沙漠研究 **22**-1, 275 -278 (2012)
Journal of Arid Land Studies

"ICAL 1 / DT X"
－Refereed Paper－

Comparison of Quality of Licorice (*Glycyrrhiza uralensis*) under Different Groundwater Levels and Soil Conditions

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

Abstract: The medicinal plant, Licorice, mainly grows on arid lands. The root of licorice constitutes about 70% of herbal medicines in Japan because it has an important medicinal element called Glycyrrhizin (GC). The effects are painkiller, antifebrile, anti-inflammatory and so on. Therefore, licorice is one of the most important medicinal plants in Japan. This study especially deals with *Glycyrrhiza uralensis* growing in Mongolia. In recent years, the expansion of desertification becomes a serious problem. The cause is chiefly man activity such as over gathering plants. Licorice is also collected intensively. The aim of this study is to prevent desertification by cultivating high quality licorice. The first step is to understand the environment where licorice grows. The second step is to understand the environment at arid lands. And the third step is to establish a technique to control geo-environment at arid lands. Following these steps, growing licorice for greening at arid lands can be achieved. This paper presents, (1) Cultivating licorice by bottom watering method, which is under constant groundwater level emulating desert ground environment by changing water supply level and soil types. The experiment clarifies the mechanism of root growth. There are some influential factors on licorice growth. (2) Investigation at Yinchuan of China, Southern Mongolia and Northeastern Mongolia. The results are water content, physical and chemical properties of the soil, elements of licorice's root and GC content. (3) Comparison of the data between cultivated at Japan and obtained at arid lands.

Key Words: Licorice, Mongolia

1. Introduction

Licorice is a leguminous plant that mainly grows on arid lands from temperate zones to subtropics at the Northern Hemisphere. Licorice can be used as medicine and grows at Southern Europe, Central Asia, Inner Mongolia and Mongolia. Especially, this study deals with *Glycyrrhiza uralensis* growing in Mongolia. **Figure 1** shows licorice growing in a green field at Mongolia.

Licorice has benefit components for human physiology and the root is used about 70% as herbal medicines in Japan because it has many properties as painkiller, antifebrile, anti-inflammatory among others. Therefore, licorice is one of the most important medicinal plants in Japan.

On the other hand, desertification becomes a serious problem in a lot of places. The cause is mainly man activity such as over gathering plants. Licorice is also collected intensively.

The aim of this study is to prevent desertification by cultivating high quality licorice. The flow of research is shown in **Figure 2**. The first step is to understand the environment to grow licorice. The second step is to understand the environment at arid lands. And the third step is to establish technique to control geo-environment at arid lands. By these steps, growing licorice for greening at arid

Fig. 1. Licorice growing in a green field at Mongolia.

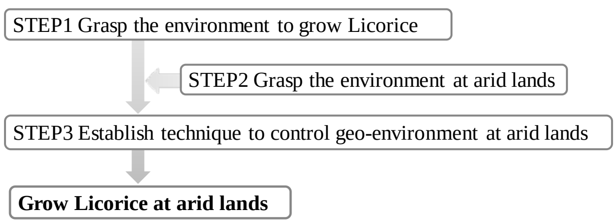

Fig. 2. Research flow.

* Corresponding Author: khkrkk@yahoo.co.jp
1108-2 WEST2 744 Moto-oka Nishi-ku, Fukuoka, Japan 819-0385
1) Graduate student / Faculty of engineering, Kyushu University, Fukuoka, Japan
3) Faculty of engineering, Fukui University, Fukui, Japan
2) Faculty of engineering, Kyushu University, Fukuoka, Japan

lands can be achieved. This paper presents the influences of water-properties on licorice using bottom watering method, the conclusion of investigation at Mongolia and China, and the comparison between the cultivating data in Japan and the data obtained by investigation in Mongolia.

2. Materials and Methods

2.1. Cultivation experiment of licorice under constant groundwater levels

In this study, the purpose is to investigate effective ways for growing roots of licorice fast and long with high quality under arid area conditions. Licorice is dicotyledonous and has long primary roots and secondary roots, so it is supposed that the root of licorice grows deeply toward underground to search for water and nutrient because the ground surface lacks of them. Therefore, when licorice is cultivated under modeling condition assuming arid areas, it is more effective to supply water and nutrient from lower the roots than from the ground surface. Therefore, licorice should be cultivated paying attention especially to water conditions on ground.

In this experiment, pipe-shaped pot made from polyvinyl chloride (PVC) was used for cultivation because it is easier to control conditions such as soil and water conditions. The diameter was 10 cm, and the shape of its cross section of axis direction was semicircle. A transparent acrylic board was attached for observing the soil conditions and roots of licorice. Several holes for absorbing water were drilled at the bottom. **Figure 3** shows the pot shape and the way of absorbing water.

Liquid manure was stored into a container. The applied manure was Otsuka liquid fertilizer A-type [N:P:K:Ca:Mg = 18.6:5.1:8.6:8.2:3.0 (me/l)], and it was diluted to 1/8th concentration. Then, the pots crammed with soils were set up in the container and potted licorice. The pot heights used in this experiment were 30, 50, 70, and 100 cm. **Figure 4** shows the pot heights. Basically, decomposed granite soil was used, as well as Silica sand No. 3 and No. 7 were used in 50 cm pipes for comparison. Decomposed granite soil can be found mainly in the western of Japan. The characteristics of each soil are mentioned later.

In the cultivation, there are some influential factors on the licorice growth. This paper discusses relationships between volumetric water content and length of roots.

2.2. Outlines of investigation

Investigations about the medicinal plant licorice were conducted. The aim of this investigation was to understand the environment of licorice and the natural growth distribution in its habitat. The places and dates were (1) Yinchuan of China, May, 2006, (2) Southern Mongolia, May, 2010 and (3) Northeastern Mongolia, September, 2010. **Figure 5** shows every place and date. All places have habitat and non-habitat place of licorice. In the habitat, licorice grew in colonies. Moreover, the habitat of licorice was not a complete desert but a land like a steppe (Fig. 1).

The investigation contents were measured, as well as water level at the well, sampling of soils, permeability, water content and so on. This paper shows grain size distribution, water content, soil nutrients from soil analysis and GC component.

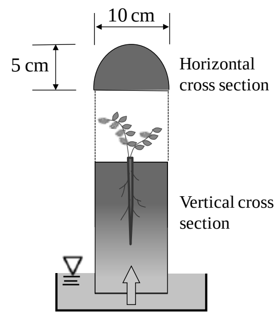

Fig. 3. Shape of the pot and bottom watering method.

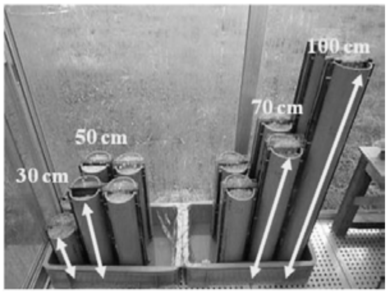

Fig. 4. Used pots with different heights.

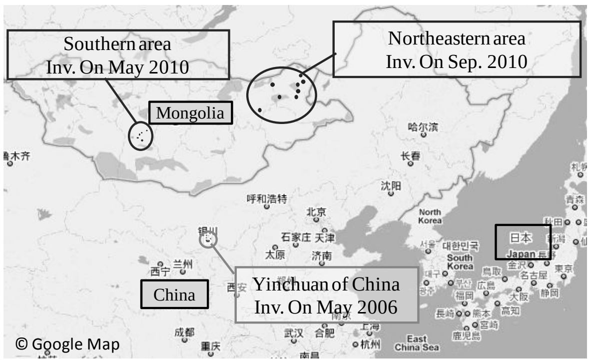

Fig. 5. Investigation areas.

3. Results and Discussion

3.1. Grain size distribution

Figure 6 shows the grain size distribution that compares the soils at cultivation and the Mongolian soils. Legends in the figure are for places, soil types and pot heights. D.s. means decomposed granite soil, and No. 3 is silica sand No. 3. Figure 6 shows that in the cultivation experiment, decomposed granite soil has the widest grain size distribution in comparison

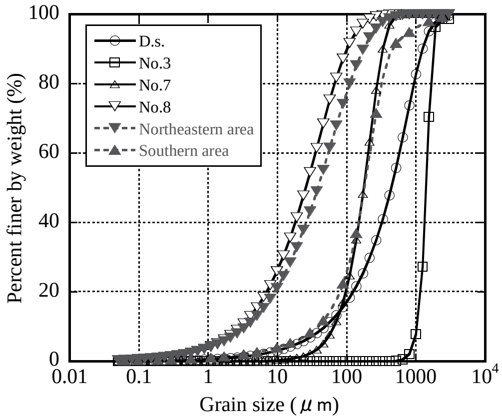

Fig. 6. Grain size distribution.

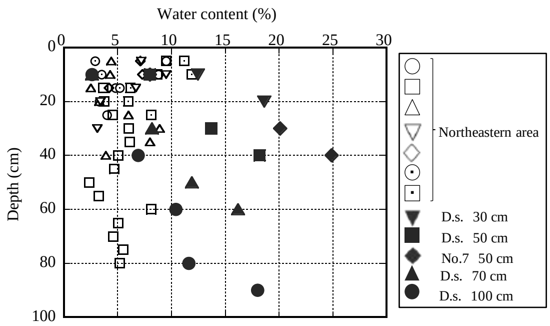

Fig. 7. Water content.

of other soils. Silica sand No. 3 and silica sand No. 7 are similar in their slopes, but the grain size of silica sand No. 3 is larger than that of silica sand No. 7.

Next, the distribution of silica sand No. 7 is similar to that one of the southern area of Mongolia. On the other hand, the distribution of northeastern area of Mongolia is similar to silica sand No. 8. Silica sand No. 8 is shown as a reference. The above explains that the soils of Mongolia is a sandy soil and have even grain size distribution.

3.2. Water content

Figure 7 shows water content, comparing the soils used for cultivation with Mongolian soils in the Northeastern area, at an arbitrary depth of the ground. Legends of white dots represent the soils at Northeastern area of Mongolia and black dots represent the soil types and pot heights in the above cultivation experiment. Horizontal axis means volumetric water content (%) and vertical axis means pot depths from the surface. The pot with Silica sand No. 3 could not be measured because the water content was too low to be measured using this sensor.

The water content in the vicinity of the ground surface at Northeastern area has dispersion probably because of rainfall, but the value shows around 5 % as it becomes deep. But then, water content of the soils used for the cultivation experiment shows lower value as approaching the surface. Water content

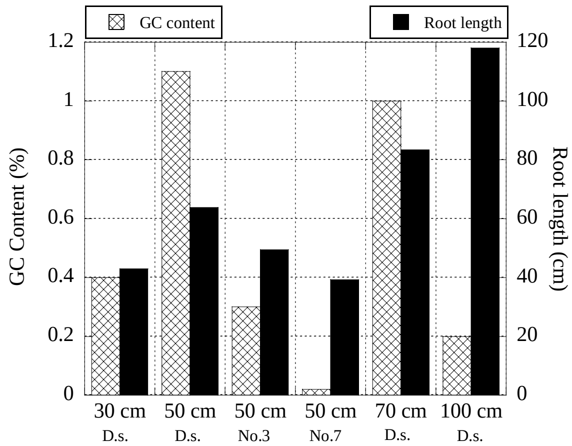

Fig. 8. GC content and Root length of the cultivation.

Table 1. Results of soil nutrients test.

items	units	samples						measurement lower limit
		China	Mongolia			Japan		
		Yinchuan (Habitat)	South (Non-Habitat)	South (Habitat)	Northeast (Habitat)	Decomposed granite soil	Silica sand No.7	
cation exchange capacity (CEC)	meq/100g・dry	3.2	8.4	3.6	6.2	6.0	1.2	0.01
exchangeable base (Ca)	mg/kg・dry	14000	8600	3380	1000	360	350	50
exchangeable base (Mg)		590	235	92	41	360	13	20
exchangeable base (Na)		32	85	125	22	54	32	1
exchangeable base (K)		43	76	57	193	32	15	1
NO_3-N		0.9	1	33.2	6.1	0.8	0.7	0.1
avaiable P_2O_5		20	150	60	-	-	110	10
available Fe		8	5	8	5	4	9	1
available SiO_2		80	100	100	90	20	30	10
soluble Al		430	90	50	30	920	200	10

—:under measurement lower limit

Table 2. Chemical components of roots.

items	units	samples				measurement lower limit
		Yinchuan of China	Northeastern area of Mongolia	Kyushu-univ.	Hokkaido	
Ca	mg/kg・dry	7100	3900	4800	4700	100
Mg		2000	-	1200	2000	100
Na		650	-	32	109	1
K		5000	5100	7800	9200	100
Total-P		1530	-	3500	1300	10
Fe		290	-	230	940	10

— : unmeasured

on the pot with height of 100 cm resembles to that of Mongolian soils. The value of 100 cm was the longest growth of roots of all conditions, but its GC content has no relation on root lengths (**Fig. 8**).

3.3. Soil nutrients

Table 1 is the result of analyzing soil nutrients in each investigation area, Yinchuan of China (licorice habitat), Mongolian southern area (habitat and non-habitat) and Mongolia northeastern area (habitat). In the Table 1, two kinds of soils in Japan were described for making the comparison. Decomposed granite soil is well distributed in Western Japan. Silica sand No. 7 is a sand with small grain diameter of 0.23 mm. Table 1 shows that Yinchuan of China and Mongolian soil have a large amount of Ca.

Ca in soils exists not only as exchangeable cations but also as calcium carbonates. And that influenced the results. On

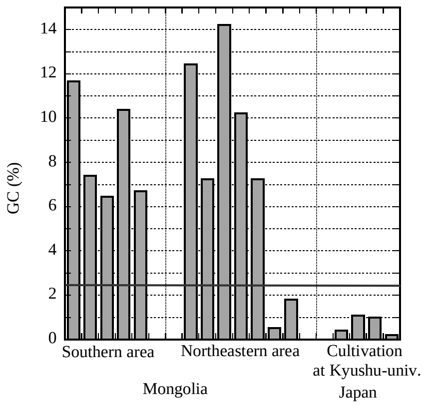

Fig. 9. GC content.

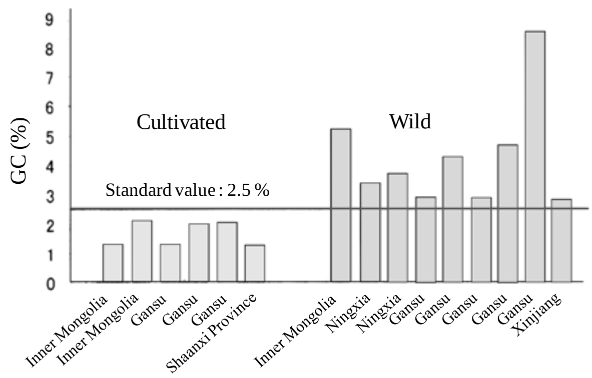

Fig. 10. Comparison between cultivated licorice and wild one's GC component.

the other hand, in Japanese soils, soluble Al is highly contained.

3.4. Chemical components of roots

Table 2 is the result of chemical components of roots. This shows that licorice root also contains a large amount of Ca. This is due to that Ca in the soil is also high. Next to Ca, the root contains relatively large amount of K.

3.5. GC content

GC content is measured from roots of licorice. **Figure 9** is the GC content that compares wild licorice at Southern and Northeastern areas of Mongolia with cultivated licorice at Japan using bottom watering method. This Figure shows that licorice of Mongolia contains more GC than Japanese one. Japanese standard value is more than 2.5% of GC content. Almost Mongolian wild licorice satisfies the standard, but Japanese cultivated licorice does not satisfy. It is difficult to calculate how long Mongolian wild licorice lives. Therefore it is difficult to conclude from the data. But generally, cultivated licorice has low GC content that it is difficult to satisfy the standard value. The reasons are not clear. **Figure 10** is a comparison between GC content of cultivated Chinese licorice and that of wild Chinese licorice.

It is guessed that soil nutrient cause this phenomenon. Therefore, more analysis and examination are needed.

4. Conclusions

This paper described the results of cultivating licorice under constant ground water as well as the investigation of licorice habitat.

The following conclusions were obtained from this study.

(1) The soil in Mongolia is composed of sandy soil with a uniform grain size distribution.

(2) Water content on the pot with height of 100 cm, cultivation experiment in Japan resembles to that one in Northeastern Mongolia. The value of 100 cm was the longest growth of roots of all conditions. But its GC content has no relation with the roots length.

(3) The amount of the soil nutrient is greatly different in the Mongolian soil and the soil used for cultivation in Japan. The quantity of nutrients found in Mongolian soils is bigger than that of the cultivation soil.

(4) From the analysis of chemical components in the root, it was found for that Ca is the most contained. Next to Ca, the root contains a relatively large amount of K.

(5) GC content showed a big difference in cultivated licorice and wild licorice.

Further cultivation experiments and studies are needed to clarify the suitable environmental conditions for growing licorice, in order to cultivate licorice with high GC content that can be used as Japanese medicines.

Acknowledgement

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

References

Kityotomo H. (2011): Growing Evaluation of licorice under different geo-environment. *Conference of Japan Societies of Civil Engineers - west.*

Satake G. (2005) : *New evolution of medicinal plant and herbal medicine development*. CMC Publishing Co.,Ltd.

Shibata T. (2005) : Aim at domestic cultivation of licorice. *The third symposium of licorice*, 3-7.

Shoyama M. (2002): *The wisdom and nature of Asia.* Kyushu University Press, 35p.