

Leaf area, Relative water content and Stay-green habit of Iranian landraces (*Triticumaestivum L.*) under water stress in field conditions

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Abstract

Water stress is one of the major and challenging abiotic stress that affects the plant almost at all stages like tillering, booting, anthesis, grain formation, and grain filling. The present study aimed to investigate the effect of water stress on relative water content, leaf area and stay green habit of Iranian landraces along with commercial relevant checks under irrigated, restricted irrigation and rain-fed conditions. Iranian landraces were selected based on minimum reduction in vigor index as compared to control lines during preliminary screening experiment in the lab in which water stress induced by Polyethylene glycol (PEG6000). A field experiment was carried out at the experimental area of the Department of Plant Breeding & Genetics, Punjab Agricultural University, Ludhiana, Punjab during 2016-2017. The relative water content of Iranian landraces was calculated at the bolting stage according to the turgid weight by applying the equation of relative water content. Leaf area was recorded by leaf area meter and stay-green habit based on a 1-4 visual scale. Analysis of variance reveals interaction among treatment and genotypes were significant ($P \leq 0.05$) for the leaf area, relative water content, stay green habit at anthesis and stay green habit at 30 days after anthesis. Based on the performance of Iranian landraces under restricted and rain-fed conditions, 5 lines IWA 8600397, IWA 8600841, 8606741, IWA 8606741 and Ctr 15395 considered as water stress tolerant.

Keywords: Iranian landraces, Leaf area, Relative water content, Stay-green habit and Water stress

Introduction

Wheat is one of the most important cereal crops in the world in terms of the area, production and nutrition as it supplies 19% of calories and 21% of the protein than any other cereal crop (1). Wheat is the second major cereal crop after the rice with respect to productivity. **Wheat forecasted global demand may rise up to 750 million tons in 2025 (1).** Among the abiotic stresses, water stress and temperature severely affect the production of wheat (6). During the reproductive stage; drought stress causes a 70-80% loss in yield of the crop as well (12). Drought stress affects the growth of plants from seedling to full maturity stage which causes in the reduction of yield (4). During water stress, there is a reduction in grain yield due to a decrease in the rate of photosynthesis and stem reservoir (17). Water stress reduces leaf area which ultimately reduces the rate of photosynthesis. Moreover the number of leaves per plant, leaf size and leaf longevity shrink by water stress. The leaves have direct relation with plant's grain ability due to their photosynthetic activity. Flag leaves make major contribution towards grain weight and are the major photosynthetic organs in plants and under water deficit conditions leaf growth is reduced because of decreased water potential which ultimately affects rate of photosynthesis (22). Relative water content is an important physiological trait that influences plant-water relations and it reflects the metabolic activity in tissues so it is considered as a measure of plant water status and used as a most meaningful index for dehydration tolerance. During the initial stages of growth and leaf development relative water content is higher however, as the leaf matures there is a reduction in the water content due to accumulation of dry matter. Under the water stress severity, relative water content, leaf water potential and transpiration rate decreased because of an increase in leaf temperature (19). **Khakwani et al (11) reported that relative water content in wheat positively correlated with grain yield, biological yield, and harvest index of the plant. Leaf area and relative water content both are useful characters reflecting the overall water status of plants (9).** The process of staying green or delay in senescence is known as stay green character in plants. Genotypes having stay green character contributed 30-50% of photosynthesis needed during grain filling time. (21). **Plants having stay green character were able to maintain longer green leaf area after anthesis which resulted in maintaining photosynthesis during grain filling (23).** Senescence is regulated by individual life, nutrients are mobilized from older to younger leaves then to flag leaf which contributed photo-assimilates during the time of grain filling. Plants which maintained stay green character, are able to produce more photo-assimilates during process of photosynthesis which results in greater number of fertile tillers and numbers of grains per ear which ultimately contributes to the maximum weight of grains (20). Phenotypes that sustain stay green character under stress improved

yield in cereal crops such as sorghum and wheat due to production of more photoassimilates (7). So stay green character is important selection trait, in breeding programmes to improve the crop adaptation under water stress environment in sorghum and wheat (5). According to Peigao L (15) stay green considered as an important component in the genetic improvement of several crops to promote stress tolerance and yield grain. The main objective of this work is to investigate the effect of water stress on leaf area, relative water content, and stay green habit of Iranian wheat landraces under water stress conditions.

Materials and Methods:

A field experiment was conducted during November 2016-17 at the Department of Plant Breeding and Genetics, Punjab Agricultural University, Ludhiana to evaluate the leaf area, relative water content, and stay-green habit of Iranian wheat landraces under water stress. Twenty seven lines along with 8 commercial checks were selected based on the vigor index from the preliminary screening experiment. 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 (10)). These Iranian landraces were grown under irrigated, restricted irrigation, 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 rain-fed condition (no irrigation). The experiment was carried out in Randomized Block Design (RBD) with three treatments and three replications. Sowing was done in the last week of November 2016. Leaf area from 10 randomly selected plants from each treatment (irrigated, restricted irrigation and rain-fed) was measured by leaf area meter (ADC Bio Scientifica Ltd.). Relative water content (RWC) was recorded at the booting stage of the plants, according to Siddique *et al* (19), where fresh weight from the flag leaves were recorded. Turgid weight was obtained after soaking the leaves for 24 hours. Samples were dried for 72 hours in the oven at 60-62°C. Relative water content was calculated from the following equation:

$$RWC = \left[\frac{\text{fresh weight} - \text{dry weight}}{\text{turgid weight} - \text{dry weight}} \right] * 100$$

Stay- green Habit of foliage leaf based on visual using the 1-4 scale:

1. <25% of foliar tissue showing green color
2. 25-50% of foliar tissue showing green color
3. 50-75% of foliar tissue showing green color
4. >75% of foliar tissue showing green color

Statistical analysis: The statistical analysis was carried out with the help of CPCS-1 software using RBD (Randomized block design) factorial.

Iranian landraces selected on the basis of vigor index from preliminary screening experiment

- | | | |
|--------------------|-----------------|-----------------|
| 1. PETERSONML68-10 | 11. IWA8600542 | 21. IWA 8600883 |
| 2. Cltr 15395 | 12. IWA 8600567 | 22. IWA 8606258 |
| 3. IWA 8600064 | 13. IWA 8600596 | 23. IWA8606633 |
| 4. IWA 8600091 | 14. IWA 8600715 | 24. IWA 8606661 |
| 5. IWA 8600179 | 15. IWA 8600795 | 25. IWA 8606739 |
| 6. IWA 8607572 | 16. IWA 8600440 | 26. IWA 8606741 |
| 7. IWA8600191 | 17. IWA 8607576 | 27. IWA 8606753 |
| 8. IWA 8600232 | 18. IWA8600796 | |
| 9. IWA 8600397 | 19. IWA 8600841 | |
| 10. IWA 8600435 | 20. IWA 8600846 | |
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Results and Discussions

ANOVA (Analysis of Variance)

Statistical analysis: The data of all parameters i.e. leaf area, relative water content and stay green habit at anthesis and 30 days after anthesis was statistically analyzed through analysis of variance (ANOVA) to check the significant differences among wheat genotypes at 0.05 probability level and After analysis of variance data was subjected to Duncan's multiple range test to evaluate significance of mean comparison ($P < 0.05$).

Table 1: Analysis of the variance of Iranian wheat landraces along with 8 checks under Irrigated, Restricted-irrigation and Rain-fed conditions during 2016-2017

Mean Square of the Characters					
Source of variation	DF	LA	RWC	SGHA	SGH30
Rep	1	63.6	231.9	1.71	1.9
Treatment	2	74.4*	888.05*	0.44	0.99
Genotype	34	536.6*	80.8*	0.17	0.95
Trt* genotype	68	843.27*	213.08*	0.63*	0.14*
Error	104	12.77	5.032	0.20	0.30
Total	209				

Abbreviations: DF- Degree of freedom, LA- Leaf area, RWC- Relative Water Content, SGHA- Stay green habit at anthesis, SGH30-Stay green habit at 30 days after anthesis, * Significance at 5% probability level ($p \leq 0.05$)

Leaf area (cm^2)

Flag leaf area plays an important role in wheat because the size of the leaf is positively related to the grain yield of the crop (13). Under water stress, there was a reduction in cell division due to a decrease in the turgor pressure of cells which ultimately reduced the leaf area (16). Water stress caused the senescence of leaves which results in reduction of yield (14). Leaf area plays an important role in plant development because it reflects the size of the assimilatory system.

Leaf area showed significant differences at ($p \leq 0.05$ level). Interactions between cultivars and among different water stress treatments were also significant (Table 1). Comparison of means of control and among water stress treatments were significantly different (Table 3).

In irrigated condition leaf area among plant genotypes varied between 160.5cm² to 187.7 cm² with an average of 174.1cm². Among commercial checks, C-306 had maximum (194.5cm²) whereas minimum leaf area was recorded in Gladius (170.5cm²). Among Iranian lines, IWA 8606661 had a maximum (187.7cm²) leaf area whereas the minimum leaf area was recorded in IWA 8606258 (160.5cm²) (Table 2). Under restricted-irrigated condition leaf area varied between 145.0cm² to 184.0cm² with a mean of 164.5cm² (Table 2). In commercial relevant checks, Bwl 5233 had maximum (187.0cm²) whereas minimum leaf area was recorded in PBW 660 (153.7cm²). Among Iranian lines, IWA8606741 had a maximum (184.0cm²) whereas IWA8600091 had a minimum (145.0cm²) leaf area (Table 2). In the rain-fed condition leaf area among plant genotypes varied between 108.1 cm² to 164.5cm² with an average of 136.3cm². Among commercial checks, C-518 had a maximum (168.3cm²) whereas minimum leaf area recorded in PBW 175 (142.5cm²). In Iranian lines, IWA 8606741 had the highest (164.5cm²) while IWA 8606258 had the lowest (108.1cm²) leaf area (Table 2).

Leaf area reduced due to loss of turgidity under water stress. Allahverdiyev *et al* (2) reported that leaf area in wheat cultivars due to limited surface area under water stress. A similar result was found by Gupta *et al* (9) in wheat, which is consistent with present studies.

Table 2: Range and mean value of leaf area of Iranian landraces and checks under Irrigated, Restricted irrigation and Rain-fed conditions

Leaf area				
Characters		Irrigated	Restricted irrigation	Rain-fed
Range	Min	160.5	145	108.1
	Max	187.7	184	164.5
	Mean	174.1	164.5	136.3
Mean value of checks	Gladius	170.5	157.8	151.8
	Bwl 5233	190.5	187	158.5
	C-306	194.5	181.5	160.5
	PBW660	178.8	153.7	145
	C-518	180.5	178.6	168.3
	C-591	182.0	174.5	157.5
	C- 273	182.5	174	145.2
	PBW175	187.0	155	142.5

Table 3: Mean comparison of Leaf area of Iranian landraces under Irrigated (IR), Restricted irrigation (RI) and Rain-fed (RF) conditions

Sr.No	Genotypes	IR	RI	RF
		(Control) Mean± SE	(Treatment) Mean± SE	(Treatment) Mean± SE
1	PETTERSON ML68-10	184.5a± 0.63	170.5b±0.577	145.6c±0.097
2	Cltr 15395	182a ±0.871	172a± 0.233	162.5a±0.160
3	IWA 8600064	187a±0.721	177.2b±0.866	158.6c±0.169
4	IWA 8600091	167.8a±1.154	145.0b±0.318	135.3a±0.212
5	IWA 8600179	186a± 0.550	161.7b±0.493	157.8a±0.134
6	IWA 8600191	181.2a±0.3351	161b±0.441	131.9c± 0.228
7	IWA 8600232	180a±0.577	175.7b±0.333	150.2c± 0.175
8	IWA 8600397	178.5a±0.556	175.1a±0.186	160a±0.284
9	IWA 8600435	186.5a±1.050	150.5b± 0.289	143.3c±0.256
10	IWA 8600440	187.5a±0.577	182b±0.351	161.9c±0.265
11	IWA 8600542	184.5a±0.513	170.5b ±0.208	159.5a±0.220
12	IWA 8600567	166.1a±0.854	165b±0.379	140c±0.169
13	IWA 8600596	175.1a±0.854	163b±0.371	147.3c±0.115
14	IWA 8600715	181.6a±1.401	152.8b±0.379	146c±0.171
15	IWA 8600795	176a±0.808	175.8b±0.577	146c ±0.171
16	IWA 8600796	182.8a±0.556	171.9b±0.493	161.5c±0.236
17	IWA 8600841	180.5a±0.854	170.5b±0.441	160.5a±0.169
18	IWA 8600846	180.5a±0.608	170.5b±0.441	150.5c±0.173
19	IWA 8600883	177.2a±0.513	160.5b±1.114	148.5c±0.169
20	IWA 8606258	160.5a± 0.855	153b±0.524	108c±0.169
21	IWA 8606633	181.5a±1.00	179b±0.667	160.5c±0.085
22	IWA 8606661	187.7a±0.665	174.5b±0.557	145c±0.169
23	IWA 8606739	186.4a±0.866	161.2b±1.155	157c±0.016
24	IWA 8606753	183.5a±0.577	182.5b±0.882	129.5c±0.115
25	IWA 8606741	187.6a±0.503	184b±0.441	164.5c±0.076
26	IWA 8607572	180a±0.513	172.4b± 0.882	155c±0.063
27	IWA 8607576	175.7a±1.250	166b±0.577	123.8c±0.076
28	Gladius	170.5a±1.00	157.8b±0.601	151.8c±0.086
29	Bwl 5233	190.5a±0.513	187b± 0.536	158.5c±0.085
30	C-306	194.5a±0.513	181.5b±0.667	160.5c±0.169
31	PBW660	178.8a±0.3785	153.7b ±0.66	145c±0.169
32	C-518	180.5a±0.763	178.6a±0.617	168.3a±0.063
33	C-591	182a±0.642	174.5a± 0.351	157.5a± 0.084
34	C- 273	182.5a±0.757	174b± 0.833	145.2c± 0.094
35	PBW175	187a±0.577	155b±0.318	142.5c±0.050

CD (5%)

A- Treatment	1.19
B-Treatment	4.09
AXB -Interaction	7.09
LSD (0.05)	13.4

Means in each column followed by not similar letter(s) are significantly different using Duncan's Multiple Range Test and SE stands for standard error of difference between means

Relative water content

Relative water content reduced under drought stress in wheat which affects the yield of the crop. Schonfledet *al* (18) reported that cultivars having high relative water content are more resistant to drought stress. Abbateet *al* (1) found that water-use efficiency during stress conditions in wheat was greater than well-watered conditions.

Relative water content showed significant differences at ($p \leq 0.05$ level). Interactions between cultivars and among different water stress treatments were also significant (Table 1). Comparison of means of control and among water stress treatments are significantly different (Table 5). In irrigated condition relative water content among plant genotypes varied between 58.7 to 35.3 with an average of 76.5. Among commercial checks, C-273 and C-306 had maximum (47.8) whereas minimum relative water content was recorded in PBW 175 (34.3) (Table 4). Among Iranian lines, IWA 8606661 had maximum (58.7) relative water content whereas minimum relative water content was recorded in IWA 8600232 (35.3). In restricted- irrigated condition relative water content among plant genotypes varied between 28.1 to 56.1 with an average of 42.1 (Table 4). Among commercial checks, C-306 and C-273 had maximum (40.3) whereas minimum relative water content recorded in PBW175 (31.1)

In rain-fed condition relative water content among plant genotypes varied between 22.8 to 54.3 with an average of 38.5 (Table 4). Among commercial checks, C-518 had a maximum (34.4) whereas minimum leaf area recorded in PBW175 (28.0) Among Iranian lines, IWA 8600091 had maximum (54.3) whereas minimum relative water content was recorded in IWA 860091 (22.8) (Table 4).

Table 4: Range and mean value of Relative water content of Iranian landraces and checks under irrigated, Restricted irrigation and Rain-fed conditions

Relative water Content				
Characters		Irrigated	Restricted irrigation	Rain-fed
Range	Min	58.7	28.1	22.8
	Max	35.3	56.1	54.3
	Mean	76.5	42.1	38.5
Mean value of checks	Gladius	45.4	34.4	28
	Bwl 5233	39.5	30	29.65
	C-306	47.8	40.3	32.8
	PBW660	35.5	32.4	29.45
	C-518	45.4	39.9	34.4
	C-591	39.5	34.5	29.65
	C- 273	47.8	40.3	32.8
	PBW175	34.35	31.1	28

Table 5: Mean comparison of Relative water content of Iranian landraces under Irrigated (IR), Restrictedirrigation (RI) and Rain-fed (RF) conditions

Sr.No	Genotypes	IR	RI	RF
		(Control) Mean± SE	(Treatment) Mean± SE	(Treatment) Mean± SE
1	PETTERSON ML68-10	52.8a± 0.017	46b± 0.061	39.3c± 0.056
2	Cltr 15395	57.9a± 0.087	54.8b± 0.127	51.8c±0.119
3	IWA 8600064	45.7a± 0.125	41.7b±0.137	37.7a±0.137
4	IWA 8600091	58a± 0.068	56.1b±0.144	54.3c±0.115
5	IWA 8600179	48.2a ±0.085	43.7b± 0.076	39.3c±0.126
6	IWA 8600191	50.7a± 0.144	36.7b ±0.129	22.8b±0.104
7	IWA 8600232	35.3± 0.068	32.4 ± 0.172	29.5±0.144
8	IWA 8600397	45.3a± 0.093	39.7b ±0.111	34.2c±0.094
9	IWA 8600435	39.5a± 0.094	34.5b± 0.129	29.6a±0.145
10	IWA 8600440	47.8a± 0.115	28.1b±0.144	32.7c±0.089
11	IWA 8600542	53a± 0.122	50.3b±0.176	47.7c±0.107
12	IWA 8600567	38.2a± 0.085	36.3b±0.089	34.5c±0.078
13	IWA 8600596	53.1a± 0.132	46.2a±0.077	39.4a±0.081

14	IWA 8600715	45.4a± 0.172	41.7b±0.137	38c±0.084
15	IWA 8600795	54a± 0.068	47.7b±0.213	41.4c±0.088
16	IWA 8600796	54.2a± 0.080	50.8b±0.186	43c±0.109
17	IWA 8600841	54.4a± 0.195	48b±0.085	41.5b±0.117
18	IWA 8600846	47.1a± 0.169	45b±0.125	42.9c±0.055
19	IWA 8600883	53a± 0.098	49.3b±0.103	45.5b±0.138
20	IWA 8606258	57.2a± 0.098	50.2b±0.034	43.3c±0.089
21	IWA 8606633	53.1a± 0.216	45.5b±0.093	38c±0.050
22	IWA 8606661	58.7a±0.129	50.9b±0.176	43c±0.081
23	IWA 8606739	47a± 0.297	45.1b±0.120	43.1c±0.119
24	IWA 8606753	53a± 0.169	50.5b±0.051	48c±0.053
25	IWA 8606741	53a ±0.157	50.5b±0.157	48c±0.056
26	IWA 8607572	50.5a± 0.098	46.7b±0.043	43b±0.115
27	IWA 8607576	35.5a ± 0.176	34.9a±0.087	34.4a±0.084
28	Gladius	45.4 a±0.176	34.4b±0.137	28c±0.120
29	Bwl 5233	39.5 a±0.049	30b±0.052	29.6c±0.008
30	C-306	47.8 a±0.169	40.3b±0.087	32.8c±0.140
31	PBW660	35.5a±0.221	32.4b±0.111	29.4c±0.084
32	C-518	45.4a±0.035	39.9b±0.102	34.4a±0.119
33	C-591	39.5a ±0.061	34.5b±0.087	29.6c±0.164
34	C- 273	47.8a±0.129	40.3b±0.807	32.8c±0.029
35	PBW175	34.3a± 0.251	31.1b±0.085	28c±0.096

CD (5%)	
A- Treatment	0.752
B-Treatment	2.57
AXB -Interaction	4.45
LSD (0.05)	1.063

Means in each column followed by not similar letter(s) are significantly different using Duncan's Multiple Range Test and SE stands for standard error of difference between means.

Stay-green habit at anthesis and 30 days after anthesis

Visual scale for stay- green habit at anthesis under irrigated condition 3 was recorded among Iranian

landraces and commercial check. In irrigated condition stay- green habit at anthesis among plant genotypes varied between 3.0 to 3.0 with an average of 3. Stay-green habit under restricted condition among plant genotypes varied between 1.0to 2.0 with an average of 1.5 .Under restricted irrigated most of the Iranian landraces and commercial checks lie on the visual scale of 2 except IWA 8600064and IWA 8601911. Under rain-fed condition among plant genotypes varied between 2 to 3 with an average of 2 (Table 6).

Stay green habit at anthesis and 30 days after anthesis showed non-significant difference at ($P \geq 0.05$ level). Interactions between cultivars and among different water stress treatments were significant (Table 1). Comparison of means of control and among water stress treatments are significantly different (Table 8 and 9). Stay- green habit after 30 days at anthesis under irrigated condition among plant genotypes varied between 2 to 2 with an average of 2 and under restricted condition ranged between 1 to 2 with an average of 1.5 Under rain-fed condition staygreen habit after 30 days anthesis among plant genotypes lie in the range of 2-1 with a mean of 1.5 (Table 7).

Table 6: Range and mean value of Stay -green habit at anthesis of Iranian landraces and checks under Irrigated, Restricted Irrigation and Rain-fed conditions

Stay- green habit at anthesis				
Characters		Irrigated	Restricted irrigation	Rain-fed
Range	Min	3	1	2
	Max	3	2	3
	Mean	3	1.5	2
Mean value of checks	Gladius	3	2	2
	Bw15233	3	2	2
	C-306	3	2	2
	PBW660	3	2	2
	C-518	3	2	2
	C-591	3	2	2
	C- 273	3	2	2
	PBW175	3	2.	2

Table 7: Range and mean value of Stay green habit 30 days after anthesis of Iranian landraces and checks under Irrigated, Restricted irrigation and Rain-fed conditions

Stay green habit 30 days after anthesis				
Characters		Irrigated	Restricted irrigation	Rain-fed
Range	Min	2	2	2
	Max	2	1	1
	Mean	2	1.5	1.5
Mean value of checks	Gladius	2	2	2
	Bw15233	2	2	2
	C-306	2	2	2
	PBW660	2	2	2
	C-518	2	2	2
	C-591	2	2	2
	C- 273	2	2	2
	PBW175	2	2	2

Table 8: Mean comparison of stay green habit of Iranian landraces under Irrigated (IR), Restricted irrigation (RI) and Rain-fed (RF) conditions

Sr.No	Genotypes	IR	RI	RF
		(Control) Mean± SE	(Treatment) Mean± SE	(Treatment) Mean± SE
1	PETTERSON ML68-10	3a±0.097	2.5b± 0.048	2c±0.160
2	Cltr 15395	3a±0	2.5b±0.048	2c±0.084
3	IWA 8600064	3a±0.05	2.25b±0.051	1.5c±0.04
4	IWA 8600091	3a±0.04	2.5b±0.078	2c±0
5	IWA 8600179	3a±0	2.75b±0.0425	2.5b±0.048
6	IWA 8600191	3a±0.058	2.25b±0.048	1.5c±0.084
7	IWA 8600232	3a±0	3a±0.016	3a±0.0487
8	IWA 8600397	3a±0.097	3a±0.019	3a±0.577
9	IWA 8600435	3a±0.097	2.5b±0.009	2c±0.029
10	IWA 8600440	3a±0	2.5b±0.054	2c±0.0487
11	IWA 8600542	3a±0.058	2.5b±0.048	2c±0.084
12	IWA 8600567	3a±0.04	2.5b±0.084	2c±0.01
13	IWA 8600596	3a±0	2.5b±0.048	2c±0.08
14	IWA 8600715	3a±0.058	2.75b±0.09	2.5b±0.05
15	IWA 8600795	3a±0	2.5b±0.029	2c±0.57
16	IWA 8600796	3a±0.09	2.5b±0.019	2c±0.84
17	IWA 8600841	3a±0.058	2.75b±0.009	2.5b±0.04
18	IWA 8600846	3a±0	2.5b±0.054	2c±0.04
19	IWA 8600883	3a±0	2.75b±0.048	2.5b±0.57
20	IWA 8606258	3a±0.097	2.75b±0.084	2.5±b0.02
21	IWA 8606633	3a±0.097	2.5b±0.048	2c±0.048
22	IWA 8606661	3a±0.097	2.75±b0.097	2.5b±0.084
23	IWA 8606739	3a±0	2.5±b0.084	2c±0.016
24	IWA 8606753	3a±0.05	2.5b±0.016	2c± 0.083
25	IWA 8606741	3a±0.04	2.5b±0.083	2c±0.054
26	IWA 8607572	3a±0.04	2.5b±0.054	2c±0.0975
27	IWA 8607576	3a±0	2.5b±0.097	2c±0.0845
28	Gladius	3a±0	2.5b±0.084	2c±0.0447
29	Bwl 5233	3a±0.05	2.5b±0.044	2c±0.0833
30	C-306	3a±0.09	2.75b±0.054	2.5b±0.0543
31	PBW660	3a±0.09	2.5b±0.093	2c± 0.0975
32	C-518	3a±0	2.5b±0.084	2c± 0.0845
33	C-591	3a±0.058	2.5b±0.044	2c±0.0297
34	C- 273	3a±0.04	2.5b±0.487	2c±0.0487
35	PBW175	3a±0	2.75b±0.097	2.5b± 0.0845

CD (5%)

A- Treatment	NS
B-Treatment	NS
AXB -Interaction	0.908
LSD (0.05)	0.216

Means in each column followed by not similar letter(s) are significantly different using Duncan's Multiple Range Test and SE stands for standard error of difference between means

Table 9: Mean comparison of stay green habit of Iranian landraces under Irrigated (IR), restricted irrigation (RI) and Rain-fed (RF) conditions

Sr.No	Genotypes	IR	RI	RF
		(Control) Mean± SE	(Treatment) Mean± SE	(Treatment) Mean± SE
1	PETTERSON ML68-10	2.3a± 0.048	2b±0.054	1.9a±0.093
2	Cltr 15395	2.4a±0.0975	2.1b±0.039	2a±0.0609
3	IWA 8600064	2.7a± 0.054	2.4b±0.039	2.3a±0.0762
4	IWA 8600091	2.8a± 0.0447	2.7b±0.029	2.7c±0.083
5	IWA 8600179	2.7a± 0.09	2.1b±0.035	2a±0.048
6	IWA 8600191	2.5a±0.025	2.2b±0.054	2.1a±0.009
7	IWA 8600232	2.5a±0.093	2.5b±0.009	2c±0.083
8	IWA 8600397	2.7a±0.060	2.4b±0.044	2.1c±0.076
9	IWA 8600435	2.5a±0.076	2.4b±0.009	2.3a±0.009
10	IWA 8600440	2.6a± 0.083	2.4b±0.009	2.3a±0.009
11	IWA 8600542	2.5a±0.048	2.4b±0.016	2.1c±0.035
12	IWA 8600567	2.7a±0.009	2.5b±0.009	2.3c±0.019
13	IWA 8600596	2.6a± 0.083	2.5b±0.079	2c±0.019
14	IWA 8600715	2.5a± 0.076	2.4b±0.016	2.3a±0.029
15	IWA 8600795	2.4a± 0.009	2.2b±0.009	2.2c±0.009
16	IWA 8600796	2.7a±0.009	2.5b±0.025	2.6a±0.016
17	IWA 8600841	2.5a±0.035	2.4a±0.009	2.3a±0.04
18	IWA 8600846	2.7a±0.019	2.5b±0.009	2.3a±0.04
19	IWA 8600883	2.6a±0.019	2.4b±0.009	2.3a±0.060
20	IWA 8606258	2.5a±0.029	2.2±0.044	2.1a±0.076
21	IWA 8606633	2.6±0.009	2.4b±0.009	2.3a±0.054
22	IWA 8606661	2.5a±0.0116	2.4b±0.009	2.3a±0.009
23	IWA 8606739	2.7a± 0.044	2.5b±0.016	2.3b±0.044

24	IWA 8606753	2.6a± 0.044	2.4b±0.009	2.2c±0.009
25	IWA 8606741	2.8a± 0.06	2.6b±0.079	2.4c±0.009
26	IWA 8607572	2.4a± 0.076	2.3b±0.016	2.1±0.016
27	IWA 8607576	2.6a± 0.054	2.4b±0.009	2.3c±0.009
28	Gladius	2.5a± 0.016	2.4±0.025	2.3a±0.079
29	Bwl 5233	2.6a± 0.009	2.4b±0.009	2.2c±0.016
30	C-306	2.6a±0.016	2.4b±0.009	2.3a±0.009
31	PBW660	2.7a±0.44	2.4b±0.009	2.2c±0.025
32	C-518	2.5a± 0.04	2.4b±0.009	2.3a±0.009
33	C-591	2.5a±0.076	2.4b±0.079	2.3c±0.009
34	C- 273	2.8a±0.09	2.7b±0.009	2.7b±0.009
35	PBW175	2.5a±0.009	2.4b±0.016	2.4b±0.447

CD (5%)

A- Treatment

NS

B-Treatment

NS

AXB -Interaction

0.78

LSD (0.05)

0.1322

Means in each column followed by not similar letter(s) are significantly different using Duncan's Multiple Range Test and SE stands for standard error of difference between means

Conclusions

Generally from the present study, it is concluded that there is a reduction in leaf area, relative water content and stay-green habit of Iranian landraces under water stress conditions i.e. under restricted irrigated and rain-fed conditions. Leaf area decreases due to a reduction in turgor pressure of cell which ultimately reduces the leaf area which affects the rate of photosynthesis and yield of the crop. Relative water content among Iranian landraces under irrigated condition is more than that of under restricted irrigated and rain-fed condition due to closure of stomata which increase the transpiration rate in the crop. Genotypes having stay-green character contributes assimilates needed during the filling time. During drought stress, stay-green character among landraces under restricted irrigated and rain-fed condition reduced only 50 % of foliar tissue shows the green color as compared to irrigated condition.

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