RESEARCH ARTICLE

EFFECT OF WATER STRESS ON PRE-HARVEST CHARACTERS OF IRANIAN WHEAT LANDRACES UNDER IRRIGATED, RESTRICTED IRRIGATED AND RAIN-FED CONDITION

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Abstract: Water stress is one of the most important abiotic stresses which severely affect plant growth and yield. With a view to understand the effects of drought stress on pre harvest components of wheat cultivars under field conditions, the present investigation was carried in the Department of Plant Breeding and Genetics with three replications under Randomized Block Design. Set of selected Iranian landraces from the preliminary screening experiment with the help of Polyethylene glycol (6000). Landraces were selected on the basis of vigor index and planted in the field along with commercial relevant checks in three environments Irrigated, Restricted irrigated and Rain-fed. Data of days to germination, flowering, maturity, plant height and tillers per meter row length were recorded. On the basis of performance,IWA 8600796,IWA 8600179, IWA 8606333 and IWA 8606258 considered as water stress tolerant .Identified landraces can be included in future breeding programmes for the wheat improvement for drought prone areas.

Keywords : Water stress, Iranian wheat landraces , Pre-harvest characters

INTRODUCTION

Wheat is important cereal crop which contributes more calories and protein than any other cereal crop(Abd- EL- Haleem et al., 2009)**.** Abiotic stresses such as drought, excessive watering, extreme temperature and salinity affect growth and development processes in plants.Drought stress is more challenging than any other abiotic stress.Water stress leads due to lack of proper moisture which is necessary for the development of plant (Zhu 2002).In extreme drought situations wilting point in plants reached at point which results in desiccation and ultimately death of the plant. Drought stress affects the plant almost at all stages like tillering, booting, anthesis,grain formation and grain filling. During reproductive stage, drought stress cause 70-80% loss in yield of crop (Kulkarni et al.,2008).Drought stress affects the growth of plant from seedling to full maturity stage which results in reduction of yield (Bilal et al., 2015).In plant life, most critical and vulnerable stage to environment stress is the seed germination.Water stress acts by decreasing the percentage and rate of germination and seedling growth (Delachiave and De Pinho 2003). Water stress is known to increase the mean germination time in crop plants (Willenborb et al., 2004).Plant height decreasesd due to reduction in cell division which is due to loss in turgidity anddehydration of protoplasm.Tillering is the most important yield contributing component. Generally, crop stand better and ultimately greater the yield as greater the number of tillers. Limited supply of water at booting stage reduced the formation of tillers in wheat which ultimately decreased the yield of crop (Rana*et al.*,1999) and Kimurto*et al*.,2003). Under irrigated condition 95% of tillers produced ears as compared to the stress where only 79% of tillers produced ears (Karim et al., 2000). The main objective of this work is to investigate pre-harvest morphological traitswhich are associated with drought tolerance and that could be used for yield improvement in wheat breeding programmes.

MATERIALS AND METHODS

In order to evaluate effect of water stress on pre-harvest characters of wheat cultivars, 27 lines were selected on the basis of vigor index from preliminary screening experiment.

Selected Iranian landraces on the basis of minimum reduction of vigor index under stress as compared to control

Sr.No.	Landraces	Minimum reduction as compared control
1	PETTERSON ML68-10	302
2	Cltr 15395	100
3	IWA 8600064	399
4	IWA 8600091	473

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5	IWA 8600179	180
6	IWA 8600191	439
7	IWA 8600232	136
8	IWA 8600397	261
9	IWA 8600435	320
10	IWA 8600440	179
11	IWA 8600542	298
12	IWA 8600567	215
13	IWA 8600596	185
14	IWA 8600715	185
15	IWA 8600795	274
16	IWA 8600796	239
17	IWA 8600841	79
18	IWA 8600846	174
19	IWA 8600883	24
20	IWA 8606258	279
21	IWA 8606633	296
22	IWA 8606661	292
23	IWA 8606739	200
24	IWA 8606753	200
25	IWA 8606741	264
26	IWA 86067576 IWA	275
27	8607572	200

These lines showed minimum reduction as compared to control in all seedling parameters (germination percentage, coleoptile length, root length, shoot length, root and shoot fresh and dry weight at 14% Polyethylene glycol (6000) treatment. 27 Iranian landraces were grown under irrigated, restricted irrigated and rain-fed conditions.

Control treatment (Irrigated) was well watered throughout the growing period (five irrigations).Drought environment was created by withholding irrigation (two irrigations) and created temporary rain shelter from water during rain. The experiment was carriedout in RBD design with three treatments with three replications. Sowing was done in last week of November 2016.Plant height was measured in centimeters from base of the plant to the tip of the spike (excluding awns) at the maturity time. When 50% of the spikes anther has extruded, date of flowering was recorded for each line for each plot and number of days were recorded starting from the date of sowing.Date of maturity was recorded from each line and number of days were counted starting from sowing date

Total number of tillers per meter row length was recorded by using a scale of 1 meter from each line at maturity recounted starting from sowing date.

RESULTS AND DISCUSSIONS

Analysis of variance for all the morpho-physiological traits was conducted. The mean square under drought stress were highly significant for all the characters under irrigated conditionexcept days to flowering (Table1), restricted irrigation(Table 2) and rain-fed conditions (Table 3)viz; days to germination, days to flowering, days to maturity, plant height and tillers per meter row length.

Days to germination

In plant life, most critical and vulnerable stage to environment stress is the seed germination.Water stress acts by decreasing the percentage and rate of germination and seedling growth (Delachiave and De Pinho, 2003). Water stress is known to increase the mean germination time in crop plants (Willenborb et al 2004).

IWA 8600796, IWA 8600841, IWA 8600846 and IWA 8606258 took minimum days to germinate under restricted irrigated and rain-fed conditions as compared to irrigated condition (Table 8 and 9).

Days to flowering

Under Irrigated conditions, range of 74.0to 84.0 days to flowering was observed with a mean of 79.0 days to flowering (Table 4). Among checks C-591 and C-273 took minimum days (75.0) while PBW 660 took maximum (82.0) days to flowering (Table 4). Among

Iranian lines minimum days were taken by Cltr 15395 and IWA 8600179 and (74) days and maximum by IWA 8600542 (84.0) days (Table 7). Under restricted-irrigated condition most of lines flowered in the range of 60.0 to 78.0 days with an average of days 69.0 (Table 5). Among checks C-591 took minimum 70.0 days to flowering. Maximum days were taken by Gladius (77.0) days to flowering (Table 5). In Iranian lines, maximum (78.0) days were recorded in IWA 8600796 IWA 8606661 IWA 8607576 and IWA 8600883 and minimum days (60.0) was recorded in IWA 8600091 (Table 8).

Under rain-fed condition most of lines flowered in the range of 54.0 to 74.0 days with an average of 64.0 days (Table 6). Among checks C-591 took minimum days (68.0) whereas maximum days (72.0) by BWL 5233 (Table 6). In Iranian landraces maximum days (74.0) were taken by IWA 8607576 and minimum by IWA 8600091 (54.0) days (Table 9).These Iranian landraces IWA 8600397, IWA 8600796, IWA 8600883, IWA 860661 and IWA 860674 took minimum days to flowering under restricted and rain-fed conditions as compared to irrigated conditions (Table 8 and 9).

Days to maturity

Under irrigated condition, most of lines matured in the range of 136.0 to 138.0 days with an average of 137.0 days (Table 4). Among commercial checks days of maturity was 135.0 to 136.0 with an average of 135.5 days (Table 4).Under restricted-irrigated most of lines matured in the range of days 129.0 to 134.0 with an average of 131.5 days (Table 5). Among commercial checks days of maturity were 130.0 to 134.0 with an average of 132.0 days (Table 5).

Most of lines under rain-fed condition matured in the range of 128.0 to 132.0 days with an average of 130.0 days (Table 6). Among checks days of maturity was 130.0 to 132.0 days with an average of 131.0 days (Table 6).These lines IWA 8600179, IWA 8600232, IWA 8600841, IWA 8600567 and IWA 8606633 took minimum days to mature as compared to irrigated conditions under restricted irrigated and rain-fed conditions (Table 8 and 9).

Plant height (cm)

In irrigated condition, plant height among Iranian landraces varied between 90.5 to 106.5 cm with an average 98.7cm(Table4). Among commercial relevant checks C-306 had highest (114.5cm) while Gladius had lowest (100.5cm) plant height (Table4). Among Iranian lines, IWA 8606741 had maximum (106.5.5cm) whereas minimum (90.5cm) plant height was recorded in IWA 8600397 and IWA 8607576 (Table 7).

Under restricted-irrigated plant height varied between82.2 to102.5cm with an average 92.3cm (Table 5). Among commercial relevant checks C-306 had highest (112.5cm) while Gladius had lowest (98.5cm) height (Table 5). Among Iranian lines, IWA 8600064 had maximum (102.5cm) whereas minimum (82.2cm) plant height was recorded in Cltr 15395 (Table 8).

Plant height under rain-fed condition varied among genotypes between 65.5 to 90.5cm with an average of 78.0 cm (6). Among commercial relevant checks C-518 had maximum (107.5cm) whereas lowest height was recorded in Gladius (84.5 cm) (Table 6). In Iranian lines, IWA 8600084 had highest (90.5 cm) and IWA 8600191 (65.5cm) had lowest plant height (Table 9).Khan and Naqvi (2011) reported in wheat that there was reduction in plant height under water stress which strengthens our findings. Similar result was found by (Qadir et al 1999 and Saleem 2003) and Khan et al (2001) in maize.The reduction in plant heightdue to loss of turgidity and dehydrationof protoplasm.

Tillers per meter row length (cm):

In irrigated condition, tillers / meter row length among genotypes showed variation between 60.5 to 98.7 with a mean of 79.6 (Table 4). Among checks C-306 and C-591 had maximum (108.5) while Gladius had minimum (100.00) tillers / meter row length (Table 4.). In Iranian lines, IWA 8600715 had more (98.7) whereas IWA 8600796 (60.5) had least number of tillers / meter row length (Table 7).In case of restricted irrigated tillers/meter row length among genotypes ranged between 50.0 to 89.0 with a mean of 69.5 (Table 5). Among checks C-306 had maximum (90.4) whereas BWL 5233 had minimum (70.7) tillers per meter row length (Table 5). Among Iranian lines IWA 8606633 had maximum (89.0) followed by IWA 8600542 (88.7) whereas IWA 8600841 (50.0) had minimum tillers/meter row length (Table 8).

Tillers per meter rowlength among the genotypes varied between 32.0 to73.0 with an average of 52.5 under rain-fed condition (Tale 6). In commercial relevant checks, PBW 175 had maximum (81.4) while C-518 had minimum (59.8) tillers/ meter row length (Table 6). In Iranian lines 8600841 had lowest number of tillers (32.0) whereas maximum was recorded in IWA 8606258 (73.0) (Table 9).Number of tillers were more affected under restricted and rain-fed conditions as compared to irrigated condition.Similar result were found by Quadir*et al* (1999) and Kabir*et al* (2009). Rana*et al* (1999) and Kimutro*et al* (2003) found that water stress at tillering or at booting stage significantly affected the formation of tillers in wheat.

Five Iranian lines PETTERSON ML 68-10 IWA 8600542, IWA 8600883, IWA 8606258 and IWA 8606333 were selected on the basis of performance under irrigated, restricted irrigated and rain-fed conditions.

Table 1. Analysis of variance for morpho-physiological traits in 27 Iranian lines along with 8 checks under Irrigated conditions during 2016-17

Mean Square of Characters						
Source of variation	**DF**	**DTG**	**DTF**	**DTM**	**PH**	**TPMRL**
Block	1	0.357	0.351	0.357	0.241	114.2
Treatment	34	0.787*	2.294	1.750*	34.11*	480.36*
Error	34	0.121	1.308	0.382	13.85	139.15
Total	69					

Table 2. Analysis of variance for morpho-physiological traits in 27 Iranian lines along with 8 checks under Restricted irrigated conditions during 2016-17

Mean Square of Characters						
Source of variation	**Df**	**DTG**	**DTF**	**DTM**	**PH**	**TPMRL**
Block	1	0.12	0.9	0.39	5.24	0.26
Treatment	34	1.08*	2.80*	2.60*	68.59*	128.38*
Error	34	0.24	0.7	0.32	26.46	64.729
Total	69					

Table 3. Analysis of variance for morpho-physiological traits in 27 Iranian lines along with 8 checks under Rain-fed conditions during 2016-17

Mean Square of Characters						
Source of variation	**Df**	**DTG**	**DTF**	**DTM**	**PH**	**TPMRL**
Block	1	0.55	0.69	0.32	1.38	78.02
Treatment	34	0.41*	3.55*	1.20*	17.52*	89.84*
Error	34	0.14	1.05	0.55	6.034	24.56
Total	69					

Abbreviations: DF –Degree of freedom, DTG- Days to germination, DTF- Days to flowering, DTM- Days to maturity, TPMRL- Tillers per meter row length and * Significance at 5 %

Table 4. Ranges and mean values of morpho-physiological and yield components traits of Iranian lines and checks under Irrigated conditions

Characters		**DTG**	**DTF**	**DTM**	**PH**	**TPMRL**
Landraces	Min	15	74	136	90.5	60.5
	Max	18	84	138	106.5	98.7
	Mean	16.5	79	131.5	98.7	79.6
Mean value of checks	Gladius	16	80	135	100.5	100
	BWL 5233	16	78	135	112.5	105
	C-306	16	77	135	114.5	108.5
	PBW 660	15	82	136	113	105
	C-518	16	78	135	113.6	107
	C-591	16	75	135	112.5	108.5
	C-273	15	75	136	110.5	100.4
	PBW 175	15	79	136	111.4	104

Abbreviations: DF –Degree of freedom, DTG- Days to germination, DTF- Days to flowering, DTM- Days to maturity and TPMRL- Tillers per meter row length

Table 5. Ranges and mean values of morpho-physiological and yield components traits of Iranian lines and checks under Restricted irrigated conditions

Characters		**DTG**	**DTF**	**DTM**	**PH**	**TPMRL**
Landraces	Min	15	60	129	82.2	50
	Max	20	78	134	102.5	89

	Mean	17.5	69	131.5	92.3	69.5
Mean value of checks	Gladius	17	77	133	98.5	73.75
	BWL 5233	17	74	132	110.5	70.75
	C-306	18	72	130	112.5	90.4
	PBW 660	18	76	134	111.5	85.2
	C-518	17	72	132	110.5	77
	C-591	16	70	134	109.5	77
	C-273	17	72	130	108.5	75.7
	PBW 175	16	74	133	107.5	85.4

Abbreviations: DF –Degree of freedom, DTG- Days to germination, DTF- Days to flowering, DTM- Days to maturity and TPMRL- Tillers per meter row length

Table 6. Ranges and mean values of morpho-physiological and yield components traits of Iranian lines and checks under rain-fed conditions

Characters		**DTG**	**DTF**	**DTM**	**PH**	**TPMRL**
Landraces	Min	17	54	128	65.5	32
	Max	20	74	132	90.5	73
	Mean	18.5	64	130	78	52.5
Mean value of checks	Gladius	17	70	130	84.5	71
	BWL 5233	17	72	131	100.5	71
	C-306	19	69	130	104.5	74.2
	PBW 660	18	70	132	107.5	72
	C-518	17	70	132	107.5	59.8
	C-591	18	68	131	104.5	63.4
	C-273	17	70	130	105.5	71
	PBW 175	18	70	131	100.5	81.4

Abbreviations: DF –Degree of freedom, DTG- Days to germination, DTF- Days to flowering, DTM- Days to maturity and TPMRL- Tillers per meter row length

Table 7. Mean values of selected Iranian wheat landraces with 8 checks under Irrigated conditions

Sr.No	Germplasm	DTG	DTF	DTM	PH	TPMRL
1	PETTERSON ML68-10	16.0	78.0	136	98.1	87.7
2	Cltr 15395	16.0	74.0	136.5	107.5	81.0
3	IWA 8600064	17.0	81.0	138	104.5	65.0
4	IWA 8600091	15.00	75.0	138	100.5	80.5
5	IWA 8600179	16.0	74.0	137.5	102.5	72.5
6	IWA 8600191	16.0	76.0	137	99.5	68.5
7	IWA 8600232	15.0	80.0	136.5	100.5	93.5
8	IWA 8600397	16.0	79.0	135.5	90.5	85.2
9	IWA 8600435	16.0	75.0	135	101.5	95.0
10	IWA 8600440	18.0	83.0	135.5	105.5	75.0
11	IWA 8600542	17.0	84.0	136	100.5	90.0
12	IWA 8600567	17.0	76.5	137	106.5	95.5
13	IWA 8600596	17.0	77.5	137	104.5	85.5
14	IWA 8600715	16.0	79.5	137.5	100.8	98.7
15	IWA 8600795	15.0	81.5	138	90.5	75.5
16	IWA 8600796	15.0	81.5	135.5	101.5	60.5
17	IWA 8600841	16.0	78.0	137	106.5	94.5
18	IWA 8600846	16.0	76.5	137	104	92.5
19	IWA 8600883	17.0	83.0	135.5	100.5	92.5
20	IWA 8606258	16.0	79.0	136.0	102.5	89.5

Sr.No	Germplasm	DTG	DTF	DTM	PH	TPMRL
21	IWA 8606633	17.0	83.0	137.0	101.5	85.5
22	IWA 8606661	15.0	81.0	137.0	100.0	84.5
23	IWA 8606739	16.0	82.0	136.5	98.5	86.5
24	IWA 8606753	15.0	79.5	136.0	104.5	72.5
25	IWA 8606741	16.0	79.5	137.5	106.5	79.0
26	IWA 8607572	15.0	81.0	138.0	100.5	85.5
27	IWA 8607576	16.0	82.0	137.0	90.5	90.4
28	Gladius	16.0	80.0	135.0	100.5	100.0
29	Bwl 5233	16.0	78.0	135.0	112.5	105.0
30	C-306	16.0	77.0	135.0	114.5	108.5
31	PBW660	15.0	82.0	136.0	113	105.0
32	C-518	16.0	78.0	135.0	113.6	107.0
33	C-591	16.0	75.0	135.0	112.5	108.5
34	C- 273	15.0	75.0	136.0	110.5	100.4
35	PBW175	15.0	79.0	136.0	111.4	104
	CD (5%)	0.79	NS	1.25	7.56	23.9

Table 8. Mean values of selected Iranian wheat landraces with 8 checks under Restricted irrigated conditions

Sr.No	Germplasm	DTG	DTF	DTM	PH	TPMRL
1	PETTERSON ML68-10	15	74	130	88	71
2	Cltr 15395	18	68	132	82.2	60.4
3	IWA 8600064	18	70	130	102.5	61.4
4	IWA 8600091	17	60	134	86.2	63.4
5	IWA 8600179	18	70	134	100	73
6	IWA 8600191	16	68	129	87.8	54
7	IWA 8600232	17	68	132	88.6	68
8	IWA 8600397	19	74	130	83.9	82.25
9	IWA 8600435	19	68	132	85.1	80.5
10	IWA 8600440	18	70	130	85.8	60
11	IWA 8600542	18	70	132	85.5	88.75
12	IWA 8600567	17	68	133	100	63.75
13	IWA 8600596	17	68	134	84.7	76.5
14	IWA 8600715	16	70	130	90.5	82.2
15	IWA 8600795	17	74	133	86.5	78.4
16	IWA 8600796	17	78	131	94.5	51.25
17	IWA 8600841	18	70	133	84.7	50
18	IWA 8600846	16	69	132	78.8	66.4
19	IWA 8600883	18	78	130	90.5	82.75
20	IWA 8606258	17	68	132	98.5	88.2
21	IWA 8606633	18	74	134	98	89
22	IWA 8606661	20	78	133	84.5	70.5
23	IWA 8606739	18	68	132	87.8	63.25
24	IWA 8606753	18	74	130	98.5	64.25
25	IWA 8606741	18	74	133	100	82.25
26	IWA 8607572	17	77	133	98.5	83.25
27	IWA 8607576	18	78	135	80.5	84.5
28	Gladius	17	77	133	98.5	73.75

29	Bwl 5233	17	74	132	110.5	70.75
30	C-306	18	72	130	112.5	90.4
31	PBW660	18	76	134	111.5	85.2
32	C-518	17	72	132	110.5	77
33	C-591	16	70	134	109.5	77
34	C- 273	17	72	130	108.5	75.7
35	PBW175	16	74	133	107.5	85.4
	CD(5%)	1.08	1.71	1.15.0	10.4	16.3

Table 9. Mean values of selected Iranian wheat landraces with 8 checks under Rain-fed conditions.

Sr. No.	Germplasm	DTG	DTF	DTM	PH	TPMRL
1	PETTERSONML68-10	17	68	128	72.5	70.5
2	Cltr 15395	20	64	129	78.7	50
3	IWA 8600064	20	64	132	90.5	47
4	IWA 8600091	19	54	130	84	44.5
5	IWA 8600179	20	64	130	90	50
6	IWA 8600191	21	60	128	65.5	51
7	IWA 8600232	19	64	130	70.5	49
8	IWA 8600397	20	70	129	68.5	49
9	IWA 8600435	19	60	129	71.2	55
10	IWA 8600440	20	68	129	75	42
11	IWA 8600542	18	55	130	68.5	70.6
12	IWA 8600567	19	60	130	90	58
13	IWA 8600596	20	62	132	78	49
14	IWA 8600715	19	68	128	87.8	45
15	IWA 8600795	18	68	130	74.5	50
16	IWA 8600796	17	70	129	84.5	49
17	IWA 8600841	18	68	130	82.5	32
18	IWA 8600846	18	55	129	70.5	64
19	IWA 8600883	20	70	128	87.8	70.5
20	IWA 8606258	18	64	128	89.5	73
21	IWA 8606633	19	68	132	85	71.5
22	IWA 8606661	20	70	130	82.5	49
23	IWA 8606739	21	64	129	80.5	51
24	IWA 8606753	20	68	128	87.8	42
25	IWA 8606741	19	70	130	90.5	58
26	IWA 8607572	19	70	129	84.5	50
27	IWA 8607576	20	74	130	68.5	70
28	Gladius	17	70	130	84.5	71
29	Bwl 5233	17	72	131	100.5	71
30	C-306	19	69	130	104.5	74.2
31	PBW660	18	70	132	107.5	72
32	C-518	17	70	132	107.5	59.8
33	C-591	18	68	131	104.5	63.4

34	C- 273	17	70	130	105.5	71
35	PBW175	18	70	131	100.5	81.4
	CD(5%)	0.77	2.08	1.51	4.99	10.1

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