International Conference

Vaccinium spp. and Less Known Small Fruits: Cultivation and health benefit

and

COST 863 Euroberry Research: from Genomics to Sustainable Production, Quality and Health, Joint Meeting WG 3&4

Dedicated to 65th anniversary of prof. Ján Matuškovič

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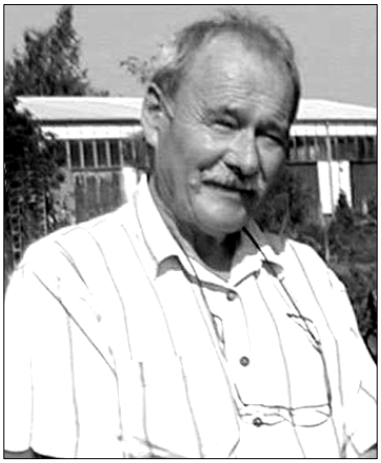

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Dedicated to 65th anniversary of Prof. Ing. Ján Matuškovič, Ph.D.

On November 2007 will Prof. Ing. Ján Matuškovič, Ph.D. celebrate his 65th birthday anniversary. Ján Matuškovič was born on November 12, 1942 in Kysucké Nové Mesto, Slovak Republic.

The first scientific steps of Ján Matuškovič were - and are still oriented in horticulture sciences. Beginnings of his research activities have been connected with Research Institute of Plant Production in Piešťany, where he participated in solving of different agrotechnological problems concerning the cultivation of peaches and apricots. His further research activities at the Slovak Agriculture University in Nitra were focused on another three plant species, such as strawberry, honeyberry and pomegranate.

In 1997 Prof. Ján Matuškovič started his pedagogical activities at the Department of Horticulture and Agrometeorology of Agronomical Faculty of the Slovak University of Agriculture in Nitra. During his pedagogical acting at the AUA he brought up many graduated as well as Ph.D. students. Except for teaching activities he was also a member, and later on the vice-president, of the Academical Tribunal of Faculty of Horticulture and Landscape Engineering and a member of several university´s scietific commissions as well. Prof. Ján Matuškovič was principal investigator of many scientific research projects focused on horticultural agrotechnology.

He is very active in publishing of scientific papers, educational texts and monographs.

Among the Slovak scientific community, the Prof. Ing. Ján Matuškovič, is considered as a recognized scientist, reputable university teacher, and for all of as, surely - a good colleague and friend.

CONTENT

PLENARY SESSION I

Sustainable production systems: State and trends in the control of crop properties

PRODUCTION OF BERRY FRUITS IN POLAND - PRESENT SITUATION AND DEVELOPMENT PROSPECTS

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Berry fruits are valued for their high quality of taste, high nutrition and health values, as well as their great potential for being processed. That is why commercial production of berry fruits on the European continent has a long tradition. From the beginning of the previous century, the growing of berry plants, except for grapevines, developed most rapidly in such countries as Great Britain, Germany, The Netherlands and France. After the Second World War, the range of berry plants cultivated in Europe has been increasing gradually. Since the second half of the previous century, Poland has become one of the Central European countries in which a very rapid increase in the total size of berry plantations has been taking place, especially those of strawberry, black currant and raspberry (Table 1). This has been favoured by soil and climatic conditions, as well as the economic situation. After the war, Polish agriculture managed to escape collectivization, which had the effect that the highly labour-intensive harvesting of berry fruits on small family farms did not pose much of a problem. Besides, Polish farmers have always earned higher incomes from growing berry plants than from growing typically agricultural crops. High labour costs in the countries of Western Europe have also made Polish berry fruit producers highly competitive against producers in the West.

An invaluable role in the development of berry plant cultivation in Poland has been played by the research work carried out since the beginning of the 1950s at the Institute of Pomology and Floriculture in Skierniewice, as well as agricultural universities. The research has concerned methods of producing healthy nursery plant material, free from serious diseases and pests, development of fertilization methods, protection of plantations against pests, diseases and weeds, and also ways of improving the technologies of mechanical fruit harvesting.

A significant role in developing this area of fruit production was played by the work on the selection of cultivars suitable for growing in the climatic conditions of Poland. In the beginning, Polish producers took advantage of the achievements of mainly foreign breeders. Thus, as a result of the German cultivar ‘Senga Sengana’ becoming widely grown, Poland has quickly become the most important producer and exporter of strawberry in Europe. In the soil and climatic conditions of Poland, this particular cultivar demonstrates high productivity, high tolerance to diseases of the root system, good fruit quality, but especially high processing value. However, the constant increase in the total area of ‘Senga Sengana’ plantations every year has resulted in an overproduction of strawberry destined for processing. This situation has made Polish producers become interested in the production of dessert strawberry. Consequently, in the past few years, a large number of valuable strawberry cultivars producing dessert fruits have been introduced to cultivation, such as: ‘Elsanta’, ‘Kent’, ‘Honeoye’, and numerous other cultivars bred at the Institute of Pomology and Floriculture in Skierniewice, for example, ‘Dukat’, ‘Elkat’, ‘Era’, ‘Fara’, ‘Filon’, ‘Feriusz’ and ‘Salut’.

Like in the case of strawberry, cultivars of foreign origin dominated until recently in the cultivation of other species of berry plants. In the production of black currant, a very high percentage constituted the cultivars ‘Roodknop’, ‘Ojebyn’ and ‘Titania’, which

were later supplanted by cultivars more resistant to pests and diseases, and suitable for mechanical harvesting such as: 'Ben Alder', 'Ben Connan', 'Ben Lomond', 'Ben Nevis', and 'Ben Tirran'. Recently, however, the achievements of Polish breeding efforts, such as: 'Tiben', 'Tisel', 'Ores', 'Ruben' and 'Tines', have been introduced. The Polish cultivar 'Bona' is currently recommended for the production of dessert fruits of black currant, and for growing in home gardens.

Even a bigger revolution has taken place among raspberry cultivars. In the case of this species, new Polish cultivars, bred by Jan Danek at the Fruit-growing Station of the Institute of Pomology and Floriculture in Brzezna, are soon going to completely supplant foreign cultivars. Among the new Polish cultivars there are both the traditional raspberry cultivars such as 'Benefis', 'Beskid', 'Laszka' and 'Nawojka', and repeat-fruiting cultivars: 'Polana', 'Polka', 'Pokusa', 'Polesie', 'Poranna Rosa'. All of them are very highly valued by fruit producers and consumers, both at home and abroad.

The recent years in Poland also mark an unprecedented boom in highbush blueberry cultivation. It is estimated that this plant species is now grown in Poland on a surface area of over 2000 ha, and interest in it is still growing as it brings producers considerable benefits. Again, scientific research has played a very big role in the development of highbush blueberry cultivation in Poland. In the case of blueberry, which a few dozen years ago was still completely unknown to an average European, scientific knowledge was of particularly great importance. Today, when the soil and climatic requirements of blueberry are known, the focus of research is mainly on improving the selection of cultivars. More information on the subject of the studies carried out on blueberry and other species of berry plants will be presented in separate papers at today's Conference.

The research work on berry plants carried out at the Department of Cultivar Evaluation and Nurseries of the Institute of Pomology and Floriculture in Skierniewice now involves as yet not very common species of berry plants that are of particular importance to human health. The research is oriented towards learning their soil and climatic requirements, improving cultivation technologies, and introducing these species to common cultivation. They include, among others, large-fruited (American) cranberry, blackberry, chokeberry, Kamtchatka berry, sea buckthorn, Cornelian cherry, and large-fruited rose. A major part of this work will be also devoted to grapevine growing and wine production.

Table 1. Annual berry fruit harvest according to GUS (Polish Bureau of Statistics)

Species	Yield (thousands of tonnes)			
	2003	***2004***	***2005***	***2006***
Strawberry	131	186	185	194
Raspberry	43	57	65	53
Black currant	192	194	187	195
Gooseberry	20	20	17	16
Other	47	45	46	48

SEA BUCKTHORN, AN INTERESTING SPECIES FOR COSMETIC INDUSTRY

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The pulp of sea buckthorn (*Hippophaë rhamnoides* L.) fruits is very rich in various antioxidants. Various genotypes of sea buckthorn were evaluated in order to select the best suited genotype for cosmetic industry.

Considerable differences in the composition of the fruit pulp were noted between genotypes from alpine and oriental regions. The alpine genotypes, richer in antioxidant agents and poorer in fatty substance, were retained by the cosmetic industry.

An analysis of the evolution of the berries during maturity showed a maximal vitamin C content in the fruits at the very beginning of fruit colouring. However the flavonoid and acid content of the fruits remained stable during the whole maturation period.

MORPHOLOGICAL AND CHEMICAL PECULIARITIES OF EUROPEAN CRANBERRY

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Collection of wild local samples of European cranberry (*Oxycoccus palustris*) species was established in Kaunas Botanical Garden. The samples were picked at several swamps in Lithuania and propagated vegetatively at field collection. Evaluation of more than 100 collection samples from different ecological habitats was done and large variability of samples was observed. Analysis showed that many collection samples were not only ecotypes but also clones with stable characteristics. Comparison of berry shape, color, and average weight revealed high variability of clones. The shape was round, cylindrical, oblate or oval. The color was red or dark red mainly but some clones had pink or purple berries. The average berry weight was 0.94 g and it variable from 0.6 up to 1.5 depending on the clones. Variation of berry weight inside clone was low (V<10%). Some clones formed not only very large berries but a high yield (1.5 – 2.5 kg/sq.m) as well.

The clones of cranberry were compared according to chemical composition. The total amount of phenolics and total amount of anthocyanins in the berries were compared. The clones accumulated from197 to 584 mg/100g of phenolic compounds and from 36 to 206 mg/100g of anthocyanins.

The time of phenological phases divided clones into two main phenotypes – early and late, with some intermediate clones.

Some differences in disease-resistance between clones were noted. Clones with dark red berries were less damaged by decay than ones with pink berries.

The weight of the berries and accumulation of biologically active substances are the most important characteristics for breeding work. Some of clones of European cranberry from ex situ collection of Kaunas Botanical Garden can fit for further breeding works.

CULTURAL AND PROPAGATION SEQUANCES OF THE HIGHBUSH BLUEBERRY

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At present, for the highbush blueberry culture there is on increasing interest both in Romania and many other countries of Europe and anywhere.

By common consent, for the high bush blueberry the light, sandy, low pH soil is the best type.

Such kind of soils are little spread in Romania, more accessible being the podzolic ones, medium to high clay content.

The application of the acid peat in the blueberry establishing and exploitation crop claims high investment costs. So, during 2000 – 2006 at the RIFG Pitesti some experiments using different materials in the blueberry crop, in order to reduce the expenses were carried out.

One experiment was settled by subdivided plots method with 3 replications and 6 bushes in the replication plot. The following 3 variants of material in the each hole planting there were used:
1 = acid peat mixed with manure (50% + 50%); 2 = coniferous soil; 3 = acid peat (50%) + manure (50%) + 40 g sulphur.

The second experiment was carried out in a 5 year old planting with 4 mulching variants: 1 = acid peat; 2 = tannin waste; 3 = sawdust; 4 = unmulched soil (control).

Also, the growth and development of the highbush blueberry crop are strongly dependent on planting material. The results of the common vegetative propagation both by hardwood and softwood cuttings are depending on many factors, such as: the cultivar, rooting conditions (substrates, stimulants, humidity, temperature), time of the cutting, etc.

In order to get the best propagation results for the new blueberry cvs: Simultan, Delicia, Compact, Lax, Azur, Augusta some experiments were conducted.

The influence on growth quality and yield of the planting and mulching material will be proved. Also, the response of the 6 new cvs to the different propagation methods in order to obtain the best quality of the planting material will be highlighted.

REACTION OF YOUNG BLUEBERRY AND CRANBERRY PLANTS TO MYCORRHIZAL FUNGI (ERM) ISOLATED FROM ECOSYSTEMS IN POLAND AND LATVIA

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Most members of *Ericaceae*, including highbush blueberry (*Vaccinium corymbosum* L.) and cranberry (*Vaccinium macrocarpon* Ait) are calcifuge plants that growth naturally in acid soils of low to moderate fertility and rich in organic matter. These specialized cultivation requirements make a barrier for their commercial production (Scagel, 2003).

The ericoid mycorrhiza (ERM) has been regarded as the most specific, limited to hosts belonging to the *Ericales*. This apparent specificity has driven much of the research into this symbiosis, especially in agrosystems which are far from demands of these plant genera. The function of the ERM fungi in agriculture system is, most probable, to cover nutrient demands of the plant growing under stress conditions, enhance tolerance to not optimal soil pH, limited water availability and increase soil stability (Straker, 1996; Midgley *et al*., 2006).

Variability in plant response to the different mycorrhiza fungi can be a major determinant of local plant species diversity. In the present study we crossed some number of fungal inoculum to determine the range of responses that can exist within symbionts: host plant and fungi.

The objective of these experiments was to evaluate reaction of blueberry and cranberry plantlets to fungi isolated from roots of plants belonging to *Ericaceae* and growing in natural ecosystems in Poland and Latvia.
Response of plants to particular inoculum, was assessed by morphological characterization of canopy and measurements of photosynthetic activity by chlorophyll fluorescence method. Other measurements as biomass production, chlorophyll and water content and leaf area were also done.

Materials and Methods. *Propagation:* Blueberry cv. 'Bluecrop' was propagated *in vitro* and rooted *ex vitro*. Cranberry cv. 'Pilgrim' was propagated by cuttings. *Mycorrhization:* Rooted plantlets were inoculated before planting into pots to the substrate. Inocula were based on fungi isolated from roots of several species belonging to *Ericaceae*, growing in ecosystems of Poland and Latvia. *Cultivation:* The plantlets were planted into substrate: peat-perlite-sand (5:1:1) with pH around 4.5. They were cultivated in greenhouse/plastic tunnel/field. The plants were fertilized with Osmocote Plus or Agriform Max (polish fertilizer). *Evaluation:* Plant response to mycorrhizal fungi was determined morphologically (length and number of shoots, leaf area) and physiologically (photosynthetic activity, dry matter and water content). Photosynthetic activity was measured with chlorophyll *a* fluorescence method.

Results and Discussion. *Blueberry.* Some inocula isolated from polish ecosystems stimulated shoot growth and leaf area. The most active were fungi originated from *Vaccinium myrtillus*, *Arctostaphylos uva-ursi* and *Vaccinium oxycoccus*. In most cases enlarged leaf area was negatively correlated with chlorophyll content. Particular inocula enhanced activity of light phase of photosynthesis but some of them decreased. Two of investigated inocula inhibited shoot growth. *Cranberry.* Shoot growth of cranberry was inhibited or unaffected by the same inocula which stimulated blueberry growth.

However, leaf area increased and photochemical activity was higher in inoculated plants.

Commercial berries production of both species without mycorrhizal component is difficult if possible at all. Cultivars of cranberry and the most cultivars of blueberry were originated in USA. It was documented that fungi developing symbiotic association with plants growing in North America are different than those in Europe (Straker, 1996). Thus, looking for microorganisms which are able to develop mycorrhizal symbiosis on American cultivars growing in Europe seems to be very important. The effectiveness of mycorrhization we assessed on young plants (nursery production), long before fruiting. For horticulturists the most important is yielding. Thus, complete evaluation of selected microorganisms we will be able to present in some time.

Aknowledgement

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DYNAMICS OF CYTOKININ LEVELS DURING FLOWER DEVELOPMENT IN RED AND WHITE CURRANT

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Plant hormones cytokinins were determined in flowers and leaves of white currant cv. Blanka and red currant cv. Vitan at the early and late flower stage. Plants infected with full blossom disease (FBD) and the healthy ones were compared. Full blossom disease (FBD) is characteristic by flower malformation, which prevents berry formation. As cytokinins play an important role during flower initiation and development, we checked whether increase in endogenous cytokinin content could serve as an early marker of FBD infection.

At the early flower stage, infected flowers of white and red currant exhibited only mild elevation of bioactive cytokinins in comparison with the healthy controls. They had significantly increased content of cytokinin phosphates (intermediates of cytokinin biosynthesis) as well as of total cytokinins. FBD had much lower impact on cytokinin levels in leaves. Only minor increase of bioactive cytokinin content was monitored in red current. In leaves of the white cultivar slightly lower bioactive cytokinin levels were compensated by the elevated content of cytokinin phosphates.

During the flower development content of bioactive cytokinins increased mildly in healthy plants. They had at the late flower stage significantly more cytokinin phosphates than at the onset of flowering. At the late stage considerable difference appeared in the infected plants between malformed flowers and those with normal morphology. Malformed flowers had significantly less cytokinin phosphates and more cytokinin deactivation products (glucosides) and inactive *cis*-zeatin derivatives. Leaves of infected plants had more cytokinin phosphates than the leaves of healthy plants, but also more inactive *cis*-zeatin derivatives (in white currant) or more inactive cytokinin glucosides (in red currant).

The results indicate that during flowering cytokinin content increased, especially in flowers. This phenomenon was not observed in malformed flowers, further development of which was prevented. The variance in cytokinin levels within infected as well as healthy plants was rather high. Thus the content of cytokinins could not be used as a reliable infection marker, even though FBD occurrence correlated with elevated cytokinin content.

Acknowledgement

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INVESTIGATIONS ON THE FRESH SEA BUCKTHORN BERRY QUALITY AT THE STORAGE TIME

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The value of sea buckthorn berries is well known and confirmed clinically. However, the shelf life of fresh berries in relatively warm room does not exceed seven days. To extend the shelf life of fresh berries different technologies can be used, as packing in polypropylene bags of different thickness and in ready-made PET/adhesive/PP containers supplied by "Huhtamaki". Gas mixture with initial composition of 10% of O2, 10% of CO_2, 80% of N_2 and ambient air as control were used. Containers were sealed on the sealing equipment "TECNOVAC Pratica". Packed sea buckthorn samples were stored at 4 ±1 º C temperatures for 50 days.

The aim of the study was to clear up the best packaging technology. The task of the investigations was to study the changes of CO_2 and O_2 content in containers and the quality of the berries during self life. To characterize the quality of the sea buckthorn berries color intensity of L*, a*, b* value were determined.

The study was carried out in Latvia State Institute of Fruit-Growing Fruit and Berry processing Centre and Packaging Material Testing Laboratory of the Faculty of Food Technology, Latvia University of Agriculture.

It was found that fresh sea buckthorn berries packed in ready-made PET/adhesive/PP containers can be stored at temperature 4 ± 1 ºC up to 30 days without any significant quality changes. Polypropylene bags of different thickness are not recommended for storage of fresh sea buckthorn berries.

THE EVALUATION OF THE NEW ACTINIDIA (HARDY KIWIFRUIT) GENOTYPES

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The breeding programs focused on the introduction of new species of *Actinidia* are being done in many countries (e.g. USA, Ukraine, and New Zealand). *Actinidia arguta* (Siebold *et* Zucc.) Planch ex. Miq., known for its frost resistance (up to -30 °C) is among these species. Its fruit with smooth skin, can be eaten without peeling. The fruit is aromatic with a sweet and intense flavour, similar to that of banana, pineapple, strawberry, pear, blackcurrant, melon and other tropical fruits (Matich *et al*., 2003). Today, hardy kiwifruit are grown commercially in New Zealand, Canada, USA, Chile, and some parts of Europe (Ferguson, 1999). The most commonly planted cultivar of *A. arguta* is Ananasnaja, also known as Anna (Strik and Hummer, 2006). Some another cultivars such as Weiki, Geneva, Jumbo, Ken's Red are now available on the Polish horticultural market (Latocha, 2006) and first their commercial plantings have been established (Werner, 2002). To maximize the production potential and commercialization of actinidia, the breeding program at SGGW, Poland has developed new promising female genotypes of hardy kiwifruit. They were obtained by free pollination of *A. arguta* and crossings of *A. arguta* and *A. purpurea*. In this paper we summarised the results of testing five our genotypes with comparison to three cultivars (including Anna as a most popular of them) and *A. purpurea* (Table 1).

In 2005 and 2006, these genotypes were subjected to fruit sensory taste (sweetness, flavour, aroma) and morphological assessments. Chemical analyses including soluble solid content (SSC), titratable acidity (TA) and dry mass (DM) were evaluated. Thirty vine-ripened fruits were randomly selected (ten fruits, 3X) and submitted for morphological and some chemical analyses. Sensory analyses, described as impression of taste, flavour, aroma of fruit were carried out using an expert panel. Quantitative Description Analysis – (QDA) was made according to instruction in PN-ISO 11035.

Female genotype L1 produced the biggest fruit and genotype D11 the smallest one, with an average mass of 8.88 and 5.61 g respectively. Genotypes L1 and M1 were round with green skin and green flesh; while genotype D11 produced fruits with red skin and flesh. Chemical characterization is important to demonstrate fruit quality. In our study, the highest level of SSC was found in genotype D11 (23.4%) and the lowest in Ananasnaja (19%). The higher level of acidity was measured for genotypes D14, D8 and L1 (1.048, 1.000, 0.986 % citric acid respectively) and the lowest in Ananasnaja (0.739% citric acid). Consumer acceptance and purchase behaviour of new hardy kiwifruit cultivars is dependent on fruit aroma and flavour (Wismer *et al*., 2005). All the tested genotypes except for *A. purpurea* were well accepted by the expert panelist (Fig.1). *Actinidia purpurea* with the lowest level of sweetness and higher of both sourness and tartness, received the lowest acceptance. Experts also appreciated the sweet and aromatic flavour of the flesh and the considerably sour taste of the skin of the tasted fruits. The "overall quality" is a very good indicator of consumer acceptance. According to this marker genotype L1 got the most acceptance, which was connected with very intensive aroma, higher sweetness, and lower sourness and tartness.

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Table 1. Results of morphological analyses of tested genotypes

Genotype	Weight (g)	Fruits' shape	Skin color	Flesh color
D8 (*A. arguta* × *A. purpurea*)	7.21 bc*	Ball-shaped, strongly flattened	Greenish yellow	Light green
D11 (*A. arguta* × *A. purpurea*)	5.61 a	Ball-shaped	Red	Pink red
D14 (*A. arguta* × *A. purpurea*)	6.07 ab	Elongated, slightly flattened	Light green with pink blush	Light green
L1 *(A. arguta)*	8.88 e	Ball-shaped	Green with light bronze blush	Green
M1 *(A. arguta)*	7.73 cde	Ball-shaped slightly flattened	Green with light bronze blush	Green
Sientiabrskaja *(A. arguta)*	7.26c	Elongated	Green	Green
National Arboretum 7 *(A. arguta)*	6.68 abc	Ball-shaped	Green with light bronze blush	Green
A. purpurea	7.62 cd	Elongated	Purple red	Purple
Ananasnaja (=Anna) *(A. arguta)*	8.67 de	Elongated	Green with red blush	Dark green

** Different letters within a row indicate significant differences at p≤0.01 separated by LSD test*

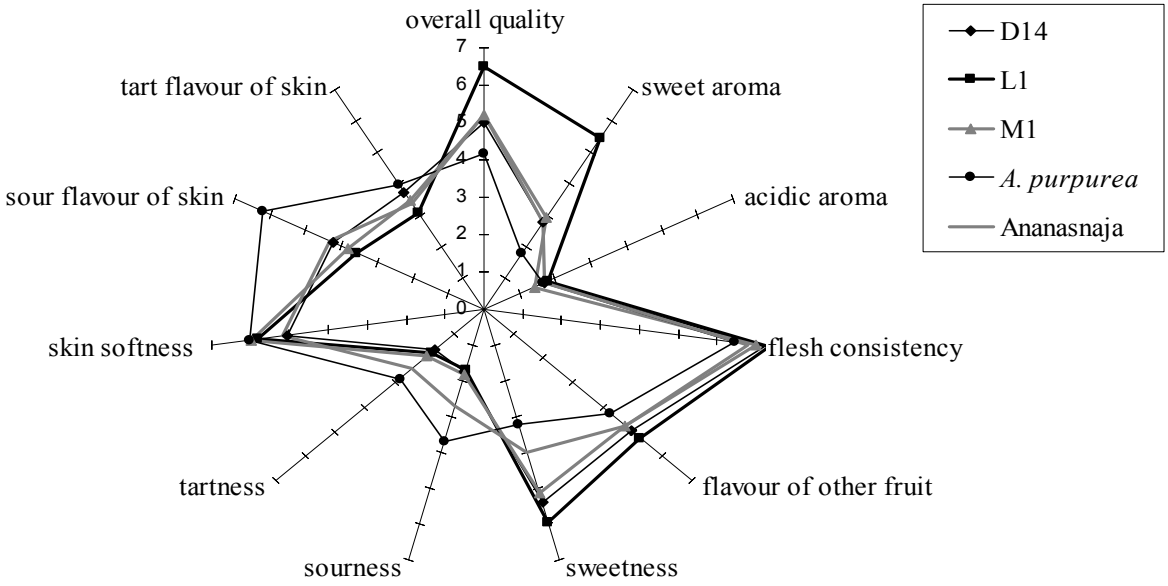

Figure 1. Results of sensory analyses of some tested genotypes

PLENARY SESSION II

Sustainable berry production: State and trends in production practices

RESPONSE OF LOWBUSH BLUEBERRY SEEDLINGS TO DIFFERENT FERTILIZERS

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In countries with abundant peat resources, where peat production is intensive, lot of exhausted peat fields are waiting for restoration. In resent years *Vaccinium angustifolium* seedlings for restoration of peat fields are used.

The ericaceous plants are sensitive to fertilizing and over fertilizing can easily kill them. The aim of our trial was to study influence of nine fertilizers having different composition, on the *Vaccinium angustifolium* seedlings development.

Berries from one fruitful and vigorous *Vaccinium angustifolium* bush were gathered in the middle of August, 2005 and stored fresh in plastic bags at +3° - +4° for 5 months, until showing in January. In the end of May, seedlings with 3–5 real leaves were pricked out into pure milled peat, 25 seedlings per box. Boxes (45 x 30 cm) with seedlings were placed in a plastic house. Two weeks after planting when the seedlings became rooted, the fertilizing trial started.

For the experiment a split plot design was employed with three replicates. The following variants were used: control – seedlings were only watered, seedlings were fertilized two times (at June 10 and June 26 using 1 g of fertilizer per 1 liter of water) with following fertilizers: Rodo kestoslannos (8-5-8), Kristallin (24-5-10+S2.5), Expert Gardener™ (33-11-11+ microelements), Kemira Power (18-9-9+Mg, Ca, S, B), Ammonium sulphate (N 21- S 23), Autumn-spring fertilizer (3-15-24), Rekle complete fertilizer (17-7-14+ S 4,75 Ca, B, Cu, Zn), Strowberry-berry fertilizer (8-6-17 + S 5.74, Ca, B, Cu, Zn) and Kemira Hortigrow (P15-K20 +Mg, S, B, Cu, Mn, Mo, Fe, Zn).

In late autumn, after first could days the height of the seedlings was measured and the number of shoots counted. All seedlings in every trial variant were divided into three classes: (i) badly branched and small sized with 1-3 shoots, (ii) seedlings having 4-5 shoots and height 7-8 cm, (iii) seedlings having more than 6 shoots and height more than 9 cm.

Data were analyzed by ANOVA (*Statistica for Windows*, 1995). Significant differences between treatment means were determined by the Turkey's HSD test. According to ANOVA, in all trial variants fertilizers have had significant influence ($p<0,001$) on shoots height, but branching of seedlings have significantly ($p<0,001$) influenced only five fertilizers: Rodo kestoslannos, Kristallin, Expert Gardener™, Kemira Power and Kemira Hortigrow. Other fertilizers do not differed significantly from control. Those five fertilizers have had influence to form more good sized seedlings, too (Figure 1). In our surprise, more seedlings suitable for planting on field has given fertilizer Kemira Hortigrow, what do not consist nitrogen at all. Special fertilizers for acidophilous plants Rodo kestoslannos and Expert Gardener™ do not differ significantly from Kemira Hortigrow by ability to develop more branched plants. Seedlings fertilized with Kristalin and Expert Gardener™ witch both consist lot of nitrogen, have had the longest shoots.

For establishing plantations seedlings should have proper size. We have noticed that

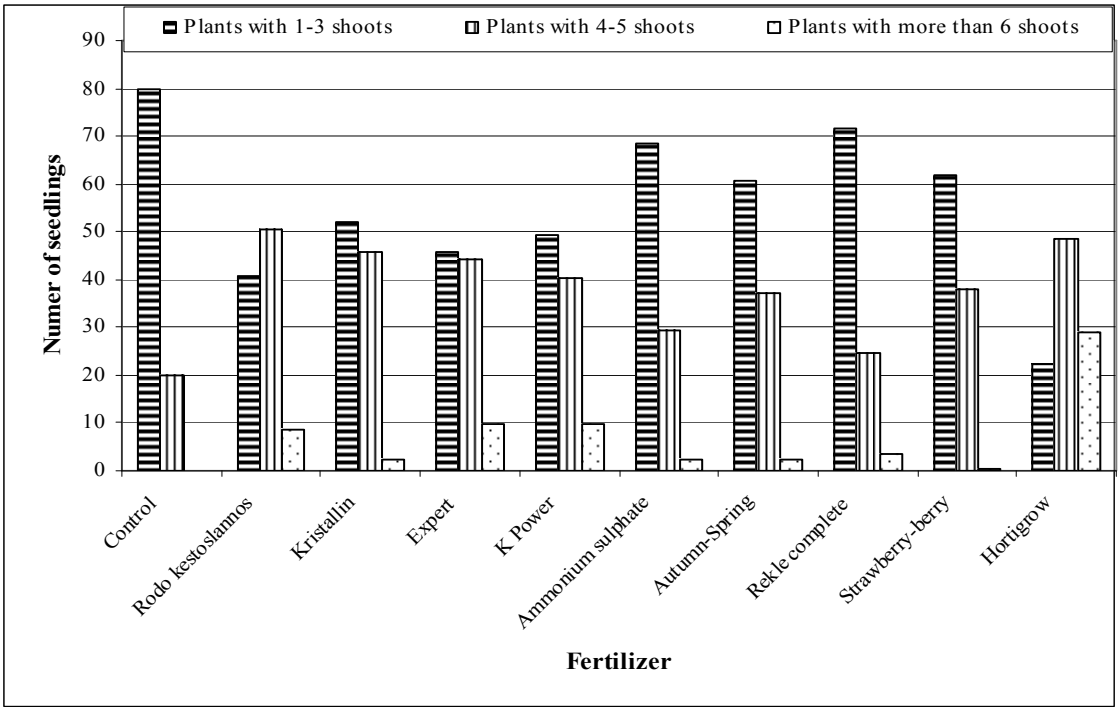

Figure 1. Branching of seedlings

seedlings with four or more shoots with length 7-8 or more cm will easily take root after planting and develop a strong bush for over wintering. Small plants may suffer from drought or could winter.

In our former research we have noticed, that seedlings should be fertilized in short summer conditions only twice. Fertilizing three times, growth do not stops before autumn frosts and shoots will be heavily damaged (Paal *et al*., 2004).

Our trial showed that for fertilizing seedlings of low bush blueberry there are several fertilizers promoting good growth of seedlings. By our trial in blueberry cultivating often used ammonium sulphate showed modest results. Nevertheless, if we want to get plants able to withstand winter conditions from seeds during one vegetation season, fertilization of seedlings is unavoidable.

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HISTORY, STATE AND PROSPECTS OF CULTIVATING HIGHBUSH BLUEBERRY AND LINGONBERRY IN SLOVAKIA

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The highbush blueberry and lingonberry culture in Slovakia is still limited though the first experiment with growing blueberries was set up in 1963 in Okoličné. However, growing for commercial purposes began only in 1998, mainly in the northern regions of Slovakia in Liptov and Orava. At present 14 hectares are planted. To meet increasing consumer demand, commercial blueberry acreage is expected to double in the next two years.

In fact, there is a long history of utilising and processing highbush blueberry and lingonberry in Slovakia, though the berries were harvested in the wild only. The experiments conducted since 1993 suggest that growing blueberries and lingonberries is acceptable both from economic and ecological point of view. Given the growing conditions for blueberries in Slovakia, the most suitable are *Vaccinium* species: highbush blueberry - *V. corymbosum* L., lingonberry - *V. vitis-idaea* L., bilberry - *V. myrtillus* L., and cranberry - *V. macrocarpon* Ait.

Highbush blueberries thrive in acidic soils in low to high areas (up to 750 m a.s.l.).

Early, early-midseason and late-midseason frost-resistant varieties are recommended for higher altitudes.

Yields ranging from 9.9 to 13.2 $t.ha^{-1}$ (about 3.300 plantings per ha) can be harvested each year. A very perspective fruit variety of the *Vaccinium* species for mountain and upland regions in Slovakia is lingonberry. There is the growing evidence that lingonberries produce higher yields only on damper sites in mountain and upland areas. Two-crop or one-crop varieties ripen satisfactorily up to 750 m a.s.l. or 1100 m a.s.l., respectively. With respect to ecological cultivation, the yield variability was most affected by a leaf disease caused by *Allantophomopsis cytisporea,* while an average yield from Koralle variety was 6 $t.ha^{-1}$. The results show that the stability of a bilberry yield grows with an altitude, while the highest and most stable yields were achieved on sites from 900 to 1400 m a.s.l. Slopes with eastern, north-eastern and northern exposure are best for its cultivation. In terms of ecological growing, yields ranged from 1300 to 4150 $kg.ha^{-1}$. The research indicated that cranberries have bigger fruits and produce substantially higher yields under the conditions in Slovakia (Orava region) than the indigenous European form of a small cranberry. This variety can be grown up to 750 m a.s.l. where early or early-midseason varieties ripened satisfactorily.

GROWTH AND DEVELOPMENT OF VEGETATIVE SPHERE OF BERRY PLANTS ON CUTOVER PEATLANDS OF BELARUS

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An important problem in the ecology of Belarus is the recultivation of the soils that were contaminated by industry. Cutover peatlands, that were completely or partially produced, apply to deposits, which were anthropologically disturbed during the process of the extraction of mineral oil. Areas of the produced cutover peatlands and plots are 209.5 thousand hectares in Belarus. And 101.0 thousand hectares is in a stage of development (Lishtvan, Loginov, 2000). These turbaries are poor by nutrients. They differ by this, that they sharply express sour reaction. The natural efficiency of them is the lowest now. Therefore more than 19% of such areas are in a waste condition (Bambalov and etc., 1997), which promotes to the further change for the worse of an ecological situation and to the infringement biosphere processes.

The problem of expansion of assortment of the new plants, which are used at the introduction, their complex studying remains still actually.

The heterogeneous planting material of wild-growing and introduction plants of family *Vacciniaceae* was used for a making of field experiences. The wild-growing species were stocked on the plots of the natural thickets that are characterized by constant and plentiful fruiting.

Growth function represents integral process of vital ability of a vegetative organism that closely connects with other physiological functions, with its numerous reactions to influence of factors of an environment and with hereditary properties. Therefore the studying of development of vegetative sphere of berry plants in new conditions of growth represents special scientific and practical interest.

Phenological phases were registered at the selected species, the rhythm of seasonal development was studied, all-round physiological researches were carried out.

At the end of a vegetative season we studied features of growth and biometric parameters at the cultivation on the cutover peatland for 15 plants of each species, which characterize general set of sample. Results of these researches are given in Tables 1 and 2.

It was established, that a large cranberry, a highbush blueberry and a lowbush blueberry exceeded in 1.5-2.5 times similar parameters at a small cranberry and a bog blueberry on the majority of parameters of development of vegetative sphere. At the same time the given values of biometric parameters of researched plants considerably concede to those for kinds that are grown on plantations in conditions of the central and southern parts of Belarus (Rupasova *et al.,* 2005). In our opinion, it testifies to dependence of growth and development of berry plants from edaphic and climatic factors.

The considerable excess (30-60 %) of the quantity of vegetative and generative shoots in relation to the cultural kinsmen is observed at a bog blueberry. But habitus of a bush of a lowbush blueberry and a highbush blueberry is higher, than of a wild-growing kind. This property of researched plants may be used for fastening against erosive processes of a soil substratum of the cutover peatlands by their more powerful root system and over ground phytomass.

Table 1. Biometric parameters of the plants of genus *Vaccinium* at the end of the third seasons of development in a field experiment on cutover peatland

Species	Height bush, *cm*		Capacity bush, dm^3		Phytomass, *g/plant*			
					shoots and leaves		roots	
	$\bar{x} \pm S_{\bar{x}}$	V,%	$\bar{x} \pm S_{\bar{x}}$	V,%	$\bar{x} \pm S_{\bar{x}}$	V,%	$\bar{x} \pm S_{\bar{x}}$	V,%
V. uliginosum L.	34,8±3,1	6,5	33,9±5,8	22,6	147,3±13,8	15,1	41,2±3,9	15,5
V. corymbosum (cv. 'Bluecrop')	46,3±9,9	12,3	37,1±9,5	32,9	167,5±22,4	28,3	93,4±15,2	33,7
V.angustifolium (Ait.)	27,1±3,3	4,3	35,8±7,6	18,8	98,1±10,1	30,1	58,7±6,5	9,4

Table 2. The comparative description of growth parameters of berry plants *Vaccinia-ceae* by cultivate on the cutover peatland

Species	Years of supervision	Quantity, *pieces/pl.*	Length, *cm*	Thickness, *mm*	Quantity of leaves
Oxycoccus palustris L.	2005	3,3±0,5	12,9±1,7	0,9±0,1	13
	2006	4,6±1,5	15,0±2,5	1,1±0,2	17
Oxycoccus macrocarpus (Ait.) Pers. (cv. 'Franklin')	2005	5,1±0,7* 10,0±1,5**	16,2±2,6 4,9±0,9	1,9±0,1 0,8±0,1	17 21
	2006	11,3±2,2 23,5±4,5	37,2±5,3 6,5±1,8	2,5±0,2 1,2±0,1	17 28
Vaccinium uliginosum L.	2005	8,5±0,7 23,9±2,1	9,4±0,6 2,5±0,1	2,7±0,3 1,1±0,2	14 9
	2006	18,5±1,0 43,5±2,5	15,5±1,3 3,6±0,4	2,9±0,8 1,5±0,9	15 11
Vaccinium corymbosum (cv. 'Bluecrop')	2005	2,5±0,5 15,3±1,1	35,7±4,9 3,5±0,6	3,1±0,2 1,7±0,1	10 5
	2006	4,0±2,1 29,6±5,1	39,0±6,5 5,2±0,3	4,3±0,2 2,4±0,2	26 11
Vaccinium angustifolium (Ait.)	2005	4,9±1,2 11,6±2,3	18,8±2,1 2,3±0,5	3,5±0,8 1,8±0,5	15 9
	2006	6,3±2,6 28,7±3,5	25,7±3,1 3,3±1,4	3,9±1,0 1,9±0,6	21 17

** vegetative shoots; ** generative shoots*

Acknowledgement

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INSECT SCOUTING CAN REDUCE THE NEED FOR PESTICIDES ON AMERICAN CRANBERRY *(Vaccinium macrocarpon)* IN NEW BRUNSWICK, CANADA

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The production of the American cranberry in New Brunswick, Canada, using productive cultivars and hybrids and modern production methods has taken place during the past ten years, although some production with native plants existed there for more than a century. There is now more than 200 hectares of cranberry in production with average yields of 20 tonnes per hectare (Estabrooks, 2006).

The American cranberry has relatively few insect pests compared to many other fruit crops.

The following Integrated Pest Management (IPM) principles are used in the new cranberry production in New Brunswick (MacKenzie, 2001): correct identification of pest; monitor pest and factors that influence their populations; use action thresholds so control treatments are applied only if pest numbers and conditions are such that damage may occur; all appropriate methods are considered; combinations of control approaches are more reliant than a single method; selective rather than broad-spectrum chemicals are used when required; and least disruptive approaches are implemented for sustainable cranberry production and healthier agro-ecosystem.

Scouting to monitor insect pests and establishing action thresholds for each pest for that region are the keys to successful pest control with minimum pesticide use.

Cranberry fruitworm (Lepidoptera: Pyralidae, *Acrobasis vaccinii* Riley) – The cranberry fruitworm is the most serious cranberry insect pest in Atlantic Canada (ACFC, 2000) and is present each year. Two chemical control applications are usually applied based upon the plants growth stage. The first application is made 7-10 days after 50% of out of bloom stage and a second made 10 days later. A cultural control measure used is to keep water on the bog until late May. Sometimes the bed can be reflooded for 17 days immediately after harvest.

Blackheaded fireworm (*Lepidoptera*: *Tortricidae*, *Rhopobota naevana* Huber) - The blackheaded fireworm larvae infest newly expanding terminal buds in spring resulting in crop loss. The second generation larvae occur from bloom to early fruit set and feed on blossoms and berries. Blackheaded fireworm larvae are monitored with a sweep net and control is applied only when the threshold level is exceeded. First generation larvae may be controlled by reflooding the beds for 10 hours (requires rapid application and removal). Pheromone traps are used to monitor fireworm moths. Presently, trap captures are not used to decide whether or not to apply control measures, but only to determine when it is required (10 days after peak trap capture).

Cranberry girdler (*Lepidoptera: Pyralidae*, *Chrysoteuchia topiaria* Zeller) - The cranberry girdler larvae feed on the bark and wood of the roots and the damage is most noticeable in the autumn. Regular sanding or spot sanding will reduce girdler problems. Pheromone traps are used in the spring to monitor moths. Flooding or application of entomopathogenic nematodes (species: *Steinernema carpocapsae*) will help control the cranberry girdler.

There are a few other insects that occasionally attack cranberry in New Brunswick including the cranberry tipworm (*Diptera: Cecidomyiidae*, *Dasineura oxycoccana* Johnson), *Sparganothis fruitworm* (*Lepidoptera: Tortricidae*, *Sparganothis sulfureana* Clemens), various species of cutworm, (including *Lepidoptera:* Noctuidae *Xylena nupera* Lintner), and spanworm (including *Lepidoptera:* Geometridae, *Itame sulphurea* Packard). The cranberry tipworm has two generations per year in NB and prefers to attack the "Early Black" cultivar. Sanding helps to cover overwintering pupae and reduce fly emergence.

A pre-harvest assessment should be carried out each year to assess the effectiveness of monitoring and control practices for cranberry insects and notes made to adjust procedures for the following year (NB Agric.2002).

Scouting to monitor cranberry insects, although time consuming and requiring technical knowledge, can reduce the need for pesticide applications to control insects and result in sustainable cranberry production.

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GUIDE VALUES AND SOIL NUTRIENT CONTENTS OF HIGHBUSH BLUBERRY (*Vaccinium corymbosum* L.) PLANTATIONS IN POLAND

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Highbush blueberry is intensive cultivated in Poland. It is estimated that hectarage of this plant is about 2 thousands (Smolarz and Pliszka, 2006). The most efficiency methods leading to increase of blueberry yield is fertilization based on plant and soil analyses and application of fertilizers as the combination of spreading and fertigation systems (Glonek and Komosa, 2004, 2006).

The main purpose of study was to estimate fertility of soils on plantations of highbush blueberry. Study was carried out in 2004-2006 on highbush blueberry crops in different regions of Poland. There were tested 225 soil samples collected from 72 plantations which consisted of: 46 samples (17 plantations) in the year 2004, 72 samples (22 plantations) in 2005, and 107 samples (33 plantations) in 2006. Samples were collected from the mid of March to the end of April in the soil deep of 0-20 cm, using a soil sampler, along the rows of shrubs in the radius of 20 cm from the drippers on fertigation lines. One average sample consisted of 15 single samples.

Estimation of soil fertility in macro and microelements were done on the basis of guide nutrient values presented in Table 1. This guide values were working out on the basis of author´s earlier study and field experiments conducted in commercial plantations of highbush blueberry. Data shown in Table 1 defined the available forms of $N\text{-}NH_4$, $N\text{-}NO_3$, P, K, Ca, Mg, Na, Cl, $S\text{-}SO_4$, B extracted with 0,03 M CH_3COOH (modified Spurway method) and Fe, Mn, Zn, Cu, B, Mo Lindsay extract (this two methods are known as the universal method; Komosa & Stafecka, 2002).

Table 1. Guide values of nutrients for mineral soils in highbush blueberry plantations (universal method)

Macroelements		Microelements		Contamination	
Nutrient	$mg \cdot 100^{-1}$ g d.m. soil	Nut-rient	$mg \cdot kg^{-1}$ d.m. soil	Nutrient	$mg \cdot 100^{-1}$ g d.m. soil
$N\text{-}NH_4+N\text{-}NO_3$	2.5-5.0	Fe	75.0-140.0	Na	<5.0
P	3.0-6.0	Mn	20.0-50.0	Cl	<5.0
K	5.0-8.0	Zn	3.0-15.0	Acidity	
Ca	10.0-30.0	Cu	1.0-4.0	pH (H_2O)	4.0-5.0
Mg	3.0-6.0	B	0.5-1.5	Salinity EC	
$S\text{-}SO_4$	1.0-3.0	Mo	0.3-1.5	$mS \cdot cm^{-1}$	<0.35

In Table 2 pointed out the percentage of samples with low, optimum and excessive content of nutrients. Average in the years of 2004 - 2006 about 74 % of soil samples had low (<2.5 $mg \cdot N\text{-}NH_4+N\text{-}NO_3 \cdot 100^{-1}$ g soil d.m) level of nitrogen. It is typical state for mineral nitrogen analyzed in spring. Nitrogen is very easy leached into the deeper layers of soil.

About 81 % of samples shown the low level of phosphorus – below 3.0 mg $P \cdot 100^{-1}$ g soil d.m. Phosphorus in low soil pH, which is typical for growing of highbush blueberry, is transformed into unavailable forms (fixation process).

Table 2. Evaluation of soil fertility on highbush blueberry plantations (%)

Element	2004 (n 46)			2005 (n 72)			2004-2006 (n 225)		
	Content			Content			Content		
	Low	Optimum	Excessive	Low	Optimum	Excessive	Low	Optimum	Excessive
N	83	15	2	51	45	4	74	24	12
P	80	16	4	64	33	3	81	16	3
K	52	33	15	47	36	17	42	28	30
Ca	9	37	54	4	53	43	4	37	59
Mg	70	21	9	37	42	21	55	35	10
S	52	33	15	24	41	35	55	24	21
Fe	0	65	35	0	63	37	3	44	53
Mn	52	35	17	43	36	21	54	33	23
Zn	11	72	17	10	65	25	14	69	17
Cu	30	70	0	53	47	0	28	55	17
B	17	83	0	4	96	0	24	76	0
	Ballast ions								
Na	0	94	6	0	100	0	-	99	1
Cl	0	64	6	0	99	1	-	98	2
	Others								
EC	0	94	6	0	97	3	-	96	4
$pH_{(H_2O)}$	4	33	63	1	56	43	3	44	53

The better status was for potassium – average 42 % of samples had low level (<3.0 mg $K \cdot 100^{-1}$ g soil d.m.). On the contrary, 59 % of samples pointed out an excess of calcium which caused the high range of $pH_{(H_2O)}$ – above 5.00. About 55 % of samples had low contents of magnesium and sulphur.

Contents of microelements in soils were more acceptable. Only the level of manganese was unsatisfied – 54 % of samples shown low level of this nutrient. The following percentage of samples had low levels of micronutrients: iron – 3 %, zinc – 14 %, boron – 24 % and cupper – 28 %. There was only marginal problem of soil salinity (EC) – 4 % of samples had excessive range (above 0.35 $mS \cdot cm^{-1}$).

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Vaccinium vitis-idaea L. AND *Oxycoccus palustris* PERS. IN NATURAL POPULATIONS AND IN CULTURE OF TAIGA ZONE OF RUSSIA

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V. vitis-idaea grows on Russia territory in forest and arctic zones, in mountains it goes up to the loach belt, fruits best in light and thin pine forests and cowberry larch forests, on glades of this types of woods and on lightly stocked swamps outskirts. Maximal harvest of cowberries in these localities reach 1000-3754 kg.ha^{-1} (Yudina *et al*., 1986; Skryabina, 1989; Egoshina, 2005). Cowberries biological stock in Russia in moderately productive year makes 480.7 thousand tons. The greatest resources of cowberry fruitage are concentrated in North-western (35 %), Far-Eastern (27 %) and Ural (20 %) federal districts (Table 1). Among separate territories the highest stocks have Republic Sakha (100.0 thousand tons), Khanty-Mansi Autonomous Area (78.1 thousand tons), Komi Republic (Bz - 59.6 thousand tons), Republic Kareliya (44.0 thousand tons), the Arkhangelsk region (35.8 thousand tons), Khabarovsk region (25.0 thousand tons). Cowberry is characterized by quite stable level of fructification. For example, in middle-and southern taiga woods of Kirov region the good harvest is noted in 33 % of years.

O. palustris - a usual kind of peat moss bogs and pine forests of taiga region. Productivity of European cranberry on oligotroph and meso-oligotroph moors of European part (Kareliya Republic, Mari-El, Udmurtiya, Leningrad, Pskov regions) can reach 2000 kg.ha^{-1} (Maznaya *et al*., 1996), in similar localities of Siberia (Omsk region, Khanty-Mansi Autonomous Area) - about 1200 kg.ha^{-1} (Egoshina, 2005). Bz of cranberry fruits in Russia in moderately productive year makes 451.5 thousand tons. The greatest resources of cranberry fruits are concentrated in North-western (62 %), Ural (15 %) federal districts (Table 2). Among separate territories the highest stocks have Komi Republic (85.0 thousand tons), Khanty-Mansi Autonomous Area (46.8 thousand tons), Arkhangelsk region (43.5 thousand tons). The level of cranberry fructification strongly varies. Thickets of cranberry on moors of the Kirov range well fructify only в11 % of years.

The degree of forests reclamation varies by kinds and regions: from 10 % in the most remote regions of Siberia and the Far East up to 100 % in the European part of the country, in settlements suburbs, along motorways that leads to degradation of highly productive phytocenosises, petering out of the most fruitful forms and loss of a genetic material. Analysis of stock dynamics of cowberry and cranberry in taiga region for 1961 - 2004 has shown that because of forests transformation they reduced almost on 40 %.

Fructification instability of cowberry and cranberry in natural populations, prompt decrease of raw material stock make actual works on cultivation of these kinds. Performed comparative study in culture of the forms selected from natural populations of cowberry and cranberry forms and sorts has shown that the best industrial parameters in conditions of the Kirov region had the selected forms and sorts of Russian selection *O. palustris* and *V. vitis-idaea*. Plants *O. macrocarpus (Ait.) Pers.* in bumper-crop years were characterized by higher level of a fructification, but they were more strongly damaged by frosts, vermin and illness, had lower stability of a fructification.

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Table 1. *Vaccinium vitis-idaea* L. yield, resources and fruits harvesting volumes in certain federal districts of Russia

Federal district	Yield, kg.ha^{-1}		Stock, thousand tons	Harvesting in 1985-89, tons	
	min- max	mean		max	mean
North-western	6 – 3754	420	168.7	6366	3060
Central	30 - 280	140	4.4	345	128
Trans-Volga	2 - 1242	200	12.4	378	222
Ural	20 - 3600	250	97.5	1130	633
Siberian	10 - 1137	170	69.0	1113	455
Far-Eastern	17 - 3400	350	128.8	1351	677
Total			480.7	10683	5175

Table 2. *Oxycoccus palustris Pers.* yield, resources and fruits harvesting volumes in certain federal districts of Russia

Federal district	Yield, kg.ha^{-1}		Stock, thousand tons	Harvesting in 1985-89, tons	
	min- max	mean		max	mean
North-western	5 - 2000	380	279.6	14754	6391
Central	1 - 1000	250	14.0	1553	223
Trans-Volga	30 - 1500	530	18.6	349.5	204.1
Ural	80 - 1820	400	67.4	1166	789
Siberian	3 - 1180	150	30.8	483	255
Far-Eastern	2 - 800	160	41.2	989	512
Total			451.5	19294.5	8374.1

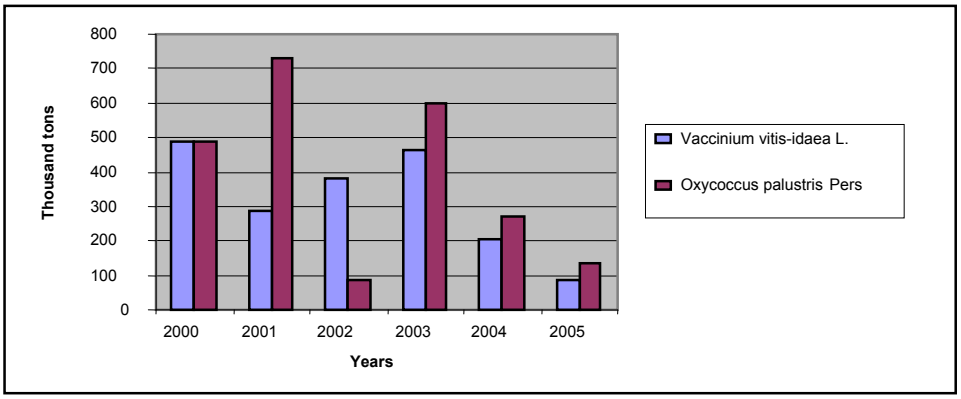

Figure 1. *Vaccinium vitis-idaea L.* and *Oxycoccus palustris Pers.* stock dynamics in Russia in 2000 – 2005

THE ASSESMENT OF GROWTH DYNAMICS OF SELECTED CLONES OF *Lonicera kamtschatica* IN THE CONDITIONS OF NITRA DURING 2004 - 2006

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The edible honeysuckle have not been cultivated throughout the territory of Slovakia. They represents a less - known fruit with many valuable properties.

Honeyberry (*Lonicera kamtschatica*) can be characterised by early harvest season (2 weeks before strawberry) so it can be considered for the first fruit to ripen in the condition of Slovakia supplied a lack of vitamins after winter season. Another positive feature is that honeyberry is remarkably cold hardy, flowers can take – 7° C without damage (Burmistrov, 1985; Bors *et al*., 2003; Plekhanova, 1998) and plants are non – demanding, able to stand all unappriopriate conditions. Flavour of berries is sweet – sour with a hint of bitterness, especially in case of cultivars. Berries contain a lot of biologically active substances such as vitamin C, potassium, anthocyanins, rutin, quercetin and isoquercetin as well.

Growth intensity represents one of the very important factors that enable us to specify only the most suitable clones in term of their further cultivation and propagation. The growth dynamics is influenced by a way of cultivation, spacing and agrotechnics. Regular yielding is conditioned by appropriate growth of shrubs. Relation between growth and yield is influenced by water, warm, light and agrotechnics. The nutrition also plays a key role for the balance between growth and yield (Matuškovič, Paulen, 2001).

Our experiments deal with the growth dynamics of selected 10 clones of *Lonicera kamtschatica* in 5 replications cultivated in the conditions of Nitra during 2004 – 2006. Our study was focussed on determination of clones, years and replications influence on the process of growing. According to geometric mean of growth index we can consider LKL – 6 as a clone with the highest increase of biomass while LKL – 66 as a clone with the lowest growth (Table 1). On the basis of our study we can set up the clones according to increasing height of shrubs into the same order than in previous study evaluated the same set of clones provided by Matuškovič *et al.* (2007) during 2003 - 2005 except for 2 clones - LKL - 6 and LKL - 21.

The set of clones was statistically evaluated as a model taken into account influence of year, clones and replications. On the basis of its results we fond out statistically significant dependence on year, especially between 2004 - 2005. There were recorded a statistically significant differences only between following pairs of clones: LKL - 6 - LKL - 42, LKL - 6 - LKL - 60, LKL - 6 - LKL - 66, LKL - 6 - LKL - 96 at 95 % level of confidence intervals. This result is in conflict with the study of Matuškovič *et al.* (2007) who found out statistically significant differences in 7 pairs of clones.

Table 1. Mean values of growth increase for *Lonicera kamtschatica* clones with the growth index during 2004 - 2006

years (1)	2004		2005		2006		
clones (2)	growth increase (3)	standard deviation (4)	growth increase	standard deviation	growth increase	standard deviation	geometric mean of growth index (5)
LKL - 5	0.116	0.046	0.180	0.082	0.094	0.064	1.254
LKL - 6	0.136	0.033	0.128	0.069	***0.200***	0.061	*1.328*
LKL -16	0.116	0.015	***0.186***	0.077	0.126	0.086	1.240
LKL -21	***0.198***	0.071	0.102	0.104	0.058	0.064	1.189
LKL -42	0.068	0.038	0.166	0.087	0.064	0.058	1.163
LKL -49	0.160	0.030	0.104	0.126	0.038	0.076	1.215
LKL -58	0.052	0.039	0.104	0.145	0.010	0.015	1.151
LKL -60	0.110	0.024	0.086	0.092	0	0	1.149
LKL- 66	0.072	0.023	0.052	0.078	0.04	0.008	1.121
LKL -96	0.106	0.042	0.104	0.123	0	0	1.144

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WAY FOR GROWING HIGHBUSH BLUEBERRY (*Vaccinium corymbosum* L.) ON A COMMERCIAL SCALE IN POLAND

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Highbush blueberry grows in the wild in North America F. Coville was the first person to promote the cultivation of blueberry in USA around the 1920s. Since then fast increase has occurred in the breeding of this species and the best new blueberry cultivars were selected and introduced into commercial cultivation. In the thirties of twenty century some people from Poland visiting USA were fascinated of highbush blueberry productivity and fruit taste. However, the trials of introducing this species into cultivation in Poland were not successful. After Second World War, one of the enthusiastic for growing plants was Prof. S.A. Pieniążek who in the years 1938 – 1946 lived in the USA. Coming back to Poland, he brought plants of few blueberry cvs. In spite of good care, plants did not grow well. Some people even expressed the opinion that the conditions of the Polish natural environment were not at all suitable for blueberry cultivation at all.

At the end of the 70s, Dr. Pliszka returned from USA and began to promote the cultivation of blueberry on light sandy soil. During my stay in USA in 1976 year I visited blueberry plantations in a number of States (Michigan, New Jersey, Massachusetts, North Carolina, Florida, Arkansas and Washington). In few States blueberry were growing on soil that richer than those recommended at that time in Poland. In 1976 I set the experiment on more fertile soil, than that recommended by Dr. Pliszka. This soil was classified as Class IV and since the year 1923 until the present time the following fertilizing combinations of single plots have been used: O (no fertilizing), CaNPK, NPK, PK, PN and PK). Already from the first year after planting highbush blueberry the best plant growth and in next years good yield were obtained from plots with full mineral fertilization (NPK) and soil pH between 3.6 and 3.8 (determined in KCl).

In 1978 I had started the experiment on cultivar evaluation. The first selected varieties for commercial cultivation were: Weymouth, Earliblue, Concord, Bluecrop, Patriot, Jersey, Herbert and Darrow. In the next years the following cultivars were recommended for the commercial use: Spartan, Bluegold, Duke and Nelson. The evaluation trials of new cultivars are executed when they were delivered. Furthermore, the experiments are carried out in terms of fertilization, pruning, irrigation and recently on rejuvenation pruning. At present highbush blueberry in Poland are cultivated on the area of more than 1500 ha. The size of plantations range from 0.5 ha up to 330 ha. There is increasing interest in cultivation of blueberry in Poland and it is expected that our country will be the biggest producer in Europe of highbush blueberry fruits in the near future.

PLENARY SESSION III

Nutritional value of berry fruits and impact on human health

BIOTECHNOLOGICAL APPROACHES TO CROSS REACTIVE ALLERGENS IN SMALL FRUITS

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Frequent consumption of small fruits has been shown to comprise several health benefits like improved short time memory, reduced cancer, reversion of normal decline of motor skills in animal models, if still not in human trials. Recently small fruits like strawberry, raspberry and blueberry have found their place in the nutritional daily intake recommendations for both children and adults, since these fruits provide rich source of vitamin C and contain high amounts of antioxidants. An increased production volume and consumption rate are expected consequences on European market. The COST Action 863 EUROBERRY (http://www.euroberry.it/index.html) intends to promote the integration of research, production systems, quality control, added nutritional value and consumer acceptance. The main objective of the Action is to improve the quality and production of berries to benefit health of the consumers and maintain profitable European production using sustainable systems. WG 4 focusses on health benefits: the levels and benefits of antioxidants and other bioactive compounds found in these berries should be understood. Accurate and substantiated information must be provided to consumers so that the health benefits are well understood to allow informed choices.

However consumption of particular fruits may also represent a health risk by eliciting allergic reactions in sensitized individuals. Most identified plant allergens belong to only few protein families related to stress- and defense mechanisms and show high homology between species.

Using the related species Malus as a model species, where previously several allergens were confirmed e.g. Mal d 1, Mal d 2, Mal d 3 and Mal d 4 (Marzban *et al*., 2005; Herndl *et al.*, 2007), the expression of heterologous proteins was investigated. These proteins are constitutively expressed and can be up-regulated by pathogen-stress factors. Reported allergies to these proteins include symptoms beginning from swollen lips and irritated mouth tissue, skin irritations, asthma, and ending with life-threatening anaphylaxis. Even in slight forms of fruit allergies, the triggered symptoms upon fruit intake have an influence on the nutritive behavior of the allergic patients, responding with an avoidance diet. It is therefore important to address the allergenicity of different small fruits, like strawberry and blueberry varieties, containing different amount of allergens. The development of novel selection markers will allow to choose breeding lines with low allergenic contents for future breeding strategies.

Recent studies on allergic patients indicate frequent development of secondary allergies due to high similarity of protein sequences and epitope structures of fruit allergens. The structural similarity of allergen homologues can occur in such distantly related taxa as birch, celery, carrot, nuts, soybeans and *Rosaceous* fruits. This feature of fruit allergens increases the risk of allergic reaction to many plant-derived foods, but may facilitate their molecular identification.

Allergome currently lists very few (> 10) allergens in small fruits. Karlsson *et al*. (2004) reported the presence of Fra a 1, a Bet v 1 homologue, in strawberries. Inhalation

of frozen raspberry powder causing an occupational asthma has been reported (Sherson *et al*., 2003). Initially, two potential allergens were detected, Rub i 1 (Acc. No. DQ660361) and Rub i 3 (Acc. No. DQ660360), showing high sequence identity to proteins in Rosaceous species like Mal d 1 and Mal d 3 from apple Marzban *et al*. (2005, 2006) and some novel allergens were recently detected (Marzban *et al*., 2007: this conference).

The next step after detecting specific allergens in small fruits, is obviously the attempt to control their expression. Down-regulation of allergen expression by post-transcriptional gene silencing (PTGS) represents a strategy to produce safer plant food. This biotechnological approach depends mainly on functional tissue culture protocols adapted to the respective species or cultivar. To optimize the efficiency of the protocol for *Agrobacterium*-mediated transformation of *Vaccinium corymbosum* cv. Goldtraube the marker-plasmid pBinGUSInt was used. Further transformation experiments with constructs designed to induce PTGS, protein extraction procedures and Western blotting were evaluated for their suitability to monitor allergen expression. Model plants are currently regenerated and acclimatized to greenhouse conditions for further evaluations following the approach indicated by Maghuly *et al*. (2007) for fruit tree species.

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POTENTIAL FOR DOMESTICATION OF *Rose* HIPS IN A NORTHERN EUROPE ATLANTIC CLIMATE

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Traditionally rose hips in Norway have been picked from uncultivated plants growing in rough grazing areas or along edges of cultivated farmland or forests, or from other open areas on the hillsides created e.g. by landslide. Mainly the rose hips have been used as marmalade and tea. Parallel with increased prosperity of the society this tradition has started to fade out along with the knowledge of how to use the rose hips. However, several species grow well, produce ripe hips of good quality and seems to be resistant to most diseases and pests. In the search of possibilities to utilize the potential of rose hips, the thought of domestication was prevalent. To start this it has been looked into some important factors that have to be of some magnitude to succeed. This article will deal with some of the experiences in Mid-Norway (63° 29´) in Stjoerdal county near Trondheim.

***Rosa spp.* growing wild**
Rosa dumalis (see picture)
Rosa majalis
Rosa villosa
Rosa rugosa (spread from gardens)

Rosa dumalis is the species that are most abundant in the region, and is chosen as a subject for domestication. It is also notified as valuable in Sweden (Ugla & Nybom, 1999), and in East Anatolia, Turkey, rose hips are harvested from the wild mainly on *R. dumalis* (Sezai Ercisli 2006, pers. comm.). The plant is upright and has a suitable height for hand- and mechanical- harvesting. The fruit yield seems good and stable between years and the fruit size is relatively large. It may be heavily injured by the larvae of the Rose hip fly, else the plant is healthy.

Propagation experiments of selected local clones show that rotting of cuttings is relatively poor. However, experiments show that there are clonal differences (0-53%). *In vitro* propagation could be a solution of propagating clones, but has so far not been successful according to Ahmet Esitken, in Turkish experiments (pers. comm., 2006). Propagation by seeds is a possibility, but the question of uniform ripening may be raised, a character important for mechanical harvest. Seed germination is relatively poor, but seeds are easy to collect in high numbers, and a high number of plants may be established in reasonable time (Uggla, 2004).

Products. There are several ways of utilizing the rose hips. In the Norwegian project efforts are concentrated to make purée which is technical convenient and is a good basis for further product development.

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Lonicera caerulaea INDUCES ANTIOXIDANT RESPONSE IN ANIMALS BEARING EXPERIMENTAL TUMORS

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Lonicera caerulea is a species of bushes originating from Kamchatka peninsula that was acclimatized in our country. Its berries resemble blueberries and are extensively studied, due to the potentially high antioxidant activity (Oprea *et al*., 2002).

The aim of our work was to investigate and to quantify the in vivo antioxidant action of *Lonicera caerulea* berry extracts upon the dynamics of experimental tumors. Preliminary data showed that the total *Lonicera caerulaea* extracts reduced the tumor volume, when administered continuously during the tumor growth and development process. In spite of the chemical composition (rich in antioxidants), the extracts did not significantly change the overall response to oxidative stress, when fed to tumorless animals (Wistar rats). Prolonged administration of total *Lonicera caerulaea* extracts diminished the oxidative stress in the tumor tissues, while amplifying the peripheral oxidative stress, but causing no significant changes in the hepatic tissue.

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CHARACTERIZATION OF BIOLOGICALLY ACTIVE COMPOUNDS AND COMMERCIAL FRUIT QUALITY IN DIFFERENT STRAWBERRY GENOTYPES: A STUDY ON ANTIOXIDANT CAPACITY OF BIOACTIVE COMPOUNDS AND THEIR ROLE *in vitro* AND *in vivo*

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Many epidemiological studies confirm that an high consumption of fruit is correlated with a lower incidence of several chronic diseases, mainly for the protective role against cardiovascular, degenerative and proliferative diseases. There is convincing evidence that the considerable health benefits of fruit are due to its specific chemical composition, particularly to compounds of nutritional relevance. For these reasons, the nutritional quality of fruit today is becoming an attribute as important as the organoleptic-sensorial quality, and breeding and biotechnological approaches are currently used to increase the content of specific bioactive compounds in fruits.

Strawberry fruit contains high levels of micronutrients, such as essential minerals and vitamins, and phytochemical compounds belonging to the huge class of phenolics. Most of these compounds exhibit antioxidant properties, and their bioactivity seems to be directly or indirectly linked to their relevant role in protecting essential biomolecules from free radicals and reactive oxigen species induced damages. In order to describe the role played by genetic background on attributes that are essential for the nutritional qualities of the fruit, we compared a number of phytochemical parameters of a selected number of genotypes from the Italian strawberry breeding program. In particular, the total flavonoid, anthocyanin, vitamin C and folate contents were measured, and cultivar effects on the total antioxidant capacities (TAC) of strawberries were also tested. In addition, the individual contribution of the main antioxidant compounds was assessed by HPLC separation coupled to an on-line postcolumn antioxidant detection system. The results showed the important role played by genetic background on the chemical and antioxidant profile of strawberry fruits. Significant differences were found between genotypes for the total antioxidant capacity, and for all tested classes of compounds. In particular, very high differences among cultivars and selections were observed on the folate content. The HPLC analyses allowed to resolve four main regions containing the most antioxidant capacity, and a qualitative and quantitative variability in the antioxidant profiles was observed. Furthermore, the relevant contribution of vitamin C and anthocyanins on the antioxidant profile of fruit was confirmed, and a good correlation was found between the total anthocyanin content measured using the pH differential method and the anthocyanin concentrations obtained according to the HPLC data.

These studies show that differences exist between cultivars to be applicable in dietary studies in human subjects. These findings are important since higher levels of micronutrients and phytochemicals may be an important tool to support a higher intake of health-promoting compounds, even in case of low consumption of fruit.

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BIOSYNTHESIS OF RASPBERRY FLAVOR MOLECULES

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Raspberry fruit contains a broad range of flavor molecules. Well known examples are ionones and raspberry ketone. These molecules derive from diverse biochemical pathways, such as the carotenoid pathway and the phenylpropanoid pathway. We have studied the production of these compounds during fruit ripening, by GC-MS analysis. Key enzymes in the biosynthesis of the flavor compounds were identified, and genes that encode these enzymes were cloned from fruit cDNA. Subsequently we have studied the behavior of the genes during fruit development, and tested their application for production of flavor chemicals.

IDENTIFICATION AND CHARACTERIZATION OF ALLERGENS IN *Rubus ssp.*

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Frequent consumption of fruits has positive influence on human health by disease prevention. However consumption of particular fruits may elicit allergic reactions in sensitive individuals.

Most identified plant allergens belong to only few protein families related to stress- and defense mechanisms and show high homology between species.

Small fruits as raspberry (*Rubus idaeus*) or blackberry (*Rubus fructiosus*) characterised by high vitamin and antioxidant content important for the prevention of cancer and cardiovascular diseases, but only little is known about their allergenic potential. Inhalation of frozen raspberry powder causing an occupational asthma has been reported (Sherson *et al.*, 2003), but so far no raspberry allergens have been identified. The initial characterization of allergenic raspberry proteins and show their cross-reactivity with known food allergens (Marzban *et al*., 2005).

To identify potential cross-reactive allergens in raspberry (*Rubus ideaus* L.), gene expression was analysed using PCR, RT-PCR, 2DE and MS/MS peptide sequencing. Specific polyclonal antibodies and patient sera were used in Western blotting. Initially, two potential allergens were detected, Rub i 1 (Acc. No. DQ660361) and Rub i 3 (Acc. No. DQ660360), showing high sequence identity to proteins in *Rosaceous* species like Mal d 1 and Mal d 3 from apple, Pru av 1 and Pru av 3 from cherry and Pru p 1 and Pru p 3 from peach. Furthermore, a protein band at about 30 kDa was identified as a class III chitinase, which reacts with most of the patient sera (> 80%) tested. Raspberry chitinase, when subjected to glyco-proteomic analysis, shows to clearly possess typical complex plant-type N-glycans with a core α1,3 fucose and a β1,2 xylose at least on one position, indicating the potential presence of a cross reacting carbohydrate determinant (CCD). MS analysis revealed the existence of a further IgE-reactive raspberry cyclophilin, a Bet v 7 homologous protein. Considering the discovery of these four novel putative allergens, it is to be anticipated, that the consumption of small fruits like raspberry might induce unexpected adverse reactions in sensitised individuals.

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CHEMICAL COMPOSITION AND ANTIOXIDANT ACTIVITY OF SEA BUCKTHORN (*Hippophae rhamnoides* L.) BERRIES GROWN IN TURKEY

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In this study, chemical composition of berries of ten selected sea buckthorn (*Hippophae rhamnoides* L.) genotypes in Turkey was investigated. The total phenolic content of the berries ranged from 21.31 mg gallic acid equivalents (GAE) per g dry weight basis to 55.38 mg GAE per g. The highest antioxidant activity was 93.54% (similar to the standard BHT at the 200 $mg.l^{-1}$) and the lowest was 80.38%. There was no correlation (R=0.688) between the total phenolic content and the antioxidant activity. The major fatty acids in berries were palmitoleic acid (35.48%), followed by palmitic acid (28.13%), oleic acid (22.89%) and linoleic acid (3.96%). Total soluble solid content of sea buckthorn genotypes varied from 10.15% to 14.80%, titratable acidity varied from 2.64% to 4.54%, the pH varied from 2.63 to 2.98 and vitamin C varied from 19 mg/100 ml to 121 mg/100 ml. The average content of minerals in the sea buckthorn berries of different genotypes was 20800 ppm N, 7100 ppm P, 7260 ppm K, 1960 ppm Ca, 1465 ppm Mg, 32 ppm Zn, 24 ppm Cu, 22 ppm Mn and 7 ppm Fe.

THE EVALUATION OF LOCALITY INFLUENCE ON NUTRITIONAL VALUE OF THE EDIBLE HONEYSUCKLE´S FRUITS IN THE CONDITIONS OF SLOVAKIA

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Edible honeysuckle are unique members of *Caprifoliaceae* family, genus *Lonicera*, comprising mainly ornamental plants (Baranec *et al*., 1998; Cagáňová, 1994). They originate in the territory of Russia – Asiatic part, Kamtschatka peninsula and the eastern Sibberia where the native inhabitants have used them as herbal plants, especially rich in polyphenolic compounds – anthocyanins, rutin, quercetin, isoquercetin with the positive effect on cardiovascular system and walls of capillars (Plekhanova, 1998; Plekhanova, Streltsyna, 1998). The edible honeysuckle have not been cultivated intensively throughout the territory of Slovakia but nowadays interest in growing them have been increasing especially among home gardeners. It is due to non - demanding cultivation and a valuable nutritional value of fruits (Petrova, 1987; Burmistrov, 1985). This knowledge has been confirmed by studies of Pokorná *et al*. (2007) referred to the exceptionally high content of ascorbic acid ranging from 28.56 mg/100 g to 86.96 mg/100g, potassium 10175 to 14764 $mg.kg^{-1}$ and anthocyanins from pomace 6.245 – 17.36 $g.kg^{-1}$ within examined samples of irrigated and non - irrigated variants of *Lonicera kamtschatica* and *Lonicera edulis* cultivated in the conditions of Nitra during 2001 - 2003.

The aim of our experiments was to asses the influence of locality on nutritional value of the edible honeysuckle´s berries cultivated in the conditions of Nitra and Bojnice during 2001 – 2003.

Two botanical species – *Lonicera kamtschatica* and *Lonicera edulis* from Nitra (irrigated and non – irrigated variants), Bojnice (only non – irrigated variant) and 3 cultivars – a bitter cultivar of *Lonicera edulis*, ´Amur´ and ´Altaj´ from Bojnice were examined especially for the content of sugar, ascorbic acid, organic acids and anthocyanins in the relation to all evaluated nutrients. The work in this paper has brought a new approach in the evaluation of locality influence provided by fuzzy c-means clustering – program FCM. From this point of view this study has evaluated the all nutrients together as well.

Results of the statistical evaluation pointed on a significant effect of locality in term of ascorbic acid, sugar content and all nutrients evaluated together (Figure 1). On contrary, in case of organic acids and anthocyanins synthesis the botanical species - cultivar have played a more significant role than the locality effect. The results of our study have not confirmed the significant effect of irrigation in term of all evaluated nutrients that is in accord with the studies of Pokorná *et al*. (2007).

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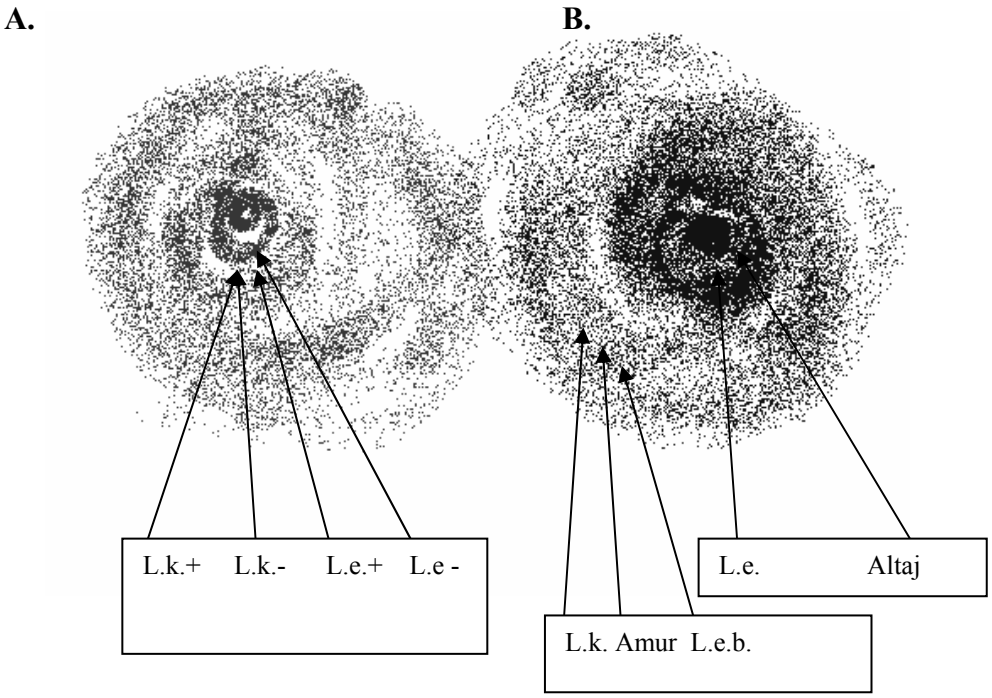

Figure 1. The evaluation of the locality influence on the nutritional value of edible honeycuckle´s berries from Nitra and Bojnice by the method of c-means clustering

A.

L.k.- *Lonicera kamtschatica* without irrigation, L.k.+ *Lonicera kamtschatica* with irrigation, L.e.- *Lonicera edulis* without irrigation, L.e.+ *Lonicera edulis* with irrigation – locality Nitra

B.

L.e. - *Lonicera edulis,* L.k. - *Lonicera kamtschatica,* L.e.b. - a bitter cultivar of *Lonicera edulis* – locality Bojnice

EVALUATION OF THE VARIABILITY OF A SELECTED GROUP OF VARIETIES OF HONEYSUCKLE – *Lonicera caerulea* subsp. *edulis* Turcz. ex Freyn.

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The genus *Lonicera* includes a number of varieties native to throughout the northern hemisphere. The majority are ornamental plants (decorative plants with inedible fruit). Varieties of the subfamily *Caerulae* have dark blue edible fruit and include *Lonicera caerulea* L., *Lonicera edulis* Turcz. ex Freyn, *Lonicera kamtschatica* Sevast. Pojark, *Lonicera turczaniniwii* Pojark, *Lonicera regeliana* Boczkarn and *Lonicera altaica* Pall. In terms of its demands for growing and attractiveness of the fruit the edible honeysuckle (honeyberry "Kamtschatka") is a valuable addition to the less widespread fruit species.

Honeysuckle grows on thick bushes of medium to strong growth of a height from 1.0 to 1.8 m. The bushes constitute, on average, 12 to 15 skeletal branches. It bears fruit on the individual parts growing out of two-year wood. Depending on the variety the flowers are tubular, funnel-shaped, arranged in clusters. The fruit is a stalked dark blue berry with a thick waxy coating, sweet-acid flavour and strong aroma. The fruit ranges between 12 and 40 mm in length and between 6 and 15 mm in width. Honeysuckle fruit contains 10 to 19 % of dry matter, 5 to 10 % sugar and the content of organic acids ranges between 1.5 and 4.5 %, of which predominant is citric acid (90 %); it also contains polyphenols, anthocyanins, carotenoids and others. The ripe fruit is consumed in fresh state or is processed for various purposes. The gene pool area at Mendel University of Agriculture and Forestry in Brno was established in two stages in 2000 and 2001 as corridor planting, 2.0 x 1.5 spacing. Most of the varieties come from the collection of the Pavlov Research Institute VIR in St Petersburg and some varieties are from the VÚOOD Research Institute in Bojnice, Herbaton s.r.o. Klčov, and from other breeders.

In the set of 31 varieties and genotypes we evaluated the morphological, biological and growing characteristics. Attention was also devoted to propagation, phenology and fertility because the potential success of the variety is based on fertility; also resistance to low temperatures and to diseases and pests. Evaluations of the variability of growth parameters were focused on the height of the bush and its cubature; bushes of the varieties Viola and *Lonicera kamschatica* were the tallest (1.65 m and 1.59 m, respectively), and the lowest were the varieties Amfora (0.74 m) and Backarskaja (0.82 m). In 2002 most of the varieties showed medium growth – 56.52 %; the share of low-growth bushes was 30.43 % and tall-growth bushes 13.05 %. In terms of the cubature of the bush, the variety Viola (2.83 m^3) had a large cubature and the variety Backarskaja small (0.90 m^3). The results of observations of the phenology stage of flowering showed that flowering lasted 3 weeks; 13 varieties flowered in the first half of our observations and 10 varieties in the second half. Worth mentioning is the number of recurring flowers towards the end of 2006 and in early 2007. Harvest was very early, usually from 15 May to 10 June. The yields were the highest in 2006, namely of the varieties Amfora (1403.50 g) and Fialka (1308.90 g). The average weight of the fruit of the variety Viola was 1.02 g and of Amfora 0.89 g (Table 1). The highest total yields were achieved in the variety Altaj, i.e. 3456.20 g, followed by the varieties Amfora 3037.03 g and Fialka 2961.26 g. The average weight of the fruit was the highest in the varieties Viola 0.93 g and Amfora 0.89 g. (Figure 1). Of the studied set of varieties we can recommend varieties, which give high yields and fruit of high quality, i.e. – Altaj, Fialka, Amfora; good results were achieved with Viola and Morena. On the basis of organoleptic evaluations the varieties Altaj, Leningradský velikán and Morena showed an extremely high quality of the fruit.

Acknowledgement
The study was funded within the framework of the joint project QF 3223 Research into cultivation technologies of less common fruit tree species and project 04/2002-2199 St National programme of the preservation and exploitation of the gene pool of plants and the agrobiodiversity.

Table 1. Average values of yields in 2004-2006

Order		Yield per bush in g			
		2004	2005	2006	2007
1	Altaj	742.20	979.90	1147.10	587.00
2	Amur	685.30	350.70	637.10	330.33
3	Amfora	473.50	639.70	1403.50	520.33
4	Bakcarskaja	347.30	224.80	373.70	143.73
5	Fialka	576.60	702.10	1308.90	373.66
6	Goluboje vereteno	675.60	333.90	433.80	283.86
7	Jaltská	598.40	156.80	323.70	205.53
8	Kamčadalka	376.50	241.20	390.70	178.66
9	Lebeduška	278.60	128.60	823.60	300.33
10	Leningradský velikán	386.10	114.20	312.10	243.80
11	Lipnická	392.40	186.50	382.10	183.93
12	Lonicera kamschatica	875.10	321.00	795.40	253.70
13	Morena	598.40	347.80	783.60	477.06
14	Nimfa	327.30	188.10	332.00	123.86
15	Roxana	450.60	120.80	383.60	160.40
16	Sanaja ptica	249.90	165.10	318.80	153.83
17	Sinoglaska	515.30	254.70	402.20	192.13
18	Tomička	526.30	336.70	372.00	115.33
19	Valchova	376.50	138.10	553.70	108.83
20	Vasiljevská	271.80	164.20	342.00	208.86
21	Vasjuganská	305.30	224.10	382.70	301.98
22	Viola	579.60	403.50	708.90	365.53
23	Zoluška	475.80	203.80	380.56	280.40

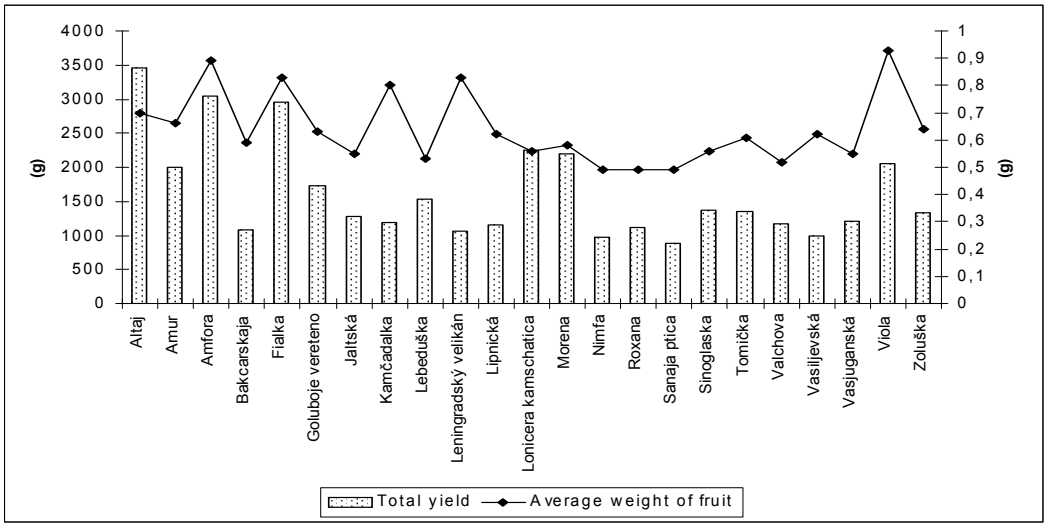

Figure 1. Average values of total yields and weight of fruit in 2004-2007

GLOBAL CHANGES ON BLUEBERRIES' MARKETS

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Blueberries market seems to be one with the highest grow in sales among berries' fruit during past four decades. This is evident because US Highbush Blueberry Council announced lately that only North American Production has increased at a steady rate increasing five fold cover the past 40 years from 9.5 million pounds in 1965 to 302.1 million pounds in 2005.

There are quite a few factors influencing the blueberries supply grow on the market. Among them the most important are health benefits for human bodies of blues consumption. This make them the most required on small fruit market. And they are considered by consumers in some countries like USA, UK, Germany and the Netherlands very trendy. Other important factor is that blueberries are very friendly for picking and handling as well as their shelf live is quite long when comparing to other berries. For that reason they are very well accepted by groceries chains which even stimulate their turnover by actions informing consumers about the health benefits of their consumption.

However, due to the high prices of blueberries not every consumer can afford to buy them and also due to the lack of information their popularity is limited mainly to the Northern Hemisphere countries where wild blueberries are known from the woods. For instance they are almost unknown by consumers in Hungary because of the absence of wild blues there.

In Europe probably the fastest growing market for blueberries is UK. In this country blueberries already account for 18% of total soft fruit sales. According to *Well Pict Europeans*, this makes them the 3rd most important soft fruit from a sales point of view. Market research shows that the main supporters of blueberries are still the older market (people over 45), however, the growing popularity among the young can not be disputed. Young people (under 28) identify with the sexiness of soft fruit as well as the health giving attributes of blueberries. Blueberry sales show no signs of a slowdown and currently they have a market value in the UK of more than £ 40 million. The 100-150% year on year growth of blueberries is a high challenge for both producers and importers. Extremely high prices at UK market at around £ 8,000-10,000 per tone busted the prices in countries in Europe. Due to the globalization they also have a little influence on the US market where the prices of fresh blueberries reached the average level of more that 2 US per pound during the period of the high crop what is very high when comparing to previous seasons.

In terms of the blueberries prices we have very interesting situation in Poland. At the biggest wholesales markets Bronisze and Poznań the prices of fresh blueberries where much lower than those designated for export (Figures 1,2,3) which is connected with the limited capacity of Polish market for relatively very expensive fruit. However the possibilities of blueberries export and much higher prices exist only for those growers who have production on bigger scale. Due to the situation on blueberries global market especially increasing demand and insufficient supply in the coming years we can expect a lot of investments in blueberries business.

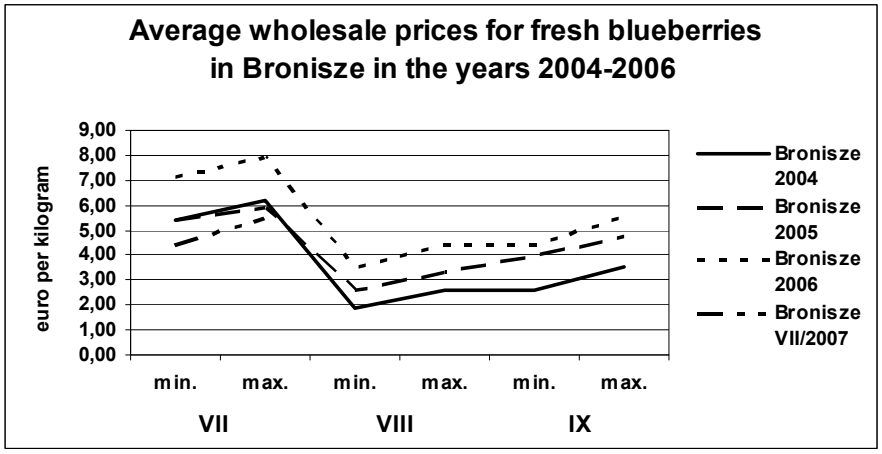

Figure 1. Values in Polish Zloties per kilogram (1Euro – 3.80 Zloties)

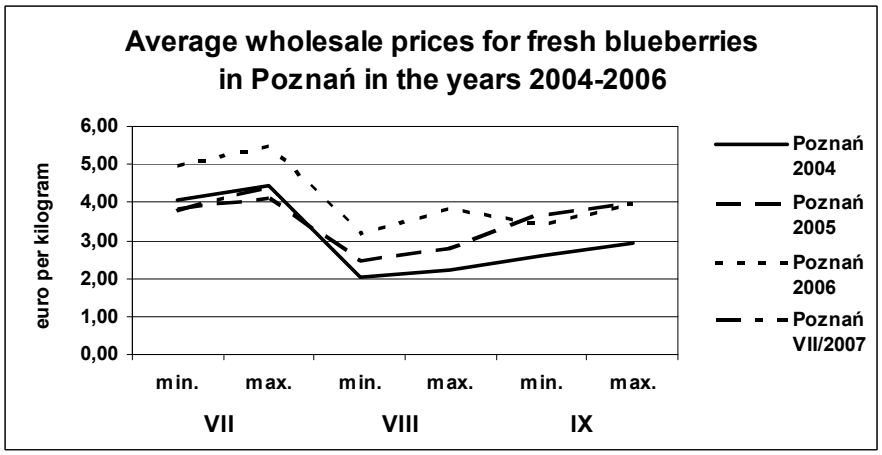

Figure 2. Values in Polish Zloties per kilogram (1Euro – 3.80 Zloties)

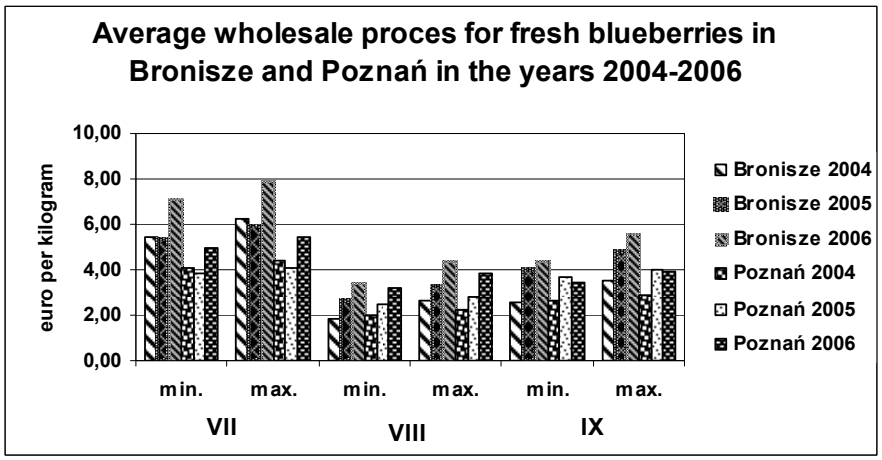

Figure 3. Values in Polish Zloties per kilogram (1Euro – 3.80 Zloties)

PLENARY SESSION IV

Propagation technologies

TISSUE CULTURE STRATEGIES TO PROPAGATE *Vaccinium* SPECIES AND CLOUDBERRY

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The commercially cultivated and medicinally important *Vaccinium* species: blueberries (*V. angustifolium* Ait., *V. corymbosum* L., *V. ashei* Reade), cranberries (*V. macrocarpon* Ait.) and lingonberries (*V. vitis-idaea* L.), and the less know small fruit of medicinal importance, cloudberries (*Rubus chamaemorus* L., family Rosaceae) are genetically heterozygous and do not reproduce progeny from seed that are similar to the seed parent (i.e., they do no 'come true' from seed). Traditionally, most of these species are vegetatively propagated, which ensures that desired genetic characteristics are preserved and a fruit production is rapidly achieved. Conventional vegetative propagation methods, although generally successful, are slow and labor-intensive and few propagules can be produced from a single stock plant. Micropropagation of selected germplasm can potentially multiply plants more rapidly than traditional propagation methods. The commercial use of this technology is for clonal mass propagation of specific clone and of parental stocks for hybrid seed production, maintenance of pathogen-free (indexed) germplasm, use as the initial step in a nuclear stock crop production system, and year-round production of plants (Debnath, 2003). *In vitro* techniques are important tools for modern plant improvement programs to introduce new traits into selected plants and to develop suitable cultivars in the minimum time (Taji *et al*., 2002). Used in conjunction with classical breeding methods, an efficient *in vitro* shoot proliferation and regeneration system could accelerate cultivar development programs. A shoot regeneration system (Figure 1) can be used to develop transgenic plants following genetic transformation of plant cells and to identify and/or induce somaclonal variants.

The *in vitro* propagation of *Vaccinium* species using axillary bud proliferation and adventitious shoot regeneration has been investigated in a number of previous studies (McCown and Zeldin, 2005; Rowland and Hammerschlag, 2005; Debnath, 2006). The morphogenesis seems to be highly dependent on plant growth regulators and media used for culture, which is again genotype specific. Bioreactor systems (Figure 2) have been introduced for mass propagation of horticultural plants (Levin and Vasil, 1989) and have proven their potential for large-scale micropropagation. In blueberry, genetic transformation has been developed using tissue culture systems with varying rates of success. This review presents the progress in-depth of various aspects of *Vaccinium* and cloudberry propagation *in vitro*, on gelled and in liquid media using bioreactors, for their improvement and for commercial production. The use of large-scale liquid cultures and automation that has the potential to resolve the manual handling of the various stages of micropropagation and decreases production cost significantly, has been discussed. It also discusses the issues that still need to be addressed to utilize the full potential of plant tissue culture techniques in mass propagation of *Vaccinium* species and of cloudberries. Application of molecular marker techniques should be useful to verify the clonal fidelity of micropropagated berry crops. Improvement of these crops

using *in vitro* and molecular techniques will develop improved cultivars suited to the changing needs of growers and consumers.

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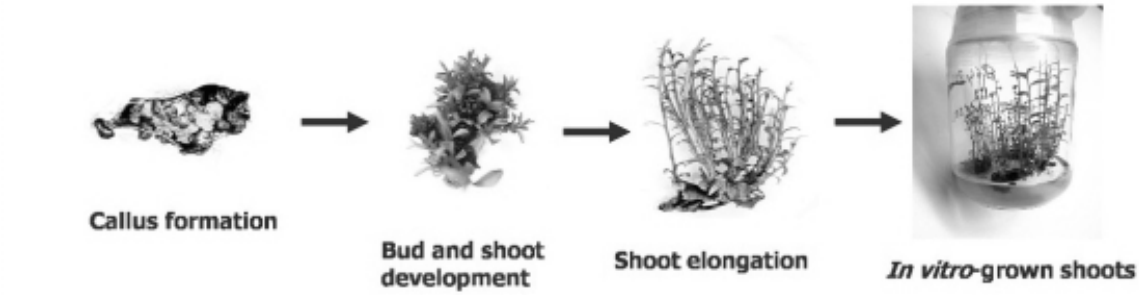

Figure 1. *In vitro* shoot regeneration in lingonberry (left to right: callus formation on 2.5-5 µM TDZ-containing basal medium after 4 wk of culture, shoot regeneration on 2.5-5 µM TDZ-containing basal medium after 8 wk of culture, shoot elongation on 1-2 µM zeatin - containing basal medium after 6 wk of transfer of 8-wk-old shoots, elongated adventitious shoots after 8 wk of transfer on 1-2 µM zeatin-containing basal medium after 8 wk of transfer of 8-wk-old shoots)

Figure 2. Bioreactor culture of lowbush blueberry *in vitro* (left: RITA bioreactor system, right: bioreactor vessel with leaf culture-derived elongated adventitious shoots)

INFLUENCE OF TERMS OF CUTTING, SUCH AS THE SOIL SUBSTRATUM AND ITS TEMPERATURE CONDITIONS ON REGENERATION ABILITIES OF GREEN CUTTINGS OF *Vaccinium corymbosum L.*

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Regeneration abilities of green cuttings of highbush blueberry, and also features of growth and development of the received plants were studied in the conditions of a greenhouse. Objects of researches were three cultivars of highbush blueberry of different terms of maturing: Earliblue, Bluecrop and Coville.

For the definition of influence of terms of cutting, such as soil substratum and its temperature conditions it has been equipped three rooting beds with underground heating - 22, 24, 26 °C and the fourth bed - without heating. Heating of a substratum for rooting was carried out within July and August. Every rooting bed was separated into 3 parts and filled with different soil substrata: peat, a mix of peat and sand (2:1) and peat, mulched with 2-cm layer of sand. In these soil mixes every 5 days 100 cuttings of three cultivars of highbush blueberry were planted. Preparation of cuttings was carried out during the period from 8 till 29 of July. Cuttings have been cut by 5-8 cm long from the sprouts of this year after finishing of the spring growth.

At the end of June of the next year striking root plants were counted and biometric parameters were defined at 20 plants in each variant of experiment.

Rooting ability of green cuttings of a highbush blueberry changed depending on terms of cutting and cultivars features. Striking root of cuttings prepared each 5 days constantly grew, and achieved a maximum on 19th of July (Table 1).

The highest degree of influence of term of reproduction on rooting of cuttings is marked at Earliblue cultivar. Fewer stable in this respect was cv. Bluecrop. Cultivar Coville show to be more tolerant to change of terms of cutting in spite highest results of rooting.

It was observed the tendency specifying that optimum terms of rooting corresponds more active period of regeneration of sprouts for all tested cultivars of blueberry. As to the total length of sprouts, the earlier cutting lead to the bigger growth of new plants.

Influence of substratum type on the rooting parameter of cuttings of a blueberry of all cultivars was insignificant. The greatest percent of striking root of the cuttings of cv. Earliblue is received on peat, mulched with sand, cv. Bluecrop - on pure peat, and cv. Coville - on a mix of peat with sand. Insignificant distinctions between variants of experience, the maximum values of striking root of cuttings that were received for each cultivar on a different soil mix specify that the type of a substratum practically did not render influence on rooting of blueberry cuttings in our experiments.

The total growth of sprouts on pure peat was higher than on the other soil mixes (at cv. Earliblue – on 2-6 %, Bluecrop – on 12 % and Coville – on 10-12 %). Pure peat show to be an optimum substratum for growth and development of root system. On our opinion the higher level of fertility of pure peat causes it.

Rooting of blueberry cuttings in beds with heating was a little bit higher, than without heating. The received data do not allow revealing optimum temperature conditions of a substratum for rooting of green cuttings. Thus, the best striking root for cv. Earliblue cuttings is received at temperature 22 °C, cv. Bluecrop – at 24 and 26 °C,

and cv. Coville – 26 °C. There was no linear dependence observed specifying, that at rising the temperature of a substratum the rooting of cuttings improves or worsens.

Table 1. Average rooting of *Vaccinium corymbosum* green cuttings of three cultivars depending on terms of cutting and substratum type, %

Cultivar	Date	Substratum						Average rooting parameter	
		peat+sand		peat, sand mulched		peat			
		$x \pm m_x$	V,%	$x \pm m_x$	V,%	$x \pm m_x$	V,%	$x \pm m_x$	V,%
Earliblue	8.07	18±1	7	17±4	39	19±3	24	18±1	6
	14.07	22±1	8	25±4	25	25±4	29	24±1	8
	19.07	34±8	36	42±3	10	37±5	23	37±2	11
	24.07	27±4	23	29±3	18	26±4	25	27±1	6
	29.07	21±6	48	27±6	37	25±5	31	24±2	12
	average	**24±4**	26	**28±6**	32	**26±4**	24	**26±1**	7
Bluecrop	8.07	38±5	21	40±7	30	25±5	13	42±3	13
	14.07	37±4	19	37±7	28	48±4	9	43±6	23
	19.07	52±4	13	49±1	1	54±3	12	50±1	3
	24.07	49±3	10	46±4	13	50±4	24	50±3	11
	29.07	38±5	20	45±2	7	57±8	41	42±2	9
	average	**43±5**	17	**43±3**	11	**50±3**	11	**45±3**	9
Coville	8.07	61±4	11	41±4	17	55±11	33	52±6	20
	14.07	72±4	10	72±4	8	62±10	26	68±3	8
	19.07	73±4	9	67±3	6	71±3	8	70±2	4
	24.07	68±9	22	58±5	15	65±5	13	64±3	8
	29.07	42±7	25	45±4	15	53±11	33	47±3	13
	average	**63±8**	20	**57±9**	24	**61±4**	11	**60±2**	6

Biometric parameters of plants received from the cuttings, grow at different temperature conditions of a substratum do not allow to ascertain essential advantages of use of underground heating. Heating of a substratum rendered beneficial effect only on formation of root system of blueberry.

Influence of underground heating on the rooting of green cuttings of highbush blueberry in our experiments was ineffective because weather conditions during this period were favorable for propagation of this culture.

That irrespective of terms of cutting, the type of rooting substratum and its temperature conditions, the higher degree of striking root was characteristic to cuttings of cv. Coville, averaging 60±2 % (Table 1). Much below index was showed by cv. Bluecrop - 45±3 %, and only 26±1 % of cuttings has got acclimatized at cv. Earliblue.
Comparative studying of biometric characteristics of the plants obtained from cuttings has shown that cv. Bluecrop and cv. Coville have generated equal number of sprouts and gave a growth of 14.5 and 14.2 cm, according to. The total length of sprouts at cv. Earliblue was in 1.6 times lower than at two other cultivars. Because of low rooting of the cv. Earliblue cuttings and according to a smaller root competition, saplings of the this cultivar have generated root system for 10 and 16 % greater volume in comparison with other cultivars.

Regeneration of green cuttings of highbush blueberry was determined mainly by a cultivar's features and the terms of cutting, and did not depend on the type of a used substratum and its temperature conditions during the experiment.

In vitro REGENERATION AND PROPAGATION OF *Vaccinium spp.*

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The interest for cultivation of highbush blueberry (*Vaccinium corymbosum* L.) and lingonberry (*Vaccinium vitis-idaea* L.) has increased in many countries. Some introduced cultivars of these species are suitable also for cultivation in conditions of Slovakia as alternative fruit crop. The native natural stands of the *Vaccinium* species in Slovakia are devastated and less productive caused by harsh collection. Experiments showed that *in vitro* techniques can be used as an alternative way of breeding and production of large number of plants also on commercial scale. Direct regeneration of shoots from nodal and shoot-tip explants, as well as adventitious shoot production from leaves and stems can be used for *in vitro* propagation and effective multiplication of these species. The shoot proliferation intensity of individual cultivars is different. The optimisation of culture conditions, plant growth regulators, mainly cytokinin type and concentration for each cultivar is necessary. In general the higher multiplication effect has been achieved on the medium with zeatin in comparison with 2iP in shoot regeneration from dormant apical and axillary buds. TDZ has been effective in adventitious shoot regeneration from the leaf tissue in highbush blueberry while zeatin in lingonberry. Microshoot rooting has been achieved on AN culture medium supplemented with IBA or directly in the peat after dipping of shoots into solution of IBA under *ex vitro* conditions.

Experiments confirmed successful regeneration and reproduction in *Vaccinium spp*. The phases of the shoot multiplication and rooting *in vitro* are without any problems. Limiting factor is transfer of plantlets to non-sterile environment depending on the different sensitivity of the genotypes.

Acknowledgements

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POSTERS

GROWTH AND YIELD CHARACTERISTICS OF A SELECTED COLLECTION OF VARIETIES – CORNELIAN CHERRY – *Cornus mas* L.

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Cornelian cherry is a thermophilic species. It is grown for its fruit and also finds its place as an ornamental plant and in ecology. It blossoms in early spring before leafing and it is a pollen-bearing plant important in apiculture. It bears fruit plentifully and regularly; the small elongated stone fruit is usually bright red to dark wine red, only rarely yellow, and is consumed fresh or processed in different ways. The biological value of the fruit is very high; very high is namely the content of vitamin C (Dolejší *et al*., 1991; Klimenko, 1990).

A number of varieties and genotypes were planted on an experimental and demonstration area of the School Farm in Žabčice. Corridor planting was established in the shape of bushes using 4.00 x 2.50 m spacing.

The objective of the present study was to evaluate the growth and yield data; i.e. height of the bushes, their cubature, length and number of runners. Phenological data were focused on the dates of the growth stages (budding, full blossom, beginning of ripening, harvest maturity). At harvest the weight and number of fruits, the weight of the stone and pulp were determined. Also the growth parameters of the harvested fruit were evaluated. The content of vitamin C, malic acid, tannins and refractometry dry matter were assessed in the laboratory.

The characteristics of growth, phenology, fertility and laboratory assessments are largely connected with the properties of the variety or genotype. The total length of the runners was the highest in the 3rd year. High values were detected in the variety Lukjanovský (20.69 m), but considerably lower values in the varieties Elegantní (18.14 m) and Fruchtal (16.25 m). The cubature of the bush increased with increasing age and in all the years of our investigations the variety Jaltský had the largest cubature; in the 2nd and 3rd year it was 3.93 m^3 and 4.48 m^3, respectively (Table 1). The Jolico and Fruchtal varieties had the smallest cubature in the 3rd year (i.e. 1.35 m^3 and1.45 m^3, respectively). The phenological stages are connected with the course of the climate, i.e. temperature and precipitation in the respective years. The earliest beginning of budding was discovered in the variety Jaltský and in our study ranged between the 12 and 20 March; it was late in the varieties Jolico and Fruchtal; also the date of harvest maturity of the Jolico variety was late.

The total fruit yields were the highest in the 3rd year of our evaluations; yields of the varieties Jaltský, Fruchtal and Elegantní were 7,011.66 g, 6,675.00 g and 6,405.33 g, respectively (Table l). The highest cumulative yields were produced by the variety Elegantní, i.e. 9,278.03 g of harvested fruit. The variety Jolico showed the highest average weight of fruit (5.19 g), followed by Lukjanovský (4.95 g) and Vydubecký (4.65 g, Figure 1). Basing on laboratory assessments the content of vitamin C was the highest in the variety Elegantní 320.66 mg.kg^{-1}; the content of malic acid was the highest in the variety Fruchtal, i.e. 1.18 %, and the tannin content was the highest in the variety Vyšgorodský (0.937 mg.kg^{-1}).

Basing on evaluations of the selected parameters we can say that the varieties Vydubecký and Vyšgorodský are perspective. In terms of yields the best varieties are Jaltský, Fruchtal and Elegantní. According to the results of laboratory assessments of the substances the best varieties are Fruchtal and Jaltský

Acknowledgement
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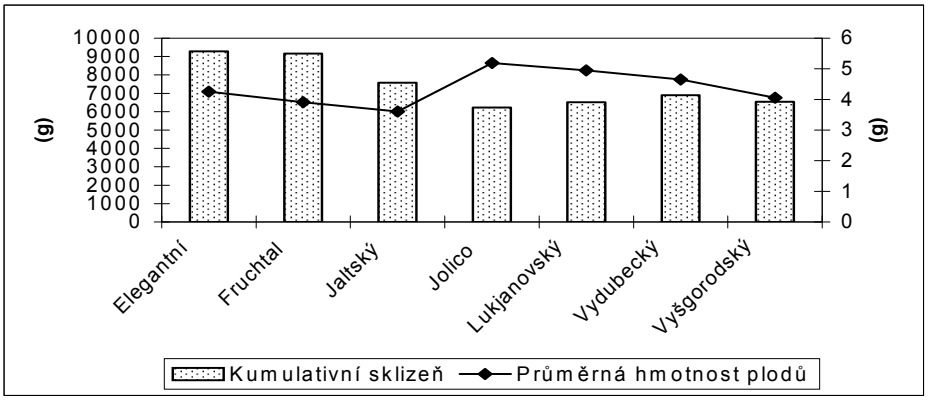
Table 1. Average values of growth and harvest data (m, m^3*)*

Order	Variants - varieties	Total length of runners -m	Cubature of bush- m^3	Weight of harvest – g, dates			Total harvest
				15 Sept.	30 Sept.	15 Oct.	
2004 Tab. 1 a							
1	*Elegantní*	13.45	1.50	120.30	185.77	-	306.07
2	*Fruchtal*	8.35	0.72	278.90	420.10	-	699.00
3	*Jaltský*	11.37	2.10	283.57	-	-	283.57
4	*Jolico*	9.20	0.75	-	179.90	560.20	740.10
5	*Lukjanovský*	12.06	1.45	-	230.60	248.06	478.66
6	*Vydubecký*	13.10	0.81	120.50	240.20	306.87	667.57
7	*Vyšgorodský*	11.15	0.86	-	350.80	113.86	464.64
2005 Table 1 b							
1	*Elegantní*	18.32	2.41	393.30	2173.33	-	2566.63
2	*Fruchtal*	10.99	0.96	341.21	1441.90	-	1782.11
3	*Jaltský*	13.11	3.93	278.71	-	-	278.71
4	*Jolico*	7.42	0.81	-	720.30	1476.50	2196.80
5	*Lukjanovský*	15.32	2.78	-	1597.64	1076.66	2674.30
6	*Vydubecký*	5.74	1.06	174.62	589.20	1318.20	2082.02
7	*Vyšgorodský*	8.36	1.99	727.33	1316.51	182.06	2225.90
2006 Table 1 c							
1	*Elegantní*	18.14	3.11	1800.00	4605.33	-	6405.3
2	*Fruchtal*	16.25	1.45	1130.00	2100.00	3445.00	6675.00
3	*Jaltský*	15.79	4.48	4660.00	2351.66	-	7011.66
4	*Jolico*	7.18	1.35	-	1733.33	1551.66	3285.00
5	*Lukjanovský*	20.69	3.43	-	1108.33	1970.00	3361.66
6	*Vydubecký*	15.44	2.24	1045.00	2191.66	919.00	4155.33
7	*Vyšgorodský*	13.12	2.64	-	1162.00	1790.00	2952.00



Cumulative harvest / Average weight of fruit

Figure 1. Graph of average values of cumulative harvest and weight

FEATURES OF LARGE CRANBERRY PROTECTION AGAINST DISEASES AND PESTS

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Large cranberry *Qxycoccus macrocarpus* (Ait.) Pers. is a perspective berry crop for industrial cultivation in Belarus, characterized by high yield, quick cover of expenditures, significant nutritive value and rich chemical composition of micro and macro elements.

At present nearly 100 ha are under large cranberry in Belarus. It is difficult to get high yields of large cranberry due to diseases infection and pest damage. The caused damage can make up to 90% from the total yield. Considering the above-stated it became necessary to develop a system of large cranberry protection against noxious organisms.

Based on monitoring of phytosanitary situation in large cranberry plantations of the concern «Belarussian cranberry» Pinsk region Brest district, and also infected organs microscoping and fungal structures analysis, for the period of 2003-2006 the workers of Fruit Crop Protection Lab of the Belarussian Institute of Plant Protection have identified 21 agents of the most important, from the economic point of view, diseases. The mycological analysis and more precise definition of structure of phytocomplex dominance of large cranberry showed that a main pathogen of vegetative organs is an agent of leaf spot disease - a fungus *Fusicoccum putrefaciens* Shear, fruit rots – a fungus *Monilia oxycoccii* Wor.

Based on our data, depending on diseases infection the berry harvest deficiency can make 33.3-37.0%. The "critical" periods for large cranberry infection by phytopathogens are determined. The initial infection of plants is done at phenophase "mass growth of vertical shoots" by *Monilinia oxycoccii, Gibbera myrtilli, Godronia cassandrae* ascospores in the first decade of May. This is the first "critical" period in plant infection by monilial blight, gibberic spot, godronia. The flight peak of above-indicated fungi is marked at phenophases "budding" (mass dissemination of *Monilinia oxycoccii, Godronia cassandrae, Diaporthe vaccinii)* ascospores; «beginning of blossoming» (mass dissemination of *Fusicoccum putrefaciens, Phomopsis vaccinii, Monilia oxycoccii, Ceuthospora lunata)* conidia in the I and II decades of June. This is the second "critical" period in plant infection by monilial blight, godronia, phomopsis, black rot.

The subsequent large cranberry infection is done at phenophase "fruit growth" (mass dissemination of *Gibbera myrtilli* ascospores*, Fusicoccum putrefaciens, Phomopsis vaccinii, Phyllosticta vaccinii)* conidia in the I and II decades of July. This is the third "critical" period in plant infection by gibberic spot, godronia, top-drying and phyllosticta disease of plants.

The biological and economic efficiency of 12 fungicides is accomplished among which the most effective are chorus, WDG, 750 $g.kg^{-1}$, scor, EC, 250 $g.l^{-1}$ and delan, 70% w.g. applied at "critical" periods against fruit rot complex during yield harvest has made 62.8, 69.1%, 78.4,%, in the standard variant with the fungicide azofos, 65% ps application – 45.6%. The carried out protective measures with the fungicides chorus,

scor and delan application gave an opportunity to preserve 17.0, 27.0, 33.5 cwt/ha large cranberry fruits, accordingly.

A main pest of large cranberry is black-head cowberry moth (*Rhopobota naevana* Hubn.), which develops under conditions of Belarussian forest area in two generations. The pest number fluctuated by years and has made 1.5-24.5 caterpillars per 1 m^2 at shoots damage from 2.5 to 80%. 16 insecticides were tested among which the most effective were fastac 10% EC, tarzan, WE, 100 $g.l^{-1}$ and danadim, 400 $g.l^{-1}$, EC. The biological efficiency of the applied in the systems of large cranberry protection insecticides against black-head cowberry moth larvae has made: danadim – 88.9%, fastac – 83.3%, tarzan – 78.6%.

Based on biological features of disease agents and pests development study, evaluation of separate technological techniques a system of large cranberry protection is developed and substantiated which includes: stratification (phenophase "dormancy period"), four times spraying with fungicides (phenophase "beginning of vertical shoots growth" – "fruit growth"), short-term strip flooding (24 hours) against the first generation of black-head cowberry moth caterpillars (phenophase "budding beginning"), single spraying with the insecticide against the second black-head cowberry moth caterpillars (phenophase "fruit growth").

The application of the developed system of large cranberry protection in 2006 allowed to decrease fruit diseases development for 85.7% and preserve berry yield for 35.0 cwt/ha.

FEATURES OF BIOCHEMICAL COMPOSITION OF *Vaccinium corymbosum* L. FRUIT WHEN INTRODUCED IN BELARUS

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In connection with research into the adaptive potential of *V. corymbosum* L. upon its introduction into southern regions of Belarus an assessment of the biochemical composition of fruit of 3 model highbush blueberry varieties - Duke (early-ripening), Bluecrop (mid-ripening) and Nelson (late-ripening) on 43 values has been given in the frames of a field experiment with the 8-alternative scheme of N60, P60, K60 application (kg/hectare a.s.) on an admixture of high peat and sod-podzolic sandy loam soil in a 4-years cycle of observations.

As a result of investigations the most evident varietal differences in the content of separate compounds have been found. The degree of their display was appreciably determined by the hydrothermal regime of a season and mineral status. It has been shown that highbush blueberry fruit, especially those of the early ripening variety, are extremely rich in phenol compounds possessing a wide action spectrum on the human body. The total content of bioflavonoids (P-vitamins) in 100 g of fruit dry matter averaged 4550…6830 mg, including anthocyans properly – 5…10, leucoanthocyans – 17…28, catechins – 1160…1580, flavonols – 3280…5210 mg. The content of tanning agents and lignins thus averaged 1.4…2.4 and 4…15 respectively. In separate seasons the marked varietal differences were registered as regards accumulation of phenolic compounds in fruit (basically within the range of 10…30 %) which degree of displaying was determined by the total quantity of incoming heat during fruit ripening. Decreasing the provision of heat in the course of the experiment promoted the activation of bioflavonoid accumulation in fruit of the early-ripening variety against the background of reduced contents of lignins and, to a lesser degree, of tanning agents which resulted in emergence of appropriate differences between this and two other varieties. The increased supply of heat in the referenced period promoted a marked leveling of those differences.

It has been shown that highbush blueberry fruit are characterized by several times higher activity of polyphenol oxidase rather than peroxidase against the background of rather weak dependence of both ferments activity on a varietal identity of plants, mineral background and geographical location of the research area.

The variation range of organic acid and terpenoid content in dry matter of highbush blueberry fruit under the combined influence of exogenous factors made up: for titrate acids (in terms of lemon acid) – 2.6…9.9 %, ascorbic, benzoic and phenol carboxylic acids – 276…923; 138…348 and 1584…1916 mg of % respectively; for triterpene acids – 1.8…3.1 %, fatty oils – 2.7…4.9 %, carotenoids – 3.1…6.8 mg of % incl. β-carotin – 0.3…1.2 mg of %. Dry matters accounted for 13.9…16.9 % in fresh highbush blueberry fruit. It has been shown that the fruit of the mid-ripening variety are in general characterized by the highest values of averaged (in a long-term observation cycle) parameters of accumulation of the majority of listed substances – benzoic and phenol carboxylic acids, fatty oils and carotenoids. The fruit of the early-ripening variety displayed the highest values for ascorbic and triterpene acids while those of late-ripening plant – for free organic acids and dry matters. At this point the less marked character of varietal differences in perennial cycle (with divergence in extreme values by no more than 10-20%) has been registered for ascorbic, benzoic, phenol carboxylic and triterpene acids, as well as fatty oils, while the most marked character (with more than 100% values divergence) - for free organic acids and β-carotin. The intermediate position in this regard was occupied by xanthophylls – with a relative scale of maximum varietal differences within the range of 30…50%.

The analysis of the carbohydrate composition of highbush blueberry fruit in the long-term observation cycle against the background of introduced mineral fertilizers has shown that depending on weather conditions during the ripening period and on the varietal identity of plants, the content of some substances in plant dry matter averaged: 19…27% as regards soluble sugars – with the absolutely dominating position of monosaccharides, first of all fructose; 3…6% for pectic substances – with pectin prevailing; and 5.8…7.9% for cellulose. It has been shown that against the background of lacking varietal differences in the aggregate content of soluble sugars in fruit, the late-ripening variety was dropping behind the two other varieties by 10…30% in glucose accumulation while overtaking them by 20…30% in the case of saccharose. At the same time it was characterized by the lowest content of pectin substances in its fruit yielding to the mid-ripening variety (the one with the highest content) by 12…28%. A gradual increase of the sugar-acid index has been registered reflecting the sweetness of fruit that was growing from late- to early-ripening varieties. A degree of dependence of varietal differences occurrence in carbohydrates accumulation in highbush blueberry fruit on the hydrothermal regime of their ripening period has been established.

The following variation ranges for the parameters of accumulation of major mineral elements in fruit have been given (%) – N – 0.62…1.73; P – 0.03…0.38; K – 0.38… 0.67; Ca – 0.05…0.13; Mg – 0.02…0.04; microelements ($mg.kg^{-1}$) – Fe – 22.7…55.6; Mn – 7.5…36.2; Zn – 1.2…7.1; Cu – 1.5…3.4. It has been shown that the elemental composition of highbush blueberry fruit is determined by the hydrothermal regime of a season and formed at the expressed inconsistency of N, P, K supply rates on the one hand, and Ca, Mg – on the other, and also with a similar inconsistency of supply as regards Fe and other microelements. A decrease in the temperature background in combination with lack of moisture resulted in the weakening of synergism between accumulation of K on the one hand, and both N and P on the other hand.

Within the frame of the general methodical approach a comparative research into resistance of biochemical components of highbush blueberry (model varieties) fruit to the global influence of meteorological factors on the basis of their average variability level analysis in a long-term cycle of observations allowed to designate a position for each of them in regard to the decreasing degree of such resistance. It also has shown that against a background of marked varietal differences the minimal variability values (V below 15 %) and hence the lowest dependence on the hydrothermal regime of the vegetative season, were characteristic for the parameters of accumulation of dry matters, leucoanthocyans, catechins, flavonols, phenol carboxylic acids, fructose and cellulose in fruit. The average dependence (V=15…30 %) was characteristic for properly anthocyans, tanning agents, triterpene acids, fatty oils, xanthophylls, saccharose, pectic agents, potassium and magnesium. The highest dependence (V> 30 %) was registered for lignins, free organic, ascorbic and benzoic acids, β-carotin, nitrogen, phosphorus, calcium, microelements, and also for the sugar-acid index value.

On the basis of research into the average level of variability indices of biochemical composition of fruit in separate years in the frames of a field experiment, providing a notion of the degree of their resistance to the edaphic factor, it has been established that the dependence of parameters of accumulation of useful substances on the state of mineral background is less marked, on the whole, than their dependence on meteorological factors. The majority of parameters were characterized by a low degree of the given dependence. The average level of the latter has been established for the content of macroelements, Mn, anthocyans, titrate acids, xanthophylls, saccharose, hydropectin and the sugar-acid index values, whereas the high level – only for β-carotin and microelements. Thus it has been shown that the ratio of influence exerted by meteorological and edaphic factors in the formation of the biochemical composition of highbush blueberry fruit in a field experiment was determined by the chemical nature of its separate elements and varietal identity of plants.

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EVALUATION OF CRANBERRY (*Vaccinium macrocarpon* AIT.) CULTIVARS

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Every year new plantations of large fruit cranberries are established in Latvia. Various introduced cultivars have been used but there is a lack of investigations about their suitability for our growing conditions.

Experiments were performed during the years 2004-2006 at the Research and Training Base of the Institute of Agrobiotechnology of the Latvia University of Agriculture. Cultivars 'Beckwith', 'Howes', 'Black Veil', 'Franklin', 'Early Black', 'Stevens', 'Bergman' and 'Piligrim' were investigated. The thickness of peat layer was 40 cm and soil acidity pH 4.4.

Damage caused by spring frost was observed for all cultivars in 2004 (- 8 ^{0}C on June 20), but less for cultivars 'Stevens' and 'Black Veil'. The beginning of vegetation period was two weeks later than in 2005. Damage to flower buds and young shoots was the reason of low yield for cultivars 'Franklin', 'Early Black' and 'Howes'. Winter 2004-2005 also was not so suitable for cranberries. On some days in January, temperature dropped to - 27 ^{0}C. The spring was cool, with frost (- 4 ^{0}C) in the second decade of June. Conditions were more suitable during winter 2005-2006. Only some sunburn of vertical shoots of cranberries was observed. The number of productive shoots correlated with the yield of cranberries, with the highest (16 %) observed for cultivars 'Beckwith' and 'Stevens', and the lowest for 'Piligrim'and 'Bergman' (Figure 1).

The duration of flowering for all cultivars was 29-31 days. The highest yield period in 2004-2006 was observed for cultivars 'Beckwith' and 'Stevens' with 2.420 and 2.297 kg.m^{-2}, respectively, but the lowest for cultivars 'Piligrim' and 'Bergman', 1083 and 1,137 kg.m^{-2}, respectively (Figure 2).

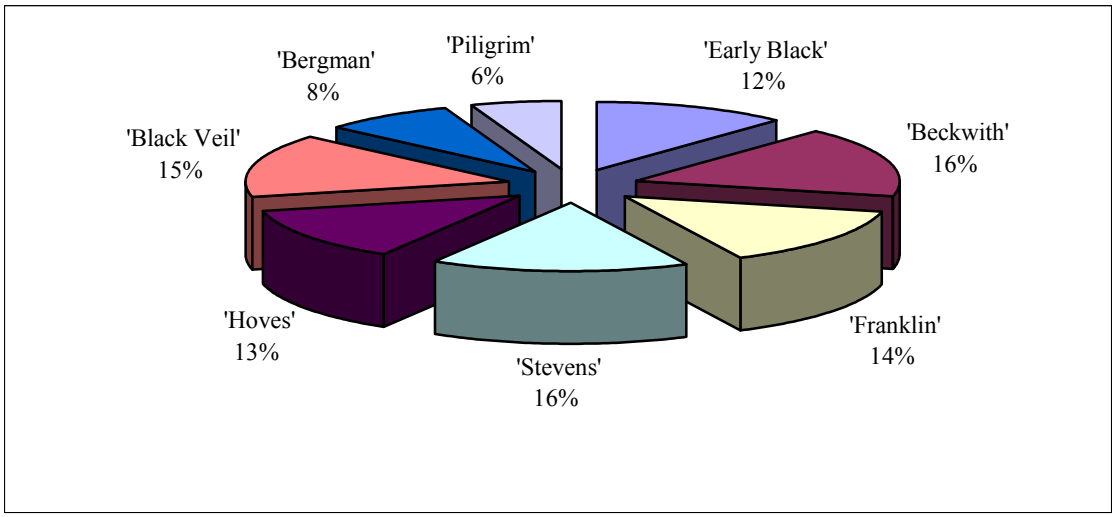

Figure1. Number of productive shoots, years 2004-2006

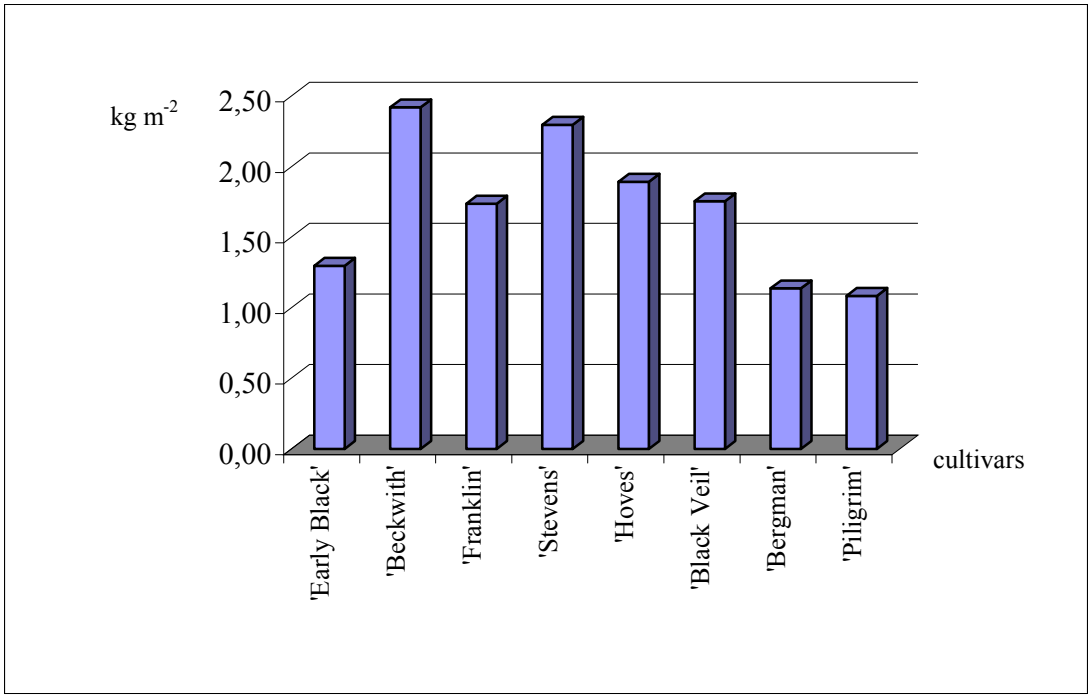

Figure 2. Cranberries yield, years 2004-2006

THE MOST IMPORTANT DISEASES OF CRANBERRY AND CONTROL MEASURES IN LATVIA

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Cranberry (*Oxycoccus macrocarpon*) is perspective and marketable culture in the market of Latvia because of the high food value: berries contain vitamins, polyphenols, a. o. Plantations of cranberry enlarge recently in Latvia too. One of the most important problems on the cranberry plantations is fungal diseases, because they reduce and damage quality of the yield. Diseases of cranberry, inter alia berry rots were not investigated in Latvia until now.

The investigation have been carried out in cranberry bog "Kalna purvs", Aluksne region. Cranberry variety 'Stevens' was observed. Cranberry diseases were investigated in plots without pesticides treatments. Fungi were identified in Latvian Plant Protection Research Centre. For detection of pathogens were used moisture camera and pathogen isolation on pure culture (PDA). Morphological properties of colony, dimensions and peculiarities of spores were described.

Identification of causal agents and clarification of peculiarities of disease development is necessary for the development of the biologically and economically justified plant protection management.

The most important production losses caused berry rot. The berries were stored at the temperature 18–20 ^{0}C for rot stimulation. In the storage until February different rots appeared on 96.8 % of all berries. *Phyllosticta elongata* causal agent of early rot, *Physalospora vaccinii* causal agent of blotch rot, *Allantophomopsis* spp. causal agents of black rot and *Phomopsis vaccinii* causal agent of viscid rot were identified. *P. vaccinii* is quarantine organism and control of this disease is important problem in all the areas where cranberry is cultivated

Black rot mostly appeared after one month storage. Development of early rot and blotch rot was observed from November till the end of February. It means that these diseases have different incubation periods. It is important information for the growers that helps to determine the real time of realization before rotting is started.

Fungicides Signum 33 WG (a.i. boscalid and pyraclostrobin) and Champion 50 WP (a.i. Cu hydroxide) are registered in Latvia for cranberry. Using of these preparations decreases berry rot incidence.

It is necessary to continue investigations for further identification of causal agents of berry rots, for better understanding of different factors influence on diseases development and investigate quarantine causal agent *Diaporthe vaccinii* (anamorph *Phomopsis vaccinii*) in Latvia. It is important to optimize the methods of cranberry diseases control.

EVALUATION OF HONEYSUCKLE (*Lonicera sp.*) CULTIVARS IN POLAND

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An experiment is located in an Experimental Orchard at Dąbrowice near Skierniewice, Poland. In spring 2002 three bushes per plot in 4 replications were planted in a distance 3x1m. Seven taxons of honeysuckle were tested: 'Dlinnoplodna', 'Sinoglazka', 'Wolszebnica', 'Tschelabinka', *Lonicera kamtschatica,* (all from Russia), 'Wojtek', 'Jolanta' (both Polish). Fruit were picked by hand in June 2004-2007. Yield, mass of 100 fruit and size of plants were established. When the growth period ended all bushes were measured.

Four Russian cultivars grow quickly and ripen early (beginning of June) but have small fruits (below 1g). The most prolific were two Polish cultivars. They are medium late and big fruited, easy to hand picking. After winter 2005/2006 with frost of - 35 ^{0}C there was no injury of plants. During very dry summer 2006 unirrigated plants suffered much more from drought than bushes of other species (*Rosa, Cornus mas*). In 2007 the crop was a little poorer because of spring frost.

Fruits of 'Wojtek' cultivar

EVALUATION OF SOME NEW BLUEBERRY (*Vaccinium spp.*) CULTIVAR IN CENTRAL POLAND

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Blueberry production continues to expand in Poland. The most popular highbush blueberry cultivar is 'Bluecrop' followed by some new cultivars (Smolarz, 1997, 2006).

The experiment with some highbush blueberry (*Vaccinium corymbosum* L.) and half-high bush blueberry (*Vaccinium corymbosum* X *Vaccinium angustifolium)*, was conducted in Skierniewice, Central Poland. The highbush blueberry cultivars Brigitta', 'Bonifacy', 'Denise', 'Toro', 'Sierra', and 'Bluecrop' (standard) and half-high bush blueberry cultivars 'Emil' and 'Putte were planted in 2001, in space 2.5 x 1 m. There were 4 replications with 5 plants in one plot. The experiment was set up in a completely randomized design and data were tested by analysis of variance, Duncan's test, at P=5%.

The aim of the research was to compare vegetative growth, flowering and harvest dates as well as yield and fruit quality. Total and mean length of annual shoots, also shoots number, plant height and width, yield and mean fruit weight, their diameter and soluble solid were compared in 2002-2006.

The experiment was conducted on poor sandy soil, with pH 4.0 status (determined potentiometrically in 1:2.5/l M KCl) and low organic matter content (1.3%). Plantation was irrigated 2-4 times a year, in drought periods. In plant rows there was the organic mulching: sawdust, about 15 cm deep (new organic matter was added every 2 years), in alley ways it was used grass sward. In the years of the experiment there was the sanitary pruning only (pruning broken, winter damaged and sick shoots). Mineral fertilizers were applied in dose: 100:20:50 NPK, every year, in the spring.

In general, bushes of 'Brigitta' grew more vigorous than other cultivars (there were 936 shoots per plant, length of 10484 cm; mean of the year, respectively: 156 number and 1747 cm). Plant of cultivar 'Emil' and 'Putte' were the lowest, and their crown capacity were smaller than other cultivars.

Plants started to flower at the beginning of May. Harvest was performed in the middle of July to the middle of August (in 2005) or the beginning of September (in 2004 and 2006). 'Brigitta' berries began to ripen later than others.

The yielding was evaluated in five years period. Average yields per plant varied from cultivar to cultivar, however there were not significant differences in total yield 2002-2006 (Table 1). In general, production level was not satisfactory because of pure vegetative growth. In 2003 and 2005 freezing temperature killed floral buds. There were especially heavy damage of cultivars 'Bluecrop', 'Brigitta', 'Denise', 'Toro' and 'Sierra' in 2003; also Brigitta' and 'Toro' in 2005. Floral buds of cultivars 'Emil' and 'Putte' were not damaged at all.

Mean fruit weight varied from year to year. The biggest fruits were in 2003, the smallest in 2006 (independent of cultivar there were two times smaller). The biggest fruits had cultivars: 'Denise' (mean fruit weight: from 2.17 g in 2003 to 1.15 g w 2006), 'Brigitta' (2.20 and 0.97 g, respectively) and 'Toro' (2.02 and 1.03 g, respectively). The mean fruit weight of standard cv. 'Bluecrop' was from 1.34 to 0.88 g, depended of the year of the study. In each time of picking fruit sizes were small and medium as well as

large and very large. In most cases the smallest fruit was 3-4 times smaller than the biggest one. For example: in 2004 single fruit weights (‘Bluecrop’), were ranging from 0.80 g to 2.71 g and in 2005 – from 0.75 g to 2.55 g; and single fruit diameters were ranging from 9.4 to 19.3 mm and from 11.35 to 19.72 mm, respectively.

In most cases fruit color of highbush blueberry was light blue with waxy bloom (besides of ‘Bonifacy’). Half-high blueberry fruits had a much less waxy bloom, appearing almost black. These berries were small but the flavor was like the wild type. Also their shape was more round than fruit shape of highbush cultivars.

Fruit soluble solids content varied with cultivar and year of the study, with Denise having relatively high refractometer reading (15.30% in 2005).

This experiment confirmed half-high bush blueberry frost resistance and their high yielding (Hjalmarsson, 2006). Because of not vigorous plant growth higher yielding could be possible by increasing planting density.

‘Brigitta’ and ‘Toro’ showed promise because of their high fruit quality, but they are not sufficiently winter hardy.

Polish cultivar ‘Bonifacy’ gave relatively high yield, time of ripening was similar to ‘Bluecrop’ and berries were much less waxy than other highbush cultivars.

In deciding whether or not to plant blueberry it is advisable to analyze the factors which can influence its productivity. Analyzing these results must be taken into consideration that we did not have an irrigation system.

Table 1. Yielding of highbush and half-highbush blueberry in Skierniewice ($kg \cdot bush^{-1}$)

Cultivar	2002	2003	2004	2005	2006	2002-2006
‘Bluecrop’	0,11	0,04 a	0,94 a	1,42 b	1,02 a	3,53 a
‘Brigitta’	0,16	0,04 a	1,00 a	0,52 a	1,22 a	2,94 a
‘Bonifacy’	0,19	0,30 d	1,10 a	1,00 ab	1,14 a	3,73 a
‘Denise’	0,12	0,04 a	1,25 a	0,93 ab	1,19 a	3,53 a
‘Emil’	0,04	0,19 bc	0,96 a	1,30 ab	1,13 a	3,62 a
‘Pute’	0,13	0,17 cd	1,03 a	1,32 b	1,01 a	3,66 a
‘Toro’	0,06	0,08 ab	0,85 a	0,75 ab	1,13 a	2,87 a
‘Sierra’	0,12	0,09 ab	0,94 a	0,79 ab	0,95 a	2,89 a

Different letters in the same column indicate significant difference (P=0.05)

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CULTIVATION OF SELECTED LINGONBERRY VARIETIES IN MOUNTAIN REGIONS IN SLOVAKIA

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During 2003 – 2006 an ecological experiment was conducted in a mountain region in Slovakia to evaluate the possibilities of cultivation and to test six varieties of lingonberry (Ida, Koralle, Runo Bielawskie, Linnea, Sanna and Sussi) for productivity and adaptability. The experiment site is situated at an altitude of 645 m. Mean annual temperature is 6°C and total annual rainfall ranges from 800 to 900 mm (with max. monthly rainfall in June and July). The soil is sandy loam, illimeric brown soil type with strongly acidic reaction (pH-KCl 3.63).

Over the experiment years we monitored plant height, flowering time, harvesting time, yield per a plant, hundred berry weight, occurrence of diseases and pests, and winter hardiness.

The results have shown that plants of varieties Runo Bielawskie and Linnea are the most vigorous in growth. Linnea variety starts to flower and ripen considerably later compared to other varieties. Varieties exhibiting two flowering periods per a growing season – Ida and Koralle (except for Runo Bielawskie) – produce higher yields than varieties flowering once, and minimum or no rotten berries (at second harvest) was found. Sanna and Linnea, once-flowering varieties, produced very high yields.

In Slovakia, an altitude from 650 to 700 m is a top limit for satisfactory ripening of two-crop varieties (Ida, Koralle, and Runo Bielawskie) which are less suitable for mechanised harvest for possible injury to flower buds, or to developing berries during the spring harvest period. Practically, the most suitable varieties for mechanised harvest are highly productive one-crop varieties Sanna and Linnea which may be also cultivated at higher altitudes.

The results also showed that Ida variety had considerably heavier berries than other varieties. The occurrence of a fungal disease (*Allantophomopsis cytisporea,* L.) causing the leaves turn black and fall off was most frequent with Ida, Sanna, Koralle and Sussi varieties.

MONITORING OF WILD BERRY PLANTS OF THE *Vacciniaceae* FAMILY IN BELARUS

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In Belarus wild berry resources have been monitored since 2006. During monitoring:

a) generative organs of partial berry shrubs are counted to give the most accurate estimate of the annual harvest of the fruit, and
b) projecting cover, productivity, foliage color, presence of insect pests and diseases on partial berry shrubs, mechanical injury to berry plants, forest condition, forest management techniques and techniques for harvesting of the fruit are assessed to make an estimate of the condition of berry plants that grow in natural habitats.

A permanent observation site may cover 0.2 to 1 ha. The site may represent a survey unit or even a transect. Its size is dependent on the evenness and projecting cover of berry plants.

Generative organs of berry plants are counted annually when their initiation takes place. Accounting areas for the lingonberry and cranberry may range from 0.25 to 1m^2, while those for the bilberry and bog blueberry must cover 1m^2. The required number of accounting areas is calculated with the following formula:

$$n = \frac{t^2 V^2}{p^2},$$

where n is the required number of accounting areas, p is the required accuracy (%), V is the coefficient of variation and t is the Student criterion.

In view of heavy mortality of generative organs and variation of fruit-bearing partial berry shrubs within a subcompartment, most specialists on wild berry resources are of the opinion that yields can be predicted with an accuracy of 20 to 25%. To accomplish this, it will suffice to establish 7 to 25 accounting areas.

It is worthwhile assessing yields before maturation of the fruit, which will permit to estimate productivity of berry plants to a high accuracy. Establishing of accounting areas in the same place is objectionable because this can lead to the compaction of the soil and mechanical injury to the partial berry shrubs.

A special scale measures the presence of insect pests and diseases on berry plants as well as mechanical injury to berry vines.

Based on the information of Table 1 it is possible to calculate a potential harvest of the fruit in Belarus on the five-point scale.

On the strength of the data on generative buds, flowers and fruit set one can predict the harvest 1year, 1 to 2.5 months and 1 to 1.5 months before the fruit bearing, respectively.

Table 1. The relation between number of generative organs of berry plants and yield

No. buds per 1 sq. m	No. flowers per 1 sq. m	Fruit set per 1 sq. m	Yield (kg/ha/point)
***Vaccinium vitis-idaea* L.**			
13/50	50/125	20/25	25/1
26/100	100/250	40/50	50/2
52/200	200/500	80/100	100/3
78/300	300/750	120/150	150/4
104/400	400/1000	160/200	200/5
***Vaccinium uliginosum* L.**			
46	32	16	50/1
91	64	32	100/2
183	128	64	200/3
274	192	96	300/4
366	256	128	400/5
***Oxycoccus palustris* Pers.**			
21	33	16	50/1
41	66	33	100/2
83	132	66	200/3
124	198	99	300/4
166	264	132	400/5
***Vaccinium myrtillus* L.**			
72	50	25	50/1
143	100	50	100/2
286	200	100	200/3
429	300	150	300/4
572	400	200	400/5
Note: *The numerator and denominator denote the number of generative organs of lingonberries that grow in northern and southern Belarus, respectively.*			

The predicted yield (Y_p) is computed from the formula:

$Y_p = 0.1\ N_{fb} \times C_b \times C_f \times C_{fs} \times F_b \times W$, or $0.1\ N_{fb} \times C$, where N_{fb} is the mean number of buds per 1 sq. m, C_b is the mean long-term coefficient of undamaged state of buds, C_f is the mean long-term coefficient of undamaged state of flowers, C_{fs} is the mean long-term coefficient of undamaged state of fruit set, F_b is the number of flowers developing from an individual bud, W is the mean weight of 100 berries (g), C is the product of $C_b \times C_f \times C_{fs} \times F_b \times W$. Table 2 gives values for the mean long-term components of the yield in Belarus.

Table 2. Coefficients of a predicted harvest of the fruit

Berry species	C_b	C_f	C_{fs}	F_b	W	C
Vaccinium vitis-idaea	0,77 / 0,5	0,4 / 0,2	0,5 / 0,4	5	25	19,25 / 5
Vaccinium uliginosum	0,7	0,5	0,5	1	60	10,5
Oxycoccus palustris	0,8	0,5	0,6	2	50	24,0
Vaccinium myrtillus	0,7	0,5	0,5	1	40	7,0
Note: *The numerator and denominator denote the coefficients of undamaged state of generative organs of lingonberries that grow in northern and southern Belarus, respectively.*						

TRIALS ON PURPOSE OF TECHNICAL IMPROVEMENTS IN BLUEBERRY NURSERY

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In this poster I summarize two pot experiments, carried out in a Japanese blueberry nursery in the experimental station of Tohoku University in Kawatabi in the North-Eastern side of Honshu Island. The main problems of the nursery were the fertilization and irrigation of blueberry saplings. How could we make it more simple and less laborious?

Fertilizer experiment. Continuous application of fluid fertilizer is very labour consuming besides it can easily lead to overdose of mineral nutrients, and changes of the pH of medium. Besides applying nutrient solution and in the same time using mist-irrigation may lead to N leaching. Blueberry is very sensitive to iron deficiency that is why special iron rich fertilizers for blueberry have been developed. These slow release fertilizers were studied in this experiment on the purposes to eliminate the disadvantages of solution fertilization and to save labour cost with their single basal application.

The pot experiment was carried out from 30th April to the middle of September in 2002. In each fertilizer treatment, 20 plants of 'Patriot' highbush blueberry cultivar were planted in peat moss, placed in vinyl containers size of 1 liter. Three slow release fertilizers with different release rate (A>B>C) were tested and compared to conventionally used Hyponex fertilizer solution. The amount of applied fertilizers was equivalent to 0.12g N, and applied as a single basal fertilizer before transplantation. Hyponex (H), (5-10-5) 100ml of 1/500 dilution, was applied ten times, every two weeks as control treatment. The length and width of plants, and number and length of shoots and branches were measured. K, Mg, Mn, and Fe concentrations of leaves were analyzed.

All of the three slow release fertilizers are suitable to blueberry fertilization in nursery, because they induced near the same responses of plants and had nearly the same production as Hyponex fertilizer application, with the advantage of labour saving and earlier shoot maturation.

Irrigation experiment. Highbush (*Vaccinium corymbosum* L.) blueberries are naturally grown in acidic swamps and bottomlands. For the shorter or longer periods of the year, they grow under flooded conditions. Due to this, especially young blueberries are sensitive to the lack of water. Our purposes were in this experiment to find the most convenient and satisfactory irrigation method in the large size blueberry nurseries, considering the claims of the blueberries and the farmers; and to describe the visible effects of the different water applications on highbush blueberry rooted cuttings.

The experiment was carried out from 5th of June to 13th of August in 2002. Fifty pots of "Blueray" highbush blueberry rooted cuttings were arranged in duplicated treatments as followings: flooded (*flood* treatment); 1 cm deep waterbed (*one cm* treatment); textile-stripe (*stripe* treatment) (self-irrigation); daily watering (*once a day* treatment); and watering as "demand of peat-moss" (it means watering, when peat-moss is dry, *dry surface* treatment). Nutrients were applied every two weeks into irrigation water containing 1/500 dilution of Hyponex solution. Plant length and width, number and length of new grown shoots, fresh and dry weights of shoots and roots were measured leaf-reddening and root-rotting were observed.

According to the results, the most effective and the labour saving irrigation method was concluded to be the *one cm* water bed and the *stripe* self-irrigation method, which are easily carried out even in large size nurseries.

THE CRANBERRY TIPWORM *Dasineura vaccinii* (SMITH, 1890) THE MOST HARMFUL PEST OF CRANBERRY PLANTATIONS IN LATVIA

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American large-fruited cranberry (*Oxycoccus macrocarpon*) is commercial culture in the market of Latvia. One of the most important on reasons of yield loss cranberry plantations are pests. Species composition of harmful and potentionally harmful insects was studied in Latvia. During three years the spread and economic importance of those organisms in cranberry plantations was evaluated.

Three years systematic studies of harmful pest species composition were carried out. The spread of insects and the course of development of the most harmful pests were regularly observed in the basic trial area Ltd "Lienama-Aluksne" (cranberry bog "Kalna purvs"), Aluksne region, North-Eastern part of Latvia. Mainly cranberry variety 'Stevens' was observed. The largest cranberry plantations were inspected once during vegetation season.

The determined pests were:

- *Dasineura vaccinii* S.;
- *Orgya antiqua* L.*;*
- *Lochmaea caprea* L*;*
- *Rhopobota (Acroclita) naevana* Hübn.;
- *Sparganothis sulfureana* Cl.;
- *Chionaspis salicis* L.;
- *Thysanoptera*;
- *Aphidinea*;
- *Acari*;
- *Mamestra pisi* (=ceramica p., melanchra p.) L.; a.e.

In Latvia, including the trial area, the most widespread and harmful pest of cranberry was tipworm of cranberry *D. vaccinii.* In the beginning it was established in north-eastern part of Latvia (2004, 2005) but in the 2006 the tipworm appeared also in other regions (Figure 1).

The main reason of considerable decrease of cranberry yield in the trial farm, from 6.2 t ha^{-1} in 2002, 4.4 t ha^{-1} in 2003 and 1.75 t ha^{-1} in 2004, in expert opinion, was directly this pest. No one insecticide is registered for cranberry in Latvia up to now.

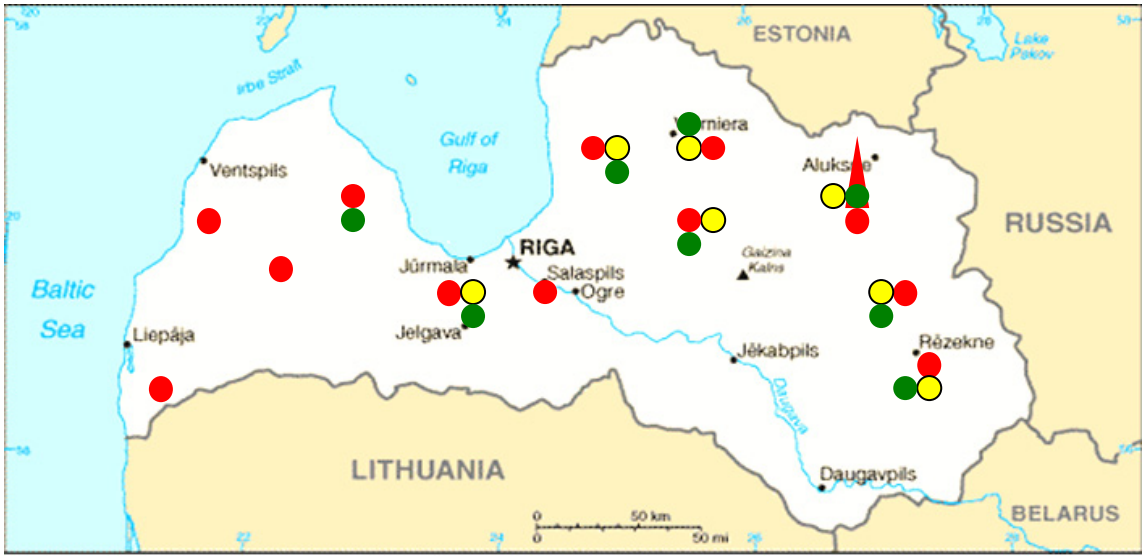

Figure 1. The distribution of cranberry plantations and *Dasineura vaccinii* in Latvia

Basic trial area

D. vaccinii:
2004., 2005.,
2006.

The largest cranberry plantations inspected

CHARACTERIZATION OF THE AMERICAN CRANBERRY AND WILD CRANBERRY NUTRIENT STATUS IN CULTIVATED PLANTINGS AND NATURAL BOGS OF LATVIA

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The industrial cultivation of the American cranberry (*Vaccinium macrocarpon* Ait.) in Latvia was started during last decade, cranberry producing plantings are mostly developed in high bog territories. American cranberry, fruit indigenous to North America, are characterized as high yielding crop with significantly higher productivity (to 40 $t.ha^{-1}$) in comparison with wild cranberry (*Vaccinium oxycoccos* L.). These cultivated berries have been noted as a good source of antioxidants, bacterial inhibitors, dietary fibber and vitamin C. Perspectives of cranberry production in Latvia could be associated with appropriate cultivation conditions - vast high bog territories, mild climate and unfulfilled market. To realize the full potential of modern high yielding crop, balanced plant nutrition is vitally important. Investigations on optimal cultivation and fertilization technologies of cranberry crop appropriate for sphagnum peat are scarce. Therefore studies on mineral nutrition regime of American cranberries and wild cranberries in Latvia are very important.

Investigations were done to find out the actual mineral nutrition status of American and wild cranberries in Latvia as well as to evaluate the peculiarities of cranberry mineral nutrition in producing beds and native bogs. 120 (peat and plant) samples were collected from 4 main cranberry producing sites and 3 native bogs during autumn 2004. Plant tissue analysis and soil testing were used to evaluate the cranberry supply with all of the biogenous elements (N, P, K, Ca, Mg, S, Fe, Mn, Zn, Cu, Mo, B). Investigation was done in the Laboratory of mineral nutrition of plants at the Institute of Biology University of Latvia. The results obtained were compared to a set of standards for nutrient elements developed by Dr. Nollendorfs (Latvia). The results obtained on nutrition status of American cranberry revealed the main problems in plant supply with essential mineral elements in Latvia. Serious disbalance was stated in the system of plant mineral nutrition. Our results suggest that only 50 % of cranberry producing plantings in Latvia were optimal provided with all of the nutrients. Insufficient level of N, P, S, Cu and Mo, and increased concentrations of Mn as main problems were stated. Although high bogs were characterized as particularly nutrient poor environment, wild cranberries showed high efficiency of Fe, Zn and Mn accumulation. In spite of broad range of element concentrations observed in peat samples rather good relationship between soil and plant nutrient level was found. Based on the present work, it can be concluded that disbalance of plant mineral nutrition could be one of the factors limiting cranberry productivity in Latvia.

Table 1. Nutrient concentrations ($mg.l^{-1}$) in peat samples from producing plantings and wild high bogs (1 M HCl extraction)

Elements	Producing plantings		Wild bogs	
	Range	Average	Range	Average
N	19 - 26	22	12 - 20	15
P	3.3 - 98	34.3	1.1 – 2.7	2
K	53 - 330	116	4 - 45	24
Ca	270 - 3850	1073	65 - 295	165
Mg	75 - 913	259	16 - 79	44
S	6.3 - 36	15	4 - 11	7.8
Fe	30 - 445	153	11.5 – 69.5	40.5
Mn	0.68 – 22.8	8.6	0.25 – 1.85	1.15
Zn	1.25 – 7.75	3.55	1.20 – 8.00	3.48
Cu	0.2 – 4.50	1.9	0.1 – 0.3	0.1
Mo	0.01 – 0.04	0.02	0.02 – 0.04	0.03
B	0.3 – 1.6	0.6	0.1 – 0.5	0.32
pH_{KCl}	2.70 – 5.84	3.66	2.62 – 4.94	3.06
EC, $mS \cdot cm^{-1}$	0.21 – 0.64	0.37	0.10 – 0.42	0.25

Table 2. Nutrient concentrations in *Vaccinium macrocarpon* Ait. and *Vaccinium oxycoccos* L. tissue samples

Elements	Unit	*Vaccinium macrocarpon* Ait.		*Vaccinium oxycoccos* L.	
		Range	Average	Range	Average
N	%	0.57 – 0.76	0.65	0.54 - 0.78	0.65
P	%	0.07 – 0.24	0.12	0.04 – 0.08	0.06
K	%	0.32 – 0.78	0.55	0.30 – 0.44	0.35
Ca	%	0.65 – 1.20	0.85	0.50 – 0.75	0.63
Mg	%	0.16 – 0.26	0.22	0.09 – 0.14	0.12
S	%	0.06 – 0.16	0.1	0.07 – 0.11	0.09
Fe	$mg \cdot kg^{-1}$	30 - 105	67	36 - 256	137
Mn	$mg \cdot kg^{-1}$	128 - 760	308	820 - 2860	1583
Zn	$mg \cdot kg^{-1}$	17 - 30	26	28 - 50	38
Cu	$mg \cdot kg^{-1}$	2.4 – 17.2	8.7	5.6 – 7.6	6.5
Mo	$mg \cdot kg^{-1}$	0.23 – 0.65	0.38	0.25 – 0.50	0.34
B	$mg \cdot kg^{-1}$	19 - 52	35	18 - 34	22

Table 3. Optimal concentrations of nutrients in American cranberry tissue and peat samples

Elements	Unit	Optimal in dried tissue	Unit	Optimal in substrate (1 M HCl extraction)
N	%	1.00 – 1.50	$mg \cdot l^{-1}$	80 – 120
P	%	0.20 – 0.30	$mg \cdot l^{-1}$	60 – 100
K	%	0.40 – 0.70	$mg \cdot l^{-1}$	60 – 100
Ca	%	0.60 – 0.80	$mg \cdot l^{-1}$	500 – 1000
Mg	%	0.20 – 0.30	$mg \cdot l^{-1}$	120 – 200
S	%	0.15 – 0.25	$mg \cdot l^{-1}$	60 – 80
Fe	$mg \cdot kg^{-1}$	80 - 150	$mg \cdot l^{-1}$	100 – 200
Mn	$mg \cdot kg^{-1}$	40 - 100	$mg \cdot l^{-1}$	4.0 – 8.0
Zn	$mg \cdot kg^{-1}$	30 - 80	$mg \cdot l^{-1}$	4.0 – 8.0
Cu	$mg \cdot kg^{-1}$	8 - 12	$mg \cdot l^{-1}$	6.0 – 10.0
Mo	$mg \cdot kg^{-1}$	1 - 5	$mg \cdot l^{-1}$	0.10 – 0.25
B	$mg \cdot kg^{-1}$	30 - 60	$mg \cdot l^{-1}$	1.0 – 1.5
pH_{KCl}	-	-	-	4.5 – 5.0
EC	-	-	$mS \cdot cm^{-1}$	0.8 – 1.2

EXPERIMENTAL VINEYARD OF RESEARCH INSTITUTE OF POMOLOGY AND FLORICULTURE IN SKIERNIEWICE – 'VICTORIA'

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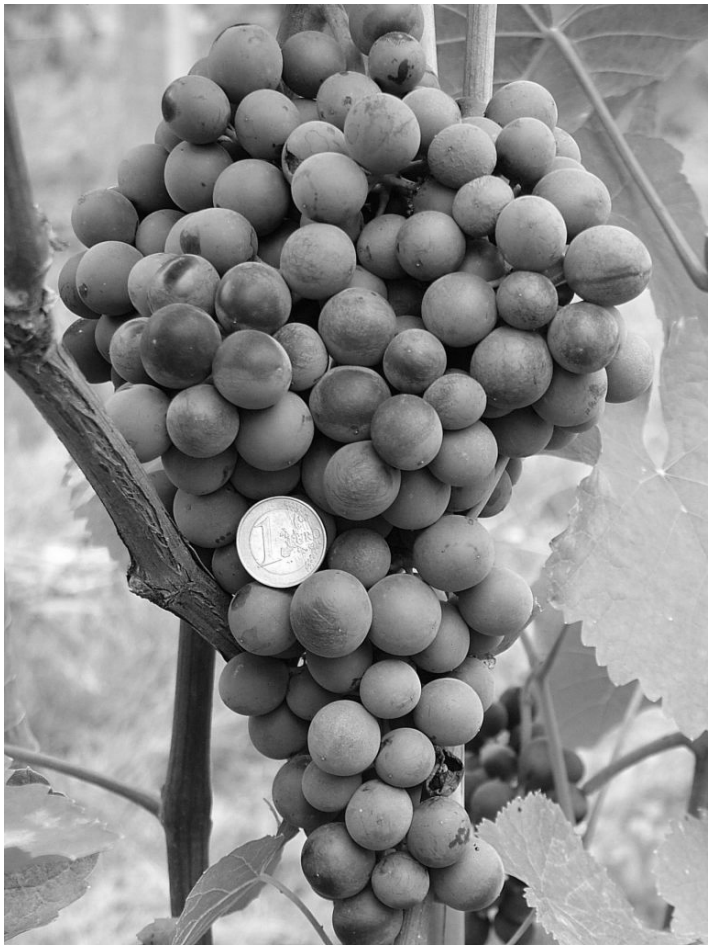
The rising interest in the growing of grapevine can be seen in the recent Years in Poland. Vineyards are established not only in Małopolska, Podkarpacie or in the region of Zielona Góra but also in the vicinity of Sandomierz and in the centre of the country. Milder climate and the introduction of new varieties, which are more resistant to frost and illnesses enable the growing of grapevine in many other regions of Poland.
As a result of this an experiment with grapevine was started at the Institute in Skierniewice. The experiment aims at finding the best varieties for field growing. The Skierniewice experiment vineyard was established in 2004 as a response to the expectations of the grapevine growers in Poland.

It is located in the Experimental Orchard ISK in Dąbrowice, 7 km to the south of Skierniewice. The plants grow on a field of 0.5 ha and more than 60 varieties of grapevine, grown for different purposes are a subject of research. The experiment concentrates on wine varieties (60%) and dessert varieties (30%). At the same time there are a few "summer house" varieties, tested for the sake of allotment or garden owners.

The purpose of the experiment is an estimation of the usage worth and getting the knowledge of the biology of growth, as well as fruit yielding of a few dozens of varieties of grapevine in the climate of Central Poland. Varieties originating from the Ukraine, Russia, Hungary, Germany and the USA are the subject of the research. Most of them have never been grown in Poland on a large scale. The bushes were planted from a one-year-old pot plants (with their own roots and a part on rootstocks) in the distance 2.80 x 1.15 m., on the medium soil, class IV b, on the clay subsoil.
In the first year the plants grew attached to bamboo sticks. In the second year supporting construction was established made of concrete posts and steel wire stretched among them at different levels. The bushes of the tested plants were bound to this construction and formed in this way. Two years after planting the forming cutting of the bushes was done.

The bushes of varieties resistant to frost were led in the form of "single Guyot". The bushes of varieties sensitive to low temperatures were cut in the form of "oblique cord". In spring 2006 the state of plants was estimated after severe winter 2005/2006, with temperatures dropping to minus 30 degrees C. No falling out of the plants was observed after the winter time, which was due to proper agrotechnique and protection during the previous season. Shoots were healthy, strong and well woodened. In the case of a few more sensitive varieties some damage of buds and woodened parts above the level of snow layer could be observed. Nevertheless, the damaged plants grew well from the lower buds and produced fruit. The bushes in "Victoria" vineyard survived the frosts in spring 2007 in a very good condition, when the night temperatures on the 30th of April and the 1st of May dropped to minus 5 and minus 7 degrees C. Due to the good agrotechnique the loss after these frosts reached only 5 to 10% of damaged buds, depending on the sensitivity of the plants.



Bunch of ‘Agat Donskij’ with Euro from ‘Victoria’

FRUITING OF NEW BLACKBERRY CULTIVARS IN POLAND

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Commercial blackberry production in Poland just starts to develop. Until now 'Thornfree' and 'Black Satin' from USA, and Polish cultivars 'Orkan' and 'Gazda' are cultivated. To assess some foreign blackberries and blackberry x raspberry hybrids, a field experiment was set in Pomology Orchard at Skierniwice.

In the springtime of 2005 potted plants of 16 cultivars were planted in a randomised block system. There are 6 replications, and 2 plants per plot in a space of 2.5 x 1.25 m. Three soil management methods are evaluated: hand wedding (control), and mulching with a black plastic or sawdust. Canes of each plant are tied to bamboo sticks, 4 floricanes to the one, and all primocanes to another. During dry weather drop irrigation is used. When the harvest is over all floricanes are removed. Before frosts primocanes are covered with a straw, so after both winters no cane injuries were observed.

In the Table 1 there are presented results received for 14 cultivars in 2006. Yield obtained in 2007 will be shown during the conference. In 2006 the first fruit of 'Karaka Black', 'Loganberry' and 'Tayberry' were picked on June 30th, on the same day as a nearby growing 'Veten' red raspberry. Few days later began picking of 'Black Butte', 'Boysenberry', 'Silvan', 'Helen' and 'Loch Tay'. Both controls ('Orkan', 'Black Satin'), 'Chester' and 'Oregon' are late cultivars. Their fruit were picked from late June – early August until the middle of September.

In the first fruiting year the most prolific were 'Black Satin', 'Loch Ness' and 'Oregon'. The yield 2.0 – 2.5 kg per plant, it is on a level of 6.4 – 8.0 t.ha^{-1}. The first yield of 'Kotata', 'Loganberry', 'Black Butte', 'Orkan' and 'Helen' was below 1.0 kg per plant.

The largest (heaviest) fruit, above 6.0 g, had 'Black Butte' and 'Karaka Black'. They are cylindrical, elongated, glossy with very attractive appearance. Most evaluated cultivars, including both controls had fruit of mean mass 3.8-4.9 g. 'Oregon' can be recognized as a smallfruited cultivar.

Until now blackberry were planted in Poland mainly in small gardens. Commercial plantations, producing fruit for fresh markets just start to develop. Producers are looking for big fruited cultivars of good taste and appearance and with a long shelf life. 'Loch Ness' looks like the most promising for this purpose. Producers should deliver fruit through as long period as possible. Cultivars evaluated in this experiment enables selling fresh fruit from an open field during about 80 days, from the end of June until the middle of September. Additional elongation of picking period is possible by production under covers e.g. plastic tunnels and greenhouses. Early cultivars are preferable for such production. Besides hybrids, 'Black Butte', 'Karaka Black', 'Silvan', 'Loch Tay' and 'Helen' can be recommended.

Table 1. Blackberry fruiting in 2006 at Skierniewice

Cultivar	First picking	Last picking	Yield [kg/plant]	Mass of 100 fruit [g]
Black Satin	02.08	19.09	2.5	386
Orkan	25.07	11.09	07	383
Black Butte	03.07	02.08	0.7	639
Boysenberry	03.07	31.07	1.1	435
Chester	31.07	19.09	1.4	394
Helen	05.07	07.08	0.9	420
Karaka Black	30.06	02.08	1.1	611
Kotata	11.07	31.07	0.6	417
Loganberry	30.06	27.07	0.7	437
Loch Ness	13.07	19.09	2.2	423
Loch Tay	05.07	21.08	1.6	297
Oregon	02.08	11.09	2.0	208
Silvan	03.07	16.08	1.1	405
Tayberry	30.06	02.08	1.1	493

BIOLOGICAL EFFICACY OF BOTANICAL INSECTICIDES IN THE CONTROL OF THE RASPBERRY LEAF APHIDS *Aphis idaei* VAN DE GOOT (*Homoptera: Aphididae*)

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The trial pursuing the study of biological efficacy of insecticides in the control of raspberry leaf aphids in organic production was performed in 2005 - 2006. The experiment included raspberry primocanes of cv Heritage. Botanical insecticides rothenon (Rotena), azadirachtin (Neemik), and pyrethrin (Pyros) were applied.

Besides botanical insecticides some conventional insecticides lambda cychalothrin and dymetho at were used only for the purpose of comparison of efficacy, as these insecticides are not allowed in organic production.

AMINO LEVULINIC ACID (ALA) AS A COMPONENT OF FERTILIZER APPLIED ON BLUEBERRY

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Pentakeep® it is a name of the group of "new-tec" liquid fertilizers combined of two basic components i.e. nutrients and 5-aminolevulinic acid (ALA). ALA has been recognized as precursor of chlorophyll. As an active fertilizer component - ALA plays predominant role of booster on chlorophyll generating metabolic pathway. By accelerating plant metabolism it positively influences nutrients assimilation.

Blueberry "Bluecrop" were treated in 2006 with Pentakeeep G-® - 6% N (1.6 %$N.NO_3$, 1% $N.NH_4$ 3.4 % $N.NH_2$), 10% $P2O_5$, 5%K_2O 2.5% MgO and microelements). In 2007 Pentakeep-V® - 9.5% N (3.8% $N.NO_3$, 5.7% $N.NH_2$, 5,7% MgO and microelements was applied. None treated by Pentakeep plants served as control. The fertilizers were sprayed four times at concentration of 0.2% in 2006 and five times at concentration of 0.4 % in 2007 at 7-9 days interval in both cases. As an effect of applied foliar fertilizer treatment an increase of chlorophyll in the leaves and blueberry yield were observed.

ANTIOXIDANT CAPACITY AND ELEMENT CONTENT OF *Rubus fruticosus* L. 'THORNFREE' AND *Sambucus nigra* L. 'HASCHBERG'

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The aim of our study was to characterize the antioxidant capacity and the element composition of blackberry (*Rubus fruticosus* L. cv. 'Thronfree') and elder-berry (*Sambucus nigra* L. cv. 'Haschberg'). In 2005 and 2006 fully ripe fruits were collected from commercial plantations situating in Western Hungary.

The measured parameters were as follows: dry matter content, acid content, pH, anthocyanin content, total phenol content, antioxidant capacity and element concentrations. Antioxidant capacity was determined by the FRAP (Ferric Reducing Ability of Plasma) method. Concentrations of Al, As, B, Ba, Ca, Cd, Co, Cr, Cu, Fe, Hg, K, Li, Mg, Mn, Mo, Na, Ni, P, Sr, Ti, V and Zn were measured by an ICP instrument. Analysis was repated three times.

For comparison total phenol content, antioxidant capacity and element composition of four cultivars ('Jonathan M40', 'Idared', 'Golden Spur', 'Starking Delicious') of apple, as the most prefered fruit in Hungary, were measured.

For the investigated parameters no differences could be detected between the two years, table 1 shows the average values of the two years. Dry matter content was the highest for 'Haschberg', while 'Thornfree' had much lower value, even smaller than three of the four apple cultivars. Anthocyanin content was also the highest in the case of the elder-berry cultivar 'Hascherg', three times higher than for the blackberry cultivar 'Thornfree'.

Total phenol content and antioxidant capacity of the two berry species were higher by about two orders of magnitude than those for the apple cultivars. The antioxidant capacity of 'Haschberg' was twice as big as that for 'Thornfree'.

Sodium concentration was the lowest for the elder-berry cultivar, while the blackberry cultivar had higher value than any of the four apple cultivars. Concentrations of calcium, magnesium were 3-4 times higher in the two berry fruits than in the apple. While the magnesium concentration was similar in the two berry cultivars, 'Thornfree' contained more calcium and 'Haschberg' had twice as big potassium concentration. Iron concentration of the two berry cultivars was about 3 times higher than that of the apple cultivars. Manganese concentration was also much higher for the berries, 'Thornfree' having three times higher value than 'Haschberg'. In case of copper and zinc concentrations there were not unambiguous differences among the investigated cultivars. The concentrations of As, Cd, Co, Cr, Hg, Li, Mo, Pb and V were below the detection limit for every sample.

On the basis of the obtained parameters it can be stated that the elder-berry cultivar 'Haschberg' have slightly higher nutritive value than the blackberry cultivar 'Thornfree'. Our results showed that the two investigated berry fruits had much better antioxidant characteristics than that of apple. From the point of view of human health it would be advisable to increase the consumption of these berry fruits.

Table 1. Composition of blackberry (’Thronfree’), elder-berry (’Haschberg’) and apple (’Jonathan M40’, ’Idared’, ’Golden Spur’, ’Starking Delicious’)

	Blackberry	**Elder-berry**	**Apple (average of four cultivars)**
Dry matter content (%)	13.21	17.74	13.92
Acid content (%)	0.94	0.58	
pH	3.26	4.37	
Anthocyanin ($mg.l^{-1}$)	789	2450	
Total phenol content ($mg.l^{-1}$)	12.09	16.40	0.19
Antioxidant capacity (mmol AA/l)	21.16	39.60	0.31
Na ($\mu g.g^{-1}$)	283.3	174.7	247.6
K ($\mu g.g^{-1}$)	10747	19502	9014
Ca ($\mu g.g^{-1}$)	2531	1993	710
Mg ($\mu g.g^{-1}$)	1560	1656	440
Fe ($\mu g.g^{-1}$)	27.15	37.04	9.02
Cu ($\mu g.g^{-1}$)	6.72	6.14	4.65
Mn ($\mu g.g^{-1}$)	31.82	13.95	3.41
Zn ($\mu g.g^{-1}$)	12.02	7.95	5.96

BIOLOGICALLY ACTIVE SUBSTANCES IN THE BERRIES OF *Actinidia kolomikta*

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In recent decades in Lithuania attention was focused on garden plants which are typical of fruit accumulating significant amounts of biologically active substances (Chesoniene et al., 2004; Pranckietis and Pranckietiene, 2000). The berries of *Actinidia kolomikta* are characteristic of chemical compounds with antioxidative properties (Moskvina et al., 1998). The aim of this study was to ascertain accumulation of different chemical compounds in berries of Lithuanian and Russian cultivars and clones. Reliable differences were determined between the total amounts of sugars, saccharose, inverted sugars, dry and soluble dry solids in case the probability level was 99% (Table 1). The largest amounts of dry and soluble dry solids, inverted sugar, saccharose and the total sugar were accumulated in the berries of *A. kolomikta* in 2002. The most significant amount of ascorbic acid in the berries of technical maturity was also determined in 2002, approximately 930 mg/100g. Reliable differences in the amount of titratable acidity, ascorbic acid and chlorophyll *b* were ascertained at the 95% probability level. The results of chemical investigations showed no statistically reliable differences between the amounts of the total chlorophylls and chlorophyll *a* in different years, also no difference in skin firmness was detected. Different cultivars and clones were compared according to the amounts of different biochemical compounds. The results have revealed that female cultivars and clones significantly differ in the amounts of ascorbic acid, sugars and chlorophylls, in skin firmness, index of sweetness and titratable acidity. The most valuable cultivars in respect of the amount of ascorbic acid are 'VIR-1' (1145.7 mg/100g), 'Landė' (1044.2 mg/100g) and 'Krupnoplodnaja' (1022.3 mg/100g). They should be used in breeding with the aim to create new cultivars that are typical of a large amount of ascorbic acid. The cultivars 'Sentiabrskaja', Landė' and 'Paukštės Šakarva' had the largest amount of sugars that was found to be 6.9; 6.89 and 6.8%, respectively. The cultivars accumulated from 3.34 ('Sentiabrskaja') to 4.67% ('Landė') of inverted sugar. In accordance with titratable acidity cultivar 'VIR-1' (2.0%) was distinguished. The determined ratio of sugars to acidity (index of sweetness) attained from 2.68 ('VIR-1') to 4.40 ('Sentiabrskaja').In the cultivars and clones reliable differences in the amount of chlorophylls were ascertained: the total amount of chlorophylls in the berries attained from 3.18 mg/100g ('Sentiabrskaya') to 5.30 mg/100g (F1M1). Chlorophyll *a* on the average amounted to 2.4 mg/100g and chlorophyll *b* to 1.8 mg/100g. A comparison has been made between the cultivars and clones according to the amount of dry solids and dry soluble solids. No essential differences between them has been found since Fisher's criterion was: $F_{05(act)}=1.92 < F_{05(theor)}=2.35$ and $F_{05(act)}=1.17 < F_{05(theor)}=2.35$, respectively. In the technical maturity stage female cultivars and clones on average accumulated from 14.4 to 17.0% of dry solids and from 10.6 to 12.4% of soluble dry solids. The berries of clone F1 were distinguished by the firmest skin (on average 300 $N.cm^{-2}$). Firm skin was characteristic

of only one Lithuanian cultivar 'Landė' (277 N.cm^{-2}) while the skin firmness of berries of cultivar 'Lankė' was 188 N/cm^2.

Table 1. The comparison of the amounts of biochemical components in the berries of *A. kolomikta* in 2001–2003

Biochemical component	The year of investigations			LSD
	2001	2002	2003	
Total amount of sugars, %	5.7	7.2	5.4	1.03 [b]
Inverted sugar, %	3.9	5.0	3.4	0.88 [b]
Saccharose, %	1.8	2.2	2.0	0.25 [b]
Titratable acidity, %	1.7	2.2	1.9	0.16 [a]
Index of sweetness	3.4	3.3	2.8	0.27 [b]
Ascorbic acid, mg/100g	803	930	894	87.1 [a]
Total amount of chlorophylls, mg/100g	4.2	4.1	4.5	0.45 [n]
The amount of soluble dry solids, %	9.8	13.3	10.8	1.25 [b]
The amount or dry solids, %	15.2	16.6	14.6	0.73 [b]
Skin firmness, N.cm^{-2}	265	234	260	72.8 [n]

[a] – *the least significant difference, in case = 0.05;*
[b] – *the least significant difference in case* $\alpha = 0.01$;
[n] – *significant difference is absent.*

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CHEMICAL COMPOSITION OF SOME BLACK MULBERRY (*Morus nigra* L.) GENOTYPES

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In this study, the chemical composition and antioxidant activity of 5 black (*Morus nigra* L.) mulberry genotypes grown in the East Anatolia Region of Turkey was investigated. The total phenolic and flavonoid contents were observed in black mulberry genotypes between 1343-1637 mg gallic acid equivalents/100 g fresh matter and 270-305 mg quercetin equivalents/100 g fresh matter), respectively. The TSS/TAc ratio of genotypes was between 9.69-13.07%. The vitamin C content of genotypes varied between 14.9-18.7 mg/100 g. Antioxidant activity and radical scavenging activity of genotypes were found very high. Organic acids were analyzed by using HPLC and organic acids from the fruit of black mulberry (*Morus nigra* L.) were quantified. Malic acid was predominant with a range of 123-218 $mg.g^{-1}$. Citric acid, tartaric, oxalic, and fumaric acid were determined as organic acids as well.

AN OVERVIEW ON BERRY FRUIT RESEARCH TRIALS IN PIEMONTE (ITALY)

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Piemonte (North West Italy) is one of the main highbush blueberry producing regions in Italy (more than 400t in 2007). Although the cultivated area is small if compared with other Italian fruit industries, the species, mostly grown in small family-managed farms on the slopes of the Alpine valleys, play an important and strategic role in marginal agroforestry systems as an alternative crop and as a supplementary income for growers.

Most of the produce is sold fresh for internal market but the national production is not sufficient to satisfy the request and tons of berries are imported from abroad. Many new and traditional cultivars are grown the market is mostly done by grower co-operatives.

In Piemonte the first researches on highbush blueberry, raspberry, blackberry and currants concerned the evaluation of the best genotypes to be introduced in different agroecosystems. Nowadays the studies are mostly focused on berry fruit storage methods, out of season productions and fruit quality, including antioxidant capacity, anthocyanins and Vit.C content in cultivated and spontaneous berry fruit species.

MINERAL COMPOSITION OF CRANBERRY FRUITS

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The chemical composition of American cranberry fruits is determined primarily by cranberry variety; but also by: the bed it is cultivated on, fertilization, climatic conditions and cultivation method (Karczmarczyk & Zbieć, 1998). Fertilization with nitrogen should be applied in low doses (10-40 kg N ha^{-1}) and exclusively in the ammonium form or any other form easily transformed into the ammonium form (Davenport *et al.*, 2000). Appropriately supplemented cranberry fruits should contain (per kg d.m.): 9-11 g N; 1-2 g P; 4-7.5 g K; 3-8 g Ca; 1.5-2.5 g Mg and >83.3 mg Mn; 125-250 mg Zn and 33.3-83.3 mg Cu (Davenport, 1995; Roper, 2006).

This study was aimed to study the effect of fertilization with urea phosphate (18% N 19.2% P) and hortisul solutions (54.1% K + 18.4% S) on the contents of macro- and microelements in fruits of three varieties of American cranberry ('Stevens', 'Searles', 'Ben Lear'). Experiments were carried out on organic bed in the years 2004-2007 in the Experimental Garden of the University of Warmia and Mazury in Olsztyn. The 1 and 2% solutions of urea phosphate and hortisul were applied 5 times in the period from the onset of vegetation till the full blooming (in two-week intervals). Chemical assays were carried out after "wet" mineralization - macroelements in H_2SO_4+H_2O_2, microelements in HNO_3+$HClO_4$+HCl following standard analytical procedures. The significance of differences between the results obtained was determined using a two-way analysis of variance for the experiment established in a randomized complete block design.

Fruits of American cranberry were characterized by diversified concentrations of macro- and microelements depending on experimental factors: 3.89-4.85 N; 1.04-1.19 P; 5.33-6.36 K; 1.09-1.28 Ca; 0.27-0.30 Mg and 0.11-0.17 g Na kg^{-1} d.m. as well as 0.10-0.15 Cd; 15.75-23.64 Cu; 2.33-3.76 Ni; 40.80-78.31 Zn and 52.37-75.75 mg Mn kg^{-1} d.m.

Urea phosphate was found to significantly contribute to changes in the contents of calcium, magnesium and sodium as well as cadmium, zinc and manganese in fruits of the three analyzed varieties of American cranberry. Amongst the macroelements, significant differences as affected by the variety occurred in the contents of phosphorus, magnesium and sodium. The investigated varieties of cranberry differed significantly in terms of zinc content of fruits; whereas the concentration of the other microelements (Cd, Cu, Mn and Ni) did not depend on the variety.

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THE YIELD AND QUALITY OF FRUIT OF CRANBERRY IN CASE OF FERTILIZATION OF THE PLANTS WITH UREA PHOSPHATE

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Between 2004 and 2006 we have evaluated the influence of fertilization on WTS of cranberry. Studies were carried out on three cranberry cultivars - 'Stevens', 'Searles' a 'Ben Lear', that have been grown in the peat type of soil in the garden of Department of Horticulture, University of Warmia and Mazury, Olsztyn, Poland. Fertilization with urea phosphate and hortizol has been performed five times in the spring. The doses of nitrogen, phosphorus, potassium and sulphur have been added twice as follow: 4,5 kg N + 5 kg P + 10 kg K + 3,4 kg S $\cdot ha^{-1}$ (I NPKS) and 9 kg N + 10 kg P + 20 kg K + 6,8 kg S $\cdot ha^{-1}$ (II NPKS).

The yield and WTS of tested genotypes were different and dependent on the type and dose of fertilizer. The highest yield of fruit was achieved in the second experimental year (2005). In the third year of experiment the yield of the cranebrry fruit was lower in comparison with first and second year. The lower NPKS fertilizer rate recorded the highest fruit yield. Cultivar 'Stevens' was most productive and cultivar 'Bean Lear' showed lowest yield with smallest size of fruit. Our results showed that higher doses of NPKS fertilizer had hegative effect on WTS with the exception of first experimental year.

BIOTECHNOLOGICAL APPROACHES TO PROPAGATION AND CONSERVATION of *Vaccinium cylindraceum*

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The genus *Vaccinium* consists of more than 450 species that are widely distributed over diverse climatic regions. It is found in acidic soils in the cooler areas of the northern hemisphere as well as subtropical or neotropical climes. A variety of *Vaccinium* are grown for fruit, but there is a range of species that are appreciated mainly for their ornamental value. *V.cylindraceum* is a neotropical species native to the islands of Azores. The large semi-evergreen, upright shrubs proved to be hardier than expected as ornamental garden plant, probably because they grow at higher, colder altitudes in an otherwise subtropical climate (Trehane, 2004).

The morphogenetic potential of *V.cylindraceum* in micropropagation as well as in adventitious regeneration from leaf tissue was examined. A seedling population collected on Terceira Island was grown in the greenhouse and analysed for genotypic variability. In vitro cultures of several selelcted clones were established. Different media formulations and hormone combinations were tested for their ability to support vigorous plant growth and multiplication. Woody Plant Medium (WPM; Lloyd and McCown, 1980) gave significantly better results than Anderson's medium (Anderson, 1980). Three out of four clones showed improved growth on WPM supplemented with 1mg.l^{-1} zeatin and 0.2 mg.l^{-1} IAA, while one clone did equally well on medium with either 2iP, 2iP riboside or zeatin.

VCY1 and VCY9 are the most active clones in respect to growth and multiplication, VCY4 on the other hand is the least vigorous. This situation is also reflected in our findings concerning adventitious regeneration from leaf tissue. While clone VCY9 showed the highest frequency of regeneration (97±3%) and excellent shoot growth on regeneration medium (WPM containing 4 mg.l^{-1} zeatin and 0.5 mg.l^{-1} IAA; Song and Sink 2004), clone VCY1 regenerated poorly, and no regeneration was observed from VCY2 and VCY 4 leaf explants. These differences are very likely connected to both genetic variations of plants in a seedling population as well as the epigenetic status of the respective mother plants (Popowich and Filipenya, 1997). Due to its high regeneration potential and active growth clone VCY9 will be used as a model clone for future biotechnological approaches in plant breeding, e.g. for the elaboration of transformation protocols, cryoconservation approaches etc.

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PROPAGATING PERSIMMON (*Diospyros kaki* Thunb.) IN A COOL TEMPERATE CLIMATE

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Persimmon (*Diospyros kaki* Thunb.) is a fruit which is widely grown in Asia, and is also grown in Mediterranean countries, South America, the USA, Australia and elsewhere. It is sold under a variety of different names, such as persimmon, sweet persimmon, kaki, sharon fruit and others.

In Italy, persimmon is usually grafted onto *Diospyros lotus* L. when the plants are still dormant, or just when vegetative growth begins. The most common type of graft is by scion (wedge, whip and tongue grafts, seldom a crown graft). Generally the graft is made about 0.2 m from the collar of the rootstock or, in areas where winters are more severe, at a distance of 0.7-1.0 m (Bellini, 2003). T-budding of persimmon is not regarded as a good method and only „chip-budding" is successful (Lunati *et al.,* 1988).

This experiment was carried out during the years 2000, 2001 and 2003 in South Moravia in the Czech Republic, which enjoys a cool temperate, continental climate, where the summers are warm and the winter cold. The plant material came from the persimmon collection in the Faculty of Horticulture in Lednice. The following propagation methods were chosen for assessment: chip-budding, T-budding and wedge grafting, performed at two different times of the year, early spring and late summer (August). 2 year-old seedlings of *Diospyros lotus* L. were used as rootstocks, obtained from plants growing in the vicinity of Lednice. Seedlings were grown in pots and the diameters of the stock used were 8-12 mm. Before budding, the rootstocks were transferred to a heated greenhouse during the winter, in January, to accelerate bud burst. Budding and grafting was performed on the sprouting seedlings in the greenhouse during March. Well-lignified scions of persimmon cultivars were taken from plants during the winter dormancy period, in December. These scions were then stored in plastic bags with moisture paper at 3 °C, until required for budding. For early spring budding both dormant and sprouting scions were used, while leafy scions were used for the summer budding (T-budding).

The best propagation technique was chip-budding in early spring, using dormant scions on sprouting rootstocks, where the success rate was 69%. For wedge grafting in early spring the success rate was 64%. Conversely, the least successful technique was summer budding, where the success rate for T-budding was 0% and for chip-budding 21%. The results were statistically evaluated using two sample F-test and two sample T-test assuming equal variances. Comparisons were made between the time of year for grafting and the three different methods. Statistically significant differences were seen between early spring and summer budding. No significant differences were observed between chip-budding and grafting. Therefore it is possible to recommend both chip-budding and wedge-grafting in the early spring as suitable propagation techniques for persimmon.

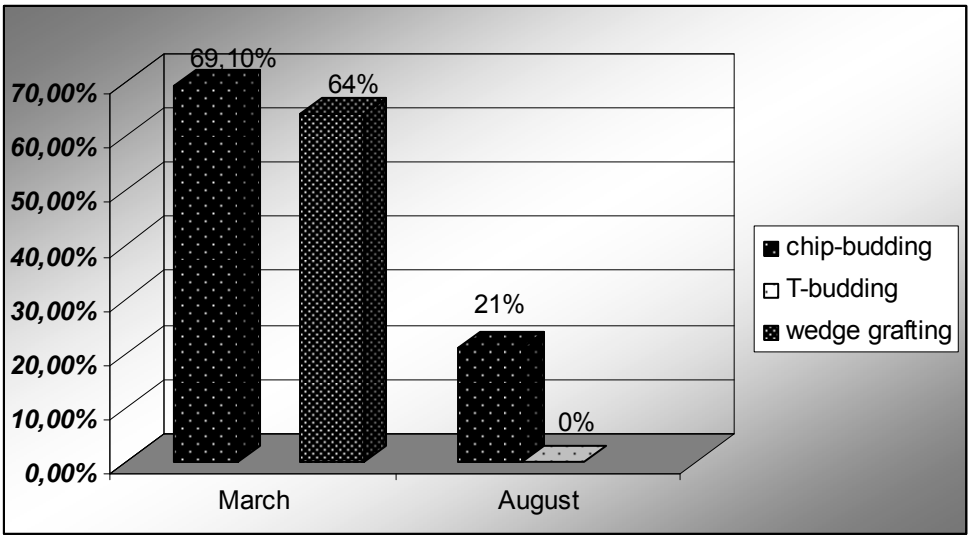

Figure 1. Percentage success of budding and grafting, regarding time of year and method

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GERMINATION POTENTIAL OF *Vaccinium Corymbosum* L. AND INTERSPECIFIC HYBRID GENOTYPES UNDER STRATIFICATION, SCARIFICATION AND HORNMONAL PRE-TREATMENTS

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Germination potential of 23 *Vaccinium* accessions during 6 months has been tested in this work, from September 8th to April 3rd 2006. The plant genetic material comes from *V. corymbosum* species and some hybrids as follows: *V. corymbosum* 'Blue Crop', 'Brigitta', 'Chandler', 'Duke', 'Elliott', 'Jubilee', 'Legacy', 'Ozarkblue', 'Rubel'; 'Fol35', 'Misty', 'Nui', 'Reka', 'RH38', 'RH48', 'RH52', 'Star'.

After extraction by maceration methods, seeds were manually classified under stereoscopic microscope. The applied tests were focused on breaking dormancy using seed pre-treatments: A- Seedling fresh seeds as soon as extracted from fruit; CH2- cold stratification 2 °C, for 12, 33 and 90 days; CH3- cold stratification + Gibberillic acid imbibition (GA_3 1.000 ppm) previous to seedling; CH4- cold stratification + scarification with Sulphuric Acid for 15 minutes. Furthermore, a new test was added on fresh seeds extracted from 100 days stratified fruits and treated with GA_3 for 'Blue Crop' in two clones, 'Chandler', and the hybrid 'Fol 35'.

Accessions had an evaluation period proportionally inverse to the stratification period for each treatment. The experiment has been carried up closely to nursery environmental conditions with no controlled physical factors. It had winter protection, placed inside a room with good natural illumination, maintained with a temperature of 18-20 °C. The genetic material was individually seeded on a substrate composed of (1:1:1) perlite, vermiculite and sand. Irrigation was performed manually with a spray applicator as needed, with acidified water (pH 4-5.5). Records were registered weekly, χ^2 test was used on data analysis.

Total germination performance varies from 4 to 100% germination, even between accessions becoming from the same cultivar, the medium result was about 31% germination.

Ten genotypes performed the best results with germination up to 60% (10 accessions in 23) for at least one test: 'RH38' germinated to 100%, 'Chandler' 100% 'Legacy' 94%, 'Blue Crop'A 92 %, 'Chandler B' 89%, 'Ozarkblue' 86%, 'RH48' 84%, 'Blue Crop'B 82 %, 'Fol 35' 66 %, 'Duke' 62%.

The best results obtained, imply Gibberillic acid imbibition, cold stratification for 33 days or interaction between both. The germination percentage increased with stratification and the results strengthened by hormones addition. The positive effect of hormone treatment and 33 days of stratification is more evident for the cultivars 'Bluecrop' and 'Ozarkblue'. 90 days of stratification tend to reduce germination values respect to 33 days of stratification.

For the pre-treated seeds with stratification with maximum 33 days and GA_3 addition, the phase of major rates of the germination performance, lasted around 3-4 weeks, compared with the ones of A test which lasted around 5 weeks, is remarkable the effect of this pre-treatment on acceleration and homogeneity of germination overcoming light requirements.

The cultivar 'Elliot' germinated to 58% with stratification for 12 days without other pre-treatment, it looks to decrease its performance inversely to the stratification period. 'Star' germinated to 42%, 'Misty'20%, 'Rubel'23%, and 'Jubilee' 28%, even when demonstrated a lower performance; in the same way their best result was obtained with CH3- 33 treatment except for 'Jubilee', which showed its best performance with CH4- 90 treatment. Sulphuric acid treatments showed scarce and irregular results with a maximum of 42% of germination with 33 days of stratification and did not produce germination with 90 days of stratification. When seeds were extracted from 100 days stratified fruits and treated with GA_3, then seeded freshly, results did not improve.

THE GROWTH OF 'BLUECROP' CV. HIGHBUSH BLUEBERRY ROOT SYSTEM IN DEPENDENCE ON MULCHING AND DIFFERENT NITROGEN FERTILIZATION RATES

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This experiment was established on mineral podsolic soil with 17 % clay and silt in experimental field SGGW located in Skierniewice in 1999. The aim of this experiment was to study among the others the influence of different ways of mulching and nitrogen (N) fertilization rate on root growth and yield of highbush blueberry, cv. Bluecrop. Plants were planting at density of 2.0 x 1.0 m. There were three plants per plot in four replications. The following soil treatments in the five rows were included:
* soil without any mulching (control),
* soil mulched with sawdust,
* soil mulched with bark,
* soil mixed with sawdust and mulched with sawdust,
* soil mixed with bark and mulched with bark.

In addition, four different nitrogen fertilization rates (0, 60, 120 and 180 kg $N.ha^{-1}$) and potassium and phosphorus rates (90 kg K and 25 kg $P.ha^{-1}$) were applied.

During five years of the experiment (2001-2005) the growth of roots system was connected with plants growth strength and yielding. Using both organic materials (bark and sawdust) mulched and mixed with soil caused more effective highbush blueberry roots growth in topsoil compared to the control combination (without any mulching). The best growth of roots system was observed on the plots with coniferous sawdust. In the case of combination with bark much lower roots number in a distance above 40 cm from the bushes was observed

Plants, which were in the control combination (where the mulching wasn't used), had the lowest yields. The extention of nitrogen fertilization rates caused yield increasing comparing to the combination without nitrogen, in every way of mulching. The positive influence of highbush blueberry yielding was observed in the combination of soil mixed with bark.

REPRODUCTIVE BIOLOGY OF *Vaccinium uliginosum* AT KLIN NATURAL PRESERVE (NORTH-WESTERN SLOVAKIA)

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Vaccinium uliginosum is deciduous shrub distributed in mountain and northern areas of Europe, Asia and North America (Jacuqemart, 1996). The species occurs relatively rare in Slovakia. Jasičová (1982) mentioned it from 5 phytogeographical divisions of Slovakia mainly in northern part of the country. A lot of localities were destroyed by turf digging so the species was included to Slovakian red list of rare plants in category "vulnerable" (Feráková *et al*., 2001). On the other hand *V. uliginosum* fruits are traditionally used in Slovakia as fruitage (Migra in verb.). The species is important crop in some countries, for example people have harvested about 20 million metric tonnes per year in Finland (Raatikainen, 1988).

Reproductive biology of endangered *Vaccinium uliginosum* L. was studied from two points of view in Klin national nature preserve during 1994-2002. Firstly, microscopic level of reproduction was researched (differentiation of male and female gametophyte, pollen viability, fertilization and embryogenesis) using microscopic techniques of Erdelská (1986). Second, macroscopic reproductive characteristics were obtained by field research (establishment and differentiation of reproductive organs, ontogenesis of seeds and fruits, morphological variability of seeds and fruits, fruit set). Germination of seeds and phenological phases were studied too.

The species was protandrous and process of microsporogenesis was standard. Average of pollen tetrads per anther was 650; maximum germination of pollen tetrads was 44.83% (10% sucrose agar). 40 anatropic tenuinucellate and unitegmic ovules were developed per ovary in average. About 50-70% ovules were transformed to full-developed seeds (23-28 pieces, Table 1). Despite relatively high seed and fruit production the vegetative spreading predominated and seedlings were found very rare because strong competition of neighbouring vegetation inhibited survival.

Fruit set varied from 25 to 62% (Table 2). According to data of Skrjabina (1970) and Pučnina (1990) the climatic conditions had important impact to this feature.

Seed shape was oval and selenic respectively. Four morphological types of fruits were found: spherical, pressed ovoid, oval and pyriform.

Germination of fresh seeds was 51% but cold seed stratification (30 days, 4˚C) increased the germination up to 88%.

Initiation of generative buds started in the end of June one year ago. *Vaccinium uliginosum* was entomophilous and the flowering stage ran from the second half of May to beginning of June (circa 3 weeks in average). Fruit development process waged approximately 2 months from pollination to ripe berry; ripe fruits were found in the end of July or in beginning of August.

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Table 1. Proportion of standard developed *V. uliginosum* seeds to average number of ovules created at Klin natural preserve during 1994-1996

Year	Number of seeds			
	Ø	Min.	Max.	%
1994	23	7	54	57.5
1995	20	6	40	50
1996	28	10	49	70

Table 2. Number of flowers, number of fruits and fruit set of *Vaccinium uniginosum* at Klin natural preserve during 1998-2002

Year	Number of flowers	Number of fruits	Fruit set [%]
1998	353	218	61,76
1999	832	207	24,88
2000	503	281	55,86
2001	268	100	37,31
2002	119	51	42,86

VEGETATIVE PROPAGATION OF *Ribes atropurpureum* C.A. MEYER

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Ribes atropurpureum is characterized by high yield, large berries, long racemes, high content of anthocyans, pectins and vitamin C in berries , resistance to powdery mildew (*Sphaerotheca mors-uvae* Berk. et Curt.), blister rust (*Cronartium ribicola* Dietr.), doubling and currant bud mite - *Cecidophyes ribis* Westw. (Voshchilko, 1971; Kravtsova *at al*., 1971; Alekseeva, 1988; Bayanova, 1996 and others).

In connection with necessity of introduction and utilization in breeding of *R. atropurpureum* promising forms the tasks of our research were study of rooting ability of hard-wood, combined and soft-wood cuttings and the peculiarities of root system formation under the action of growth regulators.

The rooting ability of hard-wood cuttings was low and amounted to 0-10% in 2005 and 0% in 2006. In 2005 four cuttings rooted in variant of 0.5% tellura-M, in twos in control (water), 1% humat potassium and 0.5% phoenix and by ones in 0.5% humat potassium, 1% silk and 1% phoenix. In 0.5% silk and 1% tellura-M the cuttings did not root. In variant of 0.5% humat potassium the roots of orders I and II of ramification were formed and in the rest of variants - roots of orders I, II and III. Most of roots of different orders of ramification were formed on cutting under the action of 0.5% phoenix (on the average 323.5 pieces), 1% humat potassium (253.0 pieces) and 0.5% tellura-M (95.8 pieces). In control variant the number of roots amounted to 25 pieces. Average length of roots on cutting in variants of 0.5% phoenix, 1% humat potassium, 0.5% tellura-M and 1% phoenix amounted to 339.9, 229.5, 167.6 and 160.8 cm respectively. It was 2.6-5.5 times bigger than in control variant (61.8 cm). It is necessary to note that the root system of hard-wood cuttings was formed in different zones of a cutting: in lower node (6 cuttings), in lower and upper nodes (5) and in upper node (2 cuttings).

The rooting ability of combined cuttings was considerably higher than that of hard-wood cuttings, and reached in different variants up to 33.0-60.0 %. In comparison with control some increase of the percentage of rooting was noted in variants of 1 and 0.5% tellura-M and 1% phoenix. In variants of 0.5 % humat potassium and 1% phoenix were formed the roots of orders I-III of ramification, and in the other variants - roots of orders I-IV. Most of roots of different orders of ramification were formed on cutting under the action of 1% tellura-M (on the average 33.8 pieces), 0.5% tellura-M (31.9 pieces), 1% humat potassium (31.8 pieces) and 0.5% humat potassium (31.1 pieces) and 0.5% phoenix (29.4 pieces). In control variant the number of roots amounted to 24.5 pieces. Average length of roots on cutting in all variants was 1.3-2.1 times bigger than in control, especially in 0.5% humat potassium, 1 and 0.5% tellura-M, where it amounted to 77.4, 60.4 and 59.7 cm respectively. In control variant average length amounted to 37.0 cm.

In 2005 soft-wood cuttings of *R. atropurpureum* rooted better than hard-wood cuttings, and their rooting ability amounted to 7.2-21.2%. In comparison with control more cuttings rooted in variants of 0.5% humat potassium, 0.5% phoenix, 1% and 0.5%

tellura-M. The roots of orders I-V of ramification were formed in variant of 1% tellura-M, orders I-IV - in variants of 0.5 and 1% humat potassium, 0.5% tellura-M, control, 0.5% and 1% silk, orders I-III - in 0.5% and 1% phoenix. Most of roots of different orders of ramification were formed on cutting under the action of 0.5% humat potassium (on the average 47.9 pieces) and 0.5% tellura-M (35.6 pieces). In control variant the number of roots amounted to 33.2 pieces. In comparison with control average length of roots on cutting was bigger in variants of 0.5% humat potassium (1.8 times), 0.5% tellura-M (1.5 times) and 0.5% phoenix (1.1 times). In 2005 the roots of orders I-III of ramification on soft-wood cuttings were shorter than ones on hard-wood cuttings.

In 2006 soft-wood cuttings of *R. atropurpureum* rooted better than in 2005. Their rooting ability amounted to 27.0-56.0% and neared to this index of combined cuttings. The highest rooting ability was noted in control. In control variant were formed the roots of orders I-IV of ramification, in the rest of variants - roots of orders I-III. Most of roots of different orders of ramification were formed on cutting in control (on the average 49.0 pieces), some less in 1% tellura-M (47.7 pieces), 0.5% humat potassium (45.0 pieces), 1% humat potassium (43.7 pieces), 0.5% phoenix (40.9 pieces) and 0.5% tellura-M (39.9 pieces). In comparison with control average length of roots on cutting was bigger in variants of 1% tellura-M (1.2 times) and 1% humat potassium (1.1 times). In all variants in 2006 the roots on soft-wood cuttings were 2.2-4.7 times longer than those in 2005 and 1.8-3.9 times longer than the roots on combined cuttings.

As a result of research conducted the possibility of vegetative propagation by soft-wood and combined cuttings of *Ribes atropurpureum* - a new species for introduction and breeding was established. Propagation by soft-wood cuttings is the best method. It was established that the regulators of growth such as humat potassium, tellura-M, phoenix created on the basis of humic acids stimulated the formation of roots. The root system on soft-wood cuttings was formed better under treatment of cuttings by 1% tellura-M and 1% humat potassium, and on combined cuttings - under treatment of cuttings by 0.5% humat potassium and 1 and 0.5% tellura-M. The roots on cuttings branched mainly to III orders of ramification, maximum to V orders.

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BERRY YIELD OF COWBERRY IN NATURAL POPULATIONS

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The object of this research is the evaluation of berry yield in coenopopulations (CP) of cowberry (*Vaccinium vitis-idaea* L.) in various ecological conditions and the analysis of yield determining reasons. The investigations were held in 1999-2000 and 2003 years on the territory of the State Natural Reserve "Bolshaya Kokshaga" of the Republic Mari El (Russia) in moss pine forests from 20 to 85 years of age, differing in floristic composition, ecological conditions (soil resources, humidification).

The Table 1 shows the yield of cowberry coenopopulation. It varies greatly both in different CP in the same year and in different CP in different years.

First of all, the cowberry yield is determined by the density of generative partial shrubs, that vary from 1.1 item per m^{-2} in CP 4 up to 6.7 items per m^{-2} in CP 2. The contribution of middle age generative partial shrubs to the density is the highest (from 40 to 50%).

Variability of yield in different CP in different years was analyzed more thoroughly for the CP 2-5 that have been observed during all the three years. Two-way variance analysis of berry mass on the observed ground showed that both factors have considerable influence and interact with each other ($P<5.9x10^{-7}$) (Figure 1). A lot of comparisons revealed that CP 4 has systematically low yield rates that do not vary from year to year. In CP 2, 3 and 5 in 1999 and 2000 the yield was the same , in the year 2003 the yield significantly declines, especially in the CP 2 (up to 0.42 g). The low cowberry yield in 2003 can be the result of weather conditions of the year (low temperature, heavy precipitation in the first and second decades of June).

The yield of cowberry on the definite ground derives from berry mass taken from separate partial shrubs. Three-way variance analysis (the factors are year, CP and ontogenetic state of partial shrub) showed that berry mass from partial shrub is determined by the factors of CP ($P<10^{-10}$), the age state of partial shrub (P=0.004) and the interaction of the factors year-CP ($P<10^{-4}$). The changes of berry mass from partial shrubs through the years characterize only CP 3, where the mass is lower in the year 1999 – 0.30 g and higher in 2000 – 0.44 g. In all the other CP the berry mass from a partial shrub does not vary in different years. The average berry mass from a partial shrub differs in all the CP: CP 5 has the biggest mass rate (0.70 g), CP 4 – the smallest (0.25 g). Young and middle age generative shrubs from a partial shrub have a greater berry mass – 0.45 g, old generative shrubs have lower mass rate – 0.37g.

Thus, the yield of cowberry in the observed coenopopulations is not high and varies greatly from year to year. It may be caused not so much by the specific ecological living conditions of area, including thirty and over than thirty year old conflagrations, but rather by regional ecological and geographical location of coenopopulations.

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Table 1. Cowberry yield in SNR "Bolshaya Kokshaga" (g.m^{-2})

CP	Year		
	1999	**2000**	**2003**
1	—	6.67	1.45
2	4.15	4.91	0.42
3	2.90	2.55	0.90
4	1.07	0.44	1.11
5	3.53	3.31	1.17
6	—	9.61	—

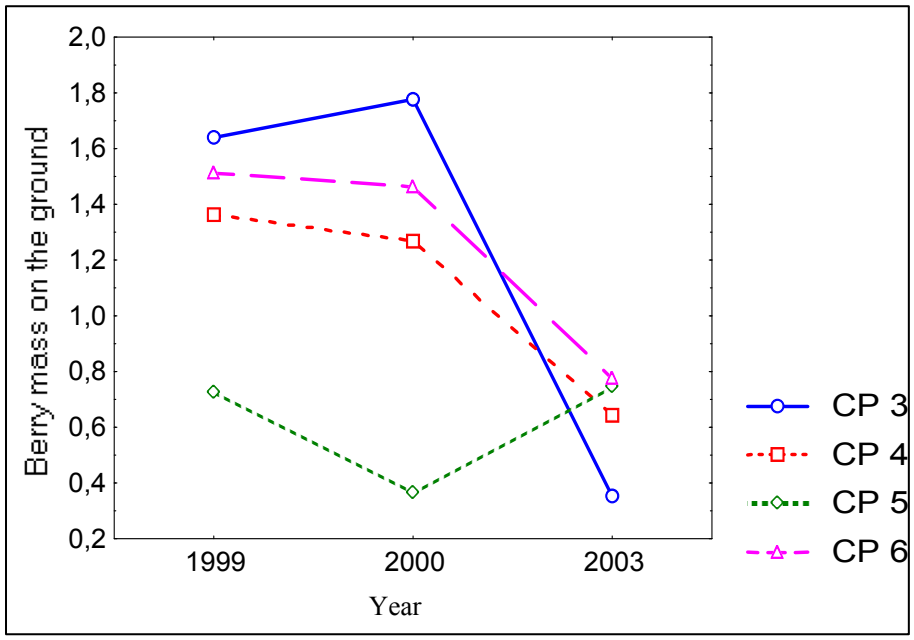

Figure 1. Average berry mass (g) of cowberry on the observed site m^{-2}

EVALUATING THE BEHAVIOUR OF CHOSEN PHENOLOGICAL PHASE OF THE HONEYSUCKLE-EDIBLE (*Lonicera kamtschatica* (Sevast.) Pojark.)

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The honeysuckle-edible (*Lonicera kamtschatica* Sevast. Pojark.), which is unpretending and it natural grows in the Siberian conditions with extreme cold is in the Slovak Republic relatively new and low augmented fruit sort, which is characteristic with a short growing season and early date of maturing of fruits. The honeysuckle-edible is a new berry plant in the Slovak Republic, which has extraction in Russia and it has introduced to home conditions at second half of 19th century. We can to say, that introduction of this interesting and useful plant for human is one of success of gardening of 20th century. This attractive fruit is also growing by plantation way in the whole north and soft climate of Russia, Europe, but in Asia and North America, too (Matuškovič *et al.*, 2003). This crop spread widely in private and commercial gardens of Northern and Central Russia, in the Urals, Siberia and the Far East. Major positive features of blue honeysuckle are extra-early ripening, high content of ascorbic acid and bioactive flavonoides in fruits, and outstanding frost resistance of plants and flowers (Plekhanova, 2000). Plants from Siberia and northern China exhibit four negative traits associated with a short dormancy period; very early bloom, early fall leaf senescence, fall flowering, and winter die-back of annual shoots. However, plants from Hokkaido, Japan and the Kurile Islands bloom 2-3 weeks later, hold their leaves until late in fall, do not flower in fall, and do not die back in winter (Thompson, Chaovanalikit, 2006). The honeysuckle-edible has a lot of useful facilities. They are frost resist, and they are not hurt by spring frost (The flowers are resist up to -7^{0C}), these facilities are implicit by natural conditions authentic environment. They are highly adaptable to local environment, relatively resisting to dry, resisting to shadow, and they are not hurting by sickness and by infestant. They are representing valued source of biological active material positive actuating to human body (Cagáňová, 1994).

The berry of honeysuckle-edible is valued source of anthocyanins. Anthocyanins are usefull for food processing like natural, sensorial active part of stuff, or like concentrate for modifocation of colourity in food article. They are useful in medicine and in blood circulation problems (Kintlerova *et al*., 1996).

The target of our research is to watch and to evaluate the adaptability of this interesting fruit sort in condition if south Slovakia. We have been watching and evaluating behaviour of phenological phase in conditions of Nitra. Evaluating is taking place on an outplanting of 23 clones plant on the land of Slovak University of Agriculture in Nitra.

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