International Symposium "Root Research and Applications"
RootRAP, 2–4 September 2009, Boku – Vienna, Austria

Effects of Cd Treatment on Root Activity in Tea Plants

Tomoo Homma[1], Mayumi Jige[1], Kuriko Yokota[1], Osamu Nagafuchi[1*], Kiyoshi Matsuo[2], Miroslava Luxova[3] and Alexander Lux[4]

[1]Chiba Institute of Science, Choshi, Chiba 288-0025, Japan
*present address: The University of Shiga Prefecture, Hikone, Shiga 522-8533, Japan
[2]National Institute of Vegetable and Tea Science, Kanaya, Shizuoka 428-8501, Japan
[3]Institute of Botany, Slovak Academy of Science, Bratislava SK-84523, Slovakia
[4]Faculty of Natural Sciences, Comenius University, Bratislava SK-84215, Slovakia
Contact: Tomoo Homma (Phone&Fax: +81-479-30-4762 E-mail: thomma@cis.ac.jp)

ABSTRACT

The present study investigated effects of one of toxic metals – cadmium - on tea plants (*Camellia sinensis*). After appearance of the new white roots in one-year old rooted cuttings of cultivar `Yabukita` cultivated with Konishi's hydroponics medium, they were treated with cadmium solution using $Cd(NO_3)_2 \cdot 4H_2O$ at the concentration of 10^{-5}, 10^{-4}, and 10^{-3}M for 1 week, respectively. Root activity was evaluated by triphenyl tetrazolium chloride (TTC) method for visualizing the activity points of succinic acid dehydrogenase related with respiratory system and O_2 uptester method which measures the consuming O_2 volume by roots. By TTC method, the root activity was inhibited partially in the 10^{-5} M Cd-treated roots and completely in 10^{-4} and 10^{-3} M Cd-treated ones. Respiratory activity of tea roots treated with 10^{-5}, 10^{-4}, and 10^{-3} M Cd measured by O_2 uptester method was 22.30±12.38 (n=11), 18.73±8.57 (n=7), and 18.78±10.70 (n=7) ($\mu molO_2\ h^{-1}\ gDW^{-1}$), respectively. In the control roots (without Cd treatment), respiratory activity was 35.54±14.41 (n=13) ($\mu molO_2\ h^{-1}\ gDW^{-1}$). The results showed that Cd inhibited the root activity. In our previous study, Cd could hardly be detected in leaves of 10^{-5} M Cd-treated tea plants. We suggested that early development of Casparian bands in exodermis may function as a barrier against toxic metals including Cd. Moreover, according to the present study, it results that the inhibition (decrease) of root activity by Cd treatment may affect Cd uptake in roots.

KEYWORDS: tea roots, Cd, respiration,

1. INTRODUCTIONS

Tea plants (*Camellia sinensis* L.) grow preferably on acidic and aluminum-rich grounds, which are not suitable for other plant species. This means tea plants have unique characteristics on their growth. In order to clarify the characteristics of tea plants, we have especially studied the relation of anatomy and function of tea roots from various viewpoints. We have focused and investigated on effects of one of toxic metals -"cadmium"- on tea plants and its uptake into them. In the 10^{-5} M Cd-treated tea plants, young white roots accumulated Cd ions, but its transport to other parts, especially above-ground parts (stems, leaves), was strictly limited. We suggested that early development of Casparian bands in exodermis may function as a barrier against toxic metals including Cd. In the present study, from the functional viewpoints of roots, we investigated the effects of Cd on the respiration activity of tea roots.

2. METHODS

2.1 Hydroponics cultivation of tea plants and treatment with Cd

One-year old rooted cuttings of ‘Yabukita’ cultivar transferred from soil were cultivated with Konishi’s hydroponics medium. After appearing and growing new white roots (generally it took some weeks), the hydroponics medium was replaced to that including 10^{-5} M, 10^{-4} M or 10^{-3} M cadmium (applied in the form of $Cd(NO_3)_2$). After treatment with Cd for 1 week, roots were washed and their activity was measured.

2.2 Measurement of root activity

For evaluating the root activity, two methods were used: triphenyl tetrazolium chloride (TTC) method for visualizing the activity points of succinic acid dehydrogenase related with respiratory system and O_2 uptester method which measures the consuming O_2 volume by roots. Roots were dipped in reaction solution (1%TTC:0.1M phosphate buffer (pH7.0):distilled water = 1:4:5) for 2 hrs in a incubator at 30 . After checking the TTC reaction, O_2 consumption for 5 hrs by roots were measured by O_2 uptester. Dry weight (DW) of roots was measured after overnight drying.

3. RESULTS AND DISCUSSIONS

Root activity measured by TTC method showed partial inhibition in the 10^{-5} M Cd-treated roots and complete inhibition in 10^{-4} and 10^{-3} M Cd-treated ones. Respiratory activity of tea roots treated with 10^{-5}, 10^{-4}, and 10^{-3} M Cd measured by O_2 uptester method was 22.30±12.38 (n=11), 18.73±8.57 (n=7), and 18.78±10.70 (n=7), ($\mu molO_2\ h^{-1}\ gDW^{-1}$), respectively. In the control roots (without Cd treatment), respiratory activity was 35.54±14.41 (n=13) ($\mu molO_2\ h^{-1}\ gDW^{-1}$). The results showed that Cd inhibited the root activity (Fig.1). According to early development of Casparian bands in exodermis from the results of our previous study, the inhibition (decrease) of the root activity by Cd treatment may affect Cd uptake in roots. In order to clarify Cd absorption in tea roots, we have analyzed Cd distribution in roots using SEM-EDS.

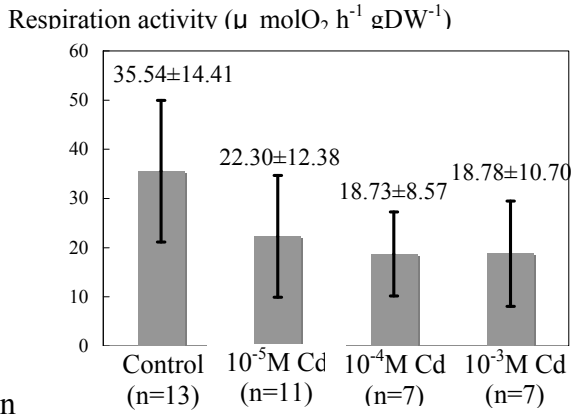

Figure 1. Inhibition of respiration activity of tea roots by Cd treatment.

4. REFERENCES

Homma T., Mizuta Y., Jige M., Yokota K., Nagafuchi O., Matsuo K., Greger M., Luxova M. and Lux A. 2007. Does tea plant uptake and accumulate cadmium ions? *Proceedings of The 3rd ICOS 2007*, p.Pr-P-114.

5. ACKNOWLEDGEMENTS

This work was partially supported by grants 2/7072/07 and 1/4354/07 from Slovak Grant Agency VEGA, 0004-06 from Slovak Research and Development Agency APVV., and CIS Research Grants program from 2006-2007.