SHORT COMMUNICATION

Response of Germplasm Lines towards PEG-induced Drought Stress in Cotton (*Gossypium hirsutum* L. and *Gossypium arboreum* L.)

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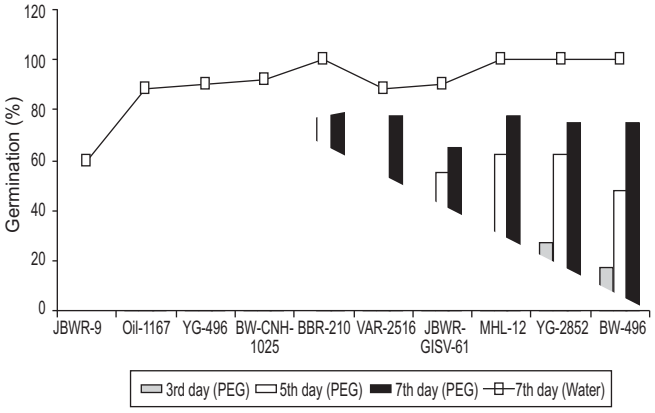
Cotton (*Gossypium* spp.), a major fibre crop of India, often encounters moisture stress during seed germination especially under rainfed cultivation in Central and South zones. Breeding for drought tolerance has always been a challenging goal in cotton research. The germplasm which is rich in diversity may be a potential source for identifying lines tolerant to moisture stress. In percent study, 22 lines of cotton genglarm were screened for drought-stress tolerance.

Ten germplasm lines belonging to *G. hirsutum* (Oil-1167, JBWR-9, MHL-12, JBWR-GISV-61, VAR-2516, BW-496, BBR-210, BW-CNH-1025, YG-496, YG-2852) and 12 lines belonging to *G. arboreum* (6506-A21, 6507-A27, 6519-AC-7, 6522-AC11, 6556-B66-AC48, 6559-AC53, 6563-AC63, 6579-AC545, 6583-AC616, 6584M11-AC617,6589-AC622 and AC-45) were used to investigate their capacity to survive under different polyethylene glycol (PEG) concentrations and early vigor. The seeds were collected from the germplasm curator, Central Institute of Cotton Research (CICR), Nagpur, and multiplied under field conditions. The seeds were observed for seed index and tested for initial germination as per the ISTA standards by rolled towel method (Table 1). Simulated water deficit stress was created using two concentrations (15% and 20%) of PEG 6000. One hundred seeds of each line were washed and surface sterilized with 0.1% $HgCl_2$ followed by thorough washing under tap water twice. Fifty seeds/replication/line were plated in each petri plate lined with filter paper soaked in equal volume of PEG solutions along with a control set maintained in double distilled water. Four replications were maintained for each treatment. Later they were kept in an incubator for 7 days at 25 ^oC. To account for any change in PEG solution, it was changed at 2 days interval. The treatments were replicated four times. The observation on germination was made daily. Seeds were considered to be germinated when radical became 2 mm long. Rate of germination was assessed by counting the number of seeds germinated each day. Comparisons between treatments and lines were made using the data on the 3rd, 5th and 7th day of seed plating.

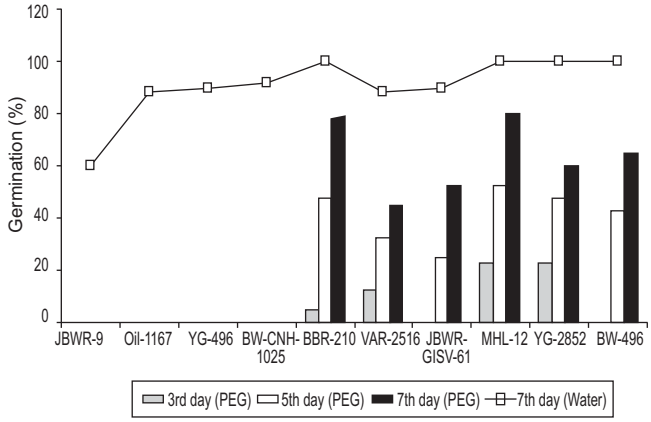
Simulated water deficit stress using PEG solutions, adversely affected germination especially, in *G. hirsutum* lines. The initial decline in root growth and subsequent reduction in germination with increasing PEG induced stress, has been reported in different crops (Bibi *et al.*, 2009; Nautiyal, 2009). The average germination in *G. hirsutum* which ranged between 15% to 82% under 15% PEG still lowered under 20% PEG especially for lines, VAR 2516 and JBWR-GISV-61 (Figs. 1a & b). The lines, JBWR-9, Oil-1167, YG-496 and BW-CNH-1025 revealed more sensitivity towards PEG stress under both 15% and 20% PEG treatments. Apparently, JBWR-9 was the most affected line as the seeds did not germinate even in 15% PEG. However in *G. arboreum*, the difference in response was not much and all lines maintained a higher germination percentage (above 80%) in both 15% and 20% PEG solutions except two lines *viz.*, AC-53 and AC-622 wherein germination under 20% PEG significantly reduced from 90% to 55% in former and from 85% to 40% in later (Figs. 2a & b). The difference in response between species might be due to slow mobilization of proteins in the sensitive species compared to the relatively tolerant species as observed in soybean (Samarah and Mullan, 2006). In cotton, it has been reported that developmentally-regulated heat shock proteins HSP 101 and HSP 17.6 appeared in the cotyledons of water-stressed cotton seedlings under PEG induced water deficit stress which were absent in cotyledons from well watered seedlings (Burke and Mahony, 2001). *G. arboreum* genotypes commonly called as *desi* cotton of Indian origin, are known to emerge earlier and to be more drought- tolerant than *G. hirsutum* (upland cotton). An earlier study on *G. hirsutum* and *G. arboreum* cultivars also revealed low/non-sensitivity of latter towards germination stress induced by methanol (Santhy and Deshmukh, 2008). Genotypic variation was observed for response to the simulated stress in both *G. hirsutum* and *G. arboreum*

Table 1. List of Germplasm lines with their IC numbers, seed index and initial germination%

Germplasm Line	IC No.	Seed index	Mean germination %
G. arboreum			
A21	412026	6.2	85
A27	412027	6.1	84
AC-7	412040	5.5	85
AC-11	412043	6.1	85
BLL-AC-48	412078	6	78
AC-53	412081	5.7	78
AC-63	412085	5.0	88
AC-545	412102	6.1	84
AC616	412107	6.7	78
MNL-AC617	412108	6.0	80
AC622	412114	6.5	80
AC-45	412074	5.8	82
G. hirsutum			
JBWR-9	M-7-CC	10.2	76
Oil-1167	357682	9.8	82
YG-496	357011	7.6	88
BW-CNH-1025	357540	8.6	80
BBR-210	356725	6.3	75
VAR-2516	359031	7.9	85
JBWR-GISV-61	GISV-61	6.8	88
MHL-12	356527	7.5	94
YG-2852	EC-138570	7.6	88
BW-496	357011	9.4	86

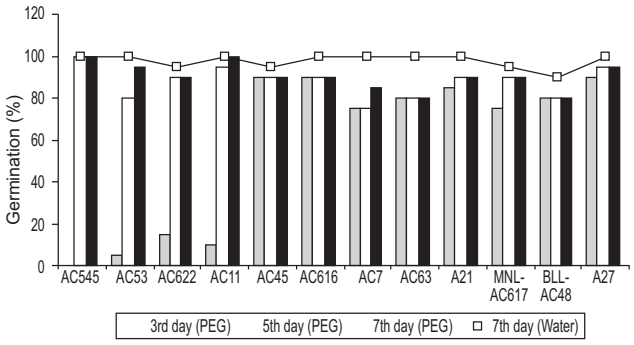


(a) Under 15% PEG osmoticum

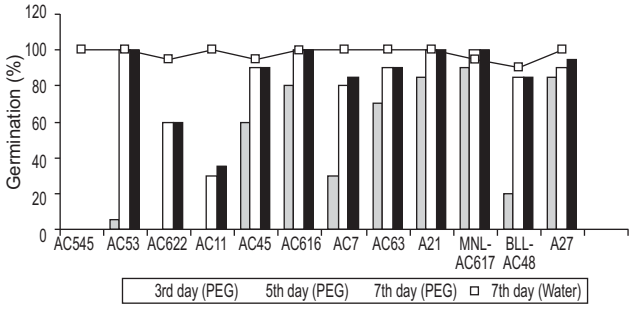


(b) Under 20% PEG osmoticum

Fig. 1. Variation in response to polyethylene glycol-simulated drought stress during germination in *G. hirsutum* germplasm lines



(a) Under 15% PEG osmoticum



(b) Under 20% PEG osmoticum

Fig. 2. Variation in response to polyethylene glycol-simulated drought stress during germination in *G. arboreum* germplasm lines

lines and it was high under 20% PEG concentration. The speed of germination observed by the total number of seeds germinated during the initial days also revealed the maximum germination percentage attained by 3rd to 5th day under both 15% and 20% PEG in all *G. arboreum* lines revealing them to be having high seed vigor and better speed of germination (Fig. 2). However, *G. hirsutum* lines showed a gradual germination distributed over

the seven days indicating a lower speed of germination (Fig. 1). The early emergence of *G. arboreum* and escape from drought stress due to higher reserve utilization efficiency has already been reported (Santhy *et al.*, 2009). The better PEG stress tolerance of *G. arboreum* and few lines of *G. hirsutum* may thus be a reliable indication as regards their ease of germination under comparatively adverse soil/water conditions which needs to be further ascertained.

References

Bibi N, A Hameed, H Ali, N Iqbal, MA Haq, BM Atta, TM Shah and SS Alam (2009) Water stress induced variations in protein profiles of germinating cotyledons from seedlings of chickpea genotypes *Pak. J. Bot.* **41:** 731–736.

Blum A (2008) Use of PEG to induce and control plant water deficit in experimental hydroponics' culture. http:/www.Plantstress.com/methods/PEG.htm

Burke J John and P J O'Mahony (2001) Protective role in acquired thermo tolerance of developmentally regulated heat shock proteins in cotton seeds. *J.Cotton Sci.* **5:** 174–183.

Florence Lasalita-Zapico, G M Janmichaelben and I P Michelle (2008) Physiological characterization for drought tolerance of selected rice varieties in Lake Sebu, Philippines *USM R & D J.* **16:** 13–16.

Nautiyal PC (2009) Seed and seedling vigor traits in cotton. *Seed Sci. Technol*. **37:** 721–735.

Noaman S. Hassan, Lamis D. Shaaben, El-Sayed A. Hashem and Eman E. Selem (2004) *In vitro* selection for water stress tolerant callus line of *Helianthus annuus* l. cv. Myak. *Int. J. Agric. Bot.* **6:** 13–18.

Norma L. Trolinder and Xaiomin Shang (1991) *In vitro* selection and regeneration of cotton resistant to high temperature stress. *Plant Cell Rep.* **10:** 448–452.

Samarah NH and RE Mullen (2006) Total soluble and dehydrin like proteins in full rounded and shriveled seeds of soybean in response to drought stress. *J. Food Agric. Environ.* **4:** 260–263.

Santhy V and RK Deshmukh (2008) Methanol stress test to evaluate initial seed vigor in cotton *Seed Res.* **36:** 78–81.

Santhy V, K Rathinavel, SM Palve and Vishwanathan (2009) Inter-relationships of seed reserve in desi cotton. *Indian J. Genet.* **69:** 69–71.

Sharma ML (1973) Simulation of drought and its effect on germination of five pasture species. *Agron. J*. **65:** 982–987.