CHAPTER 16

DEMAND AND AVAILABILITY OF *RHODIOLA ROSEA* L. RAW MATERIAL

BERTALAN GALAMBOSI

Agrifood Research Finland, Ecological Production
Karilantie 2A, FIN-50600 Mikkeli, Finland
E-mail: bertalan.galambosi@mtt.fi

Abstract. *Rhodiola rosea* L. roseroot, (Golden root or Arctic root) is a herbaceous perennial plant of the family *Crassulaceae*. The yellow-flowered roseroot species is a circumpolar species of cool temperate and sub-arctic areas of the northern hemisphere, including North America, Greenland, Iceland and the Altai, Tien-Shan, Himalaya mountains in Asia. The European distribution includes Scandinavia and most of the mountains of Central Europe. Roseroot has traditionally been used in Russia and Mongolia for the treatment of long-term illness and weakness caused by infection. *Rhodiola* radix and rhizome is a multipurpose medicinal herb with adaptogenic properties: it increases the body's nonspecific resistance and normalizes body functions.

A special emphasis in pharmacological research has been put on roseroot in the former Soviet Union. Several clinical studies have documented roseroot's beneficial effects on memory and learning, immune-response stress and cancer therapy. *Rhodiola* preparations have widely been used to increase the stress tolerance of the cosmonauts. Salidroside and its precursor tyrosol, and cinnamic glycosides (rosin, rosavin and rosarin) have been identified from the roots and rhizome. Other important constituents are flavonoids, tannins and gallic acid and its esters (Brown et al. 2002).

Based on the documented pharmacological effects and its safe use, the commercial interest for roseroot-based products has quickly increased worldwide. Presently one of the biggest problems is to meet the raw-material requirement for the growing industrial demand. Nearly all raw material originates from the natural populations. The largest populations are situated in the Altai area of South Siberia. Due to the intensive collection, natural populations are severely threatened. Roseroot is on the Russian Red List and its collection is nowadays strongly regulated. The collecting activities in the European countries have less economical importance, because collection and transport costs are high in the mountain areas.

Roseroot cultivation seems to be the only solution to produce raw material in sufficient quantities for industrial purposes. Cultivation experiments have been carried out in several parts of the former Soviet Union, Poland and Sweden. Due to national industrial interest, domestication experiments were carried out also in Finland in 1994 - 2002. The first cultivation technologies for roseroot have been introduced in practice. Roseroot can be grown successfully in South Finland using organic growing methods. The dry root yields ranged between 1.5 and 3.0 ton/ha in South Finland.

However, cultivation of roseroot has its own problems. The cultivation costs are high, because the field cultures have to be established by transplantation of seedlings, the cultivation period from planting to harvesting is five years long and the root harvest and post-harvest processing are labour-intensive. For

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the continuous supply of industrial raw material, new plantations have to be established every year. A stable financial background seems to be necessary for the growers involved in large-scale production of roseroot raw material.
Keywords: *Rhodiola rosea* L.; plant collection; field cultivation methods; yield

INTRODUCTION

Rhodiola rosea L. roseroot (golden root or Arctic root) is a herbaceous perennial plant of the family *Crassulaceae* (Figure 1; see colour pages elsewhere in this book). *Rhodiola* as a genus may have originated in the mountainous regions of Southwest China and the Himalayas. Botanists have established that various species of the genus *Rhodiola* naturally display a circumpolar distribution in mountainous regions in the higher latitudes of the Northern Hemisphere (Brown et al. 2002).

In Central and Northern Asia, the genus is distributed from the Altai Mountains across Mongolia into many parts of Siberia (Komarov 1939). According to Hegi (1963), its distribution in Europe extends from Iceland and the British Isles across Scandinavia as far south as the Pyrenees, the Alps, the Carpathian Mountains and other mountainous Balkan regions.

In the Nordic and Baltic region, roseroot occurs in the indigenous flora in Iceland, Norway, Sweden and Finland. In Norway and Iceland, roseroot is widely distributed from mountain areas to the western coastline (Hjaltalin 1830). Roseroot is found at a maximum altitude of 2280 m above sea level in Jotunheimen in Norway. Roseroot is quite common also in mountainous areas in Sweden and Finland, and can be found at some coastal habitats in Sweden. Roseroot does not occur in Denmark and the Baltic countries. Despite its fleshy rootstock and leaves roseroot is dependent on relatively stable water supplies. Several varieties of *Rhodiola* species have also been identified across Alaska, Canada and the northern mountains of the continental United States (Small and Catling 1999).

TRADITIONAL USE

Roseroot has been traditionally used in its original growing areas for various purposes. According to several Norwegian reports, in the eighteenth century the plant was known as an effective remedy for scurvy (Alm 1996). The oldest report on its use is from a journey made by King Christian IV who travelled to Finnmark and Kola in 1599. In that area the plant was used by both the Laps and the Russians (Hansen and Schmidt 1985).

In Alaska the Eskimos have used roseroot as a vegetable and it may still be used in that way. It was cooked or mixed in various meals and the leaves were eaten as a salad (Hedman 2000). The leaves were ground and mixed with the ingredients to make bread. The children eat the leaves raw (Høeg 1976). The importance of roseroot as a vitamin resource is high, since it grows in very extreme Nordic conditions and is available very early in spring, after the long winter period. The leaves of roseroot contain 33 mg vitamin C per gram, while the rhizomes only contain 12 mg per gram (Nordal 1939). The Eskimos in Greenland have eaten roseroot and in 1762 Herman Ruge, a priest from Valdres in Norway, wrote: “I have myself eaten it, both fried and roasted as well as boiled. And I have found it disagreeable either in taste or in effect” (Lagerberg et al. 1955). The plant has been much used medicinally, especially for treating burns, but it was also taken internally against lung inflammation and as a remedy for urinating. The rhizome contains substances that help against pain (Ryvarden 1993). In addition, roseroot has been used in folk medicine for washing the hair since it gave a pleasant scent and was supposed to be good for the hair (Alm 1998).

According to a recent overview (Brown et al. 2002), roseroot has traditionally been used widely in Russia and Asia. Traditional folk medicine used *R. rosea* to increase physical endurance, work productivity, longevity, resistance to altitude sickness and to treat fatigue, depression, anaemia, impotence, gastrointestinal ailments, infections and disorders of the nervous system. In mountain villages of Siberia, a bouquet of roots is still given to couples prior to marriage to enhance fertility and assure the birth of healthy children. In Central Asia, *R. rosea* tea was the most effective treatment for colds and flu during severe winters. Mongolian doctors prescribed it for tuberculosis and cancer. For centuries only family members knew where to gather the wild ‘golden roots’ and the methods of extraction. Siberians secretly transported the herb down ancient trails to the Caucasian mountains where it was traded for Georgian wines, fruits, garlic and honey. Chinese emperors sent expeditions to Siberia to bring back the ‘Golden root’ for medicinal preparations (Figure 2; see colour pages elsewhere in this book).

PHARMACOLOGICAL EFFECTS

In pharmacological research, special emphasis has been put on roseroot in the former Soviet Union. Several clinical studies have documented beneficial effects of roseroot on memory and learning, immune response, stress and cancer. *Rhodiolae* radix and rhizome is a multipurpose medicinal herb with adaptogenic properties: it increases the body’s non-specific resistance and normalizes body functions. *Rhodiola* preparations have been widely used to increase the stress tolerance of astronauts. Salidroside and its precursor tyrosol and cinnamic glycosides (rosin, rosavin and rosarin) have been identified from the roots and rhizome. Other important constituents are flavonoids, tannins as well as gallic acid and its esters (Brown et al. 2002).

MARKET POTENTIAL AND ENDANGERED STATUS

Based on the documented pharmacological effects and on its safe use, commercial interest in roseroot-based products has rapidly increased world-wide. Preparations are marketed in various forms, like pure alcoholic extracts or tablets or in combinations with other medicinal plants.

Presently one of the biggest problems is to meet the raw-material requirement for the increasing industrial demand. Nearly all the raw material for industrial processing is obtained by collection from natural populations. The largest populations are situated in the Altai area of Southern Siberia. The estimated quantity of dry *Rhodiola* roots exported from Russia is around 20-30 tons/year (Ramazanov 2005, personal communication). Due to intensive collection, the natural populations are seriously threatened. Roseroot is on the Russian Red List and its collection is nowadays strictly regulated.

Natural populations of *Rhodiola* exist in the countries of the Alps and Carpathians, as well as in the Scandinavian countries, but collection in these European countries has less economic importance because of the high labour costs and the difficulties of transport in the high mountain areas.

Although collection in the European countries is not as extensive as in the Altai area in Russia, the species has been reported as a threatened medicinal plant in several countries. Roseroot is not red-listed in any of the Scandinavian countries but, according to Lange (1998), it is registered as an endangered plant in the Czech Republic and Bosnia-Herzegovina and as vulnerable in Slovakia.

The rapidly growing demand and also high prices for raw material for industry could cause increased pressure on natural habitats. Commercial quantities are collected in Norway as raw material for the new commercial products and Norwegian scientists working with *Rhodiola* have received requests to facilitate deliveries of several tons of *Rhodiola* root harvested from natural populations.

INTRODUCTION INTO CULTIVATION

Cultivation of roseroot seems to be the only hope of producing raw material in sufficient quantities for industrial purposes. Cultivation experiments have been carried out in several parts of the former Soviet Union, in Russia (Elsakov and Gorelova 1999), as well as in Sweden, Poland (Furmanowa et al. 1999) and Germany (Schittko 2005, personal communication).

Due to national industrial interest, domestication experiments were carried out also in Mikkeli (61° 44’ N, 27° 18’ E), Southern Finland during 1994-2002. In the first phase, from 1994 to 1998, observation experiments explored basic questions of propagation biology, growth, biomass accumulation and characteristics of the root yield. In the second phase, from 1997 to 2002, several detailed field experiments were carried out that studied different agronomic issues of organic cultivation, such as mass propagation, weed control, fertilization, root harvesting and seed production. The results of the small plot experiments have been confirmed in a semi-large-scale experiment. Based on the results of these experiments, the first cultivation techniques have been established and published for use (Dragland and Galambosi 1996; Galambosi et al. 2003; Galambosi 2004).

CULTIVATION PRACTICES OF *RHODIOLA ROSEA* L. IN FINLAND

Field selection

According to the natural ecological requirements, roseroot can be successfully cultivated in climatically cool and sufficiently moist areas, with equal precipitation.

It cannot grow in the shade. Due to its large root system, the soil must be deep and easily penetrated. *Rhodiola* will thrive under cultivation in moderately rich and well-drained soils, which are neutral to slightly acidic (pH 6 to 7). Loam or sandy loam soils are suitable. Even though in nature it grows close to rocks, in cultivation stony fields and soils with standing water should be avoided. The established plants are fairly drought-tolerant. Since roseroot will be grown for five years at the same place, before transplantation the soil must be cleaned chemically or mechanically from perennial, deep root weeds.

Fertilization

Information on the nutrient requirements of *Rhodiola* in field cultivation is quite limited. In its natural habitat, it grows on weak soils, on rocks in a very thin soil layer. The root size in arctic and high mountain conditions is very small, in accordance with the insufficient nutrient supply from the soil. In cultivation, roseroot develops much bigger roots and produces larger quantities of seeds than in nature.

Due to the lack of experimental data, an organic fertilizer experiment was carried out during 1997-2000 in Mikkeli, Finland. One-year-old seedlings were transplanted to stony till soil covered by black plastic mulch in four replications. Before transplantation three compost doses (5-10 and 20 tons/ha) were incorporated into the soil (Biolan composted cow manure).

According to the compost analysis, the applied nitrogen, phosphorus and potassium levels of the compost applications were as follows:

LO	0	no fertilization
L1	5 tons/ha	NPK = 25-25-50 kg/ha
L2	10 tons/ha	NPK = 50-50-75 kg/ha
L3	20 tons/ha	NPK = 75-75-150 kg/ha

No additional fertilization was applied during the four years of growth. According to the results, increasing compost doses increased the growth of vegetative shoots and the fresh weight of the roots. The tallest and heaviest plants were measured with the higher compost doses applied. The differences in the shoot weights were statistically verified at the 5% level, but the variations in fresh root weight were quite large and the results were not significant. Increasing compost doses decreased the dry-matter content of the fresh roots and, although the fresh root yield shows an increasing trend, the dry root yields were nearly similar (Table 1).

Table 1.*The effect of compost fertilizer on root growth and yield of Rhodiola rosea during 1997-2000, Finland*.

Fertilization	Root weight g/pot		Dry matter	Root yield kg/m²	
	fresh	dry	%	fresh	dry
L_0	933	251	28.3	4.66	1.26
L_1	970	263	28.3	4.85	1.31
L_2	1026	254	25.5	5.13	1.27
L_3	1035	265	25.3	5.17	1.37
Mean	991	258	26.8	4.95	1.29
	ns	ns	***	-	-

These results were confirmed by Russian scientists who obtained the highest root weight using NPK= 50-50-70 kg/ha with 50 tons/ha additional manure in North Russia, Kola area (Elsakov and Gorelova 1999).

The effects of fertilization on the content of active metabolites are presented in Figures 3, 4 and 5. There were significant differences in the contents of the active metabolites between the dry hairy roots and the rhizomes. Generally the ratio of hairy roots to rhizomes in the dry root yields is 70:30%. The flavonoid contents of the hairy roots were three times higher than that of the rhizome and showed a decreasing trend with increasing fertilization. The contents of the most effective components, salidroside and rosavin, were higher in the rhizome, and the highest contents were measured using a fertilization level NPK= 50-50-75 kg/ha.

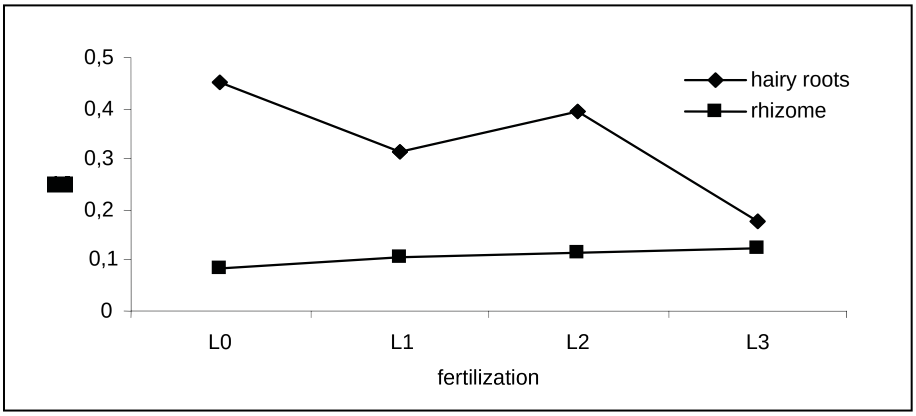

Figure 3. *Content of flavonoids of Rhodiola rosea roots effected by fertilization*

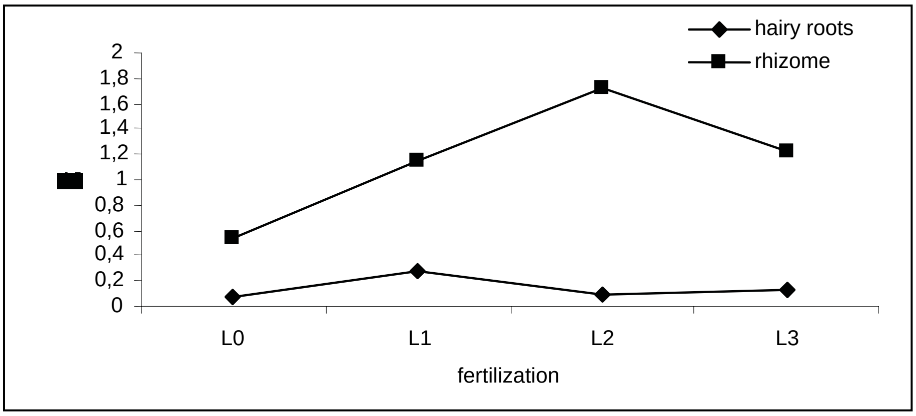

Figure 4. *Content of salidroside of Rhodiola rosea roots effected by fertilization*

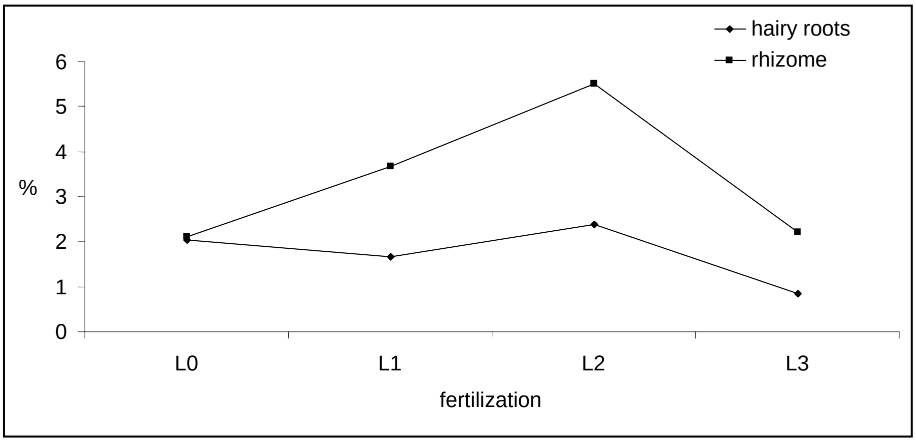

Figure 5. *Content of rosavin of Rhodioloa rosea effected by fertilization*

Generally, in practical cultivation roseroot can produce a sufficient root yield in soils with good condition. The proposed organic fertilization in Finland could be 20-30 tons/ha compost before transplanting. This amount is to be applied over the 3-4-year crop duration. In the event of weak growth additional fertilization could be applied in spring or early summer.

Propagation

Rhodiola rosea can be propagated in different ways. The growth of the young seedlings is generally slow, and its dynamic depends on the method used. The plants grow faster in cultivation than in nature, and in cultivation more intensively from root division than from seedlings (Table 2). In the case of larger-scale cultivation, the most effective method is mass production of seedlings.

Table 2. *Growth of roseroot in the nature and in cultivation (Kim 1976)*

Growth features	Age	In nature	In cultivation	
			from seedlings	from root division
Plant height in cm	1	-	8.0	21.8
	2	9.7	24.3	26.6
	3	17.6	20.5	28.7
No. of flowering stems	1	-	1.0	3.1
	2	2.5	5.5	7.8
	3	2.6	13.1	16.0
Total plant weight in g	1	2.1	2.8	37.0
	2	1.7	30.3	143.3
	3	3.9	100.7	251.4
Root weight in g	1	0.12	1.2	26.7
	2	0.42	19.0	98.45
	3	1.66	52.4	167.7

Vegetative propagation (root division)

As a perennial root plant, roseroot can be propagated by root division. The underground rhizome-like roots of the mother plant can be cut into sections 1.5 to 15 cm long, maintaining at least one bud and some hair-roots on each piece. Root division can be performed in early spring and also in the late summer on crops from their third year. The cuttings must be potted and kept outdoors or in light shade in a cold frame or greenhouse until they are rooting well. After three weeks the plantlets should have rooted and started to grow. They can be planted out in early autumn or the following spring.

Propagation by seeds

The seeds of *Rhodiola rosea* are very small (about 1.5-2.0 mm long by 0.3-0.6 mm wide). The thousand-seed weight is 0.2 g. The dried seeds have a low germination rate (2-36%). After 30 days stratification at –5°C the germination rates increase to 50-75%. The dry seeds are soaked in water overnight, then mixed into moist sand and kept in a suitable container. After storage for one month at a temperature of 2-4 °C, the germination capacity will typically increase to around 75% (Revina et al. 1976).

According to our experience over several years in Finland, we successfully use simple natural winter stratification, in which it is possible to achieve 95-100%

germination. The seeds are sown equally during October-November on the surface of a sand/peat mixture, the sowings are kept outdoors during the whole winter, under the snow. During April/May, the boxes are transferred into a glasshouse with a temperature of 18-22 °C. Germination starts after 3-7 days. The seedlings with 1-3 pairs of leaves are picked into pots of a size of 300-400 cm^3. Three to five small seedlings are planted into one pot.

The seed germination can be improved by pre-treating seeds with plant growth hormone. According to Italian results (Aiello and Fusani 2003), seeds treated with 100 mg L^{-1} GA_3 and exposed to 20-24C° temperature showed 87% germination. The seeds remain viable for 10 years if stored at a temperature of about 5°C (Kozłowskj and Szczyglewska 2001).

Seedling age

Due to the slow-growing characteristic of *Rhodiola*, the age of the seedlings has a great effect on the plant growth and the root yield. In a comparison experiment, seedlings 5 months and 12 months old were transplanted into the field in June and September 2000. The plants were grown in the field for 3 and 4 seasons. According to the results, all parameters of plants 12 months of age and 4 growing seasons were twice as high as the younger seedlings (Table 3).

Table 3. *Effect of seedling age on growth and yield of Rhodiola rosea in Finland.*

Age of seedlings month	Growing season in field (month)	Shoot height cm	Fresh root weight g/pot	Seed yield g/pot	Root yield kg/m²	
					fresh	dry
5	3	29.8	370	2.07	1.84	0.47
12	4	43.5	790	4.02	4.07	1.06
Significance		***	***	**	-	-

*** = P<0.01, ** = P<0.05

These results confirm previous Russian guidelines. According to Nuhkimovsky et al. (Nukhimovskii et al. 1987), the seedlings are kept in pots for 2 years and before transplantation to the permanent growing sites. In this way the root yield is higher and the field weeding cost is lower.

Spacing and weeding systems in the field

The optimal spacing for roseroot seedling seems to be 40 x 40 cm. The theoretical plant density of plant populations is about 110,000 plants/ha. However, during the 3 years of cultivation the most important factor is weed control and the final plant density is determined by the weed control system employed. At present there is no chemical weed control method for roseroot, only mechanical weed control methods can be used, such as 1) harrowing, 2) plastic mulch or 3) potato ridge. In a weed control experiment in Finland, both organic straw mulch and black plastic mulch increased the root weights and root yields by 35-45 % (Figure 4).

1. In the case of a flat field, plants can be planted with 60 cm between rows and 20 cm within the rows. The required quantity of seedlings is about 83,000 plants/ha. Weed control means mechanical harrowing between the rows and hand weeding between the plants as necessary, generally 2-4 times/summer.
2. Roseroot may be grown on raised beds or planted in plastic mulch. In such cases the spacing should be modified accordingly. The recommendation is to plant 30 cm apart within and between rows. In Canada, four rows per bed or plastic sheet is proposed, allowing 30 cm between plastic sheets or beds, which gives 89,000 plants/ha (Kwesi 2004). In Finland, we used 2 or 3 rows in a plastic bed with 80 cm net surface width (Figures 6 and 7; for Figure 7 see colour pages elsewhere in this book).

   To suppress the weeds, organic mulches could be applied with the further advantage of keeping the moisture in the soil better during the hot summer periods, but due to the yearly spreading of mulches it is an expensive method. Organic mulches are suitable only for smaller areas in organic cultivation.

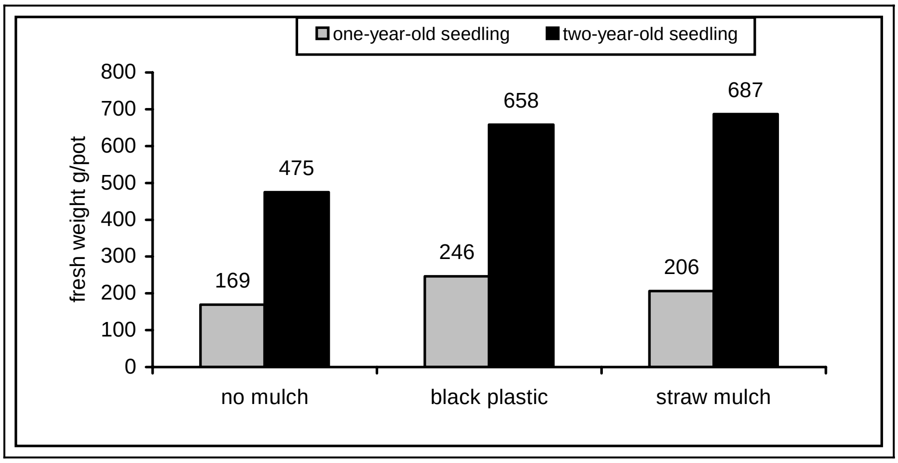

Figure 6. *Effects of mulches on the root weight of Rhodiola rosea after 3 growing years*

3. The seedlings can be planted in potato ridges with 80 cm between ridges and 20 cm between plants within a ridge. This method allows effective regular harrowing between the rows using the potato ridge former machine. The high plant density within the rows may minimize the growth of weeds between the plants.

Several types of transplanters are available in different countries to mechanize the field transplanting and harrowing processes. Older transplanters open a furrow and plants are placed in the furrow by hand. Newer models transfer plants to the furrow by 'arms' on the machine, which grip and hold the plant or drop the plant and pot into the furrow from a cone over the transplanting furrow. ‘Punch’ planters are also available which puncture plastic mulches and set the plant into the hole (Kwesi 2004).

Care of the plantation

Besides regular weed control, irrigation could be necessary after transplantation and during very dry periods. In Finland, during a ten-year period we had to irrigate only once, during a very dry period in July 1999. If the growth of roseroot seems to be weak, additional N fertilizer should be applied at a rate of 50-70 kg/ha in spring. It should be incorporated into soil with raw cultivation or given in a liquid form.

There is very little experience of pests and diseases. The greatest enemy of *Sedum* species in general is the vine weevil (*Otiorhynchus sulcatus*) (Stephenson 1994). In Finland, we have observed aphids on shoots and a saprophytic fungus *Armillaria mellea* on roots, only twice.

Seed yield and seed harvest

In natural growing conditions the growth of young roseroot is very slow with the first flowers appearing in the 7th or 8th year. Russian researchers stated that in cultivation the individual roseroot plants develop more quickly, and they produce bigger flowers and more seeds. In the High Altai areas, one flowering stem produced 560-930 seeds (Polozhii and Revyakina 1976). In Tomsk Botanical Garden, the quantity of seeds from two- and three-year-old plants was 780 and 3620 seeds per flowering stem, respectively (Revina et al. 1976).

In cultivation, the seed yield can be collected every year. In Southern Finland, during July the seed capsules are deep brown in colour and become dry and begin to open. The collection of the seeds can begin when the seeds begin to fall if the stems are shaken. The collection should be carried out in the morning, when the capsules are still wet, cutting stems of 5-7 cm. After keeping them in a dry place for a week the seeds are shaken from the capsules. The expected seed yield can range between 2 and 10 g/plant depending on the age and size of the plant.

Root harvest

The roots and rhizomes are suitable for harvest after the plants have been growing for 4-5 years. The roots are generally harvested in autumn, but it could be done in spring as well. However, the growth of roseroot shoots starts soon after the snow melts, leaving only a short period for spring harvesting.

In larger-scale cultivation, the root yields are harvested mechanically. Different machinery can be used, depending on the local possibilities. Due to the root morphology, sugarbeet or red-beet harvesters are not directly suitable for harvesting roseroot root. More suitable are ploughs or plant lifters as used in nurseries or ginseng shakers. In general, strong shakers are necessary, since the root and rhizome mass is situated at a depth of 15-20 cm in the soil. The tractor should have about 80-90 horsepower. The lifted roots have to be collected from the field and transported to the place of postharvest handling.

Postharvest processing

The fresh shoots have to be separated from the rhizomes and before washing the big roots should be sliced. Cutting of the roots is necessary for various reasons: the sliced roots can be washed more effectively, any stones can be removed more certainly and the roots can be dried more effectively. For root washing, vegetable washing machinery or an ordinary concrete mixer could be used. Scrub cutters were used successfully for slicing in Finland.

The harvested roseroot yield consists of rhizome and hairy roots. According to our measurements, the proportion is about 70:30 %. Although the smaller part, the hairy roots are valuable raw material as well with total flavonoid contents nearly twice as high as in the thick rhizomes (Figure 1).

The white colour of the sliced roots soon turns brownish or reddish. The roots could be dried in forced air dryers where the thickness of the root layer is 8-10 cm. Without slicing the drying time of the roots was more than 5 days, the sliced roots dried in less than 44 hours in a forced air drier at 40-45 °C.

Root yield

The fresh and dry root yield depends strongly on the plant density and plant age. The average fresh weight of four-year-old roots (two years in pots and two years in the field) was 454 g/pot. After 5 years (2 + 3) the root weight was 1224 g/pot. In our plot and semi-large-scale experiment, the fresh and dry root yields after the 3rd and 4th field growing year ranged between 2.28 and 4.95 kg/m² and between 0.5 and 1.2 kg/m², respectively. Older populations produce higher yields. After 6 growing years the fresh root weights were more than 2 kg/plant and the calculated fresh yield was 9.0 kg/m².

These experimental results are in harmony with the result obtained by Elsakov and Gorelova (1999) in a fertilization experiment in the Kola peninsula in North Russia. Transplanting two-year-old seedlings with a density of 10 plants/m² after two years of field cultivation the fresh yield was 3.57 kg/m² and after three years it was 5.5 kg/m².

The future of Rhodiola rosea

Although at present the main source of *Rhodiola rosea* raw material is collection from the wild, in the long term sufficient quantities of raw material for industrial use could be obtained by cultivation. However, field cultivation of roseroot has its own problems. The cultivation costs are high, because the fields have to be established by transplantation of seedlings, the cultivation period from planting to harvesting is five years and the harvesting and post-harvest processing of the root yield are labour-intensive. In addition, for a continuous supply of industrial raw material, new plantations have to be established every year. Due to this phenomenon, the sizes of the present cultivation areas are small and the production costs are high. It seems that a stable financial background is essential for long-term and continuous large-scale field production of roseroot raw material.

Successful efforts have been reported recently from Canada (Kwesi et al. 2005). Finding the endemic, cold-tolerant roseroot to be a promising new alternative crop with stable market potential, a five-year project has been initiated in the province of Alberta. The main goal of the project is to establish several hundred acres of commercial roseroot fields. Such large quantities of raw material will supply the demands of industry and at the same time decrease the negative impacts on the natural populations of *Rhodiola rosea*.

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