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Changes in cyclic hydroxamic acid content of various rye varieties for the effect of abiotic stress

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ABSTRACT According to our opinion cyclic hydroxamic acids (cHx-s) are stress metabolites. For the effect of stress the level of cHx rises and through their various biological effects the cHx-s prevent the plants from the harmful influences of stress. In these experiments I examined the changes in cHx-content of rye plants (*Secale cereale* and *S. cereanum* varieties). The plants were grown in nutrient solution and were treated with 100mM NaCl. My hypothesis in the case of shoots was proved: the cHx-content of shoots of all varieties changed according to stress syndrome. I could not demonstrate early decrease in cHx-content of roots, but I suppose that it had occurred before my first observation. **Acta Biol Szeged 49(1-2):103-104 (2005)**

KEY WORDS

cyclic hydroxamic acid
abiotic stress
stress syndrome
rye

Cyclic hydroxamic acids (cHx-s) are secondary metabolites of graminaceous species (Cambier et al. 1999). DIBOA [2,4-dihydroxy-2H-1,4-benzoxazin-3(4H)-one] is te most abundant cHx-compound of rye (Tang et al. 1975). 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). The cHx-s form complexes with metal ions. It makes possible to promote not only the ion uptake, (Pethő et al. 1997; Lévai 1999) but the tolerance against high concentration of metal ions (Makleit et al. 1999-2000). For the effect of abiotic stress the level of cHx-s rises. The elevated cHx-content contributes tolerance and survival of stress situation in various ways (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).

Various abiotic stress factors bring radical changes in the metabolism of gaminaceous species (Tóth et al. 1995; Veres et al. 1998; Kiss et al. 2000; Kiss and Wolf 2001). My hypothesis is that the cHx-content changes according to the stress syndrome, that means an atypical answer, independent from the type of stress factor (Láng 1998). To strengthen this hypothesis I examined the changes in DIBOA-content of various rye varieties for the effect of salt stress.

Materials and Methods

Two rye (*Secale cereale* L.) varieties (Kisvárdai 1 = K1; Kisvárdai alacsony = KA) and a new species of *Secale*, *S. cereale* x *S. montanum* =*S. cereanum*, (variety Kriszta = KS) were used as experimental plants. Plants were cultivated on nutrient solution according to Treeby et al. (1989) with addition of iron in form of Fe(III)-EDTA in quantity of 10^{-4} mole/litre. Twelve pieces of rye plants were placed into a 0,8-litre pot. The nutrient solution was changed every three days and was ventilated constantly. The salt stress was produced by the addition of 100 mM NaCl to the nutrient solution of plants at the plant age of 14 days. I measured the quantity of cHx-s in roots and shoots after 1, 2, 4, 8, 24 and 48 hours of the addition of NaCl to experimental plants by using the method of Long et al. (1974). I measured the cHx-content of control plants at the age of 14, 15 and 16 days. The method of Long et al. (1974) is based on the measuring of extinction of cHx-s Fe(III)-complex. For determination of quantity of cHx-s (mg/kg fresh weight) I constructed standard curves by using SPSS statistic programme. For this purpose I isolated pure cHx-s: DIBOA from etiolated rye plants according to the method of Hartenstein et al. (1992).

Results

For the effect of addition of 100 mM NaCl to the nutrient solution (salt stress) the cHx-content of shoots and roots changed.

The cHx-content of shoots was lower than of the control 1 hour after the start of the salt treatment. Then 2 hours after the start of the salt treatment the cHx-content of shoots started to increase and became higher than of the control. The cHx-content of shoots reached its maximum value 4-8 hours after the start of the salt treatment, then it started to decrease gradually down to the control. The maximum was 184,94-208,46% of the control. The cHx-content of *S. cereale* varieties reached its maximum 4 hours after the start of the salt treatment, but in the case of *S. cereanum* variety the maximum was at 8 hours.

The cHx-content of roots showed maximum value at the first measurement time, 1 hour after the start of the salt treatment. It was 195,66-208,12% of the control value. In the case

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of the later measurements the cHx-content of roots was lower and decreasing gradually, but did not reach the value of the control. It can be supposed that as I measured at the shoots the cHx-content of roots also shows lower values than of the control at the early stage of stress, but it occurs earlier than in the shoots.

It can be logical that the reaction to salt stress is quicker in the roots, because this stress effects the roots directly.

The cHx-content of roots and shoots was higher in the *S. cereale* varieties, than in the *S. cereanum* variety in the case of control and treated plants as well.

Discussion

According to the results cHx-s can be classified as stress metabolites. After the application of stressor the change of cHx-content occurs similar to the changes in the content of other compounds considered to be stress metabolites. Naturally this hypothesis must be proven by other stress factors and in the case of other plant species.

These experiments raise other questions too:

Whether the cHx-content of roots decreases or not after the appearance of the stress factor? Whether the level of rise of stress metabolite is determined or not by the strength of stress? Is there a daily change of cHx-content or not of the non-stressed plants? These questions are to be answered.

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