Effect of Serpentine on the Growth and Matter Allocation of *Raphanus sativus* var. *radocula* Seedlings in Cultivation Medium Including Cu

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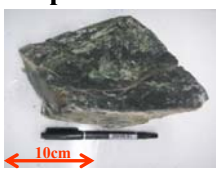
INTRODUCTION

Heavy metals are essential elements for plant growth as micro nutrients, whereas high concentration of heavy metals inhibit plant growth as toxins. Heavy metals in soil supplied after weathering of rocks are important source of essential elements for plants. Thus, chemical property of parent rock is an important determinant factor of vegetation and primary production of the community. In this study, we tried to evaluate the role of rocks with special notice to the interaction between plant growth and heavy metals in soil.

Serpentine contains Ni and Cr, and high concentration of these elements is toxic to plants. Thus we used serpentine for analyzing how heavy metals in soil affect plant growth. Serpentine soil has characteristic for its high heavy metals contents and high base contents. Specific morphologic change of root and desiccation tolerance of leaves for plants growing on serpentine soil have been reported. We investigated how the serpentine rock affect growth and morphology of plants cultivated in the medium including Cu in order to clarify the interaction between Cu and heavy metals released from serpentine rock.

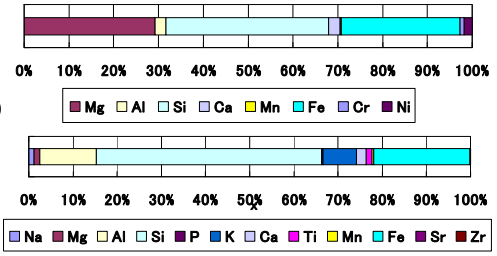
MATERIALS & METHODS

Serpentine



Locality
:Minamikawa belt in Ohita
(Cretaceous, Mesozoic)

Composition
: Antigorite



X-ray fluorescence analysis
Upper: elements in serpentine
Bottom: elements in Mitate conglomerate

Mitate conglomerate

Locality
:Mitate formation, Chichibu belt in Miyazaki
(Lower Miocene, Cenozoic)

Composition
: Quarts, Albite

Condition of cultivation

- Cultural medium
  : Hoagland solution including Cu
  (0.005, 0.02, 0.1, 0.25, 0.5, 1ppm)
- Added rock: 2g (ϕ 1-2mm)
- Plant: *Raphanus sativus* var. *radocula*
  ("Aishikuru" Takii & Co., Ltd.)

- Growth term: 15 days after sowing
- Temperature : 20℃
- Photon flux density : 220.6±0.1μmol $m^{-2}s^{-1}$
- Control : adding silica sand
- Replication: 5

RESULTS & DISCUSSION

1. Main root elongation and dry-weight of each organ

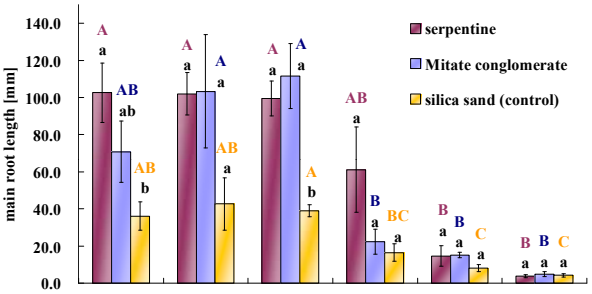
● Effect of serpentine

In the medium of Cu concentration of 0.005-0.1ppm, the length of main root increased by adding serpentine.

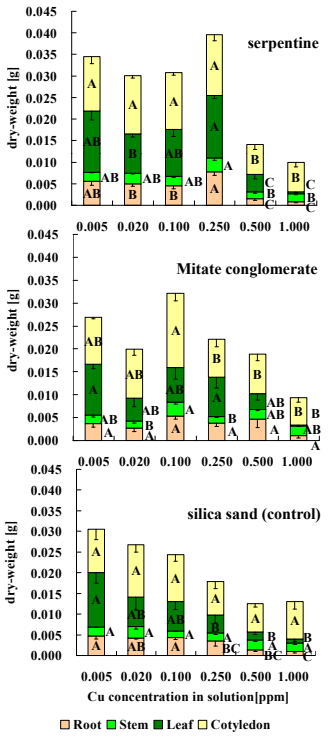
Dry matter allocation to root and leaf increased in the medium of Cu concentration of 0.25ppm.

Increase of number of lateral roots was observed.

Serpentine could reduce Cu stress to *R. sativus*.
Number of lateral root was dependent on main root elongation.
Difference of morphology of root may change allocation of nutrient because lateral root is important for absorbing nutrients by plants.



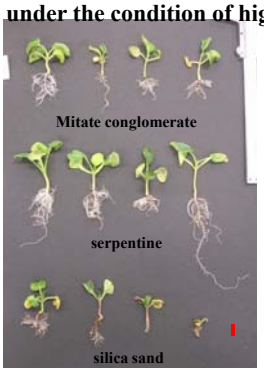
The length of main root (upper) and dry-weight of each organ (right) of *R. sativus* grown in medium including Cu for 15 days.
Capital letters of the alphabet: Significant between different Cu concentration treatments ($p<0.05$), ; Lower letters: Significant between rocks ($p<0.05$). Means sharing the same letters were not significantly difference.

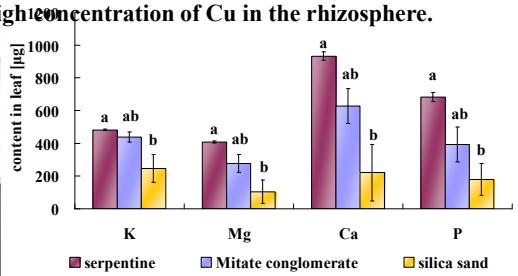


2. Allocation of Cu and nutrient to each organ cultivated in the medium of 0.25ppm Cu concentration

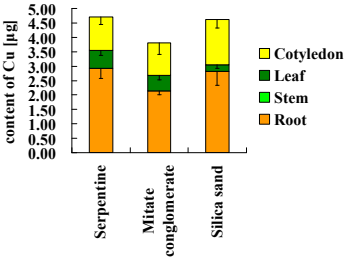
When serpentine was added to cultivated medium including Cu of 0.25ppm, K, Mg, Ca and P contents in leaves were higher than control (adding silica sand). Therefore, serpentine promoted growth of root of *R. sativus* and reduced inhibiting activity of Cu for nutrient allocation to leaf under the condition of 0.25ppm Cu concentration.

Serpentine can be expected to have an effect of reducing Cu stress to *R. sativus*, although interaction between Cu and serpentine should be further clarified. Allocation of Cu to plant organs was not significantly different between serpentine and silica sand, although the difference of dry matter allocation was significant. Serpentine could maintain high allocation of dry matter to root of *R. sativus* and maintain nutrient absorption activity of root even under the condition of high concentration of Cu in the rhizosphere.

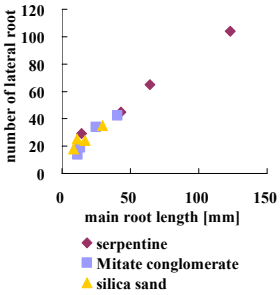




Left: *R. sativus* cultivated in medium containing 0.25ppm of Cu concentration for 15 days. Bar is 10mm.
Upper: Content of nutrients in leaf of *R. sativus* cultivated in medium of 0.25ppm Cu for 15 days cultivation. Means sharing the same letters were not significantly difference ($p<0.05$).



Upper: Content of Cu in each organ of *R. sativus* cultivated in medium of 0.25ppm Cu for 15 days. There were no significant difference between rocks.



Upper: Correlation between main root length and number of lateral root of *R. sativus* cultivated in medium containing 0.25ppm of Cu after 15 days of cultivation.