SUMMARY OF DOCTORAL THESIS

Name : **Han Wenjun**

Title : **Studies on ecology and mineral absorption properties of halophytes**

Scarce water resources in arid areas force people to use highly saline water for irrigation. The practices result in the expansion of areas affected by secondary salinization. The countermeasures to cope with the soil salinization problem include the utilization of salt tolerant crops or halophytes.

To examine the feasibility to utilize halophytes, ecological distribution, responses of halophytes against salt treatments and mineral absorption by plants were examined in this Thesis taking *Salicornia* plants as an experimental material.

The major results obtained are stated below.

1. Ecological characteristics of halophytes in the arid areas

Plant ecological analysis was carried out around salt lakes and salt affected areas in central to western parts of Inner Mongolia. Special attention was paid on the usage of plants.

Halophytes of 20 families with 113 species were recorded on 5 sites. Among them, there were 34 medicinal plant species and 41 forage plant species (among them, 11 species have high quality for forage). Twelve species were common with Japanese flora. Fifty eight species have their close relatives in Japanese flora. Plants with no close relatives in Japanese flora numbered 40 in family level and 3 in species level.

Chenopodiaceae plants like *Salicornia*, *Suaeda* and *Kalidium* formed colonies as pioneer plants on the salt affected areas in central to western parts of Inner Mongolia. *Phragmites australis*, *Salicornia europaea*, and *Suaeda corniculata* produced high biomass at the central parts of salt affected areas. The biomass of these species was 23.8, 8.9, and 7.2 kg/m^2, respectively.

Species diversity calculated by Simpson's index ranged between 0.000 and 0.791. On the plot where salt accumulated more, the index fell around 0,showing the breakdown of diversity.

2. Mineral absorption and salt tolerance properties in *Salicornia* plants

Exp.1. The shoot growth and mineral absorption were examined by treating 2 species of *Salicornia* plants (*Salicornia herbacea* and *S. bigelovii*) with various dilutions of sea water.

Growth was promoted under saline water treatments. Maximum growth was observed when plants were treated with 100% sea water. Na content in the shoot of 2 species increased conspicuously in proportion to salt concentration treatments. K content, on the contrary, decreased with them. Ca content decreased gradually in response to higher salt concentrations in case of *S. bigelovii ,* while increased in case of *S. herbacea* . In *S.herbacea* , Ca contents in treated plots were higher than in control plot. Mg absorption varied similarly as Ca did. N and C in shoot decreased in response to salt concentrations.

The results stated here prove the feasibility to grow *Salicornia* under sea water irrigation.

Exp. 2 . Growth and physiological responses of *Salicornia bigelovii* were examined under various NaCl solutions.

Growth was promoted most under the proper concentrations of NaCl, namely 0.6 to 1.2 %. The largest factor which promoted growth was inferred to be the increase in photosynthesis as the results of expansion in plant size, branch number and plant height. C and N content in shoot tended to stay constant. Water potential of stem and root decreased with the increase in treated NaCl concentrations. Na was accumulated more in the upper branches where growth was much active. K absorption was greatly suppressed by the increase in treated NaCl concentrations. Ca and Mg were accumulated more in the root.

Thus, certain degree of NaCl treatments promoted *Salicornia* growth. Na was translocated and accumulated in the upper branches where growth took place much actively.

Exp. 3 . Characteristics of *S. bigelovii* in salt accumulation and salt uptake were examined

by growing plants under various concentrations of natural salt which was produced through drying up sea water.

Growth was promoted even under higher Na concentrations of natural salt than that of sea water. Na content in upper branches increased in proportion to treated salt concentrations. Plant Na content of 5% treatment plot was 7 times higher than that of control plot. Mineral elements tended to distribute more in the order of upper branch > central to lower branch > root. It was estimated to reflect the intensity of growth activity. Fe content tended to increase with treated salt concentrations. N content also tended to increase similarly. Na and K content in root were kept around 1% level. This might contribute to keep high osmotic pressure in the root. Na and K content in 4.5% and 5% salt treated plot increased extraordinarily. This might be caused by the breakage in control function on salt uptake in plant root. Na:Ca ratio was kept low in each parts of a plant, and especially in root. High Ca was estimated to contribute to osmotic adjustment.

Thus, natural salt mitigated the adverse effects of Na ions and promoted growth even higher salt concentrations than under NaCl treatment. High Ca content seems to be important for osmotic adjustment.

3. Effects of nitrogen fertilization and planting density on the growth and mineral absorption by *Salicornia bigelovii* plants grown under various salt concentrations

① Effects of nitrogen fertilization was examined by growing *Salicornia bigelovii* under various concentrations of salt. The N concentration of 0.4% promoted plant growth most. There was a high positive correlation between N concentrations in the culture medium and those in plant shoot. Nitrogen fertilization did not give much influence on the pattern of cation absorption.

② Effects of planting density was examined in the similar way as stated above. The dry weight of plants increased with higher densities of planting. It reached plateau in the higher densities. EC value of soil filtrated water and salt concentrations of the soil decreased with higher densities. Total absorbed Na was 261 g/m^2 in 56 plants/m^2 plot and 490 g/m^2 in 336 plants/m^2 plot. Mineral content in plants tended to decrease with increase in planting density. No conspicuous variation was observed in the pattern of mineral nutrient absorption among the planting density treatments. C and N content in shoot increased with the planting density. Above results showed that *Salicornia bigelovii* belongs to nitrogen-file plant and under higher density treatments it can absorb more salt out of the soil.

From the experimental results stated above, the following suggestions for the utilization of halophytes were obtained.

(1) Halophytes such as *Salicornia*, *Suaeda* and others distribute naturally in the salt affected areas. Their biomass production is quite high. Selecting the proper species, animal feed can be produced. The feasibility expands the options of countermeasures to resume destroyed plant vegetations.

(2) *Salicornia* plants accumulated quite high amount of minerals. Rich miner

used as supplements for human health. Since halophytes can grow even under sea water irrigation, they help to produce food, forage or medicines on the salt affected land.

(3) In order to increase biomass yields, a larger size plants like *Salicornia bigelovii* should be chosen among *Salicornia* plants. Nitrogen fertilization can increase yields. For the utilization of halophytes to remove salt out of soil, high density planting is recommended.