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Evaluation of Excised Leaf Water Loss and Relative Water Content, As Screening Techniques for Breeding Drought Resistant Wheat

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Abstract: Significant differences between the generations were observed for excised leaf water loss(ELWL), plant height, spike length, spikelets per spike, grains per spike and 100 grain weight. Differences for Relative Water Content were non-significant. A negative correlation of ELWL with the yield components was also observed but it was non-significant statistically. The study suggested that these traits were not correlated genetically with yield components and did not play any role in yield enhancement rather they contribute towards the survival of plants under drought stress and can be used as early stage screening techniques in breeding programme on drought resistance.

Key words: Drought, Relative Water Content, Excised Leaf Water Loss, Correlation, Breeding

Introduction

Wheat ranks after rice for providing protein and caloric requirements to one third of the world population. It is a stable food in Pakistan and is cultivated under irrigated as well as the rainfed conditions. Of the total area cultivated under wheat crop, 16.9% is rainfed which suffers from a serious moisture stress at all stages of the crop growth resulting in low productivity (Anonymous, 1996). This problem can be mitigated by breeding varieties which can produce stable yields in water limiting areas.

Some physiological characters of the plant have been advocated as indicators for the development of drought resistant cultivars (Schonfeld *et al*., 1988; Matin *et al*., 1989; Ritchie *et al*., 1990). A number of physiological traits like ELWL and RWC etc., which confer drought resistance to wheat have been identified (Malik, 1995). The species adapted better to dry environments have higher RWC at a given water potential (Jarvis and Jarvis, 1963). A similar correlation study between RWC and tissue elasticity indicated some contribution of tissue elasticity to drought resistance by maintaining higher RWC at zero turgor potential (Coyne *et al*., 1982). Many workers have evaluated wheat cultivars for drought resistance and have reported that a smallest decrease in RWC produced more dry weight and grain yield per plant (Khan *et al*., 1993; Ashraf *et al*., 1994; Al Hakimi *et al*., 1995).

Rate of water loss from excised leaf bestowed drought resistance in wheat by a mechanism of low water loss rate through leaf cuticles (Salim *et al*., 1969). Therefore differences among genotypes for rate of water loss, which presumably is an estimate of cuticular transpiration rate, could be used for screening wheat genotypes against drought resistance (Clarke and McCaig, 1982). In a similar study ten wheat varieties and one triticale genotype were found to differ in leaf water content and water retention estimated using leaves air-dried for 48 hours (Randhawa *et al*., 1988). Their study suggested that high leaf water retention was an indicator of drought tolerance.

This study was initiated to evaluate the parameters used for characterization of drought resistance as an early stage screening tool and to estimate genetic differences between two wheat genotypes and their F_3 segregating generation.

Materials and Methods

This study was conducted in the Department of Plant Breeding and Genetics, University of Agriculture, Faisalabad. One hundred F_3 families alongwith the parents were grown in polyethylene tubes containing 400 grams of air dried mixture of soil and sand in 1:3 ratio. The tubes were kept in the wire house of the Department and the experiment was conducted in randomized complete block design having four replications. Five plants of each parent and 25 F_3 families in each replication were maintained. Tubes carrying plants were supplied uniform dose of "Hogland" nutrients solution to keep up the fertility. Moisture level was kept uniform in all the tubes by adding water to make up a uniform weight of watered tubes.

Drought stress was imposed at 3-leaf stage of the plants by withholding water. Plants were observed daily for monitoring symptoms of drought stress. Moisture content at stress level was also kept uniform in the experiment by maintaining a uniform stress weight of tubes. Data about the physiological traits Relative Water Content and Excised Leaf Water Loss were collected when first symptom of leaf wilting appeared.

Second leaf of the each plant was taken at leaf wilting stage to estimate the RWC. Leaf samples collected early in the morning were surface dried gently with tissue paper and were wrapped in polyethylene bags tagged properly. These samples were carried to the laboratory immediately and leaves were weighed to measure their fresh weight (FW).

These leaves were soaked in distilled water overnight at room temperature to revive turgidity. Turgid leaves were carefully blot dried and weighed to measure the turgid weight (TW). Leaf samples were then oven dried for 72 hours at 70°C and dry weight (DW) was recorded on electronic balance (CX-600 COMPAX). The RWC of the leaves was calculated by using the following formula (Malik, 1995).

$$\text{RWC \%} = (\text{FW} - \text{DW}) / (\text{TW} - \text{DW}) \times 100$$

Excised Leaf Water Loss study was carried out on third leaf. Leaf samples were collected exactly the same way as for the RWC above. Fresh weight of the excised leaves was measured soon after hurried to the laboratory and leaf samples were spread on a laboratory bench for six hours to wilt at room temperature (20°C). After six hours leaves were weighed again to obtain wilted weight. The leaves were then oven dried for 72 hours at 70°C and dry weight was recorded. Excised Leaf Water Loss was calculated (g/g) using the following equation:

ELWL (Fresh Wt. - Wilted Wt.) /Dry Wt.

Drought stress was relieved after taking the leaf samples for RWC and ELWL and the plants were transplanted in pots each carrying 8 kg of fertile field soil. The plants were supplied with uniform water and nutrients until maturity. Data were recorded for plant height, spike length, number of spikelets per spike, number of grains per spike on main tiller of the plant and grain weight on a random sample at maturity.
Correlation and analysis of variance of the data were computed using minitab computer programme to draw the inferences.

Results and Discussion

Efficient screening techniques applicable at early stage of plant growth have been dire need of plant breeders to eliminate the unwanted material and focus on promising lines. Certain physiological parameters which confer drought resistance in plants have been identified for screening the genotypes (Malik, 1995). Data computed for the characterization of different parameters of drought tolerance and yield components revealed significant differences between the generations for Excised Leaf Water Loss, plant height, spike length, spikelets per spike, grains per spike and 100 grain weight under drought stress conditions. Generation means for RWC were non-significant. The generation means and generation mean squares are given in Table 1.

Table 1: Showing generation means and generation mean squares.

Parameters/Yield Components	Pak-81	L-aba 18	F_3	Gen. MS
ELWL	1.50	1.84	0.99	0.73*
RWC	90.30	88.90	85.40	0.003^{NS}
Pl.height	44.50	41.40	47.90	42.85*
Sp. lenght	7.50	6.50	7.70	1.46*
Grains/spike	39.80	36.70	31.90	64.2*
Spit./ spike	16.25	13.17	13.41	11.64
100 grain wt.	3.46	2.92	2.27	0.29**

The data show that the generation mean for ELWL in drought tolerant genotype Pak-81 (1.5) was significantly less as compared to the susceptible genotype LowABA-18 (1.84). Similarly generation mean square for this character was also statistically significant. The results obtained suggested the use of ELWL as an early stage selection criteria for drought tolerance and the study supported the suggestions of earlier workers, Salim *et al*. (1969), Clarke and McCaig, (1982) and Malik (1995).

Table 2: Showing correlation of Excised Leaf Water Loss with plant height, spike length, grains/spike, spikelets/spike and 100 grain weight

Yield Comp.	ELWL
Plant height	-0.007^{NS}
Spike length	-0.063^{NS}
Grains per spike	-0.098^{NS}
Splt/spike	-0.144^{NS}
100 grain weight	-0.006^{NS}

Relative Water Content for Pak-81 was comparatively greater (190.3) than the variety Low ABA-18 (88.9) which is drought (susceptible. But the differences between means were statistically non-significant. The results obtained in this study were in agreement with the results of Malik (1995), who observed low RWC in Pak-81, as compared to the drought susceptible genotype Low ABA-21. Present results are in contrast to the findings of Jarvis and Jarvis (1963), Coyne *et al*. (1982), Khan *et al*. (1993) and Ashraf *et al*. (1994), who observed the significant correlation between RWC and yield. The contrary findings might be due to the gene source for drought resistant and susceptible plant material used in these studies. The drought tolerance of Pak-81 might be explained on the basis of other physiological adaptations. Correlation studies carried out to associate the expected response of other characters with ELWL is given in Table 2.
The table depicted non-significant results for plant height and yield components on F_3 plants. The study revealed that the Excised Leaf Water Loss was not statistically correlated with any of the yield components. The results are congruent with the findings of Ling *et al*. (1995), who observed that there was no correlation between Excised Leaf Water Loss and grain yield under drought stress. Similar results were also observed by Kheiralla *et al*. (1993). However, contrary to this Clarke and Romagosa (1989) and Clarke and Townley-Smith (1986) found positive correlation between water retention capacity of leaves and grain yield. The study clearly indicated that there was no correlation among RWC, ELWL and any of the yield components which suggested that the genes controlling these physiological characters had no linkage with the genes controlling grain yield per plant.
Although, these physiological traits are not genetically linked to the yield components but definitely, as the study has indicated, they confer some sort of drought tolerance to the plants and contribute towards their survival under drought stress. The above discussion has provided enough evidence for the use of these traits as screening criteria for developing drought tolerant wheat varieties.

References

Al Hakimi, A., P. Monneveux and G. Galiba, 1995. Soluble sugars, proline and relative water content (RCW) as traits for improving drought tolerance and divergent selection for RCW from *Triticum polonicum* into *Triticum durum*. J. Genet. Breed., 49: 237-243.

Anonymous, 1996. Economic survey, 1996-1997. Government of Pakistan, Economic Advisors Wing, Finance Division, Islamabad

Ashraf, M.Y., A.R. Azmi, A.H. Khan and S.S.M. Naqvi, 1994. Water relations in different wheat (*Triticum aestivum* L.) genotypes under soil water deficits. Acta Physiol. Plant., 16: 231-240.

Clarke, J.M. and I. Romagosa, 1989. Evaluation of excised-leaf water loss rate for selection of durum wheat for dry environments. Proceedings of the Physiology-Breeding of Winter Cereals for Stressed Mediterranean Environments, July 3-6, 1989, Montpellier, France.

Clarke, J.M. and T.F. Townley-Smith, 1986. Heritability and relationship to yield of excised-leaf water retention in durum wheat. Crop Sci., 26: 289-292.

Clarke, J.M. and T.N. McCaig, 1982. Evaluation of techniques for screening for drought resistance in wheat. Crop Sci., 22: 503-506.

Coyne, P.I., J.A. Bradford and C.L. Dewald, 1982. Leaf water relations and gas exchange in relation to forage production in four *Asiatic bluestems*. Crop Sci., 22: 1036-1040.

Jarvis, P.G. and M.S. Jarvis, 1963. The water relations of tree seedlings.: IV. Some aspects of the tissue water relations and drought resistance. Physiol. Plantarum, 16: 501-516.

Khan, A.H., M.Y. Ashraf and A.R. Azmi, 1993. Osmotic adjustment in wheat: A response to water stress. Pak. J. Scient. Ind. Res., 36: 151-155.

Kheiralla, K.A., R.A. Dawood and E.A. Teama, 1993. Performance of some wheat cultivars for grain yield and excised leaf-water loss as an indicator of drought resistance under different levels of nitrogen. Assiut J. Agric. Sci., 24: 293-310.

Ling, J.X., M.R. Kun, L.S. Zhen, J.J. Li and L.J. Li, 1995. A study on genotypical differences of stomata and non-stornatal water loss traits in winter wheat. J. Hebei Agric. Univ., 18: 46-52.

Malik, T.A., 1995. Genetics and breeding for drought resistance in wheat: Physcio-molecular approaches. Ph.D. Thesis, University of Wales, UK.

Matin, M.A., J.H. Brown and H. Ferguson, 1989. Leaf water potential, relative water content and diffusive resistance as screening techniques for drought resistance in Barley. Agron. J., 81: 100-105.

Randhawa, A.S., S.K. Sharma and H.S. Dhaliwal, 1988. Screening for drought tolerance in wheat. Crop Improv., 15: 61-64.

Ritchie, S.W., H.T. Nguyen and A.S. Holaday, 1990. Leaf water content and gas-exchange parameters of two wheat genotypes differing in drought resistance. Crop Sci., 30: 105-111.

Salim, M.H., G.W. Todd and C.A. Stutte, 1969. Evaluation of trchniques for measuring drought avoidance in cereal seedlings. Agron. J., 61: 182-185.

Schonfeld, M.A., R.C. Johnson, B.F. Carver and D.W. Mornhinweg, 1988. Water relations in winter wheat as drought resistance indicators. Crop Sci., 28: 526-531.