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Survey Papar

Production of Ginseng (*Panax ginseng*) in Nagano Prefecture, Japan

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Abstract

Ginseng grows natively as understorey plants in mountaineous woodland of East Asia. Now it is being cultivated in only specific areas. In Japan, 80% of the total product comes from Nagano Prefecture. For cultivation, Ginseng seeds are harvested in July to August and stratificated in cold, moisted river sand at 2-5 months long. Soaking the seed in GA_3 100 ppm for 24 hr before stratification is also carried out to shorten the stratificating duration. Treated seeds will be sowed into planting beds in November or March. A lot of compost is applied to the soil to improve soil physical properties, drainage and also nutrient supply. Ginseng house is constructed over the planting bed to regulate light intensity, to protect the plants from wind and direct rainfall. Pests and soil moisture content suppose to be the main factors influencing yield potential and yield quality.

Plants are harvested at 6 years of age. Roots are processed through different procedures into Red Ginseng, White Ginseng, Normal Dry or Others, by which Red Ginseng is claimed to be the superior quality and is the main product exported from Japan to Hongkong, Taiwan, West Germany and England.

1. Introduction

Among the crops sofar cultivated throughout the global, Ginseng is one of the very few crops, which has the very high market value. Its export price from producing area arised to 11,000 Yen/600 g dry weight in the year 1989 and tends to increase year after year due to the big demand in the worldwide market. This crop is however one of the most difficult to cultivated crops. It needs a particular environmental conditions and the special crop management procedure. In many cases, crop management technologies are kept very secret among the family. Informations about the cultivating procedures are therefore very lacking.

To investigate and compile the conventional management technology for Ginseng in Japan, the study trip to Nagano Prefecture had been made during 9-12 September 1990 to visit the main Ginseng producing estates. All informations writen in this report are therefore relied on the data, results of the research works and the cultivation technologies founding during this excursion.

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2. Economic importance of Ginseng

Ginseng production and consumption in Japan bring about the economic importance in two-way system. Whereas some of the high quality products are exported to the world market, large amount of Ginseng have been imported supplemently for the domestic consumption.

In Table 1 are the amount and values of Ginseng exported from Japan to various countries in the year 1960. In this year, Japan exported Ginseng in the types of Red-, White Ginseng and Other with the total amount of 136,265 kg and total value of 3,573 million Yen. The main markets are Taiwan, Hongkong, Singapore, West Germany and England.

For the domestic consumption, Japan imported Ginseng mainly from Korea (N & S), China, Taiwan, Hongkong and USSR in the form of products: Red Ginseng, White Ginseng and Other. The total amount of imports in the year 1960 was 420,654 kg and in the value of 5,366 million Yen (Table 2).

It must be noted that the annual consumption of Ginseng in Japan in the year 1960 was much higher than 420, 654 kg, since the non-exported, low quality products harvested in Japan were also used for domestic consumption. Due to the health booming in the late years, demand of Ginseng in Japan has been drastically increased. In the year 1989, much smaller amount of Japan produced Ginseng was being exported, whereas larger amount must be imported.

Table 1. Amount and value of Ginseng exported from Japan to different countries in year 1960 (Osumi, 1971)

Countries	Red Ginseng	White Ginseng	Other
Taiwan	58	—	—
Hongkong	114,946	9,935	5,392
Singapore	120	600	2,802
West Germany	100	—	—
Great Britain	—	900	—
Other	153	—	1,260
Total amount (kg)	115,376	11,435	9,454
Total value (million Yen)	3,194	244	135

Table 2. Amount and value of Ginseng imported to Japan in the year 1960 (Osumi, 1971)

Countries	Red Ginseng	White Ginseng	Other
Korea (South)	—	170,600	3,750
Korea (North)	6,720	427	—
China	145,532	31,281	55,341
Taiwan	—	—	—
Hongkong	6,200	—	—
USSR	—	—	1
Other	—	802	—
Total amount (kg)	158,452	203,110	59,092
Total value (million Yen)	2,088	2,581	697

3. Taxonomical characteristics

Ginseng is a fleshy rooted herbaceous perennial plant of the genus Panax, family Araliaceae, indigenous to Eastern Asia and North America. The three medicinally utilized species are *Panax ginseng* C.A. Meyer (East Asia), *P. quinquefolium* L. (North America) and *P. pseudoginseng* (Himalaya Mountains, northern India and Thailand).

In its wild state the true Ginseng (*P. ginseng*) grows from 30 to 60 cm high, bearing three or more palmate compound leaves in three years, each consisting of five ovate leaflets, pointed at apex and narrowed at the base. A cluster, which contains of 4 to 40 small pale yellow-green flowers, is produced in summer, followed with many bright crimson berries, each containing one to two flattish wrinkled seed 5-6 mm long and 4-5 mm wide (Fig. 1). The seedlings may be expected to bear seeds in the third year, but it usually takes at least six years for the root to reach the marketable size.

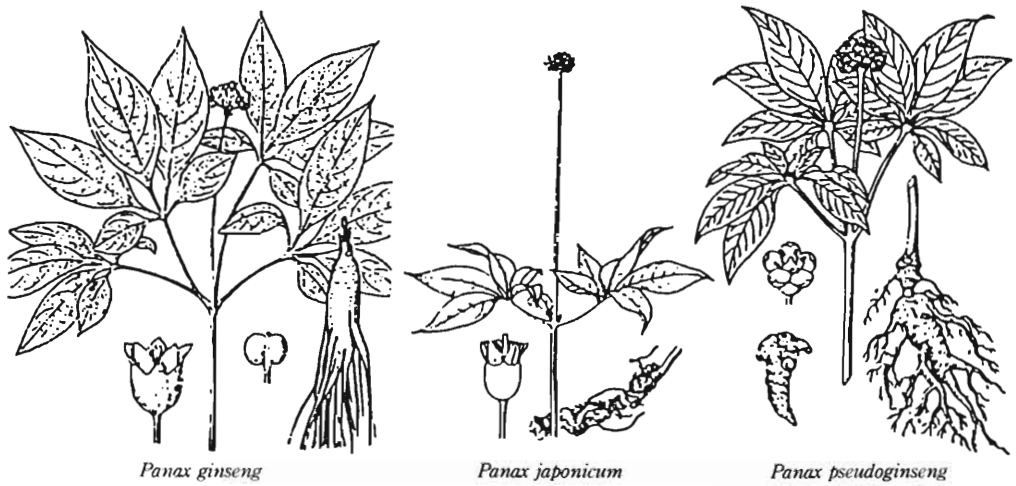

Fig. 1. Morphology of *Panax* different species

4. Distribution and main producing areas of the true Ginseng

The original habitats of (the true) Ginseng are mountainous areas of north-eastern China, Ussurisk in USSR and of Korea. The Ginseng has long been cultivated in China and Korea and since 1716 has been cultivated in Japan as an expensive medicinal plant. In Japan, the plants are produced mainly in Nagano (about 80% of total production), Hukushima and Shimane Prefectures. The research for cultivation of the Ginseng has been also made in the Maritime Province of Siberia in USSR recently (Fig. 2).

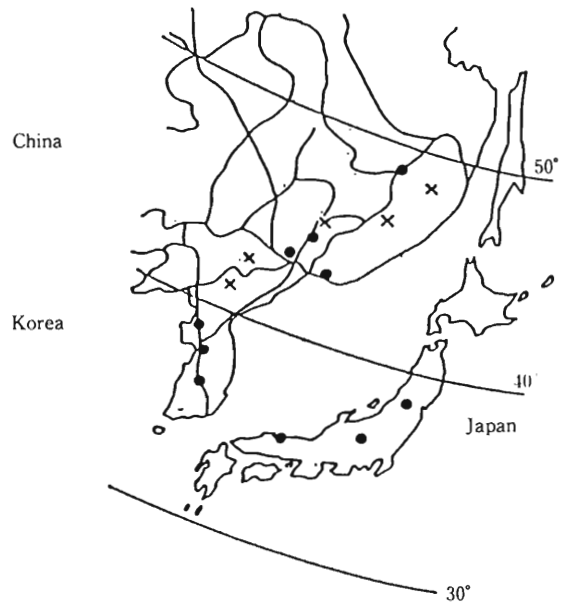

Fig. 2. Original and cultivating areas of *Panax ginseng* (× =natural grown, ● =cultivation)

5. Environmental Requirement

Natively, Ginseng grows as understorey plants in temperate woodland of Eastern Asia. Due to its specific requirement of environmental conditions, the natural distribution is occured in only particular areas, and a successful cultivation can sofar be carried out in small parts of the world. This makes Ginseng a long lasting expensive crude drug of the global.

The environmental requirements of Ginseng can be concluded according to Mr. Miyazawa (1990) as follows:

5.1 Light intensity

Ginseng needs a relative low light intensity like its original habitat. According to the long experience in growing Ginseng, an optimum light intensity should be at 4,000 lux. Increase of irradiance upto 30,000-40,000 lux would caused a strongly leaf necrosis and sun burn, whereas the low light intensity of 1,000 lux was too low for the optimum growth rate.

5.2 Air temperature

Ginseng needs an optimum air temperature of 25-28℃. Plants shows a relative high capability for cold-resistance. A high air temperature over 35℃ already damages the plants.

5.3 Air humidity

The average air humidity of 40% is optimum for the plant growth. The lower humidity tends to be more advantage than the higher, since the high air humidity together with the high temperature usually cause a severe problems of pest and disease.

5.4 Soil condition

Volcanic and loamy soil are suitable for the plant development. In especially, the loamy soil is the best soil condition, due to its good drainage and appropiate moisture content. The light

and perforate soil particles allows the good penetration and expanding of roots during the development. Moreover, harvesting will also be easily done with a less root damage.

The optimum soil moisture content is 60% AWP and soil pH of 5~5.5. Ginseng plants grow on the soil with lower pH value (4) or with the higher value (6.3) produced the unhealthy leaves with the necrotic appearance.

Soil should be very rich in organic matter to offer both the good soil physical properties and the nutritional supply.

In Fig. 3 are the meteological data in term of air temperature, rainfall as well as maximum and minimum temperature recorded at the Nagano Prefecture Vegetable and Flower Experimental Station (Kitamimaki Experimental Station) in Kitamimaki Village. This experimental station is the main institute concerning researchs on Ginseng cultivation of Nagano Prefecture.

6. Production of Ginseng in Nagano Prefecture

6.1 History of Ginseng cultivation in Nagano Prefecture

In Japan, the first successful cultivation of the Ginseng was performed in 1728 in an official medicinal plant garden in Nikko (near-by country of Nagano) by Tokugawa's government but it is said that the cultivation of the plant in Nagano started in 1845, more than a hundred years later. Since then the Ginseng cutivation was spread out drastically and continued as a special product named "Shinshu (Nagano) Medicinal Ginseng" in this prefecture. Some of the documents about the production of Ginseng in Nagano Prefecture is shown in Table 3.

Table 3. Yearly output of Ginseng (dry roots) in Nagano Prefecture

Year	1873	1879	1904	1910	1946	1950	1960	1970	1980	1989
Output (tons)	9.4	83.3	3.7	16.1	24.0	64.0	62.0	195.0	439.0	278.0

6.2 Cultivation of Ginseng

6.2.1 Propagation

Seeds are the only plant part used for propagation in Nagano Prefecture. The full ripening fruits with brilliant red exocarp are harvested in July to August and pulped out the fruit skin to achieve the seeds. Ginseng seeds usually remain their dormancy for a very long duration. A direct sowing of seeds to the planting bed normally take 18 months to germinate. To break this dormancy, farmers in Nagano Prefecture use two different technologies. One with only stratification and another one with GA_3 treatment before stratification. Fresh seeds after fruit skin pulping will be soaked in GA_3 100 ppm for 24 hour and stratificated 2-3 months long before sowing. Without GA_3 treatment fresh seed will be stratificated 8 months long from August to March of the next year.

For the stratification, seeds will be firstly soaked in Benlate solution for 10 minutes and mixed throughly with moisted river sand, put in the double layer ceramic pot and kept under the shade in constant sand moisture, pot should be covered with rice straw or rice husk and watered intervally by no rain or low air humidity. A research work carried out in Kitamimaki Experimental Station about the effect of stratificating condition on germinating percentage of Ginseng seeds found that, seeds should be kept in two layers pot filled with moisted river sand for 3 months to achieve a germinating percentage upto 96% (Fig. 4).

Normally, GA_3 soaked and stratificated Ginseng seeds would germinate, under suitable atmospheric condition, within 2 weeks after sowing, but in Nagano Prefecture treated seed takes another 5 months, due to cold temperature of winter, to germinate under warmer weather in

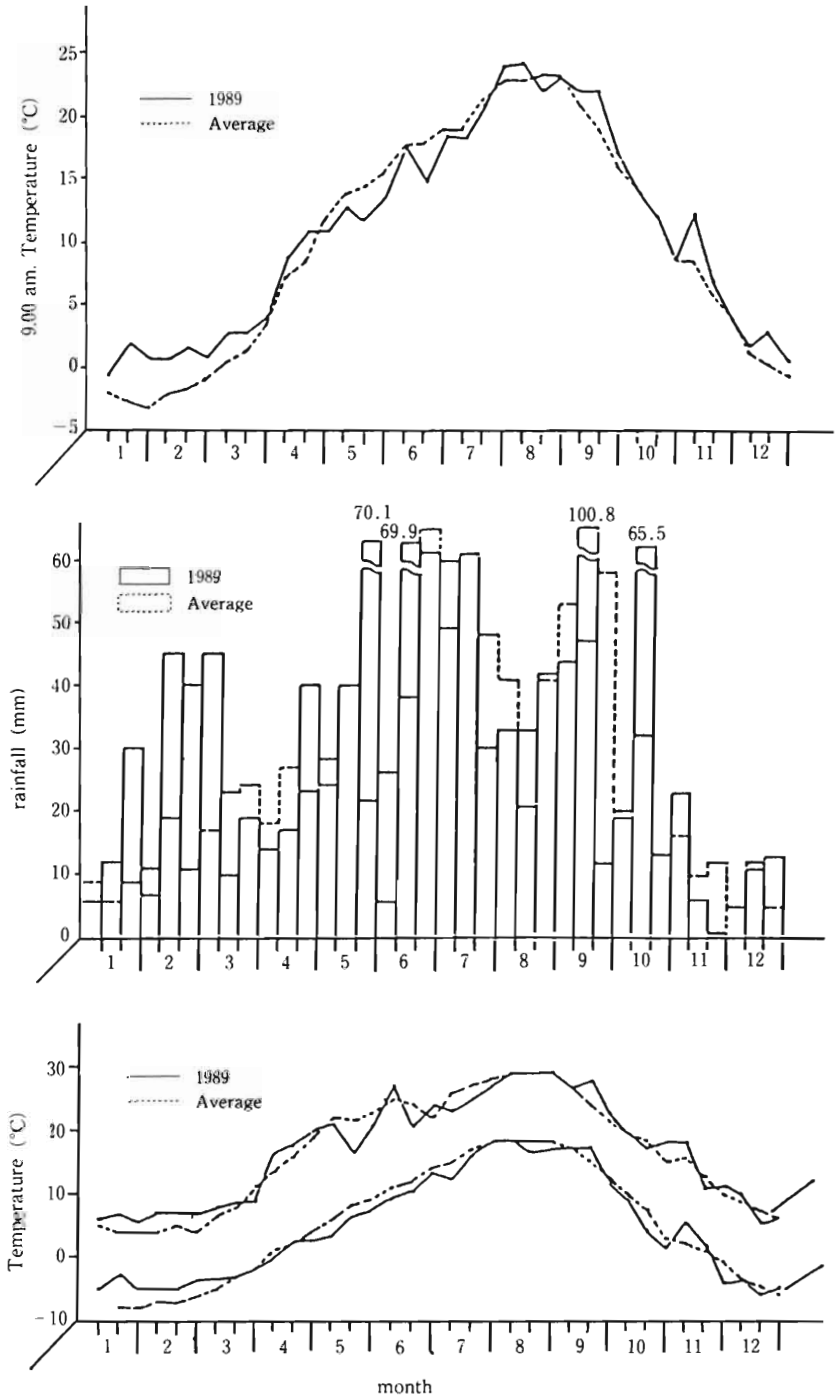

Fig. 3. Meteorological data of the year 1989 and 10 years average at Kitamimaki Experimental Station in Nagano Prefecture

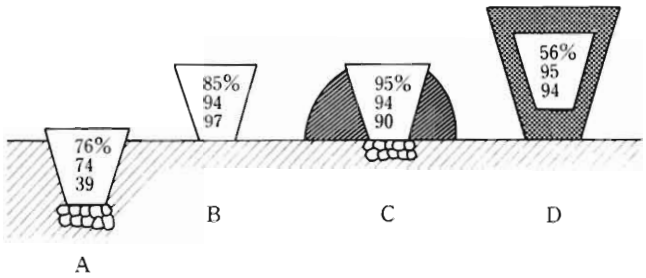

Fig. 4. Effect of stratificating conditions on germinating percentage of Ginseng seeds (Kitamimaki Exp. St., 1989). A=single plot kept underground, B=single plot overground, C=single plot covered with soil, D=two layers pot filled with sand

Spring (April). Seasonal pattern of Ginseng propagation is diagrametiacally showed in Fig. 5.

As shown in Fig. 5. Farmers in Nagano Prefecture used to sow seeds in two periods; in November for the GA_3 treated seeds and in March for non-GA_3 treated seeds. But new seedlings will emerge at the same period under warmer climate of April. From fruit harvesting to emerging of new seedling usually takes 9 months.

6.2.2 Land preparation and seed sowing

Terraces with a small degree of slope are firstly constructed on area with a steep slope to achieve a proper drainage and soil moisture condition. Large amount of green grass, corn or compost upto 6-7 ton/10 acre is mixed to the soil by tillage. In the case of growing Ginseng at the second time on the same plot, smaller amount of compost/green manure will be used but soil treatment with TPN and Chloropicrin 80% is needed to control nematode and the soil-borne diseases.

Planting beds will be constructed at the standard width of 90 cm and height of 20-30 cm. Narrow grooves upto 3 cm deep are then made on the bed cross-wise to the length at about 20 cm spacing. Stratificated seeds with emerging radicle and slightly opening of cotyledon are placed 5-10 seeds/groove and covered with the normal soil and rice husk respectively to maintain the soil moisture.

According to Mr. Miyazawa (1990), land preparation is the most important step for the good success in Ginseng production. The good soil preparation must promote.:

1) a good drainage and aeration
2) an optimum soil pH of 5.0-5.5
3) a good prevention of soil-borne diseases, insects and nematode
4) a constant soil moisture at 60% AWP
5) a slow release of nutrient supply meanwhile with a relative low concentration

6.2.3 Shade regulation and Ginseng house

The optimum light intensity for Ginseng is around 4,000 lux, which is only about 10% of the light intensity of the sunny day in Japan. In practice, each Ginseng bed will be covered with the roofmade of grass (*Miscanthus sinensis*) and rice straw to protect the plants from direct sunlight and rain. Slope of the roof will be adjusted between 35-45° to regulate the optimum light intensity. To protect the plants from wind, a fencing made of grass upto 1.50-2 m height will be constructed around the Ginseng plantation. Details of Ginseng house and fencing are shown diagramatically and figuratively in Fig. 6 and 7.

6.2.4 Importance of soil water content and irrigation

Soil water content is one of the main factors influencing the quality of Ginseng root and disease problem. The optimum available water potential (AWP) of soil should be at 60%. Too high soil moisture not only causes many diseases infection but also a poor root development. Studies at

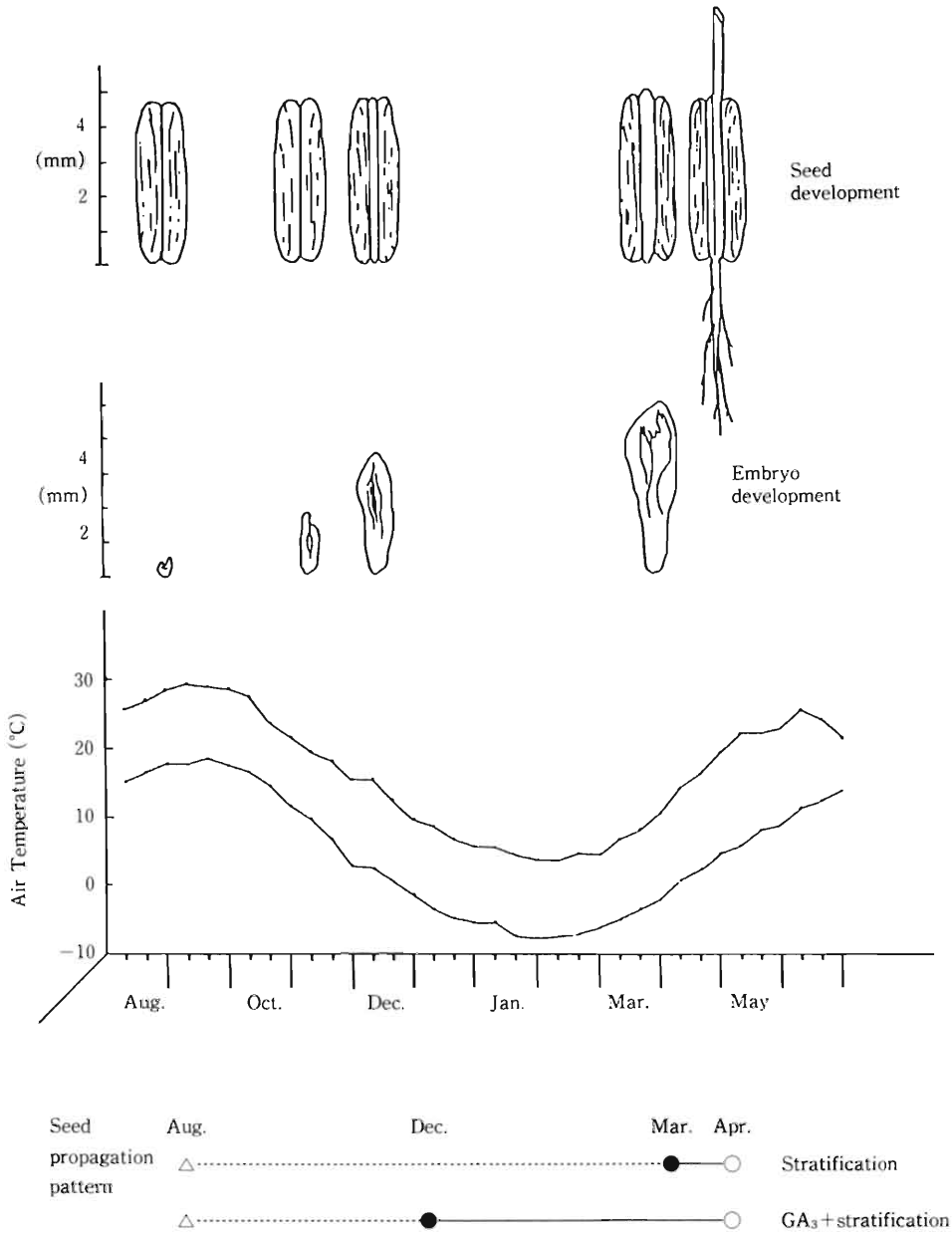

Fig. 5. Temperature change and seasonal pattern of Ginseng seed propagation in Nagano Prefecture and development of GA_3 treated embryo during stratification. (△=harvesting time, ● =sowing, ○ =emerging)

Kitamimaki Expt. St. in many years found that Ginseng plants grown in too high soil moisture content produced a small and short root with many branchings as shown in Fig. 8 and 9.

For controlling of soil water, farmers in Nagano Prefecture do a lot of procedures:

1) povide a good drainage of soil,

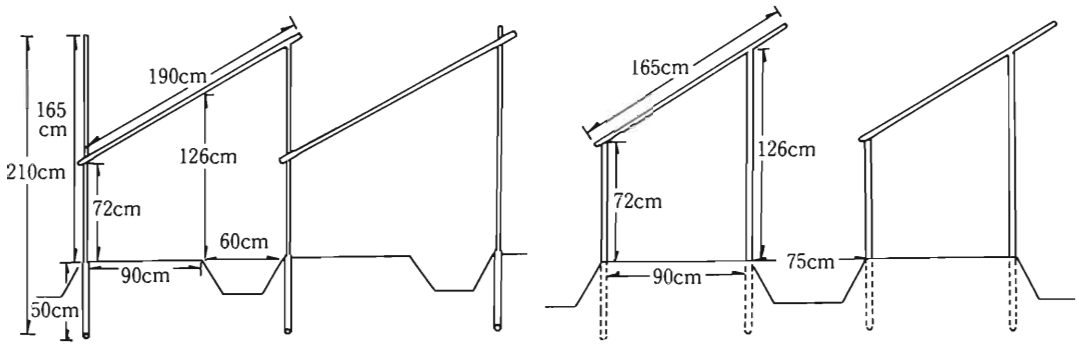

Fig. 6. Diagram of Ginseng house and bed size

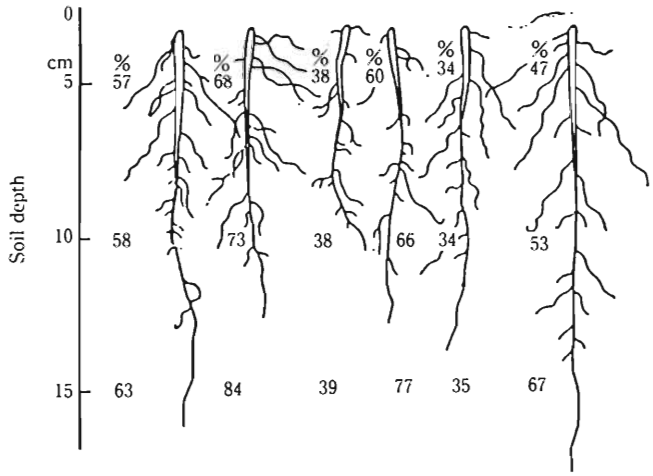

Fig. 8. Development of Ginseng root grown at different soil moisture content (Osumi, 1971; %=soil moisture content)

2) protect the planting bed from direct rain,
3) keep the soil moisture lower at the top soil and higher at the beneath soil,
4) when need, furrow irrigation will be carried out and let the water penetrate through the beneath soil upto the top soil,
5) irrigate the crop only the first and second year.

6.2.5 Nutrient requirement

According to Mr. Miyazawa (1990) Ginseng is the crop which has a very low metabolic and growth rate. It may accumulate a root fresh weight of only 100 g within 6 years. Plants therefore have a very low nutrient requirement compared to the other root crops, eg. chinese radish or carrot. In practice, only compost is given to the soil to provide the plant nutritional supply. Use of chemical fertilizer is very rare, due to a low nutrient requirement of Ginseng and the danger of salt stress by the regular low soil moisture content.

6.2.6 Pest management

Insects, diseases and nematode are the common pests found in the most planting areas in Nagano Prefecture.

Fig. 7. Ginseng house and fencing in Nagano Prefecture

Aphids, thrips, cabbage army worm, mealy bugs and click beetles are found damaging the Ginseng leaves. Weevil (Pyralididae) destroys the plants at its three developmental stages. Adults eat the plant leaf blade whereas the larva bore into the main root, stem and leaf petiole

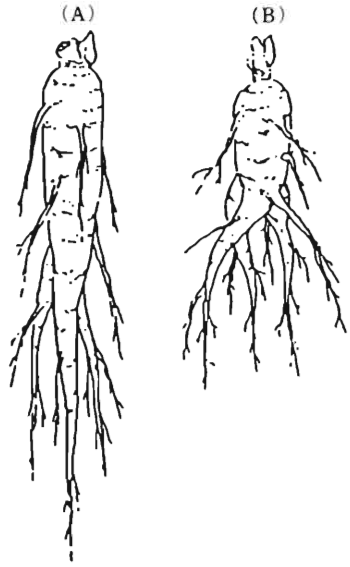

Fig. 9. Appearance of Ginseng root grown under appropiate soil water content and correct irrigation system (A) and under too high soil moisture or sprinkle watering system (B)

and develop into pupa in those plant tissues. EPN (o-Ethyle-o-p-nitrophenylbenzenephosphomethioate) and other chemical insecticides are used to control these insects.

Many soil-borne fungi are found destroying both leaf and root of the plant. The most serious species are:

1) *Alternalia panax* (leaf spot, leaf blight and fruit rot)
2) *Bacillus* sp. (root rot)
3) *Botrytis* sp. (shoot tip and root rot)
4) *Cylindrocarpon destructants* (root rot)
5) *Fusarium* sp. (fusarium wilt)
6) *Rhizoctonia solani* (root rot)
7) *Sclerotinia* sp. (root rot).

6.2.7 Harvesting and Post-harvest management

Harvesting of Ginseng root is normally carried out at the 6 years of age. Harvest season starts from September to November. Roots are carefully dig out from the planting bed. Overground plant parts, which is still green in September or dry in November, will be cut out. Roots are washed thoroughly before sending to the factory for post-harvest management.

Post-harvest managements are differing due to the type of products. in 4 categories:

1) Red Ginseng (Kōjin): main roots are steamed at 90-93°C for 2-4 hour before drying process
2) White Ginseng (Haku Jin): main roots are stripped out the thin outer skin with bamboo stick before drying
3) Boiled Ginseng (Yudoshi): main roots are boiled at 85°C for 10 minutes before drying.
4) Normal dried Ginseng (Nama boshi): main roots are washed and drying process is carried out in hot air oven at 40-50 C.

According to the quality and market value, Red Ginseng is better than White Ginseng, Boiled-, Normal Dried Ginseng and Others respectively. In Nagano Prefecture, Red Ginseng is made only

from the first class Ginseng and use for export or in expensive products, whereas the other categories are mainly used for domestic consumption and for extraction.

The first class Ginseng must meet the following criteria :

Fig. 10. Ginseng root after harvesting

Fig. 11. Wrapping to protect the root from cracking during boiling or steaming

Fig. 12. Ginseng products

1) long and good shape root system
2) figure like man
3) short and wide head
4) root diameter over 2 inches
5) fresh weight over 100 g.
6) no insect and disease infected scar
7) white or cream in colour

7. Marketing system and utilization

In Fig. 13 is the flow charge of marketing system of Ginseng in Nagano Prefecture. The Ginseng producers can sale their products to three different agencies, eg. Agricultural Cooperative Association, Nagano Ginseng Cooperative Association or Processor Association. Passed through many intermediate marketing agencies, Ginseng will be lastly send to Pharmaceutical Companies, Crude Drug Wholesale or to the Export Companies.

Dried roots of Ginseng are used in different purposes, eg: for their tonic-effects and as stomachic medicine. Forms of consumption can be divided into:

1) Pieces: a thin sliced pieces are used in many mixed crude drugs.
2) Powder: the grinded Ginseng are used as Ginseng tea, tablet or granule and in mixed crude drugs.
3) Extract: The extraction are carried out with two different methoods
   —steam extraction to achieve a concentrate tonic beverage
   —ethanol extraction to make the product of tonic beverage or tablet.

Ginseng beverage or tablet medicine can be used as a pure Ginseng or mixed with many other medicinal plants.

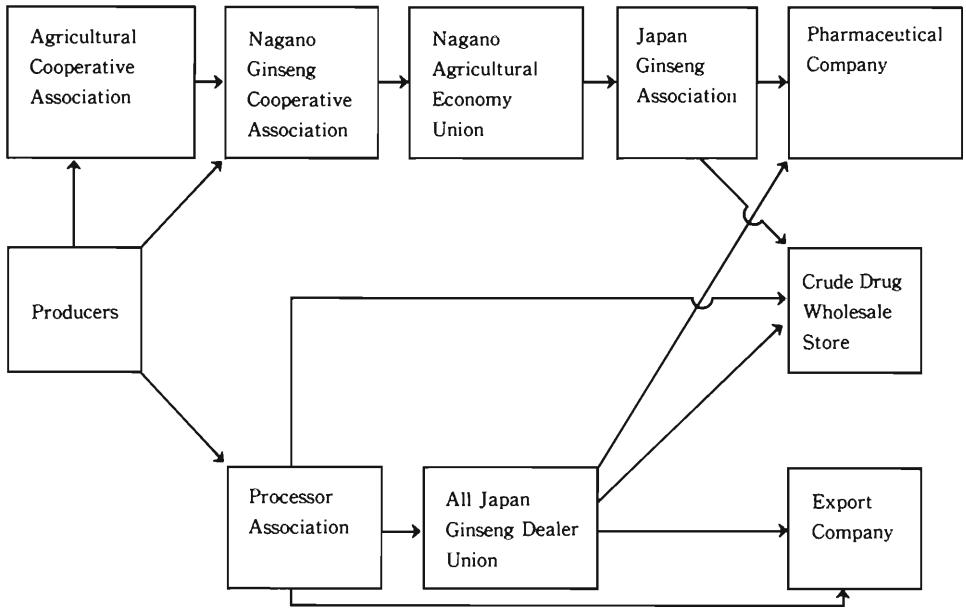

Fig. 13. Marketing system of Ginseng in Nagano Prefecture

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All best thanks are extended to Mr. M. Tanaka for his wonderful hosting and guidance, Mr. O. Koyama for his plant specimens, Mr. H. Seki for the permission to visit his Ginseng processing factory and to Mr. Y. Miyazawa for his valuable informations.

長野県における薬用人参（*Panax ginseng*）の生産

ピタヤ・スラムシリ，尾垣光治，杉野　守

摘　　要

本調査は，近畿大学とチェンマイ大学（タイ国）とのプロジェクト研究，[タイ国における有用植物の栽培研究とその薬理効果に関する研究]，の一環として行われたものである．そして，特にタイ国における日本の薬用植物の栽培研究の目的もかねて，共同研究者の一人であるチェンマイ大学のピタヤ博士を1990年９月１日より約１ケ月間近畿大学農学部に招聘した．

この間，近畿地域の薬用植物の栽培，生産，薬種商施設の見学，研修を行った他，特に長野県の薬用人参の栽培，加工，生産施設を歴訪見学し多くの有益な情報を得ることができた．

長野県は，薬用人参栽培についておよそ150年にわたる歴史をもつとともに，今日でもその国内生産量の約80％を占めている．そこで，薬用人参の現在の市場要求性も考慮して，タイ国での栽培を試みる目的から，薬用人参種子の催芽方法，栽培設備，成育管理方法，病虫害防除技術，収穫および生産物処理技術等について，県内の上記施設の見学と懇切な教示により調査した．

この調査結果を参考にして，今後特にタイ北部高地における薬用人参の栽培試験を行う予定である．

APPENDIX-I.

Meteological data at Kitamimaki Experimental Station

		1		2		3		4		5		6	7		
		Y	AV	Y	AV	Y	AV	Y	AV	Y	AV		5 cm	10 cm	15 cm
		℃	℃	℃	℃	℃	℃	mm	mm	mm	mm	h	℃	℃	℃
	F	−0.1	−1.9	5.6	5.2	−5.5	−5.2	5.9	9.2			34.4	0.4	0.1	0.8
Jan.	M	2.0	−2.7	7.4	4.2	−2.7	−7.6	12.0	6.4			31.6	2.2	2.0	2.5
	L	0.8	−3.2	6.2	3.7	−4.9	−7.9	30.1	9.1			64.8	1.4	1.5	2.2
	F	0.9	−2.0	7.6	3.8	−5.1	−7.7	10.7	7.4			68.0	1.0	0.9	1.2
Feb.	M	1.7	−1.7	6.8	4.5	−5.0	−7.3	45.1	19.9			43.2	1.9	1.7	2.1
	L	0.8	−0.8	6.9	4.2	−3.7	−6.2	39.4	10.8			36.8	2.1	2.2	2.6
	F	3.3	0.4	8.4	6.6	−3.6	−5.0	45.1	17.2			55.1	3.3	3.1	3.6
Mar.	M	3.1	1.5	9.2	8.0	−3.7	−3.4	10.0	22.9			63.9	4.3	3.7	4.4
	L	4.4	3.8	9.2	10.2	−2.4	−2.1	18.6	24.0			48.9	5.1	4.8	5.1
	F	9.1	7.3	15.6	13.9	−0.1	0.7	14.4	18.3	24.9	27.9	66.5	8.4	7.8	7.8
Apr.	M	10.9	8.6	17.1	16.1	2.3	2.1	17.1	27.2	41.1	36.4	73.8	10.2	9.4	9.3
	L	10.7	12.0	19.8	19.2	2.5	4.3	40.0	23.5	37.2	46.3	54.5	11.1	10.4	10.5
	F	12.8	14.0	20.9	22.0	2.8	5.2	27.8	24.5	42.4	51.6	31.0	13.2	12.7	12.3
May.	M	12.2	14.5	16.5	21.7	6.0	7.9	40.5	40.3	26.3	46.5	37.1	13.0	12.7	13.0
	L	14.0	15.6	21.2	22.7	7.5	8.7	70.1	23.6	36.1	51.9	61.4	15.5	14.7	14.6
	F	18.2	18.1	26.7	25.2	8.9	11.1	5.7	25.6	58.6	54.3	55.6	19.1	18.6	18.2
Jun.	M	15.4	18.1	19.7	23.9	10.3	12.1	69.9	38.5	35.7	44.4	39.1	17.2	16.9	16.9
	L	18.4	18.6	23.5	21.7	13.0	13.8	61.0	65.0	33.8	39.1	46.2	19.7	19.3	18.6
	F	17.8	18.8	23.4	25.6	12.3	15.1	48.6	60.1	35.7	40.1	32.9	19.9	19.3	19.2
Jul.	M	21.0	21.6	25.2	26.9	16.0	16.6	60.8	45.5	32.7	39.6	37.0	22.1	21.9	21.2
	L	24.0	22.9	26.7	28.1	17.7	17.7	30.4	48.0	62.2	52.0	53.0	25.1	24.3	24.0
	F	24.4	23.2	28.6	29.1	17.8	17.6	32.9	41.4	46.9	49.5	63.6	25.0	24.5	23.9
Aug.	M	22.1	23.5	28.9	28.9	16.1	18.4	21.3	33.4	48.7	49.1	38.8	24.8	24.2	24.2
	L	23.4	23.2	28.9	28.7	16.8	17.4	42.1	41.1	62.6	49.0	62.4	24.5	24.3	24.0
	F	22.0	21.2	26.8	27.2	16.8	16.4	43.5	52.9	20.6	39.1	23.3	23.4	23.1	22.9
Sept.	M	21.9	18.8	27.7	23.6	16.5	14.5	100.8	47.1	37.2	31.3	38.0	23.5	23.2	23.2
	L	17.2	16.0	22.1	21.5	10.7	11.7	12.1	58.7	22.8	25.4	41.1	19.3	18.7	19.2
	F	13.9	14.3	18.9	19.3	8.8	9.8	18.8	19.5	19.8	21.1	31.6	17.0	16.7	17.4
Oct.	M	11.6	12.1	17.0	18.0	4.0	6.9	65.5	32.4	25.1	22.5	40.7	13.6	13.2	14.2
	L	8.7	8.3	17.8	15.4	0.8	2.7	0	12.9	33.4	25.0	58.1	10.9	11.0	11.8
	F	12.7	8.6	18.4	15.6	5.9	2.4	23.7	16.4	19.0	17.5	44.2	11.9	11.7	12.8
Nov.	M	6.7	5.8	11.1	12.4	1.6	0.6	6.4	9.7	13.8	17.4	26.5	9.0	9.0	10.1
	L	3.7	3.5	11.2	9.7	−4.0	−1.3	0.3	12.1	16.4	15.5	50.1	3.8	3.7	5.6
	F	2.1	1.3	10.4	8.7	−3.6	−3.7	0	4.9			59.2	2.6	2.6	4.1
Dec.	M	2.8	0.1	5.4	6.8	−6.1	−4.9	10.7	12.0			62.7	1.1	1.1	2.3
	L	0.7	−0.7	5.5	5.7	−4.8	−5.6	12.9	4.7			33.3	1.0	1.2	1.7

Abbreviation :

1 =Air temperature at 9.00 am.
2 =Maximum temperature
3 =Minimum temperature
4 =Rainfall
5 =Evaporation
6 =Sun shining hour
7 =Soil temperature
Y =Year 1989
AV =10 years average
F =First 10 days of the month
M =Second 10 days of the month
L =Last 10 days of the month

APPENDIX-II
Different types of dried Ginseng (After Osumi, 1971)