Effects of Chitosan on Soluble Sugar Content in *Prunus davidiana* Seedlings

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Abstract. A pot experiment was conducted to study the effects of different concentrations of chitosan solutions (0, 1, 2, 4, 6 g/L) on soluble sugar content in *Prunus davidiana* seedlings. The result showed that there was no significant difference of the soluble sugar content in roots, stems, leaves and shoot in *P. davidiana* seedlings between at 1 g/L concentration and the control. All concentration treatments were reduced the soluble sugar content in roots and stems of *P. davidiana* seedlings compared with the control. On the contrary, all concentration treatments were improved the soluble sugar content in leaves and shoot of *P. davidiana* seedlings compared with the control and the concentration treatment of 2 g/L and 4 g/L was at a higher level. All concentration treatments were improved the content in relative conductivity of blade in *P. davidiana* seedlings and the concentration treatment of 4 g/L was at a higher level. On the contrary, all concentration treatments were reduced the content in soil conductivity. Therefore, the chitosan solutions concentration of 2 g/L and 4 g/L concentration was beneficial to soluble sugar content in *P. davidiana* seedlings. On the contrary, high concentration of chitosan solutions was not good for soluble sugar content.

1 Introduction

Chitosan is a natural nitrogen-containing polysaccharide bioactive substance, which is the sixth essential life factor besides sugar, protein, fat, cellulose and minerals [1]. Many studies have shown that chitosan has great potential in promoting plant growth, increasing yield and improving quality. Chitosan can be used as crop growth regulator to enhance crop resistance, and promote seed germination, growth and development of crops such as soybeans, corn and wheat, and increase crop yields [2-4]. Many studies have shown that the effect of chitosan on seedling growth is reflected in low concentration promoting growth and high concentration inhibiting growth [5]. The study shows that the wet weight, dry weight, bud length and root length of radish seedlings increase with the increase of concentration in the range of 0%-0.25% chitosan, and the growth of these seedlings decrease when the concentration exceeded [6]. The study also shows that low concentration of chitosan can promote the growth of cucumber seedlings, while high concentration can inhibit the growth of cucumber seedlings [7]. Chitosan can also enhance the metabolism of sugars in seedlings, and enhance the fixation and synthesis of chlorophyll to sugars. The study showed that the soluble sugar content in seedlings increased with the increase of chitosan concentration in the range of 0%-0.8%. When the concentration exceeded 0.8%, the soluble sugar content in seedlings began to decrease again [8]. Thus, spraying chitosan requires an appropriate concentration. Therefore, this study

investigated the effects of different concentrations of chitosan (0, 2, 4, 6, 8 g/L) on soluble sugar content in *Prunus davidiana* seedlings then to screen out the optimum concentration that can promote growth of *P. davidiana* seedlings.

2 Materials and methods

2.1 Materials

P. davidiana seeds were purchased from a market in Chengdu, Sichuan, China. Non-polluted soil was collected from the Chengdu campus of Sichuan Agricultural University (30°42'N, 103°51'E) in Chengdu, Sichuan, China. The basic soil properties were as follows: pH, 7.71; organic matter content, 15.29 g/kg; alkaline nitrogen content, 87.99 mg/kg; available phosphorus content, 55.77 mg/kg; and available potassium content, 41.96 mg/kg. The basic physical and chemical properties of the soil were based on references [9].

2.2 Experimental design

The Experiment was conducted in a greenhouse at the Chengdu campus of Sichuan Agricultural University from April to July 2019. In April 2019, *P. davidiana* seeds were sown in perlite and watered every 3 days. The germinated seeds were irrigated with Hoagland nutrient solution every 3 days until the seedlings reached a height of 10 cm (with about seven true leaves). Four uniformly

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growing seedlings were transplanted to a pot [15 cm (height) × 18 cm (diameter)] containing 3.0 kg soil. The soil moisture content was maintained at 80% of field capacity. At 7 days after transplanting, the leaves of *P. davidiana* seedlings were sprayed with chitosan solutions (0, 2, 4, 6, or 8 g/L) until water droplets formed on the foliar surface, without dripping. Each treatment was repeated three times. At 1 month after the chitosan treatments, the upper mature leaves of *P. davidiana* seedlings were collected to determine the relative conductivity of blades by Conductivity Analyzer. And the roots, stem, and leaves of each plant were separately harvested, washed with tap water, and rinsed three times with deionized water. The plant materials were blanched at 110 °C for 15 min, dried at 75 °C until reaching a constant weight, and weighed and crushed, which was used to determine the soluble sugar content in various parts of *P. davidiana* seedlings [10]. The soil in pots were air-dried and ground into a powder (soil particle diameter < 1 mm) to determine the soil conductivity and the soil conductivity was measured with a 1:5 (w/v) suspension of soil and deionized water by Conductivity Analyzer.

2.3 Statistical analyses

Statistical analysis was carried out by using SPSS 18.0 statistical software. The data were analyzed by one-way

ANOVA, with the least significant difference at the 5% confidence level.

3 Results and Discussion

3.1 Soluble sugar content in *P. davidiana* seedlings

There was no significant difference of the soluble sugar content in roots, stems, leaves and shoot in *P. davidiana* seedlings between at 1 g/L concentration and the control. All concentration treatments of *P. davidiana* seedlings decreased the soluble sugar content in roots and stems compare with the control (Table 1). The soluble sugar content in roots decreased by 9.69%, 17.53% and 24% at 2 g/L, 4 g/L and 6 g/L compared with the control, respectively. The soluble sugar content in stems decreased by 6.83%, 16.47% and 28.38% at 2 g/L, 4 g/L and 6 g/L compared with the control, respectively. The soluble sugar content in leaves and shoot of *P. davidiana* seedlings of all concentration treatments was higher than the control except at 6 g/L. The soluble sugar content in leaves increased by 8.92%, 12.09% and 5.14% at 2 g/L, 4 g/L and 6 g/L compared with the control, respectively. The soluble sugar content in shoot of all concentration treatments increased by 5.72% and 5.54% at 2 g/L and 4 g/L compared with the control, respectively.

Table 1. Soluble sugar content in *P. davidiana* seedlings

Treatments (g/L)	Roots (mg/g)	Stems (mg/g)	Leaves (mg/g)	Shoot (mg/g)
0	74.79±1.040a	36.19±1.236a	98.38±1.91d	71.70±1.62b
1	72.76±1.379a	35.03±0.521ab	101.91±2.66cd	72.93±1.73ab
2	67.56±0.709b	33.72±0.954b	107.16±1.87ab	75.80±1.48a
4	61.68±1.872c	30.23±0.090c	110.27±0.87a	75.61±0.53a
6	56.84±0.132d	25.92±0.926d	103.44±0.86bc	70.12±0.09b

Value are means ± standard errors. Means with the same letter within each column are not significantly different at $p < 0.05$.

3.2 Relative conductivity of blade

All concentration treatments were improved the content in relative conductivity of blade in *P. davidiana* seedlings (Fig. 1). There were significant differences between the treatment with different concentration of chitosan and the control. The content in relative conductivity of blade in *P. davidiana* seedlings increased by 7.07%, 7.45%, 7.89% and 7.37% at 1 g/L, 2 g/L, 4 g/L and 6 g/L compared with the control, respectively.

3.3 Soil conductivity

All concentration treatments were reduced the content in Soil conductivity (Fig. 2). Except for treatment of 1 g/L, there were significant differences between the other concentration treatments and the control. The content in soil conductivity decreased by 11.97%, 14.75% and 16.96% at 2 g/L, 4 g/L and 6 g/L compared with the control, respectively.

Figure 1. Relative conductivity of blade. Different lowercase letters indicate significant differences based on one-way analysis of variance in SPSS 18.0 followed by the least significant difference test ($p < 0.05$).

Figure 2. Soil conductivity. Different lowercase letters indicate significant differences based on one-way analysis of variance in SPSS 18.0 followed by the least significant difference test ($p < 0.05$).

4 Conclusions

According to the experiment, all concentration treatments were reduced the soluble sugar content in root and stem of *P. davidiana* seedlings compared with the control and the concentration treatment of 1 g/L and 2 g/L was at a higher level. On the contrary, all concentration treatments were improved the soluble sugar content in leaves and shoot of *P. davidiana* seedlings compared with the control and the concentration treatment of 2 g/L and 4 g/L was at a higher level. All concentration treatments were improved the content in relative conductivity of blade in *P. davidiana* seedlings and the concentration treatment of 4 g/L was at a higher level. On the contrary, all concentration treatments were reduced the content in soil conductivity and the concentration treatment of 1 g/L was at a higher level. Therefore, the chitosan solutions concentration of 2 g/L and 4 g/L concentration was beneficial to soluble sugar content in *P. davidiana* seedlings. On the contrary, high concentration of chitosan solutions was not good for soluble sugar content.

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