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Effects of Soil Water Gradient on Stress-resistant Enzyme Activities in Phragmites australis from Yellow River Delta

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Abstract

A simulated experiment with 5 soil water gradients was conducted to study the responses of peroxidase (POD) and the catalase (CAT) activities in *Phragmites australis* from Yellow River Delta on different water stresses. The results showed that: 1) the value of CAT was much higher than that of POD under all conditions; 2) a similar fluctuation change was present in both POD and CAT among the inundation levels generally, and the values of POD CAT were much higher under drought condition than those under other inundation levels, and decreased gradually with the increasing inundation levels, except CAT value has a little rise at the inundation level of 15cm, which indicated that POD and CAT were positive to drought stress and played major role in resistance to drought in oxidative defensive systems of *Phragmites australis*.

Keywords: Resistant enzyme, Peroxidase (POD), Catalase (CAT), *Phragmites australis*, Yellow River Delta

1. Introduction

Vegetation and hydrology are two main environmental characteristics of wetland, which play important roles in wetland ecosystems [1], and water conditions contribute to the species composition and

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diversity, as well as plant community succession in the wetland system [2,3] . Wetzel and van der Valk (1998) [4] reported that higher soil moisture led to an increase in biomass of 15% to 50%, and for the common conditions, the plants will be not harmed and affected by the activity oxygen due to the purging systems [5], while the drought/water stress will take a significant effect on the physiology of vegetation and affected some enzymes [6], then have an inhibitory action on the vegetation growth [7, 8]. Chen and Liu (2003) [9] studied the effects of the water stress on some enzyme activities related to respiratory metabolism in litchi *Chinensis* leaves, and found that the production of catalase was exceeded the purging ability of the plant cells. Meanwhile, some authors detected a positive response of some enzymes to drought/water stress [10, 11], while others presented different results [12].

Phragmites australis, a typical wetland plant, grows in both drought and wet area and acts a crucial part of wetland function. So, the peroxidase (POD) and the catalase (CAT) in *Phragmites australis* from Yellow River Delta were chosen to investigate their responses to different water stresses.

2. Material and Methods

2.1. Site description

The Yellow River Delta is a typical ecotone of the Yellow River and Bohai Bay, which is mainly located within the Dongying and Binzhou cities in Shandong province, China ($37^{o}20'$-$38^{o}12'$N and $118^{o}07'$-$119^{o}10'$E). It covers more than 600,000 hm^2, of which the wetland area is about 8000km^2 [13] and belongs to continental monsoon climate with obvious seasonal changes. The annual mean air-temperature is 12.1°C, and the annual mean precipitation and evaporation are 600 mm and 1962 mm, respectively [14]. The soil type in this region is mainly coastal saline soil, deriving from the sediment and the parent materials of loess soil.

2.2. Incubation experiment and analysis

Phragmites australis were collected in five sampling sites with obviously water, salinity and alkalinity gradient in Yellow River Delta, and then all plants were refrigerated and returned to lab and panted in five containers. A simulated experiment was conducted under five inundation levels: water height of 0cm (wet condition), 5cm 10cm, 15cm, and dry condition. *Phragmites australis* were incubated under the temperature of 30°C at daytime and 25°C at night.

The tested lamina samples were collected from *Phragmites australis* after 30-day incubation, and the activities of POD and CAT were measured by the methods reported previously [15-17]. Soil water content was measured between 0-100 cm soil depth at 20 cm intervals by a neutron probe (503DR, ICT, USA). And the data were analyzed by excel 2007 and origin 7.5.

3. Result and Discussion

The activities of the POD and CAT in *Phragmites australis* were measured and the result was showed in Fig.1. The value of POD was decreased with the increased water levels, and it was proximately three times at dry condition as much as that at other water gradient, while the POD contents presented little change and nearly equal to each other with water gradient more than 5cm level. The activity of POD was higher at dry environment elucidate that POD played an important role and promote the ability of the *Phragmites australis* in resisting the drought stress [18, 19].

Except a slight rise at 15cm level, the change trend of the CAT content was generally similar to that of POD with the water gradient, but in a moderate decrease form with the change value was from 815 U ·g-

1FW·min to 840 U ·g-1FW·min, which indicated that the CAT acted a positive part in response to both drought and water stress. Farhad et al. (2011) [20] also found that the CAT activity was increased with the decrease of irrigation water. Zhou and Wang (1997) [11], Li et al. (2006) [10] covered that the activities of CAT and POD were increased all the time in pea under the drought stress, But Zhang and Kirkham (1994) [12] also found that POD was great increased to drought stress, and CAT activities showed an increase or maintenance in the early phrase of drought and then decrease with a further increase in magnitude of water stress.

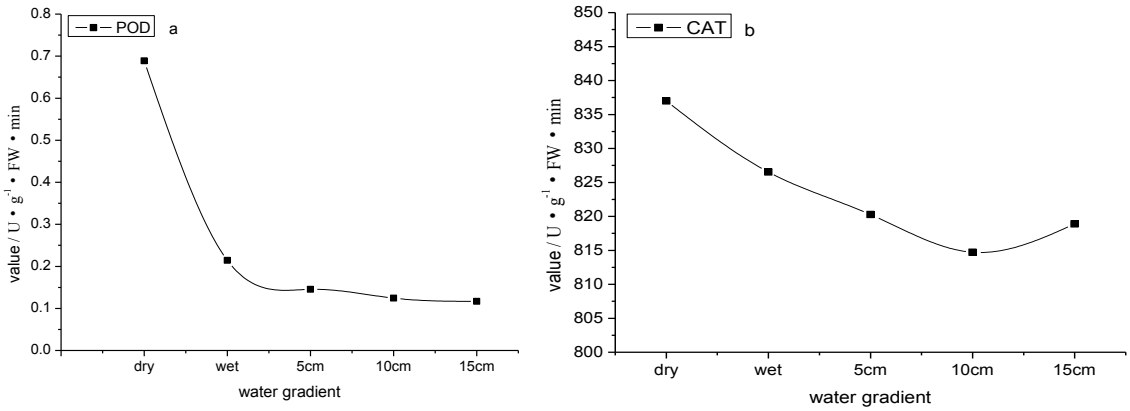

Fig. 1 The changes of the POD (a) and CAT (b) under different water gradient.

4. Conclusion

Both the two enzymes showed a positive response to the drought stress, and promote the ability of the *Phragmites australis* in resisting the drought stress. A moderate increased was presented in the CAT activity, while a sharp increased was turned up in the POD activity under the drought stress. The value of CAT activity was showed a slight increase in water stress with the value of 15 cm level, while there was no response occurred in POD activity to the high water stress.

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