PAPER • OPEN ACCESS

Effects of Living Pterocypsela laciniata and Its Straw on Potassium Uptake of Grape Seedlings under Selenium Stress

To cite this article: Hongqiang Chen *et al* 2019 *IOP Conf. Ser.: Earth Environ. Sci.* **310** 042039

View the article online for updates and enhancements.

This content was downloaded from IP address 180.160.60.121 on 08/10/2019 at 14:32

Effects of Living Pterocypsela laciniata and Its Straw on Potassium Uptake of Grape Seedlings under Selenium Stress

Hongqiang Chen[1], Yan Huang[1], Lijin Lin[1], Ming'an Liao[2] and Xiulan Lv[1*]

[1]Institute of Pomology and Olericulture, Sichuan Agricultural University, Chengdu, Sichuan, 611130, China

[2]College of Horticulture, Sichuan Agricultural University, Chengdu, Sichuan, 611130, China

[*]Corresponding author's e-mail: xllvjj@163.com

Abstract. To investigate the effects of intercropping and applying *Pterocypsela laciniata* straws on potassium uptake of grape seedlings, this pot experiment was conducted to set up five treatments under selenium stress. From the results, the content of total K in parts of plants was different. In plants, the content in leaf was higher than that in root or stem. Among five treatments, applying *P. laciniata* straws always decreased the total K content in plants. Furthermore, intercropping with *P. laciniata* seedlings could increase the content in stem, leaf and shoot of grape seedlings. So the results showed that applying root, stem and leaf straws of *P. laciniata* could not improve nutrient accumulation or the growth of grape seedlings. But for the available K content, it was on the increase by intercropping and applying straws. Among them, applying stem straw of *P. laciniata* made the content higher. Although there was higher available K content in soil by applying straws, the total K content in plants was lower. Thus, applying *P. laciniata* straws was not effective on the growth of grape plant.

1. Introduction

The objective of the study was to explore the effects of the potassium uptake of grape seedlings by intercropping and applying straws in soil. Intercropping with hyperaccumulator plant could decrease heavy metal content in grape seedlings and influence the growth of plants [1]. The previous studies suggest that intercropping with different hyperaccumulator plants can increase the content of potassium in varying degrees [2-3]. Straw, an important renewable resource, has great comprehensive utilization value [4]. Returning straw can increase the available potassium in soil by the release of potassium from the straw and influence the yield and benefit [5-6].

Pterocypsela laciniata, a perennial herb of *Pterocypsela*, not only has good flavor, delicate texture and high nutritional value, but also plays an important role in different diseases [7]. Thus, this experiment selected *P. laciniata* to intercrop with grape seedlings for studying the effects of potassium uptake.

2. Materials and methods

2.1. Materials

During this experimental process, grape and *P. laciniata* seedlings were used as materials to study the effects of potassium uptake by intercropping and applying *P. laciniata* straw. The seeds of *P. laciniata* were collected from the farmland around Sichuan Agricultural University. In January 2019, the soil

Content from this work may be used under the terms of the Creative Commons Attribution 3.0 licence. Any further distribution of this work must maintain attribution to the author(s) and the title of the work, journal citation and DOI.
Published under licence by IOP Publishing Ltd

was also supposed to prepare and weighed 3 kg air-dried soil putting into each plastic pot (15 cm high, 18 cm in diameter), soaking uniformly by 10 mg/kg Se (in the form of Na_2SeO_3) solution for four weeks.

2.2. Methods
In January 2019, the *P. laciniata* seeds were placed in the climate chamber for culture. At the same time, the cutting seedlings of grape for the experiment were prepared. In February 2019, it was time to select uniform seedlings for intercropping while the fifth true leaves grew from *P. laciniata* seedlings. Three grape seedlings were transplanted into pot for monoculture and two of them intercropped with one *P. laciniata* seedlings. Furthermore, some *P. laciniata* seedlings were collected and divided into three parts of root, stem and leaf. Then, using deionized water to wash them for three times and simmered for 15 min at 110 °C. Finally, dried at 80 °C until constant weight and cut them into small pieces less than 1 cm as different straws. The three parts of *P. laciniata* straws were respectively blended with soil. Each pot contained 6 g *P. laciniata* straws and it meant that every kilogram soil was mixed with 2 g straws of *P. laciniata*. The soil was kept moist and balanced for one week. Then three uniform grape seedlings were transplanted into soil with straws. In a word, this experiment consisted of five treatments: (1) grape seedlings monoculture (MG); (2) grape seedlings intercropping with *P. laciniata* seedlings (PG); (3) applying the leaf straw of *P. laciniata* in soil with grape seedlings (PLG); (4) applying the stem straw of *P. laciniata* in soil with grape seedlings (PSG); (5) applying the root straw of *P. laciniata* in soil with grape seedlings (PRG). Each treatment set up three repetitions and the soil moisture was made 80%. Also, the distance between pots was 15 cm and the position was often exchanged to mitigate marginal effects.

After 2 months, the soil was collected and the whole grape seedlings were harvested and divided into three parts of root, stem and leaf. Washed them successively with tap water and deionized water. Then weighed the fresh weight, simmered for 15 min at 110 °C, dried at 80 °C until constant weight and passed through a 100-mesh sieve to analyze potassium content of root, stem, leaf and shoot and the dried soil was also to measure the available potassium content [8].

3. Results and discussion

3.1. Total K content in root of grape seedlings
Compared to grape seedlings monoculture, the total K contents in PG, PLG, PSG and PRG were all lower and reduced by 7.82%, 27.06%, 9.55% and 13.63% (Figure 1, $p < 0.05$), respectively. Among five treatments, the total K contents in root of grape seedlings were the lowest by applying leaf straw of *P. laciniata*. The figure 1 showed that applying *P. laciniata* straws significantly decreased the total K content in grape seedlings compared with intercropping.

3.2. Total K content in stem of grape seedlings
The contents of total K in stem of grape seedlings were a little different than that in root (Figure 2). In five treatments, grape seedlings intercropping with *P. laciniata* seedlings could increase the total K content compared with monoculture. Similarly, there was the lowest content while the soil applied leaf straw and applying stem and root straws were also lower than monoculture. From Figure 2, the total K content ranked as: PG > MG > PSG > PRG > PLG.

3.3. Total K content in leaf of grape seedlings
The total K content in leaf was higher than that in root and stem. The Figure 3 showed that there was no significant difference among PLG, PSG and PRG and it meant that applying root, stem and leaf straws of *P. laciniata* appeared the same result about increasing or decreasing the total K content. The content from high to low was ordered: PG > MG > PSG > PRG > PLG. Compared with PG, the content decreased by 10.39%, 7.68%, 4.83% and 5.34% (Figure 3, $p < 0.05$), respectively.

3.4. Total K content in shoot of grape seedlings

Under selenium stress, the content of total K in shoot was lower than that in leaf. Also, compared with grape seedlings monoculture, intercropping could increase the total K content which increased by 9.75%, on the contrary, applying leaf, stem and root straws of *P. laciniata* in soil apparently reduced the total K content and it decreased by 8.20%, 3.86% and 3.76% (figure 4, $p < 0.05$), respectively. There was no significant difference between PSG and PRG. Compared to applying *P. laciniata* straws, intercropping had the better promotion of the potassium uptake in plants.

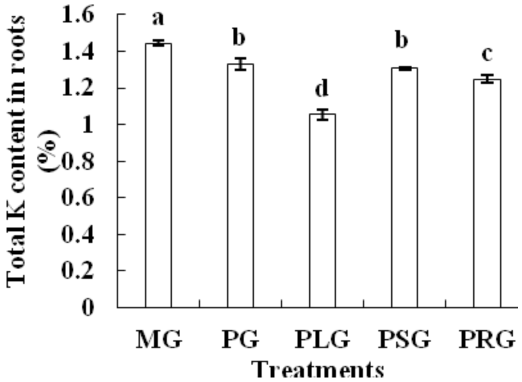

Figure 1. Total K content in roots of grape seedlings. Different lowercase letters indicated significant differences among treatments at 0.05 levels. MG = grape seedlings monoculture; PG = grape seedlings intercropping with *P. laciniata* seedling; PLG = applying the leaf straw of *P. laciniata* in soil with grape seedlings; PSG = applying the leaf straw of *P. laciniata* in soil with grape seedlings; PRG = applying the leaf straw of *P. laciniata* in soil with grape seedlings.

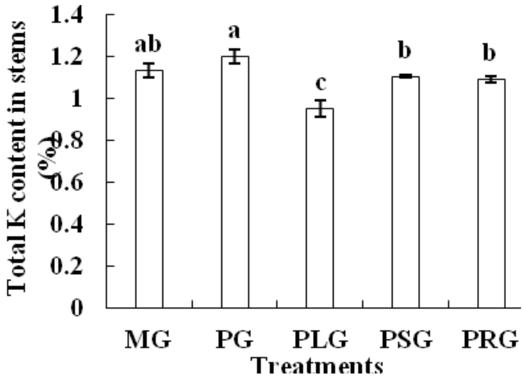

Figure 2. Total K content in stems of grape seedlings. Different lowercase letters indicated significant differences among treatments at 0.05 levels. MG = grape seedlings monoculture; PG = grape seedlings intercropping with *P. laciniata* seedling; PLG = applying the leaf straw of *P. laciniata* in soil with grape seedlings; PSG = applying the leaf straw of *P. laciniata* in soil with grape seedlings; PRG = applying the leaf straw of *P. laciniata* in soil with grape seedlings.

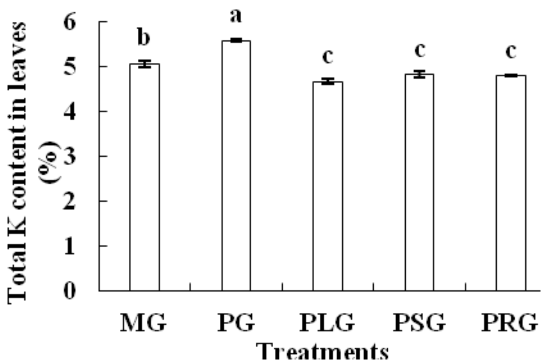

Figure 3. Total K content in leaves of grape seedlings. Different lowercase letters indicated significant differences among treatments at 0.05 levels. MG = grape seedlings monoculture; PG = grape seedlings intercropping with *P. laciniata* seedling; PLG = applying the leaf straw of *P. laciniata* in soil with grape seedlings; PSG = applying the leaf straw of *P. laciniata* in soil with grape seedlings; PRG = applying the leaf straw of *P. laciniata* in soil with grape seedlings.

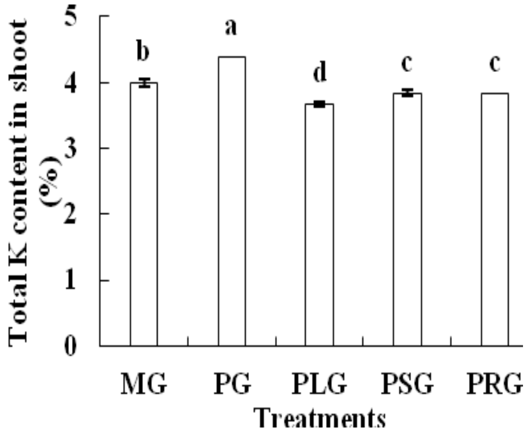

Figure 4. Total K content in shoots of grape seedlings. Different lowercase letters indicated significant differences among treatments at 0.05 levels. MG = grape seedlings monoculture; PG = grape seedlings intercropping with *P. laciniata* seedling; PLG = applying the leaf straw of *P. laciniata* in soil with grape seedlings; PSG = applying the leaf straw of *P. laciniata* in soil with grape seedlings; PRG = applying the leaf straw of *P. laciniata* in soil with grape seedlings.

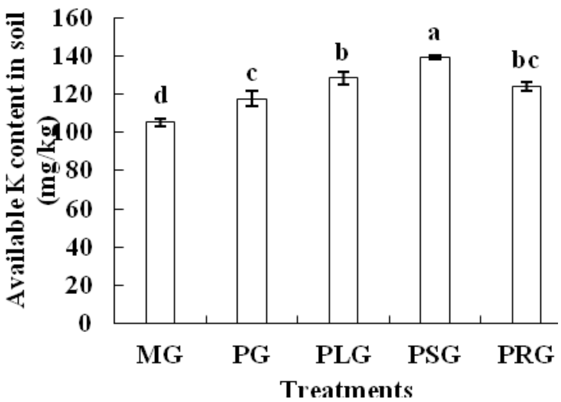

Figure 5. Available K content in soil. Different lowercase letters indicated significant differences among treatments at 0.05 levels. MG = grape seedlings monoculture; PG = grape seedlings intercropping with *P. laciniata* seedling; PLG = applying the leaf straw of *P. laciniata* in soil with grape seedlings; PSG = applying the leaf straw of *P. laciniata* in soil with grape seedlings; PRG = applying the leaf straw of *P. laciniata* in soil with grape seedlings.

3.5. Available K content in soil

The figure 5 showed the available K content in soil by applying *P. laciniata* straws and intercropping with *P. laciniata* seedlings. The change of available K content in five treatments was different from the total K content in plants. Compared to the control, applying *P. laciniata* straw could increase available K in soil and increased by 21.96%, 32.04% and 17.93% in PLG, PSG and PRG, respectively. PG made available K content in soil increase by 11.81%.

4. Conclusions

Under selenium stress, there were setting up five treatments to study the effects of intercropping and applying *P. laciniata* straws on potassium uptake in plants and soil. The results showed that the potassium content was different in parts of grape seedlings. The total K content in leaf was higher than that in root and stem. The changing trend of total K content was basically similar in plants and the order was: PG > MG > PSG > PRG > PLG. However, the available K content in soil was a big difference among five treatments. Intercropping and applying straws were all increasing the available K content compared with grape seedlings monoculture.

Acknowledgments

This work was financially supported by the Application Infrastructure Project of Science and Technology Department of Sichuan Province (2016JY0258).

References

[1] Hu, R.P., Zhang, Z.J., Lin, L.J., Liao, M.A., Tang, Y., Liang, D., Xia, H., Wang, J., Wang, X., Lv, X.L., Ren, W. (2019) Intercropping with hyperaccumulator plants decreases the cadmium accumulation in grape seedlings. Acta Agric. Scandinavica, Sec. B-Soil & Plant Sci., 69: 1-7.
[2] Shi, J., Huang, T.Y., Chu, X.D., Lin, L.J., Liao, M.A. (2015) The effects of different ecotypes of intercropped accumulator plants on nutrient absorption of cherry seedlings under cadmium stress. Acta Agric. Univ. Jiangxiensis, 37: 231-238.
[3] Lin, L.J., Liao, M.A., Mei, L.Y., Cheng, J. (2014) Two ecotypes of hyperaccumulators and accumulators affect cadmium accumulation in cherry seedlings by intercropping. Environ. Prog. Sustain. Ener., 33: 1251-1257.
[4] Shen, Y.Y., Chen, H. (2009) The progress of study on soil improvement research with straw stalk. Chin. Agric. Sci. Bull., 25: 291-294.
[5] Jiang, C.Q., Zheng, Q.S., Zu, C.L. (2015) Research progress on effects of straw returning on soil potassium and its substitute for potassium fertilizer. Chin. J. Ecol. 34: 1158-1165.
[6] Peng, W.D., Chu, C.X., Zhong, Y.Q., Lai, W.H., Zhang, H.B., Huang, L.Y., Shi, X.X., Wei, J.L. (2016) Effect of sweet corn straw returning to the field on soil fertility, yield and benefit. Meteorological and Environmental Research, 7: 59-63, 67.
[7] Xu, D., Wei, Y., Gao, Y. (2018) Study on selenium accumulation characteristics of *Pterocypsela laciniata*. IOP Confer. Ser. Earth & Environ. Sci., 199: 042025.
[8] Bao. J.F. (2006) Plant Physiology Experiment Guide. Higher Education Press, Beijing, China.