学位論文審査の要旨

博士の専攻分野の名称　　博士（農学）　　氏　名　　Qingnan Chu

審査担当者　主査　　准教授　渡部敏裕
副査　　教授　　波多野隆介
副査　　教授　　小池孝良
副査　　特任教授　　大崎　満
副査　　客員准教授　岡　紀邦

学位論文題名

Study on dynamics of ionome and nitrogen in plant and soil

（植物と土壌におけるイオノームおよび窒素の動態に関する研究）

This thesis is composed of 116 text pages, 22 figures, 16 tables, and attached with 1 related papers.

Ionome is a profile of elements in an organism at the organ, tissue or even cell level. In past studies, the ionomics study in plant under field conditions was rare. Moreover, among the nutrients required by plants, nitrogen (N) is the most essential nutrient in terms of quantity. Study on interaction between N and ionome in plant and soil is important to develop strategies for better nutrient management, but this interaction has not been understood very well. In addition, nobody has ever studied the ionomic interaction between plant and soil with emphasis on rhizosphere. As a result, three independent experiments were carried out.

Firstly, the ionomic differences among thirty-three varieties of *Amaranthus* were investigated. Secondly, the influence of various N sources on the interaction between N and ionome in soybean at different growth stages was examined. Finally, the interaction between N, ionome, and soil metabolism in the rhizospheric soil of different plant species was studied.

1) Interactions between Cs, Sr, and other element accumulations in *Amaranthus* shoot in response to variety effect

Thirty-three varieties of *Amaranthus* were cultivated in the fields of Iino in Fukushima prefecture and the concentrations of 23 mineral elements in shoots were analyzed. Among 23 elements, *Amaranthus* were less sensitive to the accumulation of Cs and Sr than most other mineral elements to the species level. There are six elements showing significant correlation with Cs, positive correlations between As, Rb, Al, Fe, Ni, and Cs, and negative correlation between Ba and Cs. Significant correlations between Ca, Mg, Mn, Zn, B, Ba, Cd, and Sr were detected, and all of the coefficients were positive. Cs and Sr did not present significant correlation, but they were both significantly correlated with Ba.

2) The dynamic state of ionome in the root nodule and shoot of soybean under different nitrogen status and at different growth stages

Relative distribution of 22 mineral elements in the root, nodule and shoot of the soybean in the vegetative and reproductive growth stages in response to N treatment (ammonium and manure) was analyzed. Although the addition of ammonium sulfate to the soil significantly reduced the biomass production of nodule and root, the accumulation of Ca, Mg, Fe, Mn, Cu and Zn significantly improved in the shoot, and that of Mo and Co improved in the nodule. The addition of manure to the soil significantly enhanced the levels of Sr, Ba, Cr and Cd in the shoot, whereas the shoot Cs concentration was decreased at reproductive stage. Moreover, the variation of concentrations of many elements was not consistent between nodule and root when soybean developed from juvenile to maturation. The variation of Mn, Zn, B and Al concentrations was independent on N treatments but Ca, Fe, Cu, Mo and Se strongly regulated by N treatments.

3) Manure application caused the divergent nitrogen utilization, ionome, and microbial metabolism in the rhizosphere

Seedlings of soybean and sorghum were grown in a rhizobox across three N input treatments (without N, ammonium sulfate or cattle farmyard manure). The manure treatment on soybean altered belowground processes by stimulating the microbial utilization on some saccharide and amine, and increasing the uptake of NO_3^-, P, and some metal elements, although these processes did not cause significant variation on shoot biomass. On the other hand, addition of manure to the soil altered the sorghum growth by stimulating the microbial utilization on several types of amino acids, increasing the uptake of amino acid, P, B and many metal elements, leading to a higher accumulation of shoot N and biomass. Results indicated that the correlation of microbial activity with N and ionome in soils differed between different species grown with manure.

This study clarifies the ionome information in plant in response to variety effect, the dynamic variation of N and ionome in the plant with its development from juvenile to ripening, as well as the interactions between N and ionome in the plant and soil in response to various N sources. These achievements contribute greatly to interpret the connection among the ionome, N fertilization, and plant nutrition.

Therefore, we acknowledge that the author is qualified to be granted the Degree of Doctor of Philosophy in Agriculture from Hokkaido University.