沙漠研究 **22**-1, 263 -266 (2012 )
Journal of Arid Land Studies

"ICAL 1 / DT X"
－Refereed Paper－

# Geo-environmental Investigation of Vegetated Area for Licorice and Fundamental Consideration for Greening by Using Pipe-shaped Pot

**Zentaro FURUKAWA*[1)], Kiyoshi OMINE[2)], Noriyuki YASUFUKU[2)], Taizo KOBAYASHI[3)], Haruka KIYOTOMO[1)] and Atsushi SHINKAI[1)]**

**Abstract:** This research is conducted for seeking the way of value added greening and stopping desertification. In order to accomplish these purposes, in-situ investigation was conducted to grasp soil condition of arid land where licorice known for remarkable medicinal plant lives naturally. And based on the results of the investigation and cultural experiment in Japan, fundamental consideration for greening by cultivating licorice and using "pipe-shaped pot" was conducted. This research was concluded that 1) Wild licorice can live around 10% of volumetric water content of ground within the depth of 1 m, 2) Wild licorice can live low nutrition environment, 3) From the results of cultivation experiment in Japan, young licorice grew well under much moisture and nutrition in the ground, and 4) From the results of application for greening by using pipe-cultivation, it was suggested that young licorice can grow well and height of 10 cm pipe was enough to support initial growth.

**Key Words:** Greening, Licorice (*Glycyrrhiza uralensis*), Pipe-shaped pot, Soil nutritive condition, Soil water condition

## 1. Introduction

Desertification is one of the remarkable global environmental problems caused by climate change, over fishing, overgrazing and so forth. Such land-degradation problem can be solved from the standpoint of geo-environmental engineering. And licorice, which is one of the most useful medicinal plants were paid attention for value added greening. It lives mainly in Chinese and Mongolian arid land (**Fig. 1**), and its root contains active ingredient called glycyrrhizin (GC) used as the ingredient of herbal medicine. However, the amount of licorice is decreasing by overgrazing and over fishing, and these facts caused desertification (Shoyama *et al.*, 2002). Therefore, if licorice is used for greening, stable supply of herbal medicine and value-added greening will be able to succeed for the future.

Licorice has a characteristic which its root grows long and deeply into the ground until its root can get the groundwater, but there are many unknown geo-environmental parameters such as soil water and nutritive condition of habitat. Therefore, in-situ investigation is needed for greening to grasp soil water and nutritive condition of arid land where licorice lives naturally. For that reason, investigation in Mongolia was conducted to reveal the geo-environmental conditions of habitat

In addition, cultural experiment by using pipe-shaped pot was conducted, which is known as suitable way of cultivation for licorice recently (Ozaki *et al.*, 2005). Finally, from the results of those investigation and cultural experiment by using pipe-shaped pot in Japan, as the fundamental consideration for value-added greening, several cultural experiments were

**Fig. 1. Licorice living in arid land.**

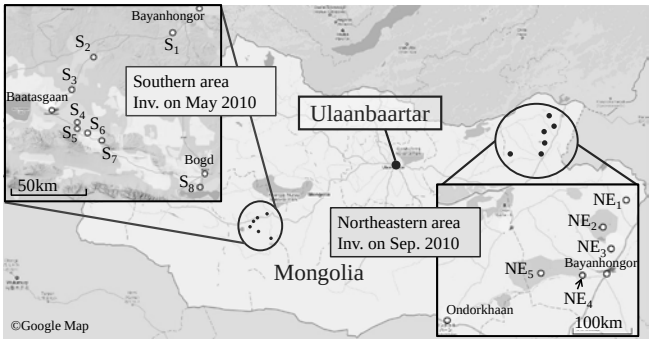


**Fig. 2. Investigation map in Mongolia.**

* Corresponding Author: soil36civil@yahoo.co.jp
744 Moto-oka Nishi-ku, Fukuoka, Japan 819-0385
1) Graduate student/faculty of engineering, Kyushu University, Fukuoka, Japan
2) Faculty of engineering, Kyushu University, Fukuoka, Japan
3) Faculty of engineering, Fukui University, Fukui, Japan

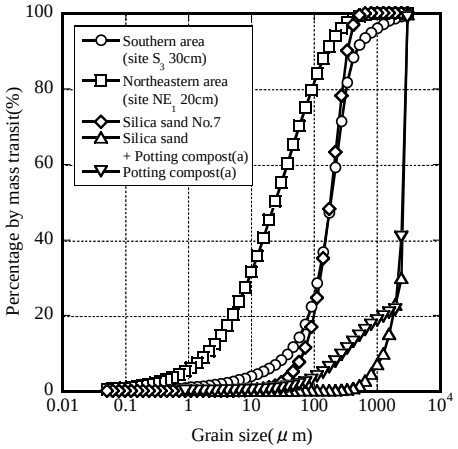


**Fig. 3.Grain size distribution**

conducted in Japan to promote initial cultivation of licorice and take root more quickly in the ground simulated arid sand.

## 2. Instruction about the Data Gotten from the Investigations

To grasp the soil water, nutrient, and the other properties on arid land, field investigation in Mongolia was conducted on May and September 2010 (indicated in **Fig. 2**). And conditions of cultivation experiment in our laboratory were selected based on the data gotten from these investigations.

### 2.1. Grain size distributions

**Figure 3** shows the grain size distribution in arid land and some kinds of soil used for cultivation experiment. As shown in Figure 3, the distribution of southern area in Mongolia is similar to silica sand No.7. Therefore, Silica sand No.7 was chosen for cultural experiment in Japan written in next paragraph in the hope that licorice grows well due to have similar permeability to arid ground.

### 2.2. Soil nutritive conditions

**Table 1**(A) shows the nutrition facts of soils in Mongolia. As the indexes of soil nutritive property, pH, EC (Electric Conductivity) and CEC (Cation Exchange Capacity) were measured. pH represents acidity of soil, EC is index of saline soil, and CEC is retention of fertility. In addition, exchangeable Ca, Mg, K, nitrate nitrogen ($NO_3$-N) and available form of phosphoric acid ($P_2O_5$) were measured. Exchangeable cation is a type of cation which can be gotten by plants. Table 1 show that the research area has high concentrations of Ca, Mg, and these are high pH. In addition, compared with potting compost which general plants can be grown easier and faster, elution amount of Ca is higher. Furthermore, CEC, $NO_3$-N and $P_2O_5$ of the soils in arid ground are lower than potting compost (in Table (B)). From the fact that wild licorice in southern and northeastern Mongolia can live under such low-nutrition environment, it is assumed that natural licorice extends the root to get nutrition in the soil such a strict environment.

### 2.3 Soil water conditions

**Figure 4** shows volumetric water content of each depth in northeastern ground. It indicates that every depth of water content is lower than the condition to live general plants. In addition, as for the water content of ground surface in each site had various values, the deeper the ground was, the smaller the difference was. And the deeper parts of the ground had around 5% volumetric water content. These facts revealed that it is strict for plants to catch the water within 1 m depth of underground such volumetric water content. Therefore, like Figure 1, it is assumed that licorice can live by growing its root deeply near the ground water.

## 3. Pipe-cultivation Experiment in Japan

From the results of in-situ investigation, licorice can live under the environment that lower volumetric water content and nutrition compared with the condition that general plants live healthily. In order to conduct the value added greening, following indexes are needed that (1) Creating the environment which licorice root can grow root deeply and quickly to get the groundwater, and (2) Supplying licorice which has high GC content stably and continuously. Therefore, consideration of the cultural conditions which satisfies above indexes (1) (2) is needed. As the method which can bring up good individuals, “Pipe-cultivation method” was selected. It is the way that pipe-shaped pot is used for cultivation, and it has been conducted experimentally in Japan recently. Since pipe-shaped pot is narrow in width and long in length, the growth of secondary roots are restricted. It is therefore considered that main root for herbal medicine is harvested easily and prompted to grow bigger and longer. According to this, it can be suitable to grow root of licorice well. And this way can be applied to cultivate high-quality and fast-grown individuals in arid land.

### 3.1. Materials and method

The soils used for cultural experiment were silica sand No. 7, potting compost (a), and mixed soil which was mixed silica sand and potting compost (a) by 1:1 compared by weight. Figure 1 shows the grain-size distributions, Figure 3 shows water conditions of each soil, and Table 1 (B) shows the nutritive properties of these soils. According to Figure 1, silica sand No. 7 has similar grain size distribution to arid sand, therefore it has similar draining ability and could be expected that licorice grown well.

**Table 1. Soil nutritive condition (n=1).**

| (A) soils of investigation area | | | | (B) soils used for experiment | | | |
|---|---|---|---|---|---|---|---|
| Items | Units | Southern area($S_8$) | Northeastern area($NE_1$) | Simulated sand (Silica sand No.7) | Potting compost(a) | Silica sand +Potting compost(a) | Potting compost(b) |
| CEC | meq/100g･dry | 3.6 | 6.2 | 1.2 | 49.9 | 14.6 | 21.3 |
| pH | -- | 7.97 | 7.61 | 8.44 | 7.37 | 8.09 | 6.35 |
| EC | mS/cm | 0.13 | 0.02 | 0.67 | 0.23 | 0.29 | 1.57 |
| Ca | mg/kg･dry | 3380 | 1000 | 350 | 4510 | 1410 | 1450 |
| Mg | | 92 | 41 | 13 | 1300 | 650 | 870 |
| K | | 57 | 193 | 15 | 160 | 171 | 400 |
| Na | | 85 | 125 | 32 | 590 | 35 | 304 |
| $NO_3$-N | | 33.2 | 6.1 | 0.7 | 90 | 27.4 | 1700 |
| $P_2O_5$ | | 60 | 10 | 110 | 750 | 170 | 708 |

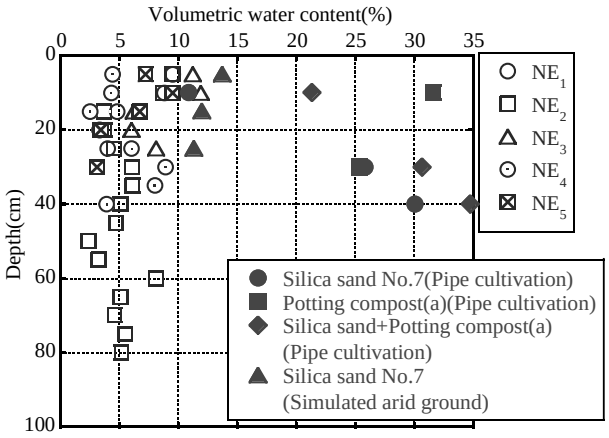


**Fig. 4. Soil water condition of arid land and cultivation experiment.**

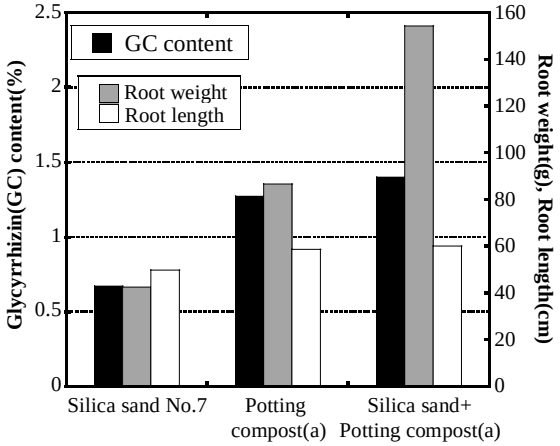


**Fig. 5. Growth of licorice with each soil condition (n=3).**

And Table 1 (B) shows soil nutritive condition of each soil. The soil included potting compost (a) has high CEC and other ingredient for the sake that plants grow well. On the other hand, silica sand has low CEC and other ingredient like arid sand. Potting compost(a) has much nutrition and water holding capacity in order to grow general plants well, and mixed condition was hoped to have suitable nutritive condition and draining ability of soil, and the reason of 1:1 mixture is in the hope that the properties of two types of soil is revealed equally. And the scale of pots used for experiment was 10 cm diameter and 50 cm height (Furukawa *et al.*, 2010).

### 3.2. Results

**Figure 5** shows the growth of licorice cultivated under these conditions written above for 2 years. Evaluation items of growth are glycyrrhizin (GC) content, root weight, and root length. The values in this figure are average from 3 individuals of same conditions. Figure 5 indicates that licorice cultivated by mixed soil had high root weight. On the other hand, the individuals cultivated by silica sand No. 7 had lower items of growth. From these results, suitable soil water and nutritive condition should be needed to cultivate licorice since they were young. And based on these results, application of pipe-cultivation in the arid land and consideration for value added greening was conducted.

## 4. Consideration for Value-added Greening by Utilizing Pipe-cultivation

From the results of pipe-cultivation for 2 years shown in Figure 5, as the application for value added greening was considered by using pipe-shaped pot.

### 4.1. Materials and method

**Figure 6** shows the conceptual scheme of the experiment. The several pipes which have different height and diameter were set on the small size cultivation field, which is silica sand, and young licorices were planted in the pot. The content of the pipe was potting compost (b). The length of the roots in the cultivation field and other growth, such as Figure 6, were measured after 3-months cultivation. The water condition is the index of “small size cultivation field” shown in Figure 3, and nutritive conditions are the indexes of “Simulated ground (Silica sand No.7)” and “Potting compost (b)” in Table 1.

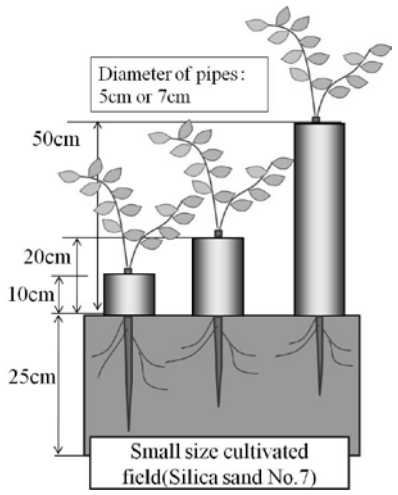


**Fig. 6. Cultivation method.**

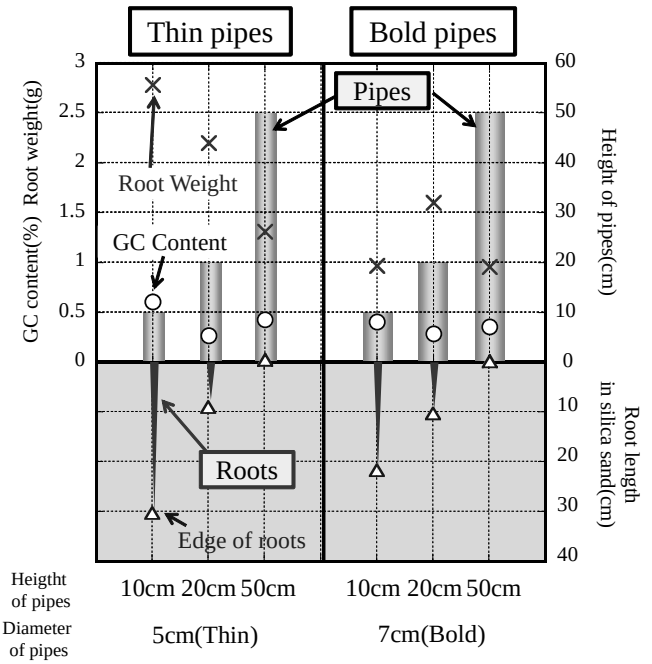


**Fig. 7. Evaluation of licorice's growth by using pipe-shaped pot.**

### 4.2. Results

**Figure 7** shows the result of the growth after 3-months cultivation. The squares represent the height of pipes, and triangles are root length. The triangles are growth in the simulated ground. As shown in Figure 7, in case using pipes of 5 cm diameter and 10 cm height, the root could be grown over 30 cm in the simulated ground. These facts represent that the promotion of initial root growth is valuable by using pipe-shaped pot.

In addition, compared with diameter of pipes, the individuals cultivated by 5 cm diameter were heavier than the individuals cultivated by 7 cm diameter. It is assumed that restriction effect revealed. Initial growth could be promoted by less diameter, but it did not reveal that the root keep growing and catch the groundwater and nutrient like natural individuals. Therefore, more examinations are going to be needed to confirm these.

## 5. Conclusions

This research was conducted for vale added greening, therefore in-situ investigation were conducted to grasp soil environment of arid land where licorice lives and to consider the suitable conditions for greening. In addition, in reference to those investigation and pipe-cultivation experiment in Japan, the fundamental experiment and consideration for greening were conducted, The contents of these are several cultural experiments to promote initial growth of licorice and take root more quickly in the ground simulated arid sand by using pipe-shaped pot.

The following conclusions were obtained from this study.

1) Natural licorice can live around 10% of volumetric water content of semi-arid ground within the depth of 1 m, and licorice can take root longer than 1 m and get groundwater.
2) Natural licorice can live low nutrition environment
3) From the results of pipe cultivation experiment in Japan, young licorice grew well under much nutrition environment. On the other hand, simulated arid sand (Silica sand No. 7) couldn't make licorice grow well.
4) From the results of application for greening by using pipe-cultivation, it was revealed that young licorice grew well and 10 cm of pipe height was enough to support initial growth.

For the future study, it should be considered that the way of supplying water to young licorice until it has grown longer to catch groundwater.

## Acknowledgement

The author would like to acknowledge financial support from the project between Kyushu-University and Genkai town, and P&P (Kyushu University Interdicisciplinary Programs Education and Projects in Research Development).

## References

Shoyama Y. (2002): *Intelligence and nature of Asia*, KUARO, 25-59 (in Japanese).

Ozaki K. (2005): Cultivation of *Glycyrrhiza uralensis* by using pipe-shaped pot, *2nd symposium on licorice*, 12-20 (in Japanese).

Furukawa Z., Yasufuku N., Omine K., Kobayashi T. (2010): Influences of differences of geo-environment on length and quality of licorice (*Glycyrrhiza ularensis*) root using pipe-shaped pot, *The 45th Japan National Conference on Geotechnical Engineering*, JGS , 1993-1994 (in Japanese).