Effects of Different Hybridization Treatment on Biomass and Cadmium Accumulation of *Solanum photeinocarpum*

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**Abstract:** A pot experiment was conducted to study the effects of different hybridization treatment on biomass and cadmium accumulation of *Solanum photeinocarpum*. The results show that the biomass and the aboveground cadmium content of the hybrid F1 generation were significantly higher than that of the parents. The root cadmium content of hybrid F1 generation whose male parent was Chengdu *S. photeinocarpum* (C-M) was significantly higher than that in the Ya’an farmland, In the root cadmium content of the hybrid F1 generation, there are no difference between hybrid F1 generation whose male parent was Ya’an *S. photeinocarpum* and (Y-M) and Ya’an, and that between Y-M and Chengdu. Hybridization significantly increased aboveground and the root cadmium accumulation of the hybrid F1 generation.

**Introduction**

In recent years, the increasingly prominent heavy metal pollution in farmland has become a hot research topic [1]. Heavy metal cadmium is mainly derived from industrial “three wastes” and factors such as fertilizer, pesticide and sewage irrigation [2]. It is a non-essential growth element of crops, which is easily absorbed and enriched by crops in the soil, and ultimately endangers human health through the food chain. The main means of soil remediation at this stage is phytoremediation technology [3]. However, from the cadmium-enriched plants that have been screened, most of them have limitations such as short stature, low biomass, and slow growth [4]. Hybridization is one method to raise heterozygosity and the genotypic composition of living organisms, which is an important driving force in plant evolution [5-6]. Studies have shown that under adverse conditions, hybrid progeny often show significant heterosis, showing higher biomass and greater tolerance than parents [7]. Therefore, this experiment uses cadmium-enriched plants *S. photeinocarpum*; as a material and uses hybridization technology. To study the effects of hybridization on the biomass and cadmium accumulation of hybrid progeny, in order to improve the cadmium accumulation of hybrids and repair cadmium-contaminated soil.

**Materials and Methods**

**Materials.** In 2013, the laboratory collected the seeds of *S. photeinocarpum*; in the farmland of Ya’an Campus of Sichuan Agricultural University and the farmland around Chengdu Campus Sichuan Agricultural University. After three years of observation, two climatic ecoregions’ *S. photeinocarpum* with stable and significant differences in biomass and cadmium accumulation were screened out. In November 2015, two species of *S. photeinocarpum* seeds were collected and air-dried for use. The Ya’an Campus Farm (29°59’N, 102°59’E) is located in Yucheng District, Ya’an City, and belongs to the mid-subtropical-cold zone of the western Sichuan Basin. The Chengdu Campus (30°42’N, 103°51’E) is located in Wenjiang District of Chengdu City, and it belongs to the middle and subtropical spring and summer drought areas in the western Sichuan Basin.

In April 2016, two different two climatic ecoregions’ *S. photeinocarpum* seeds were planted in advance. When the plants entered the flowering period, selected the full flower buds on the two plants.
After emasculation, *S. photeinocarpum* was positive and negative hybridized, and bagging management. After the hybridized fruit was mature, the seeds were harvested and air-dried, and the previously harvested parent seeds were stored at 4 °C for use. The treatments are as follows: Ya’an (*S. photeinocarpum* in the farmland of Ya’an), Chengdu (*S. photeinocarpum* in the farmland around Chengdu), Y-M (hybrid F1 generation whose male parent was Ya’an *S. photeinocarpum*) and C-M (hybrid F1 generation whose male parent was Chengdu *S. photeinocarpum*).

The test soil is paddy soil, taken from the farmland around the Chengdu Campus. The basic physical and chemical properties are: pH 6.36, organic matter 18.10 g/kg, total nitrogen 1.04 g/kg, total phosphorus 1.36 g/kg, total potassium 20.78 g/kg, alkali nitrogen 43.90 mg/kg, available phosphorus 92.71 mg/kg, available potassium 134.25 mg/kg, effective cadmium is not detected. The test heavy metal cadmium was added to the test soil at a concentration of 10mg/kg in the form of an analytical pure solution of CdCl$_2$•2.5H$_2$O.

**Experimental Design.** In April 2017, full *S. photeinocarpum* parent and positive and negative hybrid F1 seeds were selected, sterilized with 10% Na$_3$PO$_4$ for 5 minutes, rinsed, and seeded in a porcelain dish with clean river sand. The same growing and robust *S. photeinocarpum* plants were selected and were transplanted into the prepared 10 mg/kg cadmium contaminated soil. Four plants were transplanted per pot, and each treatment had 9 pots. Soil moisture was maintained at around 80%. After 30 days of transplanting, the whole plant was collected and the biomass and cadmium content were determined.

**Results and Discussion**

**The Aboveground Biomass of *S. photeinocarpum* and Its Hybrid.** Under the condition of 10 mg/kg cadmium pollution, the biomass of the shoots of *S. photeinocarpum* in the hybrid F1 generation was significantly higher than that of the parents (Fig. 1). Among them, the aboveground biomass of Chengdu is 13.39% higher than that of Ya’an. Compared with Ya’an and Chengdu, the aboveground biomass of Y-M increased by 23.23% and 8.68%, respectively. And the aboveground biomass of C-M increased by 27.17% and 13.19%, respectively. The difference between Y-M and C-M is not significant.

**The Root Biomass of *S. photeinocarpum* and Its Hybrid.** Hybridization significantly increased the root biomass of the hybrid F1 generation of *S. photeinocarpum* (Fig. 2). Among them, the root biomass of Y-M increased by 22.94% and 16.52% compared with that of Ya’an and Chengdu, respectively. And the root biomass of C-M increased by 30.28% and 23.48%, respectively. In addition, the difference between Y-M and C-M and that between Y-M and C-M are not significant.

**The Aboveground Cadmium Content of *S. photeinocarpum* and Its Hybrid.** As shown in Fig 3, the aboveground cadmium content of the shoots of *S. photeinocarpum* in the hybrid F1 generation
was significantly higher than that of the parents. Compared with Ya’an, the aboveground cadmium content of Y-M increased by 11.46%. But there is no difference between Y-M and Chengdu. The aboveground cadmium content of C-M increased by 23.39% and 15.10% compared with Ya’an and Chengdu, respectively. The difference between Y-M and C-M is not significant.

The Root Cadmium Content of *S. photoinocarpum* and Its Hybrid. As shown in Fig 4, the root cadmium content of Chengdu is significantly higher than that of Ya’an by 6.07%. In the hybrid F1 generation, there are no difference between Y-M and Ya’an and that between Y-M and Chengdu. The root cadmium content of C-M is higher than that of Ya’an by 12.01%.

The Aboveground Cadmium Accumulation of *S. photoinocarpum* and Its Hybrid. Hybridization significantly increased the aboveground cadmium accumulation of the hybrid F1 generation of *S. photoinocarpum* (Fig. 5). Among them, the aboveground cadmium accumulation of Chengdu is significantly higher than that of Ya’an by 21.56%. And the aboveground cadmium accumulation of C-M is significantly higher than that of Y-M by 15.30%. Compared with Ya’an and Chengdu, the aboveground cadmium accumulation of Y-M increased by 37.35% and 12.99%, respectively. And the aboveground cadmium accumulation of C-M increased by 58.37% and 30.28%, respectively.

**Fig. 3** The aboveground cadmium content of *S. Photinocarpum*

**Fig. 4** The root cadmium content of *S. photoinocarpum*

**The Root Cadmium Accumulation of *S. photoinocarpum* and Its Hybrid.** As shown in Fig 6, the root cadmium accumulation of Chengdu is significantly higher than that of Ya’an by 11.91%. And the root cadmium accumulation of C-M is significantly higher than that of Y-M by 16.49%. Compared with Ya’an and Chengdu, the root cadmium accumulation of Y-M increased by 25.26% and 11.93%, respectively. And the root cadmium accumulation of C-M increased by 45.92% and 30.39%, respectively.

**Fig. 5** The aboveground cadmium accumulation of *S. Photoinocarpum*

**Fig. 6** The root cadmium accumulation of *S. photoinocarpum*
Conclusions

Under the treatment of 10 mg/kg cadmium, hybridization promoted the growth of *S. photeinocarpum* and increased the cadmium content and cadmium accumulation of the upper and the root.

References


