Original scientific paper

**The effect of water deficit on growth and cyclic hydroxamic acid content of wheat**

Péter Makleit

*University of Debrecen, Centre for Agricultural Sciences and Engineering, Institute of Plant Sciences, Division of Agricultural Botany and Crop Physiology, 4032 Debrecen, Bőszőrményi út 138; Hungary. pmakleit@agr.unideb.hu*

**Abstract**

Cyclic hydroxamic acids (cHx-s) are secondary metabolites, produced by graminaceous species. These chemical compounds are being examined intensively according to their diverse biological roles. The aim of this work was to verify how the water deficit influences the level of the cHx-content and growth of wheat. As a result of water deficit, in contrast to our expectations, the cHx-content of shoots significantly decreased in the case of the examined varieties. It seems that abiotic stress factors are not affecting the cHx-content in the same way or the reaction for stressors depends on the variety. The growth of shoots naturally decreased for the effect of water deficit.

**Keywords:** water deficit, abiotic stress, cyclic hydroxamic acids

**Introduction**

Cyclic hydroxamic acids are secondary metabolites of graminaceous species (*Cambier et al. 1999*). The main cHx of wheat is DIMBOA [2,4-dihydroxy-7-methoxy-2H-1,4-benzoazin-3(4H)-one]. (Figure 1.), (*Copaja et al. 1991*). Among their diverse biological roles it is very important that they play role in tolerance and resistance against bacteria, fungi and various insects. The higher is the cHx-content of the variety, the lower is the rate of infection and sensitiveness for pathogens and pests (*Niemeyer, 1988*). For the effect of abiotic stress the level of cHx-s also changes. The changed cHx-content contributes to tolerance and survival of stress situation (*Hashimoto et al. 1991; Hashimoto-Shudo, 1996*). On the basis of these statements cHx-s are considered to be stress metabolites (*Epstein et al. 1986; Richardson-Bacon, 1993; Pethő, 1999*). For understanding the function of cHx-s in the stress process I examined how an abiotic stress factor - the water deficit - affects the cHx-content of various wheat varieties.

![Figure 1. The structure of DIMBOA (R₁: CH₃O; R₂, R₃: H)](image-url)
Material and methods
The effect of water deficit was examined in independent experiments in the year of 2006 and 2008. In 2006 Jubilejnaja 50 was used, while in 2008 Carlo variety. The experiments were carried out in an open greenhouse. Plants were cultivated in sandy loam soil, in two litre pots. After germination 20 plants were left in each pot. After selection, experimental plants were divided into two groups: irrigated plants were regularly watered till the 65% of the field water capacity. At the non-irrigated group irrigation was stopped. I measured the growth and the cHx-content of shoots before and after the soil reached its wilting point. According to the various weather conditions it was various days after stopping irrigation. For the evaluation of cHx-content we used the method of Long et al. (1974). For determination of quantity of cHx-s (mg/kg dry weight) I constructed standard curves by using SPSS statistic programme. For this purpose I isolated pure DIMBOA from etiolated maize plants according to the method of Hartenstein et al. (1992).

Results and discussion
The first year of testing (2006) In these experiments the soil reached its wilting point after the plants became 13 days old. There was no accessible amount of water in the soil when the plants were 15 days old. There was a significant difference in the cHx-content between the irrigated and non-irrigated 15 days old plants caused by the water deficit of the soil. The same effect could be observed in the water deficit of shoots. There was also a significant difference in the dry weight of shoots of 15 days old plants between the irrigated and non-irrigated plants (Table 1).

Table 1. Properties of wheat shoots as affected by water supplies

<table>
<thead>
<tr>
<th>Wheat shoot characteristics in two years of testing</th>
<th>2006: wheat cultivar Jubilejnaja 50</th>
<th>2008: wheat cultivar Carlo</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plant age</td>
<td>Irrigated</td>
<td>Non-irrigated</td>
</tr>
<tr>
<td>cHx-content (mg/kg dry weight)</td>
<td>1269.9</td>
<td>1210.6</td>
</tr>
<tr>
<td></td>
<td>1182.1</td>
<td>1071.4</td>
</tr>
<tr>
<td>LSD: 77.8</td>
<td>348,3149</td>
<td></td>
</tr>
<tr>
<td>Dry weight (mg/piece)</td>
<td>31.23</td>
<td>29.27</td>
</tr>
<tr>
<td></td>
<td>39.47</td>
<td>32.31</td>
</tr>
<tr>
<td>LSD: 3.27</td>
<td>LID: 4.11</td>
<td></td>
</tr>
<tr>
<td>Water deficit (% of max. water content)</td>
<td>3.42</td>
<td>4.95</td>
</tr>
<tr>
<td></td>
<td>3.61</td>
<td>9.47</td>
</tr>
</tbody>
</table>

The second year of testing (2008) In these experiments the soil reached its wilting point after the plants became 12 days old. There was no accessible amount of water in the soil when the plants were 16 days old. There was a significant difference in the cHx-content between the irrigated and non-irrigated 16 days old plants caused by the water deficit of the soil. The 16 days old, non-irrigated plants markedly showed the symptoms of water deficit. The water deficit of shoots increased for the effect of stopping irrigation. It was a significant difference in the dry weight of shoots between the irrigated and non-irrigated 16 days old plants (Table 1).
It can be seen from the experiments, that the cHx-content of different varieties is usually variable in a large scale.

Conclusions
Water deficit decreased the growth and the cHx-content of the examined varieties. The latter statement is in contrast to our earlier results. In our earlier research work we had established that hypoxia and salt stress increased the level of cHx-s in experimental plants. According to our earlier and recent results it seems, that not all the stress factors affect the level of cHx-s at the same manner or the reaction for the stressor depends on the variety. In this field further investigations are needed. According to the expectations the cHx-content declines when the plants become older. It also can be seen from our results, that cHx-content of various varieties can differ to a great extent.

References
Cambier V., Hance T. et al. (1999). Non-injured maize contains several 1,4-benzoxazin-3-one related compounds but only as glucoconjugates. Phytochemical Analysis. (10): 119-126.
