Feasibility Study on Soilless Cultivation of Organic Ginseng

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Abstract Based on the present situation and problems concerning ginseng cultivation as well as soilless cultivation features, we analyze the growth indicators and input-output ratio of different ginseng cultivation patterns, and conform that the soilless cultivation technology for organic ginseng is feasible. And this technology provides theoretical basis and technological feasibility for the sustainable development of ginseng industry.

Key words Organic ginseng, Medium culture, Feasibility

1 Introduction

Ginseng is a perennial rare medicinal plant, with a long period of growth and development. Due to stringent environmental conditions on ginseng growth, in the process of developing ginseng industry at home, except underwood cultivation, large-scale cultivation always uses the pattern of deforestation and ginseng planting, and it is only limited to the use of forest humus for cultivation. Although the production is high, it causes serious damage to the forest resources and environment[1]. With the launching of natural forest protection project, deforesting to plant ginseng is severely restricted. The continuous cropping of ginseng is not allowed and ginseng industry land is short, severely restricting the sustainable development of ginseng industry[2]. Now the consumers place an increasingly high demand on the safety of ginseng products, and they need high-end organic ginseng products. Therefore, we study the soilless cultivation of organic ginseng in order to save land resources, reduce the damage to the ecological environment and realize sustainable development of ginseng industry.

2 Current ginseng cultivation pattern

2.1 Cultivation of ginseng under forest As to the woodland for planting ginseng under forest, it is necessary to select the broad-leaved forests or mixed broadleaf-conifer forests with less human and livestock activities[3-8]. In addition to the above two types of woodland, it has also been reported that the coniferous forest with particularly good site conditions can also be chosen[8]. The places with thick humus soil are often chosen. The upper humus layer is generally best at 5 - 10cm, the lower layer can be black soil, yellow soil or yellow sand, and the soil moisture is appropriate at 40% -50%[7-8]. The ginseng under forest is harvested after growing for more than 8 years. Depending on different circumstances, we can harvest at one time or many times according to specifications[3]. Any woodland and harvest method will damage the forest to a certain degree. Although this ginseng product reaches the organic food level, the growth cycle is long and yield is low, so it can not meet the needs of society.

2.2 Cultivation of ginseng in old ginseng soil One of the main problems of old ginseng soil lies in many diseases. After planting ginseng for a few years, a large number of pathogens are accumulated in the old ginseng soil[9-10]. Studies have shown that in the two-crop old ginseng soil, five kinds of antagonistic actinomycetes only account for 22.22%. Meanwhile, the old ginseng soil acidification also creates a suitable environment for the propagation of a lot of bacteria[11]. Therefore, old ginseng soil-borne diseases become the most important factor in continuous cropping of ginseng. The production of ginseng in old ginseng soil must use a lot of pesticides, so the organic ginseng can not be produced.

2.3 Cultivation of ginseng in the field Due to the special needs of ginseng for growth environment, it is necessary to choose the flat terrain or gentle sloping land for the cultivation of ginseng in the field. There is a need to choose the loose fertile soil with good performance of retaining water and fertilizer or sandy loam, and the previous crop should be corn, wheat and other cereal crops. At the same time, there is also a need to improve soil. The researchers point out that applying humus, EM agents and multi-microbial agents in soil is an effective measure to improve soil physical and chemical properties and improve soil organic matter content[12-14]. Although we can improve seedling rate, yield and saponin content of ginseng after improving the field soil suitable for growing ginseng, it has some influence on the later growth[13], and the comprehensive utilization rate of the soil decreases. The soil of field for planting ginseng contains a lot of fertilizers and agricultural chemicals used in the previous crop production, so the ginseng products can not reach the level of organic products.

3 Feasibility study on soilless cultivation of ginseng

3.1 Overview and features of soilless cultivation of ginseng The soilless cultivation is a method of growing plants using mineral nutrient solutions, in water, without soil. Terrestrial plants may be grown with their roots in the mineral nutrient solution only, or in an inert medium, such as perlite or gravel. The two main

Received: August 19, 2015 Accepted: October 13, 2015
Supported by Yanbian Science and Technology Development Program (2013BC19).
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types of soilless cultivation are solution culture and medium culture. Solution culture does not use a solid medium for the roots, just the nutrient solution. The three main types of solution cultures are static solution culture, continuous-flow solution culture and aeroponics. The medium culture method has a solid medium for the roots and is named for the type of medium, e. g. , sand culture, gravel culture, or rockwool culture. There are two main variations for each medium, sub-irrigation and top irrigation. For all techniques, most hydroponic reservoirs are now built of plastic, but other materials have been used including concrete, glass, metal, vegetable solids, and wood. The containers should exclude light to prevent algae growth in the nutrient solution. Medium culture is to use the organic and inorganic medium or reasonably mixed organic and inorganic medium to cultivate crops[15]. The soilless cultivation can improve land utilization rate and energy use efficiency, eliminate the continuous cropping harm arising from the cultivation of ginseng in soil, and better solve some problems caused by continuous cropping of ginseng such as soil nutrient imbalance and serious pests. Compared to soil cultivation, the disinfection costs will significantly lower and the early economic input will decrease. In addition, soilless cultivation can also meet the needs of ginseng for light, temperature, humidity and nutrition, and create high ginseng yield. Some soil cultivation operations such as plowing and weeding are no longer needed, and thus we can greatly save labor and time, and increase labor efficiency[16]. In the experiment, it is found that placing the medium in the box to be completely separated from the earth's soil can greatly reduce the loss of irrigation water. Soilless cultivation is conducive to the automation of plant cultivation and modern management. Since the soilless cultivation is divorced from the soil cultivation conditions and simplifies the planting procedures, the cultivation is facilitated, operational management is modernized, and the plant growth is entirely under manual control[17].

3.2 Advantages of ginseng medium culture The ginseng medium culture is mostly in the artificial facility environment such as plastic greenhouses which can provide reasonable temperature, humidity, ventilation and shading, improve land utilization rate and reduce ginseng pests and diseases. It the production, it spurns soil disinfectants and pesticides so that the ginseng produced really achieves the standards for organic agricultural products; solves the shortage of land for planting ginseng, in line with the natural forest protection project, and has far-reaching significance to the protection of natural resources and ecological environment; dispenses with soil management for the cultivation of ginseng in farmland, weed control and shade grid setting, and reduces labor intensity. Whether it is in rural or suburban areas, soilless cultivation of ginseng can be carried out, and unlike vegetable cultivation, it can be harvested after being transplanted and managed for 3 – 4 years. It may become the best choice for the urban residents who are interested in agriculture.

3.3 Preparation of medium The peat soil, perlite and vermiculite are mixed with a small amount of natural phosphate rock, loess, dolomite and soybean meal in different proportions into different media. The medium formulation volume ratio is peat soil: perlite: vermiculite = 50: 40: 10 (6.0g/L of phosphate rock; 6.0 g/L of dolomite; 2.0 g/L of soybean meal).

3.4 Comparison of different media culture and cultivation in farmland Through the comparative analysis of growth indicators of ginseng cultivated in medium and farmland, it demonstrates that in terms of the plant height, root weight and stem diameter, the ginseng under solid medium culture is superior to the ginseng cultivated in farmland soil; in terms of plant height and stem diameter, the ginseng cultivated in nutritive medium is also superior to the ginseng cultivated in farmland soil. Therefore, the medium culture for ginseng is feasible, and it can reduce consumption of farmland soil nutrients and improve soil utilization rate.

3.5 Economic benefit of the ginseng cultivated in different media and farmland soil The medium culture for ginseng can obviously increase yield. Studies have reported that the nutrient solution Feiyang is applied to ginseng twice in the whole growth period, and the input-output ratio 1:90 yuan[18]. At present, the ginseng cultivated in farmland soil needs soil disinfectant, ginseng shed material, seeds and labor, and the input-output ratio is 1: 2, while the input-output ratio of solid medium culture for ginseng is 1:19.9. Therefore, the medium culture is a quick, non-polluting and non-toxic cultivation method, with high value for promotion.

Table 1 Comparison of different media culture and cultivation in farmland

Cultivation mode	Plant height cm	Root weight g	Stem diameter cm
Solid medium culture	20.150	5.594	0.560
Nutritive medium culture[18]	33.000	–	0.700
Cultivation in farmland soil[19]	13.960	3.400	0.343

Table 2 Economic benefit of the ginseng cultivated in different media and farmland soil

Cultivation mode	Input yuan/m^2	Output yuan/m^2	Input-output ratio
Solid medium culture	27.45	548.667	1:19.90
Nutritive medium culture	19.00	1710.000	1:90.00
Cultivation in farmland soil	49.91	100.310	1:2.01

4 Conclusions and discussions

Based on the present situation and problems concerning ginseng cultivation as well as soilless cultivation features, we analyze the growth indicators and input-output ratio of different ginseng cultivation patterns, and conform that the soilless cultivation technology for organic ginseng is feasible. And this technology provides theoretical basis and technological feasibility for the sustainable development of ginseng industry. In fact, the soilless cultivation of ginseng is an effective strategy for the ginseng development, and it can make the ginseng products reach the level of organic food. The cultivation of ginseng in each country starts from deforestation for planting ginseng, but with increasing consumers' demands on agricultural products, people are finally forced to study soilless culti-

vation of ginseng. In the 1940s, due to forest shortage, South Korea and Japan were forced to embark on the road of soilless cultivation of ginseng. After 20 years of efforts, the supporting technologies for soilless cultivation of ginseng have been improved, and the previous studies have confirmed that the soilless cultivation technology of organic ginseng is feasible. Therefore, it is necessary to discard the practice of deforestation for planting ginseng as soon as possible, and promote soilless cultivation technology of organic ginseng.

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to different levels. It is found that the original driving force of farmers' decision-making is need, and there is sufficient rationality when farmers make decisions. At different stages, the pursuit is different, and such difference reflects that farmers are in dynamic rationality, and change decisions according to the external environment and their own needs. Problems involving farmers loom large such as agricultural quality and safety problems, pollution problems in rural areas, rural left-behind children and the elderly problems and rural education problems. To solve the problems related to rural areas, it is necessary to fully tap the influence mechanism of farmers' rationality. Meeting farmers' food and clothing is the most basic problem to maintain social stability and promote social development. Only after the problem of food and clothing is solved can farmers live a well-off life. Agriculture is impossible to achieve leapfrog development, and farmers can not achieve development irrespective of food and clothing problems. Steady progress is a real demand, and a road of scientific development.

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