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Presumable protective role of peroxidase and polyphenol oxidase enzymes against freezing stress in peach (*Prunus persica* /L./ Batsch)

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ABSTRACT Antioxidant enzymes have important roles in inactivation of the active oxygen forms induced by the different stresses. During winter, the over-wintering organs of peach are exposed to severe chilling temperatures. Our aim was to study the role of two antioxidant enzymes in the protection mechanisms against freezing injuries in three peach genotypes representing contrasting levels of cold hardiness. The activity of these two antioxidant enzymes in the different plant tissues increased during the first half, while decreased during the second half of the dormancy period. Due to the cold spells during ecodormancy the activity of antioxidant enzymes increased again in some sample. This phenomenon was mostly characteristic to the cold tolerant genotypes. In floral buds the activity of polyphenol-oxidase changed to a greater extent, while in the vegetative tissues it was the peroxidase enzyme showing a greater change. Thus to establish the exact role of antioxidant enzymes in abiotic stress tolerance requires further detailed investigations.
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KEY WORDS

peach
dormancy
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Of the stress enzymes, the activities of catalase and peroxidase in different peach organs have been studied in the greatest details. In floral buds the catalase activity was found to be the highest at the end of endodormancy (Kaminski and Rom 1974). Fluctuation in the peroxidase activity was characteristic to the shoots of peach during dormancy, with one – one peak at the end of endo-dormancy and after the tetrad stage of flower buds (Citadin et al. 2002). Between the end of endodormancy and start of blooming, a continuous increase in the activity of peroxidase and polyphenol-oxidase in different organs was apparent in the peach cultivar 'Dixired' (Kenis 1976).

There has been only a few results concerning on the changes in enzyme activity in the near-relative species of peach. The activity of the catalase has been studied in apricot flower buds (Scalabrelli et al. 1991), while in plum shoots the activities of peroxidase and polyphenol-oxidase (Szecskó et al. 2002). The results were in agreement with previous findings that the activity of stress enzymes in over-wintering organs was the highest at the end of endodormancy.

Materials and Methods

The plant tissue samples were collected from the experimental orchards located 30 km of Budapest. Three different cultivars were involved in the experiment, 'Springtime' is frost sensitive, 'Champion' is frost tolerant, while 'Dixired' possesses medium frost tolerance. Samples of each genotypes were collected at the middle of each month in the period between 2004 October and 2005 March. The activities of peroxidase and polyphenol-oxidase was analysed in flower buds, vegetative buds and shoots with spectrophotometer applying the methodology of Srivastava et al. (1983) and Bassuk et al. (1981), respectively. The protein content of the samples was also measured. For both enzymes the activities are given in Units/ mg protein.

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Results and Discussion

The activity of both peroxidase and polyphenol-oxidase showed an increase in the over-wintering organs of each genotype at the beginning of dormancy, while the enzyme activity decreased with the oncoming of spring. This change emphasises the probability of the protective roles these enzymes play in enhancing the frost tolerance of the over – wintering organs (Citadin et al. 2002). We found, however, large differences in the dynamics of the activity changes of these enzymes in the different plant organs, which was also genotype dependent to a smaller extent.

In floral buds the activity of peroxidase increased continuously at the beginning of dormancy, and reaching its maximum level it started to decrease rapidly. In 'Springtime' the peroxidase activity reached its maximum level in November, in 'Dixired' in December, while in 'Champion' in February. This order corresponds to the end of the endodormancy of the floral buds in these cultivars.

In the vegetative buds the peroxidase activity reached its maximum level in November as the earliest in the frost sensitive cultivar 'Springtime', while this occurred one month later

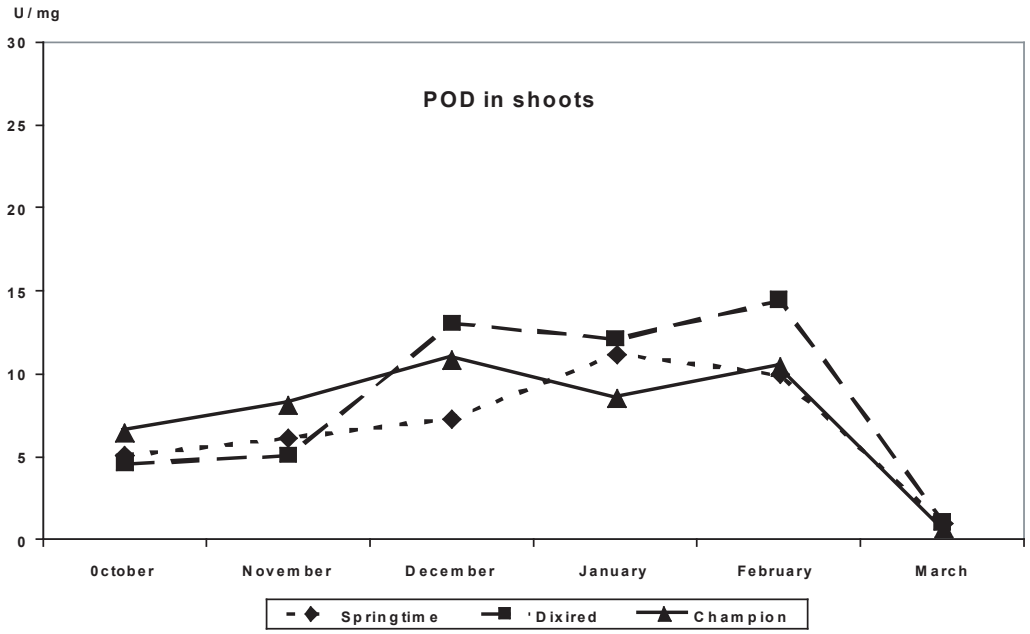

Figure 1. Changes of peroxidase activity in peach shoots (2004-2005).

in the other two cultivars. The peroxidase activity decreased after reaching the maximum level at the beginning of winter. But there was a small increase again in February, which was probably due to a severe cold spell, which followed the mild January weather conditions. This second increase in peroxidase activity was the smallest in the frost sensitive genotype.

The dynamics of peroxidase activity in the shoots were very similar to that found in vegetative buds. The presence of the dual peaks appearing in December and in February was characteristic to both genotypes with good and medium frost tolerance, while in the case of the frost sensitive genotype there was only one peak in January (Fig. 1). Citadin et al. (2002) identified a very similar pattern measured in different genotypes, which were grown under climatic conditions contrasting from our climate.

The activity of polyphenol oxidase changed significantly in the floral buds of the frost sensitive and the moderately tolerant genotypes during dormancy, while it remained at a constant low level in the cold tolerant genotype. In the vegetative buds, however the large changes in polyphenol oxidase activity could not be associated either with the genotypes or the phenological stages. The polyphenol oxidase activity in the shoots remained at low levels in all the three genotypes during dormancy.

Our findings are in agreement with the previously published results, and emphasise the possible protective roles played by peroxidase and polyphenol oxidase enzymes together with other components in the defensive mechanisms against frost stresses in peach through inactivating the active oxygen forms. To establish the exact role of antioxidant enzymes in freezing stress tolerance requires further detailed investigations.

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