http://www.pjbs.org

PJBS

ISSN 1028-8880

Pakistan Journal of Biological Sciences

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Pakistan Journal of Biological Science 7 (1): 90-92, 2004
ISSN 1028-8880

Drought Tolerance Studies of Wheat Genotypes

Hafiz Muhammad Akram, Muhammad Sarfraz Iqbal,
Muhammad Saeed, Allah Yar, Abbas Ali, K.A. Sahi and Mushtaq A. Nadeem
Agronomy Section (Cereals and Pulses), Ayub Agricultural Research Institute, Faisalabad, Pakistan

Abstract: To nose out the best drought tolerant wheat variety, an experiment was conducted during 1998-99 at Agronomic Research Farm, Ayub Agricultural Research Institute, Faisalabad, Pakistan. Ten wheat genotypes namely, Inqilab-91, Chakwal-83, Pasban-90, 85205, Rohtas-90, 4072, 4943 and Faisalabad-83 grown under an iron structure with moveable plastic sheet cover for protecting the plants from rain, were exposed to soil moisture stress at milking stage. Stress was imposed simply by withholding one irrigation. Various physiological and agronomic attributes were studied. On the basis of absolute grain yield, cultivar Barani-83 was found to be the most drought tolerant because of its better osmotic adjustment and Inqilab-91 the most sensitive one as it suffered from maximum loss (37.38 %) in grain yield due to decline in 1000- grain weight.

Key words: Drought, genotype, Barani-83, Inqulab-91, sensitive, drought tolerant, Faisalabad, 1000-grain weight, physiological, agronomic

INTRODUCTION

Wheat (*Triticum aestivum* L.) is grown under a wide variety of climatic and soil conditions in Pakistan. About one third of the total wheat acrage falls in the rain-fed regions where rain-fall is the scarce. Water deficit affects every aspect of plant growth and the yield modifying the anatomy, morphology, physiology, bio-chemistry and finally the productivity of a crop (Turner and Begg, 1981). Osmotic adjustment under water stress conditions help in maintaining growth and other physiological functions of plants and hence, a crop variety with high osmotic adjustment under drought conditions will be high yielding. Singh and Singh (1989) observed in a field study on the water stress effects on diurnal variations in leaf water potential and stomatal conductance, that the leaf water potential decreased during day time upto 14-00 hours, started increasing afterward and was the highest during night. Differential response of wheat genotypes is well documented as studied by Rao and Moorthy (1981). Under low moisture supply, the spring wheat was the most drought and heat tolerant at later stages of development (Layshok and Biryukov, 1982) while the reverse was true for winter wheat at early stages of development. Danil and Latyuk (1985) reported that short statured wheat varieties under drought conditions reacted more markedly than tall ones at stem elongation stage. It was observed that out of eight wheat varieties, LYP-73 was the most tolerant and R-5 the most sensitive to moisture stress at pre-heading stage (Tariq, 1980). Schonfield *et al*. (1989) found that water deficit had no effect on tiller number and growth rate while water potential, its components and relative water contents declined with increasing the stress. Response of six wheat varieties to moisture stress in terms of number of tillers per meter square, spike length, number of spikelets per spike, 1000-grain weight, grain yield and harvest index was similar except that plant height was maximum in LU-26. The present study was contemplated to evaluate the differences in drought tolerance of wheat genotypes exposed to water stress at milking stage.

MATERIALS AND METHODS

Ten wheat cultivars were grown in micro plots under an iron structure over which a plastic sheet was spread to check rain water. Each plot measuring 0.45 m^2 consisted of a single row of each variety. The experiment was conducted on well drained non saline and sandy loam soil having pH 7.8 employing split plot design with three replications. Water stress was imposed by with-holding irrigation. Sowing was done on 25th November 1998 fertilizer was applied at the rate of 150-100-50 NPK kg ha^{-1} at the time of sowing. Weeds were controlled by hand weeding. In total five irrigations were given. Harvesting was done on 28th April 1999. All the other agronomic practices were kept optimum. The data collected were analysed using Steel and Torrie method of analysis of variance (Steel and Torrie, 1980).

Methods of measurement of different physiological parameters are detailed as below.

Bulk osmotic potential: Plant leaves were washed is distilled water for 10 seconds, blotted dry with tissue paper, transferred to eppendorf tubes and the tubes were immediately kept in deep freezer. Frozen samples were thawed, crushed with a glass rod and the sap was centrifuged out at 600 kg. Osmotic pressure was measured with automatic micro-osmometer by calibrating the equipment in m Osm. Kg^{-1} of water. The concentration units were converted into pressure units using the Vant Hoff relationship at 20°C (Nobel, 1983). The pressure figures were converted into potential ones by putting a negative sign as prefix.

Stomatal resistance: Counts for three randomly selected standing plants from each treatment were recorded with the help of a porometer, MK-3. Taking the average, these counts were converted into resistance by drawing a graph between counts and the resistance at a specific scale.

Xylem vessel diameter: Two-centimeter long segments were cut off at 2 cm away from the base of seminal roots. The segments were preserved in formalin acetic alcohol (FAA). Free hand sections were cut and double stain combination of safarmin and the fast green was use to colour the slides. Data of xylem vessel diameter were recorded using a laboratory microscope.

RESULTS AND DISCUSSION

Response of ten wheat genotypes to water stress at milking stage was evaluated and the results are presented in Table 1, 2 and 3a,b. Water deficit affected osmotic potential, stomatal resistance, xylem vessel diameter, infertility in spikelets, 1000-grain weight and economic yield significantly. Varieties as well as interaction of treatments and varieties too depicted a significant differential response. The maximum decrease in osmotic potential was recorded in Pak-81 followed by 4072 and 85205 whereas, the minimum in case of 4943. Barani-83 showed the maximum increase in stomatal resistance (31.47%) under limited water supply followed by 85205 and chackwal-86. Whereas, stomatal resistance was the lowest in Pak-81 under drought. The Xylem vessel diameter decreased non significantly, however the differences among varieties were significant in this respect.

Infertility in spikelets was 3.83 in control as against 7.57 spikelets per spike in water stress. The increase in infertility of spikelets was 49.40%. Pasban-90 was affected more and the Barani-83 less than other cultivars by drought in this regard. The decrease in 1000-grain weight at milking stage was 37.43% in control as against 25.56% under the stress. The decline in grain weight was the maximum (52.45%) in Inqilab-91 and the minimum (5.66%) in Baranbi-83. Economic yield was decreased by 20.22% by water deficit. Reduction in grain yield was the maximum

Table 1a: Osmotic potential (-MPa) of ten wheat cultivars as affected by water stress

Varieties	Control	Stress	Mean	%Decrease
FSD-83	1.35a	1.50b	1.43a	11.11
Pak-81	1.27b	1.45c	1.36dc	14.17
Chakwal-86	1.13a	1.38d	1.26f	22.12
85205	1.28b	1.45c	1.37c	13.28
Rohtas-90	1.23c	1.49b	1.36dc	21.14
Passban-90	1.25c	1.49b	1.37c	19.20
Barani-83	1.10e	1.45c	1.28e	32.37
4072	1.28b	1.48b	1.38c	15.62
Inqulab-91	1.37a	1.50b	1.43a	20.00
4943	1.35 a	1.62a	1.40b	6.66
Mean	1.26b	1.48a	--	17.46

b Stomatal resistance (s cm^{-1}) of ten wheat cultivars as affected by water stress

Varieties	Control	Stress	Mean	%Decrease
Inqulab-91	3.09h	4.00k	3.55g	22.75
Pak-81	4.33e	4.99c	4.66a	13.23
Chakwal-86	3.14k	4.21f	3.68f	25.42
85205	3.75I	5.12ab	4.43b	26.76
Rohtas-90	3.12k	4.07gh	3.60g	23.34
Pasban-90	4.01h	4.97c	4.49b	19.32
Barani-83	3.44j	5.02bc	4.23c	31.47
4072	3.72 I	4.57d	4.25d	18.60
4943	4.16 fg	5.19a	4.68a	19.85
Fsd-83	3.73I	4.34e	4.04e	16.35
Mean	3.65b	4.65a	--	27.40

Table 2a: Xylem vessel diameter (*u*m) of ten wheat cultivars as affected by water stress

Varieties	Control	Stress	Mean	%Decrease
FSD-83	65.00N.S.	64.40	64.70c	0.92
Pak-81	60.67	60.00	660.34d	1.10
Chakwal-86	70.33	70.00	70.17b	0.47
85205	60.33	59.70	60.02d	1.04
Rohtas-90	74.00	73.80	73.90a	0.27
Pasban-90	63.33	62.50	62.92c	1.31
Barani-83	71.33	71.00	71.17b	0.46
4072	55.00	54.25	54.63e	1.36
Inqulab-91	61.00	60.20	60.60d	1.31
4943	65.00	64.30	64.65c	1.08
Mean	64.60N.S.	64.02	--	0.90

b No. of infertile spikelets per spike of ten wheat cultivars as affected by water stress

Varieties	Control	Stress	Mean	%Decrease
FSD-83	5.67ef	8.33c	7.00b	46.91
Pak-81	4.00gh	7.33cd	5.67c	83.25
Chakwal-86	4.00gh	5.67ef	4.83cd	41.75
85205	5.67ef	11.00b	8.33a	94.00
Rohtas-90	3.00ghi	4.33fg	3.67e	44.33
Pasban-90	3.67ghi	10.00b	6.83b	172.48
4943	3.00ghi	4.00gh	3.50e	30.95
4072	2.33I	13.00a	7.67ab	143.90
Inqulab-91	2.67hi	6.33de	4.50de	137.08
Barani-83	4.33fg	5.67ef	5.00cd	33.33
Mean	3.83b	7.57a	--	83.29

Table 3a: 1000-Grain weight (gms) of ten wheat cultivars as affected by water stress

Varieties	Control	Stress	Mean	%Decrease
Inqulab-91	36.80e	17.50p	27.15f	52.45
Pak-81	45.03b	27.20k	36.12c	39.60
Barani-83	31.80I	30.00j	36.90b	5.66
85205	35.00f	19.47o	27.23f	44.37
Pasban-90	43.37c	32.30n	37.83a	25.52
Chakwal-86	36.50e	32.30h	30.30d	11.51
Rohtas-90	40.00d	34.13g	37.07b	14.88
4072	27.00k	21.00n	24.00g	22.22
FSD-83	46.80a	26.00l	36.40c	44.44
4943	32.00hi	23.90m	27.95e	25.31
Mean	37.43a	25.56b	--	31.71

Table 3b: Economic yield (tons ha^{-1}) of ten wheat cultivars as affected by water stress

Varieties	Control	Stress	Mean	%Decrease
4072	4.37g-i	3.07k	3.72e	29.75
Pak-81	6.22ab	4.28g-i	5.25ab	31.19
FSD-83	5.18c-e	4.51f-h	4.85bc	12.93
85205	4.68e-g	3.67jk	4.17d	21.58
4943	6.17ab	4.99d-f	5.58a	19.12
Pasban-90	5.13c-e	4.43f-i	4.78c	13.65
Barani-83	5.67bc	5.29cd	5.48a	6.70
Chakwal-86	4.39f-i	3.84ij	4.12de	12.53
Inqulab-91	6.51a	4.08g-j	5.30a	37.38
Rohtas-90	4.61e-g	4.01h-j	4.32d	13.58
Mean	5.29a	4.22b	--	20.23

(37.38%) in case of Inqilab-91, followed by Pak-81 and 4072, whereas the minimum (6.7%) in case of Barani-83.

In this investigation Barani-83 performed better and proved to be the most drought tolerant, while Inqulab-91 the most sensitive to water stress. Moisture stress probably perturbed the physiological mechanisms of the sensitive varieties more severely than the tolerant ones. The conclusions are in agreement with those of Rajki (1982), Monayeri *et al.* (1984), Ahmad *et al.* (1986), Khan (1990) and Khan (1991).

REFERENCES

Ahmad, N.M., R.H. Qureshi, M. Tariq and M. Sarwar, 1986. Drought tolerance of wheat genotypes. Pak. J. Agric. Sci., 24: 231-34.

Danil, P.V. and G.I. Latyuk, 1985. Reaction of short and tall wheat varieties to drought. Referativnyi Zhurnal, 4: 120-125.

Jones and Turner, 1978. Osmotic adjustment in leaves of sorghum in response to water deficits. Plant Physiol., 61: 122-126.

Khan, J.A., 1990. Physiology of drought tolerance in wheat genotypes. M. Sc. Thesis, Dept. Crop Physiol. Univ. Agric. Faisalabad, Pakistan, pp: 70-72.

Khan, S., 1991. Physiological responses of wheat varieties to water stress imposed on the basis of various evapotranspiration (Et) levels. M.Sc. Thesis., Dept. Crop Physiol., Univ. Agric. Faisalabad, Pakistan, pp: 75-77.

Layshok, A.K. and S.V. Biryukov, 1982. Effect of soil drought and high temperature during ontogeny on yield in spring and winter wheat. Referativnyi Zhurnal. 7.65-207. Wheat Barlay & Triticale Absts., 2:70.

Monayeri, M.O., A.N. Higazi, N.H. Ezzat, H.M. Saleem and S.N. Tohoun, 1984. Growth and yield of some wheat and barley varieties grown under different moisture levels. Annals Agric. Sci. Mushtohor, 20: 231-243.

Nobel, P.S., 1983. Biophysical plant physiology and Ecology. W.H. Freeman and Co. San Fransisco, U.S.A., pp: 484-486.

Rajki, E., 1982. Drought sensitive phase in development of wheat and possibility of testing drought resistance in the phytoron. Cereal Res. Comm., 10: 213-221.

Rao, A.C.S. and B.R. Moorthy, 1981. Effect of moisture stress on the yield. Nutrients uptake, nutrients movement into grains in nine wheat varieties. Indian J. Plant Physiol., 24: 269-282.

Schonfield, M.A., R.C. Jhonson, B.F. Carver and D.W. Mornhinweg, 1989. Water relations in winter wheat as drought resistant indicators. Indian J. Plant Physiol., 32 : 275-277.

Singh, T. and B. Singh, 1989.leaf water polential and stomatal conductance of wheat as affected by water stress. Indian J. Plant Physiol., 32: 278-280.

Steel, R.G.D. and J.H. Torrie, 1980. Principles and procedures of statistics. McGraw Hill Book Co., New York, (U.S.A)., pp: 173-177.

Turner, N.C. and J.E. Begg, 1981. Plant water relations and adaptation to stress. Plant Science, 58: 97-131.

Tariq M., 1980. Effect of moisture stress on yield and yield components of two wheat varieties. M.Sc. Thesis. Agron. Deptt. Univ. Agric. Faisalabad, Pakistan, pp: 77-79.