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Effects of Grafting on Total Phosphorus Content in Post Generations of *Cyphomandra betacea* Seedlings

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Abstract. The effects of eggplant, *Solanum nigrum* and tomato as rootstocks on the total phosphorus content in the grafted offspring of *Cyphomandra betacea* seedlings were studied by pot experiment. The total phosphorus contents in root, stem, leaf and shoot of the offspring of *C. betacea* seedlings were analyzed. The results showed that the total phosphorus content in the roots and shoots of *S. nigrum* rootstock was significantly higher than that of ungrafted offspring. There was no significant difference in the total phosphorus content between roots and stems of eggplant and tomato rootstocks compared with ungrafted offspring. The total phosphorus contents in the leaves and shoots were significantly lower than that in ungrafted offspring. Therefore, proper selection of grafted stock can improve the total phosphorus uptake of grafted offspring of *C. betacea* seedlings.

1. Introduction

Grafting is a traditional asexual reproduction technique, which plays an important role in crop reproduction and improvement [1]. Grafting cultivation has changed the main absorption organ of the nutrient of the root system, which will inevitably affect its absorption of mineral elements [2]. Studies have found that grafted *Panax* has an increase of 28.21% in phosphorus absorption from roots [3]. Chen et al. found that the grafted watermelon roots developed early and the growth rate was fast. The phosphorus content in the root wound fluid was significantly higher than that of the self-rooted seedlings [4]. Sun Y et al. confirmed that grafting cucumber can improve the dry weight of root system and the absorption capacity of phosphorus [5]. Phosphorus is one of the many elements needed for plant growth. It participates in the metabolic process of plants in a variety of ways, can promote the growth of plants, and has an important impact on the yield and quality of vegetables [6-7]. In theory, grafting does not alter the genetic information of current and future generations. However, in fact, many researchers have found that grafting between some plants can induce grafting body variation, and this variation can be passed on to the offspring stably [8]. *Cyphomandra betacea* is a perennial evergreen shrub of Solanaceae. Its flesh is delicate, sweet and sour, rich in nutrients. It is a kind of plant that integrates flower viewing, fruit viewing and food [9]. In this study, under the condition of cadmium pollution, the seeds of *C. betacea* collected after grafting and survival of different rootstocks were planted. The effects of cadmium pollution on the total phosphorus content of the grafted offspring of *C. betacea* seedlings were studied, and the absorption and utilization characteristics of phosphorus elements in *C. betacea* seedlings were explored.



2. Materials and Methods

2.1. Grafting

Eggplant, *S. nigrum*, and tomato seeds were sown on the Chengdu campus of Sichuan Agricultural University in February 2018. When the eggplant, tomato, and *S. nigrum* seedlings had reached a height of approximately 10 cm (March 2018), they were trimmed to a height of 5 cm and used for grafting. The scions were 5-cm long, young *C. betacea* branches. The cleft grafting method was used, and the graft union was bound with 1-cm-wide plastic film. All leaves of the rootstock were retained until scion survival was assured. After completion of grafting, all seedlings were covered with transparent plastic film and a shade net, and the soil moisture content was maintained at 80% of field capacity. The transparent plastic film, shade net, and plastic binding film were removed after 10 days. The *C. betacea* seeds were allowed to mature and then collected, dried in air, and stored at 4 °C.

2.2. Experiment design

The *C. betacea* seeds of eggplant, *S. nigrum*, and tomato grafting were sown on the Chengdu Campus of Sichuan Agricultural University in November 2018. After the soil was dried, crushed and screened by 5 mm, the soil was named 3.0 kg in the plastic basin of 15 cm × 18 cm (high × diameter). The CdCl₂·2.5H₂O solution was added to the soil to make the soil cadmium content 5 mg kg⁻¹. When the heights of seedlings were about 10 cm, they were transplanted into Cd contaminated soil, with four seedlings placed in each pot. Four treatment groups were set up: ungrafted (cutting seedlings), eggplant rootstock, *S. nigrum* rootstock, and tomato rootstock. Each treatment was replicated five times (one pot per repeat) in a completely randomised design. Pots were watered daily from plant transplantation until harvest to maintain the soil water holding capacity at 80%. After cultivation for 60 days (February 2019), the plants were harvested to determine total phosphorus contents in roots, stems, leaves, and shoots [10].

2.3. Statistical Analyses

Statistical analyses were performed using SPSS 20.0 statistical software (IBM, Chicago, IL, USA). Data were analysed by one-way analysis of variance, with significant differences assessed at the 5% confidence level.

3. Results and Discussion

3.1. Effect of grafting on total phosphorus content in roots of post generations of *C. betacea* seedlings

As can be seen from Figure 1, under the condition of cadmium pollution, compared with the ungrafted offspring, the content of total phosphorus in the roots of the grafted offspring of *S. nigrum* were significantly increased, increasing by 6.73%. However, there was no significant difference in the total phosphorus content between the roots of the grafted offspring of eggplant rootstock and the roots of the grafted offspring of tomato rootstock compared with the ungrafted offspring, decreasing by 1.44% and 3.36%.

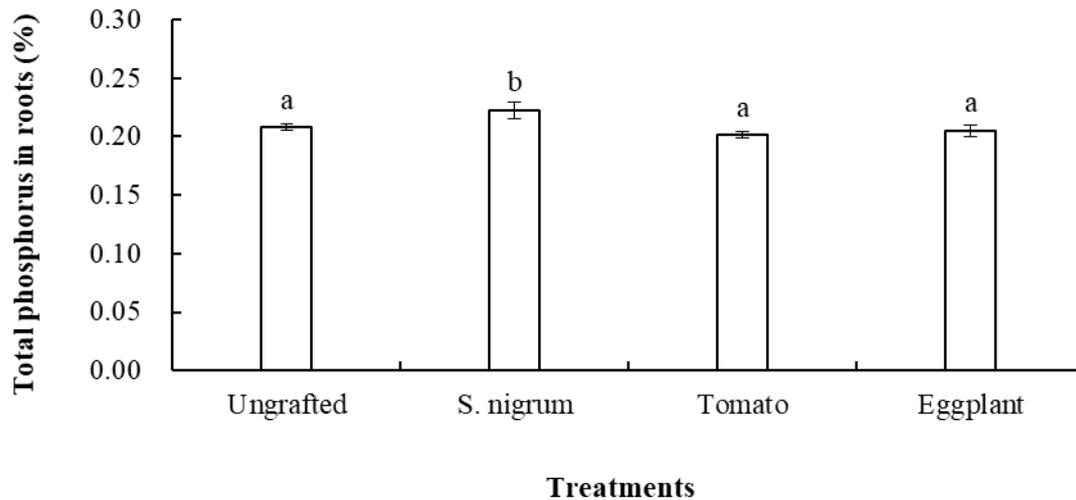


Figure 1. Total phosphorus content in roots of post generations of *C. betacea* seedlings

3.2. Effect of grafting on total phosphorus content in stems of post generations of *C. betacea* seedlings

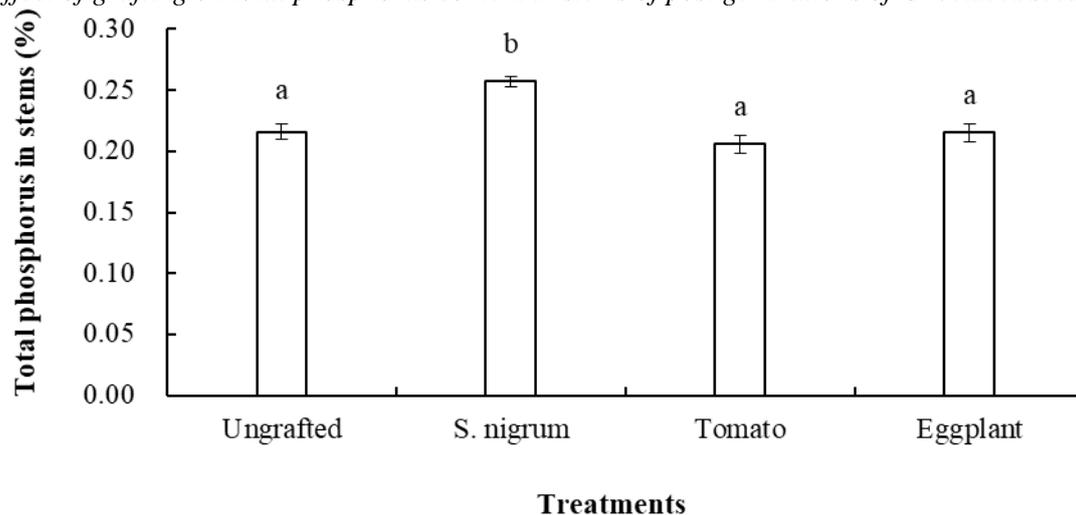


Figure 2. Total phosphorus content in stems of post generations of *C. betacea* seedlings

It can be seen from Figure 2 that, under the condition of cadmium pollution, similar to the total phosphorus content in the roots, compared with ungrafted offspring, the content of total phosphorus in stems of the grafted offspring of *S. nigrum* were significantly increased, increasing by 18.98%. However, there was no significant difference in stems total phosphorus content between grafted offspring of eggplant rootstock and grafted offspring of tomato rootstock, decreasing by 0.46% and 4.63%.

3.3. Effect of grafting on total phosphorus content in leaves of post generations of *C. betacea* seedlings

As can be seen from Figure 3, under the condition of cadmium pollution, compared with ungrafted offspring, the content of total phosphorus in leaves of the grafted offspring of *S. nigrum* were significantly increased, increasing by 17.29%. However, the total phosphorus content of the leaves of the grafted offspring eggplant rootstock and the grafted offspring of tomato rootstock were significantly lower than that of the ungrafted offspring, decreasing by 14.41% and 22.19%.

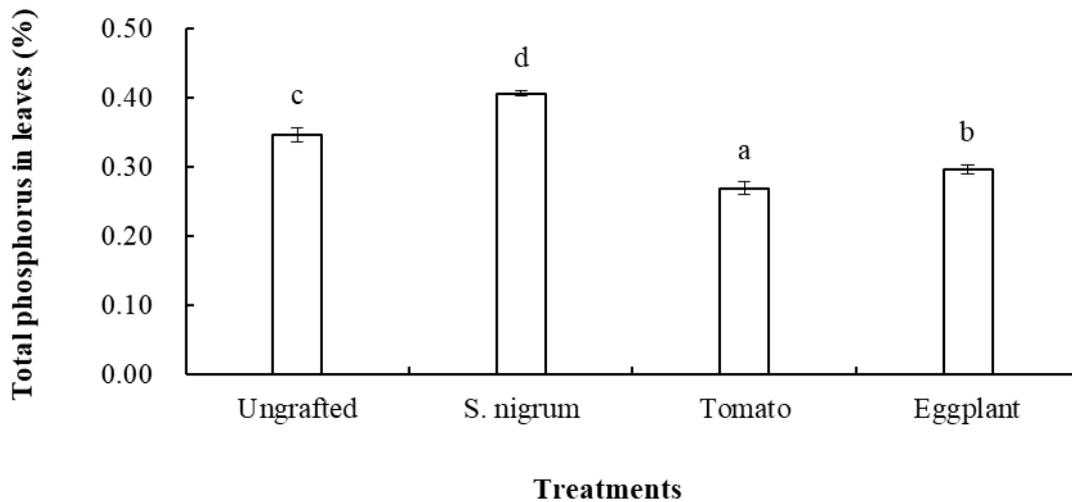


Figure 3. Total phosphorus content in leaves of post generations of *C. betacea* seedlings

3.4. Effect of grafting on total phosphorus content in shoots of post generations of *C. betacea* seedlings

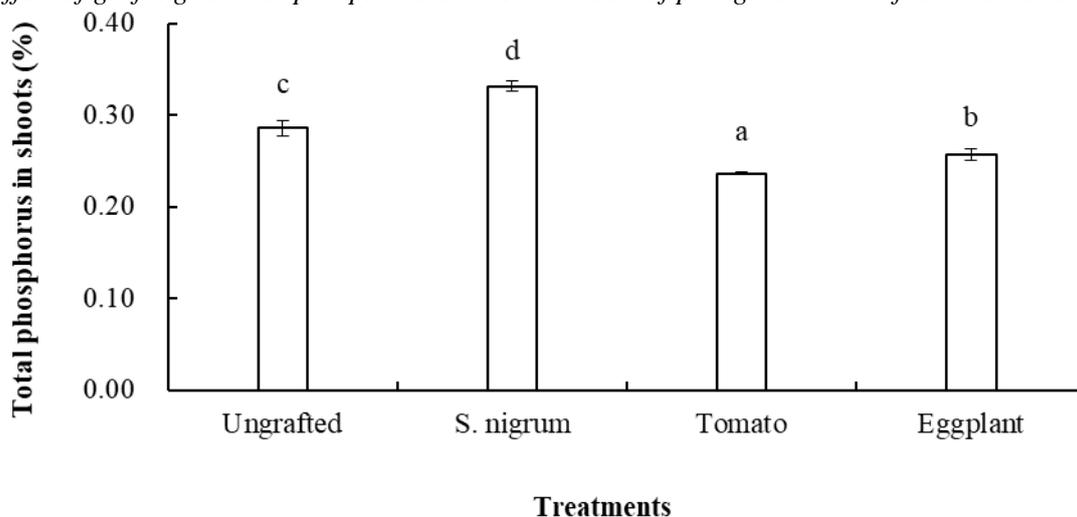


Figure 4. Total phosphorus content in post generations of shoots of *C. betacea* seedlings

As can be seen from Figure 4, under the condition of cadmium pollution, different rootstock have different amounts of total phosphorus in shoots of grafted offspring, in the order of size: *S. nigrum* rootstock grafted offspring > ungrafted offspring > Eggplant rootstock grafted offspring > tomato rootstock grafted offspring. The total phosphorus content in the shoots part of the grafted offspring was significantly higher than that of the ungrafted offspring, increased by 16.08%. However, the total phosphorus content in the shoots of the grafted offspring of eggplant rootstock and tomato rootstock were significantly lower than that of the ungrafted offspring, decreasing by 10.14% and 17.13%.

4. Conclusion

Under the condition of cadmium pollution, the selection of different grafting rootstock had different effects on the total phosphorus content of the grafted *C. betacea* offspring. The grafting rootstock of *S. nigrum* significantly increased the total phosphorus content in the roots and the shoots of *C. betacea* seedlings. However, grafting of eggplant rootstocks and tomato rootstocks significantly reduced the shoots of phosphorus content of *C. betacea* offspring seedlings. In conclusion, under the condition of cadmium pollution, the grafting of *S. nigrum* rootstock can effectively increase the absorption and utilization of phosphorus in soil by *C. betacea* seedlings and promote the growth of *C. betacea*.

Acknowledgments

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