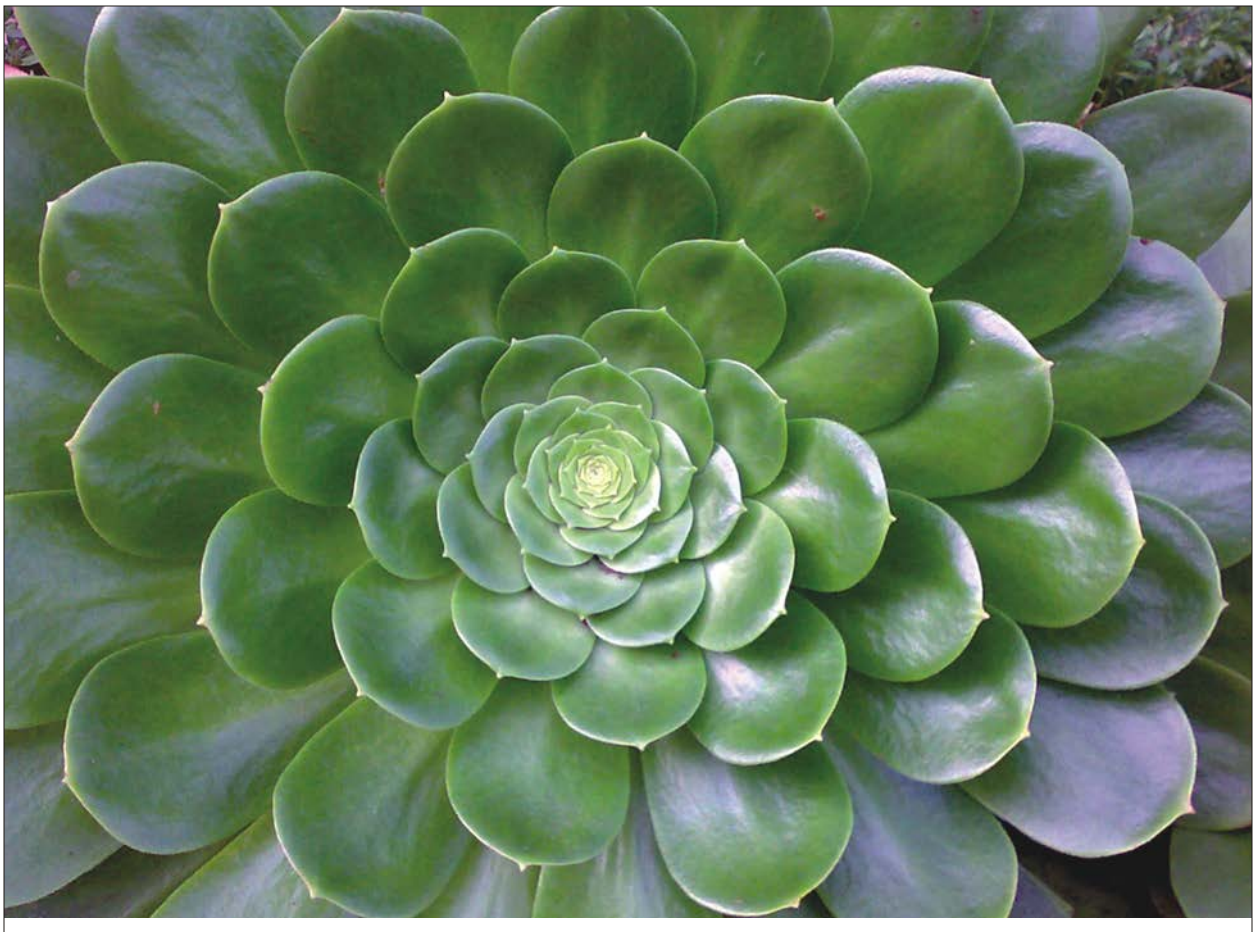

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The Effects of Steviol Glycosides Blending Liquid on Seeding Growth and Development in Upland Rice

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Abstract: Using the method of liquid culture and selecting the variety of Handao502, the effect of Steviol glycosides Blending Liquid (SBL) on seeding growth and development in upland rice had been studied in phytotron. Many indexes were studied including the germination rate of seed, the fresh weight and dry weight, the indexes of physiology and biochemistry in seeding stage. The results indicate that the appropriate treatment of SBL increases the seed germination rate, promotes the growth of shoot and the roots in the seeding stage, increases the fresh weight, dry weight and the radio of root to shoot, increases the peroxidase (POD) activity, the free proline content and the root vigor, decreases the malondialdehyde (MDA) content. So, proper SBL increases the unsuitable resistance ability in the growth and development of seeding stage in upland rice. This study provides a certain foundation for the high yield cultivation of upland rice.

Key words: Upland rice, steviol glycosides blending liquid, growth and development

INTRODUCTION

Rice is the important grain crop and next to the wheat (Langer and Hill, 1991). According to the statistics, the number of people living on rice is more than a half of the total population in the world. There are 122 countries for the cultivation of rice, the cultivated area is around 1.40-1.57 billion hectare in a normal year and the 90% of total area is in Asia (Cheng *et al*., 2007; Guang and Shi, 2007). But because of the change of the climate, the water becomes the important factor to restrict the agricultural production. In order to save water and to exploit the maximum benefit of the water resources by Lu *et al.* (2006) has been done in the world for the study and development of the upland rice. The upland rice is the special plant-type of cultivated rice, the sowing method is direct seeding in upland and the cultivation and management relies on the natural rainfall and adequate irrigation (Ai *et al*., 2008a). The increasing yield of upland rice per unit is lack of progress in recent 5 years. Upland rice has the good traits in drought-resistance, low water requirements, is one of the optimum upland crops in the implementation in the water-saving and dry farming agriculture (Xue *et al*., 2002; Liu *et al*., 2008). Therefore, people become to pay widely attention to the yield increasing ways of upland rice (Wang *et al*., 1990, 1999; Xu *et al*., 1997). The morphological characteristics and the physiological and biochemical index are closely linked with the yield and the seedling root morphological feature has an inseparable relationship with the ability of rice seeding root system to absorb water and nutrition (Pan, 1979). In this study, the effect of the different concentrations of SBL on seed germination and seedling growth and development had been studied, the aim is to provide theoretical basis for upland rice high yield cultivation.

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MATERIALS AND METHODS

The study was carried out from August 2008 to March 2009 in the Dryland Technology key laboratory of Shangdong Province in Qingdao, Agricultural University (North latitude 36°11', East longitude 120°17').

The SBL includes Steviol glycosides and other nutrient elements, produced and mixed by the Dryland Technology key laboratory of Shangdong Province in Qingdao, Agricultural University. There are 4 treatment, used the distilled water as check (CK), the T_1 is 10 mg kg^{-1}, the T_2 is 100 mg kg^{-1}, the T_3 is 1000 mg kg^{-1}, all treatments were repeated 3 times.

The rice variety was Handao 502 (Qiu guang×Hong guang lao shu ya) in upland and was bred by the Rice Cropping Institute of North China in China Agricultural University in 2003.

In this study, the upland rice seeds were soaked with ethanol (75%) for 10 sec, then were rinsed 3 times by tap water, then rinsed by 500 mL sterile water, handpicked and 40 rice seeds were put in diameter 90 mm cultivation vessel with 4 layers qualitative filter paper, which contained 15 mL different concentration of SBL. Put all cultivation vessel into the phytotron and cultivated by 29±1°C constant temperature.

After 48 h, take the materials from the phytotron and calculated the germination rate of seed. Then put the materials into the phytotron again and were in the same environment for continuing the cultivation.

After for continuing the cultivation for 168 h, 10 seedlings were randomly selected from every cultivation vessel. The physiological and biological indexes of root and shoot were measured in upland rice. The root length and the shoot length were measured with straightedge (Accuracy is 1/100 m), the Root Fresh Weight (RFW), the Shoot Fresh Weight (SFW), the Root Dry Weight (RDW) and the Shoot Dry Weight (SDW) with electronic balance (Accuracy is 1/100 g). The free proline content was measured by acidic hydration ninhydrin method (Zhang *et al*., 1990), the POD activity by the guajacolum method (María-de-la-Luz *et al*., 2008), MDA content by the pair of group spectrophotometer method (Lin *et al*., 1984), the root vigor by the 2,3,5-Triphenyltetrazolium chloride (TTC) method.

RESULTS

The Effects of SBL on the Germination Rate of Seed in Upland Rice

In this study, the results of different SBL on the germination rate of seed in upland rice were shown in Fig. 1. When the solution concentration was 10 mg kg^{-1} (T_1), the germination rate was 96.67%; the CK was the second, the germination rate was 95.80%; the 100 mg kg^{-1} (T_2) and the 1000 mg kg^{-1} (T_3) were the same condition, the germination rate was 95.00%. The germination rate of Tr1 was higher 0.87, 1.67 and 1.67% than CK, T_2 and T_3, respectively. It indicated that the properly SBL (T_1) could improve the germination rate of upland rice seeds and unsuitable SBL (T_2, T_3) would reduce the germination rate.

The Effect of SBL on Growth Characteristics of Seeding Stage in Upland Rice

The effects of SBL on growth characteristics of seeding stage in upland rice were presented in Fig. 2a-d. It showed that there was no significant difference between T_1 and CK in root length, shoot length, SFW and SDW, but the difference in RFW, RDW and the root-shoot ratio was significantly. There was 8.7% higher than CK in RFW, 20.4% higher in RDW, 19.0% higher in root-shoot radio. The growth characteristics were significantly promoted by SBL in T_2, there was 17.6% higher in root length than CK, 8.31% higher in shoot length, 26.1% higher in RFW, 24.3%, higher in RDW, 8.4% higher in

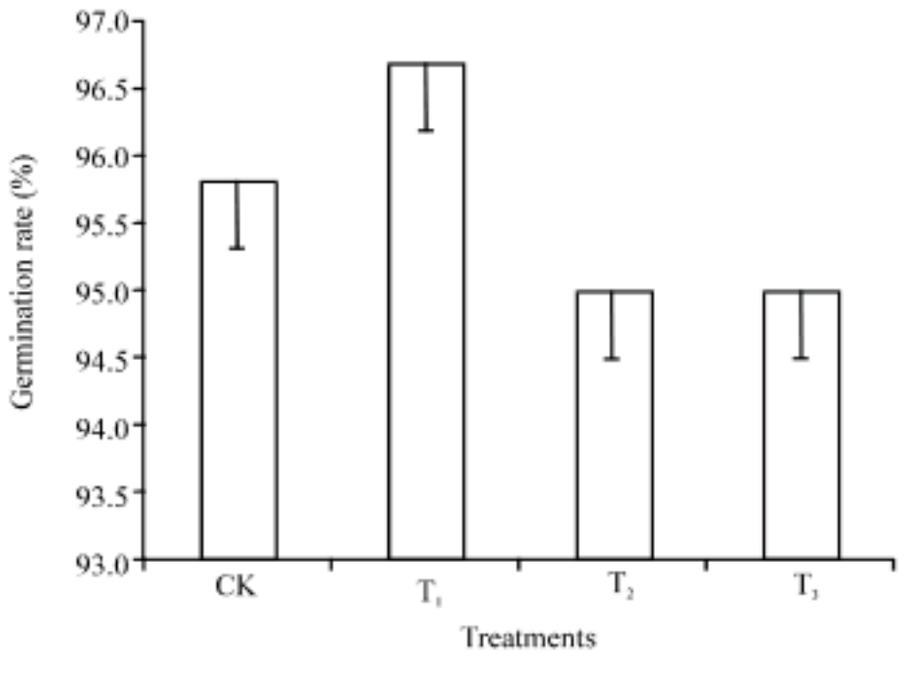

Fig. 1: The effect of SBL on the germination rate of upland rice

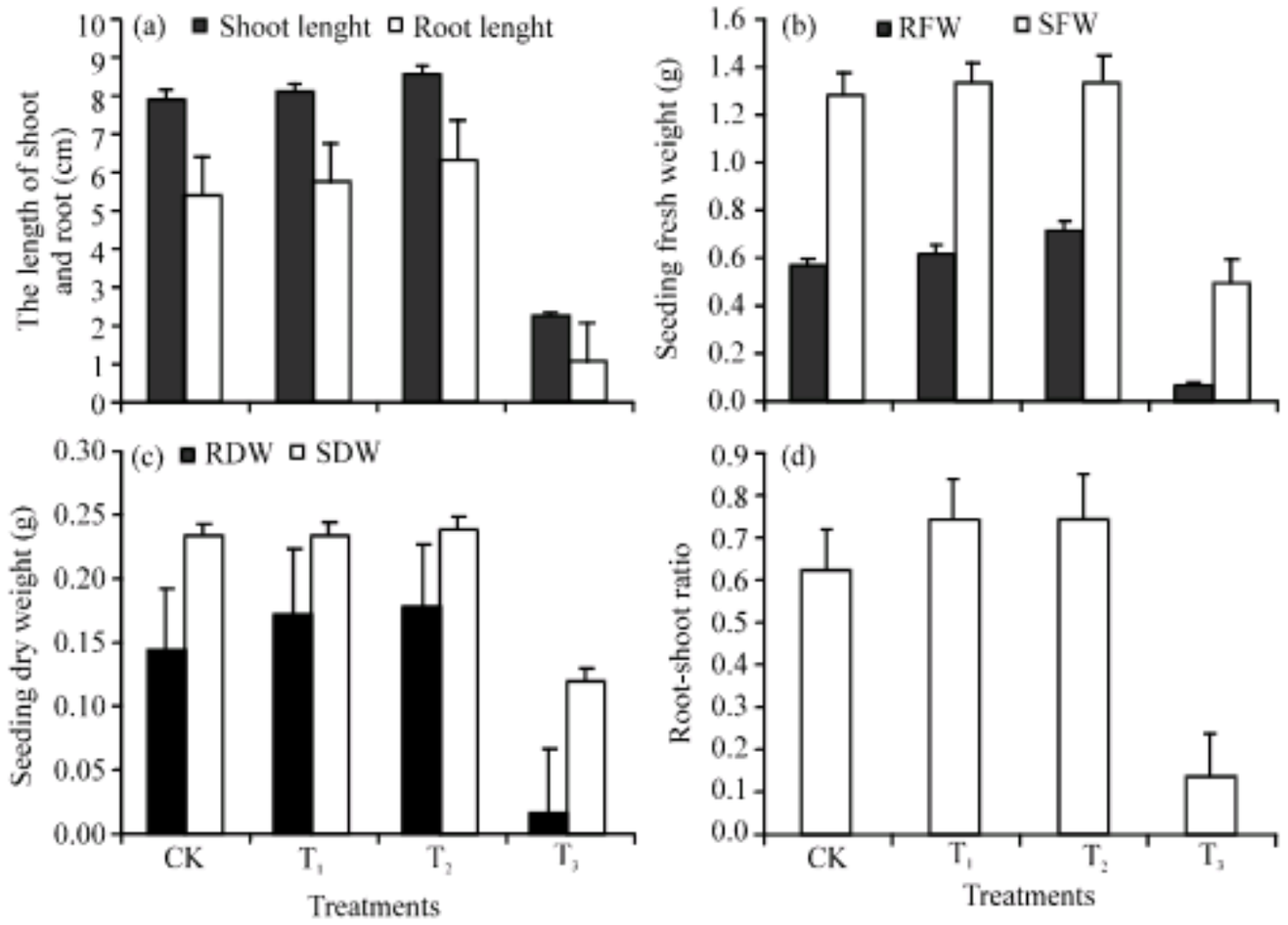

Fig. 2: (a) The effect of SBL on the shoot and root length, (b) fresh weight, (c) dry weight and (d) the root-shoot ratio of upland rice seeding

SFW, 3.3% higher in SDW, so there was 20.3% higher in root-shoot radio than CK. The significant differences between T_2 and T_1 in the growth characteristic were root length and RFW: the root length of T_2 was 10.6% higher than T_1, the RFW of T_2 was 15.3% higher than T_1, respectively. But the growth was affected seriously by SBL in T_3 (there was 80.3% lower than CK in the root length than CK, 71.5% lower in shoot length, 88.6% lower in the RFW, 89.1% lower in RDW, 61.9%lower in SFW, 48.5% lower in SDW and 78.7% lower in root-shoot ratio). The results showed that when the concentration of SLB rises in the proper range, the SBL could promote the growth and development of the upland rice seeding (T_2, 100 mg kg^{-1}) and the over high concentration can decrease the growth and development in upland rice seeding.

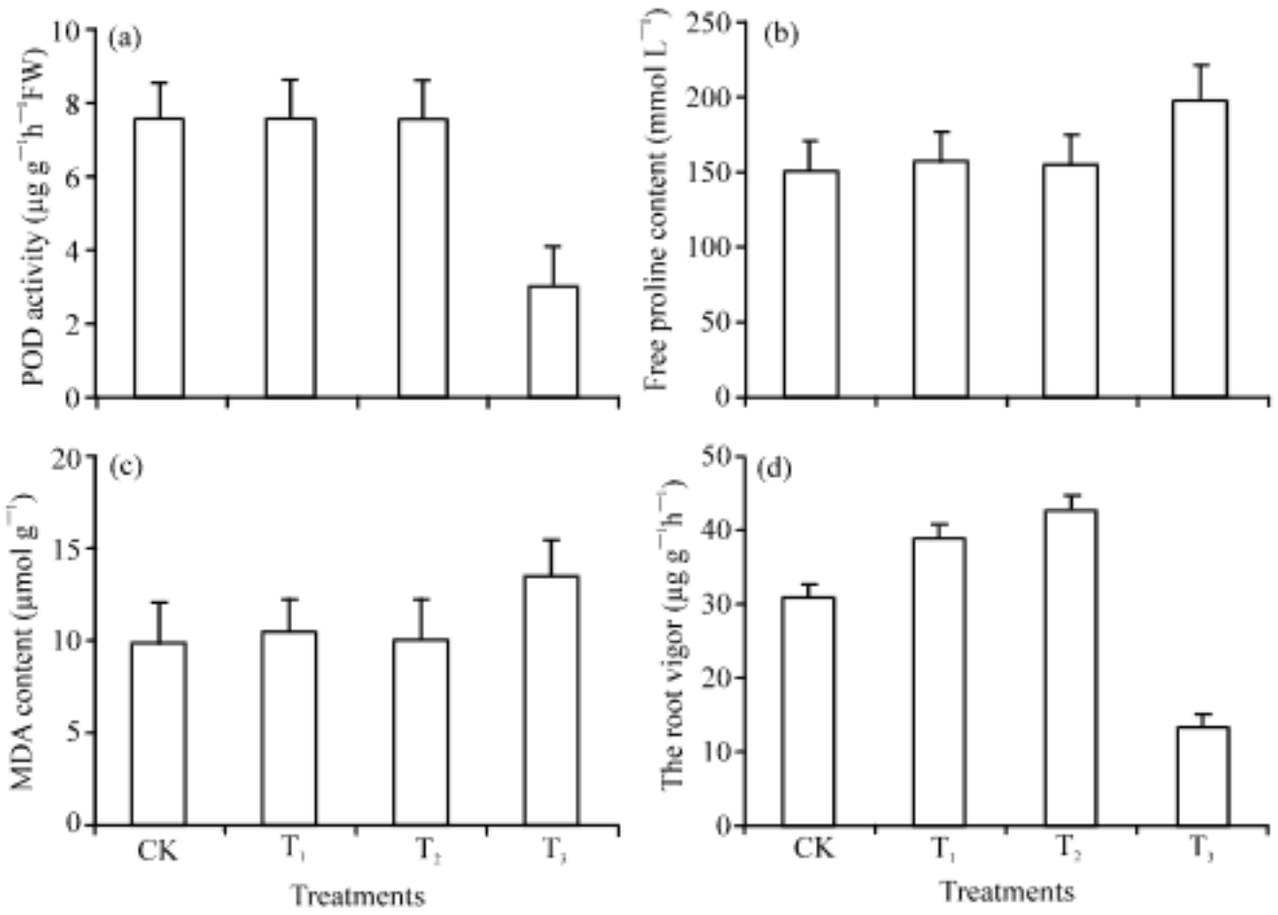

Fig. 3: (a)The effect of SBL on the POD activity, (b) the free proline content, (c) MDA content and (d) the root vigor of seeding stage in upland rice

The Effect of SBL on the Pod Activity, the Free Proline Content, MDA Content and the Root Vigor of Seeding Stage in Upland Rice

In Fig. 3a-d, there was no significant difference between T_1 and CK in POD activity, free proline content and MDA content in the seeding stage, but there was 26.2% higher than CK in the root vigor. The difference between T_2 and CK is mainly shown in root vigor (it was 38.69% higher than CK).When the concentration of SBL was up to 1000 mg kg^{-1} (T_3), the changes between T_3 and CK in POD activity, the free proline content, MDA content and the root vigor were all significant, it was 58.89% lower than CK in the POD activity, it was 32.67% higher in the free proline content, it was 34.90% higher in the MDA content and it was 57.64% in the root vigor. In this study, we could know that when the concentration of SBL was in the proper rang, the indexes of physiology and biochemwastry of the upland rice seeding could be kept on the normal level (T_1 and T_2) and the root vigor was promoted by the SBL and the condition of T_2 was the best. But when the concentration of SBL was over high (T_3), the normal growth and development of the upland rice seeding would be damaged and the POD activity and the root vigor were decreased significantly, the free proline content and the MDA content were increased significantly. The reason of the free proline content rising would be to adapt the stress of environment or the membrane system was destroyed, so it could not promote the growth and development of the upland rice seeding.

DISCUSSION

The results showed that the SBL could increase the germination rate and promote the growth and development of the upland rice seeding, but the different treatment had different results.

When the concentration is 10 mg kg^{-1}, the germination rate was the best in this study and with the rising of the concentration, the rate became lower. The key factor that causes the reduction of germination rate may be that the increasing concentration of SBL make the water uptake become slowly and may be the high-concentration of SBL make the activity of a-amylase decreased, so the

high-concentration of SBL can hinder the accumulation of the soluble sugar and make the germination lower (Yang, 2006; Ai *et al*., 2008b).

The root length and shoot length, the RFW and RDW, the SFW and SDW all reach the best result in this study, when the SBL is 100 mg kg^{-1} and it has a significant effect on the root-shoot ratio, so the SBL can promote the upland rice to take up nutrients. When the concentration rises properly, the POD activity, the free proline content and the MDA content will be optimized respectively, but when the concentration is over high, the POD activity and the proline content will decrease sharply and the MDA content will increase significantly. The reason is that proper concentration of SBL can make the upland rice seeding to increase physiochemical activity (Chen *et al*., 1999; Yan *et al*., 1997; María-de-la-Luz *et al*., 2008; Verslues *et al*., 2005; Wu, 2003) and the over high concentration causes severe stress. And the proper concentration of SBL increases the root reducing capacity of upland rice seeding (Chen, 1996; Liang *et al*., 1999) and increase the root vigor, so that lead to promote growth and development of the root (Zhou *et al*., 2001).

This study showed that the SBL could increase the germination rate of the upland rice seed, promote the seeding to take up nutrients when it grow and develop, but no research were concerned about using SBL in upland rice, so this study could provide theoretical basis for upland rice cultivation. But after long time treatment in the whole growth period of upland rice, the treatment of SBL improves yield and quality weather or not, it needs further research and discussion.

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