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SHORT COMMUNICATION

EFFECT OF MOISTURE STRESS ON PLANT WATER RELATIONS AND YIELD OF DIFFERENT WHEAT GENOTYPES

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A field experiment was conducted to study the effect of moisture stress on wheat genotypes grown under irrigated, mild stress and severe stress conditions. Canopy temperature depression (CTD), relative water content (RWC) and water potential (Ψ_w) decreased significantly with increase in moisture stress. The CTD was higher in genotypes IWP 72, PBW 175 and C 306 both in mild as well as severe moisture stress by keeping their canopy cooler. Maximum RWC was found in PBW 175 followed by IWP 72 and PBW 343. Moreover, these genotypes exhibited higher water potential. Yield and its attributes for all genotypes decreased significantly in the stressed environments. The per cent reduction in grain yield over control was 23.8 and 57.6 in mild and severely stressed treatments respectively. Maximum reduction in yield (66.8%) under severe stress was observed in genotype PDW 233. However, genotype C 306 exhibited least reduction in yield i.e. 7.8% and 39.7% under mild and severe stress, respectively. It can threfore, be concluded that the high yielding genotypes should maintain cooler canopy, higher internal water status and yield attributing characters under the depleting soil moisture condition.

Key words : **Canopy temperature depression, leaf water potential, moisture stress, relative water conent, wheat, yield.**

Rainfed agriculture in India constitutes about 63% land area. Wheat production in rainfed areas is hampered by moisture stress of varied degree and duration during growing season (Singh 1998). Decreased water potential and RWC lead to reduced photosynthesis, increased stomatal resistance (Rekika *et al.* 1998) and subsequently lower yields. Canopy temperature has also been related to stomatal conductance, which is turgor driven process and is associated with yield in wheat (Kumar and Tripathi 1991), Indian mustard (Chaturvedi *et al.* 1999) and finger millet (Ankegowda *et al.* 1999). The present study was therefore, carried out to evaluate the usefulness of different plant water relation parameters as indices for screening and selection of drought tolerant wheat genotypes.

A field experiment was conducted to study the effect of moisture stress on wheat genotypes during *rabi* season at Research Farm of CCS Haryana Agricultural University, Hisar. The soil of the exprimental field was slightly alkaline in reaction (pH 8.1) and sandy loam in texture. The experiment was laid-out in factorial RBD with three replications. Seeds of 15 contrasting genotypes were sown in six rows at 22.5 cm spacing of 3.0m length. The moisture stress treatments were imposed by not applying any irrigation (severe stress) and applying two irrigations at 35 and 65 DAS (mild stress) against the normal irrigated control with four irrigations at 35, 65, 90 and 115 DAS.

The plant water relation parameters were recorded at anthesis stage (95 DAS) between 1200 to 1400 h. The leaf water potential (Ψ_w) was measured by Pressure Chamber (PMS Instrument Co., Oregon, USA), relative water content (RWC) of flag leaf following Weatherley (1950) and canopy temperature depression (CTD) using Infra-red thermometer (Teletamp AG42). Yield attributes were recorded from five plant samples taken from each plot at harvest. Grain and biological yields were recorded from individual plots and expressed in kg ha^{-1}. The statistical analysis for different parameters and yield were worked out as per standard procedures.

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The increased level of moisture stress decreased the Ψ_w and RWC, wheareas CTD increased significantly (Table 1). Among the genotypes, the highest Ψ_w and RWC was observed in PBW 175 closely followed by PBW 343 and IWP 72, which were statistically at par. Whereas, Ψ_w and RWC were lowest in Sere-Punjab and PDW 233 respectively. The lowest CTD was recorded in IWP 72 followed by C 306, K 9107 and PBW 175, which did not differ significantly among themselves. The highest CTD was recorded in Sere-Punjab, PDW 233 and HUW 318. The interaction of moisture stress level with genotypes was significant in all the three plant water relation parameters. The relative reduction in Ψ_w with increased moisture stress from mild to severe was minimum in PBW 343 although highest value of Ψ_w under severely stressed treatment was in PBW 175 and IWP 72. Almost similar trend was observed in RWC and CTD in different genotypes under severely stressed environment. These results are in confirmity with those of Martin *et al.* 1997 in wheat. Enhanced RWC helped the plants to perform various physiological processes and biochemical metabolism more efficiently even under low soil moisture condition (Rekika *et al.* 1998). Cooler canopy of these genotypes might be associated with better water uptake/ efficient root and water status for longer period, resulting in stomata being open, thus maintaining high transpiration rate even during moisture stress (Kumar and Tripathi 1991, Chaturvedi *et al.* 1999).

Grain yield and its attributes were reduced significantly under water stress in all the genotypes. The per cent reduction in grain yield was 23.8 and 57.6 over control in mild and severely stressed environment, respectively. These variations were due to reduction in various yield attributes i.e. number of productive tillers per plant (5 and 28%), test weight (11 and 25%) and number of grains per spike (16 and 37%) under mild and severe stressed, respectively. The highest grain yield was recorded in PBW 175 followed by PBW 343 and IWP 72 under all the three conditions, which were at par statistically. The gene pool of these genotypes was quite different, as the genotypic variability in grain yield was 48%. The genotypic variability reduced with the increase in moisture stress indicated that under stressed environment genotype like PBW 175, PBW 343 and IWP 72 could not express fully and that is why the per cent reduction in grain yield under stress was more. The highest grain yield in PBW 175 was because of highest test weight, grains per spike and number of tillers per plant (Table 2). These results are in line with those reported by Karim *et al.* (2000) and Kumar and Tripathi (1991). The lowest reduction (39.7%) in grain yield under severely stressed environment over

Table 1. Effect of moisture stress on plant water relations of wheat gentoypes

Genotypes	Leaf water potential (-bars)				Relative water content (%)				Canopy temp depression (°C)			
	Irriga-ted	Mild stress	Severe stress	Mean	Irriga-ted	Mild stress	Severe stress	Mean	Irriga-ted	Mild stress	Severe stress	Mean
C306	15.9	21.6	26.1	21.2	73.6	64.9	60.2	66.2	-0.4	-0.1	0.8	0.1
HD2329	16.6	23.6	28.6	22.9	68.0	64.2	61.2	64.5	0.3	0.6	0.9	0.6
HUW318	17.9	25.6	29.6	24.4	71.3	64.2	60.6	65.4	-0.6	0.9	1.7	0.7
IWP72	17.6	19.9	23.1	20.2	70.9	68.3	67.1	68.8	-0.8	0.3	0.6	0.0
K9107	17.9	26.6	24.1	22.9	72.8	67.1	60.8	66.9	-1.0	0.4	0.8	0.1
LOK1	18.6	22.1	28.1	22.9	70.6	68.1	60.9	66.5	-0.4	0.6	0.9	0.4
PBW175	17.1	19.6	23.1	19.9	73.3	72.1	67.7	71.0	-0.8	0.4	0.7	0.1
PDW233	19.6	25.6	34.1	26.4	65.8	62.8	60.6	63.1	-1.1	1.5	1.7	0.7
PBW343	18.4	18.6	23.6	20.2	69.1	67.6	67.4	68.0	-0.8	0.3	1.0	0.2
Raj 3765	18.1	21.6	34.1	24.6	74.0	65.6	62.0	67.2	-0.8	0.6	1.2	0.3
Sere Punjab	19.9	27.1	36.6	27.9	71.2	66.1	60.6	66.0	-1.1	1.3	1.9	0.7
UP2338	15.9	26.6	30.1	24.2	71.0	68.7	62.9	67.5	-0.4	0.4	1.7	0.6
WH147	16.6	24.1	30.1	23.6	68.1	67.5	62.9	66.2	-0.6	0.6	1.0	0.3
WH533	16.9	24.1	29.1	23.4	70.0	67.2	65.1	67.4	-1.5	1.3	1.3	0.4
WH542	16.9	24.6	28.4	23.3	71.0	68.1	60.2	66.4	-0.3	0.7	0.9	0.4
Mean	17.6	23.4	28.6	23.2	70.7	66.8	62.7	66.7	-0.7	0.7	1.1	0.4
	G	E	GxE		G	E	GxE		G	E	GxE	
CD at 5%	0.4	0.6	0.8		4.5	3.6	7.8		0.2	0.4	1.0	

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Table 2. Effect of moisture stress on yield attributes of wheat genotyppes

Genotypes	No. of productive tillers/plant				No. of grains/spike				1000 grain wt. (g)				Grain yield (kg ha^{-1})				Harvest index (%)			
	Irrigated	Mild Stress	Severe Stress	Mean	Irrigated	Mild Stress	Severe Stress	Mean	Irrigated	Mild Stress	Severe Stress	Mean	Irrigated	Mild Stress	Severe Stress	Mean	Irrigated	Mild Stress	Severe Stress	Mean
C306	4.1	3.8	2.6	3.5	35.9	28.7	18.0	27.5	42.0	40.3	32.5	38.3	3581	3217	2060	2953	35.1	37.9	38.4	37.2
HD2329	3.7	3.7	2.1	3.2	40.5	21.9	11.6	24.7	45.4	33.1	31.8	36.8	4802	4245	2341	3796	35.7	43.8	35.5	38.3
HUW318	3.3	3.0	2.1	2.8	35.5	28.6	16.5	26.9	38.1	30.9	27.1	32.0	4582	3032	1791	3135	36.7	33.5	32.8	34.3
IWP72	3.9	3.5	3.0	3.5	40.7	37.8	28.6	35.7	40.3	38.6	34.0	37.6	5863	4376	2501	4247	37.5	37.4	41.5	38.8
K9107	4.0	3.8	2.1	3.3	30.2	28.7	22.1	27.0	39.7	38.7	35.0	37.8	5173	3923	2208	3768	38.1	37.9	34.2	36.7
LOK1	3.7	3.5	2.7	3.3	31.3	29.6	26.7	29.2	41.6	39.7	30.9	37.4	4843	4325	2223	3797	31.2	38.6	34.2	34.7
PBW175	4.1	3.6	3.2	3.6	40.9	38.6	28.7	36.1	46.1	44.9	38.6	43.2	6007	4763	2502	4424	42.6	41.2	34.5	39.4
PDW233	3.7	3.1	2.0	2.9	32.0	26.9	19.7	26.2	37.0	30.8	25.2	31.0	5221	3027	1752	3333	38.5	32.8	29.2	33.5
PBW343	3.9	3.8	2.9	3.5	38.7	36.0	30.6	35.1	42.1	39.4	35.7	39.1	5996	4360	2613	4323	43.7	42.4	34.7	40.3
Raj 3765	3.4	3.2	2.9	3.2	42.7	26.0	20.9	29.9	41.3	38.2	30.1	36.5	4546	3883	2044	3491	43.0	36.4	35.1	38.2
Sere Punjab	2.3	2.1	2.0	2.1	34.2	32.6	23.7	30.2	41.2	36.0	30.9	36.0	4882	3728	2068	3559	35.3	33.6	29.6	32.8
UP2338	3.7	3.7	2.9	3.4	35.6	30.4	22.8	29.6	38.6	32.7	26.0	32.4	4211	3598	1852	3220	33.4	33.2	30.8	32.5
WH147	3.6	3.5	3.2	3.4	36.5	30.5	26.7	31.2	36.9	33.0	25.1	31.7	4993	3441	2083	3506	41.6	35.6	32.6	36.6
WH533	3.5	3.4	2.7	3.2	36.5	34.6	28.5	33.2	38.9	32.8	28.2	33.3	5028	3361	2390	3593	39.9	31.6	33.5	35.0
WH542	3.5	3.1	2.8	3.1	40.1	34.0	21.9	32.0	37.1	30.0	23.8	30.3	5128	3553	2361	3681	42.8	37.1	34.7	38.2
Mean	3.6	3.4	2.6	3.2	36.8	31.0	23.1	30.3	40.4	35.9	30.3	35.6	4990	3789	2186	3655	38.3	36.9	34.1	36.4
	G	T	GxT		G	T	GxT		G	T	GxT		G	T	GxT		G	T	GxT	
CD at 5%	0.6	0.2	1.0		1.6	0.6	2.8		1.5	0.5	2.6		328	495	568		2.3	3.1	3.9	

G, genotype; T treatments

control was recorded in genotype C 306. The lowest reduction in this genotype may be due to better drought tolerance and low potential yield, which was evident from its lowest harvest index under all the three environments and lowest grain yield under irrigated control. Similar genotypic variability among wheat genotypes was also observed by Pannu *et al.* (2002).

The grain yield had highly significant association with harvest index (r = 0.80), Ψ_w (r = -0.78) and CTD (r = -0.70). Grain yield was also found significantly related with number of grains per spike (r = 0.63), RWC (r = 0.61) and number of productive tillers per plant (r = 0.54). This showed that plant water relation parameters had direct bearing on yield formation via yield attributes. Among the yield attributes number of grains per spike decided the maximum quantum of reduction in grain yield under moisture stress condition whereas quantum of reduction was least due to test weight. The study indicated that the genotypes PBW 175, PBW 343 and IPW 72 with higher potential yield along with better plant water status under different moisture stress levels would perform better.

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