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Effect of Compost Application Level on Seedling Growth of *Panax ginseng* C. A. Meyer

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ABSTRACT : Good quality seedlings produced in the seedbed of Yangjik, traditional seedling cultivation, is one of the most important factors in determining the yield and quality of 4~6-year-old ginseng. This study was carried out to substitute Yacto, traditional organic fertilizer, for economical compost in the cultivation of seedling by fertilizing relatively little amount of compost into seedbed soil. Bulk density and solid phase were decreased in physical properties of seedbed soil, while air phase and porosity were increased by more addition of compost. When the amount of applied compost in seedbed soil was above 8 ℓ per Kan, the contents of nutrient were exceeded the range of optimal standard for ginseng cultivation. Chlorophyll content and stem length were increased by more addition of compost, while the length and the width of leaves showed the highest value at the application level of 8 ℓ per Kan. Heat injury was also increased distinctly above the application level of 8 ℓ per Kan. The number of first grade seedlings and usable seedlings, and fresh root weight per plant showed the peak at application level of 8 ℓ per Kan, respectively. Fertilizing the compost of 8 ℓ per Kan into seedbed soil was the optimal amount for producing the good quality seedlings.

Key words : *Panax ginseng*, seedbed, compost, greenhouse, quantum, air temperature, seedling, growth characteristics, yield

INTRODUCTION

Transplanting the good quality seedlings is one of the most important factors that have an effect on the yield and the quality of 4~6-year-old ginseng. Standard size of seedling is above 15 ㎝, and about 1.0 g in root length and weight, respectively. And it also must not be infected with disease such as root rot and red-colored root. When the standardized seedlings were transplanted to the field, it was possible to harvest the desirable shape of ginseng that resemble human body, and to raise their productivity owing to the decrease of missing plant (Lee *et al.*, 1984). Good quality seedlings were traditionally cultivated in the seedbed of Yangjik mixed by the ratio of 3 to 1 in disease-free sandy loam and Yacto (leaf mold), respectively. But Yangjik cultivation has a several defect that it needs Yacto of 70~80 ℓ per Kan (0.9 m wide × 1.8 m length × 0.2 m deep). In addition, it is difficult not only to collect a lot of broadleaf, but also it takes three years to make the collected leaves into optimal fertilizer. Though Yangjik cultivation can produce the good quality seedlings, its cost is high because of labouring to make Yacto and special seedbed. Moreover, the facilities of shading also are built every year in non-cultivated field to prevent the infection of disease. Lee *et al.* (2002) had tried out the experiment of their cultivation in greenhouse to save its cost by cultivating them repeatedly, but the growth of seedings was poor because transmitted light was decreased inadequately by the fixed covering of fourfold black PE net on the surface of greenhouse. And in the study of Lee *et al.* (2003) for substituting Yacto to commercial compost, seedling production was also very poor because the excessive application of compost caused to the physiological disorder of seedling by exceeded nutrition. Therefore the object of this study was to examine the possibility of seedling cultivation in greenhouse by using cheap compost in oder to substitute Yacto and to save the labour that must build shading facilities every year.

MATERIALS AND METHODS

This experiment was practiced from November 2004 to November 2005 at National Institute of Crop Science, Suwon. Seedbed soil was made of disease-free sandy loam with 20% peatmoss, and it was put into the case of 0.9 m wide × 1.8 m long × 0.2 m deep, and space between ridges were 0.9 m. Commercial compost was fertilized into seedbed soil at the level of 4, 8, 12, and 16 ℓ per Kan (0.9 × 1.8 × 0.2 m). This compost was made of 30% bark, 20% sawdust, 30% expeller cake, and 20% domestic fowl's excrement, and these chemical properties were described in Table 1.

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Table 1. Chemical properties of compost used in this experiment

OM	T-N	T-P	K_2O	CaO	MgO
%					
43.5	1.56	1.20	0.93	3.43	0.52

Variety used in this study was cv. Jakyeongjong, a Korean conventional ginseng variety. Planting density was 3.3 × 3.3 ㎝, and stratified seeds of 1,458 ea per Kan were sowed on November 20th, 2004. Plot size was 3.3 m^2, and arrayed by randomized block design with 3 replications.

In order to control light transmittance ratio and air temperature the blue PE net of twofold was covered on the vinyl surface of greenhouse with the size of 4.5 m high × 14 m wide × 22 m long. And horizontal aluminum curtain with 70% shading rate shaded at its inside. Everyday inner aluminum curtain was opened from 5:00 to 10:30 a.m., and then closed from 10:30 a.m. to 19:00 p.m. by automatic controller. Ventilating opening of 50 ㎝ wide was installed in the ceiling of greenhouse to make air temperature lower. Transmitted quantum and air temperature measured with Datalogger (Li-1400, Licor, USA) at greenhouse showed as in Fig. 1.

The content of organic matter and available P_2O_5 were measured by Tyurin and Lancaster method, respectively. Exchangeable cation were analyzed with ICP after extraction with 1 N NH_4OAc (pH 7.0). And NO_3 were analyzed with Auto-analyzer after extraction with 2 M KCl. Growth characteristics of above-ground and underground part of the seedlings were investigated on September 1 and November 10, respectively. Heat injury ratio of leaves was measured by the percentage of injured plant to normal plant. Seedlings harvested were classified as first, second, and offgrade on the basis of root weight and root length per plant; the first grade was above 0.89 g and 15 ㎝, and second grade was above 0.60 g and 10 ㎝. The number of usable seedling was calculated by the summation of the first and second grade.

RESULT AND DISCUSSION

Change of physical and chemical properties by compost application level in seedbed soil

The changes of physical and chemical properties by application level in seedbed soil were followed as in Table 2, when the commercial compost of 4~16 ℓ per Kan was added to

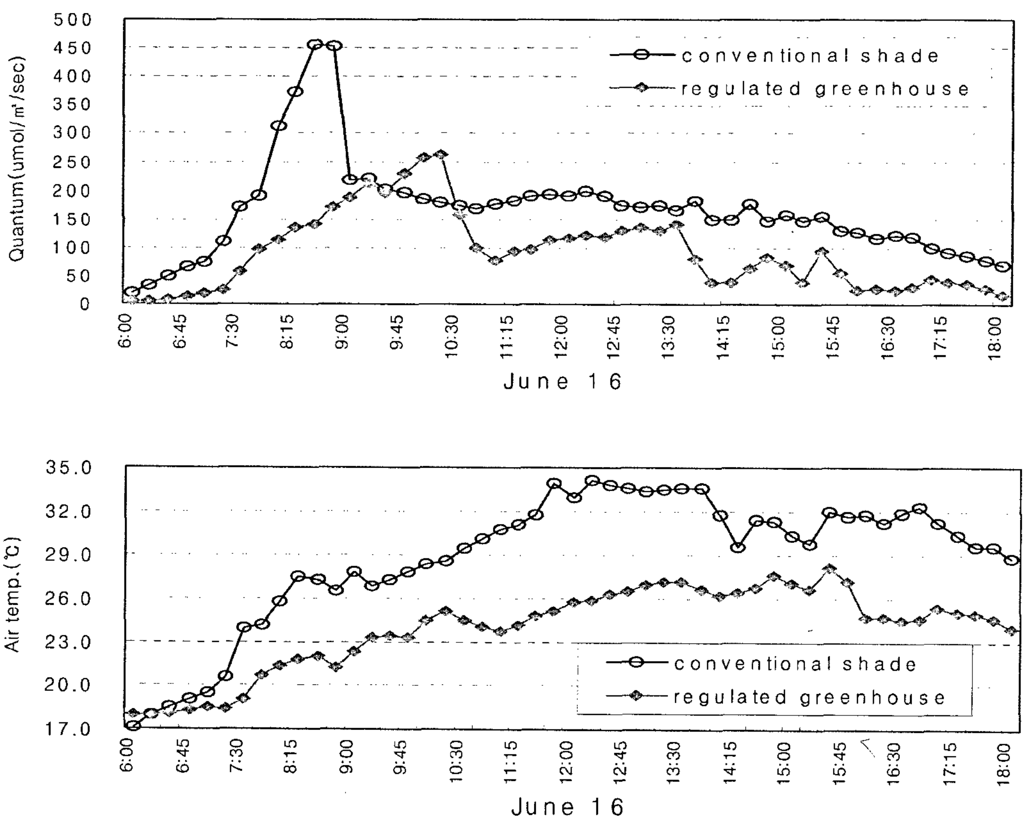

Fig 1. Changes of transmitted quantum and air temperature during daytime on June 16 between the regulated greenhouse and the conventional shade of Type 1.

Table 2. Soil physical properties by compost application level in seedbed soil before sowing

Application level	Bulk density	Solid phase	Air phase	Liquid phase	Porosity
(ℓ / Kan[†])	(g/㎤)	%			
4	1.075	40.6	46.9	12.5	59.4
8	1.062	40.1	46.4	13.6	59.9
12	1.038	39.2	47.3	13.5	60.8
16	1.025	38.7	48.4	12.9	61.3

[†]Kan : 0.9 m wide × 1.8 m length × 0.2 m deep

Table 3. Soil chemical properties by compost application level in seedbed before sowing

Application level (ℓ / Kan[†])	pH (1 : 5)	OM (g/kg)	Av. P_2O_5 (mg/kg)	Ex.Cation(cmol[+]/kg)				EC (dS/m)
				K	Ca	Mg	Na	
4	4.9	13.4	54	0.35	2.03	0.92	0.16	0.37
8	5.0	15.5	92	0.48	2.40	1.06	0.20	0.47
12	5.1	18.3	127	0.57	2.68	1.08	0.23	0.49
16	5.1	19.1	137	0.64	2.77	1.11	0.24	0.52

[†]Kan : 0.9 m wide × 1.8 m length × 0.2 m deep

Table 4. Growth characteristics of above-ground part of ginseng seedling by compost application level

Application level	Chlorophyll con.				Stem length	Leaf length	Leaf width	SLW[‡] (㎎/	Heat injury ratio
	a	b	a/b	Total					
(ℓ / Kan[†])	㎎/g				㎝			(㎠)	(%)
4	1.34c	0.51a	2.64a	1.85c	8.29a	3.96a	1.86a	3.26a	6b
8	1.45ab	0.54a	2.67a	1.99ab	9.30a	4.36a	2.07a	3.06b	6b
12	1.48a	0.55a	2.69a	2.03a	9.63a	4.20a	2.01a	3.07b	15a
16	1.52a	0.57a	2.68a	2.08a	9.60a	4.07a	1.99a	3.05b	16a

*Mean with same letters are not significantly different in DMRT ($p = 0.05$)
[†]Kan : 0.9 m wide × 1.8 m length × 0.2 m deep
[‡]SLW: specific leaf weight, Investigation date: August 30

seedbed soil mixed by the rate of 80% disease-free sandy loam and 20% peatmoss. In its physical properties bulk density and solid phase were decreased, while air phase and porosity except liquid phase were increased by its increased level. When the physical properties in the above results were compared with that of Lee *et al.* (1985), the liquid phase values from our study was quite low in comparison with 20.1 ± 6.1% investigated in 32 farmer's fields of Yangjik cultivation, expecting that low water content showed the negative effect on seedling growth. But air and solid phase, and porosity were similar to that of 32 farmer's fields. Optimal soil moisture content had a distinct effect on the increase of root weight (Nam *et al.*, 1980; Park *et al.*, 1982), and it was more important than light transmittance rate in ginseng seedling (Lee *et al.*, 1984). And root weight showed positive correlation with air phase and porosity (Lee *et al.*, 1995). It is important to control the soil moisture properly for preventing a physical disorder in greenhouse condition.

The contents of organic matter, inorganic nutrient, and electronic conductivity (EC) in its chemical properties were increased by increased application level (Table 3). Potassium exceeded an optimum contents (RDA, 2000) when application level was above 8 ℓ per Kan. And the content of EC exceeded its standard when it was above 12 ℓ per Kan.

Growth characteristics and yield of seedling by compost application level

Chlorophyll content and stem length were gradually increased up to the application level of 16 ℓ per Kan, but the length and the width of leaves were maximized at the application level of 8 ℓ per Kan (Table 4). Specific leaf weight showed the highest value at the application level of 4 ℓ per Kan, and there was no significant difference among the application levels of 8~16 ℓ per Kan. Heat injury that caused

Table 5. Growth characteristics and yield of underground part of ginseng seedling by compost application level

Application level	Total root wt.	Root wt. per plant	Root length	No. of survived plant	No. of first grade seedling	No. of second grade seedling	No. of usable seedling
(ℓ /Kan†)	(g/3.3 m²)	(g)	(cm)	ea/3.3 m²			
4	654a	0.54a	19.2a	1,201a	89c	449a	538b
8	948a	0.73a	18.1a	1,293a	473a	492a	965a
12	828a	0.66a	18.1a	1,255a	302b	546a	848a
16	722a	0.60a	17.5a	1,196a	204b	482a	686b

* Mean with same letters are not significantly different in DMRT ($p = 0.05$)
†Kan : 0.9 m wide × 1.8 m length × 0.2 m deep, Investigation date: November 10

leaves to wither was gradually increased by increased compost levels more than 8 ℓ per Kan. It was reasonable to suppose that heat injury was increased in this experiment because of the increase of inorganic nutrient in condition of low soil moisture content as showed in Table 2 and 3. Mok (1996) reported that heat injury of 2-year-old ginseng was increased when soil water wasn't absorbed into ginseng root properly by the malfunction of root hair on condition that EC was above 0.5 dS/m and soil moisture content was low.

The number of survived plant per 3.3 m² and root weight per plant showed the peak at the application level of 8 ℓ per Kan (Table 5). Root length of seedling was decreased by increased compost level. The first grade of seedling, and the usable seedling showed the greatest number at application level of 8 ℓ per Kan. When the usable seedling of 965 ea per 3.3 m² at the application level of 8 ℓ per Kan were compared with 627 ± 187 ea investigated at 32 farmer's field of Yangjik cultivation (Lee *et al.*, 1985), it was possible to produce the usable seedling as much as Yangjik cultivation by using commercial compost of 8 ℓ per Kan without using Yacto. It was necessary that relatively little amount of compost as 8 ℓ per Kan should be added into seedbed soil in order to prevent the physiological disorder of seedling induced by exceeded nutrient.

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