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Effect of Seeding Depth and of Soil Texture on Seedling Emergence and Root Shape of American Ginseng

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Abstract : Stratified American ginseng(*Panax quinquefolium* L.) seeds were planted in a shaded greenhouse at four depths and in four different soil types to observe effects on emergence rate and root size. Seeding depth affected seedling emergence rates and the number of days required to complete emergence. The shape of the roots was affected by the texture of soil, especially percentage of sand.

Key words : *Panax quinquefolium* L.

Introduction

In Canada, plantations of American ginseng (*Panax quinquefolium* L.) have expanded rapidly in the last few years and Canada has become one of the major production regions in the world.[1,6] In British Columbia, with a suitable climate and cultural environment, ginseng rowers produce high yield with excellent quality. It is one of the major specialty crops of the agricultural industry with farm gate value of $50 million dollars in 1996.

Many factors affect seedling emergence. Besides soil and environmental conditions, seeding depth plays a major role. Limited information is available in the literature regrading the effect of seeding depth on seedling emergence. Liu[3] reported that Asian ginseng(*P. ginseng* C.A. Meyer) seeded at a depth of 5 cm had a 22% higher emergence rate than at depths of 3.3 and 6.6 cm. In North America, it is recommended that ginseng is seeded at depth of 1.3 to 2.5 cm.[5]

North American ginseng needs four years of cultivation before harvesting. Well drained, sandly loam soil ideal for growing ginseng.[1] Heavy soil contains a higher level of moisture which will increase the incidence of soil-borne disease[2] and roots will be short and chubby.[3] Roots grown in light or sandy soil will be elongated with many small branches or root hairs, so called "cows' tail", which have low market values.[7]

The purpose of the present project was to study the effects of seeding depth on seedling emergence and of soil texture and soil amendment on the size or shape of ginseng roots.

Materials and Methods

Ginseng seeds were randomly collected in early September from 4-yr-old plants in a commercial ginseng garden. Newly picked seeds were depulped, cleaned and soaked in formaldehyde (1%) for 20 minutes. For stratification, seeds were mixed with sand(1:1, v/v) and placed in a wooden box with 10~15 cm clean sand at the bottom of the box for good drainage. Seed boxes were enclosed in a wooden frame with top and bottom screened to allow moisture and air to move freely and keep out rodents. This wooden frame was buried to ground level, with a straw mulch over the top to stop surface evaporation. In the following September, seeds were separat-

ed from the sand ready for planting. All the data generated from the experiments were subjected to analysis of variance using the SAA GLM procedure and Duncan's New Multiple Range Test was applied to compare differences among treatments.

Stratified American ginseng seeds were seeded in plastic pots(15 cm diam.) filled with potting soil(sandy loam; organic jmatter : 3.6%; pH : 7.2, N : 37 ppm; P : 21 ppm; K : 139 ppm; Mg : 242 ppm; Ca : 1162 ppm; S : 44 ppm; B : 3.3 ppm; Cu : 1.0 ppm; Fe : 13.3 ppm; Mn : 4.0 ppm and Zn : 20 ppm), at depths of 1.25, 2.5, 5.0 or 7.5 cm. There were 20 seeds per pot, and 10 pots per treatment. Pots were placed in a shaded greenhouse (20~22℃) for germination. The numbers of seedlings emerged were counted every other day and emergence rates and the number of days required for complete seed emergence were recorded. Seedlings were grown in shaded(78% with woven synthetic fabrics) greenhouse for 20 weeks before individual root size was measured.

Soil samples were collected from three major ginseng growing regions, Kamloops, Vernon and Summerland, of British Columbia. Soil from each location was mixed and sieved separately to remove gravel. The particle size of each sample was determined by Griffin Laboratory of Kelowna, British Columbia, A total of six soil samples was categorized into sandy loam, silt loam, silty loam, silty clay loam or loamy sand, using the Canadian System of Soil Classificantion.[4]

Stratified American ginseng seeds were germinated in flats filled with perlite in a shaded greenhouse(20~22℃). Ten plastic pots(20 cm diam., 25 cm deep) were filled with each soil sample. Newly emerged seedlings were transplanted, and there were 20 seedlings per pot. The plants were grown ina shaded greenhouse for two growing seasons with overwinter dormancy in cool storage(1~2℃) for 12 weeks. The two-year-old roots were washed and evaluated. Fresh root weight, length, and width were recorded. Correlation coefficients were calculated between root length and percentage of sand, silt and clay in the soil.

One of the soil samples, a silty clay loam(6.0% sand, 56% silt, and 38% clay), was further studied in a soil amendment experiment. Twenty-five and 50% (v/v) of sand(medium size, 0.25~0.45 mm, according to the standard set up by Canada Soil Survey Committee) were added before seedlings were transplanted. These plants were grown in a shaded greenhouse for two years as described in Experiment 2.

Results

The seeding depth of 1.25 cm had significantly higher emergence rates than the other three seeding depths(Table 1). The depth of 1.25 cm needed significantly fewer days(55) to complete seedling emergence compared with the other seeding depths. Seeding at the depth of 7.5 cm had the lowest emergence rate and needed longest time to complete germination. Roots from the seeding depths of 1.25, 2.5 and 5.0 cm showed significantly heavier fresh weights than from 7.5 cm deep planting.

There was difference in the length and width of roots from different soil types(Table 2). Roots from sandy loam soil were significantly longer than any other types of soil. Silt loam soil produced wider roots than the roots grown in silty clay loam and sandy loam. Statistically, there was significant positive correlation(r^2=0.86)

Table 1. Effects of seeding depth on seedling emergence rate, total number of days required to complete emergence and root fresh weight

Seeding depth (cm)	Seedling emergence rate (%)	Ave. # of days required to complete emergence	Ave. root fresh wt. (g)
1.25	64.0a*	55.0c	0.75a
2.50	53.0b	60.7b	0.78a
5.00	52.5b	62.8b	0.69a
7.50	25.5c	74.3a	0.55b

* Value in each column with a common letter are not significantly different(p=0.05) according to Duncan's New Multiple Range Test.

Table 2. Soil texture and its effects on the growth of ginseng roots

Soil sample	% of soil particle size			Root size (mm)	
	sand	silt	clay	length	width
Sandy loam 1	66.0	29.5	4.5	84.9*	5.8bc
Sandy loam 2	69.5	26.0	4.5	85.6a	5.8bc
Silty clay loam	6.6	56.0	38.0	52.8d	5.6c
Loamy sand	83.0	14.5	2.5	60.8cd	6.5ab
Silt loam 1	43.5	51.0	5.5	60.8cd	6.5ab
Silt loam 2	20.5	70.5	9.0	70.8cd	6.9a

* Value in each column with a common letter are not significantly different(p=0.05) according to Duncan's New Multiple Range Test.

Table 3. Effects of soil amendements in clay soil on the size of ginseng roots

Treatment	Root length(mm)	Root width(mm)
Non-treated control	53.0b*	5.5b
25% sand mixed	60.3a	5.8b
50% sand mixed	62.8a	7.2a

* Value in each column with a common letter are not significantly different(p=0.05) according to Duncan's New Multiple Range Test.

between percentage of sand in the soil and the length of the roots, and negative correlation between silt and clay contents in the soil and the length of the roots(r^2=-0.73 and -0.78, respectively).

Silty clay loam soil(6.56 and 38% sand, silt and clay respectively) mixed with 25% and 50% sand produced significantly longer roots than non-treated control(Table 3). Average root width was significantly increased when 50% sand was added compared with 25% sand amendment and control.

Discussion

Oliver[5] reported, in his production guide, that American ginseng seeds can be sown on the soil surface or up to 2.5 cm deep. Liu[3] indicated, without statistical analysis, that Asian ginseng seeded at a depth of 5 cm gave a 22% higher emergence rate than at depths 3.3 and 6.6 cm. The results from our experiments indicated that seeding depth of 1.25 cm had significantly higher emergence rate than 2.5, 5.0 and 7.5 cm and fewer number of days needed to complete germination. This is important since fewer days needed to complete germination will give more uniform seedlings and this well have long term effects on root size and yield.

The positive correlation between sand content and root length(r^2=0.86) indicated that soil type has a significant effect on the shape of roots. In this experiment, silty clay loam with 6% sand produced the shortest(52.8 mm) roots and sandy loam(69.5% sand) produced longest(85.6 mm) roots. As shown in Table 2, there was difference in the length and width of roots grown in the different soils especially between silty clay loam and silt loam. These observations confirmed the results reported by Liu[3] and Xiao.[7]

Silty clay loam soil has only 6% sand content (Table 2). After amendment with sand(25% and 50%), the average root length and width increased significantly(Table 3), confirming the observations of the previous experiment. In other words, shape of the ginseng roots, legth and width, are affected by the type of soil, specifically, the percentage of sand in the soil.

These pot experiments in a shaded greenhouse over more than two years clearly demonstrated that seeding depth has a significant influence on the emergence rate and number of days required to complete germination. It was also demonstrated that the shape of the roots is affected by the texture of soil, specifically, percentage of sand in the soil.

References

1. Li, T. S. C. : *HorTechnology* **5**, 27 (1995).
2. Li, T. S. C. and R. Utkhede, *Current Topics in Bot. Res.* **1**, 101 (1993).
3. Liu, C. N. (ed.) Cultural methods of ginseng. Wu-Chou, Taiwan. 428 p. (1988).
4. McKeague, J. A. (ed.) The Canadian system of soil classification. Canada Dept. of Agriculture Publication 1646, 164p. (1978).
5. Oliver, A. (ed.) Ginseng production guide for commercial growers. British Columbia Min-

istry of Agriculture Fisheries and Food. 193p (1996).
6. Proctor, J. T. A and W. G. Bailey : *Hort. Rev* **9**, 187 (1987).
7. Xiao, P. G., Z. Y. Zhu, F. Q. Zhang, W. H. Zhu, J. T. Chen, G. D. Zhang and G. T. Liu. eds. Ginseng research and cultivation. Agri. Publ. House, Beijing, China. 252p (1987).