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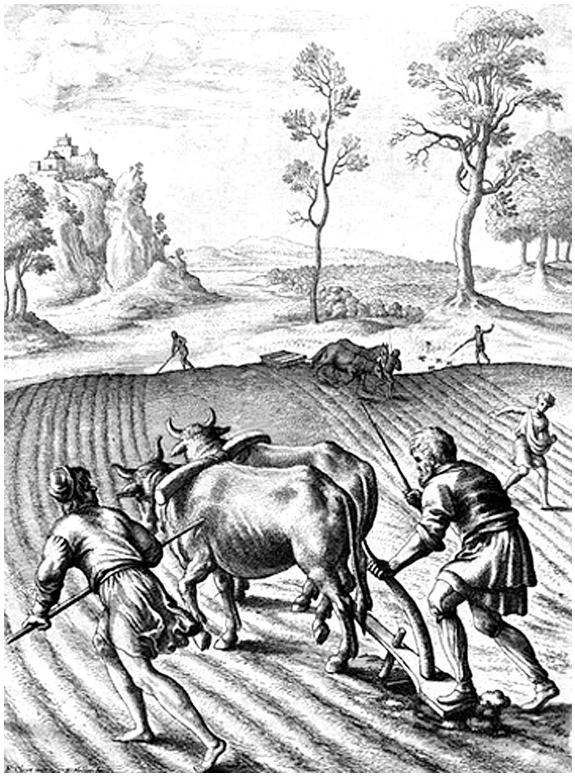

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The Effect of Steviol Glycosides Blending Liquid on Senescence after Flowering in Upland Rice

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Abstract: The effect of steviol glycosides blending liquid (SBL) on senescence after flowering in upland rice had been studied. By measured the superoxide dismutase (SOD) activity in using NBT method to inhibit photoreduction activity NBT 50% for a units; malondialdehyde (MDA) content by using the two-component spectrophotometry and also the catalase (CAT) activity measured by the method of ammonium molybdate. The results showed with different concentrations of SBL sprayed, the SOD activity and CAT activity in upland rice increased, the MDA content in rice flag leaves reduced. Compared the treatment of different concentration, the middle concentration was found to be the best one. The SOD activity could been kept the highest activity until 15 days after flowering in the middle concentration, but it could been started to be down at 5 days after flowering in control and the treatment of low concentration and high concentration. The MDA content increased slowly in the middle concentration and increased rapidly in control and the treatment of low concentration and high concentration. The CAT activity was significantly higher in the treatment of middle concentration and high concentration than that in the low-concentration and control at 5 days after flowering. So, the treatment of middle concentration of SBL has the best effect in delaying senescence of flag leaves.

Key words: Upland rice, steviol glycosides blending liquid, flag leaf, senescence

INTRODUCTION

Rice is the most important food crops in China (Cao, 2009). The rice area occupies about 23% of rice area in the world and 27% of the total sown area in China, while the production is about 29% of the world's production and more than 40% of the total grain output in China (Yu, 2009).

Due to huge demands for China's natural conditions and socio-economic development and so on, the sustainable development of agriculture faces a serious water crisis. The reduction of rice production caused by drought has become a serious problem in rice production (Xin, 1991).The characteristics of decline in leaf function as well as physiological and biochemical mechanisms have an important significance in production as guidance of using reasonable measures to delay the senescence of leaf in late stage. Rice Leaf senescence is one of the main factors that affecting rice yield and quality (Zhu *et al*., 2009). Leaf is the main site of photosynthesis, leaf senescence can lead to photosynthesis reduced and the results will decrease the rice grain-filling rate (Hu and Liu, 2001). It was reported that plant growth regulators could enhance the chlorophyll content and the SOD activity, reduce the MAD accumulation and the membrane permeability, delay the leaf senescence (Wang *et al*., 2005; Zhu *et al*., 2009). The SOD and CAT are important protective enzymes of active oxygen scavenging enzymes system (Jia *et al*., 2009) which can effectively prevent the injury of reactive oxygen species and prevent membrane lipid peroxidation and delay the plant senescence, so that to maintain plant growth and development normally. Some researcher had found that the leaf senescence would decrease the SOD activity and the CAT activity, increase the MDA content (Liang and Cao, 1993; Hua and Wang, 2003). But so far the study of characteristics of functional decline of leaves is not much and the reports are not consistent (Wu and Wu, 1992; Chen and Zhang, 1994; Xiao *et al*., 1998). In this study, the effects of SBL on the senescence of flag leaves in upland rice had been studied; the results would provide a theoretical basis for delaying the senescence in upland rice.

MATERIALS AND METHODS

The experiment was carried in the experimental station of Qingdao Agricultural University in 2008. The upland rice Handao502 (Qiu guang×Hong guang lao shu

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ya) was used as an experimental material. The steviol glycosides blending liquid compose of stevioside and some other nutrient elements and made by Qingdao Agricultural University. There are 4 treatments, T1 is 50 mg L^{-1} SBL, T2 is 100 mg L^{-1} SBL, T3 is 200 mg L^{-1} SBL and the control (CK) is 0 mg L^{-1} SBL plus water. The soil is sandy, 0-30 cm surface soil taken from the fertile agricultural land next to the Moshui River where organic matter is 1.32%; total nitrogen is 1.11 mg kg^{-1}; available nitrogen is 87.67 mg L^{-1}, available phosphorus is 25.09 mg L^{-1}, available potassium is 85.54 mg L^{-1}. The diameter of pot is 30 cm and the height is 35 cm. Seedlings were transplanted in the three-leaf period. The SBL was sprayed at jointing stage, heading stage and flowering stage. There are 21 pots in every treatment and each treatment was repeated 3 times. Five rice plants were transplanted in each pot.

SOD activity was measured by NBT method to inhibit photoreduction activity NBT 50% for a units (Wang *et al*., 1983). The MDA content was measured by using the Two-component spectrophotometry (Dai *et al*., 2006). The CAT activity by the method of ammonium molybdate (Peng *et al*., 2009).

Using Microsoft Excel and the DPS software to analyze the data.

RESULTS

SOD activity: SOD activity in flag leaf of each treatment has been showed in Fig. 1, highest value all appeared 5 days after flowing in CK, low concentration and high concentration treatments, then showed a downward trend. The SOD activity in the middle concentration treatment reached the peak at 15 days after flowering and then descended. The SOD activity of flag leaves at 5 days after flowering in low concentrations treatment was significantly higher than controls, while the middle concentration and high concentration was significantly lower than the control. It showed that an appropriate concentration of SBL can improve the flag leaf superoxide dismutase activity to increase active oxygen scavenging capacity of plants and thus delay the senescence of flag leaf. The SOD activity kept increasing 5 days after flowering which can decline the senescence of flag leaves, so it can enhanced photosynthesis, as well as increased biological yield.

The effect on MDA content: The MDA content in flag leaves in middle concentration SBL treatment was significantly lower than other treatments at 5 days after flowering (Fig. 2). The MDA content in flag leaves of rice treated by the middle concentration of SBL was lower

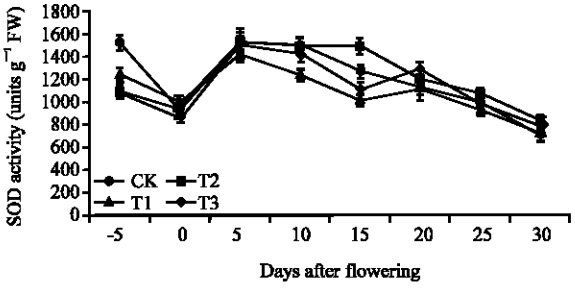

Fig. 1: Effect of SBL on SOD activity after flowering in upland rice

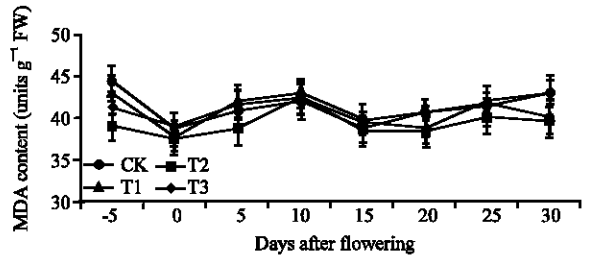

Fig. 2: Effect of SBL on MDA content after flowering in upland rice

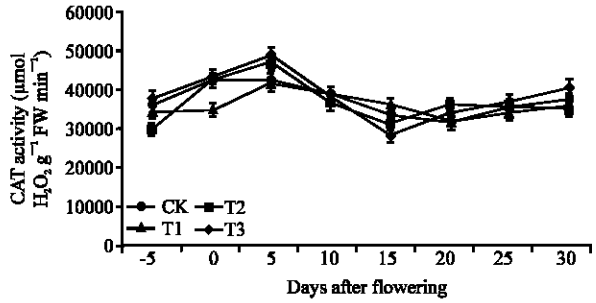

Fig. 3: Effect of SBL on CAT activity after flowering in upland rice

than the other three treatments. It shows that the suitable concentration of SBL treatment can reduce the MDA content in flag leaf and delay flag leaf senescence.

CAT activity: Although, the overall trend is the same, but in different periods, there were significantly different in all treatments. From the 5 days before flowering to 5 days after flowering, the CAT activity in each treatment increased (Fig. 3). The CAT activity of rice flag leaf sprayed by high concentration and the middle concentration of SBL was significantly higher than the low-concentration and control at 5 days after flowering. But when CAT activity of flag leaf in each treatment decreased gradually, the middle concentration and the

high concentration similarly, significantly reduced and the high concentration has the minimum value at 15 days after flowering, middle concentration has a lower reduce than higher concentration. According to the comprehensive analysis, the middle concentration of treatment is appropriate.

DISCUSSION

Since McCord (1969) reported the characteristics of SOD, the SOD-centered study of the biological activity of oxygen metabolism progressed very quickly. As an important protective enzymes in enzyme defense system of plants, the activity of SOD directly affect the size of free radical scavenging ability during aging (Wang,1988; Wu *et al*., 2008). The SOD activity decreased in plant's late growth stage, which reduced the ability to scavenge oxygen free radicals, oxygen free radicals is one of the important reasons that cause rapidly senescence of plant. The MDA can react with membrane and intracellular proteins, nucleic acids, enzymes and macromolecules resulting in the destruction of membrane structure and function, was a final product of Membrane Lipid Peroxidation (MLP) happening on cell membrane when plants suffer stresses. The MLP often occurs when the organs is mature or suffer stresses, meanwhile, the early reduction of activity of SOD and CAT will also lead to MLP causing reactive oxygen species metabolic disorders (Cheng *et al*., 2002). As a final product of MLP, MAD reflect the extent of injury after stresses. With the advancement of rice growth stages, its MDA content was gradually increased. The MDA content in leaves of rice will increase when being stressed and increases with rapid worsening. The CAT is one of the key enzyme to remove H_2O_2 in plants, which related to not only individual development process, but also resistance against adverse environmental conditions.

Results of experimental showed that spraying the appropriate concentration of SBL could increase SOD and CAT activity of the flag leaf before and after flowering and also could reduce MDA content of plants, the results could delay the decrease of SOD and CAT as well as the increase of MDA content in control. As a protective enzyme in scavenging system, SOD can prevent the accumulation of high concentrations of oxygen, thus, delaying the senescence of flag leaf. However, different concentrations made difference in activity regulation. The SOD activity began to decrease at 15 days after flowering, SOD activity reduction was delayed in middle concentration. At 5 days after flowering, the effect of low concentrations of SBL was better than that of middle concentration and high concentration in improving the CAT activity and reducing level in MDA. The middle concentration of treatment was best for all processing, middle concentration could be reduced MAD content throughout the whole growth period. By contrast with high concentration and low concentration, middle concentration could significantly reduce CAT levels at 5 days after flowering, thus delayed senescence of rice.

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