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Effect of PEG Induced Stress on the Performance of Sunflower Hybrids

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Abstract

Sunflower is one of the important oil seed crops and its growth is severely affected if the stress occurs during germination. To examine the effect of stress at the time of germination, an experiment was conducted in different sunflower hybrids. Seeds were germinated in aluminium trays containing filter paper at different concentrations (-2, -4, -6, -8,-10, -12 bars) of poly ethylene glycol (PEG-6000), a high molecular weight compound creates stress in seed coat along with control where seeds were sown with water. Then the seedlings were transferred to field and observations on germination per cent, relative water content and water loss, shoot length and root length were recorded during the crop growth and grain yield was estimated after the harvest. Results showed that per cent germination decreased with the increase in the concentration of the PEG.. KBSH-1 and KBSH-41 showed highest germination per cent. KBSH-1 performed better at higher PEG concentration by maintaining leaf turgidity even under stress. KBSH-42 and KBSH-44 were shown to be sensitive to stress. KBSH-1 can be considered as stress tolerant after examining their consistency in performance.

Key words : Sunflower, Poly ethylene glycol (PEG-6000), Moisture stress, Relative water content, Relative water loss.

The sunflower (*Helianthus annuus* L.), belonging to the family Asteraceae is the world's fourth largest oil seeds crop (1). Being oil seed crop sunflower achene germination is particularly susceptible to water stress (2). Adequate water and nutrient supply are important factors affecting optimal plant growth and successful crop production. Water stress is one of the severe limitation of crop growth especially in arid and semi arid regions of the world as it has a vital role in germination, seedling growth and flowering which are critical stages for water stress (3). In sunflower, limited rainfall or shortage of water during growing season significantly reduces the germination. Therefore growing of drought tolerant cultivars will contribute to more stable sunflower production and screening of sunflower cultivars or breeding lines to drought stress can play a crucial role in breeding programs. Therefore, the present study was conducted with the objective, initially to determine the response of sunflower hybrids to drought stress at germination, seedling growth and their effect on grain yield, using PEG-6000. Hence this method can be used as screening criteria for drought tolerance in sunflower. Poly ethylene glycol (PEG-6000) a higher molecular weight compound creates stress in the outer layer of sunflower seeds by restricting the entry of water into the seeds during imbibition.

Methods

Promising sunflower hybrids (KBSH-1, KBSH-41, KBSH-42, KBSH-44, KBSH-53, KBSH-55 and KBSH-58) of University of Agricultural Sciences, Bangalore were used in two replications. Thirty seeds were germinated in aluminum trays with filter paper at -2 bars (119.57 g/l water), -4 bars (178.34 g/l), -6 bars (223.66 g/l), -8 bars (261.95g/l) and -14 bars (354.36 g/l) of PEG-6000 along with water as a control and maintained in laboratory. The appropriate treatment solution (PEG) was applied daily in each tray after washing the previous solution. Number of seeds germinated was counted and 8 days after germination, shoot length and root length of each hybrid were measured and all the seedlings were transplanted in the field separately and maintained in the field as per package of practice and watered as and when required.

During vegetative stage, relative water con-

Table 1. Effect of PEG-6000 on growth and yield in sunflower hybrids.

Treatments (bars)	Shoot length (cm)	Root length (cm)	RWC (%)	RWL (%)	Grain yield (g/pl)
		KBSH-1			
C	4.34	11.90	80.83	1.79	30.0
-2	3.16	11.38	77.08	2.14	36.0
-4	2.66	9.60	74.41	2.60	33.5
-6	2.60	5.78	73.76	2.71	30.7
-8	2.08	5.70	71.28	3.00	23.0
-10	1.00	4.90	70.59	7.74	27.0
-12	0.50	2.16	67.35	3.60	16.0
		KASH-41			
C	6.4	15	80.33	2.28	39.0
-2	4.6	12.3	78.37	2.96	38.0
-4	3.46	10.8	77.11	2.89	27.0
-6	2.24	7.24	76.94	3.06	23.2
-8	2	6.26	76.66	2.93	25.0
-10	1.12	5.52	76.44	3.09	17.0
-12	0.5	2.84	-	-	-
		KBSH-42			
C	5.94	15.66	73.96	1.66	30.0
-2	2.9	13	72.49	2.45	35.0
-4	2.5	9.22	72.47	2.32	21.0
-6	2.06	4.7	68.12	2.54	20.2
		KBSH-44			
C	4.28	9,04	78.75	2.07	42.5
-2	1.36	3.50	74.61	2.26	32.5
-4	1.14	2.76	67.75	2.43	25.5
		KBSH-53			
C	3.20	14.4	70.13	2.20	38.0
-2	2.16	10.2	70.75	1.98	33.0
-4	2.00	5.3	74.42	3.25	19.0
-6	1.44	4.8	77.34	2.80	21.3
-8	1.30	2.8	72.67	3.34	25.0
-10	0.47	1.67	68.63	3.84	23.0
		KBSH-55			
C	5.38	22.3	84.14	2.50	31.8
-2	3.22	19.7	76.09	2.41	39.0
-4	2.88	16.0	72	2.63	27.0
-6	1.84	7.94	70.75	2.69	31.0
-8	1.26	4.88	70.39	3.21	25.0
-10	0.48	2.8	64.65	3.34	21.0
		KBSH-58			
C	5.3	18	79.81	1.64	30.0
-2	3.5	12.2	76.92	2.38	23.0
-4	2.14	9.1	74.72	2.44	30.0
-6	2.08	7.3	71.21	2.74	16.0
-8	1.2	4.8	70.39	3.06	16.0
-10	0.8	2.34	68.13	3.14	16.0

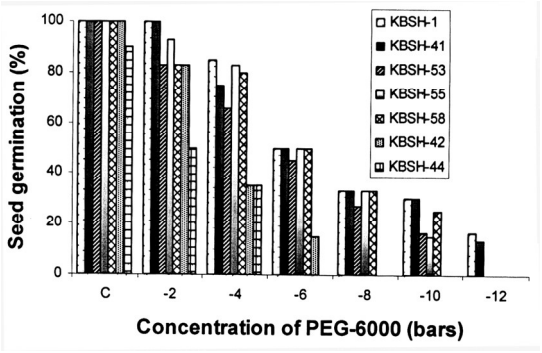

Figure 1. Effect of PEG-6000 on seed germination in sunflower hybrids.

tent (%) was measured by the method proposed by Slatyer and Barrs (4). Relative leaf water loss (RWL %) was also measured by removing the leaves along with petiole and kept in beaker containing water. Decline in fresh weight was measured over time (0, 1, 2, 3, 4, 5, 6 hr). After the harvest of the crop grain yield was estimated.

Results and Discussion

Results of the experiment showed that, seeds in control started germinating within two days. PEG induced stress resulted in delay in germination in all the hybrids. Increase in concentration of PEG-6000 in trays showed adverse effect on germination time. Time taken for seeds to germinate was from 5 days (-2 bars) to 10 days (-12 bars). KBSH-42 and KBSH-44 did not germinate from -8 bars and -6 bars, respectively. KBSH-1 and KBSH-41 showed highest germination per cen from -2 (100% to -12 bars (33%) (Fig. 1). In the later stages of the crop growth KBSH-41 grown at -12 bars did not survive in the field. The germination per cent was low for KBSH-53 (16.52%), KBSH-55 (15%) and KBSH-58 (25%) at -10 bars.

Results on shoot and root length at the time of transplanting showed that more root length was observed at less PEG concentration which was reduced at higher levels in all the hybrids. Though KBSH-53 and KBSH-55 seedlings were survived at -10 bars, the root and shoot length were reduced (Table 1).

Relative water content (RWC) was reduced with increase in PEG concentration. KBSH-1 and KBSH-41 maintained higher RWC even at -10 bars (70.59 and 76.44%, respectively) indicating that these hybrids maintain leaf turgidity even at stress. Similarly relative leaf water loss was more at higher PEG levels at different time intervals. It was relatively less in KBSH-41 (3.09%) compared to other hybrids.

At -10 bars, some hybrids like KBSH-1 (27 g/pl), KBSH-53 (23 g/pl) and KBSH-55 (21 g/pl) showed better yield. Even at high PEG concentration (-12 bars), the grain yield of KBSH-1 was 16.0 g/pl.

Over all results of this experiment indicate that KBSH-42 and KBSH-44 were sensitive to PEG induced water stress. KBSH-1 performed better at higher concentration by showing more resistance for water stress created by PEG, which was followed by KBSH-53, KBSH-55 and KBSH-41. These hybrids performed better by showing better germination per cent, seedling growth and grain yield. However, their consistency and performance need to be examined along with their parental lines.

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