INT. J. BIOL. BIOTECH., 5 (1-2): 65-69, 2008.

DROUGHT TOLERANCE IN WHEAT GENOTYPES

Yousaf Ali and J. Akhter

Nuclear institute for Agriculture and Biology P. O. Box 128, Jhang Road, Faisalabad, Pakistan
Email: Yousafpro_niab@yahoo.com

ABSTRACT

Ten genotypes of wheat were studied at three water regimes by applying three, two and only one irrigation at different intervals/stages. The experiment was conducted at NIAB Farm, Faisalabad, Pakistan on clay loam soil applying normal doses of N and P fertilizer during 2005-06 in three replications keeping varieties as main plot and treatments as subplots. Date for seven morphological characters viz. Plant height, productive tillers per plant, spike lets per spike, spike length, grain per spike, yield per plant and 1000 grain weight were recorded and subjected to analysis for variances and means were computed following DMR test. Effect of water stress on different morphological attributes in all treatments showed significant differences. All the seven plant attributes reduced at less number of irrigations while sterility percentage was increased at less moisture conditions. Maximum grain yield per plant was recorded in varieties Sarsabz and Sarcc-3. This might be due different genetic makeup of the breeding lines and behaviour and interaction in water stress environment. It may be concluded that for achieving maximum economic yield Sarsabz and Sarcc-3 can be grown in water stress environments.

Key-words:

INTRODUCTION

The main source of irrigation water in Pakistan is from vast canal system which is however, inadequate to meet crop water requirements and mainly supplemented with ground water (Ramzan, 2000). Water being the most scarce resource demands that it must be used most judiciously without wasting a single drop of it. Irrigation system of the Pakistan is the largest contiguous return of canals in the world. The irrigation area has considerably increased from 10m ha to 18m ha since 1960. A significant portion (25% or 32Bm^3) of the divested water is lost in the conveyance system. The losses in the field due to poor farm layouts, unleveled fields and wasteful irrigation practices are estimated as 45% or 43Bm^3. Frequent droughts also have great adverse impact on the economy of the country. Further more the droughts affect large geographical areas and may last for months and in some cases may extend over several years (Majeed *et al*., 2002). Keeping in view the shortage of water the present research was planned to estimate the optimum water requirement of wheat crop and effect of water stress on the production of its economic yield.

MATERIALS AND METHODS

Ten genotypes wheat viz. 2006, 2005, 2134, 2013, Pasban-90, Marvi, Sarsabz, Sarcc-3, Sarcc-2 and Sarcc-1 were evaluated at three different water regimes viz. three irrigation, two irrigations and only one irrigation to the crop. At each time of irrigation the field was flooded with canal water up to three inches depth approximately. The experiment was conducted at NIAB Farm Faisalabad on clay loam type soil, seeds were sown in (3m x3m) in a randomized block design in three replications with row spacing of 30cm, keeping varieties as main plant and treatment as subplot during the year 2005-06. The fertilizers P (single super phosphate @ 200kg/ha) and N (urea @120kg/ha) were applied to all plants. Weeds were removed manually as and when required.

Seven morphological characteristics viz. plant height, number of productive tillers per plant, spike lets per spike, spike length (cm), grains per spike, yield per plant (g) and 1000 grain weight (g) were recorded on plant and plot basis and data thus collected were subjected to analysis of variance (Steel and Torrie, 1980) and means were compared following DMF test.

RESULTS AND DISCUSSION

Analysis of variance of grain yield per plant of wheat genotypes at different treatments of irrigation showed that varieties irrigation treatments exhibited highly significant differences but varieties x irrigation treatments showed non-significant difference (Table 1)

Effect of water stress on different morphological attributes indicated that all treatments showed significant differences, plant height (96.23cm), number of productive tillers per plant (10.8), spike lets per spike (17.8), spike length (11.38cm), number of grain/spike (49.3), yield per plant (18.42gms), and 1000 grain weight (43.3gms) showed maximum values at maximum level of irrigations (T3). The values decreased at the stress was increased and lowest values of plant height (92.0cm), productive tillers per plant (9.03), spike lets per spike (15.87), spike length (10.39cm) grains per spike (49.1), yield per plant (13.10gms), and 1000 grain weight (41.93gms) were noted in treatment (T1) where only one irrigation was applied (Table 2).

Genotypes Sarcc-3 obtained maximum plant height (128.6cm) followed by variety Sarsabz (100.8cm), Sarcc-2 and Sarcc-1. The lowest plant height was attained by Pasban-90 (84.6cm); (Table 4). Number of productive tillers were highest is Sarsabz (11.44) and lowest number of tillers were recorded in 2134 (7.44). Maximum of spike lets per spike (18.55) were recorded in Sarsabz and minimum spike lets per spike were noted in Sarcc-1 (14.55). Maximum spike length was also noted in Sarsabz (12.20cm) and minimum spike length was noted in Pasban-90 (9.02cm). Number of grains per spike was higher in Marvi (58.77) while the lowest numbers of grains per spike were noted in Sarcc-1 (41.55). Yield per plant was more in Sarsabz (21.30gms) followed by Sarcc03 (17.14gms). The lowest yield per plant was noted in Pasban-90 (12.49gms). Maximum 1000 grain weight was recorded in Sarcc-3 (53.01gms) and Sarsabz gave only (36.22gms) which was the lowest in all the genotypes tested.

Regarding interaction between varieties x treatments (Table 3) varieties Sarcc-3 attained maximum height (140.73cm) in T3 where maximum irrigations were applied. Maximum number of productive tillers per plant were noted in 2013 (12.33), number of spike lets per spike were more in Marvi (20.33), spike length was highest in Sarsabz (13.27cm).Maximum number of grain per spike were noted in Marvi (59.67), 1000 grain weight in Sarcc-3 (55.37g) and yield per plant (23.47 g) in Sarsabz inT3.

The seed yield is the ultimate product of many physiological processes occurring throughout the development of the plant till it dies. Grain yield depends on the number of fertile tillers surviving up to maturity, spike length, fertile spikelets, number of seeds per spike and 1000 grain weight. In wheat water deficit reduced all the yield components viz. plant height, number of productive tillers per plant, spike lets per spike, spike length, grains per spike, yield per plant and 1000 grain weight. The yield per plant was ultimately reduced due to stress on yield components. The sterility as more pronounced in less irrigation treatments as compared to T2 and T3 where more number of irrigations were applied. The reduction in yield per plant was only up to 20% in case of Sarsabz followed by Sarcc-3 in which the reduction in yield was 28%. In case of spike length the reduction in Sarsabz was up to 15% while in Sarcc-3 it was only 9% our results are in accordance with the results of Ashraf (1998). He studied eight wheat genotypes against water stress. He noted that number of tillers per plant and number of grain per ear were reduced by water stress. He noted that reduction in tillers per plant was 22% while Talukudar *et al*. (1989) and Khan *et al*. (1993) showed that the grain yield reduction caused by water stress was mainly due to the reduction in 1000 grain weight.

Conclusion

It may be concluded that for achieving maximum economic yield in stressful environment varieties Sarsabz and Sarcc-3 are suitable to avoid drastic reduction in yield. These lines have the potential to grow in less water and can boost up the wheat yield in barani areas of Pakistan.

Table 1. Performance of Wheat genotypes in different water regimes during the year 2005-06.

Table 1(a): Analysis of Variance table (plant height cm)

Values	Source	Degree of freedom (d. f)	Sum of squares (s. s)	Mean square (m. s)	F value	Prob.
1	Replication	2	217.071	108.535	2.7723^{NS}	0.0708
2	Genotype	9	14147.846	1571.983	40.1524**	0.0000
4	Irrigation	2	264.256	132.128	3.3749*	0.0411
6	AB (2x4)	18	1275.853	70.881	1.8105*	0.0459
7	Error	58	2270.722	39.150		
	Total	89	18175.749			

Table 1(b): Analysis of Variance table (productive tillers/plant)

Values	Source	Degree of freedom (d. f)	Sum of squares (s. s)	Mean square (m. s)	F value	Prob.
1	Replication	2	10.289	5.144	2.8405^{NS}	0.0665
2	Genotype	9	140.622	15.625	8.6271**	0.0000
4	Irrigation	2	67.489	33.744	18.6319	0.0000
6	AB (2x4)	18	32.511	1.806	0.9973^{NS}	
7	Error	58	105.044	1.811		
	Total	89	355.956			

Table 1(c): Analysis of Variance table (spike lets/spike)

Values	Source	Degree of freedom (d. f)	Sum of squares (s. s)	Mean square (m. s)	F value	Prob.
1	Replication	2	1.756	0.878	0.2867^{NS}	
2	Genotype	9	113.344	12.594	4.1134**	0.0004
4	Irrigation	2	56.156	28.078	9.1707**	0.0003
6	AB (2x4)	18	72.956	4.053	1.3238^{NS}	0.2078
7	Error	58	1.77.578	3.062		
	Total	89	421.789			

Table 1(d): Analysis of Variance table (spike length cm)

Values	Source	Degree of freedom (d. f)	Sum of squares (s. s)	Mean square (m. s)	F value	Prob.
1	Replication	2	0.560	0.280	0.2005^{NS}	
2	Genotype	9	55.277	6.142	4.3965**	0.0002
4	Irrigation	2	17.638	8.819	6.3129**	0.0033
6	AB (2x4)	18	18.191	1.011	0.7234^{NS}	
7	Error	58	81.026	1.397		
	Total	89	172.693			

Table 1(e): Analysis of Variance table (no. of grain/spike)

Values	Source	Degree of freedom (d. f)	Sum of squares (s. s)	Mean square (m. s)	F value	Prob.
1	Replication	2	41.356	20.678	0.5181^{NS}	
2	Genotype	9	3899.333	433.259	10.8565**	0.0000
4	Irrigation	2	1.356	0.678	0.0170^{NS}	
6	AB (2x4)	18	2032.200	112.900	2.8290**	0.0014
7	Error	58	2314.644	39.908		
	Total	89	8288.889			

Table 1(f): Analysis of Variance table (yield/plant gms)

Values	Source	Degree of freedom (d. f)	Sum of squares (s. s)	Mean square (m. s)	F value	Prob.
1	Replication	2	3.078	1.539	0.3512^{NS}	
2	Genotype	9	479.865	53.318	12.1659**	0.0000
4	Irrigation	2	432.054	216.027	49.2919**	0.0000
6	AB (2x4)	18	89.702	4.983	1.1371^{NS}	0.3427
7	Error	58	254.191	4.383		
	Total	89	1258.889			

Table 1(g): Analysis of Variance table (1000 grain weight gms)

Values	Source	Degree of freedom (d. f)	Sum of squares (s. s)	Mean square (m. s)	F value	Prob.
1	Replication	2	19.385	9.692	0.9406^{NS}	
2	Genotype	9	2004.184	222.687	21.6100**	0.0000
4	Irrigation	2	30.075	15.037	1.4593^{NS}	0.2408
6	AB (2x4)	18	286.476	15.915	1.5445^{NS}	0.1077
7	Error	58	597.679	10.305		
	Total	89	2937.799			

Table 2. Effect of water stress on different morphological characteristics of wheat 2005-06

Characters	T1	T2	T3
Plant height (cm)	92.070B	93.67AB	96.23A
Productive tillers/plant	9.03B	8.9B	10.8A
Spike lets/spike	15.87B	16.77B	17.8A
Spike length (cm)	10.39B	11.26A	11.38A
Grain/spike	49.1A	49.00A	49.3A
Yield/plant (g)	13.10C	15.60B	18.42A
1000 grain weight (g)	41.93A	42.3A	43.3A

T1 = One irrigation; T2 = Two irrigation; T3 = Three irrigation

Table 3a. Mean performance of morphological attributes of wheat genotypes at different irrigation levels 2005-06.

Sr. No	Genotypes Wheat	Plant height (cm)			Productive tillers/plant			Spike lets/spike			Spike length (cm)		
		T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3
1	2006	84.33 EFGH	85.73 DEFGH	86.20 DEFGH	7.67 GHI	7.67 FGHI	10.0 ABCDEFG	16.33 BCDEF	18.23 ABCD	19.67 AB	11.17 ABCDEF	11.77 ABCDE	11.40 ABCDEF
2	2005	82.77 FGH	90.1 CDEFG	100.23 BC	8.67 DEFGH	10.0 ABCDEFG	12.0 AB	15.67 CDEF	15.67 CDEF	19.0 ABC	10.33 CDEFG	10.93 ABCDEF	11.20 ANCDEF
3	2134	91.20 CDEFG	91.03 CDEFG	84.40 EFGH	8.67 DEF	5.67 I	8.0 FGHI	15.67 CDEF	17.0 ABCDEF	16.33 BCDEF	10.37 CDEFG	10.70 BCDEF	11.43 ABCDEF
4	2013	77.67 H	86.93 DEFGH	96.60 BCDE	10.67 ABCDE	10.0 ABCDEFG	12.33 A	16.33 BCDEF	17.0 ABCDEF	17.0 ABCDEF	10.37 CDEFG	11.0 ABCDEF	10.90 BCDEF
5	Pasban-90	81.67 GH	86.0 DEFGH	86.27 DEFGH	8.0 EFGHI	8.67 DEFGH	11.0 ABCD	13.67 F	16.33 BCDEF	17.0 ABCDEF	8.27 G	9.50 EFG	9.30 FG
6	Marvi	84.73 EFGH	85.37 DEFGH	85.20 DEFGH	8.67 DEFGH	9.3 CDEFGH	11.67 ABC	16.33 BEDEF	15.33 DEF	20.33 A	10.90 BCDEF	11.53 ABCDEF	12.20 ABC
7	Sarsabz	105.17 B	92.43 CDEFG	105.1 B	11.67 ABC	10.67 ABCDE	12.0 AB	17.0 ABCDEF	19.0 ABC	19.67 AB	11.30 ABCDEF	12.03 ABCD	13.27 A
8	Sarcc-3	126.83 A	128.40 A	130.73 A	7.67 FFGHI	7.0 HI	9.0 DEFGH	16.33 BCDEF	17.67 ABCDE	19.0 ABC	10.57 CDEF	10.70 BCDEF	11.63 ABCDEF
9	Sarcc-2	94.77 BCDEF	93.27 CDEFG	94.47 BCDEF	10.0 ABCDEFG	10.33 ABCEDF	11.0 ABCD	17.0 ABCDEF	16.33 BCDEF	15.67 CDEF	10.93 ABCDEF	11.47 ABCDEF	11.83 ABCDE
10	Sarcc-1	91.57 CDEFG	97.43 BCD	93.13 CDEFG	8.67 DEFGH	9.67 BCDEFG	11.0 ABCD	14.33 EF	15.0 DEF	14.33 EF	9.67 DEFG	12.97 AB	10.63 BCDEF

Table 3. Mean performance of morphological attributes of wheat genotypes at different irrigation levels 2005-06

Sr. No	Genotypes Wheat	Grain/spike			Yield/plant (g)			1000 grains wt. (g)		
		T1	T2	T3	T1	T2	T3	T1	T2	T3
1	2006	59.0 ABC	53.0 BCDEFGH	56.67 BCDE	14.73 EFGHIJK	13.02 IJKLM	20.22 ABC	39.50 DEFG	40.30 CDEFG	43.23 CD
2	2005	38.33 JK	56.0 BCDEF	51.67 BCEDFGHI	13.74 HIJKL	16.67 CDEFGHI	17.80 BCDEFGH	44.23 CD	45.30 BCD	43.90 CD
3	2134	48.67 BCDEFGHIJ	55.67 BCDFG	46.33 DEFGHIJK	12.79 IJKLM	13.94 GHIJKL	16.67 CDEFGHI	44.30 CD	44.27 CD	44.33 CD
4	2013	52.33 BCDEFGH	53.0 BCDEFGH	52.67 BCDEFGH	10.38 LM	15.86 DEFGHIJ	18.10 BCDEF	35.20 FG	40.40 CDEFG	40.27 CDEFG
5	Pasban-90	35.33 K	45.0 DEFGHIJK	37.0 JK	9.52 M	12.21 JKLM	15.75 DEFGHIJ	41.23 CDEF	41.0 CDEF	41.70 CDE
6	Marvi	70.0 A	46.67 CDEFGHIJK	59.67 AB	11.54 KLM	16.17 DEFGHIJ	17.88 BCDEFG	36.40 EFG	39.80 DEFG	34.43 G
7	Sarsabz	57.33 BCD	52.33 BCDEFGH	60.33 AB	18.75 BCDE	21.71 AB	83.47 A	36.1 EFG	36.37 EFG	36.23 EFG
8	Sarcc-3	43.33 GHIJK	42.0 HIJK	44.0 FGHIJK	14.92 EFGHIJK	15.76 DEFGHIJ	20.76 AB	50.77 AB	52.90 A	55.37 A
9	Sarcc-2	39.67 IJK	48.0 BCDEFGHIJ	44.67 EFGHIJK	12.89 IJKLM	16.69 CDEFGHI	19.04 BCD	46.37 BC	46.23 BC	46.60 BC
10	Sarcc-1	47.0 CDEFGHIJK	38.0 JK	39.67 IJK	11.34 KLM	13.68 IJKL	14.44 FGHIJK	45.27 BCD	46.45 BC	46.96 BC

Table 4. Mean values of different water regimes estimated for various wheat genotypes

Sr. No	Genotypes	Plant height (cm)	Productive tillers/plant	Spike lets/spike	Spike length (cm)	Grain/spike	Yield/plant	1000 grains wt. (gms)
1	2006	85.4 D	8.44 DEF	18.11 AB	11.44 AB	56.22 AB	15.99 BC	41.01 DE
2	2005	91.0 CD	10.22 ABC	16.77 ABC	10.82 B	48.66 CDE	16.06 BC	44.47 BC
3	2134	88.8 CD	7.44 F	16.33 BCD	10.83 B	50.22 BCD	14.49 CDE	44.30 BCD
4	2013	87.0 D	11.0 AB	16.77 ABC	10.75 B	52.66 ABC	14.77 CD	38.62 EF
5	Pasban-90	84.6 D	9.22 CDE	15.66 CD	9.02 C	39.11 F	12.49 E	41.31 CDE
6	Marvi	85.1 D	9.88 BC	17.33 ABC	11.54 AB	58.77 A	15.19 BCD	36.87 F
7	Sarsabz	100.8 B	11.44 A	18.55 A	12.20 A	56.66 AB	21.30 A	36.22 F
8	Sarcc-3	128.6 A	7.88 EF	17.66 AB	10.96 AB	43.11 EF	17.14 B	53.01 A
9	Sarcc-2	94.1 C	10.44 ABC	16.33 BCD	11.41 AB	44.11 DEF	16.20 BC	46.40 B
10	Sarcc-1	94.0 C	9.77 BCD	14.55 D	11.08 AB	41.55 F	13.15 DE	42.89 CD

REFERENCES

Ashraf, M.Y. (1998). Yield and yield components response of wheat (*triticum aestivum* L.) genotypes grown under different soil water deficit conditions. *Acta Agronomica Hungarica*, 46(1): 45-51.

Khan,A.h., M.Y. Ashraf and A.R. Azmi (1993). Osmotic adjustmentin wheat. A response to water stress *Pak. J. Sci: Ind.Res*., 36:151-155.

Majeed. A., A. Azam and A. Mumtaz (2002). Drought and water management strategies in Pakstan. In: *Proceedings of the SAARC workshop on drought and water management strategies* (M.A Kahlown, N. Yasmin and M. Ashraf eds.)16-18 Sep. 2002. Lahore, Pakistan, pp 119-135.

Ramzan, M.C. (2000). Ground water quality variation in Pak. *Proceedings of Regional Ground Water Seminar*, held at Islamabad, Oct. 9-11-2000.

Steel, R. G. D. and T. H. Torrie (1980). *Principles and Procedures of Statistics*. 2nd edition. Mc Graw Hll Book Co. Inc. New York. Pp. 481.

Talukuder, M.S.U., M.A. Islam, M. Ahmad, M.S.U. Ghaiyan and M.A. Majid (1989). Yield and water use of wheat as affected by water stress. *Pak. J. Sci. Ind. Res*., 32:50-55.

(*Accepted for publication December 2007*)