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Effect of Polyethylene Glycol Induced Water Stress on Germination and Seedling Growth of Wheat (*Triticum aestivum*)

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Abstract

The performance of twenty wheat genotypes under Polyethylene Glycol (PEG) induced water stress during germination and early seedling growth stages were tested under three levels of water potential i) Control (Tap water), ii) -2 bars and iii) -4 bar at the Crop Physiology and Ecology Laboratory of Hajee Mohammad Danesh Science and Technology University, Dinajpur during September 2014 to October 2014. Rate of germination and vigor index of all wheat genotypes were delayed with the increment of water stress induced by PEG. Shoot and root lengths and seedling dry weight of 10 days old seedlings were found to be reduced due to the increment of water stress. However, the degree of reduction of these parameters with the increment of water stress was not similar for all wheat genotypes. Stress tolerance index (STI) based on seedling dry weight indicated a wide difference in stress tolerance among the wheat genotypes. At moderate water deficit stress, BARI Gom 25, E 34, E 28 and BAW 1170 showed more stress tolerance and the wheat genotypes- Sourav, E 23 and BAW 1140 showed greater stress sensitivity than the other wheat genotypes. At higher water deficit stress, BARI Gom 25, BARI Gom 28, E 28 and BAW 1170 showed more stress tolerance and the wheat genotypes- Satabdi, Sourav, BARI Gom 26, E 23, E 38, E 24, BAW 1163, BAW 1140 and BAW 1151 showed greater stress sensitivity than the others. Considering both moderate and high water deficit stress, BARI Gom 25, E 28 and BAW 1170 were found as tolerant and Sourav, E 23 and BAW 1140 were found as water deficit stress sensitive wheat genotypes.

Key words: PEG, Stress tolerance index, germination characteristics and wheat.

1. Introduction

Wheat (*Triticum aestivum*), next to rice is the staple food of the peoples of Bangladesh grown over an area of 0.43 million hectare with an annual production of about 1.303 million metric tons at average of3.03 t ha^{-1} (Anonymous, 2014). Its consumption has been increasing with changing food habit in our country. The average production of this crop in Bangladesh is low compared to other wheat growing countries because wheat is mainly grown under non-irrigated conditions during the dry winter (November to April) in Bangladesh (Hossain and Silva, 2013). Although the vast storage of soil moisture resulted from monsoon rain supports the plant growth favorably at the early stages of growth, the plant suffers from water stress at the reproductive stage when the residual soil moisture depletes (Lopez *et al.*, 2003).

Polyethylene glycol widely used to induce water stress in plants is a non-ionic water soluble polymer which is not expected to penetrate into cells (Djibril *et al.,* 2005). Selection for drought tolerance at early stage of seedlings is most frequently practiced using poly ethylene glycol (PEG 6000) in the medium (Rauf *et al.,* 2006). 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, Singh *et al.,* 2008). The seedling traits when pooled together could discriminate between drought tolerant and susceptible genotypes (Noorka and Khaliq, 2007). Therefore, to expand wheat cultivation and to sustain wheat yield under drought prone areas the present investigation was carried out to evaluate germination characters and seedling growth of wheat as screening criteria against drought stress.

2. Materials and Methods

2.1 Location and duration

The experiment was conducted at Crop Physiology and Ecology Laboratory, Hajee Mohammad Danesh Science and Technology University, Dinajpur during September 2014 to October 2014.

2.2 Experimental design and treatments

The experiment was carried out in completely randomized design (factorial) with three replications. One factor consisted of three levels of water potential- Control (Tap water), moderate stress (-2 bars induced PEG 6000) and higher stress (-4 bars induced by PEG 6000) and the other factor consisted of twenty wheat genotypes including advance lines and popular varieties (Table 1).

2.3 Collection and placement of seed

Seeds of twenty wheat genotypes (Table 1) collected from Wheat Research Centre of BARI, Dinajpur, Bangladesh were surface sterilized by dipping the seeds in 0.1% mercuric chloride solution for 2 minutes and rinsed thoroughly with sterilized water. Required amount of PEG 6000 was dissolved in tap water as described by (Michel, 1983) to develop -2 bars and -4 bar water potential. Thirty seeds of each genotype were placed for germination in 11cmpetridish on sand bed irrigated with respective treatments. The petridishes were irrigated daily with required amount (5 ml) of respective solution. Each treatment was replicated thrice. Seedlings were allowed to grow up to 7 days after placement for germination.

2.4 Data recorded and analysis

Germination was counted at 24-hour interval and continued upto 7^{th} day (168 hrs). A seed was considered germinated as plumule and radicle came out and were >2 mm long. The rate of germination was calculated using the formula as described by Krishnasamy and Seshu (1990) and co-efficient of germination and vigor index were calculated using the formulae as described by Copeland (1976). At 7th day after placement for germination, all other seedlings were removed from each petridish keeping 10 healthy seedlings and allowed to grow upto 10 days by adding required amount (5 ml) of respective solution daily. At 10 days after placement for germination, five seedlings from each petridish were sampled. Shoot and root length of individual seedling were recorded manually with scale. Then the seedlings were dried separately at 70^0C for 72 h in an electric oven (Model- E28# 03-54639, Binder, Germany) and weight were recorded with an electrical balance (Model- EK-300 i). The mean length (cm) and dry weight were recorded for each treatment combination. Stress tolerance index was calculated as Goudarzi and Pakniyat (2008). The data were analyzed by partitioning the total variance with the help of computer using MSTAT program.

3. Results and Discussion

3.1 Germination character

3.1.1 Rate of germination

Rate of germination which indicates the speed of germination was significantly influenced by the interaction effect of water potential levels and wheat genotypes during germination (Table 2). Rate of germination was higher at control (with a range from 82.66 in BAW 1170 to 98.66 in Satabdi and BARI Gom 27 and a mean of 93.28), moderate at moderate stress (with a range from 77.00 in BAW 1140 to 95.66 in E 34 and a mean of 88.36) and lower at higher water deficit stress (with a range from 63.33 in BAW 1140 to 91.33 in E 34 and a mean of 81.44). The results of Table 2 showed that the speed of germination was reduced with the increment of water deficit stress but the degree of reduction in rate of germination was not similar for all wheat genotypes at moderate and higher water deficit stress compared to control. At moderate water deficit stress, wheat genotypes- BARI Gom 25, BARI Gom 26, BARI Gom 28, E 30, E 2, E 24, E 34, BAW 1138, BAW 1170 and BAW 1151 showed less than 5% reduction and wheat genotypes- Satabdi, Sourav, BARI Gom 27, E 23, E 38, E 28, BAW 1171, BAW 1157, BAW 1163 and BAW 1140 showed more than 5% reduction in rate of germination compared to control. At higher water deficit stress, wheat genotypes- Sourav, BARI Gom 25, BARI Gom 26, E 30, E 2 and E 34 showed less 10% reduction and wheat genotypes- Satabdi, BARI Gom 27, BARI Gom 28, E 23, E 38, E 24, E 28, BAW 1138, BAW 1171, BAW 1170, BAW 1157, BAW 1163, BAW 1140 and BAW 1151 showed more than 10% reduction in rate of germination compared to control.

3.1.2 Germination vigor index

Different levels of water potential interacted significantly to wheat genotypes in influencing vigor index which also expresses the speed of germination (Table 2).

Table 1. List of wheat genotypes used for the present study

Sl. No.	Genotypes	Remarks
1.	Shatabdi	Variety
2.	Sourab	Variety
3.	BARI Gom 25	Variety
4.	BARI Gom 26	Variety
5.	BARI Gom 27	Variety
6.	BARI Gom 28	Variety
7.	E 30	Advanced line
8.	E 23	Advanced line
9.	E 2	Advanced line
10.	E 38	Advanced line
11.	E 24	Advanced line
12.	E 34	Advanced line
13.	E 28	Advanced line
14.	BAW1138	Advanced line
15.	BAW1170	Advanced line
16.	BAW1157	Advanced line
17.	BAW1157	Advanced line
18.	BAW1163	Advanced line
19.	BAW1140	Advanced line
20.	BAW1151	Advanced line

Table 2. Rate of germination and vigor index of different wheat genotypes as influenced PEG induced water deficit stress

Genotypes	Rate of germination (mean ± SE)			Vigor index (mean ± SE)		
	Control (Tap water)	Moderate stress (- 2bar)	Higher stress (- 4bar)	Control (Tap water)	Moderate stress (- 2bar)	Higher stress (- 4bar)
Satabdi	98.66±1.70	93.00±1.09 (-5.74)	87.33±2.18 (-11.48)	43.32±1.83	37.49±1.28 (-13.46)	36.88±0.87 (-14.87)
Sourav	90.00±1.01	83.33±1.49 (-7.41)	82.66±1.47 (-8.16)	36.47±0.48	34.17±2.17 (-6.31)	33.97±0.48 (-6.86)
BARI Gom 25	97.33±3.05	94.66±0.62 (-2.74)	88.66±4.98 (-8.91)	38.98±0.91	38.02±1.00 (-2.46)	37.73±0.91 (-3.21)
BARI Gom 26	97.33±2.40	94.33±1.41 (-3.08)	88.00±1.56 (-9.59)	41.48±0.87	37.57±0.34 (-9.43)	37.22±0.34 (-10.27)
BARI Gom 27	98.66±2.00	89.33±2.33 (-9.46)	86.66±4.00 (-12.16)	38.94±1.00	38.47±1.28 (-1.21)	37.96±0.18 (-2.52)
BARI Gom 28	93.66±1.33	91.66±6.67 (-2.14)	78.66±2.60 (-16.02)	38.93±1.25	36.87±0.91 (-5.29)	34.03±0.34 (-12.59)
E 30	94.33±0.54	93.00±0.77 (-1.41)	89.66±0.83 (-4.95)	42.76±2.17	40.86±0.72 (-4.44)	36.01±0.87 (-15.79)
E 23	94.00±1.14	86.66±2.60 (-7.81)	83.33±1.20 (-11.35)	39.62±0.34	37.43±1.25 (-5.53)	34.94±0.76 (-11.81)
E 2	91.00±0.83	89.66±0.54 (-1.47)	85.00±0.77 (-6.59)	41.59±0.18	40.51±0.76 (-2.60)	36.71±0.18 (-11.73)
E 38	90.66±0.77	85.28±0.11 (-5.93)	71.88±0.83 (-20.71)	38.01±0.18	33.77±0.18 (-11.15)	32.76±0.48 (-13.81)
E 24	94.66±1.14	92.66±1.67 (-2.11)	85.00±1.14 (-10.20)	37.99±1.00	36.78±1.00 (-3.19)	36.38±0.34 (-4.24)
E 34	97.00±0.77	95.66±0.54 (-1.38)	91.33±0.77 (-5.85)	39.69±0.48	37.28±0.87 (-6.07)	35.78±0.18 (-9.85)
E 28	97.33±0.83	88.00±0.11 (-9.59)	77.33±1.20 (-20.55)	40.04±2.11	37.47±1.28 (-6.42)	34.93±0.34 (-12.76)
BAW1138	92.66±2.60	90.66±1.14 (-2.16)	83.33±2.60 (-10.07)	40.45±0.48	36.89±0.76 (-8.80)	35.91±1.00 (-11.22)
BAW1171	97.33±0.83	89.33±0.77 (-8.22)	87.33±0.54 (-10.27)	43.62±1.25	40.27±1.00 (-7.68)	33.71±2.11 (-22.72)
BAW1170	82.66±1.67	80.66±2.60 (-2.42)	70.00±0.11 (-15.32)	40.81±0.72	38.72±0.34 (-5.12)	35.90±1.25 (-12.03)
BAW1157	91.33±1.20	83.00±0.54 (-9.12)	80.66±1.14 (-11.68)	40.04±0.72	36.55±1.00 (-8.72)	33.89±0.18 (-15.36)
BAW1163	87.33±0.11	81.33±0.83 (-6.87)	73.66±1.20 (-15.65)	34.50±1.00	29.00±2.11 (-15.94)	26.29±0.76 (-23.80)
BAW1140	90.33±1.20	77.00±1.14 (-14.76)	63.33±2.60 (-29.89)	40.34±0.76	33.23±1.25 (-17.63)	27.75±2.11 (-31.21)
BAW1151	89.33±0.83	88.00±0.54 (-1.49)	75.00±1.67 (-16.04)	38.06±0.72	37.02±1.00 (-2.73)	34.31±1.28 (-9.85)
CV (%)		2.08			1.65	
Significance level		**			**	

Value within parenthesis indicates percent reduction from control, SE=standard error

Table 3. Shoot length (cm) and root length (cm) of different wheat genotypes as influenced PEG induced water deficit stress

Genotypes	Shoot length (mean ± SE)			Root length (mean ± SE)		
	Control (Tap water)	Moderate stress (- 2bar)	Higher stress (- 4bar)	Control (Tap water)	Moderate stress (- 2bar)	Higher stress (- 4bar)
Satabdi	23.18±0.37	17.41± 0.15 (-24.89)	12.88± 0.39 (-44.43)	10.72± 0.18	9.93± 0.17 (-7.37)	8.86± 0.31 (-17.35)
Sourav	23.78±0.43	15.43± 0.29 (-35.11)	10.72± 0.37 (-54.92)	11.74± 0.20	10.80± 0.08 (-8.01)	8.44± 0.28 (-28.11)
BARI Gom 25	20.73±0.15	17.74± 0.15 (-14.42)	14.72± 0.08 (-28.99)	11.94± 0.09	11.50± 0.31 (-3.69)	10.46±0.18 (-12.40)
BARI Gom 26	21.71±0.37	15.85± 0.32 (-26.99)	10.72± 0.13 (-50.62)	12.44± 0.17	10.72± 0.20 (-13.83)	9.16± 0.17 (-26.37)
BARI Gom 27	23.63±0.32	18.54± 0.28 (-21.54)	8.92± 0.37 (-62.25)	13.88± 0.28	12.10± 0.18 (-12.82)	10.8± 0.40 (-22.19)
BARI Gom 28	17.43±0.39	13.53± 0.08 (-22.37)	8.25± 0.43 (-52.67)	12.10± 0.18	11.15± 0.31 (-7.85)	8.38± 0.08 (-30.74)
E 30	22.26±0.37	17.83± 0.29 (-19.90)	10.41± 0.15 (-53.23)	10.90± 0.20	10.00± 0.40 (-8.26)	9.82± 0.20 (-9.91)
E 23	19.78±0.37	15.42± 0.13 (-22.04)	10.33± 0.39 (-47.77)	11.96± 0.17	11.58± 0.13 (-3.18)	11.34±0.28 (-5.18)
E 2	17.43±0.43	15.85± 0.18 (-9.06)	9.86± 0.29 (-43.43)	12.95± 0.18	12.47± 0.31 (-3.71)	8.54± 0.17 (-34.05)
E 38	23.00±0.15	17.88± 0.32 (-22.26)	11.97± 0.37 (-47.95)	12.51± 0.18	12.28± 0.40 (-1.84)	11.47±0.13 (-8.31)
E 24	20.75±0.39	16.36± 0.08 (-21.15)	11.82± 0.43 (-43.03)	11.09± 0.40	10.26± 0.18 (-7.48)	9.80± 0.40 (-11.63)
E 34	19.18±0.43	15.84± 0.18 (-17.41)	11.98± 0.15 (-37.53)	12.73± 0.28	12.31± 0.18 (-3.30)	11.43±0.28 (-10.21)
E 28	22.61±0.37	18.06± 0.13 (-20.12)	15.54± 0.43 (-31.27)	11.61± 0.31	10.22± 0.13 (-11.97)	9.76± 0.18 (-15.93)
BAW1138	23.70±0.08	17.24± 0.18 (-27.25)	10.46± 0.15 (-55.86)	12.12± 0.17	11.12± 0.20 (-8.25)	8.45± 0.28 (-30.28)
BAW1171	18.93±0.15	15.42± 0.37 (-18.54)	9.88± 0.39 (-47.80)	13.34± 0.40	12.50± 0.08 (-5.92)	10.52±0.17 (-21.14)
BAW1170	20.96±0.37	17.62± 0.43 (-15.94)	15.47± 0.29 (-26.93)	12.48± 0.28	11.34± 0.09 (-9.14)	10.24±0.18 (-17.95)
BAW1157	19.96±0.29	15.74± 0.28 (-21.14)	9.88± 0.32 (-50.50)	13.67± 0.08	12.27± 0.31 (-10.24)	8.45± 0.13 (-38.19)
BAW1163	21.53±0.39	15.33± 0.15 (-28.79)	10.65± 0.37 (-50.53)	9.94± 0.20	8.98± 0.18 (-9.66)	8.00± 0.18 (-19.52)
BAW1140	20.25±0.37	12.25± 0.29 (-39.51)	7.32± 0.37 (-63.85)	11.08± 0.17	9.00± 0.28 (-18.77)	7.42± 0.20 (-33.03)
BAW1151	15.43±0.43	10.56± 0.39 (-31.56)	10.37± 0.15 (-32.79)	10.86± 0.18	9.10± 0.13 (-16.21)	7.88± 0.40 (-27.44)
CV(%)		2.96			4.02	
Significance level		**			**	

Value within parenthesis indicates percent reduction from control, SE= standard error

Vigor index was found higher at control (ranging from 34.50 in BAW 1163 to 43.62 in BAW 1171 with a mean of 39.61) moderate at moderate stress (ranging from 29.00 in BAW 1163 to 40.86 in E 30 with a mean of 37.09) and lower at higher water deficit stress (with a range from 26.29 in BAW 1163 to 37.96 in BARI Gom 27 and a mean of 34.65). The results on vigor index showed that the speed of germination was reduced with the increment of water deficit stress but the degree of reduction was not similar for all wheat genotypes at moderate and higher water deficit stress compared to control. At moderate water deficit stress, wheat genotypes- BARI Gom 25, BARI Gom 27, E 30, E 2, E 24 and BAW 1151 showed less than 5% reduction and wheat genotypes-Satabdi, Sourav, BARI Gom 26, BARI Gom 28, E 23, E 38, E 34, E 28, BAW 1138, BAW 1171, BAW 1170, BAW 1157, BAW 1163 and BAW 1140 showed more than 5% reduction in vigor index compared to control. At higher water deficit stress, wheat genotypes- Sourav, BARI Gom 25, BARI Gom 27, E 24, E 34 and BAW 1151 showed less than 10% reduction and wheat genotypes- Satabdi, BARI Gom 26, BARI Gom 28, E 30, E 23, E 2, E 38, E 28, BAW 1138, BAW 1171, BAW 1170, BAW 1157, BAW 1163 and BAW 1140 showed more than 10% reduction in vigor index compared to control.

As water is one of the primary requirements in seed germination (Shaban, 2013) the water stress developed by PEG reduced germination ability of seed greatly. Slower germination of wheat under water deficit stress was found due to lower surface contact of water with seed (Wuest *et al*., 1999) which restricts the water availability to the seeds (Soltani *et al*., 2002). Water deficit stress may also lead to degradation and inactivation of the essential hydrolytic and other group of enzymes required for germination (Pratab and Sharma, 2010). Differential degree of sensitivity in speed of germination to different water potentials was also found among the wheat genotypes. It may be due to genetic variability of wheat intolerance to water stress. Noorka and Khaliq (2007), Khayantnezhad *et al*. (2010) and Singh *et al*. (2008) also found differential sensitivity in germination velocity among different wheat genotypes in their studies.

3.2 Early seedling growth

3.2.1 Shoot length

Shoot length of 10 days old seedling was significantly influenced by the interaction effect of water potential levels and wheat genotypes (Table 3). The shoot length was found to be higher at control (with a range from 15.43 cm in BAW 1151 to 23.78 cm in Sourav and a mean of 20.81 cm), moderate at moderate stress (ranging from 10.56 cm in BAW 1151 to 18.54 cm in BARI Gom 27 with a mean of 16.00 cm) and lower at higher water deficit stress (with a range from 7.32 cm in BAW 1140 to 15.54 cm in BAW 1138 and a mean of 11.11 cm). The shoot length was found to be reduced with the increment of water deficit stress but the degree of reduction was not similar for all wheat genotypes. At moderate water deficit stress, wheat genotypes-BARI Gom 25, E 30, E 2, E 34, BAW 1171and BAW 1170 showed less than 20% reduction and wheat genotypes-Satabdi, Sourav, E 30, E 2, E 38, E 24, BAW 1171, BAW 1157, BAW 1163 and BAW 1140 showed more than 20% reduction in shoot length compared to control. At higher water deficit stress, wheat genotypes- Satabdi, BARI Gom 25, E 23, E 34, E 2, E 38, E 24, E 28, BAW 1171, BAW 1170 and BAW 1151 showed less than 50% reduction and wheat genotypes- Sourav, BARI Gom 26, BARI Gom 27, BARI Gom 28, E 30, BAW 1138, BAW1157, BAW 1163 and BAW 1140 showed more than 50% reduction in shoot length compared to control.

3.2.2 Root length

Root length of seedling was significantly influenced by the interaction effect of water potential levels and wheat genotypes (Table 3). The root length was found to be higher at control (with a range from 9.94 cm in BAW 1163 to 13.88 cm in BARI Gom 27 and a mean of 12.00 cm), moderate at moderate stress (ranging from 8.98 cm in BAW 1163 to 12.50 cm in BAW 1171 with a mean of 10.98 cm) and lower at higher water deficit stress (with a range from 7.42 cm in BAW 1140 to 11.43 cm in E 34 and a mean of 9.46 cm). The root length was found to be reduced with the increment of water deficit stress but the degree of reduction was not similar for all wheat genotypes. At moderate water deficit stress, wheat genotypes- Satabdi, Sourav, BARI Gom 25, BARI Gom 28, E 30, E 23, E 2, E 38, E 24, E 34, BAW 1138, BAW 1171, BAW 1170 and BAW 1163 showed less than 10% reduction and wheat genotypes- BARI Gom 26, BARI Gom 27, E 28, BAW 1157, BAW 1140 and BAW 1151 showed more than 10% reduction in root length compared to control. At higher water deficit stress, wheat genotypes- Satabdi, BARI Gom 25, E 30, E 23, E 38, E 24, E 34, E 28, BAW 1170 and BAW 1163 showed less than 20% reduction and wheat genotypes- Sourav, BARI Gom 26, BARI Gom 27, BARI Gom 28, E 2, BAW 1138, BAW 1171, BAW 1157, BAW 1140 and BAW 1151showed more than 20% reduction in root length compared to control.

3.2.3 Seedling dry weight

Seedling dry weight was significantly influenced by the interaction effect of water potential levels and wheat genotypes (Table 4). The seedling dry weight was higher at control(from 83.66 mg in BARI Gom 28 to 150.66 mg in Satabdi), moderate at moderate stress (from 74.66 mg in BARI Gom 28 to 116.33 mg in Satabdi) and lower at higher water deficit stress (from 67.33 mg in E 24 to 100.00 mg in BARI Gom 25). The seedling dry weight was reduced with the increment of water deficit stress but the degree of reduction was not similar for all wheat genotypes. At moderate water deficit stress, wheat genotypes- BARI Gom 25, BARI Gom 26, BARI Gom 27, BARI Gom 28, E 38, E 24, E 34, E 28, BAW 1171, BAW 1170 and BAW 1163 showed less than 20% reduction and wheat genotypes- Satabdi, Sourav, E 30, E 23, E 2, BAW 1138, BAW 1157, BAW 1140 and BAW 1151showed more than 20% reduction in seedling dry weight compared to control. At higher water deficit stress, wheat genotypes- BARI Gom 25, BARI Gom 27, BARI Gom 28, E 30, E 34, E 28, BAW 1138, BAW 1171, BAW 1170 and BAW1157 showed less than 30% reduction and wheat genotypes- Satabdi, Sourav, BARI Gom 26, E 23, E 2, E 38, E 24, BAW 1163, BAW 1140 and BAW 1151 showed more than 30% reduction in seedling dry weight compared to control.

Water deficit stress developed by PEG reduced the shoot length, root length and seedling dry weight of wheat genotypes in the present study. Similar results were found by Datta *et al*. (2011),Almaghrabi (2012), Khakwani *et al.* (2011), Raza *et al.* (2012) and Jajarmi (2009) in their studies. Because increasing the level of water stress not only inhibits the germination characteristics but the extension growth of the seedlings was also obstructed (Pratap and Sharma, 2010). Water stress also reduced the seed reserve utilization (Soltani *et al.*, 2006 and Harb, 2013) solubilization of sugars (Harb, 2013) during germination which contributed to lower seedling dry weight of wheat. Different wheat genotypes showed differential degree in reduction in shoot length, root length and seedling dry weight in the present study. This may be due to differential genetic sensitivity of wheat genotypes to water deficit stress.

3.2.4 Stress tolerance index based on seedling dry weight

Stress tolerance index (STI) of twenty wheat genotypes based on seedling dry weight at moderate water deficit stress is presented in Figure 1. These STI values indicated a wide difference in water deficit stress tolerance among the wheat genotypes. Wheat genotypes- BARI Gom 25, E 34, E 28 and BAW 1170 showed more than 0.90 STI, the wheat genotypes- Sourav, E 23 and BAW 1140 provided less than 0.70 STI and the other wheat genotypes (Satabdi, BARI Gom 26, BARI Gom 27, BARI Gom 28, E 30, E 2, E 38, E 24, BAW 1138, BAW 1171, BAW 1157, BAW 1163 and BAW 1151) showed STI in between 0.70 to 0.90.

Table 4. Seedling dry weight (mg) of different wheat genotypes as influenced PEG induced water deficit stress

Genotypes	Seedling dry weight (mean ± SE)		
	Control (Tap water)	Moderate stress (- 2bar)	Higher stress (- 4bar)
Satabdi	150.66± 0.61	116.33± 0.52 (-22.79)	95.33± 0.83 (-36.73)
Sourav	125.00± 1.40	83.33± 0.35 (-33.34)	83.33± 0.76 (-33.34)
BARI Gom 25	122.33± 0.93	110.30± 0.46 (-9.83)	100.00± 0.11 (-18.25)
BARI Gom 26	131.66± 0.52	113.66± 0.61 (-13.67)	89.66± 1.40 (-31.90)
BARI Gom 27	111.00± 0.11	96.00± 0.46 (-13.51)	83.66± 0.93 (-24.63)
BARI Gom 28	83.66± 0.61	74.66± 1.40 (-10.76)	68.33± 0.76 (-18.32)
E 30	115.33± 0.83	86.33± 0.58 (-25.15)	86.33± 0.35 (-25.15)
E 23	109.00± 1.53	75.00± 0.61 (-31.19)	68.00± 0.52 (-37.61)
E 2	105.00± 0.93	77.66± 1.40 (-26.04)	73.00± 0.76 (-30.48)
E 38	118.66± 0.58	95.00± 1.40 (-19.94)	78.66± 0.61 (-33.71)
E 24	102.33± 1.53	84.33± 0.93 (-17.59)	67.33± 0.83 (-34.20)
E 34	92.66± 1.40	90.66± 0.31 (- 2.16)	68.66± 0.33 (-25.90)
E 28	97.00± 0.76	88.33± 0.52 (-8.94)	86.00± 0.35 (-11.34)
BAW1138	127.33± 0.61	95.33± 0.83 (-25.13)	96.00± 1.53 (-24.61)
BAW1171	116.33± 0.33	96.66± 0.93 (-16.91)	92.66± 0.58 (-20.35)
BAW1170	94.00± 1.53	85.33± 0.35 (-9.22)	84.66± 1.40 (-9.94)
BAW1157	116.00± 0.52	89.33± 1.40 (-22.99)	82.00± 0.46 (-29.31)
BAW1163	124.33± 1.40	105.00± 0.33 (-15.55)	78.66± 0.11 (-36.73)
BAW1140	136.00± 0.46	83.00± 0.58 (-38.97)	80.66± 0.52 (-40.69)
BAW1151	134.66± 0.52	99.66± 1.53 (-25.99)	83.66± 0.35 (-37.87)
CV(%)		2.64	
Significance level		**	

Value within parenthesis indicates percent reduction from control, SE=standard error

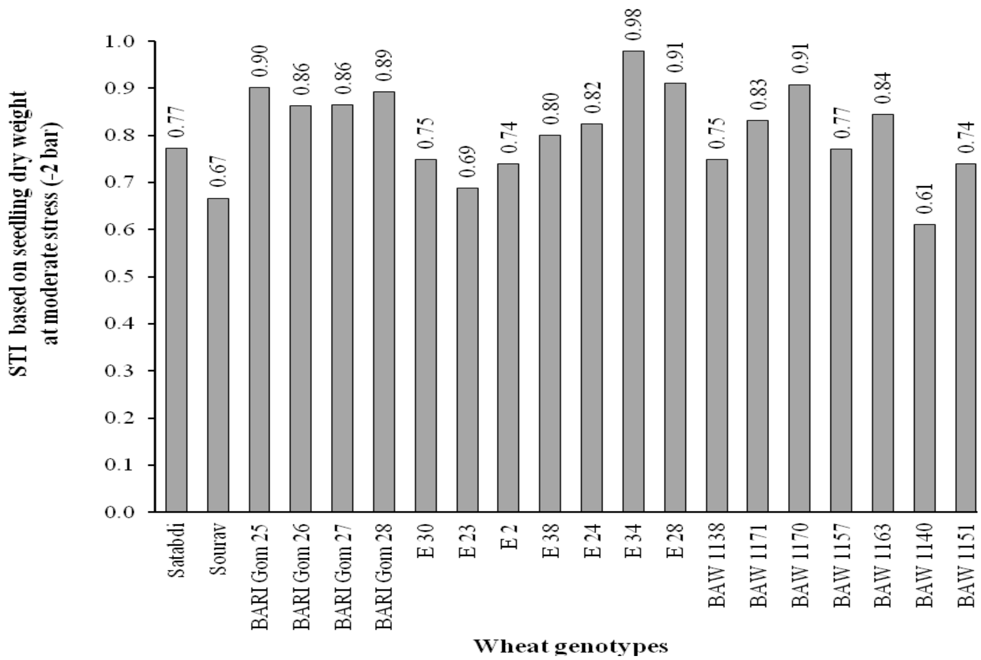

Figure 1. Stress tolerance index based on seedling dry weight of different wheat genotypes at moderate water deficit stress (- 2 bar)

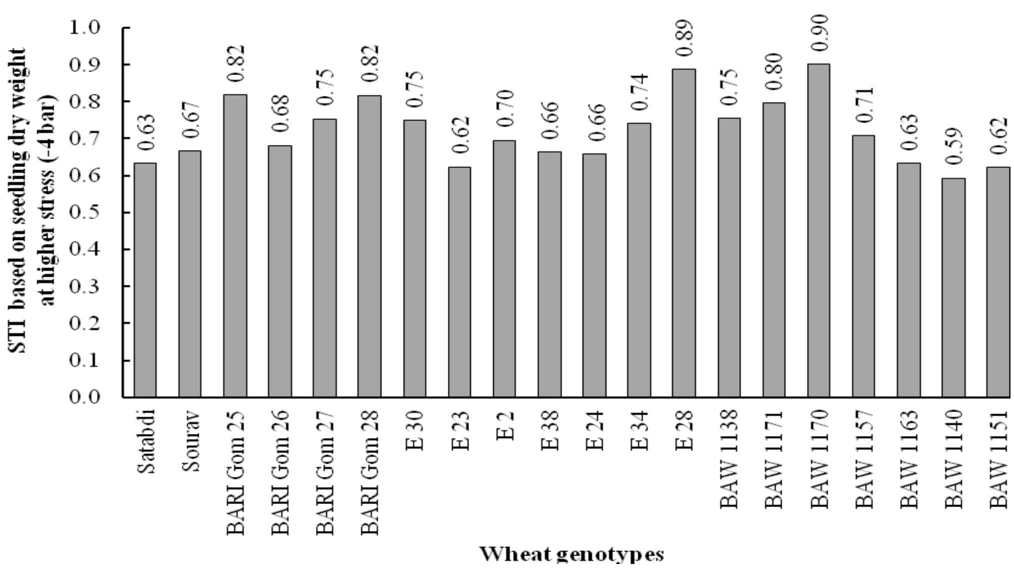

Figure 2. Stress tolerance index based on seedling dry weight of different wheat genotypes at higher water deficit stress (- 4 bar)

Figure 2. shows the stress tolerance index (STI) of twenty wheat genotypes based on seedling dry weight of at higher water deficit stress. These STI values also indicated a wide difference in water deficit stress tolerance among the wheat genotypes. Wheat genotypes- BARI Gom 25, BARI Gom 28, E 28 and BAW 1170 showed more than 0.80 STI, the wheat genotypes- Satabdi, Sourav, BARI Gom 26, E 23, E 38, E 24, BAW 1163, BAW 1140 and BAW 1151 provided less than 0.70 STI and the other wheat genotypes (BARI Gom 27, E 30, E 2, E 34, BAW 1138, BAW 1171 and BAW 1157) showed STI in between 0.70 to 0.80.

4. Conclusions

Based on seedling dry weight, under both moderate and high water deficit stress BARI Gom 25, E 28 and BAW 1170 were found as tolerant and Sourav, E 23 and BAW 1140 were found as water deficit stress sensitive wheat genotypes during germination.

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