.

Morilla, C.A., Boyer, J.S. and Hageman, R.H. (1973). Nitrate reductase activity and poly ribosomal content of corn (*Zea mays* L.) having low leaf water potential. *Plant Physiol.* **51** : 817-824.

Munjal, Neeru, Sawhney, S.K. and Sawhney, Veena (1988). Ferricyanide restores nitrate reductase activity in leaf extracts of water stressed wheat seedlings. *J. Plant Physiol.* **152** : 577-579.

Sharma, K., Gurubaksh Singh, Sharma, R. and Singh, G. (1990). Biochemical changes in groundnut seedlings grown under glycol induced water stress. *Environ and Ecol.* **8** : 854-856.

Singh, K. and Afria B.S. (1985). Evaluation of moisture stress tolerance in castor cultivars during germination, seedling growth and emergence. *Proc. Indian Natl. Sci. Acad. Biol. Sci.* **51** : 364-368.

Singh, K.P. and Singh, K. (1983). Water uptake and germination of wheat seeds under different external water potentials in osmotic solutions. *Seed Res.* **11** : 13-19.