帝京科学大学紀要 Vol.14（2018）pp.47-50

Establishment of handy cultivating system in a greenhouse for an oil plant, jojoba

Koji IWASE　Shogo NIWAYAMA

Department of Natural and Environmental Science, Faculty of Life and Environmental Sciences, Teikyo University of Science

油糧植物ホホバの温室内簡易栽培システムの構築

岩瀬剛二　庭山翔冴

帝京科学大学生命環境学部自然環境学科

Abstract

The cultivation of jojoba, a well-known oil seed plant, was attempted in a greenhouse. In a usual pot, roots of jojoba hooked because of insufficient depth of the pot, while using long polyvinyl chloride pipe, natural shape of long root system was obtained. Furthermore, inoculation of arbuscular mycorrhizal fungi to the roots of jojoba promoted the root growth especially under relatively drought condition, which suggests arbuscular mycorrhizal fungi could have some good function under natural environment. The results in this study could supply handy cultivation system for jojoba in a greenhouse experiments such as strain selection or influence of growth promoting substances.

和文摘要

油糧植物として知られているホホバの温室での栽培を試みた。通常の植木鉢を用いると、鉢の深さが不十分なために根が曲がってしまったが、代わりに長い塩ビ管を利用することで、自然でまっすぐに伸びた根系を得ることができた。さらに、アーバスキュラー菌根菌をホホバの根に接種したところ、比較的乾いた条件下では根の成長を促進する結果が得られた。ホホバは本来比較的乾燥した土地に生育している植物であるため、自然条件下でもアーバスキュラー菌根菌は何らかの良い役割を果たしていることが示唆された。本研究の結果は、系統選抜や成長調節物質などの試験に利用できる簡易な栽培システムを提供することができたと言える。

キーワード：ホホバ、油糧植物、塩化ビニル管、栽培システム
Keywords：*Simmondsia chinensis*, jojoba, oil-plant, Polyvinyl chloride pipe, cultivating system

1. Introduction

Jojoba (*Simmondsia chinensis*) is a kind of evergreen shrub indigenous to southwestern United States to northern Mexico, especially to some extent in drought region[1]. This species is a unique component species belonging to a family Simmondsiaceae, which means this family is consisted of only one genus, *Simmondsia* and one species, jojoba. One of the unique characteristics of this species is dioecious, which means different male and female flowers are formed in the different individuals[2]. The most notable feature of this species is the oil or wax contained in the seeds[3]. The usage of this oil is diverse, but mostly for skin care products and cosmetics mainly because of considerable expensiveness due to low productivity compared with other plant oils. Jojoba has been, therefore, introduced to Asian or African countries for the production of oil[4], but the productivity in total is not so much promoted, mainly because the growth is rather slow and selection and breeding of superior strains are not fully conducted. In Japan, suitable area for cultivation could be in Okinawa Prefecture, especially in Yaeyama Islands. However, for the purpose of growth improvement and strain selection, handy cultivation method is required. The plants have rather long root system to gain water from the deep soil under dry environment[5], which strongly suggests that the usual pot is inappropriate for jojoba cultivation due to insufficient depth. In order to avoid a drawback of the usual pot, we have tried to cultivate jojoba plants with long polyvinyl chloride pipe. The purpose of this study is to examine the applicability of polyvinyl chloride pipe for jojoba cultivation and its trial optimization.

2. Materials and methods

1）Plant material

Seeds of jojoba （*Simmondsia chinensis* （Link） Schneider） were obtained from Egypt, which has been cultivated for commercial production of jojoba oil, and stocked in a bottle at room temperature.

2） Treatment for seed germination

Surface of jojoba seeds were first sterilized by soaking into sodium hypochlorite solution （0.5% available chlorine） for 15 min. at room temperature, and rinsed thoroughly by distilled water. Seeds were then placed on the moistened cultivating soil （Akadama soil:vermiculite 3:1 （v/v）） in a pot and covered lightly by the same soil. Pots were placed in an incubator at 25°C with 14 h day period. Emergence of radicles was designated as germination.

3） Cultivation of jojoba seedlings

Cultivating soil as mentioned above supplemented with 6 g of granular fertilizer （Magamp K medium grained, Hyponex Japan） was first sterilized by autoclaving （121 °C for 20 min.）. Seedlings around 60 days from the germination treatment were transplanted in the cultivating soil in plastic pots （No. 10, ca 20 cm in depth） or polyvinyl chloride pipes （75 mm diameter, 1 m long）, abbreviated as PCP hereafter. In case of cultivation with PCP, a jiffy pot was placed at the bottom of a pipe to prevent soil flowage. Those PCPs were placed into plastic pots No. 5 （Fig. 1）. For comparison of root growth in pots or PCPs, 4 each pots and PCPs were used. Watering was made by 2 L each of tap water every 6 days. After 30 days from transplanting, seedlings were dug up from the soil, and the root shape was examined. For examination of inoculation of arbuscular mycorrhizal fungi and watering interval, 4 each PCPs were used. In half number of PCPs, roots of transplanted seedlings were inoculated with 1 mL each of commercially available arbuscular mycorrhizal fungi （Mycorise ASP, Premier Tech Biotechnologies）. The planted seedlings were grown in a greenhouse with natural light irradiation. Watering （2 L per PCP） was conducted every 4, 6 or 8 days in order to change the aridity of the plants. Four each seedlings were treated with each watering interval. Seedlings height and root length were measured after 90 days from transplanting.

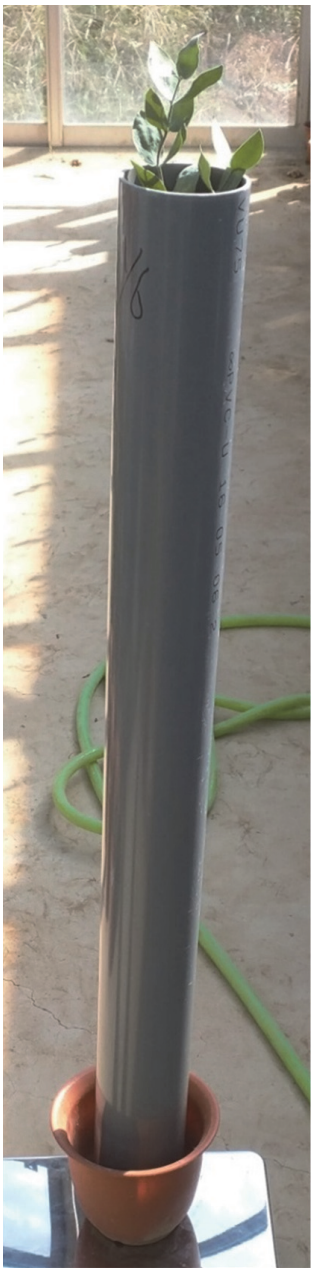

Fig. 1. Jojoba cultivating system with long polyvinyl chloride pipe

3. Results

1） Comparison of root growth in pots or PCPs

In the seedlings grown in usual pots （No. 10）, main root was found to hook （Fig. 2a）, while main root was grown straight in PCPs （Fig. 2b）. In a field grown jojoba, roots are grown straight deep into soil to gain water. Therefore, straight root shape seems to be preferred.

Fig. 2. Root system shape in jojoba
a: grown in usual pot No. 10, b: grown in polyvinyl chloride pipe

2) Effects of watering interval and inoculation of arbuscular mycorrhizal fungi

Shoots were almost not grown for 90 days after transplanting to PCPs. The shoot grown length in 90 days was around 1 to 1.5 cm regardless to the different conditions (Table 1). Roots were, however, well grown in the same period. Root grown length was around 15 to 42 cm among the different conditions (Table1). The best grown condition was watering at every 8 days and with inoculation of arbuscular mycorrhizal fungi, and only this condition affected significantly the root growth of all.

4. Discussion

Jojoba is a very useful plant for the oil or wax contained in the seeds. This species was already introduced into sub-tropical to tropical Asian or African countries in order to produce oil or wax. However, the most favorable strain has not been selected, and the optimum condition for the growth and development was not established, yet. Therefore, handy cultivation system for jojoba to examine the above mentioned matters has been needed. As shown in the results in this study, the shoot growth is very slow, while root growth is vigorous. This characteristic of vigorous root growth

Table 1. Shoot and root growth of jojoba seedlings in 90 days after transplanting

Water supply	Shoot grown (cm)		Root grown (cm)	
	-AMF*	+AMF**	-AMF	+AMF
Every 4 days	1.53 ± 0.15[a]	1.45 ± 0.16[a]	30.5 ± 13.7[b]	26.1 ± 4.20[b]
Every 6 days	1.15 ± 0.44[a]	1.28 ± 0.40[a]	15.1 ± 4.90[b]	18.7 ± 3.10[b]
Every 8 days	1.02 ± 0.15[a]	1.37 ± 0.16[a]	24.5 ± 7.00[b]	42.0 ± 7.01[c]

Values in table indicate mean values ± standard deviations of 4 each samples.
Different character a, b or c indicates significant difference among others at $p<0.05$.
*-AMF: no addition of aubuscular mycorrhizal fungi
**+AMF: addition of aubsucular mycorrhizal fungi

made the usual pot unfavorable as shown in Fig. 2a. However, the long polyvinyl chloride pipe instead of usual pot suited the feature of long growing root of jojoba plants in greenhouse experiments. Inoculation of arbuscular mycorrhizal fungi to jojoba roots promoted root growth under relatively dry condition, which suggests arbuscular mycorrhizal fungi has some good effects on the growth of jojoba especially under drought environment. However, further examination is really needed. As a result, the cultivation system appropriate for these characteristics was devised and approved for demand in this study. This cultivation system could be applied for the experiments of such as strain selection, influence of growth promoting substances, etc.

Acknowledgements
We thank Dr. Kiichi Fukui, Dr. Suguru Tsuchimoto, Dr. Naoki Wada and Dr. Hiroe Sakai in Faculty of Engineering, Osaka University for their discussion and encouragement during this study. We are indebted to Dr. Adel Hegazy in Universty of Sadat City, Ezypt for jojoba seed supply.

References

1) H. S. Gentry: The natural history of jojoba (*Simmondsia chinensis*) and its cultural aspects. *Economic Botany*, 12 (3) : 261-295, 1958.
2) S. L. Buchmann: Floral biology of jojoba (*Simmondsia chinensis*) , an anemophilous plant. *Desert Plants*, 8 (3) : 111-124, 1987.
3) M. Sánchez, M. R. Avhad, J. M. Marchetti, M. Martínez, J. Aracil: Jojoba oil: A state of the art review and future prospects. *Energy Conversion and Management*, 129: 293-304, 2016.
4) H. Suganuma: Jojoba as a tree species for revegetation in arid and semi-arid zone in tropical and sub-tropical area. *Agricultural Electrification*, 54 (4) : 8-13, 2001.
5) R. L. Dunstone, J. E. Begg: Biology of jojoba.*1st Australian Jojoba Conference, Bathust N.S.W.*, 1-18, 1979.