Responses to temperature and light

103(2aC01)

COMPARISON OF ANTIFREEZE ACTIVITIY ASSAYS

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Antifreeze activities have been found in various organisms including Arctic and Antarctic fish, wintering insects and most recently in apoplast fluids of some cold-hardened plant species. In the previous studies, observation of ice crystal growth using nanoliter-osmometer has been the most frequently used assay, which is rather qualitative. Recently we have developed a new antifreeze activity assay that relies on the recrystalization inhibition. Here we compare the results of these assays using some fish antifreeze proteins. In the presence of a fish antifreeze protein (AFP), fine architecture of ice crystals was retained even after prolonged exposure to −10 ~ −25°C whereas in the absence of AFP, the ice crystals grew into larger pillow-like crystals by the compensation of finer crystals. We also report the results of such activity from plant tissues using these assays.

104(2aC02)

THE PROCESS OF WILTING AT LOW TEMPERATURES

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The process of chill-induced wilting was studied using *Phaseolus vulgaris, Vicia faba* and *Brassica campestris* as plant materials. We focused on the ability of water-uptake and stomatal behavior under different temperature conditions.

When roots and shoots of plants were exposed to different temperatures, a '5 °C shoot / 25°C root' regime did not cause wilting, while the 25°C/5°C regime caused wilting and reduced the rate of water-uptake irrespective of plant species. Therefore, it is apparent that cooling of roots triggered wilting. Stomatal behavior under cold condition was characteristic depending on the plant species. In a chilling sensitive plant *P. vulgaris*, stomatal closure was inhibited during chilling periods despite severe dehydration from the leaves. By contrast, stomatal response to water stress was not affected by lowered temperature in *B. campestris*. These results suggest that wilting was primarily caused by reduced water-uptake, and in some chilling sensitive plants, inhibition of stomatal closure to water stress may enhance wilting.

105(2aC03)

DIURNAL VARIATION IN THE CHILLING SENSITIVITY OF CROP SEEDLINGS

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When crop seedlings (rice, mung bean and azuki bean) were chilled at 4 °C in a dark and humidified atmosphere, their abilities to survive after chilling varied strikingly depending on the starting time of chilling. The seedlings at the end of dark period were most sensitive to chilling and wilted easily after chilling much more than those at the end of light period. When the seedlings at the end of dark period were chilled with '4°C shoots / 25°C roots', the wilting injuries were reduced.

After chilling, bleeding sap volume increased in the seedlings at the end of light period, but not in those at the end of dark period. Treatment with 100 μM $HgCl_2$ solution for 20 min before chilling accelerated chilling-induced wilting in the seedlings both at the end of dark and light period, but wilting injuries were more strikingly in those at the end of dark period.

Our results suggest that the diurnal variation in the chilling sensitivity is caused by the degree of chilling-induced reduction of water uptake through roots. The involvement of water channels of roots will be discussed.

106(2aC04)

LOW-TEMPERATURE INDUCED SUGAR ACCUMULATION IN STORED POTATO TUBERS

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Low-temperature storage of potato tubers leads to an accumulation of reducing sugars. The extent of sugar accumulation is dependent on the respective cultivar. To analyze the phenomenon of the low-temperature sweetening, we measured the sugar content and enzyme activities of sugar metabolism over several months in tubers of 6 cultivars stored at 4°C or 20°C.

At 20°C, little change in sugar content took place over a period of 19 weeks in tubers of all cultivars. On the other hand, when stored at 4°C three-types of changes in sugar content were observed among the cultivars: (i) increased level of reducing sugars during storage, (ii) low levels of reducing sugars throughout the storage, (iii) increased sucrose, not reducing sugars. The activity of acid invertase increased sharply for two weeks at 4°C and continued to rise in the tubers of type i-cultivars, whereas in the tubers of type ii- and type iii-cultivars the activities were very low during storage. It is suggested that the activity of acid invertase is related to the low-temperature sweetening. The activities of total-amylase rose for the first week and then fell in all cultivars compared with those stored at 20°C. The relationship between sugar change and the enzymes of sugar metabolism during low-temperature storage will be discussed.