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RESEARCH PAPER

Effect of PEG and mannitol to induce drought stress on seed quality and stand establishment in wheat (*Triticum aestivum* L.) genotypes

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Abstract : An experiment was conducted to study the screening of wheat (*Triticum aestivum* L.) genotypes for drought tolerance under laboratory condition during2018 at Department of Seed Science and Technology, College of Agriculture, Vijayapura. The experiment was carried out in a factorial Complete Randomized Block Design with seven treatments replicated three times. Twenty six wheat genotypes were screened for drought tolerance using 0, 15, 30, 60 per cent polyethylene ethylene glycol 6000 (PEG6000) and 1, 2, 5 per cent mannitol solutions. Data were recorded on various seedling parameters like germination percentage, root length, shoot length, seedling dry weight and seedling vigour index. The seedling traits showed a decreasing trend in response to increased concentrations of PEG6000 and mannitol. Wheat genotype DBW-110 (98.70 %) and C-306 (92.50 %) were found to be the best genotype for screened based on germination percentage at 15 per cent PEG6000 and 5 per cent mannitol. Wheat genotypes HI-1620 (6.7 cm) and NIAW-3212 (4.5 cm) produced maximum root length, respectively at higher concentrations of PEG6000 and mannitol. The genotype HI-1620 (6.4 cm, @ 15 %; 5.4 cm, @ 5 % mannitol) showed maximum shoot length. The genotype HD-2733, DBW-14, DBW-88 showed highest reduction of seedling parameters observed at increase in osmotic stress condition.

Key Words : Drought, Polyethylene glycol, Mannitol, Wheat, Genotypes

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INTRODUCTION

Wheat (*Triticum aestivum* L.) is an annual, self-pollinated crop and belonging to *Poaceae* family (grasses). Wheat crop is cultivated and considered as an essential staple food grain. This tribe contains about 35 genera including *Thinopyrum, Triticum*, *Dasypyrum, Aegilops, Secale and Lophopyrum.*

Drought tolerance is attribution of several anatomical, morphological and physiological characters, together constitutive and inducible which interact with growth maintenance and development process under edaphic and climatic conditions (Stephohkus *et al.,* 1980). Soil moisture stress resulting loss of turgor, which leading to decrease in stomatal conductivity, photosynthesis and grain yield (Sullivan and Ross, 1979).

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Drought can be induced by artificial molecule, like polyethylene glycol (PEG), which is used for the screening for drought tolerance at early stages. Polyethylene glycol molecules (PEG6000) are non-ionic, inert and virtually impermeable chains that have commonly been used to induce water stress without causing any physiological damage and maintain uniform water potential throughout an experimental periods and mimics dry soil (Lu and Neumann, 1998 and Veslues *et al*., 1998). The use of PEG thus, has become a popular technique to reduce water potential of nutrient solutions. Similarly mannitol is a polyhydric alcohol used as a causative agent of the drought osmotic stress in plants (Soetaert *et al.,* 1999).

Earlier reports on identification of the drought tolerant wheat genotypes using different concentrations of PEG 6000 have showed significant differences for different seedling traits (Rauf *et al.,* 2006 and Singh *et al.,* 2008). The seedling traits when pooled together could discriminate between drought tolerant and susceptible genotypes (Noorka and Khaliq, 2007). Therefore, the present investigation was carried out to evaluate germination characters and seedling growth of wheat as screening criteria against drought stress.

Material and Methods

The experiment was conducted at Seed Science and Technology laboratory, College of Agriculture, Vijayapura, University of Agricultural Sciences, Dharwad during 2018. An experiment consisted of total 182 treatment combinations involving 2 factors *viz.,* twenty six wheat genotypes and seven seed treatments (control, 15, 30, 60 % PEG6000 and 1, 2, 5% mannitol) with three replications.

Osmotic potentials were produced using different concentrations of polyethylene glycol 6000 (PEG6000) and mannitol as suggested by Michel and Kaufmann (1973). Emphasis on seedling morphology has little relationship with rapidity of growth and considered as a prime criterion of the potential for successful stand establishment. Clean and bold wheat seeds of each genotype were surface sterilized by soaking in 5 per cent of sodium hypochlorite (NaCl) solution for 10 minutes followed by washed with distilled water several times and blotted on fine quality filter paper. Seeds were then germinated in sterilized glass Petri dishes on filter paper under controlled condition (0), 15, 30 and 60 per cent PEG 6000 and 1, 2 and 5 per cent mannitol with respective treatment in three replications. Twenty seeds of wheat genotypes were placed in a Petri dish and covered to prevent the loss of moisture by evaporation and put into an incubator for eight days at 25/20 °C day/ night temperature. Seeds were considered as germinated when the emergent radical reached 2 mm length. Seed germination percentage was noted after 8 days of incubation and germination percentage was recorded. Shoot length, root length, seedling dry weight and seedling vigour were recorded.

Results and Discussion

The seed germination percentage was highly significant due to influence of different concentrations of PEG6000 and mannitol on wheat genotypes (Table 1). The genotype DBW-110 (98.70 %) noticed highest percentage of germination at PEG 15 per cent followed by HI-1620 (97.00 %) as compared to genotype DBW-14 (81.70 %). The genotype C-306 showed maximum germination percentage @ all levels of mannitol *i. e*., @ 1 per cent (98.30 %), @ 2 per cent (96.70 %) and @ 5 per cent (92.50 %). Minimum percentage of germination was noticed in the genotype DBW-14 (83.5 % @ 1 %, 80.00 % @ 2% and 75.30% @ 5% mannitol). The seed germination was adversely affected by moisture stress. The genotypes of wheat responded in a different way to various osmotic stress levels. Reduction in seed germination and seedling vigour under stress levels was due to occurrence of several metabolic disorders (Ayaz *et al*., 2000).The reduction in germination percentage and germination rate may be due to reduction in water absorption into the seeds at the time of seed turgescence and imbibitions (Hadas, 1977) and similar findings were also reported by Jatoi *et al.* (2014) in wheat cultivars.

The genotypes were significantly differed for root length at osmotic stress levels (Table 1).The superior radical length was recorded in the genotype HI-1620 (6.7 cm) @ 15 per cent PEG6000 followed by DBW-166 (6.6 cm) and DBW-110 (6.5 cm) when compared to DBW-14 (2.7 cm). The highest radical length was recorded @ 1 per cent (6.5 cm), 2 per cent (5.5 cm) and 5 per cent (4.5 cm) of mannitol in the genotype NIAW-3212. Minimum values of radical length was recorded for the genotype HD-2733 (2.5 cm @ 1 %) and DBW-14 (1.7 cm @ 2 % and 1.4 cm @ 5 %), respectively.

The genotypes were significantly differed for shoot length at osmotic stress levels (Table 2). The highest

Table 1: Effect of PEG 6000 and mannitol induced osmotic stress on germination per cent and root length of wheat genotypes

Sr. No.	Genotypes	Treatments							Mean	Treatments							Mean
		T_1	T_2	T_3	T_4	T_5	T_6	T_7		T_1	T_2	T_3	T_4	T_5	T_6	T_7	
1	BRW-3806	98.3 (82.6)*	93.3 (75.0)	0.0	0.0	94.7 (76.6)	91.7 (73.2)	86.7 (68.6)	66.4 (54.6)	5.9	5.8	0.0	0.0	5.8	4.6	3.5	3.6
2	C-306	100.0 (90.0)	95.3 (77.5)	0.0	0.0	98.3 (82.6)	96.7 (79.5)	92.5 (74.1)	69.0 (56.2)	5.8	5.7	0.0	0.0	5.7	4.9	4.2	3.8
3	DBW-14	91.7 (73.2)	81.7 (64.6)	0.0	0.0	83.5 (66.0)	80.0 (63.4)	75.3 (60.2)	58.9 (50.1)	5.3	2.7	0.0	0.0	2.6	1.7	1.4	2.0
4	DBW-88	98.3 (82.6)	83.3 (65.9)	0.0	0.0	85.0 (67.2)	81.7 (64.6)	80.7 (63.9)	61.3 (51.5)	4.5	3.1	0.0	0.0	3.9	1.8	1.5	2.1
5	DBW-110	97.7 (81.2)	98.7 (83.4)	0.0	0.0	95.3 (77.5)	92.0 (73.6)	91.7 (73.2)	68.0 (55.6)	6.9	6.5	0.0	0.0	6.1	5.3	3.6	4.0
6	DBW-166	98.3 (82.6)	96.3 (79.0)	0.0	0.0	94.3 (76.2)	93.3 (75.0)	91.3 (72.9)	67.6 (55.3)	6.7	6.6	0.0	0.0	5.0	4.3	2.9	3.6
7	GW-477	100.0 (90.0)	95.3 (77.5)	0.0	0.0	91.7 (73.2)	89.3 (70.9)	88.7 (70.3)	66.4 (54.6)	5.1	5.0	0.0	0.0	5.5	5.3	4.4	3.6
8	HD-2733	98.3 (82.6)	83.7 (66.2)	0.0	0.0	83.7 (66.2)	80.0 (63.4)	73.8 (59.2)	59.9 (50.7)	6.2	3.8	0.0	0.0	2.5	2.1	1.8	2.3
9	HI-1620	98.3 (82.6)	97.0 (80.0)	0.0	0.0	93.3 (75.0)	88.3 (70.0)	86.7 (68.6)	66.2 (54.5)	6.9	6.7	0.0	0.0	5.1	4.7	4.5	4.0
10	HI-1628	90.0 (71.6)	90.0 (80.0)	0.0	0.0	91.0 (72.5)	89.7 (71.2)	88.3 (70.0)	64.1 (53.2)	5.1	3.8	0.0	0.0	4.8	4.5	3.8	3.2
11	HW-1235	98.3 (82.6)	85.8 (71.6)	0.0	0.0	91.7 (73.2)	88.3 (70.0)	84.7 (66.9)	64.1 (53.2)	5.4	5.2	0.0	0.0	4.9	4.8	4.0	3.5
12	JWS-810	98.3 (82.6)	91.7 (67.8)	0.0	0.0	92.3 (73.9)	86.7 (68.6)	85.0 (67.2)	64.9 (53.6)	5.3	5.2	0.0	0.0	4.2	3.7	3.4	3.1
13	K-1317	93.3 (75.0)	90.3 (73.2)	0.0	0.0	90.0 (71.6)	86.6 (68.6)	86.7 (68.6)	63.9 (53.0)	5.7	5.3	0.0	0.0	5.1	4.2	4.0	3.5
14	M-516	96.7 (79.5)	85.0 (71.9)	0.0	0.0	88.3 (70.0)	87.0 (68.9)	86.7 (68.6)	63.4 (52.8)	5.5	5.3	0.0	0.0	4.3	3.9	3.3	3.2
15	MACS-6695	95.0 (77.1)	93.3 (67.2)	0.0	0.0	93.3 (75.0)	89.7 (71.2)	88.3 (70.0)	65.7 (54.1)	5.4	5.2	0.0	0.0	4.8	4.2	3.3	3.3
16	MACS-6696	96.7 (79.5)	91.0 (75.0)	0.0	0.0	90.0 (71.6)	83.3 (65.9)	80.0 (63.4)	63.0 (52.5)	5.3	5.0	0.0	0.0	5.1	3.8	2.6	3.1
17	MP-1331	96.7 (79.5)	95.0 (72.5)	0.0	0.0	93.7 (75.4)	88.8 (70.5)	85.0 (67.2)	65.6 (54.1)	5.4	5.6	0.0	0.0	4.8	4.4	3.1	3.3
18	MP-3288	90.0 (71.6)	89.7 (71.2)	0.0	0.0	89.3 (70.9)	84.0 (66.4)	82.0 (64.9)	62.1 (52.0)	6.5	5.2	0.0	0.0	5.0	4.6	3.8	3.6
19	NI-5439	96.7 (79.5)	94.7 (76.6)	0.0	0.0	93.3 (75.0)	91.7 (73.2)	89.0 (70.6)	66.5 (54.6)	6.0	5.7	0.0	0.0	4.9	4.5	3.6	3.5
20	NIAW-3170	93.3 (75.0)	92.0 (73.6)	0.0	0.0	89.7 (71.2)	86.7 (68.6)	85.0 (67.2)	63.8 (53.0)	4.2	3.8	0.0	0.0	4.4	3.4	3.0	2.7
21	NIAW-3212	95.0 (77.1)	94.3 (76.2)	0.0	0.0	96.0 (78.5)	90.0 (71.6)	88.3 (70.0)	66.2 (54.5)	6.7	4.6	0.0	0.0	6.5	5.5	4.5	4.0

Table 1 : Contd……

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22	RIL-SI-38	98.3 (82.6)	93.3 (75.0)	0.0	0.0	93.3 (75.0)	91.7 (73.2)	88.3 (70.0)	88.3 (54.6)	5.3	5.2	0.0	0.0	4.4	4.2	3.1	3.2
23	RW-5	95.0 (77.1)	95.0 (77.1)	0.0	0.0	94.0 (75.8)	91.7 (73.2)	88.3 (70.0)	88.3 (54.5)	6.6	5.3	0.0	0.0	5.2	4.6	3.9	3.6
24	UAS-347	98.3 (82.6)	91.0 (72.5)	0.0	0.0	90.0 (71.6)	86.7 (68.6)	81.7 (64.6)	81.7 (53.1)	4.7	4.5	0.0	0.0	4.3	4.4	3.0	3.0
25	UAS-375	96.7 (79.5)	90.0 (71.6)	0.0	0.0	90.0 (71.6)	87.0 (68.9)	83.7 (66.2)	83.7 (53.1)	5.1	5.0	0.0	0.0	4.6	3.7	3.2	3.1
26	UAS-446	95.0 (77.1)	86.7 (68.6)	0.0	0.0	88.3 (70.0)	86.7 (68.6)	83.3 (65.9)	83.3 (52.5)	4.8	4.6	0.0	0.0	3.7	3.5	2.7	2.8
Mean		95.3 (78.9)	88.9 (72.8)	0.0	0.0	90.6 (72.9)	87.4 (69.8)	85.4 (67.6)	83.6 (53.5)	5.6	5.0	0.0	0.0	4.7	4.1	3.3	3.3
			S.E.±				C.D. (P=0.01)				S.E.±				C.D. (P=0.01)		
Genotype (A)			0.38				1.39				0.04				0.15		
Teatment (B)			0.20				0.72				0.02				0.08		
A×B			1.00				3.67				0.11				0.40		

Note:* Figures in the parenthesis indicate arcsine values
T_1: Control T_2: PEG 6000 @ 15 % T_3: PEG 6000@ 30 % T_4: PEG 6000 @ 60 % T_5: Mannitol @ 1 % T_6: Mannitol @ 2 % T_7: Mannitol @ 5 %

shoot length was noticed in the genotype HI-1620 (6.4 cm) as followed by BRW-3806 (6.0 cm) @ 15 per cent PEG6000 when compare to DBW-14 (3.1 cm). The greater shoot length was noticed in the genotype BRW-3806 (6.9 cm @ 1% and 6.7 cm @ 2% mannitol). At 5 per cent of mannitol, the genotype HI-1620 (5.4 cm) noticed highest value of shoot length followed by BRW-3806 (4.8 cm). Lowest value of shoot length was noticed in the genotype DBW-88 @ 1 per cent (3.6 cm), 2 per cent (3.0 cm) and HD-2733 @ 5 per cent (2.7 cm) of mannitol.

The decline in the root length and shoot length were due to an impediment of cell division and elongation, leading to a kind of tuberization. This tuberization and lignifications of the root system allow the water stress plant to enter a slow down state, while waiting for the conditions to become favourable supported by Fraser *et al.* (1990).Similarly, root length and shoot length of wheat genotypes were reduced with increase in concentrations of osmotic stress due to an inhibition of cell division and elongation supported by Fraser *et al*. (1990).

The wheat genotypes were induced through osmotic stress potential found significantly superior in seedling dry weight (Table 3). The genotype HI-1620 (401.30 mg @ 15 %PEG6000, 473.3 mg @ 1 %, 416.7 mg @ 2 % and 395.0 mg @ 5 % of mannitol) followed by GW-477 was superior in respect to seedling dry weight. Minimum value of seedling dry weight was recorded in DBW-14 (229.00 mg and 250.00 mg) at osmotic potential of 15 per cent PEG6000 and all the stress levels of mannitol. The decline in seedling dry weight was mainly attributed to length of the seedling was lesser with increased osmotic stress level. The similar finding was reported by Ming *et al.* (2012); Mouchesh *et al*. (2012); Saghafikhadem (2012) and Sassi *et al.* (2012).

All the wheat genotypes were significantly superior for seedling vigour index under different concentration of PEG6000 and mannitol (Table 3). Maximum seedling vigour index was noticed in the genotype HI-1620 (39) @ 15 per cent PEG6000 followed by C-306 (38) while compared to DBW-14 (19). The genotype HI-1620 recorded highest seedling vigour index @ 1 per cent (44), 2 per cent (37) and 5 per cent (35) of mannitol followed by GW-477. Lowest value of seedling vigour index was recorded in the genotype DBW-14 (26 @ 1 %, 21 @ 2 % and 19 @ 5 %). As increase in concentrations of artificial drought inducer PEG6000 and mannitol, overall reduction in seedling vigour index was observed due to physiological disorder. These results are in agreement with the findings of Raziuddin *et al*. (2010).

Table 2: Effect of PEG 6000 and mannitol induced osmotic stress on shoot length (cm) and seedling length (cm) of wheat genotypes

Sr. No.	Genotypes	Treatments							Mean	Treatments							Mean
		T_1	T_2	T_3	T_4	T_5	T_6	T_7		T_1	T_2	T_3	T_4	T_5	T_6	T_7	
1.	BRW-3806	8.5	6.0	0.0	0.0	6.9	6.7	4.8	4.7	14.4	11.8	0.0	0.0	12.7	11.4	8.2	8.3
2.	C-306	7.7	5.8	0.0	0.0	5.9	4.9	4.0	4.0	13.5	11.5	0.0	0.0	11.5	9.8	8.2	7.8
3.	DBW-14	8.8	3.1	0.0	0.0	4.7	4.2	3.5	3.5	14.2	5.8	0.0	0.0	7.3	5.9	4.9	5.4
4.	DBW-88	6.3	3.2	0.0	0.0	3.6	3.0	2.8	2.7	10.8	6.3	0.0	0.0	7.5	4.7	4.3	4.8
5.	DBW-110	7.3	4.7	0.0	0.0	5.6	4.6	4.3	3.8	14.2	11.2	0.0	0.0	11.6	9.8	7.9	7.8
6.	DBW-166	7.6	4.0	0.0	0.0	5.7	4.6	4.4	3.8	14.3	10.6	0.0	0.0	10.7	8.8	7.3	7.4
7.	GW-477	8.4	5.2	0.0	0.0	6.5	6.4	4.7	4.5	13.5	10.2	0.0	0.0	12.0	11.8	9.2	8.1
8.	HD-2733	7.9	3.2	0.0	0.0	3.8	3.5	2.7	3.0	14.1	7.0	0.0	0.0	6.3	5.6	4.6	5.4
9.	HI-1620	7.1	6.4	0.0	0.0	6.4	6.0	5.4	4.5	14.0	13.1	0.0	0.0	11.4	10.7	9.9	8.4
10.	HI-1628	9.3	4.6	0.0	0.0	5.6	5.1	4.5	4.1	14.4	8.4	0.0	0.0	10.4	9.6	8.3	7.3
11.	HW-1235	7.5	5.7	0.0	0.0	5.3	4.2	3.9	3.8	12.9	10.9	0.0	0.0	10.2	9.0	7.9	7.3
12.	JWS-810	6.5	5.2	0.0	0.0	3.7	3.5	3.3	3.2	11.8	10.4	0.0	0.0	7.9	7.2	6.6	6.3
13.	K-1317	5.7	3.8	0.0	0.0	5.7	5.1	3.2	3.4	11.5	9.0	0.0	0.0	10.8	9.3	7.2	6.8
14.	M-516	5.6	4.4	0.0	0.0	4.0	3.5	3.4	3.0	11.1	9.7	0.0	0.0	8.3	7.4	6.7	6.2
15.	MACS-6695	7.3	4.7	0.0	0.0	5.5	4.8	4.5	3.8	12.7	9.9	0.0	0.0	10.3	9.0	7.8	7.1
16.	MACS-6696	7.5	4.0	0.0	0.0	5.7	3.9	3.6	3.5	12.7	9.0	0.0	0.0	10.8	7.6	6.2	6.6
17.	MP-1331	5.9	4.8	0.0	0.0	5.1	4.8	3.9	3.5	11.3	10.4	0.0	0.0	9.9	9.2	7.0	6.8
18.	MP-3288	8.1	5.0	0.0	0.0	5.1	5.0	4.0	3.9	14.6	10.2	0.0	0.0	10.1	9.6	7.8	7.5
19.	NI-5439	7.8	4.9	0.0	0.0	5.1	4.5	4.2	3.8	13.8	10.7	0.0	0.0	10.0	9.1	7.7	7.3
20.	NIAW-3170	4.3	3.7	0.0	0.0	6.1	3.8	3.4	3.1	8.6	7.5	0.0	0.0	10.5	7.3	6.4	5.7
21.	NIAW-3212	9.9	5.0	0.0	0.0	6.8	5.5	3.8	4.4	16.6	9.6	0.0	0.0	13.3	11.0	8.3	8.4
22.	RIL-SI-38	8.0	5.0	0.0	0.0	7.9	6.3	2.9	4.3	13.4	10.2	0.0	0.0	12.3	10.5	6.0	7.5
23.	RW-5	5.3	4.6	0.0	0.0	5.6	5.3	4.5	3.6	11.9	9.8	0.0	0.0	10.8	9.8	8.4	7.2
24.	UAS-347	7.4	4.3	0.0	0.0	6.0	3.9	3.4	3.6	12.1	8.7	0.0	0.0	10.4	8.4	6.4	6.6
25.	UAS-375	6.3	4.5	0.0	0.0	4.7	4.5	4.2	3.5	11.3	9.6	0.0	0.0	9.3	8.2	7.4	6.5
26.	UAS-446	7.6	3.8	0.0	0.0	4.5	4.0	3.6	3.4	12.4	8.5	0.0	0.0	8.2	7.5	6.3	6.1
Mean		7.3	4.6	0.0	0.0	5.5	4.7	3.9	3.7	12.9	9.6	0.0	0.0	10.2	8.8	7.2	7.0
		S.E.±			C.D. (P=0.01)					S.E.±			C.D. (P=0.01)				
Genotype (A)		0.06			0.21					0.08			0.28				
Teatment (B)		0.03			0.11					0.04			0.14				
A×B		0.15			0.56					0.20			0.73				

Table 3: Effect of PEG 6000 and mannitol induced osmotic stress on seedling dry weight (mg) and seedling vigour index of wheat genotypes

Sr. No.	Genotypes	Treatments							Mean	Treatments							Mean
		T_1	T_2	T_3	T_4	T_5	T_6	T_7		T_1	T_2	T_3	T_4	T_5	T_6	T_7	
1.	BRW-3806	363.3	330.0	0.0	0.0	387.0	360.0	316.7	251.0	36	31	0	0	37	33	27	23
2.	C-306	483.3	350.0	0.0	0.0	396.7	326.7	323.3	268.6	48	38	0	0	40	32	30	27
3.	DBW-14	416.7	229.0	0.0	0.0	309.0	264.7	250.0	209.9	38	19	0	0	26	21	19	18
4.	DBW-88	336.7	350.0	0.0	0.0	356.7	333.3	313.3	228.1	35	30	0	0	26	25	22	20
5.	DBW-110	436.7	320.0	0.0	0.0	373.3	336.7	290.0	241.4	37	37	0	0	34	31	29	24
6.	DBW-166	360.0	356.7	0.0	0.0	310.0	303.3	266.7	251.0	43	37	0	0	35	31	26	25
7.	GW-477	533.3	300.0	0.0	0.0	470.0	410.0	385.0	299.8	53	35	0	0	43	37	34	29
8.	HD-2733	436.7	365.0	0.0	0.0	453.3	306.7	255.0	259.5	43	27	0	0	38	25	19	22
9.	HI-1620	480.0	401.3	0.0	0.0	473.3	416.7	395.0	309.5	47	39	0	0	44	37	35	29
10.	HI-1628	426.7	372.0	0.0	0.0	396.7	326.0	311.4	261.8	38	32	0	0	35	29	28	23
11.	HW-1235	373.3	363.3	0.0	0.0	414.0	323.3	283.3	251.0	37	30	0	0	35	29	24	22
12.	JWS-810	443.3	336.7	0.0	0.0	333.3	363.3	280.0	251.0	44	31	0	0	31	28	24	22
13.	K-1317	563.3	370.0	0.0	0.0	458.7	341.7	313.3	292.4	53	32	0	0	33	30	27	25
14.	M-516	363.3	313.3	0.0	0.0	356.7	333.3	330.0	242.4	35	29	0	0	32	29	29	22
15.	MACS-6695	480.0	353.3	0.0	0.0	380.0	350.0	337.7	271.6	46	34	0	0	37	31	30	25
16.	MACS-6696	456.7	369.0	0.0	0.0	412.7	402.7	280.0	274.4	44	32	0	0	32	28	22	23
17.	MP-1331	360.0	324.0	0.0	0.0	353.3	316.7	290.0	234.9	36	35	0	0	36	31	26	23
18.	MP-3288	480.0	340.0	0.0	0.0	350.7	341.3	314.7	261.0	43	30	0	0	31	29	26	23
19.	NI-5439	470.0	334.3	0.0	0.0	350.0	330.0	263.3	249.7	45	34	0	0	34	30	23	24
20.	NIAW-3170	356.7	373.3	0.0	0.0	376.7	360.0	346.7	259.0	35	34	0	0	32	31	29	23
21.	NIAW-3212	480.0	373.3	0.0	0.0	330.0	316.7	336.7	262.4	46	35	0	0	34	31	30	25
22.	RIL-SI-38	470.0	313.3	0.0	0.0	356.7	336.7	296.7	253.3	35	31	0	0	30	28	27	22
23.	RW-5	356.7	333.3	0.0	0.0	320.0	307.7	303.3	231.6	45	37	0	0	35	33	30	26
24.	UAS-347	570.0	373.3	0.0	0.0	390.0	386.7	270.0	284.3	56	34	0	0	33	30	27	26
25.	UAS-375	380.0	358.7	0.0	0.0	423.3	333.3	380.0	267.9	37	32	0	0	30	28	27	22
26.	UAS-446	440.0	373.3	0.0	0.0	400.0	333.3	276.7	260.5	42	31	0	0	32	29	24	23
	Mean	7.3	4.6	0.0	0.0	5.5	4.7	3.9	3.7	42	32	0	0	34	30	27	24
			S.E.±				C.D. (P=0.01)				S.E.±				C.D. (P=0.01)		
	Genotype (A)		0.06				0.21				2.37				8.66		
	Teatment (B)		0.03				0.11				1.23				4.49		
	A×B		0.15				0.56				6.26				22.91		

Conclusion:

The decrease in percentage of germination was observed with the increase in levels of PEG at 15 per cent and 1, 2, 5 per cent of mannitol. But there was no germination observed at 30 and 60 per cent of PEG 6000 in all the genotypes. The higher percentage of germination was seen in the genotypes C-306, HI-1620, GW-477, DBW-110, DBW-166, MACS-6695, MP-1331, NIAW-3212, NI-5439 and RW-5were reflecting drought tolerance characteristics. The significant difference was found in all genotypes of wheat. Overall, with increase in the concentration of drought stress inducer PEG6000 and mannitol there was reduction in seedling quality parameters was observed.

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