

# Effects of Different Selenium Concentrations on Physiology of *Prunus davidiana* Seedlings

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**Abstract.** To study the effects of selenium on physiology, *Prunus davidiana* seedlings were treated with the irrigation of different selenium concentrations solution. The result showed that the photosynthetic pigment content was relatively higher at selenium concentrations of 0, 0.05 and 0.1 mg/L except for carotenoid content which was the highest at 0.1 mg/L but the lowest in control seedlings. In terms of antioxidant enzyme activity, the activities of peroxidase (POD), catalase (CAT) and superoxide dismutase (SOD) in selenium-treated seedlings were all higher than that in control seedlings and especially at the selenium concentration of 1 mg/L. The soluble protein content accumulated most at 0.25 mg/L selenium concentration. The content of malondialdehyde (MDA), as membrane lipid peroxidation index, was the lowest at selenium concentration of 0.5 mg/L. In a word, irrigating lower selenium concentrations could increase the photosynthetic pigment content and higher selenium concentrations enhanced the antioxidant enzyme activity to increase cell protection and kept the *P. davidiana* seedlings good growth and resistance to adverse environments.

## 1 Introduction

Selenium, a trace element essential for people's health, has a wide range of pleiotropic effects of good antioxidant capacity, immune function, an anti-cancer and incorporated into selenoproteins to make difference [1-2]. Selenium was capable of prolonging the green retention time of lettuce leaves and increases the content of proline to enhance the resistance of plants [3-4]. With the increase of exogenous selenium concentrations, the activity of antioxidant enzymes (SOD, POD and CAT) in tomato seedlings significantly increased and the content of MDA gradually decreased [5]. There are also many studies on selenium in fruit trees. The previous researches report that selenium treatments can increase photosynthetic rate, chlorophyll content and disease resistance of grape seedlings [6]. It also works on walnut and persimmon trees [7]. In this experiment, irrigating selenium solution was used to study the changes of physiology on *Prunus davidiana* seedlings.

Speaking of *P. davidiana*, it belongs to the genus peach of Rosaceae and has good drought resistance, salt and alkali resistance, good grafting affinity for other significant researches [8]. There were few studies on selenium of *P. davidiana* and it is necessary to conduct a research for application of selenium in *P. davidiana* seedlings.

## 2 Materials and methods

### 2.1 Materials

*P. davidiana* seeds, purchased from a market in Chengdu, Sichuan, China, were used as materials to reveal the effects of physiology in *P. davidiana* seedlings by irrigating different concentrations of selenium solution. Meanwhile, the Hoagland nutrient solution was needed for solution culture experiment, which was bought online.

### 2.2 Experimental design

The experiment was conducted in a greenhouse at the Chengdu campus of Sichuan Agricultural University from August to September 2019. Then, *P. davidiana* seeds were seeded into perlite which was placed in climate chamber for sprouting and irrigated with Hoagland nutrient solution in August 2019. Nine uniformly growing *P. davidiana* seedlings were transplanted into a plug for solution culture and irrigated Hoagland nutrient solution with different selenium concentrations (0, 0.05, 0.1, 0.25, 0.5, 1 and 2 mg/L) every 3 days, when *P. davidiana* seedlings grew to a height of 10 cm. Each treatment repeated for three times.

After one month with selenium treatments, the mature leaves from the top of *P. davidiana* seedlings were collected for the assay of photosynthetic pigment of chlorophyll a, chlorophyll b, carotenoid and total chlorophyll, the antioxidant enzyme [superoxide dismutase (SOD), peroxidase (POD) and catalase (CAT)] activity, the osmotic adjuster of the soluble protein content and the malondialdehyde (MDA) content as described by Hao et al [9]. By measuring the above data, the effects of selenium solutions on physiological status

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of *P. davidiana* seedlings were more clearly and knew more the characteristics of selenium in pomology.

### 2.3 Statistical analyses

Statistical analyses were conducted to use statistical software of SPSS 17.0. Data was analyzed by one-way ANOVA with least significant difference at 5% confidence level.

**Table 1.** Photosynthetic pigment content in *P. davidiana* seedlings.

Treatments (mg/L)	Chlorophyll a (mg/g)	Chlorophyll b (mg/g)	Carotenoid (mg/g)	Total chlorophyll (mg/g)	Chlorophyll a/b
0	2.605±0.092a	0.973±0.014a	0.521±0.017c	3.578±0.098a	2.678±0.092c
0.05	2.633±0.048a	0.958±0.028a	0.540±0.014c	3.592±0.075a	2.747±0.035c
0.1	2.629±0.035a	0.940±0.012a	0.664±0.015a	3.570±0.029a	2.797±0.066c
0.25	2.498±0.043b	0.890±0.009b	0.583±0.009b	3.388±0.044b	2.806±0.057c
0.5	2.476±0.039b	0.836±0.032c	0.537±0.014c	3.312±0.071bc	2.964±0.065b
1	2.361±0.032c	0.856±0.029c	0.568±0.016b	3.217±0.050c	2.761±0.089c
2	2.352±0.089c	0.712±0.026d	0.567±0.029b	3.064±0.102d	3.307±0.136a

Values are means ( $\pm$  SE) of 3 replicate pots. Different lowercase letters indicated significant differences among treatments at 0.05 levels.

The photosynthetic pigment content of chlorophyll a, chlorophyll b and the total chlorophyll had no significant difference ( $p > 0.05$ ) at selenium concentrations of 0, 0.05 and 0.1 mg/L and was the highest at 0.05 mg/L (Table 1). Then increasing the selenium concentration up to 2 mg/L, the content of chlorophyll a and total chlorophyll began to gradually fall. At 0.1 mg/L selenium concentration, the carotenoid content was the highest but the lowest in control *P. davidiana* seedlings. For the chlorophyll a/b ratio of seedlings, it had no striking difference ( $p > 0.05$ ) at selenium concentrations of 0, 0.05, 0.1, 0.25 and 1 mg/L. The ratio was higher at 2 mg/L selenium concentration than other treated or control treatments.

## 3 Results and discussion

### 3.1 The photosynthetic pigment content in *P. davidiana* seedlings

### 3.2 Antioxidant enzyme activity and osmotic adjuster content of *P. davidiana* seedlings

Irrigating different selenium concentrations could increase antioxidant enzyme activities of POD, CAT and SOD compared with control treatment (Table 2). Increasing selenium concentration from 0.05 mg/L to 1 mg/L, the activity of POD, CAT and SOD were always increased. At selenium concentration of 2 mg/L, the activity began to decrease. In terms of the osmotic adjuster content, the soluble protein content was all relatively lower at selenium concentrations of 0, 0.05 and 0.1 mg/L and peaked at 0.25 mg/L selenium concentration. For the content of MDA, there was no significant difference ( $p > 0.05$ ) among the irrigation of 0, 0.05 and 0.1 mg/L selenium concentrations and they were all higher than other treatments. At selenium concentration of 0.5 mg/L, the MDA content was the lowest and it fitted with the result of antioxidant enzyme activity.

**Table 2.** Antioxidant enzyme activity and osmotic adjuster content of *P. davidiana* seedlings.

Treatments (mg/L)	POD activity (U/g/min)	CAT activity (mg/g/min)	SOD activity (U/g)	Soluble protein content (mg/g)	MDA content ( $\mu$ mol/kg)
0	16.31±0.685e	0.912±0.022g	116.0±4.448f	10.92±0.868c	16.29±0.386a
0.05	17.47±0.871e	1.577±0.026f	121.0±2.141f	6.128±0.228d	16.55±0.524a
0.1	20.83±1.062e	2.114±0.087e	148.3±2.746e	11.30±0.756c	15.99±0.344a
0.25	115.4±3.606d	3.064±0.098c	158.0±4.632d	20.56±0.946a	13.09±0.211c
0.5	241.1±6.319b	4.603±0.133b	232.7±9.319b	15.91±0.254b	10.86±0.373e
1	469.0±6.818a	5.582±0.115a	244.4±5.534a	16.64±0.557b	12.31±0.173d
2	148.7±2.816c	2.332±0.056d	186.8±6.095c	11.35±0.525c	15.19±0.244b

Values are means ( $\pm$ SE) of 3 replicate pots. Different lowercase letters indicated significant differences among treatments at 0.05 levels.

## 4 Conclusions

In this experiment, the results showed that the effects of antioxidant enzyme activity and photosynthetic pigment content on *P. davidiana* seedlings by irrigating Hoagland nutrient solution with different selenium concentrations. The photosynthetic pigment content was all higher at selenium concentrations of 0, 0.05 and 0.1 mg/L except for the carotenoid content and the lowest at 2 mg/L. The chlorophyll a/b ratio in treated *P. davidiana* seedlings was all higher than that in control seedlings. Irrigating selenium concentrations increased antioxidant enzyme activity of POD, CAT and SOD. In selenium treatments, 1 mg/L selenium concentration was the best one for increasing activity. Similarly, the MDA content was lower at 0.5 and 1mg/L which was good for the growth and resistance of *P. davidiana* seedlings.

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