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Environmental management, land use, biodiversity

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András Béres (Herman Ottó Institute Nonprofit Ltd.)
Technical editor:
Nóra Koplányi (Herman Ottó Institute Nonprofit Ltd.)

Graphic designer
Ildikó Dávid
Photos
Gábor Boronkay

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VARIETY RESEARCH IN ROSE GARDEN BUDATÉTÉNY (BUDAPEST, HUNGARY)

GÁBOR **BORONKAY**

NARIC Research Institute for Fruitgrowing and Ornamentals, Park u. 2. Budapest, Hungary, H-1223

HISTORY OF THE ROSE VARIETY RESEARCHES

The Rose Garden Budatétény is considered the largest rosarium in Hungary, where 1100 verified rose cultivars are shown. Budatétény is the district of Budapest, where our garden is situated. Although the rosarium itself was built in 1963, its collection was established earlier. The plant material is as old as the parent institution of the garden: the Horticultural Research Institute, first predecessor of the NARIC Research Institute of Fruitgrowing and Ornamentals. Both of them were established in 1950. That was the year, when Gergely Márk - founder of the rose garden - got the job to collect and show all the outdoor rose cultivars, which was available in Hungary at that time. The Rose Garden Budatétény at Park Street 2. didn't exist at that time, therefore the new collection was planted in the relatively small garden of the old Dőry's mansion.

Despite the small showing area, the rose collection became fairly quickly the biggest and most popular rose gene bank of the country. From the foundation, the collection was also a field of cultivar researches. Originally, Gergely Márk, and his team evaluated the cultivars exclusively for climate tolerance (Márk, 1959). Although that time global warming was an unknown threat, the climate of Hungary was always a serious hardship of the rose cultivars bred in Western Europe, where they had been selected in milder winters and summers. Therefore, it was no coincidence that Mr. Márk has changed the main direction of his research, and he started to breed winter-hardy roses. This kind of cultivar-research activity was more suitable for Gergely Márk, therefore even nowadays Mr. Márk is still better known as a hybridizer than a researcher.

After the retirement of the founder of Rose Garden Budatétény, the direction of the rose researches shifted to cultivar evaluation. Although we continued the climate tolerance examinations initiated by Mr. Márk, besides the simple, ranking based methods we also started to elaborate some new numerical evaluation procedures, which are based on mathematical statistics and modelling. This kind of work complements well Mr. Márk's breeding work, and properly adjusted to the requirements of the 21st Century. Nevertheless, our primary goal did not change at all: We want to examine the marketability of roses, especially of the Hungarian bred ones. Although we emphasize the complex and objective ornamental value of roses, our results are still based on climate tolerance (Boronkay et al., 2005).

RESEARCH ACTIVITIES IN THE ROSE GARDEN BUDATÉTÉNY, IN GENERAL

Evaluating scientific plant collections needs numerical methods, which supports fast data recordings and great number of examined items. Therefore, as a part of our objective for the case of cultivar evaluations, we have been elaborating mathematical models based on colorimetrical measurements and correcting formulas. By the help of mathematical statistics and colorimetry, we can compute exact, numerical indices of ornamental value from ranked data, although ranking is fast but not a precise method. This modelling procedure is very useful to determine many type of ornamental values, although there are some special features, like blooming dynamism, or flower life decorativeness, which need different approaches, and special indices.

Our method of cultivar research, which is based on colorimetry and modelling is unique. It was initiated at the Rose Garden Budatétény, it is used exclusively here, and to our knowledge there is no other place where similar examinations is being done.

However, we didn't finish the simple (uncorrected) rank type assessments either, because with ranking we can evaluate a great number of items in a very limited time, and examine innumerable features. Therefore, we evaluated a weighting system, which is suitable for summarizing the unprocessed ranked values, and creating a complex index, which mirrors the planting value of a variety. (Boronkay and Jámborné-Benczúr, 2009).

In a well-maintained scientific cultivar collection, variety evaluating is not enough. During the practical work, variety identification is also very important. Therefore, we initiated a completely different direction of research as well: cultivar description based on flower morphology. For describing items in the gene bank or cultivar registration we are elaborating a new flower- and inflorescence morphology system, which will be suitable for both outdoor works and indoor computerized classifications. This system is based on mathematics (where it is possible) and its level of detail is optimized for the outdoor variety identification: not simplified, but not inapplicable detailed either.

MODELS WITH QUALITY/QUANTITY STRUCTURE

To take advantage of the 1100-cultivar-assortment of the Rose Garden Budatétény, we wanted to use cultivar evaluations, which are as accurate as possible, but usually we don't have enough time to measure all this roses. Therefore we elaborate mathematical models, witch are suitable for evaluating even a whole collection of roses objectively. In other words with these models we can compute accurate ornamental values of the rose cultivars only from data, which can be recorded fast and *in situ* (outdoors). The ornamental values, which are based on quality/quantity mathematical model are the following: ornamental value of young spring foliage, summer foliage (here yearly dynamism can also be computing) (Boronkay, and Jámborné-Benczúr, 2006), flower life, blooming of a whole plantation (here yearly dynamism can also be computing) and hips.

The general structure of our ornamental value models can be described as "ornamental value = quality index + quantity index". Here quantity usually means extent of visible surface area, while the index of quality is based on chromatic values (colours), because these types of data can be measured quickly, they are objective and very suitable for characterising the decorativeness.

QUALITY INDEX

The most important part of any plant decorativeness index is the ornamental quality of a visible part or organ. Nevertheless, we cannot use a general quality, the quality indices of different organs needs different measuring method to record it.

Foliage: We have found, that in the case of foliage the quality index has to be the reflection (gleam) of the upper side of the leaves, because the colour of the foliage (green, bronze or purple) is independent from the visually interpreted decorativeness. The decorativeness of the leaf colour is a matter of taste only.

Hip: In the case of hips the quality index is the CIE (Commission Internationale de l'Éclairage) a* parameter (Güneş et al., 2016), which describes the orange-red coloration of the hip during the ripening. The importance of the CIE a* value in decorativeness (Figure 1) was proved by our experiments (Boronkay, 2018b).

Flower: Unlike the hip colour, the petal colour is a matter of taste only, it lacks any well-defined ornamental value. In contrast, the colour stability (Ferrante, et al. 2010) or

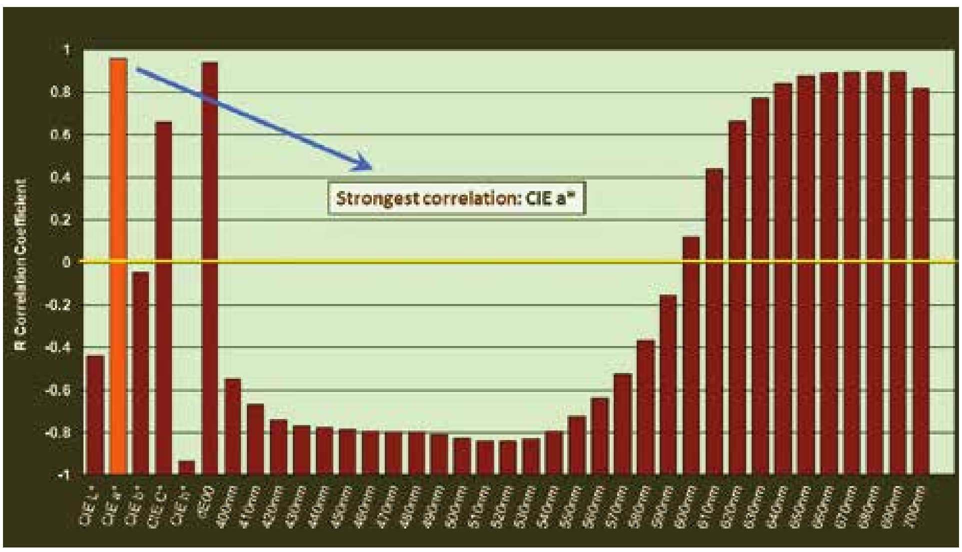

Figure 1: Pearson type paired correlation between ranked decorativeness and measured colour parameters of the surface of hips. CIE a* shows the he strongest correlation, thus this colour dimension is the most suitable for measuring the quality of the ornamental value of hips.

Chromatic difference in CIE Lab model with $CIEDE_{2000}$ method

K_l, K_h, K_c weight factors: 1,00 1,00 1,00 Suggested factors: $K_l = K_h = K_c = 1.00$

First colour L	a	b	Second colour L	a	b	Differences ΔL	Δa	Δb	ΔE_{00}
32,53	58,10	5,33	22,73	96,18	94,34	9,80	38,08	89,01	30,74
35,60	25,83	41,35	70,30	91,96	61,38	34,70	66,13	20,03	40,28
52,02	114,33	82,60	69,45	12,25	13,18	17,43	102,07	69,43	31,33
47,83	25,89	92,59	27,21	95,56	6,94	20,62	69,67	85,65	57,12
56,35	23,08	119,42	94,99	28,18	56,66	38,64	5,10	62,77	32,92
60,84	123,51	39,68	74,34	127,85	98,16	13,50	4,33	58,48	20,96
46,44	53,74	77,26	54,64	77,24	121,71	8,21	23,50	44,45	11,60

Munsell>M% / M%>Munsell / RGB dE / Munsell dE / CMC / CIE dE76 / CIE dE94 / CIEDE2000

Figure 2: The CIEDE2000 chromatic difference page of our 'Colour Conversion Centre' software. The program can be downloaded from the ccc.orgfree.com site for free.

Szabó Dezső emléke									
Phenological stages of the flower	2	4	6	6.5	7	7.5	8	8.5	Sum
Optimal colour (stage 6.)									
Colour of stage									
Chromatic difference (ΔE_{00})	20.9	12.0	0.0	0.5	9.2	20.2	31.2	34.2	
Ornamental value: 15-ΔE_{00}	-5.9	3.0	15.0	14.5	5.8	-5.2	-16.2	-19.2	-8.2

Figure 3: This example shows the calculation procedure of the ornamental value of a flower colour. The example is 'Szabó Dezső emléke' floribunda variety, bred by Gergely Márk.

the extent of the colour shift of flower is really important and well measurable (Boronkay et al., 2009). However computing the proper distance between the measured colours is not an easy task, because it needs special standard chromatic difference formulas. While the old (1976, 1994) standards are simple and easily understandable, the newest and actual one (CIEDE2000 or CIE ΔE_{2000}) is very sophisticated. As we couldn't find any usable program, we have written a user-friendly interface of the CIEDE2000 standard, which is based on the works of Sharma et al. (2005). This already published freeware program (Figure 2) is called „Colour Conversion Centre" (Boronkay and Kürti 2008-2019). The practical value of our interface is proved by more than dozen articles in international scientific publications, where our software was cited, like Aitkenhead and Black (2017), Parr et al. (2012), Riascos (2015), Smith et al. (2016) or Vicuña, (2015).

The CIEDE2000 method gives a 3D nonlinear distance between two colours in CIELab space. The results are in ΔE_{00} psycho-chromatic dimension, and the values are very close to the human eyesight. If we are evaluating colour stability, the chromatic difference should be measured between the consecutive phenological stages. If we would like to measure the value of flower colour, the colour difference should be measured between the stage and the stage with optimal coloration (in our system it is No. 6). In both cases, we should cumulate the measured chromatic differences of the consecutive stages. According to our results, different number of phenological stages can be informative (for freshly opened flower -> wilting flower). Naturally, the chromatic difference is in reverse proportion (Figure 3) of the decorativeness, higher ornamental value means higher colour stability and smaller colour distance.

QUANTITY INDEX

Defining the quantity index raises several questions. Quantity is usually easily measurable, but measuring can be destructive sometimes, and it needs so much time, that it is unusable when we have to evaluate hundreds of items in the field. Although ranking as a data-recording method is fast enough, but unfortunately, it is also very inaccurate. Therefore, ranking the items is not enough, the recorded data need some refining with more accurate correction processes.

For solve the difficulty, we tried to find function-like correlations between ranking classes of the visually estimated quantity and real biological productions. For that purpose, we both measure and rank a smaller, but representative portion of the items as samplings. With the help of these samples, we can calculate regression type correlations, where X meansvisually ranked values, and Y means measured, factual production. In case we have a well fitting regression function, we can estimate the real production of the items from the ranked values.

According to our results, (Figure 4) the correlation between the visually recorded rank values and the actual measured production is always power or exponential type.

Thus, the quantity index is the ranked by the quantity of the organs (leaf, flower, fruit) corrected by the appropriate regression formula. This method combines rapidity with accuracy, and is suitable for a quantity index. What kind of biological productions do we use?

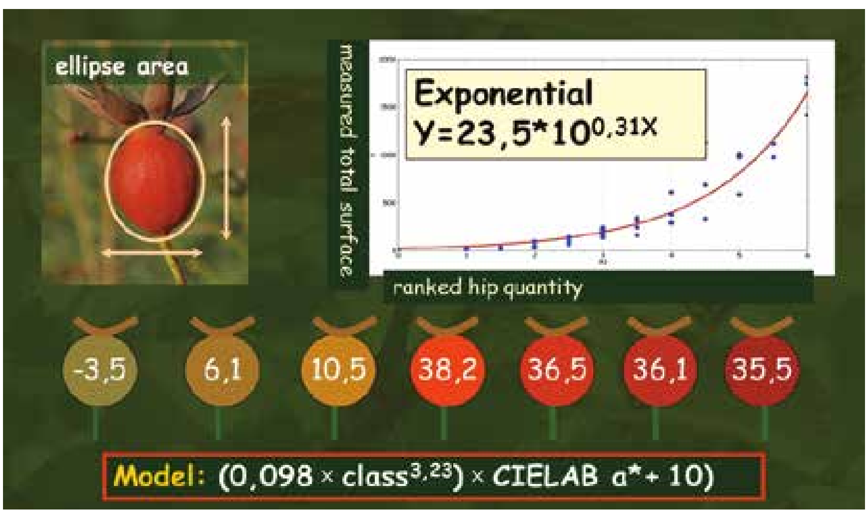

Figure 4: The correlation between the measured visible surface area of the hips and ranked quantity of the hips. In the bottom of the figure you can see the CIE a* colour parameter of the maturing hips. The more saturated and orange-red the hip is, the higher the a* value is.

Foliage: The ranked value in our evaluation is foliage density, and the dimension of the production is the fresh weight of the leaves/bush.
Flower: The ranked quantity of the flower ornamental value is the blooming intensity or flower coverage, while the measured production is the total visible surface area of the flowers/foliage surface area. Here the flower shape can be simplified as a cone or a cylinder.
Hip: The parameters are similar to the previous ones: The dimension of the ranking is the hip coverage, and the measured correcting factor is the total visible surface area of the hips/foliage surface area. The visible surface area of the hip can be modelled as the area of an ellipse.

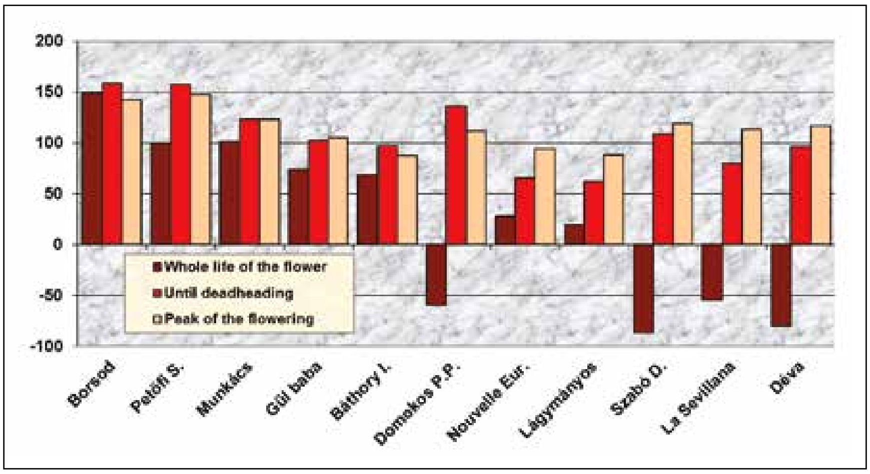

Figure 5: Total ornamental value of the flower life of red roses computed for three ranges of consecutive phenological stages.

Figure 6: Phenological stages of the flower of 'Domokos Pál Péter' and 'Munkács' Hungarian roses, and flower opening dynamism (flowering speed) of some rose cultivars.

FINALIZATION OF THE ORNAMENTAL VALUE MODEL

After we recorded and computed the quality and the quantity indices, we have to standardize them ($X'=(X-\mu)/\sigma$), because the sets of values of the two indices can be very different. The final ornamental value is the sum (or average) of the two standardized indices, not a multiplication, because standardised values can be negative. Therefore the general structure of our model is: OV= standardised quantity index + standardized quality index.
A good example for this quantity / quality type model is the already published fruit or hip ornamental value. The full model is the following: OV_{hip}= standardised ($0.067\times C_{hip}^{3.44}$) + (standardised CIELAB a^*_{hip}), where OV_{hip} = ornamental value of the pseudo-fruit (hip) isC_{hip} = category of the ranked hip quantity, CIELAB a^*_{hip}= a^* (red content) of the surface area of the hip in CIELAB standard (Boronkay, 2018a).
Creating these models are part of our actually running researches: the hip model has been published recently, the foliage model will have been finished by 2020, while modelling the ornamental value of the flowering is being planned only.

ORNAMENTAL VALUE OF FLOWER LIFE

Ornamental value of a flower opening process cannot be evaluated with the above-mentioned method, because it needs a three-elements type model, where speed of the blooming should also be taken into account.
The method, which was created by us, is based on phenological stages of flowers (Figure 5) from bud stage to the petal falling. In the case of roses, we could define 22 stages in the life of the flower (Figure 5). We measured the duration of the stages (speed of the opening and wilting), the chromatic difference between the colour of the stages and the optimum stage (No. 6), and the relative size (visible surface area) of the flower at each stage, where 100% is stage 6. From these three indices (duration, colour difference, size), we can define the ornamental value of a phenological stage, which can even be a negative number. If we want to define the ornamental value of flower life as an index, we have to cumulate the values of different set of consecutive stages.
According to our published results the proper formula is: $OV_c = \Sigma(OV_{ph}\times t_{ph}) = \Sigma[(15-\Delta E_{00ph}) \times A_{ph}\%]\times t_{ph})$, where

OV_{ph} is the ornamental value of a phenological stage, t_{ph} is the duration of the stage, ΔE_{00ph} is the chromatic difference between the colour of the stage and colour of the optimal stage (No. 6) in CIEDE2000 standard. A_{ph} is the relative visible surface area of the flower at that stage in the percentage of stage 6. The visible surface area of the bud is usually a cone, while the open flower has a cylindrical shape.

With the help of this three-element-model we were able to compare both very similar cultivars and very different ones as well (Boronkay, 2015). It has proved that this method also gives usable information about the required level of agrotechnique. For example, 'Szabó Dezső emléke' variety does not need deadheading (removing the dried flowers), while without pruning, the total ornamental value of the flower of 'Bodor Péter emléke' drops significantly (Figure 6).

INDICES FOR FLOWERING DYNAMISM

We also analyzed the yearly dynamism of the flowering intensity (Boronkay, 2012). Here, dynamism means yearly course of the flowering intensity. For measuring the intensity, we use the total flower surface area / foliage surface area parameter in percentage (%).

As the yearly flowering dynamism is a compound curve, we need several indices to describe it properly. Therefore, we elaborated 12 indices, based on MS Excel functions (Figure 7). The indices are the followings: time and value of the maximal flower coverage of the whole year, the same indices of the summer flowering period (remontancy), the time between the flowering peaks, average of the first blooming wave and the yearly blooming, first and last day of the summer flowering period, and some normalised values. We defined six typical flower dynamism types (Figure 8), and we could classify the examined cultivars into these 6 classes with calculations only. Except the limit-days of the remontancy (the day after the first flowering wave and last frost free day), all indices can be computed by spreadsheet functions.

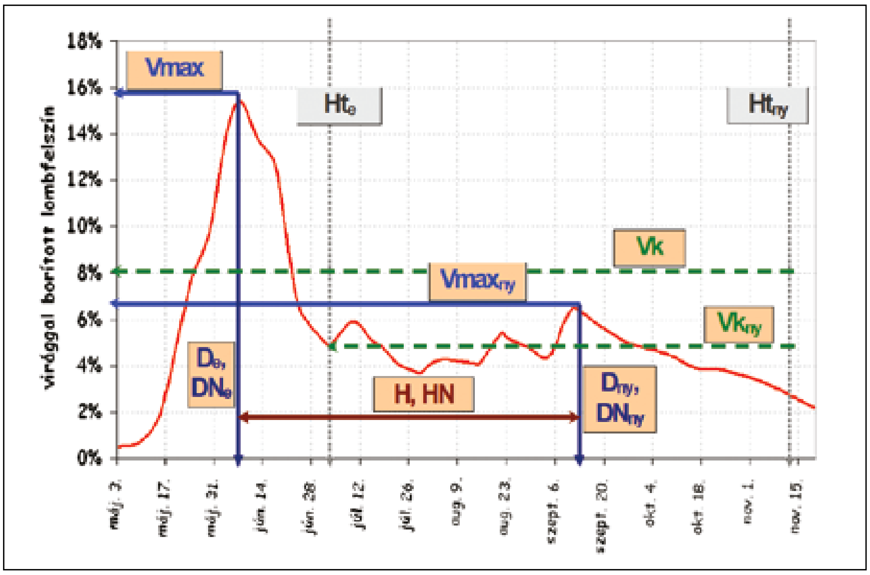

Figure 7: Pictorial representation of the 12 indices, which describe the yearly flowering dynamism of a variety.

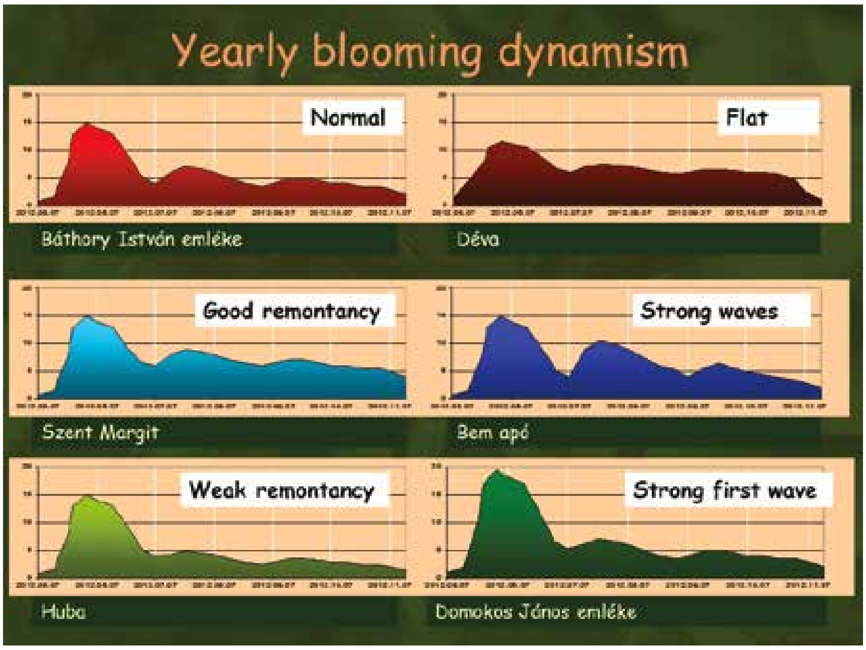

Figure 8: The six most characteristic patterns of the yearly flowering dynamism with one example for each pattern. All of the examples are Hungarian cultivars.

This direction of research is not useless at all: The flowering dynamism is very important in garden designing, with the help of these indices, the designer can avoid the situation, when all of the roses in a garden are flowerless.

WEIGHTING SYSTEM FOR UNCORRECTED (PURE) RANKING

Although modelling is a very efficient method in cultivar evaluation, we cannot avoid using pure ranking. This is a very fast data collecting method and we can record sev-

Table 1: Planting value of the best Hungarian hybrid teas, based on weighted indices. The data was recorded in 2013 and the previous years

Cultivar name	Score*	Generative features					Vegetative features					
Ranked features**		Blooming intensity				Wilt.	Frag.	Wood.	Foliage		Spr.	Aut.
		First	Rem.	Yearl.	Max.				Dens.	Health		
Weighting factors		**1.5**	**1.5**	**1.5**	**1.5**	**1**	**3**	**3.5**	**2.5**	**1.5**	**1**	**1.5**
'Marcsika'	21.5	1	1		-1	2	2	2	2			
'Brassó'	21	2		1	-1	2		2	2		1	2
'Radnóti Miklós emléke'	20	1	1	1		1		2	2	1	1	
'Csodálatos mandarin'	19.5				1	-1	2	2	2		1	
'Csalhó'	18	2	1	1	1		-1	2	2	1		
'Ruttkai Éva emléke'	17.5		1		-1		1	2	2	1	1	
'Eötvös József emléke'	17	1	2	1			1	2	1		1	
'Márton Áron emléke'	16.5			-1		1	2	2	1	1		

*: higher than the upper quartile: +2, higher than average: +1, lower than average: -1.
** The evaluated features are the following: blooming intensity of the first flowering wave, blooming intensity in summer, yearly average of the blooming intensity, highest blooming intensity, wilting (self cleaning), fragrance, vigour of the woody parts, foliage density, health of the foliage, ornamental value in spring (young foliage), ornamental value in autumn (foliage, flowers, hips)

eral important features in a very short time. Therefore, we have worked out a weighting system for the uncorrected ranked features, with which we can evaluate numerous qualities in a complex and balanced way. We record features such as scent, sun radiation tolerance, rain tolerance, storm and wind tolerance, winter hardiness, vigour of the branches, peak of flowering waves, foliage coverage, decorativeness in spring and autumn. Each of our ranking has 10-20 classes, and after the data recording, we standardise (eliminate the effect of the different number of the classes) the ranked values. After that, we simplify the set of values by reclassifying them by the help of quartiles, for get a transparent and balanced set of indices.

If we want to get complex planting value of the cultivars, we have to summarize the indices with weighting. The greatest advantage of our weight system is that it gives good balance between the generative and vegetative features, and the result can mirror the expectation of the garden designers. Nevertheless, the indices are also interpretable independently (for example: good flowering capabilities, but poor vigour), therefore we use tableform (Table 1) to define the advantage and disadvantages of the examined cultivars.

RESULTS

Altogether, we compared three sets of cultivars. First of all, we examined the total verified collection of the rose garden. Here we could evaluate about 850 cultivars by all the above-mentioned features for a couple of years. Although we have several another excellent varieties, they could not be evaluated, because in their case some data sets are missing.

Our result suggest, that the following cultivars are worthy for attention: out of the hybrid teas (roses for cutting) 'Aida', 'Szerb Antal emléke' and 'Proud Land' proved to be the best, while the most valuable modern bedding roses (floribundas) are 'Szent Margit emléke', 'Báthory István emléke' and 'Rosalyn Carter'. We can find highly valuable bedding roses among the low growing polyanthas also, like 'Csinszka emléke', 'Orléans Rose' and the Hungarian 'Savaria'. Out of the tall shrub/climbing class, the 'City of York' climbing rose proved to be the most valuable.

Although with smaller number of repetition, and without any ornamental value model, we could evaluate almost all the cultivars bred by Gergely Márk in his breeding garden in Törökbálint. According to our records, the most valuable cultivars out of Mr. Márk's hybrid teas are 'Marcsika', 'Brassó' and 'Radnóti Miklós emléke' cut roses. The best Hungarian floribundas are 'Domokos János emléke', 'Marosvásárhely', 'Laborfalvi Róza emléke, 'Királyhelmec, 'Budaörs', and out of the smaller polyanthas: 'Dayka Margit emléke', 'Kempelen Farkas emléke' and 'Savaria'. It seems that the majority of the valuable Hungarian cultivars are small flowered bedding roses like floribundas and polyanthas. We could find only one valuable cultivar in the miniature class, but it is proved excellent, it was the 'Ernye' variety.

While these two surveys focus on the features, which can be recorded fast and easily, the third survey about the Hungarian roses of Rose Garden Budatétény is based on the much more accurate modelling methods. Since these evaluations are still in process, final results cannot be given yet.

Nevertheless, it is important to know, that Mr. Márk wasn't the only Hungarian who bred roses, so we are evaluating some cultivars of Rudolf Geschwind, Ferenc Müller, Árpád Mühle also.

FLOWER-INFLORESCENCE CLASSIFICATION

Assessing rose cultivars is not enough if we have some doubts about the origin of the rose items in a gene bank. If the items are Hungarian cultivars, the problem is much more serious. There are two main fields, where accurate variety descriptions are highly important: plant propagation, and cultivar protection.

Considering that the currently used flower description standards are not suitable for verifying huge plant collections (RHS is too merged, UPOV is too analytic), we needed a system, which is developed especially for everyday outdoor works, and the details of the classification are enough for the identification of varieties. As we could not find any suitable describing system, we started to develop some more appropriate classifications: we specified the number of the classes and described them. This classification system consists of the following features: flower diameter, flower shape, flower colour and shape of inflorescence.

The flower diameter system and the inflorescence classes are ready, since they don't need sophisticated statistics. Even the flower shape classification is finished, although it needed a lot of recordings and interpretations (Boronkay and Egyed, 2017). We evaluated all the rose items of the Rose Garden Budatétény several times, and we studied rare historical varieties, which couldn't be found in Hungary. Finally, we have found, that instead of complex flower morphology, two independent shape systems exist, flower- and petal shapes, and both of them are needed to be evaluated. We could isolate, name and describe 33 flower shapes and 15 petal shapes.

Recently we have been elaborating a new classification system of the rose flower colour (Boronkay, 2017). We want to create a chromatically balanced and psychologically accurate system, which is also suitable for automatic software based classifications. During our research, we need to use several huge chromatic difference matrices, most of them contain 2 million or more CIEDE2000 values.

The balance of the colour system is based on mathematical-colorimetrical rules. The minimal and second least CIEDE2000 chromatic difference (ΔE_{00}) between a colour class and the nearest class are limited, they have to be between 5 and 7.5. Besides that, all of the measured and known petal colours have to be nearer than 7.5 ΔE_{00} to the nearest class of the system (Boronkay, 2019). Recently our almost finished colour system consists of 107 colour classes, where not only the accurate colour parameters are defined, but we specified the grouping system of the colour classes, descriptions in the international RHS (Royal Horticultural Society) colour system, names in a standard way and the reference varieties, which represent the colour classes.

When our classification and modelling systems have proved both in theory and in practice, we will be able to publish our result in international media or to acquire the industrial property rights to our methods. Our directions of research are not purposeless at all: the goal of our methods is screening the most valuable Hungarian varieties with authentic techniques. In the near future, with the help of our objective, scientific evaluations we will be able to recommend Hungarian roses for marketing for both Hungary and abroad. Ultimately we will help the Hungarian breeders to spread their cultivars, and we will be able to help the country to receive more income from the cultivars to support the new generations of Hungarian breeders.

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HISTORY OF THE BUDATÉTÉNY ROSE GARDEN

BORBÁLA **ÖRSI** – GÁBOR **BORONKAY**

NARIC Research Institute for Fruit- and Ornamental Growing, Budapest Research Station; H- 1223 Budapest, Park u. 2., Hungary

THE PAST – GENIUS LOCI

The history of the Budatétény Rose Garden is deep-rooted in the past.

Since ancient times the gentle slopes of the right riverside of river Danube from Szentendre to Tétény has been famous for its flourishing viticulture due to its unique microclimatic conditions.

During the Turkish subjection the area had been abandoned but the vineyards survived. After the recapture of Buda in 1686 the imperial quartermaster officers started the resettling of the abandoned land.

The first settlers arrived in the 18th century from Rhineland, Germany. The German speaking catholic population — completed later with a smaller community of Serbs and the urban citizens of Pest — established a new, flourishing viticulture in the region. The area of vine plantations was the largest in the times of the Hungarian revolution. In Promontor 72%, in Tétény 50% of cultivated land was covered with vine. The Buda wine region consisted of four vine growing areas: Szentendre, Buda, Promontor and Tétény. The wines of Gellért Hill and Sas (Eagle) Hill were especially respected.

At the beginning of the 19th century smaller mansions were erected in the vicinity of wine cellars and Kis-Tétény soon became a popular summer resort for the citizens of Pest.

The last great vine harvest is dated to 1882, before the Phylloxera destroyed the whole viticulture in the Buda region. The American pest completely eradicated the vineyards within a very short time. Farmers planted almond and peach trees into the empty lands or started crop production and other cultures while some parts of the area were consumed by urbanisation.

The central part of our Institute was organized around two mansions built in the early 19th century. One of the buildings belonged to the wine trader Dőry György who rebuilt it in 1867 to the present form. This building — called Györgyháza, „the home of George" — was the residence of the Institute's Department of Ornamentals, and its garden nourished also the first roses of the Institute.

The other building is the central office of the Research Institute at present. It is called Czigány Villa and we have only sparse information about its history. According to the historical data the building was already there at the time when Klauzál Gábor the ex-minister of the First Hungarian Government in 1848 did his first visit in Kis-Tétény in the years of 1820. The minister later purchased a vine plantation in the Kurz Ried and built a cottage and a wine cellar on his property. The building (rebuilt) and the cellar still stands in Klauzál Gábor Street. In 1858 Klauzál established a nursery in this area („one and a half mile south from Buda"), probably just in the present area of the Research Institute. The nursery played an important role in the dissemination of stone fruits and roses. In its catalogue printed in Hungarian and in German for the years 1858/59 36 varieties of peach, 13 of apricot, 40 of cherry and sour cherry and 358 of rose are registered and promoted. The nursery was still producing plants after the death of the founder in 1866, up to 1906.

Between the two World Wars the owner of the property was the Czigány family. Czigány Adél produced flowers and ornamental plants for her French style florist's shop in Pest, Teréz Boulevard 60.

ESTABLISHING THE INSTITUTE, FIRST STEPS

The predecessor of our institute, the Horticultural Research Institute was established in 1950, with the following departments: breeding of vegetables, fruits, ornamentals, herbs and garden art. The personnel consisted of 1 director, 1 head of department, 4 senior and 15 junior researchers and 10 manual workers. Therefore, it was necessary to invite the teachers of the High School of Horticulture and Viticulture for supervising. The head of the department of ornamental plant breeding was Domokos János, Maliga Pál was the head of the department of fruit breeding, while Angeli Lambert conducted the breeding of green sweet peppers.

The staff moved in the two restored but weakly equipped buildings (Györgyháza and Czigány Villa) in 1951. The first greenhouses were also ready for this time. The Department of Ornamental Plant Breeding started its work in the 1.5 ha garden of Györgyháza under the supervision

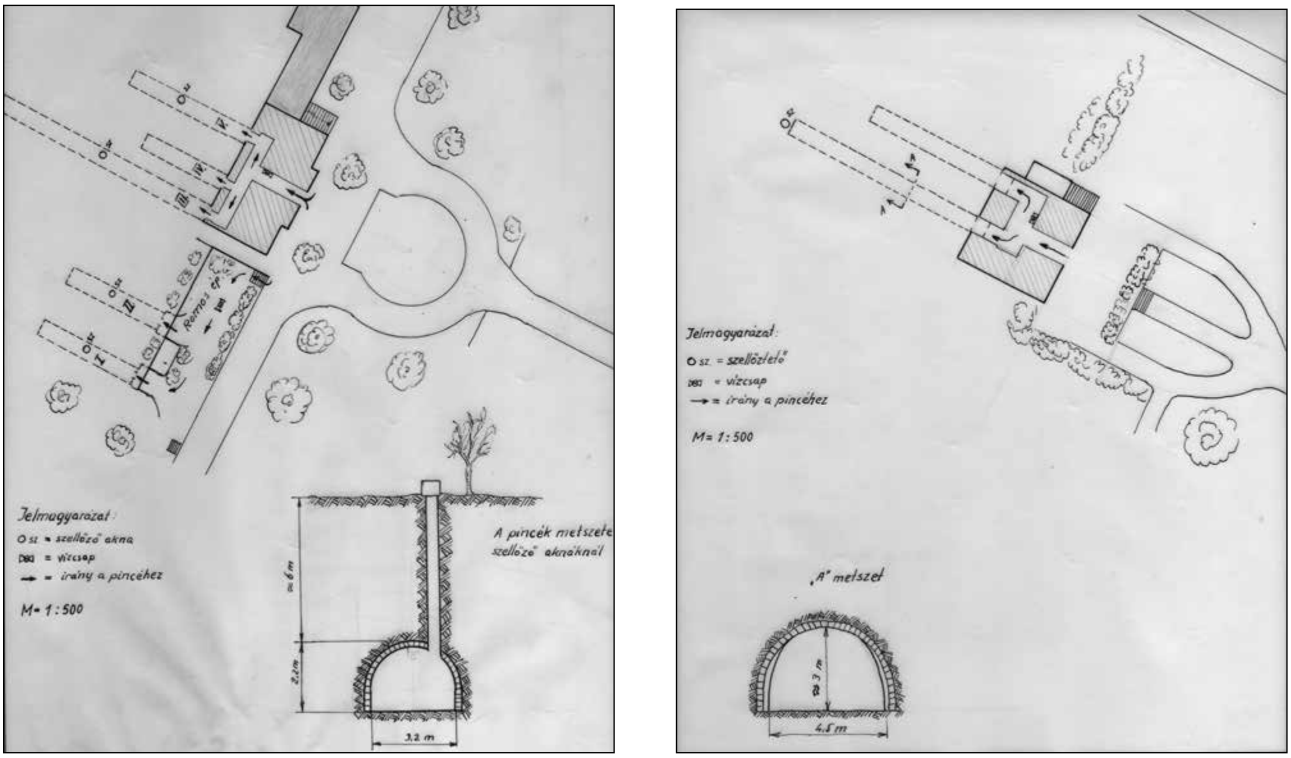

Figure 1: Layout of the two buildings and their cellars

Figure 2: Villa Czigány

However, in Érd Elvira Grange seed and herb production was present since the beginning. Research themes were the analysis of volatile oils and active agents of different plants, both wild and domesticated species. The research of herbs was already present for 30 years but the first outdoor field for research purposes was established at this time: first in Martonvásár, later in Érd. The Institute started fruit research in 1952, in Érd Elvira Grange, in the experimental of Domokos János. As an experienced gardener he had knowledge of flower seed production and on this base he organized the breeding and seed production of annual ornamentals which work was later continued by Kováts Zoltán achieving great international respect.

The Department of Herb Breeding was placed in Herman Ottó Street and at the University of Science. Later the Department moved to Dániel Street.

Figure 3: Györgyháza and the Rose Garden under construction

Figure 4: Györgyháza

only one but fifty stems per variety. In its best period the collection consisted of 2700 varieties.

The Institute started its rose breeding program in 1957 and opened a new era in Hungarian rose breeding as well. No Hungarian rose variety got any international awards since the varieties of Geschwind Rudolf and Mühle Árpád. In the first year 300 cross breedings were performed but only 20% of the cross pollinations resulted in fertilization because of the lack of information about the chromosomal constitution of the varieties and the high number of sterile pollens. In order to define the sterility 200 varieties were examined. The objective was breeding drought tolerant, frost and pest resistant, healthy, long flowering varieties, being compatible with the Hungarian continental climate.

Márk Gergely bred 125 varieties within the walls of the Institute, 22 of them got state certification. The first of his varieties, 'Budatétény' was rewarded with gold medal in Hamburg in 1963. The greatest professional success came in 2000 when his park rose variety 'Árpád-házi Szent Erzsébet' got the gold medal on the Italian international contest of new rose varieties. Five years later he got bronze medal on the same contest with his bed rose variety 'Lippay János emléke'. The success continued: on the BUGA 2007 horticultural exhibition in Gera, Germany his variety 'Fáy Aladár emléke' got second prize while 'Kodály Zoltán emléke' and 'Lippay János emléke' got the third prize. Every year the new and successful varieties were presented to the public on these exhibitions.

Figure 5: The new central building

plantation. The Department of Garden Art remained the part of the High School of Horticulture and Viticulture.

ROSE GARDEN, ROSE EXHIBITIONS

In 1950 a young agricultural engineer joined the staff, Márk Gergely (1923-2012). His task was breeding drought tolerant herbs and cultivated roses. He started the work with great enthusiasm and gathered all the available rose varieties, more than 1200, which was an extraordinary achievement in the years of the Cold War.

The first rose exhibition was organized in the garden of Györgyháza in 1958. More than six thousand guests visited the event without any promotion. The lack of financial support was compensated by hard manual work and the assistance of Márk's personal connections. The most important contributors were Forrai Gábor, the scene-painter of the Hungarian Opera House and Somogyi József sculptor. The colleagues of the Research Institute worked day and night in order to prepare the hand-made vases and other artefacts for the installation of cut-roses. In 1959 the rose garden showed 1400 rose varieties, though only one stem per variety. The second exhibition was visited also by the high level politicians of the era and they had also a small talk with the organizers. Márk Gergely took the opportunity to outline his dreams about a „real" rose garden. Maybe he was the most surprised that the dream got free way and even financial support.

The plans of the rose garden were prepared by Ormos Imre, the head of the Department of Garden Architect of the High School of Horticulture and Viticulture. The place of the exhibition was the surroundings of Czigány Villa and the lands to the south-south west from the building. The structure of the 5 ha garden was ready in 1963, and two years later the field was filled with roses — not

Márk Gergely had good relations with the leaders of the National Gallery. The Gallery lent statues for the garden, at first only for the duration of the exhibitions and later for longer periods. The two limestone statues and a pyrogranite statue of the present garden are the remnants of those times.

In the middle of the sixties the construction of a new, representative, modern central building was decided, with large terraces towards the rose garden. The building process was performed between 1968-1971, in accordance with the plans of Pázmándi Margit.

The outdoor field exhibition was completed with a cutflower-show, rose contest for rose producers, classical concerts and art exhibitions. Famous and popular Hungarian artists sang on these concerts — Ágai Karola, Leblanc Győző, Pitti Katalin, Réti József, Szalma Ferenc, Takács Paula, Tokody Ilona, Udvardy Tibor — just for a boquet of rose. The pupils of the local Nádasdy Kálmán Art School were also regular guests on the stage. The art exhibitions ranged from roses in Hungarian paintings or Csángó folk art to rose-decorated stamps, china and pottery. According to the memories of Márk Gergely the exhibition had not finished yet when the organization of the next one has already started. The rose exhibition was so famous and popular that even groups of foreign tourists visited it.

Figure 6: Rose Garden

Figure 7: Cutflower-show in the new building

RESEARCH

In this vast and beautiful garden, huge rose exhibition programs were organized in the two weeks periods in the main flowering season of roses. However, in the most part of the year, horticultural research and rose breeding were taking place. Márk Gergely established the score system of variety evaluation in 1954; as a result, he described 750 old varieties and published his book titled A rózsa [The Rose]. He also wrote a lot of articles and four books altogether; these are: A rózsa [The Rose] (1959, Mezőgazdasági Kiadó, Budapest), Die Rose (the German version of the above mentioned book, 1962, VEB Landwirtschaftsverlag, Berlin), Kis rózsakönyv [Small Book of Roses] (1966, Mezőgazdasági Kiadó, Budapest), Rózsák zsebkönyve [Booklet of Roses] (1976, Mezőgazdasági Kiadó), Magyar rózsák könyve [Book of Hungarian Roses] (2004 Mezőgazda Kiadó, Bp.). The German version was so beautiful that it won a silver medal in Paris.

Márk Gergely was also the manager of the program titled "Horticultural Utilization of Extreme Areas". This program included dry and barren areas (Budatétény and Akali), shifting sands areas (limey sand between the rivers Danube and Tisza, Bugac), sodic and boggy areas.

Some topics with relevance to rose breeding must be mentioned. In the theme of dry and barren areas, there were investigations to select the Hungarian wild rose for its high vitamin C content. Rose hip is utilized to cover our vitamin C needs in winter months; besides covering Hungarian consumption, we export rose hip products to the Northern countries. In the course of the investigations,

it was found that the vitamin C content of the individual plants is very different varying from 40 mg% to 1200 mg% per 100 g pure rose hip. At the end of the program, several thousand plants of Rosa canina with high vitamin C content were provided for production.
Rosa canina phyla were examined with rootstock experiments and comparative experiments. As regards to rose rootstock selection, a new one with favourable characteristics was found in the driest part of Hungary, on the plateau of Hajmáskér.
Rootstock nurseries were established with different rootstocks.
Layering experiments were started with the new successful varieties.
Crossbreedings were carried out mainly in glasshouses. In 1960, 2500 crossbreedings were realized in 600 combinations; in 1961, 4000 crossbreedings in 500 combinations.
Márk Gergely also investigated medicinal plants and applied for three patents in this field. His first patent, obtained together with Chemical Works of Gedeon Richter Plc. in 1980, was a Digitalis species resistant to fungal diseases and suitable for cultivation. The variety is crossbred from two species found in distant territories (one in the Pilis Mountain, the other in the lower Danube region), its name is Dilacte M. I. In 1986, Márk applied for another patent with Gedeon Richter Plc. The object of the patent was a new Digitalis plant with high cardiac glycoside content. It was created by crossbreeding certain genotypes of the above mentioned variety with a genotype coming from Southern Békés County. Its variety name is Rior. Márk's third patent, obtained with Caola Rt. in 1992 was a shaving liquid containing medicine plants like Verbena officinalis, Glechoma hederacea, Arctium lappa, Achillea millefolium and Petasites officinalis.

THE END OF THE GOLDEN AGE

The golden age was over; the rose garden had to be renewed. In the early 1980s, Márk retired. In his new life, he devoted himself to rose breeding in his own Törökbálint garden. Together with his wife and with one of his former colleagues, Benedek Sarolta, they cultivated an area of 2 ha, where they bred 5-600 rose plants.
However, the Rosarium of Budatétény was left without director. At that time, the Expo Bécs Budapest, planned to take place in 1996, seemed to be a good chance for the garden. In the course of preparing the Expo, the institute applied successfully for the reconstruction of the garden, but finally it was not realized in its totality as the Expo did not take place. However, the nutrient supply of rose beds was provided and the propagation of old plants was realised, though the infrastructure of the garden was not renewed. Another great loss was that a huge part of the territory had to be sold due to financial problems: the territory of the institute decreased to its third by selling its southwestern part and the central building C as well as the right wing of building B (villa Czigány).
As financial possibilities were decreasing, the quality of the park maintenance worsened. Rose gardens were tended in a minimal way for several years, some of the varieties disappeared. However, scientific research became more important, and the rose garden became a field of variety research again with the direction of Boronkay Gábor since the 2000s. Main research fields were resistance to diseases, climate tolerance, discolouring of flowers, dynamics of flowering, appearance of foliage, colouring of rose hip – just to mention the most important ones.

PRESENT DAYS AND FUTURE PLANS


Figure 8: Plant protection in the Rose Garden / Kőrösi János sprays the rose beds

Today, the territory of the rose garden is 2.5 ha, with a rose bed of about 10.000 square metres. We have 1000 controlled varieties in 1600 rows. The most precious part of the gar-den is the plant material coming from the 1950-1960 years. However, for cultural and aesthetic reasons, we would like to present the oldest traditional rose varieties as well as the newest ones. Today, the garden covers rose breeding of 3450 years. Our oldest variety is the Abyssinian Saint Rose, the earliest representation of which can be seen on one of the frescos in the Knossos Palace. Our newest variety is a romantic English one, issued after 2010. We have about 200 Hungarian varieties including half-wild rose hip and the famous 'Grüss an

Teplitz' variety of Geschwind Rudolf, and the most successful rose of Márk Gergely, the famous park rose Saint Elizabeth of Hungary.
In 2017, the Hungarian State and the local government provided for resources to renovate paths and stairs in the garden, to build recreation facilities like garden seats and pavilions, to buy new and special ornamental plants and roses, to restore statues and to establish memory places for Márk Gergely and Kováts Zoltán, who passed away in the meantime. As a consequence, the park and the rose beds became more intensive, the garden well arranged and more beautiful.
Our future plans include creating a drinking fountain in the lower part of the garden, and planting trees and shrubs in order to realize an ecological puffer zone between the rose beds and the Nagytétényi Street. Besides, we should like to become a bird friendly garden. We are also planning to realize a reception building in place of the ruined small house on the Nagytétényi Street. The new building would include a small shop, restrooms, and a terrace overlooking onto the garden.

STATUES

1. Woman with lute – made by Medgyessy Ferenc, sculptor with Kossuth Prize and Excellent Sculptor Prize (1948, 1957). The statue is made of Haraszt stone, and was first erected at the tomb of Medveczkyné in the cemetery of Farkasrét in 1941. The photo of the original statue is published in the book of László Gyula. The statue was restored in 2017 by Horváth Tibor, who could identify it by its damages and the defects of the stone as compared to the one seen on the photo. In 1956, a replication of the statue was also created; this one is erected on the Tagore promenade in Balatonfüred.
2. Mother with her child – made by an unknown creator. Life-sized statue of a woman and a boy with a band on his head, made of limestone. In the book of Rajna György, the data of several art works are indicated, but this statue is not mentioned.
3. Woman – made by Tar István (1910-1971). The statue is created of glazed ceramics. Tar was a sculptor with Munkácsy Prize (1950, 1958) and Excellent Sculptor Prize (1968). In its early artistic period, he followed the neoclassic style of Bory Jenő, his master. Later he found his own suggestive and realistic way of expression. In his art works, he did not insist on figuring the real shapes of a human being; he had a passionate intention to express its dynamism and inner tensions. He has about 50 statues erected on public places; one of his most energetic creations is the Statue for the Liberation at Kispest. His last statue erected in his life is the Cohors [Fight of Romans with barbarians] on square Március 15, near the Castrum of Contra Aquincum made in the Roman Empire.

Figure 9: Mother and child (Anonymous artist)

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STATUES

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DISPLAYING ROSES IN PUBLIC AREAS OF BUDAPEST

BORBÁLA **BIRÓ**

Főkert Ltd., Budapest

Top priority green areas of Budapest are maintained and developed by FŐKERT Nonprofit Zrt., . These green areas that are highly important for the cityscape have a varied visage, ranging from larger public parks and small city squares to green belts, tree lines and nature reserves.

Traditionally, vast majority of green areas of the capital are areas with trees, groves, grasslands with extensive shrubs. More intensively maintained areas such as perennial, annual or rose plantations occur at a lower ratio..

Today, the reason for moderate use of roses in public areas is its special, demanding, manual labor, and the lack of cultured park use, namely frequent thefts and damage.

In the past century, in addition to the smaller rose beds in private and institutional gardens in the capital, Budatétény, Margaret Island and St. Stephen Parks boasted rose gardens with a larger and planned design.

In Budatétény, the rose garden also served as a collection garden for research and development purposes, while Szenti István Park and the Margitsziget Park area were all aimed at attracting visitors.

The appearance of roses in Margaret Island can be traced back to the early 1800s when chief gardener Károly Tost created the first "rosarium" near the palatine villa, initiated by Archduke Joseph, the Palatinate of Hungary.

In the 1870s –thanks to the support of Archduke Joseph – chief gardener György Magyar created a "rosarium" on the premises of the horticultural establishment of the island. The "rosarium" that had a European reputation also started to sell rose cuttings. The rose garden gained its European fame by its unbelievably wide range of cultivars, roses were represented from all over the world, from all respected cultivating houses. In 1912, a new, more modern rose garden was established after the maintenance of the park was passed to the Council of Public Works in Budapest.

The building of the Gardening Company of Budapest stood in place of the current rose garden in Margaret Island. The garden was moved in the 1920s to its current position. In the first period, mainly hybrid tea roses were planted at the rectangular flowerbeds.

Figure 1: Margaret Island, Rose garden 1937. The statue of Queen Elisabeth (Photo: Bálint Magyar, Fortepan. 55413.)

In 1963, the rose garden was rearranged according to the plan of Éva Hreblayné Ág. Annual flowerbeds, solitaire plants were also placed here. At this time, irregularly shaped flowerbeds were created with large surfaces instead of the traditional square-shaped beds where visitors were able to admire the close to ten thousand polyantha and floribunda roses as well as 3000 hybrid tea roses.

Around 1963, in the total 5 558 m^2 area, of the island 35 800 roses were registered. The rose garden itself had 24 253 rose stems in 3 520 m^2 of flowerbeds, but in 1967 roses occupied only 200 m^2 sized area outside of the rose garden and the area of the flowerbeds in the rose garden shrunk to 2 782 m^2.

The rosarium got its final form in 1976-1977 according to the plan of Annamária Nemesné Kucsovszky with the form of a rose bed with a basalt border, mounted in a mosaic lawn.

In November 2000 during the renovation of the rose garden, the soil of the rosebeds was extracted to a depth of 35 cm. The mixture created on site to replace the soil consisted of acidic turf and sifted compost. When the roses were planted, the soil of the 431 m^2 flowerbeds was covered with a 8-10 cm thick wood chip layer.

Out of the 2 313 planted roses, there were 760 pcs of hybrid tea roses, 1160 pcs of floribunda, 200 pcs of poly-

Figure 2: Planting roses in the rose garden of Margaret Island at 28/11/1965. - from the diary of the Youth Brigade (Source: www.fokert150.hu)

Figure 3: The rose garden of Margaret Island with the flower bed created by replacing the pool, with the pergolas in the background (Photo: Borbála Biró)

antha, 40 pcs of dwarf roses, 24 pcs of park roses, 35 pcs of climbing roses and 94 pcs of tree roses. It merits special mention that all these rose variants cane from 43 variants of Hungarian rose breeder Gergely Márk.

During the last renovation in 2013, planted area was extended by transforming the pools to rosebeds. According to Adrienne Szalkai, the chief designer of Főkert, a fragrant mass of roses was much more justifiable in Margaret Island than a collection of variants. It was also a design principle that so-called colour rooms should be created, therefore roses of similar shades of colour should establish three colour groups: yellow, red and purple. This time, roses were not Hungarian variants but they originated from the famous rose-breeding garden of Kordes, Germany. When the variants were selected, attention was consciously paid to choose resistant variants that moderately require pesticides therefore having less environmental burden and that they should be able to be acquired easily.

In the theme of the existing arrangement, the rose garden was extended with nearly 2000 roses of 20 variants in 2017 by the inclusion of the grass-covered area next to Palatinus bath. In this area, historical rose breeds were planted amongst others still from the variants of rose garden Kordes. The flower garden created this way with its 1342 m^2 area of roses is currently the biggest rosarium of the Hungarian capital on public grounds.

A rose garden collecting Hungarian variants commemorating the rose-breeding work of Gergely Márk was established in 2010 in "Szent István" park in the 13^{th} district. An average of five roses was planted into small cassettes with metal edges from each species and signs were also placed.

Figure 4: Lower garden of the Rose Garden of Margaret Island in summer 2018 (Photo: Borbála Biró)

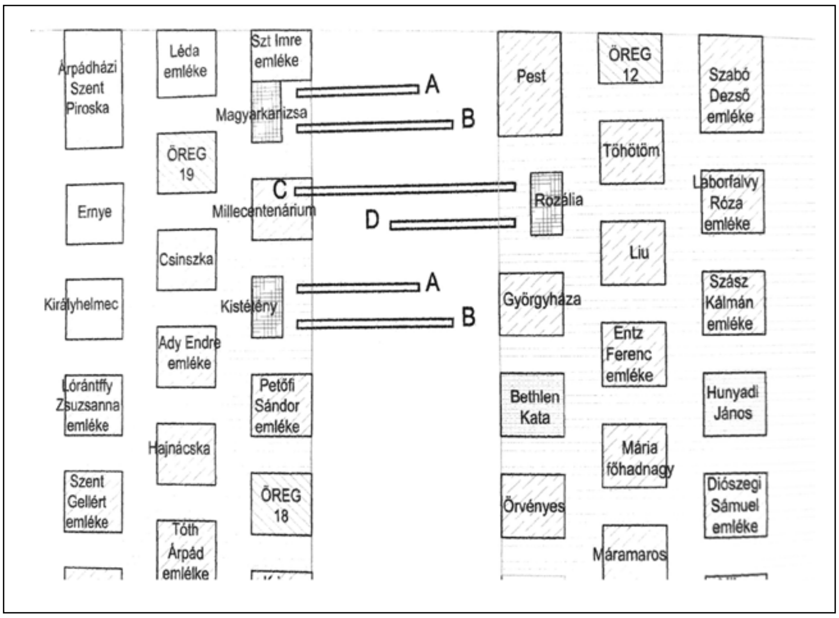


Figure 5: Plan of the rose garden in "Szent István" square – part (Source: FŐKERT Plan Repository)

Figure 6: Rose garden in Szent István park in summer 2011 (Photo: FŐKERT Photo Repository)

According to the plans, floribunda and polyantha were planted in 492 m^2 to 100 flowerbeds, hybrid teas to 35 flowerbeds, shrub roses to 37 flowerbeds, dwarf roses to 19 flowerbeds and climbing roses to 4 flowerbeds. The work of Gergely Márk encompasses many more rose varieties but those were selected during planning that were expected to perform in a reliable, balanced manner when they are used in public spaces.

Due to its nature as a collection, the challenge of maintenance is that eventual replacements are grown for individual orders but this also what lends special value to the garden because stems are regularly collected for grafting – thereby using the rosarium as a kind of variety bank.

There are also some rose plantations at other important public spaces of the capital.

During the renovation of the Széll Kálmán square in the 2nd district, the designers of the "Lépték-Terv" Landscape Architect Office planned the colourful annual flower areas with resistant roses that can have a second flowering.

In the bare park of the "II. János Pál pápa" (Pope John Paul II) square where the layer structure did not enable planting trees, FŐKERT planned clean, geometric rose and annual flower plantations in sync with the urban structure by using ground-covering "The Fairy" rose and blue spire (Perovskia atriplicifolia).

Roses bred by Gergely Márk that had been removed during the 2013 renovation of the rose garden in Margaret Island but were still in living condition were moved to the corner of the park around Lake "Feneketlen" bordering Kosztolányi Dezső square in the 11th district. Roses were planted into irregularly shaped ribbon-like flowerbeds,

Figure 7: Mixed rose flowerbed with Kordes variants at the slope top above Széll Kálmán square in 2018 (Photo: Borbála Biró)

Figure 8: Picture of the plantation at “II. János Pál pápa” (Pope John Paul II) square in summer 2015 (Photo: Borbála Biró)

separating the variants with strips of larkspur (Delphinium).

It is worth mentioning that one of another application type of roses in an urban environment is the usage of ground-covering roses with moderate environmental needs. Beside the very widespread “The Fairy” group, sometimes Rosa rugosa and its variants bred for urban plantation can be seen, too.

Current maintenance practice also confirms that besides selected cityscapes, the use of roses in the bedside is justified.. In relation to the rose garden in Margaret Island, the typical work processes and their frequency is summed up by the following table, supporting the former statement about intensive maintenance routine.

Figure 9: Rosebed at the park around Lake “Feneketlen” of Hungarian-bred variants with larkspur (Photo: Borbála Biró)

Table 1: Typical work processes of rose maintenance and their frequency in the Rose Garden of Margaret Island, 2018 (Source: FŐKERT registry)

Work process	Frequency (2018)
Rose pruning, cutting it back	6 times
Applying pesticides	5 times
Hoeing	11 times
Supplying nutrients	2 times
Covering roses and removing cover	2 times

As a summary, it can be stated that there is a place and role for creating rose surfaces in urban public spaces but the two main directions require two approaches. One application method is the establishment of collections or thematic gardens with a recreational goal, so-called rosariums that should mainly be created in intimate, even guarded, fenced-off areas. It is also necessary to be fully aware of the intensive maintenance need of such rose gardens. The other goal is to use roses as shrubs or ground cover,.in which case rose surfaces with less decorative value andwith lower maintenance requirements may appear in more exposed areas.

THE ROLE OF THE ROSE AND THE ROSE GARDEN IN THE LOCAL COMMUNITY: ACTIVITY OF THE HUNGARIAN ROSE SOCIETY

KATA **JÓZSA**

Hungarian Rose Society

Perhaps no other plant on our planet embodies so much throughout human history as the rose. It has been grown since ancient times as well as used for decoration, perfume, food and drinks or even as a symbol. It goes out of fashion, then comes back again and enchants most people, even those who do not always admit to it.

The Hungarian Society for Rose and Garden Culture was formed in May 2011. We, the members, call it simply Rose Society and set it up to be a self-organizing civil association of rose-fanciers, beginners as well as experienced rose growers.

The Rose Society helps its members to acquire the skills of rose cultivation and learn about cultivars. We also strive to help all Hungarian plant-lovers to learn more about garden roses and hopefully this way we can raise the level of our national garden and environment culture. The Society has members of all ages; it attracts also young people because the rose is back in fashion as a garden plant and decoration; the meetings are held monthly on Saturday mornings (not on workdays), and last but not least because we offer a varied program and lectures of high standard.

Before and after the talks we exchange our ideas in a friendly atmosphere with coffee and home-made cakes. Naturally we chat about roses and other plants, our gardens and environment, their beauty or even their problems. Sharing these insights with each other we go home enriched with very useful tips or fellow members' experiences.

It has to be mentioned that we are not exclusively rose fans. We are well aware that the beauty and nobility of the rose is enhanced in the company of other plants. We also know that our built environment is based on many factors. Good gardeners cultivate their garden not only affectionately but also mindfully, collaborating with nature, not working against it. So we welcome lectures about plant growing, plant pests and diseases, landscape architecture, conservation of nature, and also on the flora and gardens of other parts of the world. The talks are flavoured by interesting and knowledgeable questions from the audience, which often includes many outside guests.

The indoor meetings take place mostly in the late autumn and winter months. In the spring, early summer and early autumn we organize garden visits or have demonstrations of rose planting, pruning and other cultivation practices. We contribute to the maintenance of the Budatétény Rose Collection by helping with the pruning.

We visit many botanical and public gardens in Austria, Germany and Slovakia and also nurseries in these countries, often coming home loaded with garden gems. We also visit as many Hungarian arboretums, botanical gardens and private gardens as we can, usually with a guide to learn more about them.

We are in contact with Hungarian rose growers and with the local representatives of foreign growers and breeders.

Every year we visit a few Hungarian nurseries, not only of roses but also other ornamental plants. Besides the delight of buying beautiful and interesting new plants, we gladly learn from professional nurserymen. During these past years we have seen many types of ornamental plants: bulbous and other perennials, dahlias, peonies, as well as the rich and variegated world of conifers and foliage trees and shrubs.

We inform the general public outside the Rose Society about our activity via the internet. We try to give useful advice about rose cultivation and the seasonal jobs concerning roses and other garden plants. The Rose Society blog is available for everybody to read. Here we announce our programme and report on the lectures and garden visits illustrated with photos taken on the spot.

Because of the relatively low number of our members, the blog is not yet entirely satisfactory, we still have to develop and improve it, as well as our presence on other internet forums.

Besides the web we publish articles about roses in the – alas not too numerous – Hungarian horticultural magazines.

Ilona Kéry, the wife of one of the great 20th century sculptors Miklós Borsos, created a beautiful garden in Tihany at Lake Balaton. There were many roses in this garden – alas no longer open to the public. She published a book about her garden, with a whole chapter dedicated to the rose, in which she writes: "One has to be fifty to become aware of what the rose flower encapsulates, to be able to see the world, the best part of the world in a single rose. I'm not talking about the cut flowers of florists' shops containing the same cultivars with uniform stalk length, uniform bud, same colour, no, I mean the first flower of an early summer dawn or the last rose of a misty autumn dusk […]"
Today the world tends to focus on technical and economic achievements and younger people rarely take a serious interest in nature, gardens and roses, even as a hobby. Nevertheless, we hope that the activity of the Rose Society and similar associations, although not easy, is still useful.

MONITORING OF DECORATION VALUE, GROWTH, AND WATER CONSUMPTION OF THREE DROUGHT-TOLERANT HUNGARIAN BRED LAWN GRASS VARIETIES PLANTED IN HIB GREEN WALL MODULES

SZILVIA **KISVARGA**[1] – EDIT **HLASZNY**[1] – GABRIELLA **ANTAL**[2] – JUDIT **KOROKNAI**[2] – ERIKA **KURUCZ**[2] – MIKLÓS G. **FÁRI**[1, 2]

[1]NARIC Research Institute for Fruit- and Ornamental Growing, Budapest Research Station; H- Budapest, Park u. 2. 1223, Hungary
[2]University of Debrecen MÉK, Department of Agricultural Botanics, Plant Physiology and Biotechnology; H-4032 Debrecen, Böszörményi út 138, Hungary
Corresponding author: Szilvia Kisvarga, e-mail: kisvarga.szilvia@fruitresearch.naik.hu

ABSTRACT

In Hungary, most of the grasses used in public areas and home garden lawn are currently bred in Western Europe, thus the wet continental, often oceanic climate dominates the breeding and maintenance of these varieties. The breeding of Hungarian horticultural lawn grass varieties has already begun in the predecessors of the NARIC Research Institute for Fruit- and Ornamental Growing, Budapest Research Station since the 1950s. *Prof. Zoltán Kováts* and his colleagues carried out the breeding of several lawn grasses registered in the state. Unluckily, some of these varieties have disappeared in the past decades form the Hungarian gene collection, but we have started working again with the surviving varieties, strains and lines. Our goal was to investigate whether the varieties of horticultural lawn grasses of *Prof. Kováts* (*Festuca heterophylla* F-2-9 and F-2-10, *Festuca sulcata* 'F112' and *Bromus erectus* 'Budapest') are suitable for vertical green wall modules with minimal cost of maintenance, plant protection, fertilization and irrigation. At the same time, we were looking for the answer to the question whether these varieties are suitable for the wider use of the future landscaping, urban green areas beyond experimental use. We have found that using *Bromus erectus* 'Budapest', *Festuca heterophylla* 'Liget' and *Festuca sulcata* 'F112' as lawn grass in HIB module opens a new dimension to research and urban applications, as they are extremely suitable for vertical surfaces, suitable for green space management. Until now, these species / varieties have not been used in these areas in our country because they lost their ornamental value in winter experiments, while our results show new directions in the field of research and use in the future.

keywords: green space management, *Festuca heterophylla, Festuca sulcata, Bromus erectus,* drought tolerance, green wall, vertical cultivation

INTRODUCTION

Current state of urban green space management in Hungary

The basic characteristic of today's public spaces is the growing wave of vegetation. The parking lots of newly established shopping centres, and the community areas of mass-built residential centres have plant beds. However, most of the herbaceous plants used today are bred and produced in Western Europe, so the wet continental, often oceanic climate dominates the selection and maintenance of the varieties. Buying Western European plantlets, as many domestic gardeners agree, is cost-effective and easy; they are completely uniform and generally, healthy. Unfortunately, the July-August weeks are destroying the non-harmoniously irrigated beds planted with such ornamentals in Hungary, because the dry continental climate, the increasingly strong UV radiation, the extremely hot summers, and the winter temperatures do not favour these varieties. All of this is also true for grasslands and lawns in green public spaces, private gardens and parks. It is also characteristic of this sector that it is also preferred to use mixtures of foreign lawn grasses, the water requirements of which are generally high, as they are mainly grown for the more humid climate (*Lolium perenne, Poa pratensis, Festuca rubra commutata, Festuca rubra rubra, Festuca arundinacea, Festuca rubra litoralis, Deschampsia caespi-*

tosa, Koeleria macrantha). Grass areas planted with such varieties need to be irrigated more frequently in Hungary, and they will be thrown out within 3-4 years, and the area must be re-installed (Kováts 1959, Kováts, 2009). It is also important to reiterate that as a result of constant irrigation, the soil is leached, the originally planted species disappear and weeds appear (*Bellis, Cynodon)* (Domokos 1934).
Research on international grassland management currently presents a versatile picture of population dynamics, the role of an invasive species (Sperry 2006; Török et al., 2012; Papp and Bíró, 2016), the communities in the soil (Belnap et al. 2001), or the evolutionary origin of species (Bulińska-Radomska et al. 1988). Water supply is always a big problem for mankind. In the 1930s, the research of non-irrigated flower garden lawns and the search for, selection and breeding of species suitable for such purposes were characteristic of Hungary (Domokos, 1934 and 1964; Kováts, 1980 and 2009). The use of Hungarian ornamental lawn grasses in the green space management, which is able to withstand the increasingly extreme conditions of the Pannonian basin, can also be a solution to the ever-increasing water scarcity, and they also provide an excellent decorative quality.
The breeding of ornamental lawn grass varieties has already begun in the predecessor institutes of the NARIC Research Institute for Fruit- and Ornamental Growing, Budapest Research Station since the 1950s. During the years of breeding, 250 varieties of 50 grass species were collected and experiments were carried out on irrigation, fertilization and lawn plots (Kováts, 1960 and 1961). As a result of many years of research, the breeding of a variety of horticultural lawn grasses registered by *Prof. Zoltán Kováts* and his colleagues has been carried out. Unfortunately, some of these varieties have disappeared in the past decades, but we have started working again with the surviving varieties, lines, and strains. Our task is to revive and perfect these varieties under our hands, so that they can build on the Hungarian landscaping and green space management, be the pillars of the professionals' work, and thus contribute to the vitality and viability of the surfaces of gardens and lawn in cities, so that we can reduce the high water consumption by our hands.
Our aim was to examine whether the ornamental lawn grasses of *Prof. Kováts* might be suitable for *vertical green wall modules*, with minimal irrigation, among other maintenance service. At the same time, we were expecting the answer to the question of whether these varieties are suitable for use in urban lawn and green space management beyond experimental use. If so, we can open new ways before the sports pitches and the *Green City, Green Streets and Green Building* movements.

MATERIAL AND METHODS

We started our measurements in the summer of 2018 at the Budatétény station of the National Agricultural Research and Innovation Centre. We have four genetic stocks and / varieties of three lawn grass species available for experimentation. All are missing from list of the breeding strategies of the foreign seed companies.

Characteristics of NARIC-bred Hungarian ornamental lawn grass varieties

Festuca sulcata 'F112': gives a very silky, fine-leaved, fully enclosed, bright green lawn. During the breeding work, the populations collected in Hungary from the different production areas gave different colours (green, gray), and the rust resistance of the populations also differed.
Festuca heterophylla 'Liget', lines 'F-2-9' and 'F-2-10': Since we did not find out how the two lines differ and where the breeding-selection work stopped in this respect, both variations were measured. In the future, based on the discrepancies, we will decide with which further measurements will be made. 'Liget' is the first variety in Hungary that can be successfully grown in shade and day and can produce seed in sufficient quantities. It gives extremely fine lawn surface. Because *Festuca heterophylla* 'Liget' versions of F-2-9 and F-2-10 showed a marked difference with each other, we consider it worthwhile to examine both versions as separate measurement groups. We keep both variants for further experiments and, in selection breeding procedures, to focus on their specific features: the smaller green weight of the F-2-9, thus the more filigree, more elegant look and smoother yield, and the larger, stronger green weight of the F-2-10. strong habitus.
Bromus erectus 'Budapest': It has 0.8 cm wide leaf (Kováts 1959). It is characterized by the fact that it gives a rich mass of foliage on dry, poor quality soils; it is also forms decorative lawn surface in sunny and semi-shaded areas.
The seeds of these varieties / lines were of different years, between 2009 and 2015. So we first test-germinated them in a drying oven at 27°C. Their rate of germination was acceptable for experimentation, from 11% to 90%). So they were thrown into horticultural growing boxes in July 2018. The growing rate was appropriate for the germination and the plants were relatively uniform. On August 27, 2018, they were placed in specially designed HIB (Hort in Box) modules, with all varieties and variants in 0.5 m^2. This means two pieces of 60 cm x 40 cm, 10 cm deep HIB module / variety.

Hort-in-Box (HIB) vertical green wall module

It is a specially designed durable green plastic tray with 126 compartments with 16 seedlings proportionally. The tray is connected to a backplate with a plastic bag that is attached to the back and is filled with specially mixed substrate. The sack behind the compartments into which the plant is placed has been pierced so that the root of the plant, growing out of the compartment, further develops in the soil of the growing box. The substrate does not breathe elsewhere, completely closed. Irrigation takes place on microtubes and two irrigation heads per module with a flow rate of four litre per hour which irrigation water is pressed, according to our previous paper (Koroknai et al., 2015). The soil used was Klasmann-Deilmann TS3 peat mixture. After implantation, mass modulation was performed with the modules, each module was imbibed with water uniformly, for 9.5 kg weight per each module. The plants were placed into the HIB modules in 16 compartments. The modules were fixed on the exterior wall of our research station building on August 30, 2018, and remained there for different research purposes. We then photographed the stock weekly. Watering was done only twice before the completion of the measurements (January 16, 2019: 5 litres of tap water; February 20, 2019: 10 litres of tap water). On March 4, 2019, the winter measurement phase was completed. The leaves than were cut off from the stems, fresh and dry weight measurements were made on an analytical scale. The dry weight was measured following a drying process of 48 hours at 40^{o}C in laboratory oven.

RESULTS

Decorative characteristics of the NARIC ornamental lawn grass varieties

The ornamental value of the Hungarian lawn grass varieties / lines produced by the stock from September 2018 to March 2019, compared to the previous works of *Prof. Zoltán Kováts*, shows that growing these varieties / lines in HIB vertical green wall modules considerably extends the period of decorative value, extending to the whole winter. In previous experimental lawn grass field plots trials cultivating *Bromus erectus* 'Budapest', *Festuca sulcata* 'F112' and *Festuca heterophylla* 'Liget' the decorative value was entirely immeasurable between November and March, and also in the autumn months. Meanwhile, from September to November the lawn grasses had only insignificant decorative value (Kováts, 1980). While keeping the HIB modules vertically, only 7.5 litres per square meters of total applied irrigation water is preserved in the studied six months period, with a bright green colour, and a uniform stock. Despite the frost, the growing season did not disappear, and the foliar damage of the grasses was almost insignificant (Figure 1).
Following fresh and dry weight measurements of our lawn grass varieties / lines, the data obtained were evalu-

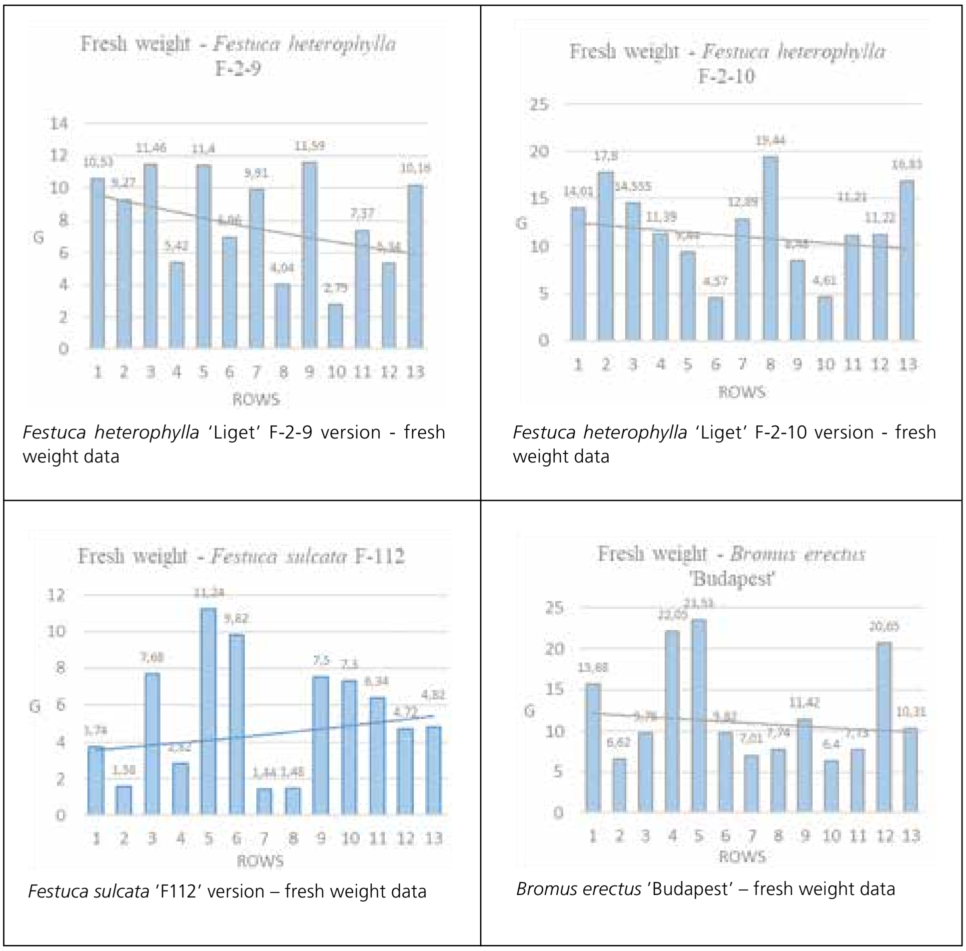
HIB modules with *Festuca sulcata* 'F112', *Festuca heterophylla* 'Liget' and Bromus erectus 'Budapest' (November 15, 2018)

HIB modules with *Festuca sulcata* 'F112', *Festuca heterophylla* 'Liget' and Bromus erectus 'Budapest' (December 18, 2018)

HIB modules with *Festuca sulcata* 'F112', *Festuca heterophylla* 'Liget' and Bromus erectus 'Budapest' (January 23, 2019)

Decoration value of grass varieties grown in HIB modules during the winter months (December 15, 2018).

Figure 1: Research on "vertical lawn grass wall" system (VLG-S) at the NARIC Research Institute for Fruit- and Ornamental Growing, Budapest Research Station. These photos show how the Hungarian bred drought-tolerant grasses can grow in Hort-in-Box (HIB) vertical green wall modules during the winter season.



Festuca heterophylla 'Liget' F-2-9 version - fresh weight data

Festuca heterophylla 'Liget' F-2-10 version - fresh weight data

Festuca sulcata 'F112' version – fresh weight data

Bromus erectus 'Budapest' – fresh weight data

Figure 2: Fresh weight indicators of *Festuca sulcata* 'F112', *Festuca heterophylla* 'Liget' and *Bromus erectus* ‚Budapest' grown in HIB modules (2019)

ated using Microsoft Excel. The fresh weight of the modules was measured at the base and the masses of the plants in the same rows were separately aggregated. This was because it was suggested that plants in the upper parts of the HIB modules might receive more water and / or light, or have a slightly larger growing surface, while the plants in the lower rows might be shaded partly due to the drooping leaves of the plants above. A total of 13 grass knots per HIB module were compared for fresh and dry weights (Figure 2).

DISCUSSION

Main findings

Looking at the HIB modules, although there were some growing differences between the rows, but we could not say that the bottom lines would have suffered from water or space shortages, as in many cases they produced similar results to the top rows. On the basis of previous measurements found on outdoor plot experiments, the decorative characteristics of the varieties in winter months are not measurable (Kováts 1980). Until now, these species / varieties have not been used in these areas because they lost their ornamental value in winter experiments, while our results show new directions in the field of research and use in the future (Figure 2). We also find that Hort-in-Box (HIB) module system can be a valuable experimental tool for further selective breeding programmes. The modules can be well separated from each other, and they can be well modelled with several breeding aspects and growing qualities.

Growing of vertical lawn grass system (VLG-S) is now possible from NARIC grasses

However, in the HIB "vertical lawn grass wall" (VLG-S) modules used by us have a good decorative value throughout the winter season (Figure 2). It can also be stated that the use of *Bromus erectus* 'Budapest', *Festuca heterophylla* 'Liget' and *Festuca sulcata* 'F112' as lawn grasses in the HIB module opens a new dimension to research, landscaping and green city applications. From all these data, it can be stated that both *Festuca heterophylla* 'Liget' F-2-9 and F-2-10, *Festuca sulcata* 'F112' and *Bromus erectus* 'Budapest' are suitable for VLG-S. They are extremely suitable for vertical applications, and suitable also for low maintaining green surfaces management.

CONCLUSIONS

According to our strategy, the HIB modules can be considered as a mini-lysimeter, i.e. a specially design closed structure for the whole root microbiome, with almost zero soil-surface evaporation. Therefore, we plan to measure the specific water consumption capacities by the active transpiration pattern of the grasses and other ornamental plants grown in HIB modules. Since the river basin performance of different grassland communities can be considered proportional to biomass, it is not related to species composition (Rychnovská 1976; Török et al., 2012), so we will measure this property on mature, settled stocks, so we can also help budget planning for cities by providing specific irrigation data. Perhaps the Pannonian Garden, dreamed by *Prof. János Domokos* and his colleagues, may finally continue in the present where he nearly stopped 100 years ago. The NAIK ornamental lawn grasses bred by *Prof. Zoltán Kováts* may be suitable for expanding domestic species and variety assortment in urban green space management. The varieties tested are well suited to the extremely good drought tolerance, the hot summers of the Hungarian climate and the relatively cold winter periods, the decorative green mass, the good surface finish. The re-use of Hungarian ornamental lawn grasses with new designs, breeding methods, and new targets for perennial and annual plants of Hungarian steppes. With their combined use, we can finally see with our own eyes the blue-yellow-orange-red flowerbed, bright green and grey grass blossoms in more and more plantings, which our ancestors only lived in dreams for many years, the foundations of which were laid and left behind.

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NEW METHODOLOGICAL POSSIBILITIES IN THE OUTDOOR HERBACEOUS ORNAMENTAL PLANT BREEDING AND TECHNICAL INNOVATION IN HUNGARY WITH SPECIAL REGARD TO MARKET OPPORTUNITIES AND THE EFFECTS OF CLIMATE CHANGE - AN OVERVIEW

MIKLÓS G. **FÁRI**[1, 2] – SZILVIA **KISVARGA**[2] – EDIT **HLASZNY**[2] – ANIKÓ **ZSILA-ANDRÉ**[1] – JUDIT **KOROKNAI**[1] – ERIKA **KURUCZ**[1] – GABRIELLA **ANTAL**[1]

[1]University of Debrecen MÉK, Department of Agricultural Botanics, Plant Physiology and Biotechnology; H-4032 Debrecen, Böszörményi út 138, Hungary

[2]NARIC Research Institute for Fruit- and Ornamental Growing, Budapest Research Station; H-1223 Budapest, Park u. 2., Hungary

Corresponding author: Prof. Miklós G. Fári, e-mail: fari@agr.unideb.hu; Tel.: + 36 52518600

ABSTRACT

Our review is based mainly on the most competitive scientific papers and R&D project reports published on outdoor ornamental crops in Hungary. In recent years and decades, we have achieved some successes with our ornamental plant varieties at international and domestic level. Therefore, we must continue this progress in the future. Our study concerns not only the annual ornamental plants, but also some other herbaceous ornamental perennials, semi-shrubs and shrubs. It is well known that some of these species can play an increasingly important role in the international and national green city management movement. It is clear, meanwhile that our main task is the further breeding and research of annual ornamental plants based on the path begun by our scientific ancestors, *Prof. János Domokos* and *Prof. Zoltán Kováts*. We have not only excellent plant genetic sources and breeding material, but also competitive biotechnological knowledge, methods and opportunities. In this paper we briefly summarize some of those R & D methods and innovative results that the Hungarian outdoor ornamental plant breeding sector have done in the recent years.

keywords: biotechnology, molecular breeding, thigmomorphogensis, vertical green wall, in vitro cultures, interspecific hybrids, intergeneric hybrids, mutation breeding

BREEDING OF OUTDOOR ORNAMENTAL PLANTS ADAPTING WELL TO CLIMATIC CHANGES

For about two decades, researchers have indicated that climate change will have a significant impact on the biological environment, and thus on wildlife and cultivated vegetation in the future. The improvement of tolerance to drought and heat is the most important breeding aim of all. Hungary has a continental climate with extreme temperature values, and the amount of precipitation here is less than in the regions of Europe (Kováts, 2009). Recently, the processes of climatic change have also affected the domestic and generally European ornamental plants sector. Obviously in this sector new and effective action plans need to be developed that fully respect the professional and economic requirements of our time. It can be an ideal scheme to successfully continue the high-quality professional partnership and collaboration network what *Prof. János Domokos* and *Prof. Zoltán Kováts* established in the decade of 1950-ies in this sector. *They were among the first scientists internationally, who – almost 70-80 years ago - have indicated that the research of drought-tolerant outdoor ornamentals, non-irrigated flowery lawns, and the breeding of ornamental plants suitable for breeding stands in the Carpathian Basin have strategic importance* (Figure 1).


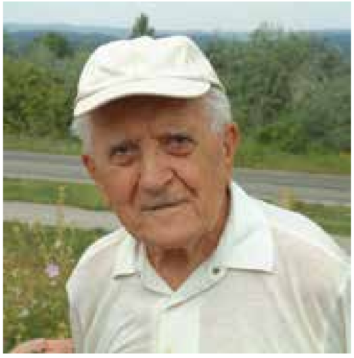

Figure 1: The master and his follower. Two outstanding figures of the modern ornamental R&D sector in Hungary. Left: Prof. János Domokos (1904-1978). Dr. Domokos founded the modern ornamental R&D and, education network in Hungary; Right: Prof. Zoltán Kováts (1924-2010), the Hungarian Karl Foerster. Prof. Kováts is the father of the modern ornamental genetics- and breeding in Hungary.

The use of the drought-tolerant or resistant annual herbaceous ornamentals is quite popular in Hungary, thanks to the pioneer work of Prof. Domokos and Prof. Kováts (Kisvarga et al., 2018). It can be viewed as a Hungarian speciality. "*In the past, the breeding of outdoor – mainly annual – ornamental plants was carried out in Germany, the Netherlands and Great Britain under more humid, cooler and more uniform weather conditions. These varieties were imported to and used widely in Hungary, but the intensive research work started in the 1950s demonstrated that most of them are not really suitable for use here. The concept that drought tolerance is required principally with the intention of saving water has turned out to be wrong. It was proved that the duration of blooming of several ornamental plant species was shorter in Hungary than in countries with oceanic climate because the vital functions of plants were accelerated by the higher temperature and stronger solar radiation, resulting in faster seed maturing. The*

Figure 2: Dr. Zoltán Kováts among the annual ornamental plants what he selected. This photo has been taken in front of the Hungarian Pavilion of the Horticultural World Exhibition' 2003 (Rostock, Germany). The Hungarian Garden was inspired by the famous landscape architect, Prof. Mihály Mőcsényi (1919-2017), a friend of Dr. Kováts. (Source: Ereky Foundation, Székesfehérvár, Hungary.)

producers in Hungary actually took advantage of this phenomenon, and the seeds of ornamental plants sown in Western and Northern European countries were produced here during most of the 20th century" wrote Prof. Zoltán Kováts in 2009 (Figure 2).

For many, the *Pannonian Garden* was just a vision; however, by spreading the mentality what this object represents, we can realize the dream of their noble ancestors with annual ornamental plants that are bred against the changing climatic conditions. Obviously, the use of the latest scientific breeding methods are essential for the creation of new and popular ornamental plant varieties. We are convinced that applying or, even combining these methods properly, we can create a new aegis for the herbaceous ornamental plant breeding in Hungary.

PHYSIOLOGY AND GENETICS OF THE CLIMATIC CHANGE RESISTANCE

For six decades, the breeding of our annual herbaceous ornamental plant species has been characterized by the use of narrow genetic sources. For the quick introduction of new, stable lines as a result of breeding, as well as creating new range of colours, shapes and sizes careful monitoring was used regarding the natural variability of the species and fixed them by positive selection method (Kováts, 1957, 1958; 1980; 1986; Kováts and Karip-Szabó, 2003). It seems that the genetic pool of annual ornamental plant species used for breeding in Hungary is largely exhausted. These include Dr Kováts Zoltán's annual herbaceous plant species too, which are, however, well marketable nowadays as well in terms of colour, shape, size and inflorescence durability. These varieties have been bred to the tolerance of the domestic climate, the most obvious of which are their high drought- and heat resistance (Kováts, 1957, 1958; 1980; 1986; Kováts and Karip-Szabó, 2003, Kováts, 2009). In our opinion, as a result of the quite unpredictable climatic extremities, the basic research line of climate tolerance for these species should be based on physiological, molecular biological and genetic basis in Hungary as well (Szabó and Fári, 2017). The NAIK GYKI (National Agricultural Research- and Innovation Institute, Research Institute for Fruit- and Ornamental Growing) actually does not have the necessary equipment and tools to perform such research studies. Meanwhile, the appropriate skills and research equipment for these research studies are now available in several Hungarian research institutions and universities, i.e. Agricultural Biotechnology Center (Gödöllő), University of Science Loránd Eötvös (Budapest), University of Debrecen (Debrecen).

RESISTANCE BREEDING AND INDUCTION OF NOVEL MUTATION

Since the 1950s the importance of the plant resistance breeding methods were known based on the knowledge of the plant-pathogen interaction. The successful application of hybridization programmes among related ornamental plant species are very time consuming approaches (Kováts, 1980; 1986). Up to the present, the most effective approaches were the selection within the existing varieties' collections looking for new resistance sources or generating new resistant lines by mutation induction method (Kováts, 1980). The crossable wild species can also be the new source of resistance. (Kováts and Karip-Szabó, 2003). Nowadays, the modern breeding programmes based on molecular biology and molecular genetics are spreading in the circle of the leading ornamental plant breeding companies and institutions. In this area there are many opportunities for the research cooperation among institutes. For instance, new resistance mutant selection programme is possible in this way. For example, the University of Debrecen carries out mutation induction research programme by some annual ornamental species within the Pannon Breeding project coordinated by Dr. László Orlóci, based on a bilateral scientific cooperation with the ATOMKI (Hungarian Academy of Science, Debrecen) and IAEA (Seibersdorf, Austria). This research concept was originally created by Prof. Zoltán Kováts and by Prof. Miklós G. Fári in 2009. This program reinforced the Hungarian ornamental plant breeding strategy involved cell biology and biotechnology, among others. It seems that the modern gene-editing tools also could play an increasingly important role in the near future. The time demand for the creation of new varieties could be shorter if the uniform cloned propagules raising is solved. In addition, in this way the genetic stability is guaranteed against to the seed propagation. An international significant mission is the induction of resistance mutation within basil cultivars against basil downy mildew (*Peronospora belbahrii*). Other research interests are the resistance induction on *Alcea rosea annua* varieties against to the mallow rust (*Puccinia malvacearum*) and the creation of the new perennial x*Althalcea suffrutescens* intergeneric hybrid lines by mutation induction technique.

IN VITRO REGENERATION, CLONING AND GENETIC CONSERVATION

In addition to the positive selection breeding methods, the aim of our research is to develop new varieties with some new attractive properties for the annual ornamental production sector in Hungary. It seems that for the selection and maintaining process of the newest lines and varieties there are required the application of vegetative propagation methods in the future. The development of cloning protocols has dual importance. On the one hand, the cloning and *in vitro* propagation of the new inbred lines and / or individuals obtained from non-uniform population, the selection process of the time-consuming classical breeding can be considerably shortened. On the other hand, the valuable newest genotypes can also be industrially propagated by biotechnological methods. Another advantage of clonal propagation technology is that the extremely dangerous seed mixing problems can be avoided during seed harvest and processing. The micropropagation of annual and other herbaceous, semi-shrub ornamental plant species (*Cosmos* sp., *Rudbeckia* sp., etc.) using invented phyto-bioreactors was relaunched in 2003 at the University of Debrecen (Debrecen, Hungary) in the framework of the GENOMNANOTECH program with the participation of Dr. Zoltán Kováts and Dr. Miklós G. Fári. In addition, the organogenesis of different semi-shrub mallow species has also been researched since 2009 by our team (Kurucz et al., 2012). We know, that in the future some of the valuable Hungarian annual ornamental plant cultivars can be 'heirloom' varieties maintained in gene bank collections. The refrigerated storage of seeds from such cultivars has recently been resolved by cooperating with the University of Debrecen (Debrecen) and the National Research Centre for Agrobiodiversity (Tápiószele, Hungary). The cryopreservation is another effective process of gene preservation (the vegetative tissues, seeds, *in vitro* tissue cultures, cells, etc. directed freezing with special tools and subsequent regeneration, revitalization). After basic research, the whole domestic breeding genetic material of annual varieties, individuals, ecotypes, clones and mutants could be long-term preserved by such a technique. In the latter field, some international cooperation is also required.

In the era of gene editing, one of the most important professional criteria for plant breeding is the controllable *in vitro* regeneration of the plant species and varieties, i.e. development of whole plant from cells and tissues. This requirement also applies to annual ornamental plants of domestic breeding. Dr. Zoltán Kováts had already established a tissue culture laboratory in 1975 (Budatétény, Hungary) to conduct such a research. Among others, it has developed bilateral plant biotechnology cooperation with the Biological Research Center (Hungarian Academy of Science, Szeged, Hungary) and University of Science Loránd Eötvös (Budapest, Hungary). Dr. Zoltán Kováts has been conducting the above detailed plant biotechnological researches at the University of Debrecen under the leadership of Prof. Miklós G. Fári since 2003 (Kurucz et al., 2012) (Figure 3).

Figure 3: Induction of somatic embryos in *Kitaibela vitifolia x K. balansae* interspecific hybrid lines (Source: Dr. Erika Kurucz, University of Debrecen)

MOLECULAR BREEDING, GENE EDITING AND VARIETY PROTECTION

One of our further urgent scientific duties is the molecular characterization of the given pathogen species as well as the set up infection assays due to the determination of the susceptibility of the newest varieties. This task requires a lot of technical development at the beginning. Thereafter, the created resistant new ornamental plant varieties will be characterised by molecular marker methods. Nowadays, the revolution of the plant breeding made a closed alliance with molecular genetics. Till the near past, controversial genetic transformation methods - due to the known regulation restriction –were not used by the ornamental plant breeders in our country. In addition, at July 2018 the European Court of Justice ruled that techniques such as gene editing fall within the European Union's 2001 GMO directive, meaning that any gene-edited plants should be considered as genetically modified organisms (GMO). Although,

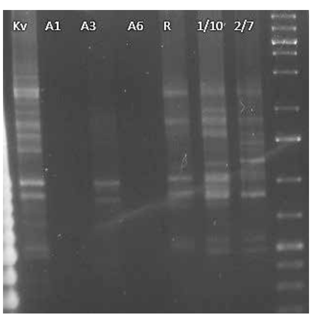

Figure 4: ISSR marker-assisted selection of *Kitaibela vitifolia x K. balansae* interspecific hybrids (Source: Dr. Erika Kurucz, University of Debrecen)

the professional viewpoint in our country is fully contrary (Balázs and Dudits, 2017). We could therefore re-evaluate the new opportunities of Hungarian modern ornamental plant breeding in consideration of these aspects and facts. It seems that the modern ornamental plant breeding needs to apply these modern techniques, including gene editing to become more suitable to present expectations (Antal et al., 2014; Kurucz et al., 2014). (Figure 4)

HUNGARIAN 'ALCEAHOLICISM' - CREATION OF NEW INTERSPECIFIC- AND INTERGENERIC MALLOW HYBRIDS

The intergeneric and interspecific semi-shrub mallow hybrids bred by Zoltán Kováts are still on the mainstream of our research work from 40 years ago. Fifteen to twenty new *Kitaibelia vitifolia x balansae* interspecific hybrid clones are also available following the breeding work started in 2008 at the University of Debrecen (Kurucz et al., 2017, unpublished). The evaluation and patenting of these hybrids could offer new opportunities for the establishment of our extensive green landscape projects based on native perennials, in other words, in our 'Pannon garden' named by Zoltán Kováts.

Kelly Norris, a famous horticulturist and writer from the USA commented his work as the following: "*In 1953, Hungarian plant breeder Zoltan Kováts made a series of novel, fascinating crosses between the common marshmallow (Althaea officinalis) and hollyhock (Alcea rosea). The result was the hybrid* x*Alcalthaea suffrutescens*"… "*Though sterile, these intergeneric hybrids offer everything a gardener wants in a hollyhock: they are highly tolerant of hollyhock rust, suffer little from nibbling summer insects, and bloom virtually nonstop from the end of June and after frost on six-to eight-foot-tall stems arranged like a vase emerging from the ground*" (Norris, 2015).

As an internationally recognised central figure of the Kelly's *alceaholicism*, Prof. Kováts wrote the following sentences about his intergeneric crossing programme:

"A hollyhock variety group generated by crossing the Althaea officinalis, a wild species in Hungary, the Alcea rosea varieties developed previously can be considered as the most unique novelty. The varieties of the group are superior in several traits to the varieties known up to now, and they are the only varieties that are resistant to hollyhock rust (Puccinia malvacearum). They are completely winter-hardy. These varieties are sterile, therefore, they do not produce seeds, resulting in continuous flowering. Previously, we propagated them via cuttings, but now the more effective method of micropropagation is used. This new variety group, being an intergeneric hybrid between Alcea and Althaea, is of high importance not only in terms of use

Figure 5: 'Alceaholicism' in Hungary: research on x*Alcalthaea suffrutescens* 'Háros' intergeneric hybrid mallow. *This new variety group, being an intergeneric hybrid between Alcea and Althaea, is of high importance not only in terms of use but from scientific aspects as well (Kováts, 2009).* Forrás: Zsila-André A. and Prof. Miklós G. Fári, University of Debrecen

but from scientific aspects as well. The development of several new traits is attributable to the application of the method of intergeneric hybridisation. We intend to use this breeding technique more often in the future, which is greatly assisted by the micropropagation procedure without which such crossings did not seem to be successful. These new hollyhock varieties highly tolerant to extreme climatic conditions encourage the use of this method for the breeding of other species as well." (Kováts, 2009).

The creation of entirely new forms of x*Althalcea suffrutescens* intergeneric hybrids is still a very promising possibility for our ornamental plant breeding programme. *In vitro* cultures of these intergeneric and interspecific hybrid clones are actually maintained at the Biotech Laboratory of the University of Debrecen by Dr. Erika Kurucz (Figure 5).

Figure 6: Research on the flowering of in vitro propagated Campanula carpatica clone in HIB module, a recently invented Hungarian vertical green-wall modular system. (Source: Judit Koroknai, University of Debrecen)

ANNUAL AND PERENNIAL FLOWERING VERTICAL GREEN WALLS FOR OUTDOOR USE

The aim of our Flowerborder program, which began also with the participation of Zoltán Kováts at the University of Debrecen in 2006, was to create new urban and innovative green surface systems with a great value of annual or perennial flowers, which were in accordance with the emerging international trends (Zsila-André et al., 2007). The most important element of this program is to research modular vertical wall elements called Hort-in-Box, or 'HIB' system (Koroknai et al., 2014). To continue this work which already has some important innovative and scientific results in the field of our horticulture sector, it requires the involvement of NAIK and other professional institutions. The importance of the work is also emphasized by the recent order of the Municipality of Budapest with the participation of the University of Debrecen completing the first Hungarian professional book that discusses details of the vertical plant walls and green facades from ecological, horticultural, technical and urban-landscape aspects (Pataky et al., 2016). (Figure 6)

PHYSICO-CHEMICAL STRENGTHENING OF THE OUTDOOR ORNAMENTAL PLANTLETS

There are many annual and perennial outdoor herbaceous ornamental species that are unique because of their flower or leaf shape or colour. These ornamental plants, planted in groups, have a decorative effect, but because of their large size and a small number of branches, they are not suitable for other uses (potted plants, flowerbed planting) because they are not resistant to wind or are non-decorative (*Scabiosa species, Coreopsis species, Matthiola incana L.*). The mechanism of action of chemicals used in dwarf plants is based mainly on inhibition of gibberellin synthesis. Applying these chemicals (Regalis WG, Toprex, Cultar, CCC), applying them on high-growing ornamental plants increases the number of branches, making the plant more bushy, which increases its decorative value and reduces plant height, making it suitable for other applications (Kisvarga et al., 2010).

Figure 7: Effect of mechanically driven tigmomorphogenesis device on the growing and development of *Celosia* 'Fresh-Look' plantlets (Source: Fári et al., University of Debrecen)

During the last decade the specialist of the Department of Agricultural Botany, Plant Physiology and Biotechnology at the University of Debrecen achieved the very promising new environmentally friendly mechanical tigmomorphogenesis method. This system uses a specially designed "dwarfing device" meaning that the plantlets have a continuous tangent and smoothing mechanical disturbance from their cotyledon state, thereby reducing the vertical growth of the plantlet axis and the young leaf peduncles (Figure 7).

CONCLUSION - SCIENTIFIC MASSAGE OF PROF. ZOLTÁN KOVÁTS

"*…In conclusion, it can be stated that one of the most reliable yet previously less often applied approaches to the adaptation to extreme climatic conditions is the development of varieties suitable for such circumstances by plant breeding practices. Such breeding programmes are most practical to be carried out at places with extreme weather conditions, or involving plants autochthonous in areas with such climate. Varieties developed under various climatic conditions can also be tested in regions with extreme weather i.e. areas with continental climate, which has almost always been neglected under the pressure of continuous innovation typical to our age. Our examinations demonstrated that ornamentals delightful under extreme weather conditions always perform really well also in areas with more uniform climate. By reason of the information contained herein, breeding and variety examination of ornamental plants in Hungary is still going to play an important role in the future in terms of developing plants adaptable to the unpredictable changes in the climate…*" (Kováts, 2009).

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