Commercial Cultivation of Seabuckthorn in Western Siberia, Russia

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SUMMARY

Seabuckthorn cultivation can be carried out in a wide range of soil and climatic conditions of temperate conditions in Russia, Europe and Asia. In Siberia, Russia, the basic limiting factor for seabuckthorn during the winter period is not catastrophically low temperatures of air, but high snow level and thawing weather. All varieties bred at Lisavenko Institute belong to subspecies *mongolica* and distinguish for high productivity (7.5 up to 18 t/h), the weight of 100 fruits from 62 to 120 g (with a maximum up to 140 g), length of a fruit steam 3-6 mm, the contents of oil 4.0-8.0 per cent, carotenoids – 15.0-48.0 mg/100 g, sugars – 5-10 per cent and acidity – 0.9-1.9 per cent. They seem to be good, however, it is necessary to note about essential disadvantages of the Altai varieties, main of which are susceptibility to withering (in Siberia basically *Fusarium* wilt), and also pest attack by seabuckthorn fly. On large scales establishing of plantation recommended in autumn period during early 10-20 days of October, rather than in spring (May), which can be used for small-scale plantation. The standard 2-year plant material of seabuckthorn should have the stem diameter not less than 15 mm for the first grade and 8-10 mm stem diameter for the second grade. For establishing of industrial plantation of 100 hectares is required from 125,000 up to 160,000 seedlings, depending on planting scheme. Manual planting of 1-year seabuckthorn seedlings is carried out in 20 cm deep furrows. For a 2-year-old material, furrows are prepared to a depth up to 30 cm. The machine (model MLU-1A) has been released nowadays, which is run by two workers; however for convenient planting, no less than two additional persons are required for preparing mash and delivering wetted seedlings to the machine. Thus, labour expenses are within the 50-60 man-days per 100 hectares that is 8-10 times lesser in comparison with manual planting. As we mentioned before, water supply is very important during summer especially for young seabuckthorn plantations. Application of soil management and mulches helps in checking the growth of weeds. Pew harmless herbicides have also been developed. Pathogenic fungi *Fusarium* mat attack and affect seabuckthorn seriously; only remedy being the development of resistant varieties. In the western Siberia, the most dangerous pest is seabuckthorn fly. We consider using a harvesting machine as a vibrator for shaking fruit bearing branches as one of the real way of reduction of labour expenses by manual way, which is applied these days during seabuckthorn fruit harvesting.

Keywords: Seabuckthorn (*H. rltamnoides* ssp. *mongolica*), Siberia, Plantation and management and Harvesting practices.

INTRODUCTION

Seabuckthorn is a highly popular crop, particularly in Siberia. During the last 70 years, after breading activity on seabuckthorn have been started, a thorny bush with small sour fruits has turned to be one of the most favorable berry cultures in the region. Many other Asian and European countries have also research program on research and development of seabuckthorn orchards.

Doubtless achievements of biochemists have opened the richest vitamin content not only in fruits, but also in other parts of seabuckthorn plant. Breeders worldwide have bred a significant amount of cultivars of this plant satisfying the basic requirements of industry. Besides, agrotechnique methods, raising efficiency of plants and quality of fruits of seabuckthorn, are also developed. Experts on

processing develop new products on a basis of seabuckthorn raw material. Thus, the powerful information base for a global spreading of this plant has been created.

Seabuckthorn industry, as well as gardening is a high capital-intensive venture, characterizing the long period of a payback. Therefore, before establishing of new seabuckthorn plantations, it is strongly recommended to studying all technological points, organizational and market conditions. High productive plantations of seabuckthorn can be achieved only by complex of operations, which require skillful specialists in the choice and preparation of a site, selection of cultivars in view of the subsequent commodity markets, care of a young and fruit bearing garden, a choice of harvesting ways etc.

This article is as an attempt to estimate optimum approaches for the cultivation of commercial scale plantations of seabuckthorn, based on the scientific data and experiences. We refer to industrial plantations only that ones which occupied not less than 100 hectares. Results are recommended for Western Siberia conditions, however, the majority of elements of technology are universal and can be transferred and used in other regions of the world as well.

The technologies for the propagation and cultivation of seabuckthorn plantations have been standardized at the Lisavenko Research Institute of Horticulture for Siberia for many years. Improved methods are approved for the significant areas of Altai territory, nearby territories, and also distant regions. Cultivation, applying of mineral and organic fertilizers, system of irrigation, manual gathering of fruits etc. under the conditions of the shortage of labour and material resources need the regular technological up gradation to minimize the cultivation expenses and labour input.

The list of basic elements of technology of seabuckthorn cultivation is well known and does not differ significantly from the majority of other fruit and berry cultures. The basic components are: site selection, cultivar choice, orchard management and harvesting etc. However each of these elements includes a lot of operations, which can considerably differ depending on different conditions such as ability of material and labour resources, ways of harvesting, utilization of raw material etc. To describe each case is not obviously possible, therefore the article describe a general situation developing in Russian agriculture today.

As it is known, the status of agriculture in Russia, particularly in Siberia is characterized by continuous reduction of the workers occupied in farming, expensive tools and insufficient government financial support. The horticultural branch undergoes similar problems. Siberia is territorially a risky agriculture, where even annual cultures frequently suffer from adverse climatic conditions, *e.g.* during winter period in East-Siberian, the temperature falling down to -48...-50°C. At the same time, substantial increase of temperature during vegetation due to intrusion of hot and dry air from the southern territories, proceeding for a long time, also is frequently observed. In such conditions, only insignificant amount of native garden cultures, such as honeysuckle, microcarpous apple and mountain ash can be recommended for the successful cultivation. We can say confidently, that under the conditions of extremely low temperatures during the winter period, insignificant snow level, unstable water supply in summer and poor soil fertility, no horticulture crop is comparable to seabuckthorn, which is most suitable under these conditions.

CULTIVATION TECHNOLOGIES

Climate

In Siberia, the basic limiting factor for seabuckthorn during the winter period is not catastrophically low temperatures of air, but high snow level and thawing weather. It is necessary to take into account the ability of plants of seabuckthorn to accumulate snow during blizzards. As a result of deep snow cover (over 120-150 cm), seabuckthorn plants could suffer not only from snow breakage, but also from damping off also. Therefore, planting of seabuckthorn on windward side of a forest belt is inadmissible. The culture essentially suffers from winter thawing weather. Plants of seabuckthorn

do not fall into a dormant period, that is why, even during short thawing weather, the level of physiological processes varies sharply, that can affect on wintering extremely negatively. This problem especially marked in Altai cultivars *(H. rhamnoides* ssp. *mongolica).* Inability of the Altai seabuckthorn to tolerate the long thawing weather is specified by Baltic and Scandinavian authors (Bruvelis, 2003; Jalakas *et al.,* 2003). Experts at the same time mark significant stability of subspecies *H. rhamnoides* ssp. *rhamnoides* to the hard conditions of this climate.

Therefore, for the moderate, continental climate conditions, territory of Siberia, the Far East, the European part of Russia, the north of Mongolia, northeast China and the similar regions, cultivation of the most productive seabuckthorn subspecies *H. rhamnoides* ssp. *mongolica* can be recommended. In Siberia, the seabuckthorn does not suffer significantly from spring frosts, however this phenomenon can be observed in southern regions of the country, where vegetation begins quite early and strong frosts are marked during flowering of seabuckthorn.

Site Selection

Botanical features of seabuckthorn are well investigated and fully described by Gatin (1963), Trofimov (1988), Ermakov and Faustov (1983), Panteleeva (2006) and by some other authors. Reviewing all these studies, we can make important conclusion about durability of seabuckthorn and possibility of its cultivation in a wide range of soil and climatic conditions. That is why the first condition for successful seabuckthorn industry, namely site selection, is not so critical as we have got used to think for other crops.

In spite of common opinion on preference of seabuckthorn in light sandy soils, our experience proves that durable, steadily fructifying and highly productive plantations are observed on fertile soils with high water capacity of black-earth type. It does not mean about impossibility of cultivation of seabuckthorn on other types of soils, in particular forestry dark grey soil etc. However under other equal conditions, productivity in the latter case is marked at lower level. The author have no experience in cultivation of seabuckthorn in heavy clay soils; however, the majority of researchers mark that such type of soils are unsuitable for seabuckthorn, where the plantation poorly develop and early die off. A t the same time, Kondrashov (1998) working in Rostov Region on a very rigid background, heavy-loam soil has achieved high productivity for some selection forms up to 15.4 t/hectare, depending on the wither resistance and characteristics of seabuckthorn plants. Moreover, even wither resistant forms of seabuckthorn have been breed, showing high productivity on the specified heavy soils.

Time of Planting

The priority of early spring planting is specified in the majority of Russian studies. But we are sure, this recommendation is most suitable for private plots and small plantations, as this time of plantation, we make sure the irrigation for the crop during summer. However, spring planting without irrigation even in a forest-steppe zone of Altai territory results in weak survival of saplings, because of a periodic drought in May-June. However, early spring planting on large scale for commercial purpose is not possible for the organizational reasons, because of long time consumption in digging out of saplings from nurseries. Long transportation of saplings, and as usual its storage before planting within several days is much more easily done in autumn period (October), rather than in spring (April). This experience has resulted in an autumn priority for establishing of large plantations for commercial or industrial purposes. According to our experience, as so as some other workers, autumn planting is quite allowable. Therefore, Severin (1993), while analyzing productivity of seabuckthorn in the various soil-climatic conditions on the state selection plots in Altai territory, Novosibirsk and Omsk areas, compared productivity of seabuckthorn planted during spring and autumn. Optimum time for autumn planting of seabuckthorn is 15-20 days prior to the beginning of the basic frosts, which is in conditions of Altai territory first 10-20 days of October. However, in Northern provinces of China, farmers do not use autumn planting because of winter damage of

seedlings. The reason of the later, probably, may be in superficial and late planting, whereas in conditions of Altai territory, the similar phenomenon is not marked.

Choice of Cultivars

The choice of a cultivar is the most important step to high productivity of a plantation. We understand the productivity as the complex concept, including biological productivity of a plantation, adaptability to manufacture, and profitable yield utilization. It is necessary to understand, that not only high productivity of plantations is providing a high financial component, differences in various types of berries cost (large and good shaped, sweet, high biologically active components activity, red colored and so on) may turn less productive plantation to more effective. Unfortunately, for this period of time in Russia, cost of raw material is not differentiated from quality, however the tendency on the internal and the world market develops on changes of the price from quantitative to qualitative characteristics. The correct variety choice, according to enterprise capacities and market demands, solves a 50 percent of task.

During a period of 70 years by the scientists of the Lisavenko Research Institute of Horticulture for Siberia, more than 40 cultivars of seabuckthorn have been bred. All varieties belong to subspecies *mongolica* and distinguish in high productivity, large fruit size, absence or insignificant amount of thorns, different period of ripening, a wide range of biochemical parameters, and also flavouring characteristics from very sour to sweet.

Productivity of modem varieties of seabuckthorn varies from 7.5 up to 18 t/h, the weight of 100 fruits: 62-120 g (with a maximum up to 140 g), length of a fruit steam: 3-6 mm, the contents of oil: 4.0-8.0 per cent, carotenoids: 15.0-48.0 mg/100 g, sugars: 5-10 per cent and acidity: 0.9-1.9 per cent. They seem to be good, however, it is necessary to note about essential disadvantages of the Altai varieties, main of which are susceptibility to withering (in Siberia basically *Fusarium* wilt), and also pest attack by seabuckthorn fly. Thus, before establishing these forms of seabuckthorn plot, it is necessary to realize that the plantation may be attacked by seabuckthorn fly, and also may suffer by wilting. Readiness for these problems should be reflected in a complex of agrotechnical operations in the seabuckthorn plantations.

There are no universal advices in the choice of cultivars. Taking into consideration the resource potential, the technical equipment available, prospective ways of harvesting and yield utilization, the cultivars are selected. Important point is a variety list in nearby nurseries. We recommend to planting two or three cultivars, differing in the ripening period with a range in 10-15 days. We should note, that varieties, completely suitable for winter gathering, have not been selected till now. A lot of researches were carried out in a direction of seabuckthorn selection, to find out the forms suitable for winter fruit gathering, and creating of late-ripening group, but we are still in search and can not recommend to emphasis on such type of harvesting on industrial volumes. Significant losses of biochemical components as a result of periodic frosts and thawing of fruits, destruction of a part of a crop by birds can reduce the efficiency of a plantation up to 30-50 per cent. The characteristics of various seabuckthorn cultivars growing at Lisavenko Institute are given in Table 1.

Table 1: The Main Characteristics of SBT Cultivars Selected by the Lisavenko Institute

Cultivar	*Sugar, %*	*Acids, %*	*Oil, %*	*VC mg/ 100 g*	*Carotenoides, mg/100 g*	*Mass 100 berries, g*	*Yield, t/hectare**
Novosl Altaya	5.5	1.6	4.5	50	14.3	50	9.8
Maslichnaya	4.0	1.5	5.7	64	10.6	37	10.2
Dar Katuni	5.3	1.6	6.9	66	13.0	40	9.6
Zololoy Pochatok	4.8	1.5	7.1	68	12.8	40	10.2

Vltaminnaya	4.6	1.6	5.9	125	13.0	57	10.0
Zivko	6.2	1.2	6.3	53	48.2	56	13.0
Chuyskaya	6.4	1.7	6.2	134	13.7	89	18.0
Chulishmanka	8.0	1.4	6.2	169	23.3	62	12.5
Chechek	7.8	1.3	7.8	157	24.7	77	15.1
Tenga	7.0	1.3	4.9	110	21.0	67	13.0
Inya	5.2	1.7	4.0	80	25.0	85	14.9
Elizaveta	6.2	1.3 *	4.8	80	19.0	100	12.7
Altayakaya	9.7	1.1	7.0	98	18.0	75	13.0
Avgustina	9.6	1.6	6.7	82	20.0	120	7.5
Agurnaya	8.3	1.9	6.2	112	12.7	110	7.5
Dzhemovaya	7.6	1 0	8.0	154	29.3	75	7.5

*Plant scheme 4x2 m

Analyzing of this data, the high productivity of the most varieties is well marked; last three cultivars are semi-dwarf and recommended for dense planting. But receiving such results in field practice as usual are not possible due to a lot of reasons, several of them are bottlenecks of the agricultural methods, which affecting basically both in weeds and pest-disease condition, absence of satisfactory irrigation, difficulty in complete harvesting etc. A real productivity, which is possible to expect for the average plantation, is about 10 tons per hectare. In Russian market, if we take into consideration the developing prices for the raw material, profit will makes $ US 3000 per hectare.

The extremely important part of cultivation technology of seabuckthorn, improperly applied may result to high mortality of seedlings. Experience shows, that in many cases, the farmers' enthusiasm falling down after the first month following the planting. Poor seedlings survival restricted the following management of the plantation.

Quality of Planting Material

To reduce the influence of negative factors of the environment during initial stage of development of plants, it is very important to use a qualitative planting material. In Russia, quality of a plant material of seabuckthorn is regulated by branch standard. The standard 2-year plant material of seabuckthorn should have the stem diameter not less than 15 mm for the first grade and 8-10 mm stem diameter for the second grade; length of roots of 20-25 cm with 4 branches and 15-20 cm with 3 branches, respectively. The seedlings height should be not less than 50-60 cm for the first grade and 35-50 cm for the second grade. At the same time, one-year standard seedlings have a regulation on height, which should be not less than 30 cm.

The specialized nurseries suggest the use of both 1-year-old and 2-year-old saplings. We understand one-year-old saplings as plants grew up for one vegetative season. If the sapling is dug out in the autumn (October), the actual age of plants is 3 months for those which are prepared from green cuttings, and 5 months for hard wood cuttings. Two-year-old saplings are understood to be growing in nursery during two seasons. Their actual age would be 15 and 17 months respectively.

For establishing of industrial plantation in 100 hectares is required from 125,000 up to 160,000 saplings, depending on planting space chosen. Purchasing of top-quality 2-year-old plants for such area, for example, in one of the worldwide known nursery of the Lisavenko Institute will cost about US$100,000. Such huge sums can strongly reduce a desire to be engaged in gardening, especial taking into consideration a slow return of the investments. To reduce cost, some enterprises can

organize propagation by themselves, which is possible after signing of license contracts with supplier or patentee. However, the propagation required additional time, therefore, the first yield is delayed for 4-5 years.

As alternative, the significant reducing of the total cost of plantation can be done by using a one-year planting material. In this case, the investment in plant material decreases twice as minimum. Seabuckthorn seedlings of such type are mainly sold by Lisavenko nursery. There are two ways in planting of the one-year material: one of them is organizing of nursery, where growing seedlings for one season. Another way is using of top-quality one-year seedlings, during establishing of plantation. It results in comparable productivity with the plantations by two-year seedlings. This explains by small damages of root system of first one during digging out, therefore they feel better, much less seeking, what summarizing in more active growth. Such way of planting is highly required in optimum irrigation, especially for the first year, mainly during leaves sprouting. It is established, that seabuckthorn in the first year develops by 50-70 per cent better on the irrigation, than in dry conditions. There is enough 2-3 watering during the most important periods (April-June). However it is obvious, that watering on large scales is a very expensive action, and only rich enterprises may afford to organize the irrigation system.

Plantation Methods

Ways of planting may differ depending on the local resources, *i.e.* manual or machine planning.

Manual Planting

Manual planting of 1-year seabuckthorn seedlings is carried out in 20 cm deep furrows. For a 2-years old material, furrows are prepared to a depth up to 30 cm. As a rule, three workers, one of Which goes over the furrows, keeping seedlings in vertical position and simultaneously tightens it, two others strewing it by ground, make manual planting. Productivity in this case is approximately up to 1.5 hectares. Two triples are served by one worker spreading of seedlings. Therefore, planting of a site is 100 hectares will demand about 230-250 man-days.

Planting Machine

Machine planting is more progressive way and carried out on large scale. There are some types of machines for planting. For years, model MPS-1 is intended for the mechanized planting of small-berries, fruit and flower cultures. Its productivity ranges from 500 up to 1800 plants per hour, or about 0.5-1.0 hectares. We use intra row spacing, not less 25 cm, inter-rows not less than 1.8 m. However, release of this machine now is stopped and it is much easier to buy a forest-planting machine; several models of which are represented in the Russian market. There are hinged machines for planting of one-year and two-year seedlings of arboreal and shrub species can be found in timber enterprises: single row (SLN-1, LMD-1) and double-rows (SLN-2). Double-rows machines are not used in seabuckthorn plantations, because of small inter-row space (no more than 2 m). Planting mechanism of SLN-1, which delivers seedlings in a furrow, is set in motion from carrier wheels of the machine during its movement. Furrows are made by ploughshare. Productivity of the machine is 0.25-0.6 hectares per hour, plant spacing is 0.5, 0.75 and 1.0 m; and depth of planting is 25-27 cm. Machine LMD-1 is more productive, and is capable to plant up to 4000 seedlings (approx. 3 hectares) per 1 h. However, such productivity is possible only for small seedlings with high in-row density. For seabuckthorn, seedlings than in-row spacing range from 1.5 to 2.0 m, this machine can plant no more than 1 hectare per hour. Depth of ploughshare run is 23-27 cm, plant spacing 37, 55, 75, 110 cm. As analogue, the model MLU-1A has been released nowadays. Two workers run the machine; however for convenient planting, no less than two additional persons are required for preparing mash and delivering wetted seedlings to the machine. Thus, labour expenses are within the 50-60 man-days per 100 hectares, that is 8-10 times less in comparison with manual planting.

Any way of planting requires further seedlings setting directed on strictly vertical position. Number of experts express opinion on expediency of inclined planting, stipulating it by a formation of a sprawling wide crown. However, our investigations show a delay in growth and, finally, decrease in efficiency of the plants, formed in such way. In formation of a sprawling crown cutting of the leading shouts of young plants on 30 per cent is more effective. In this case, intensive growth of lateral shoots and formation of a productive bush is observed. Cutting is required also for the next years, but it has и sanitary character and as a rule is not carried out on the big areas.

Irrigation

As we mentioned before, water supply is very important especially for young seabuckthorn plantations. But expensive irrigation installations force us to the necessity of searching for the ways of water regulation. The main source for additional water supply in Siberia is winter precipitations. Rainfall saving is also too important. The complete and wide accessible methodical manual for such kind of activity, you can find at proceedings of academician Habarov. He offers ways of regulation of a water mode and optimization of the processes, occurring in community of garden cultures for different soil-climatic conditions. But, there is some specific exist in considered type of plantation. Unfortunately, the theory of modeling blocks, which ideally suitable to the industrial garden including a lot of cultures, unsuitable for a monoculture. Moreover, necessity of protective forest belts on seabuckthorn plantations is under the doubts. On the one hand, the positive role of forest belts on the microclimate of a garden is well-known, but on the other hand, additional expenses for forest belts planting, significant ground area, occupied by them (up to 10-15 per cent), their weak work in the first years of growth, result to an idea about inexpediency of their use. Planting of forest belts with prospect on reusable use of plantations can be justified, if after seabuckthorn, the field will be occupied with other cultures demanding similar conditions. But it is necessary to know what after planting seabuckthorn is not recommended. Growth of harmful organisms affect decrease in efficiency, increase the cases of withering, caused by group of fungi, in Altai territory mainly by *Fusarium.*

Drainage

Long-term studies show that a local drain regulation in borders of an industrial garden, is possible only by using system of soil-protection measures. The system includes three basic components: creation of water banks, covering a whole garden and subdividing it on separate contours; water-retaining deep ditches with organic filler, on border of each separate quarter of a garden; agro constructions, used in inter-rows, such as drowned checks, alternation deep draining ditch, strip grassing, deep annual cultivation on the crone projection (Habarov).

Creation of bank (height up to 1 m) with a direction of a water stream in specially organized slope drowns is very effective action directed on the regulation of a drain. It is established that the water-modular area is necessary for flooding of drown by the area of 1 hectare is from 15 up to 20 hectares. Thus the water levels in drown reaches 40-60 cm. Such flooding adversely affects development of the majority of garden cultures, however the seabuckthorn is exception. Such action provides increase in efficiency of seabuckthorn in comparison with dry conditions in two and more times, reaching a level of 30 tons per hectare (at the planting space 4x1 m).

Besides some positives, it has also some disadvantages. The basic lacks are: necessity of significant material inputs, and also necessity of special hydroengineering preparation. From the point of view of additional water delivery, these hydroconstructions are less productive. Water-retaining ditches are also ineffective from this point of view, which in the greater degree promote reduction of erosive processes, than to uniform distribution of moisture on a site. The most comprehensive and accessible way of water regulation, in our opinion, is creation of drowned checks

(shafts), which are formed after planting and look like the closed quadrangles in length up to 10-15 m, depending on a steepness of slope of a site. Soil banks in height up to 30 cm are made by bulldozer, appreciably retain spring water, and rainfalls also. In result, the favorable humidifying on checks is observed up to second half of July, while on the control, only to the beginning of June.

Weeding

Soil Management

One of responsible and discussible element of seabuckthorn cultivation technology is the soil management. This element is more important for young gardens, where weak plants are not capable to compete with abundant weeds for soil moisture and minerals. Generally, the recommendations are keeping soil in a garden as black fallow. However, in some circumstances to support soil according to such type is not only labour consuming, but also economically inexpedient. It is clear that numerous manual weeding in rows demands the huge man power, that is practically impossible. Alternative methods of weed control include grassing, green manure crop sowing, mulching of trunk stripes and application of herbicides. The way of full grassing cannot be recommended because of strong competition for moisture between grasses and a crop like seabuckthorn, that finally decrease the development of young plants of the crop. The way of alternated grassing is more comprehensible, however also demands manual skills at weeding.

Straw Mulching

We find as high effective agrotechnical method of weed control is mulching of straw. In experiment carried out by Mihailova, it is established, that mulching by using of straw at the rate of 4.2 kg per linear meter is the most effective. Besides absence of weeds, the moisture capacity under straw is significantly increased. However, such way demands up to 1000 tons straw per 100 hectare of seabuckthorn plantation. That is why we do not recommend this way on big plantations.

Green Manure Crops

Another alternative is application of the green manure crop as mulching. In areas of sufficient humidity, such way is very effective. Sowing of green manure crop improves the fertility and decreasing soil erosion, while reducing the weed spreading up to 30 times. Thus, we consider sowing of green manure crops at the end of June, and cutting at the period of budding as the most economically justified system of soil management both for young and old-aged seabuckthorn plantations.

Herbicides

Chemical methods of weed control in seabuckthorn plantations have not been enough investigated and applied restrictedly. Influence of herbicides on withering of seabuckthorn, as also residues of them in berries and leaves are under discussion. Nevertheless, preliminary investigations of some herbicides show high efficiency of their application on seabuckthorn. Depending on a specific variety of weeds in a seabuckthorn plantation, various herbicides are applied. It is necessary to note, that in Russia in the list of the herbicides allowed for application in seabuckthorn, "Raundap" and Prometrin" are only permitted. The first preparation has a wide spectrum of action at a dose of 4 l/hectare (approximately $ US 700 per 100 hectares), well controlling majority of weeds. However, in fructifying plantations, a serious protection of seabuckthorn plants from hit of this herbicide on the leaves surface is required, that on the big plantations, which is practically impossible to provide. The second one "Prometrin" is a soil herbicide and controlling basically annual weeds. Using of it is limited by short period of time before seabuckthorn sprout leaves, and also demands favorable weather conditions during this period, in particular, damp and warm weather that promotes simultaneous germination of weeds and due to that a good action of a herbicide. Cost of its application is a little bit higher, if comparison to "Raundap". Depending on soil fertility, the norm of

treatment is from 4 up to 6 l/hectare, and the price is within the limits of US $ 1000-1500 per 100 hectares.

The known limits of application of both herbicides demand to conduct searching for the alternative means of chemical protection of fructifying seabuckthorn plantations. Thus monocotyledonous weed-control much easier because of dicotyledonous nature of seabuckthorn. It is possible to achieve a significant reduction of weeds in seabuckthorn plantation without causing harm to a cultural plant using of some antigramineous herbicides. Controlling of dicotyledonous weeds is more problematic.

Nevertheless preliminary tests were successfully passed using "Lontrel" at a dose of 0.6 l/hectare. Destroying a majority of dicotyledonous weeds, it does not injure a plant of seabuckthorn at the same time. Thus, applying mixture of Lontrel in a combination with antigramineous herbicides is the most effective method of chemical weed-control of fructifying plantations of seabuckthorn. Cost of such treatment is the same or a little bit higher in comparison to described earlier, makes up to $ US 1500 per 100 hectares. It is necessary to use these herbicides during the period from the middle up to the end of June during mass weed growing. The chemical analysis of residual amount of pesticides has shown their full absence in the fruits to the period of harvesting. However, despite positive aspects of using of the above herbicides, their absence in the list of allowed herbicides on seabuckthorn, does not allow us to recommend their wide application on industrial scales.

Pests and Diseases

Each region has specific pests and diseases. In the western Siberia, the most dangerous pest is seabuckthorn fly, and the basic disease *Fusarium* wilt. If the first one is under chemical control, the second one does not have any real treatment, and consider as the most dangerous phenomenon, which is capable destroying a large-scale plantation. The diseases leads to sudden yellowing of leaves, darkening of a bark with the further dying off of the dried branches and plants as a whole. Neither chemical, nor agrotechnical methods of controlling are not revealed yet. It is possible to count on varieties resistant to disease, but their productivity is incomparable to the best ones. The investigations have shown, that neither the structural composition of soil, nor methods of its management and irrigation influence the withering processes. Predecessor crops have an important role in spread of disease, where *Fusarium* bearing plants should be present in the field. Therefore, it is also undesirable to plant seabuckthorn after another seabuckthorn crop. In another case, a disaster withering of seabuckthorn up to 50 per cent and more might be registered. The matter of fact that at present time, the establishing of seabuckthorn plantations even with high qualitative plant material should meant approximately 10 per cent losses of plants. There are a lot of recommendations about reduction of this disaster in literature, however our experience shows, that selection of a proper cultivar for cultivation is a real way to find the solution of a problem.

Harvesting

Generally, harvesting of seabuckthorn is the most difficult operation of seabuckthorn cultivation and searching the ways of mechanization of process occupies minds of many researchers. Undoubtedly, only labour-rich facilities can afford to itself manual picking of seabuckthorn. At the same time, the labour cost for seabuckthorn picking can rise up to 25 per cent per kilogram. Such level of labour receive up to $ US 30, while collecting 100-150 kg of fruits of seabuckthorn per 8 hours. Even such high cost of gathering allows us achieving a high level of profitability in an enterprise. Thus, for harvesting of seabuckthorn plantation in 100 hectares with productivity of 5 tons per hectare, it is required from 3,000 to 3,500 man days. In other words, about 100 skilled workers are capable to gather a yield completely for 30-40 days. But not many varieties are capable of so high efficiency in harvesting. For manual picking "Chuyskaya" is the most perspective cultivar, as so "Panteleevskaya", "Inya" and “Elizaveta". In a word, the myth about complexity of harvesting of seabuckthorn berries is considerably exaggerated. It is much difficult to gathering the majority of other garden cultures such as currant, raspberry, strawberry, honeysuckle, cherry, etc.

In spite of attractive financial side, nowadays, it is more and more difficult to involve workers in gathering of fruits of seabuckthorn. In this connection, there is a necessity for search of ways as full mechanization, so as to partly reduce the expenditures of labour in this operation. We shall not describe all possible approaches to partial or full mechanization of harvesting, we shall notice only, that most of them are only hypothetical and can not be applying in many cases. The deterrent here is absence of universal remedies, suitable for all conditions and varieties. Besides, release of similar technical equipment is not easy, and in this connection, purchase of similar special equipment is problematic.

We consider cutting of fructifying branches with the subsequent shaking them on vibrating installations as one of the real way of reduction of labour expenses by manual way, which is applied these days during seabuckthorn harvesting. The design of these installations was developed in many institutes of Russia and abroad and different models essentially do not differ from each other. Here we should not discuss a principle of action of these mechanisms, because it is well known, but we shall consider very important and responsible moment the cutting technology of fructifying branches.

Mechanical harvesting has both positive and negative sides. The known periodicity of fructification is the basic disadvantage of this method. However, there is not absolutely true opinion that gathering seabuckthorn by cutting differs by biannual periodicity. Actually, full productivity of plants, which were cut on 3-years wood, is restored only for the third year. Moreover, partial withering of strongly cut plants is possible, especially in droughty years. It is important to know, that gathering of all fruits of seabuckthorn by cuttings is ineffective. There is considered as an optimum gathering up to 60 per cent of branches by means of cutting. Fructifying branches free of sprouts, or with weak ones, total length of which do not exceeding 2-year-old fructifying part are under cutting. In such way, the sum of crops for some years exceeds those on a variant with full cutting for 30-50 per cent. The offered method of cleaning demands special training of collectors, but differs by high efficiency. Productivity on gathering increases by 3-5 times in comparison with manual way. Here we should mention that it is important to compare the mechanical type of harvesting to manual gathering not only by efficiency, but by productivity for the area also. Plants after manual gathering keep not less than 20 per cent of berries; besides significant damages of plants as result of barbarous breaks and branches cleaning are marked. Thus, in practice, the total productivity in cutting is registered not below than the manual gathering. Moreover this method allows receiving fruits with high quality, suitable for further utilization.

CONCLUSION

Cultivation methods of seabuckthorn have been standardized especially for Siberian conditions In Russia. However, still studies are required for improvement of appropriate cultivation technologies specific to local conditions arid various cultivars, particularly diseases and pest control. As a conclusion, we would like to notice, that in spite of all possible difficulties in cultivation of seabuckthorn plantations, such venture is extremely promising and will award careful and competent farmer by constantly high yields In order to promote seabuckthorn cultivation, there is need a for establishment of enough processing enterprises and proper marketing. In this connection, the small plantations become less perspective. Demand and the price for raw material grow at constant high rates. And nowadays, there in a best time for establishing of scale seabuckthorn plantations, considering increasing demand in local and global markets.

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