

Study on cold hardiness and its physiological and biochemical characteristics of winter turnip rape (*Brassica campestris*)*

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Abstract

Superoxide dismutase(SOD)activity, peroxidase(POD) activity, soluble sugar contents, and soluble protein contents of 8 winter turnip rape cultivars were tested during overwintering period. The results indicated: the change in enzyme activity and the contents of soluble substance were similar of 8 cultivars, but the degree of change was difference in cultivars. The studies showed that the enzyme activity and soluble substance contents of strong hardiness cultivars higher than weak one. POD activity, soluble protein contents and soluble sugar contents were close related with winter hardiness of winter turnip rape, which could be regarded as one of the guides for selecting the hardiness cultivars in different low temperature.

Key words: Winter turnip rape, Cold hardiness, physiological-biochemical characteristic

Introduction

The winter-killing is one of the natural disasters that badly endanger agriculture production. Selecting and breeding cold hardiness cultivar was the basic way that prevented the winter injury and the foundation of winter resistance breeding was identification. A lot of research indicated that cold hardiness correlate closely to activity of protective enzyme and some soluble substance contents, these indexes could regard as deliberated index of cold hardiness. However, how changed these indexes in winter turnip rape during overwintering period, what's about the relationship between these indexes and winter survival rates, whether there have correlation. In light of these condition, the study selects 8 winter turnip rape, tested 4 indexes during overwintering period, Testing results and winter survival rates try to find the physiological biochemical index that correlate closely to winter hardiness, in order to provided the theory basis for selecting and breeding cold hardiness winter turnip rape.

Material and methods

The experiment carries on in Gansu agricultural university in 2005-2006. 8 Winter turnip rape cultivars were: 02Cza, WXM-1, 9852, 9889, DQW-1, yanyou2, WYW-1, Tianyou2, the variety provides by the Tianshui academy of agriculture sciences, The experimental material sowed seeds on August 22th, each variety 3 repetitions, arranges immediately, conventional management.

Superoxide dismutase activity: Nitroblue tetrazolium photoreduction. Peroxidase(POD) activity: Guaiacol colourimetry. Soluble protein contents: Coomassie Brilliant Blue G-250 method. Soluble sugar contents: Anthrone coloration method.

Results

The winter survival rate was the most useful method for identification winter hardiness of plants, the result was truly. 8 cultivars were classified 3 kinds based on winter survival rate, MXW-1, DQW-1 were the strongest cold hardiness. WYW-1, Yanyou2 were the medium cold hardiness. 02Cza, 9852, 9889, and Tianyou2 were the weak ones. Their winter survival rate were: 96.80%, 95.90%, 87.90%, 86%, 33.50%, 27.90%, 26.50%, 25.90%.. According to the correlate analysis, POD activity and winter survival rates have significant correlation during overwintering period, the results indicated cold hardiness index correlate closely to temperature, we can select different index under different low temperature

Table 1. The correlate analysis of survival rate and cold hardiness indexes in different period (Correlation is significant at the 0.01 level, * Correlation is significant at the 0.05 level)**

Date	Temperature	Cold hardiness indexes			
		SOD activity	POD activity	Soluble protein contents	Soluble sugar contents
October 5	14°C	-0.487	0.09	0.510	0.560
October 25	6°C	0.721*	0.934**	0.614	0.901**
November 5	1°C	0.821**	0.905**	0.917**	0.893**
November 30	-4°C	0.868**	0.908**	0.950**	0.751*

Changes of SOD activity in leaf of winter turnip rape was showed in figure 1. From October 5th to October 25th, SOD

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activity climbed sharply, Its indicated winter turnip rape have been injured for low temperature while temperature descent from 14°C to 6°C. SOD activity of MXW-1 was the highest among them, it reached 358.6U, and 9852 was the lowest one, only 253.2U. Afterward, with the descent of the temperature, SOD activity of all cultivars was raised slowly. Until November 5th, when the lowest temperature was 1°C, SOD activity reached maximum. The activity of MXW-1 and DQW-1 always kept higher levels, when the lowest temperature was descent to 4 below zero (November 25th). The activity of all cultivars began decline. The result showed that the cultivars of higher winter survival rate have higher SOD activity.the lower ones were not. Although SOD activity and winter survival rates have correlation somewhat, there was no significant difference among 8 cultivars. So the SOD activity could not regard as main basis for identified the cold hardiness cultivars.

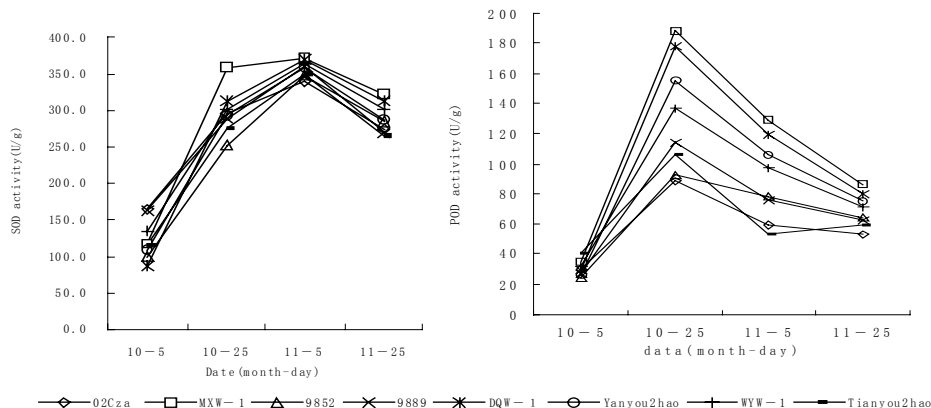


Fig.1 change of SOD, POD activity in leaf during overwintering period

POD activity of 8 cultivars (figure 1) lasted increased from October 5th to 25th, MXW-1, DQW, Yanyou2 increased about 5 or 6 times, there have remarkable difference among 8 cultivars, and POD activity of all cultivars got to highest level. After this, with the descent of the temperature, POD activity began gradually decreases, but the rule of strong or weak did not changed. Cold hardiness of cultivars and POD activity were positive correlation. The result also showed that the cultivars of higher winter survival rate have higher POD activity.the lower ones were not, and what's more, the difference of 3 kind cultivars was obvious. The result accord with winter survival rate, so, within the limits of 6°C to -4°C, POD activity could regard as one of identification indexes for cold hardiness.

Fig. 2 showed that the change trendy of soluble protein contents during overwintering period, the results of November showed the correlation on soluble protein contents and winter survival rates. Under 1°C temperature, MXW-1 have higher winter survival and higher soluble protein contents,But Tianyou2, 9852, 9889, 02Cza have lower contents. So, soluble protein contents could regard as one of the indexes for cold hardiness under 1°C.

The changes trendy of soluble sugar contents and soluble protein were similar, but changes of soluble sugar embodied cold hardiness of cultivars earlier. October 25, MXW-1 has high soluble sugar contents as well as with high winter survival rate under 6°C temperature. Winter survival rate of WYW-1 and Yanyou2 were about 87% with medium contents. Other 4 cultivars with lower survival rate and worse soluble contents, but there were not correlate among them, so, soluble sugar contents could regard as one of the indexes for cold hardiness under 6°C temperature.

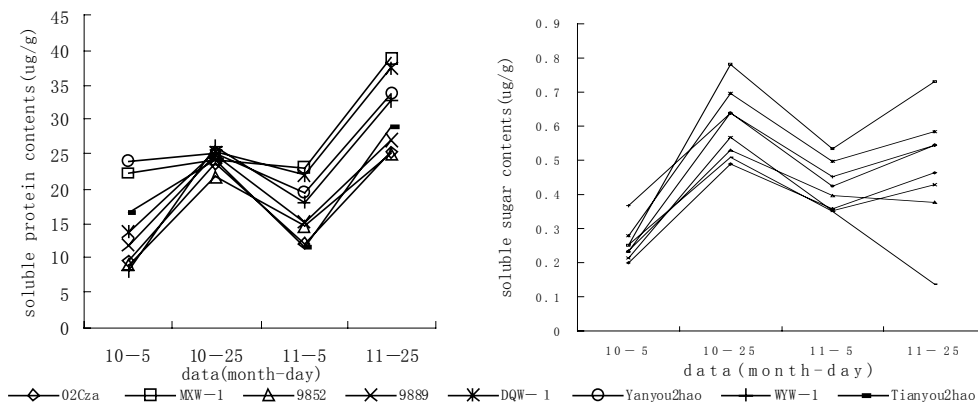


Fig.4 Change of soluble protein, soluble sugar contents in leaf during overwintering period

Discussion

SOD and POD were regarded protective enzyme of cell membrane, the higher of enzyme activity, the better of ability to clear free radical, meantime, the plant have higher stress tolerance. According to the change of SOD activity in leaves of winter turnip rape under low temperature, Plants could reduce hurt from super oxide radical by increase the SOD activity.

Early, the activity of SOD increase continually, and what more, the stronger cold hardiness cultivars have higher enzyme activity, the weaker ones have lower enzyme activity. With the descent of temperature and prolong of the time, the injury of low temperature was worse and worse, so that the plant could not keep higher enzyme activity. The activity of enzyme began descent with different degree; the cultivars of higher winter survival rate have higher SOD activity, the lower ones were not. But there was no remarkable difference in 8 cultivars. So, The SOD activity could not regarded as the main index for identification of cold hardiness.

POD was related to aging, the activity would strengthen under low temperature, the capacity of clear free radical also increased. Similar to SOD, POD activity was also increased and decreased with the descent of the temperature, but POD activity decreased began on October 25th, the lowest temperature was 6°C. After this, enzyme activity and survival rate was interrelated. The cultivars of higher winter survival rate have higher POD activity, the lower ones were not. There was significant difference in 8 cultivars. The POD activity could regard as the main index for identification of cold hardiness under 6°C.

A lot of research has indicated there was positive correlation between soluble protein contents in cell and cold hardiness during low temperature acclimatization. High contents of soluble protein increased cell juice consistency, it's very important to strengthen plant cold hardiness. The tested results show that the correspondence between soluble protein contents and survival rate. MXW-1 have highest survival rate with high contents of soluble protein. Tianyou2, 9852, 9889, 02Cza have lower contents. In consequence, soluble protein contents could regard as one of the reliable index for identification of cold hardiness.

It is generally thought that soluble sugar as protective substance that could inducement to protein synthesis thereby improving the plant cold hardiness. With the lower of temperature, soluble sugar contents increased greatly in leaves of *brassica napus*^[10]. Compared with soluble protein, soluble sugar embodied the cold hardiness of relative strength early, MXW-1 have highest survival rate with high soluble sugar contents, 4 lower survival rate cultivars have lower contents. So, soluble sugar contents also could regard as one of the main identification index of cold hardiness under 6°C.

Conclusions

Although POD activity, soluble protein contents and soluble sugar contents correlate closely to cold hardiness of Winter Turnip Rape as well as regard as main index for identification of cold hardiness under different low temperature, these indexes could compare relative intensity of cultivars not the standard of identification. In addition, cold hardiness was result of a series of physiological and biochemical action, so anyone index could not as identification index of cold hardiness singly, the reliable conclusion would be draw only according to results of different indexes.

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