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COMPARISON STUDY OF CULTIVATED HIGHBUSH AND WILD BLUEBERRY NUTRIENT STATUS IN PRODUCING PLANTINGS AND WOODLANDS, LATVIA
KRŪMMELLEŅU UN SAVVAĻAS MELLEŅU MINERĀLĀS BAROŠANĀS NODROŠINĀJUMA LĪMENIS RAŽOJOŠĀS SAIMNIECĪBĀS UN LATVIJAS MEŽOS

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Abstract

Highbush blueberries (*Vaccinium corymbosum* L.) grown on more than 170 ha have become an important horticultural commodity in Latvia with a high market demand. To realize the full potential of this modern high yielding crop, balanced plant nutrition is vitally important to ensure adequate growth and fruit production. The main aim of this study was to find out the actual mineral nutrition status of cultivated highbush and wild blueberries (*Vaccinium myrtillus* L.) in Latvia as well as to evaluate the peculiarities of blueberry mineral nutrition in producing plantings and native woodlands. About 100 (soil and plant) samples were collected from different blueberry producing sites and 5 woodlands during the summer of 2008. Plant leaf analysis and soil testing were used to evaluate the blueberries supply with all of the biogenous elements (N, P, K, Ca, Mg, S, Fe, Mn, Zn, Cu, Mo, B). Our results suggest that only about 40 % of the plant leaf nutrient indices and soil tests were in the optimal range. Insufficient levels of N, P, Ca, Mo, B and increased concentrations of Mn in highbush blueberry leaves were the main problems. In spite of the high heterogeneity of the element concentrations in soils, deficiency of N, Zn, Mo, B was found in the vast majority of samples analyzed. Although forest soils were characterized as an acid nutrient poor environment, wild blueberries showed especially high efficiency of K, Ca, Mg, Fe, and Mn accumulation in their leaves. The present investigation forms the basis for the development of scientific knowledge based blueberry fertilization practices in Latvia

Kopsavilkums

Pēdējos gados Latvijā strauji attīstās jaunas netradicionālas ogu kultūras - augstkrūmmu melleņu (*Vaccinium corymbosum*) audzēšana. Krūmmelleņu stādījumu kopplatība Latvijā 2008. gadā jau sasniedza 170 ha. Darba mērķis bija noskaidrot un salīdzinoši izvērtēt krūmmelleņu un savvaļas melleņu (*Vaccinium myrtillus*) minerālās barošanās stāvokli Latvijā, kā arī novērtēt minerālās barošanās īpatnības ražojošu saimniecību un meža augsnēs. 2008. gadā no piecām Latvijas lielākajām krūmmelleņu saimniecībām un piecām dabisko mežu audzēm ievāca 100 (augsnes un lapu) paraugus. Noteica 12 augiem nepieciešamos barības elementus (N, P, K, Ca, Mg, S, Fe, Mn, Zn, Cu, Mo, B), augsnes pH un kopējo sāļu koncentrāciju (EC). No visiem iegūtajiem augsnes un lapu analīžu rezultātiem tikai 40 % rādītāju bija optimālā līmenī. Krūmmelleņu lapās kopumā raksturīgs – N, P, Ca, Mo un B deficīts, kā arī paaugstinātas Mn koncentrācijas. Neskatoties uz elementu koncentrāciju augsto heterogenitāti, N, Zn, Mo un B deficītu konstatēja vairākumam izanalizēto augšņu paraugu. Lai arī meža augsnes raksturojas ar īpaši skābu un barības elementiem nabadzīgu vidi, savvaļas mellenes uzrāda augstu K, Ca, Mg, Fe, Mn un Zn uzņemšanas efektivitāti. Pētījumā gūtās atziņas papildina zināšanas un izpratni par krūmmelleņu mēslošanas likumsakarībām Latvijā.

Key words: *Vaccinium corymbosum* L., *Vaccinium myrtillus* L., mineral nutrition, plant analysis, soil testing

Introduction

The wild blueberry (*Vaccinium myrtillus* L.) is one of the most popular wild-harvested fruit in Latvia, traditionally used fresh and processed as a health food. The leaves and fruits of the wild blueberry are dried for teas and used in folk-medicine. Unfortunately berry production of the wild blueberry fluctuates annually with weather conditions – spring frosts and summer droughts can greatly decrease yields (Kuchko, 1988). Latvia, where wild blueberries have been picked for centuries, is now replacing them with cultivated North American highbush varieties.

The commercial cultivation of the highbush blueberry (*Vaccinium corymbosum* L.) in Latvia was successfully started during last 10 years. Highbush blueberries grown on more than 170 ha have become an important horticultural commodity in Latvia with high market demand. Cultivated blueberry fruits and juice have become increasingly popular due to their excellent taste, high dietary and health values. Among berry fruits, blueberries are considered to be not only an excellent source of phenolic compounds and vitamins, but also a valuable source of minerals and dietary fibre (Ehlenfeldt and Prior, 2001; Trehane, 2004; USDA National Nutrient Database for Standard Reference, 2006).

Many external factors are important in producing high blueberry yields including soil type, light, temperature, water availability and quality, as well as management practices. Highbush blueberries evolved in low pH (optimum between pH 4.3 and 4.8) soils that were poor in nutrients and rich in organic matter are adapted specifically to these soil conditions and are generally regarded as very sensitive to excessive fertility (Smolarz and Mercik, 1989; Hanson and Hancock, 1996; Hanson, 2006). Although the fertilization requirements of cultivated blueberries are relatively smaller than for other berry crops, investigations indicate that balanced and precise fertilizer applications can improve the nutrient status, growth, development and yield of blueberries (Percival *et al.*, 2003).

While the nutrient status of highbush blueberries in the United States and Canada (the main blueberry production countries in the world) has been studied in considerable detail (Eck, 1988; Strik *et al.*, 1993; Hart *et al.*, 2006), investigations on optimal cultivation technologies of the blueberry crop in Latvia are in their very beginning stages. At present high bush blueberries in Latvia are cultivated on light, acid mineral soils rich in organic matter as well as on high bogs after peat extraction. As highbush blueberries are grown in many non-native regions all over the world (Strik, 2005) and often on soils that have been differently modified by acidification, liming or organic matter incorporation, direct application of nutrient recommendations and management practices from North America are limited in their practicality. Therefore intensive scientific research on soil, climatic requirements and the mineral nutrition regime of highbush blueberries as well as wild blueberries in Latvia are very important.

The main aim of this study was to find out the actual mineral nutrition status of the cultivated highbush (*Vaccinium corymbosum* L.) and wild blueberries (*Vaccinium myrtillus* L.) in Latvia as well as to evaluate the peculiarities of blueberry mineral nutrition in producing plantings and native woodlands.

Materials and methods

About 100 (soil and plant) samples were collected from different blueberry producing sites (Aluksne, Jelgava, Riga, Valmiera and other districts) and 5 woodlands (Cesis, Saldus, Tukums, Valka districts and forest territory of Jurmala city) in Latvia during summer 2008.

The soil samples were taken with a soil probe to a depth of 20 cm. For each sample, five to eight subsamples were obtained and thoroughly mixed to form one sample. The soil samples were air-dried; plant roots and all particles, mineral and organic with a diameter larger than 2 mm were removed by sieving through a 2-mm sieve. To determine the plant available amounts of 12 biogenous elements (N, P, K, Ca, Mg, S, Fe, Mn, Zn, Cu, Mo, B) the soil samples were extracted with 1 *M* HCl (soil - extractant volume ratio 1:5) (Rinkis *et al*., 1987).

For each highbush blueberry plant sample 50-100 of the most recently fully expanded leaves from current season shoots were collected from locations representative of the planting. Wild blueberry leaf materials were collected at each site as a composite sample from an area of about 10x10 m. The plant material was dried at 60 $^{\circ}$C and ground. Then the plant samples were dry-ashed with HNO_3 vapours and re-dissolved in HCl solution (HCl - distilled water mixture 3:100) (Rinkis *et al*., 1987).

Concentrations of 12 biogenous elements (N, P, K, Ca, Mg, S, Fe, Mn, Zn, Cu, Mo, B) were determined in all soil and leaf samples. The levels of Ca, Mg, Fe, Cu, Zn, and Mn were estimated by an atomic absorption spectrophotometer (Perkin Elmer AAnalyst 700, acetylene-air flame), those of N, P, Mo, B by colorimetry, S by turbidimetry, and K by flame photometer (Jenwey PFP7, air-propane butane flame). Soil pH was determined in 1 *M* KCl (soil - extractant volume ratio 1:2.5) potentiometrically by pHmeter Sartorius PB-20 (Rinkis *et al*., 1987). Soil electrical conductivity (EC, mS cm^{-1}) was determined in distilled water extract (soil - distilled water volume ratio 1:5) by the conductometer Hanna EC 215. Analytical replication was performed at least three times. The levels of statistical significance were determined using MS Excel 2003. T-test “Two-Sample Assuming Unequal Variances” ($p<0.05$) was used to compare mean element concentrations between species.

Results

To determine the mineral nutrition status of the highbush blueberry and wild blueberry the levels of 12 biogenous elements as well as pH and EC were estimated in the blueberry soil samples. Mean macro- and micronutrient concentrations, the concentration range as well as soil standards developed by Dr. Nollendorfs (2004) for highbush blueberries in Latvia are shown in Table 1.

Our research revealed an especially high heterogeneity of plant available nutrient concentrations in highbush blueberry soils. The highest concentration diapason was found for S, Fe and Mn (max/min: 117.9, 406.3, 1850.0, respectively), but the lowest for the macronutrients N, K (max/min: 16.3 and 26.3) and the micronutrients Zn, Mo and B (max/min: 14.8, 14.0, 14.0, respectively). It should be stressed that almost all the elements concentration range, with exception of Ca and Mo, in woodland soils was narrower.

Table 1. Nutrient concentrations in blueberry soil samples from producing plantings and woodlands in Latvia, 2008.

Ele-ment	Concentrations in 1*M* HCl extraction, mg l^{-1}				
	V. corymbosum L.		*V. myrtillus* L.		optimal in highbush blueberry soils
	range	mean ± SE	range	mean ± SE	
N	15-245	70.59±8.30a[1]	13-32	22.87±1.61b	120 - 150
P	34-1908	334.92±56.17a	27-47	35.27±1.43b	150 - 180
K	19-500	150.43±18.48a	30-130	70.07±6.27b	100 - 140
Ca	288-16900	2388.46±572.16a	7-1400	588.73±84.57b	700 - 1200
Mg	100-3875	383.92±101.51a	22-350	109.33±18.78b	120 - 250
S	7.0-825	79.54±26.12a	7-11	8.67±0.33b	30 - 50
Fe	24-9750	1115.62±275.72a	90-380	177.93±23.87b	600 - 1500
Mn	0.10-185.00	47.31±7.87a	0.70-24.00	10.19±2.42b	15 - 25
Zn	1.35-20.00	5.77±0.69a	1.60-12.50	5.77±0.72a	8 - 20
Cu	0.45-17.50	3.61±0.57a	0.10-2.00	0.51±0.13b	2.5 – 4.0
Mo	0.01-0.14	0.04±0.005a	0.01-0.41	0.06±0.03a	0.06 – 0.20
B	0.10-1.40	0.48±0.06a	0.10-1.00	0.42±0.08a	0.6 – 1.2
pH_{KCl}	2.76-7.20	4.30±0.16a	2.59-4.01	3.06±0.10b	4.2 - 4.8
EC, mS cm^{-1}	0.15-5.39	1.05±0.19a	0.20-0.37	0.28±0.01b	0.8 – 1.2

[1]Means with different letters in a row were significantly different (t-Test, $p < 0.05$)

Significantly ($p<0.05$) higher levels of the macronutrients N, P, K, Ca, Mg and S were found in highbush blueberry soils in comparison with the nutrient poor forest soils of the wild blueberry. A comparison of the two species studied showed statistically similar mean concentrations for the microelements Zn, Mo and B, while the Fe, Mn, and Cu content were higher in the cultivated blueberry soils. Corresponding to macronutrient levels in the growing medium, wild blueberry soils had a 3.8 times lower mean EC than highbush blueberry soils. In addition, wild blueberry soils could be characterized as a particularly acid growing environment (mean pH_{KCl} 3.06).

Information obtained on mean nutrient concentrations in blueberry plant samples, concentration range as well as highbush blueberry tissue standards (Nollendorfs, 2004) are shown in Table 2. In accordance with wide dispersion of plant available mineral element concentrations in cultivated blueberry soils, the highest concentration variance for almost all nutrients (except Mg) was stated in highbush blueberry leaf samples. Particularly high concentration range was noted for Cu (0.8-362.0 mg kg^{-1}, Cu_{max}/Cu_{min}= 452.5).

Statistically significant differences ($p<0.05$) were found in the macronutrient composition of wild and cultivated blueberry leaves. The highest mean concentrations of N, P and S (1.36, 0.16 and 0.16 mg kg^{-1}, respectively) were found in the highbush blueberry, while the highest K, Ca and Mg (on average, 0.77, 0.84 and 0.84 mg kg^{-1}, respectively) concentrations were found in wild blueberry plant samples. A comparison of the two species studied showed similar concentrations for the micronutrients Fe, Zn and B in blueberry leaves. The chemical analysis of plant samples revealed significantly higher mean levels of Cu and Mo in highbush blueberry leaves. Especially high mean concentration of Mn (814.4 mg kg^{-1}) was found in wild blueberry leaves, which exceeded the value for cultivated blueberries 4.3 times.

Table 2. Mineral element concentrations in *V. corymbosum* L. and *V. myrtillus* L. leaf samples in Latvia, 2008

Ele-ment	Concentrations in dried tissue				optimal levels in highbush blueberry leaves
	V. corymbosum L.		*V. myrtillus* L.		
	range	mean ± SE	range	mean ± SE	
			Macronutrients (%)		
N	0.63-4.6	1.36±0.13a[1]	0.80 – 1.5	1.08 ± 0.05b	1,70 – 2,00
P	0.07-0.33	0.16±0.01a	0.08 – 0.17	0.12 ± 0.01b	0,20 – 0,30
K	0.36-1.70	0.62±0.04a	0.64 – 1.0	0.77 ± 0.03b	0,45 - 0,70
Ca	0.23-0.80	0.40±0.02a	0.56 – 1.12	0.84 ± 0.05b	0,50 - 0,80
Mg	0.12-0.31	0.18±0.01a	0.17 – 0.54	0.32 ± 0.03b	0,15 - 0,30
S	0.08-0.46	0.18±0.01a	0.12 – 0.18	0.15 ± 0.01b	0,15 - 0,25
			Micronutrients (mg kg^{-1})		
Fe	26.0-362.0	76.4±11.2a	54.0 – 128.0	81.87 ± 6.76a	80 - 150
Mn	24.00-880.00	189±29.4a	130.0 – 1720.0	814.40 ± 146.42b	40 - 100
Zn	8.8-76.0	19.3±2.4a	14.0 – 26.0	18.60 ± 0.96a	20 - 60
Cu	0.8-362.0	19.8±11.0a	3.6 – 6.4	4.97 ± 0.24b	8 - 12
Mo	0.10-2.49	0.46±0.09a	0.2 – 0.3	0.23 ± 0.01b	1 - 5
B	7.0-58.0	24.1±2.2a	15.0 –30.0	22.73 ± 1.21a	30 - 60

[1]Means with different letters in a row were significantly different (t-Test, $p < 0.05$)

The results obtained on the percentage of highbush blueberry plant and soil samples in low, optimum and excessive nutrient supply levels are shown in Figure 1. Almost 60 % of the plant samples were completely sufficient in macronutrients. The worse situation was found for the micronutrient supply – more than 55 % of indices were in the deficient range, optimal supply was provided only for 31 % of leaf samples. In general, equal distribution (39 %) between all indices in low and optimal levels was found for highbush blueberry soil samples. Unlike blueberry leaves, a better situation was found for the micronutrient supply in cultivated blueberry soils.

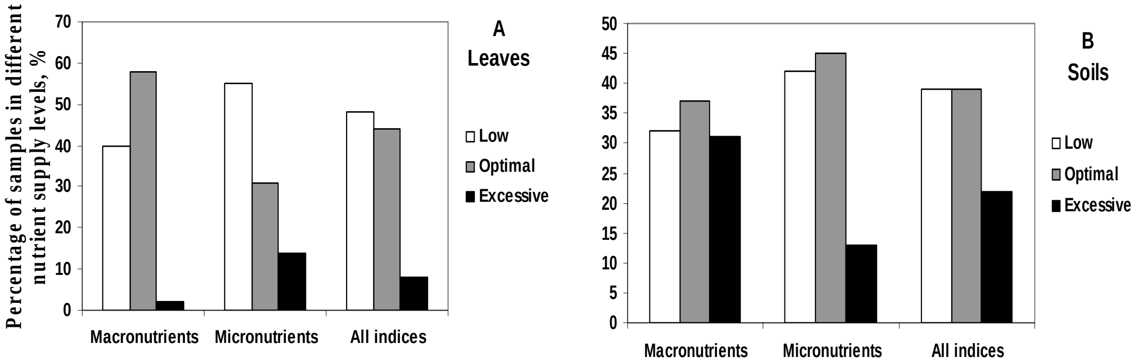

Figure 1. Distribution of highbush blueberry leaf (A) and soil (B) samples in different nutrient supply levels in Latvia, 2008

Discussion

Increased consumer demand for blueberries is being driven by the health benefits associated with functional food characteristics. Wild blueberry have historically been used to help improve eyesight, treat diarrhoea, improve blood sugar levels in diabetics, strengthen blood vessels and improve circulation (Trehane, 2004). The powerful antioxidant properties of the highbush blueberry appear to play a conclusive role in the prevention and delay of certain diseases such as cancer, cardiovascular issues, and the aging process (Ehlenfeldt and Prior, 2001).

To realize the full potential of modern high yielding crop, balanced plant nutrition is vitally important to ensure adequate growth and fruit production. A deficiency in any of the essential nutrients will disrupt either the vegetative or reproductive growth cycles in plants (Marshner, 1995; Fuqua et al, 2005).

The results obtained on the nutrition status of the highbush blueberry revealed the main problems in plants supply with essential mineral elements in Latvia. In general, our results suggest that only about 40 % of plant tissue nutrient indices were within the sufficient range. Mean macronutrient concentrations, with the exception of low N and slightly decreased P and Ca could be characterized as optimal. Nitrogen is the controlling element in blueberry nutrition and adequate fertilization is necessary to maintain renewal growth, crop production, and flower bud development (Strik and Hart, 1997). Our study suggests that optimal N levels were provided by only 20 % of blueberry leaf samples in Latvia. It can be mentioned that deficiencies of N are the most frequently encountered problems in growing blueberries in North America also (Pritts, 2000; Fuqua et al 2005).

The main tendencies in mean micronutrient supply were also detected – deficiency of Mo, slightly decreased B, optimal levels of Fe and Zn, as well as increased concentrations of Mn and Cu in the plant tissue. While Mn concentrations in highbush blueberry leaves were rather high, in most of cases they could not be considered as toxic, with the exception of the highest concentrations: 450 mg kg^{-1} to 880 mg kg^{-1}. As the cultivation environment influences the chemical composition of plant leaves, our study suggests that the increased Mn concentrations in highbush blueberries reflect high Mn availability in low-pH soils, excessive soil Mn, and sometimes the mistaken application of fertilizers containing Mn. According to recommendations based on the first studies on blueberry nutrition in Latvia the use of the foliar micronutrient (Cu, Zn, B, Mo) fertilization was started during recent years to correct the specific deficiencies stated in the tissue tests. Consequently, excessive Cu concentrations could be caused by the adhesion properties of foliar fertilizers and the use of fungicides.

Our results revealed statistically significant differences between wild blueberry and highbush blueberriy results for N, P, K, Ca, Mg, S, Mn, Cu, Mo in leaf samples. Cultivated highbush blueberry leaves had higher mean concentrations of N, P, S, Cu, and Mo while wild blueberry leaves showed higher levels of K, Ca, Mg, and Mn. It is interesting that there were no significant differences in leaf Fe contents between wild blueberry and highbush blueberry growing in cultivated and forest soils with completely different Fe concentrations: 1115.6 mg Fe l^{-1} and 177.9 mg Fe l^{-1}, respectively. Although wild blueberry leaves were comparatively high in Mn content (on average, 814.4 mg kg^{-1}), reported mean values for Mn (1900 mg kg^{-1}) in wild blueberry leaves from Northern Europe (Reumann *et al.*, 2002) and Poland - 2758 mg kg^{-1} (Kozanecka *et al.*, 2002) were twice to three times higher than our Mn results for wild blueberries in Latvia.

Our previous studies suggest that, in general, blueberry fruit chemical analysis confirmed mineral element differences in wild blueberry and highbush blueberry leaves. A comparison of the two species studied showed that the highest mean K, Ca, and Mn concentrations were also characteristic for wild blueberry fruits (Pormale et al, 2009).

Several investigations have shown that leaf analysis provides a picture of the nutrient status of a crop at a particular point in time resulting from all factors affecting plant growth and is an excellent method to be used on established plantings (Strik *et al.*, 1993; Marschner, 1995). But this diagnostic method cannot detect the character of the nutrient deficiencies or toxicities and the soil content of the nutrients. Therefore soil testing is very important in determining the ability of the soil to supply the nutrients needed for optimum plant growth.

Although a particularly broad range of element concentrations in highbush blueberry soil samples was found, in general, soil tests revealed nutrient deficiencies in the cultivated blueberries. Deficiencies of N, Zn, Mo, and B as well as increased Mn levels were the main problems found. Our results suggest that only 39 % of all soil indices in blueberry producing plantings in Latvia were in the optimal range. It should be noted that the lowest macro- and microelement concentration levels in cultivated blueberry soils are highly comparable with element concentrations in nutrient poor forest soils, thus indicating insufficient fertilization. This could seriously limit the highbush blueberry yield in Latvia. Although mean levels of soil $pH/_{KCl}$ and EC meet requirements of soil standards, the samples with marginal values did not correspond to the optimum for highbush blueberry growth and development.

The results obtained on nutrient concentrations in wild blueberry soils revealed significantly lower N, P, K, Ca, Mg, S, Fe, Mn and Cu levels compared with highbush blueberry soils. Particularly low concentrations were found for N and S in the woodland soils. This is not surprisingly because nutrients in anion form are more leachable from light acid forest soils, as well as during the last 20 years industrial emissions have been seriously decreased in Latvia (Ļulko *et al.*, 2008).

Although both wild blueberries and highbush blueberries can be classified as typical calcifuges, since they thrive in nutrient poor soils with low pH (Korcak, 1989), wild blueberries showed an especially high efficiency rate of K, Ca, Mg, Fe, Mn, accumulation in their leaves. This phenomenon can be considered as a potential wild plant physiological adaptation mechanism to infertile soils.

Conclusions

The results obtained on the nutrition status of the highbush blueberry revealed the main problems in plant supply with essential mineral elements in Latvia. Insufficient levels of N, P, Ca, Mo, B and increased concentrations of Mn in highbush blueberry leaves were found to be the main problems. In spite of the high heterogeneity of the element concentrations in soils, the deficiency of N, Zn, Mo, B was found in a vast majority of samples analyzed. In general, our results suggest that only about 40 % of plant leaf nutrient indices and soil tests were in the optimal range. Although forest soils were characterized as acidic and a nutrient poor environment, wild blueberries showed an especially high efficiency of K, Ca, Mg, Fe, Mn accumulation in their leaves. The present investigation forms the basis for the development of ongoing scientific research and knowledge about blueberry fertilization practices in Latvia.

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EXAMINATION OF CORNEL (*CORNUS MAS* L.) FRUITS IN BORSOD-ABAUJ-ZEMPLEN COUNTY (HUNGARY)
KIZILA (*CORNUS MAS* L.) AUGĻU IZVĒRTĒŠANA BORSOD-ABAUJ-ZEMPLEN APGABALĀ (UNGĀRIJA)

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Abstract
The domestication of cornel has already begun in the neighbour countries by the selection of valuable individuals. The spontaneously growing North-Hungarian specimens could be a good material for similar selection and domestication because foreign cultivars may not adapt to the dry climate of Hungary. Fruit collectors are making from cornel berries delicious palinka (a kind of spirit) and jam. The needs of the processing industry and the market is larger than the gathering can provide, therefore the culturing of new cultivars would be favorable. Our purpose was to show there are several valuable individuals in the Hungarian cornel population, which have outstanding qualities. We observed individuals growing in a natural habitat in 2006, measured the weight of fruit, seeds, and the parameters of fruit length and width. The 19 samples were collected in the Aggtelek Karsts and the southern slopes of Bükk hill. The measured fruits weighed between the 1.2 – 2.85gramm, the seeds were 0.27 – 0.41gramm, so the calculated flesh ratios were average 72.93 – 86.66 %. The average lengths of fruits were between 15.43mm and 20.02 mm, and the average widths of them were between 10.41 – 14.67 mm. Even in a small sample there can be found valuable fruit types for further examination, although it is necessary to observe a wider range of samples to find a good cultivar which is adapted to the local climate.

Kopsavilkums
Kizila kultivēšana kaimiņu valstīs ir sākusies ar vērtīgāko indivīdu atlasi. Ziemeļungārijā spontāni augošie eksemplāri varētu būt labs materiāls līdzīgai atlasei un kultivēšanai, jo ievestās šķirnes varētu nebūt piemērotas sausajam Ungārijas klimatam. Augļu vācēji no kizila ogām gatavo garšīgu "palinku"(alkoholiskā dzēriena veids) un ievārījumu. Pārstrādes rūpniecības vajadzības un tirgus ir lielāks kā ogu vācēji var nodrošināt, tādēļ jaunu šķirņu kultivēšana varētu būt izdevīga. Mūsu nolūks bija parādīt dažas vērtīgas ungāru kizila populācijas ar izcilu kvalitāti. 2006. gadā mēs novērojām eksemplāru augšanu dabiskā vidē, nosakot augļu un sēklu svaru un augļu garuma un platuma parametrus. Aggtelek Karsts un Bükk kalna nogāzēs tika savākti 19 paraugi. Augļu masa bija starp 1.2 – 2.85 g, sēklu masa 0.27 – 0.41 g, aprēķinātā augļa mīkstuma masas attiecība pret sēklu masu bija vidēji 72.93 – 86.66 %. Vidējais augļa garums bija starp 15.43 un 20.02 mm un vidējais platums bija 10.41 – 14.67 mm. Pat mazā paraugā varēja atrast vērtīgus augļu veidus