J. Hortl. Sci.
Vol. 8(2):262-267, 2013

Short communication

Seed germination and seedling growth in *Solanum* species to water stress under *in vitro* conditions

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ABSTRACT

A study on seed germination and seedling growth was conducted with five cultivars of *Solanum melongena* L. (cvs. Arka Nidhi, B.P.L.H.-1, Arka Neelakanth, Arka Keshav and Mattu Gulla) and a wild species *Solanum macrocarpon* L. under different levels of osmotic potential induced by polyethylene glycol (PEG 8000). Germination declined progressively in response to decreasing (more negative) water potential, and no germination was found beyond -0.4MPa in any of the cultivars/species. Except for cvs. Arka Nidhi, B.P.L.H.-1 and Mattu Gulla, no germination was seen at -0.4MPa Cultivar Arka Neelkanth failed to germinate under any of the osmotic concentrations tested. Response in term of root growth was better in Arka Neelkanth, followed by Arka Nidhi and B.P.L.H.-1, upto transfer from different levels of osmotic potential to Control (0MPa). Germination of primed seeds within 24h indicates that many processes leading to normal germination would have been completed during the priming process itself. In contrast to germination, growth extension in radicle was less sensitive to water stress.

Key words: Brinjal, germination, osmotic potential, water stress

Seed germination and early seedling growth indirectly determine crop density, crop growth and, consequently, plant yield particularly, under limited water conditions in arid and semi-arid areas. Here, surface soil often dries up rapidly and prevents seed germination and seedling establishment. As a consequence of climate change, there is occurrence of high temperature spells and erratic rainfall, thus causing limited water (drought) and excess water (flood) situations. Drought, or limited moisture condition, is considered to be one of the main environmental factors strongly limiting growth and yield of plants worldwide (Chaves *et al*, 2003). Horticultural crops in general, and vegetable crops in particular, are sensitive to environmental extremes. Relative performance of an individual plant during early stages of its life, i.e., germination and seedling establishment, can have serious effects on subsequent growth and fitness (Roach, 1987). Brinjal, an important crop of the sub-tropics, is a hardy crop of the solanaceous vegetables. However, scanty work has been reported on germination behaviour and seedling growth in relation to limited water conditions. The present study, therefore, was conducted to determine seed germination and seedling growth response in various brinjal cultivars exposed to various osmotic concentrations.

Studies were conducted with five cultivars of *Solanum melongena* L. (cvs. Arka Nidhi, B.P.L.H.-1, Arka Neelakanth, Arka Keshav, Mattu Gulla) and a wild species, *Solanum macrocarpon* L. Seeds were placed on filter paper in 90 mm (dia) glass petri dishes. Three replicates of 20 seeds were used per treatment. The petri dishes were placed in an incubator in the dark at 25°C for determining seed germination in relation to water stress. Seeds were subjected to different osmotic concentrations (0MPa, -0.2MPa, -0.4MPa, -0.8MPa and -1.0MPa) effected with polyethelene glycol (PEG 8000). Germination was recorded daily for 10 days. Root and shoot length were measured at the end of the experiment (10th day). Ungerminated seeds from under various PEG concentrations were transferred to petri dishes containing distilled water (0MPa) at the same temperature (25°C), and germination recorded daily for 10 days. Root and shoot length were also measured here at the end of the experiment (10th day). In another experiment, seeds were primed for 7 days in -1MPa PEG 8000 solution. Twenty seeds of each cultivar/species were placed in petri dishes containing distilled water (0MPa). Germination was recorded for 10 days.

Germination pattern was different between cultivars (Fig. 1). Germination began by Day 4 in cvs. Arka Nidhi, Arka Keshav, Arka Neelkanth and *Solanum macrocarpon* L. under the Control (0MPa), and by Day 5, in cv. B.P.L.H.-1. However, earliest germination (within 24h) was seen in cv. Mattu Gulla under Control. In all the cultivars, 50% germination was reached by Day 6, except in cvs. Arka Neelkanth and B.P.L.H.-1. Lowest germination (45%) was seen in B.P.L.H.-1 under Control. Germination was affected significantly when seeds were subjected to various osmotic concentrations. Except for cvs. Arka Nidhi, B.P.L.H.-1 and Mattu Gulla, there was no germination at -0.4MPa. In cvs. Arka Keshav and *Solanum macrocarpon,* no germination was observed beyond -0.2MPa. Cv. Arka Neelkanth did not germinate under any of the osmotic concentrations tested. No germination was seen beyond -0.4MPa in any of the cultivars/species. Maximum germination under -0.2 and -0.4 MPa was recorded in Mattu Gulla and Arka Nidhi (Fig. 1). Root growth was better in cvs. B.P.L.H.-1, Arka Nidhi and Mattu Gulla under water stress as indicated by higher root length compared to the Control (Table 1). However, shoot growth was significantly low due to stress in all the cultivars/species.

When ungerminated seeds from various osmotic concentrations (-0.2MPa, -0.4MPa and -0.6MPa) were

Table 1. Percentage seed germination, root and shoot growth under different levels of water potential after 10 days

		(a)% Germination Osmotic concentration		
Cultivar/species	0MPa	-0.2MPa	-0.4MPa	-0.6MPa
Arka Nidhi	77.8 (63.04)	40.0 (39.22)	40.0 (38.14)	0.0 (0.0)
B.P.L.H. -1	46.7 (43.09)	45.0 (41.81)	30.0 (32.20)	0.0 (0.0)
Mattu Gulla	100.0 (89.96)	100.0 (89.96)	95.0 (79.52)	0.0 (0.0)
Arka Keshav	84.5 (67.47)	70.0 (56.77)	0.0 (0.0)	0.0 (0.0)
Solanum macrocarpon	66.7 (54.87)	10.0 (18.43)	0.0 (0.0)	0.0 (0.0)
Arka Neelkanth	55.5 (48.23)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
	Cultivar	Treatment	Interaction	
S. Em.±	2.15	1.75	4.30	
CD (*P= 0.01*)	8.17	6.67	16.35	
Figures in parentheses indicate transformed values of per cent germination				
		(b) Root length (cm) Osmotic concentration		
Arka Nidhi	3.46	3.30	6.60	0.00
B.P.L.H. -1	3.55	6.10	7.47	0.00
Mattu Gulla	3.02	5.30	5.60	0.00
Arka Keshav	2.08	3.10	0.00	0.00
Solanum macrocarpon	3.23	0.00	0.00	0.00
Arka Neelkanth	2.40	0.00	0.00	0.00
	Cultivar	Treatment	Interaction	
S. Em.±	0.23	0.19	0.46	
CD (*P= 0.01*)	0.86	0.71	1.73	
		(c) Shoot length (cm) Osmotic concentration		
Arka Nidhi	2.64	0.50	0.90	0.00
B.P.L.H. -1	3.50	0.90	0.40	0.00
Mattu Gulla	2.89	1.20	0.60	0.00
Arka Keshav	1.03	0.40	0.00	0.00
Solanum macrocarpon	3.29	0.00	0.00	0.00
Arka Neelkanth	1.41	0.00	0.00	0.00
	Cultivar	Treatment	Interaction	
S.Em.±	0.13	0.11	0.26	
CD (*P= 0.01*)	0.50	0.40	0.99	

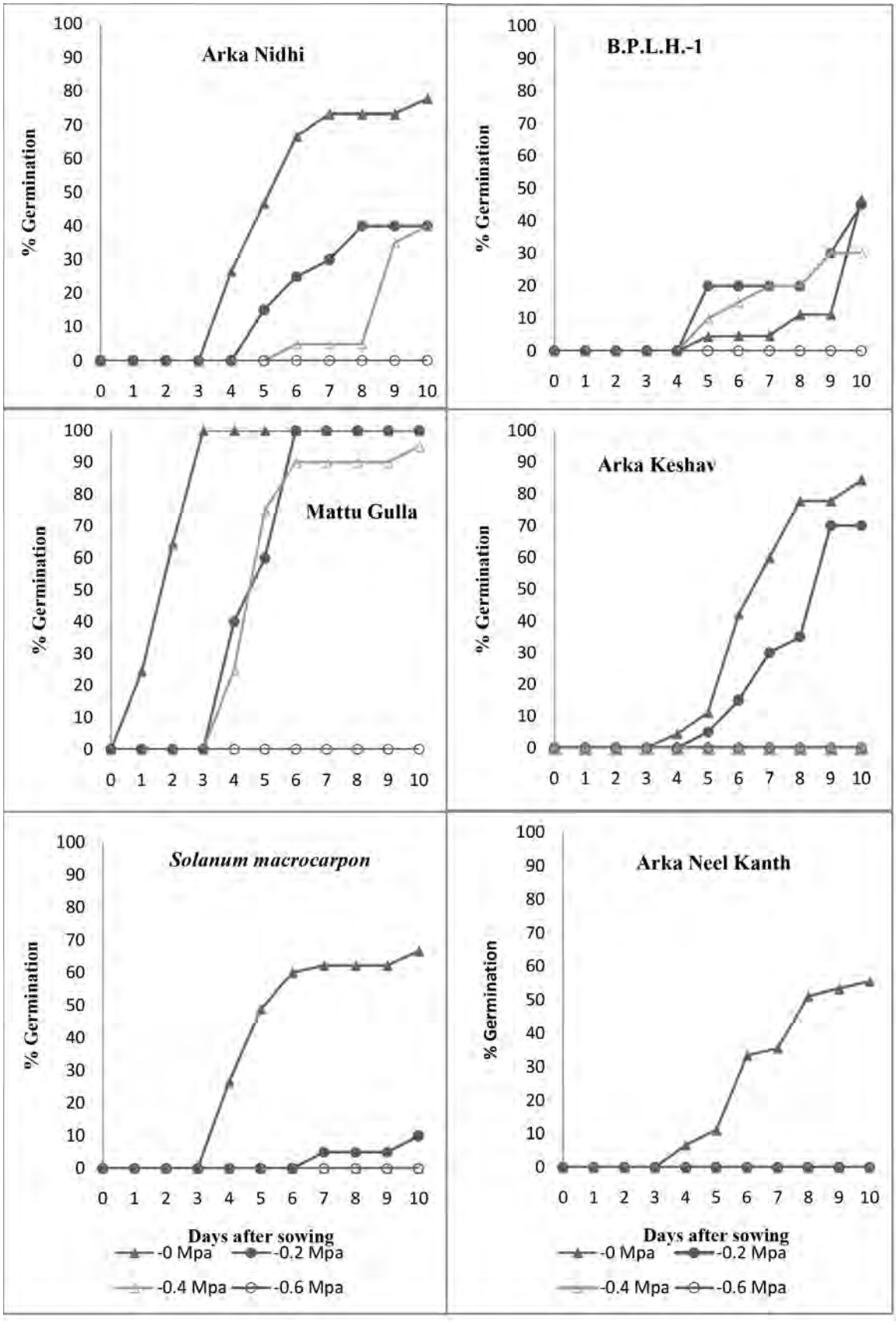

Fig 1. Germination behaviour of brinjal cultivars under different levels of water potential

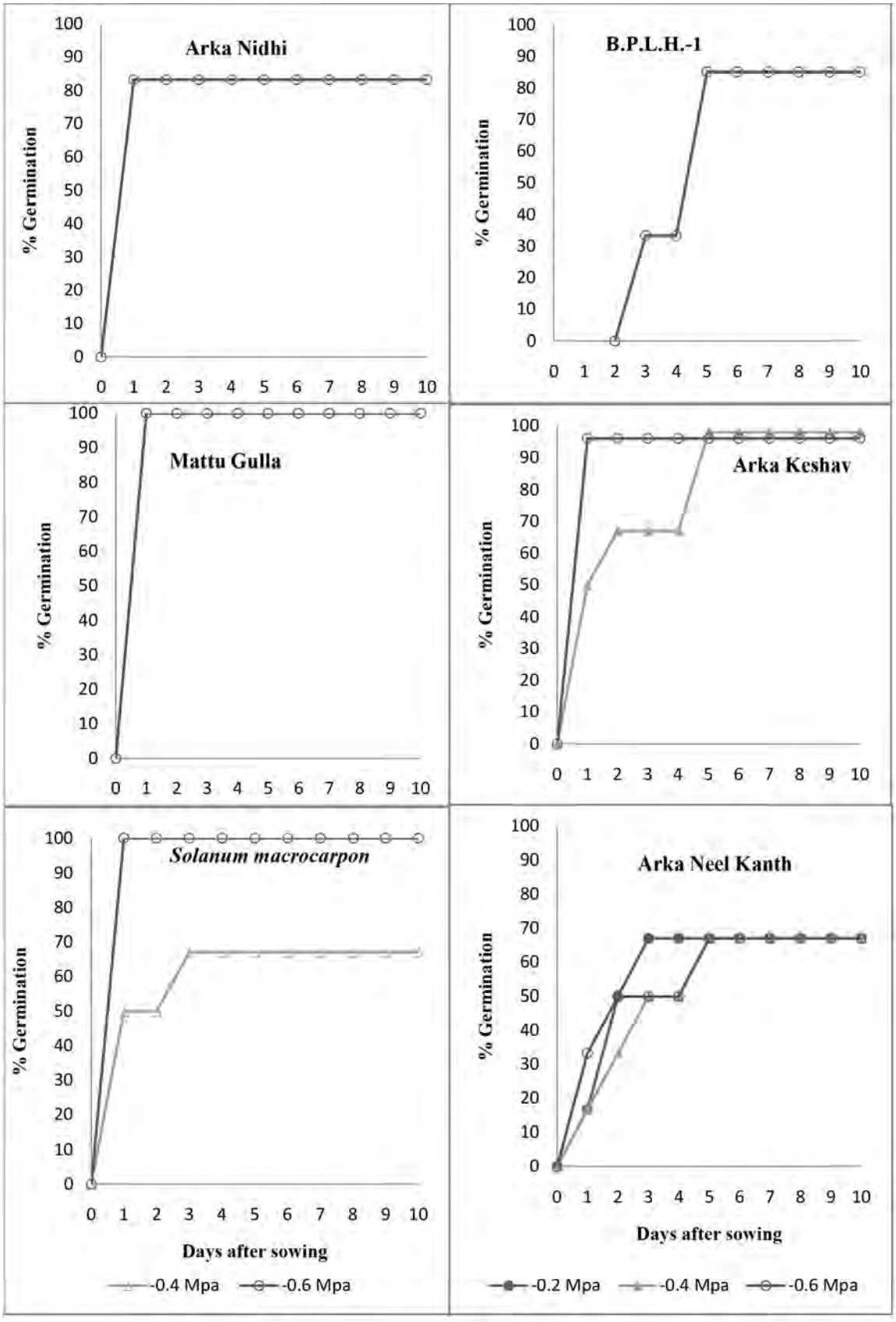

Fig 2. Germination pattern of ungerminated brinjal seeds upon transfer to water from different osmotic concentrations

Table 2. Percentage seed germination, root and shoot growth upon transfer of ungerminated seeds from different levels of osmotic concentration to water (0 MPa)

(a) % Germination Osmotic concentration			
Cultivar/Species	-0.2MPa	-0.4MPa	-0.6MPa
Arka Nidhi	0.0 (0.0)	83.3 (65.85)	83.3 (65.85)
B.P.L.H. -1	0.0 (0.0)	98.0 (81.22)	85.0 (67.38)
Mattu Gulla	0.0 (0.0)	100.0 (89.96)	100.0 (89.96)
Arka Keshav	0.0 (0.0)	98.0 (82.63)	96.0 (78.49)
Solanum macrocarpon	0.0 (0.0)	67.0 (54.92)	100.0 (89.96)
Arka Neelkanth	67.0 (54.92)	67.0 (54.92)	67.0 (54.92)
	Cultivar	Treatment	Interaction
S. Em.±	0.35	0.25	0.60
CD (*P= 0.01*)	1.34	0.95	2.33
Figures in parentheses indicate transformed values of per cent germination			
(b) Root length (cm) Osmotic concentration			
Arka Nidhi	0.0	5.20	7.40
B.P.L.H. -1	0.0	5.57	6.27
Mattu Gulla	0.0	2.47	0.90
Arka Keshav	0.0	5.57	3.07
Solanum macrocarpon	0.0	4.83	4.93
Arka Neelkanth	5.70	6.50	7.43
	Cultivar	Treatment	Interaction
S. Em.±	0.38	0.22	0.55
CD (*P = 0.01*)	1.54	0.89	2.17
(c) Shoot length (cm) Osmotic concentration			
Arka Nidhi	0.0	3.47	4.87
B.P.L.H. -1	0.0	2.67	2.73
Mattu Gulla	0.0	1.53	0.30
Arka Keshav	0.0	2.97	2.00
Solanum macrocarpon	0.0	5.17	5.30
Arka Neelkanth	3.97	3.83	4.13
	Cultivar	Treatment	Interaction
S. Em.±	0.28	0.16	0.49
CD (*P= 0.01*)	1.11	0.64	1.57

transferred to the Control (0MPa) concentration, germination began within 24h. in almost all the cultivars, except for B.P.L.H.-1, where germination started on Day 3. Ungerminated seeds transferred from -0.6MPa to Control (0MPa) had >80% germination, except Arka Neelkanth where seed germination did not cross 67% at 0MPa after transfer from lower osmotic concentrations (Fig. 2). In general, roots in these seeds were longer when seeds from lower osmotic concentrations were transferred to 0MPa (Table 2). In seeds primed at -1MPa, germination was >60%

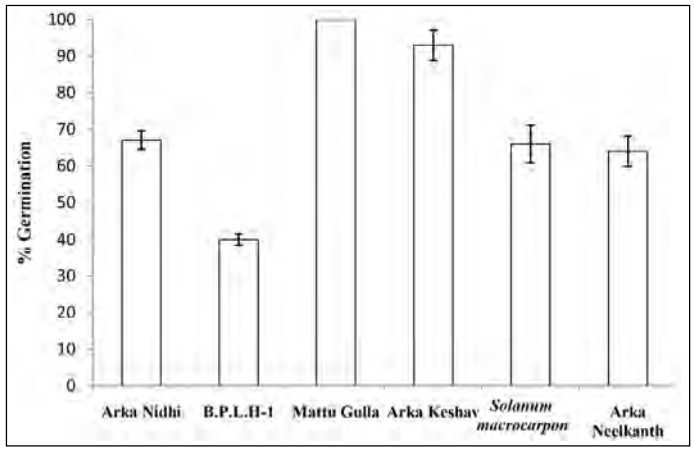

Fig 3. Germination of brinjal cultivars upon priming at -1.0 MPa for 7 days.

in all the cultivars, except B.P.L.H.-1 where germination did not cross 40% under Control (Fig. 3).

Results indicate that increasing moisture stress beyond -0.2MPa considerably reduces germination in all the cultivars, with significant differences among them. Increasing water stress increased the time taken for germination (Fig. 1). It is clear from the results that for most of the brinjal cultivars studied, critical water potential required for germination lies between -0.2 and -0.4 MPa. Reduction in germination percentage may be attributed to lower diffusion of water under lower water potential. This is further supported by induction of germination within a day upon transfer of the ungerminated seeds under different concentrations, and primed seeds at -1MPa to distilled water (0MPa). Root growth improved with increasing moisture stress, but shoot length decreased under the same moisture conditions in almost all the cultivars, as indicated by higher root length under stress (Table 1). The water-sensitive phase of seed germination occurs before radicle emergence (Bhatt and Srinivasa Rao, 1987; Srinivasa Rao and Bhatt, 1990). Ungerminated seeds under lower water potential germinated within 24h. after transfer to 0MPa (Control). This indicates that several processes leading to normal germination may have been completed during the priming process. Response of root growth was superior in cv. Arka Neelkanth, followed by cv. Arka Nidhi and B.P.L.H.-1 upon transfer from different levels of osmotic potential to Control (0MPa). In contrast to germination, growth extension in radicle was less sensitive to water stress in brinjal.

ACKNOWLEDGEMENT

The present work was conducted under "National Initiative on Climate Resilient Agriculture" (NICRA) Project. The authors are grateful to Director, Indian Institute of Horticultural Research, for providing necessary facilities.

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(MS Received 13 February 2013, Revised 10 September 2013, Accepted 23 September 2013)