THE EFFECT OF WATER STRESS ON CUTICULAR TRANSPIRATION AND RELATIONSHIPS WITH WINTER WHEAT YIELD

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ABSTRACT

Drought effects on the water loss by cuticular transpiration and grain yield of eight wheat (*Triticum aestivum* L.) cultivars were evaluated. The experiment was conducted under field conditions in 2004 using conventional crop management practices. The water stress was imposed starting with April 10 by restricting irrigation, the plot being covered with special plastic folia. Exposure of plants to drought led to noticeable decreases in leaf water loss by cuticle and biomass accumulation, with a negative consequence on grain yield. There were significant negative correlations between water loss by cuticular transpiration and yield both under field conditions in 2004 and water stress conditions (r = -0.569* , r = -0.602*), suggesting that low cuticular water loss could be used in selecting drought tolerant cultivars.

Key words: cuticular transpiration, water stress, wheat yield

INTRODUCTION

Drought is probably the most aggressive envirومental stress, with strong negative effect on growth and plant productivity. One of the best way to improvement yield and yield stability under low soil moisture conditions is to develop drought tolerant crop varieties.

A physiological approach would be an attractive way to rapidly develop new varieties (Turner and Nicolas, 1987), but in this case, breeding is specific and involves a deeper understandin g of the yield determining process under suboptimal environments (Blum, 1983).

In a water-limiting environment, grain yield is dependent on the amount of water used by the crop, on water use efficiency and on the ratio of grain produced to above-ground biomass (harvest index) (Passioura, 1977). Improvement of anyone of the above mentioned factors in a water-limited environment should result in increased yield.

Water use efficiency is equal to the ratio between plant assimilation and transpiration. Cuticular (or residual) transpiration represents the main way of water loss during night under optimal conditions and during noon under drought conditions, when stomata are closed. It was suggested as selection trait in wheat breeding for drought resistance (Clarke at al., 1991, Balota, 1995).

This study investigated the cuticular transpiration and association between this trait and grain yield under normal field and water stress conditions in winter wheat.

MATERIAL AND METHODS

Eight winter wheat genotypes were studied. The experiment was conducted under field conditions in 2004 using conventional crop management practices. The water stress was imposed starting with April 10th by restricting irrigation, the plot being covered with special plastic folia.

Cuticular transpiration, according to Clarke et al. (1991) method, was measured on excised flag leaves. Following the initial weight determination, the leaves were wilted in dark for 5 h at 25°C, weighed again and than dried overnight at 90°C to estimate water loss by cuticular transpiration. Water loss was expressed in grams of water lost per gram of leaf dry matter.

RESULTS AND DISCUSSION

The quantity of water lost through cuticle is up to 10-20 time lower than water loss by stomata. Nevertheless, under water stress conditions, when the stomata are closed, it represents the main way of water loss. The analysis of variance regarding water loss by cuticular transpiration showed a very significant influence of the treatment, genotype and their interaction, but the variance of treatment was higher than the variance due to genotypes (Table 1).

Table 1. ANOVA for cuticular transpiration

Source of variation	DF	Cuticular transpiration		
		Sum of squares	Mean square	F value

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Treatment	1	18.4224	18.4224	3568.363***
Error A	4	0.0207	0.0520	
Genotype	7	7.0240	1.0034	65.360***
Interaction	7	3.3101	0.4729	30.802***
Error B	56	0.8597	0.0154	

*** significant for P < 0.01%

Figure 1 shows the water loss by cuticular transpiration for the tested genotypes under normal field and water stress conditions and the correlation between the two. The decrease of water loss under water stress conditions is obvious .

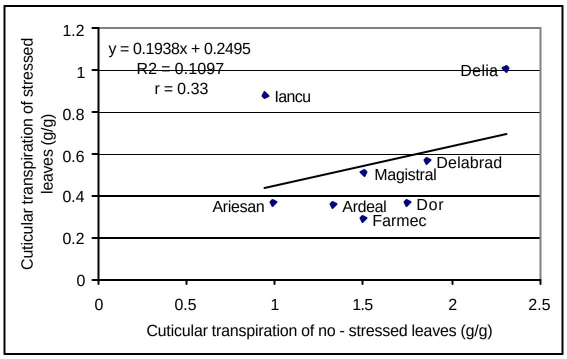

Figure 1. The effect of water stress on cuticular transpiration for eight winter wheat genotypes

However, cultivars reacted differently to water stres. For example, cultivar Iancu, which had the lowest cuticular transpiration under no stress, had one of the highest cuticular transpiration under water stress. On the other hand, cultivars Ariesan, Ardeal and Farmec had relatively low cuticular transpiration under both conditions, while the cultivar Delia, previously described as one of the most drought susceptible Romanian cultivars (Balota and Saulescu, 2000) had the highest water loss through cuticle, in both growth conditions. A non significant correlation was found between cuticular transpiration of not-stressed leaves and cuticular transpiration of stressed leaves when all studied cultivars were taken into consideration (Figure 1). On the other hand excluding the cultivar Iancu this correlation was significant, expressed by a correlatin coefficiet of 0.80**, suggesting that differences among cultivars may be dependent on cuticula propertiers that prevent water loss (Figure 2).

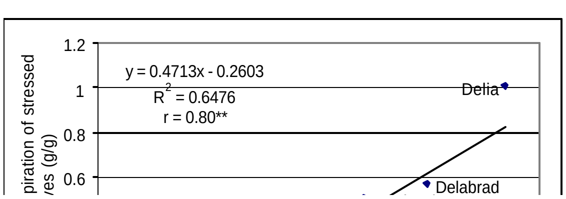

Figure 2. The effect of water stress on cuticular transpiration for seven winter wheat genotypes

There were significant negative correlations between water loss by cuticular transpiration and yield both under experimental field and water stress conditions (r = - 0.569*, r = - 0.602*), suggesting that low cuticular water loss could be used in selecting drought tolerant cultivars (Figures 3 and 4).

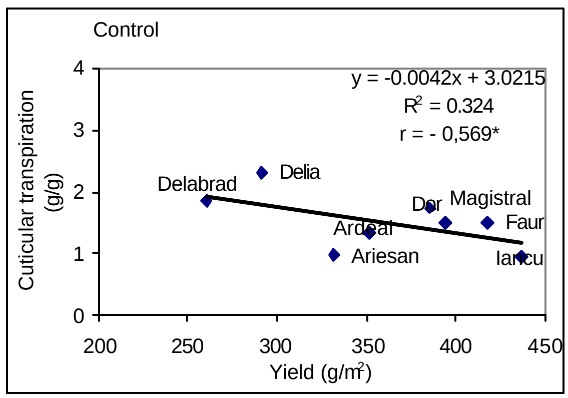

Figure 3. Relationship between yield and cuticular transpiration without imposed water stress

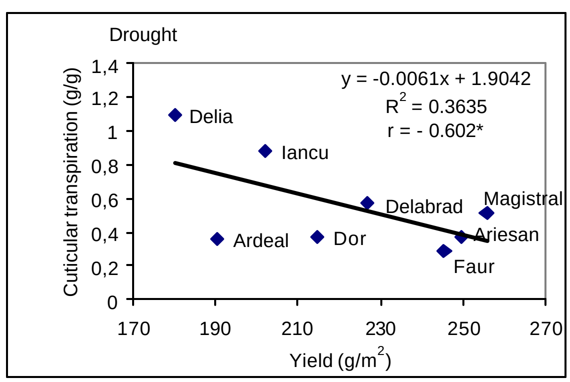

Figure 4. Relationship between yield and cuticular transpiration under water stress conditions

CONCLUSIONS

The results of this study indicate a strong negative effect of water stress on cuticular transpiration and yield of studied winter wheat genotypes.

The significant negative correlation between cuticular transpiration and yield suggests that cuticular transpiration is a major factor explaining the genotipic differences in drought resistance among the studied winter wheat genotypes.

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