BIOLOGIJA. 2008. Vol. 54. No. 2. P. 139–146
DOI: 10.2478/V10054-008-0029-1

Selection and presentation of tulip (*Tulipa* L.) species and cultivars to the Lithuanian Plant Genetic Resources

R. Juodkaitė[1*], A. Baliūnienė[2], J. R. Naujalis[3], M. Navalinskienė[4], M. Samuitienė[4]

[1] *Department of Plant Systematic and Geography of Botanical Garden of Vilnius University, M.K. Čiurlionio 110, LT-03100 Vilnius, Lithuania*

[2] *Experimental Station of Field Floriculture, A. Kojelavičiaus 1, LT-11000 Vilnius, Lithuania*

[3] *Department of Botany and Genetics of Vilnius University, M. K. Čiurlionio 21, LT-03104 Vilnius, Lithuania*

[4] *Institute of Botany, Žaliųjų Ežerų 49, LT-08406 Vilnius, Lithuania*

Information on the tulip growing tradition in Lithuania, development of introductive investigations, which were divided into two periods is presented in this work. Within the first period including years, 1972–1992, scientific investigations on tulip introduction and bulb reproduction were carried out at the Vilnius Section of Bulbous Flowers of Kaunas Botanical Garden. The tulip collection contained approximately 600 tulip species and cultivars. During the second period (1997–2007), investigations were continued at the Department of Systematics and Geography of Botanical Garden of Vilnius University. Within this period, the tulip collection consisting of 263 species and cultivars belonging to 15 classification groups was accumulated. Since 2002, scientific work on the examination and assessment of the ornamental quality and phytopathological state of tulip species and cultivars have been carried out as a constituent part of the Lithuanian State Programme "Genefund", State Scientific Programme of the Botanical Garden of Vilnius University "Scientific investigations of Lithuanian genetic resources" and the theme "Accumulation, investigation and preservation of the genefund of Lithuanian ornamental plants". The main criteria for the evaluation of introduced plants are the possibility and expediency of their growing. Expediency is defined by their ornamental–applied value; the possibility is determined by suitability to grow in our climatic conditions and resistance to diseases. Basing on general criteria for selection of introductive plants for preservation and specific criteria for tulips, tulip species and cultivars were selected and presented for preservation in the Lithuanian Plant Genetic Resources.

Key words: tulip, decorative capacities, resistance, *tulip breaking potyvirus*, *Botrytis tulipae*, main criteria, specific criteria, genetic resources, indexed tulip bulb vegetative reproduction coefficient

INTRODUCTION

Tulip (*Tulipa* L.) is a Monocotyledona and belongs to the *Liliaceae* Juss. family.

The assortment of cultural tulips during four centuries has greatly changed; numerous cultivars and groups have been lost. Especially many cultivars disappeared in the 16th–17th centuries when due to the lack of knowledge tulips with variegated flowers which became color-broken because of viral infection were highly valuated, propagated and widely distributed [1–5].

Tulip is a unique representative of plants; their significance has always been exceptional. The creation of all-year-round bulbous flower forcing technologies predetermined the mass expansion of this culture in the 20th century [6–19]. The vegetative propagation of tulips is effective, but creation of new tulip cultivars is especially time-consuming because tulip seedlings begin to blossom only after seven years. Investigations were carried out to make this period shorter, but no positive results were received. Tulip cultivars are created not only by sexual hybridization, but also by spontaneous mutagenesis under the influence of physical and chemical mutagens. The process of creating a new cultivar takes 25–30 years because not only the period from sowing till blossom of seedlings is long, but also a long period is needed for bulb propagation till standard extents of industrial production [20]. That is why the extent and change of tulip cultivars are not as great and rapid as, for example, of gladioli, lilies or daylilies.

It is unknown how many tulip cultivars have been created since their first introduction in Europe in 1554, but it is supposed that this number is about 10–12 thousands. Systemic registration of tulip cultivars was started by the English Royal Society; this work was continued by the Tulip Nomenclature Committee including tulip experts from Holland and England. International Tulip Registers are published not periodically; they have included approximately 3000 tulip species and cultivars, among them there are several-century-old cultivars [1, 20, 21].

Tulips in Lithuania have been known, grown and cherished as a favorite flower for a long time. Comprehensive knowledge of ornamental bulb plants appeared at the end of the 18th century [22]. In the book of the famous horticulturist of Vilnius district J. Strumiłło there is a large chapter on tulips concerning their

* Corresponding author. E-mail: regina.juodkaite@gmail.com

growing and flower forcing [23]. In a catalogue edited by this author, 1076 species and cultivars of ornamental plants were presented, including *T. gesneriana*, *T. flore plena* and *T. monstra.* J. A. Pabrėža in his scientific work on Lithuanian plants "Botanika, or Taislius auguminis" indicated *T. Sylvestris* L., *T. suaveolens* Roth and *T. Gesneriana* L. [24]. Tulips were mentioned in publications of J. Dagys and L. Vailionis [25, 26].

Little is known about tulip collections in pre-war Lithuania. In Soviet times, the expansion of this crop started from the beginning of tulip bulb import from the Netherlands in 1965. Approximately 100 cultivars were imported till 1976, and in 1978 tulips covered an area of 50 ha. 90% of tulips belonged to the Darwin hybrid group (4 'Apeldoorn', 4 'Oxford', 4 'Parade'). Eleven farms and numerous private growers were involved in tulip growing [1, 20].

A tulip collection at the Kaunas Botanical Garden was established in 1961. The collection was renewed in 1972. Scientific investigations were directed by A. Baliūnienė. The main goal of research work was investigation of the possibilities of tulip growth regulation and development, concentrating on problems of bulbous flower forcing and vegetative reproduction [27–29].

Conditions for tulip collections in Lithuania were unfavorable in 1979. After the rainy autumn and severe winter, large quantities of tulips were lost and several farms ceased tulip growing.

The most intensive investigations of tulip introduction in Lithuania are divided into two periods. Within the first period (1972–1992), scientific investigations on tulip introduction and bulb reproduction were carried out at the Vilnius Section of Bulbous Flowers of the Kaunas Botanical Garden. The tulip collection contained approximately 600 tulip species and cultivars [1, 20]. In the second period (1997–2007), investigations were continued at the Department of Systematics and Geography of the botanical Garden of Vilnius University [30–32]. In this period, a tulip collection consisting of 263 species and cultivars was accumulated.

Since 2002, scientific work on examination and assessment of the ornamental quality and phytopathological state of tulip species and cultivars have been carried out as a constituent part of the Lithuanian State Programme "Genefund"; the State Scientific Programme of the Botanical Garden of Vilnius University "Scientific investigations of the Lithuanian genetic resources" and the theme "Accumulation, investigation and preservation of the genefund of Lithuanian ornamental plants" [33, 34].

The aim of the present work was, basing on data of previous investigations of tulip species and cultivars, from highly evaluated tulip species and cultivars to select and present the candidates to the Lithuanian Plant Genetic Resources.

MATERIALS AND METHODS

The main criteria for evaluation of introduced plants are the possibility and expediency of their growing. Expediency is defined by their ornamental–applied value; the possibility is determined by suitability to grow in our climatic conditions and resistance to diseases. Introductive investigations included: 1) tulip resistance to climatic conditions; the influence of wintering conditions, spring frosts and other stressing factors were observed; 2) resistance to viral and fungal diseases; 3) assessment of ornamental quality; 4) assessment of vegetative reproduction.

There are general criteria of selecting plants for preservation in the Genetic Resources, but for each plant group or separate species the criteria have a different content and capacity determined by the diversity the applied significance of a plant and its specific features. Tulip species and cultivars have been selected to the Lithuanian Plant Genetic Resources according to general and specific criteria for introduced plants, worked out by A. Baliūnienė (1995). The minimal duration of investigation should be seven years.

Tulip cultivars selected as candidates to the Lithuanian Plant Genetic Resources deserved the highest introductive estimation according to the indicated criteria. The main criteria for establishing the tulip introductive value are: 1) ornamental quality; 2) resistance to viral diseases; 3) resistance to fungal diseases; 4) endurance to climatic and meteorological factors; 5) vegetative reproduction.

Assessment of the ornamental quality of tulip species and cultivars. The ornamental quality of tulips was estimated according to the methodology of O. Holtischer [35–37], A. Baliūnienė and R. Juodkaitė [20]. Ornamental quality was estimated visually within the limits of each classification group, applying a complex five-point system in the period of mass blooming. The main positions for evaluation of tulip ornamental quality: 1) blossom colour intensity and the harmony of colour combinations; 2) the form of blossoms (highest evaluation for tulips with an excellent and stable form of blossoms; petals should not open in sun); 3) resiliency of petals; 4) proportions of flower and stem heights; 5) the texture and form of leaves; 6) resiliency of stems.

Assessment of tulip resistance to tulip breaking potyvirus. In the second research period, a widge-scope analysis of 263 tulip species and cultivars was carried out. The collection included tulips of 15 classification groups: 1) Single Early tulips make up 38% of the tulips; 2) Double Early tulips – 2.3%; 3) Triumph tulips – 21.4%; 4) Darwin hybrid tulips – 6.5%; 5) Single Late tulips – 15%; 6) Lily Flowered tulips – 7.6%; 7) Fringed tulips – 8%; 8) Viridiflora tulips – 4.6 %; 9) Rembrandt tulips – only one cultivar; 10) Parrot tulips – 7%; 11) Double Late tulips – 3.8%; 12) Kaufmanniana varieties and hybrids – 5%; 13) Fosteriana varieties and hybrids – 2.3%; 14) Greigii varieties and hybrids – 3% and 15) other species and their varieties and hybrids – 10%.

The initial detection of virus-infected plants was carried out by establishing symptom expression on leaves and flowers [38]. The identification of agents was carried out at the Plant Virus Laboratory of the Institute of Botany applying methods of test-plants [39], electron microscopy [40], DAS-ELISA [41]. Tulip breaking potyvirus (TBV) is established as a ubiquitous and the most damaging virus affecting tulips, so the resistance of tulip cultivars to viral diseases has been evaluated by resistance to this virus. Tulip cultivars were arranged into three groups: 1) resistant, 2) moderately resistant, 3) non-resistant [34].

Assessment of tulip species and cultivars to *Botrytis tulipae*. By resistance to *Botrytis tulipae* (*B. tulipae*), the tulip cultivars were divided into three groups: resistant (plants were healthy or the number of infected plants within cultivar was below 20%); moderately resistant (21–50% of infected plants); non-resistant (more than 50% of infected plants).

Assessment of tulip vegetative reproduction. The data analysis was carried out on 299 tulip species and cultivars of

10 classification groups: 1) Single Early tulips make up 10% of the studied tulips; 2) Double Early tulips – 2%; 3) Triumph tulips – 30%; 4) Darwin hybrid tulips – 20%; 5) Single Late tulips – 24%; 6) Lily Flowered tulips – 5%; 7) Fringed tulips – 5%; 8) Viridiflora tulips – only one cultivar; 9) Parrot tulips – 3%; 10) Double Late tulips – 1%. To assess the vegetative capacity of varying size tulip bulbs, they were arranged by size into seven fractions. The data analysis was carried out by using the statistical analysis tools of MX Excel 2002 (Microsoft Corporation) and Statistica 5.5A (StafSoft, Inc) programmes. Tulip bulb vegetative reproduction capacity was established by special reproduction coefficients: the total reproduction coefficient (TRC), the generative bulb reproduction coefficient (GRC), the forcible bulb reproduction coefficient (FRC) and the indexed reproduction coefficient (IRC) [20, 31, 32]. To analyse the biological range of the study parameters and the type of cultivar dispersion, tulip bulbs of all the studied cultivars within the range of fractions were grouped into five grades of reproduction. The gradation was carried out by ranking the range of mean data on the cultivars of the whole mother bulb cross-section into five equal graduations.

Not all tulip cultivars of a high ornamental quality could be selected to the Genetic Resources. Because the criteria for selection of species and cultivars are specific for tulips. Tulip species and cultivars – candidates to Lithuanian Plant Genetic Resources were selected from cultivars with a high introductive value satisfying additional criteria.

Specific criteria for selecting tulip species and cultivars to the Lithuanian Plant Genetic Resources: 1) historically valuable tulip cultivars; 2) tulip cultivars most massively grown in a certain period; 3) mutable cultivars; 4) cultivars with unique ornamental properties; 5) cultivars with a high ornamental quality and resistant to viral and fungal diseases; 6) cultivars with a high reproductive capacity.

RESULTS AND DISCUSSION

Basing on long-term scientific investigations of the expansion of tulip species and cultivars in our country, their ornamental quality and resistance to viral and fungal diseases, the tulip cultivars – candidates to the Lithuanian Plant Genetic Resources have been selected and are presented in this work.

Resistance to negative climatic factors. Tulips are rather resistant to grow in Lithuanian climatic conditions, but it is necessary to mulch tulip fields [1, 42]. In March 23–30, 1964 the night temperature was below –20 °C, tulip tips had been sprouted from mulch, but no negative influence was observed. Conditions for tulip fields in Lithuania were unfavorable in 1979 when the rainy autumn was followed by a severe winter (snowless December). Tulip growers experienced great damages. The tulip collection at the Experimental Station of Field Floriculture was severely damaged by frosts in the winter of 1992–1993 and in 1996 when in May 6–7, during the flowering of Darwin hybrid group tulips, spring frosts reached seven degrees below zero. However, these solitary facts do not allow drawing conclusions about the impropriety of Lithuanian climatic conditions for tulip growing; they only warn of damage possibilities. It is considered that spring frosts to two degrees below zero are not damaging to tulips even after the beginning of vegetation, but lower temperatures (3–4 degrees below zero) damage the tips of leaves and later stimulate the spreading of *B. tulipae.*

Tulip cultivars of high ornamental quality. Within the first introductive investigation period, 237 tulip cultivars have been characterized in detail; 101 tulip cultivars were described basing on literature data. Material was published by A. Baliūnienė and R. Juodkaitė [20]. For detailed descriptions, new comprehensive data have been presented: 1) the amplitude of flowers and flower stems for each tulip (including all, from smallest to largest, flowering bulbs); 2) the relative number of flowering plants inside the smallest possible flowering bulbs; 3) flower forms in the beginning and mass flowering in gloomy and sunny days. 65% of the total of 665 tulip species and cultivars have been evaluated by the highest points. Within the second research period, a detailed biological information on 263 tulip species and cultivars belonging to 15 classification groups was accumulated and analysed. 70% of tulip cultivars from the collection were recognized to be of the highest ornamental quality (38% of tulip cultivars were estimated by 5 points, 32% – by 4 points) [34]. However, not all highly ornamental tulip species and cultivars could be selected to the Genetic Resources. In climatic conditions of our country, ornamental qualities and vegetative reproduction capacities of tulips and others ornamental bulbous flowers are greatly decreased by viral and fungal diseases. Completing the tulip lists for the Genetic Resources, the phytopathological evaluation of species and cultivars has been carried out.

Resistance to tulip breaking potyvirus. Single Early tulips were rather susceptible to viral diseases. Only 20% of tulip cultivars were resistant, 50% were non-resistant, whereas the rest cultivars were moderately resistant to the tulip breaking potyvirus (TBV). Most cultivars of Double Early tulips were moderately resistant to TBV (50%), 33% were resistant and 17% non-resistant to the above virus. Triumph tulips were rather susceptible to viral diseases, among them 20% of cultivars were resistant to TBV, 38% were moderately resistant and 42% non-resistant to the above virus. Darwin hybrid tulips were highly resistant to viral diseases: 64% were resistant, 31% were moderately resistant, and 4% non-resistant to TBV. Single late tulips were susceptible to viral diseases, and only 15% of the study cultivars were resistant to TBV, 39% were moderately resistant and 46% non-resistant to this virus. Lily Flowered tulips were susceptible to viral diseases: only 20% of these cultivars were resistant to TBV, 30 % moderately resistant and 50% non-resistant. Most of Fringed tulip cultivars were moderately resistant to TBV (34%), 22% were resistant and 22% non-resistant. Viridiflora tulips are rather susceptible to viral diseases: 16% of this group of cultivars were resistant to TBV, 42% moderately resistant, and 42% were non-resistant. Most of Parrot tulip cultivars were moderately resistant to TBV (56%), 22% were resistant and 22% – non-resistant to this virus. Most of Double Late cultivars were resistant to TBV (60%), and 40% were moderately resistant. Kaufmanniana, Fosteriana, Greigii varieties and hybrids and Other Species and their varieties and hybrids were resistant to TBV (Fig. 1).

From all tulip species and cultivars grown in the collection, Darwin hybrid tulips were the most resistant to both viral and fungal diseases. Kaufmanniana, Fosteriana, Greigii and Other Species and their varieties and hybrids were also resistant to TBV. Most of Double Early tulips and Parrot tulips were moderately

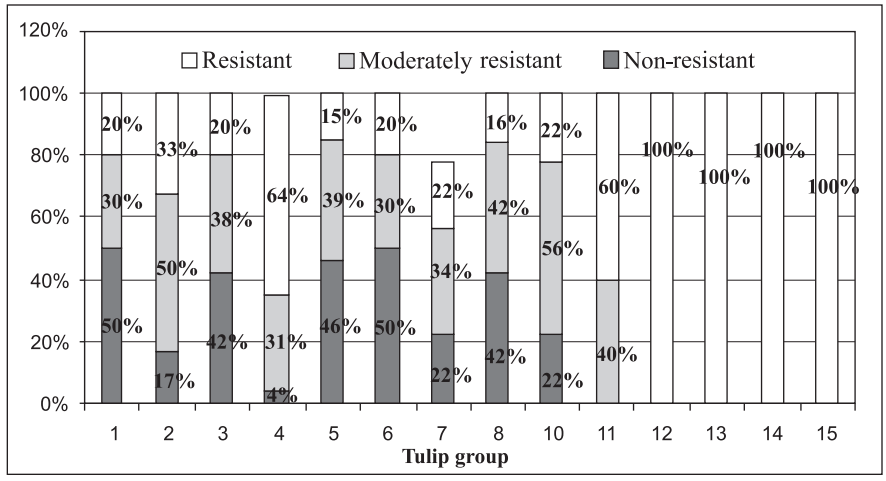

Fig. 1. Distribution (%) of tulip group species and cultivars by resistance to tulip breaking potyvirus (1997–2007)

resistant to TBV. Single Early tulips, Single Late tulips, Lily Flowered tulips and Fringed tulips were non-resistant to TBV. Among the 15 classification groups of tulips species and cultivars studied, 40% were resistant, 32% were moderately resistant, and 28% were non-resistant to TBV.

Resistance to *Botrytis tulipae*. Fungal diseases in Lithuanian climate conditions are not so damaging, except the disease induced by *B. tulipae* when conditions for this disease are favourable [43, 44]. It was noticed that not a very low temperature (–1 – –2 °C) did not usually influence tulips negatively; leaves, especially their tips, could be frozen at lower temperatures (–3 – – 4 °C). During the study period, tulips growing in the collection were resistant to fungal diseases. Only in 2005 an outburst of *B. tulipae* was registered in the collection. The causal conditions were formed by late spring frosts and rainy weathers in the beginning of the vegetation period. Most cultivars of Single Early tulips were resistant to *B. tulipae* (60%), 30% were moderately resistant and 10% non-resistant. Most cultivars of Double Early tulips were resistant to *B. tulipae* (83%), and 17 were moderately resistant. Most of Triumph tulips were resistant to fungal diseases (67%), 26% of the cultivars were moderately resistant, and 17% were non-resistant to these diseases. Darwin hybrid tulips were highly resistant to fungal diseases (94%), only 6% being non-resistant to *B. tulipae.* Most cultivars of Single Late tulips were moderately resistant to *B. tulipae* (67%), 15% were resistant and 18% non-resistant. Most of Lily Flowered tulips were moderately resistant to *B. tulipae* (60%), 25% were resistant and 15% non-resistant to fungal diseases. Most of Fringed tulip cultivars were moderately resistant to *B. tulipae* (45%), 22% were resistant and 22% non-resistant. A larger number of Viridiflora tulips cultivars were moderately resistant to *B. tulipae* (68%), 16 % were resistant and 16% non-resistant to fungal diseases. The majority of Parrot tulips were moderately resistant to *B. tulipae* (72%), 17% of the tulips were resistant and 11% non-resistant. Most of Double Late cultivars were resistant (50%) and moderately resistant (40%) to *B. tulipae*, only 10% being non-resistant to fungal diseases. Kaufmanniana and Fosteriana varieties and hybrids were moderately resistant to *B. tulipae.* Most cultivars of Greigii varietes and hybrids were moderately resistant to *B. tulipae* (63%), and 37% were resistant to the above diseases. Other Species and their varieties and hybrids were highly resistant to both fungal diseases (Fig. 2).

The general, Single Early tulips, Double Early tulips, Triumph tulips, Darwin hybrid tulips, Double Late tulips and tulip species and hybrids of the 15th group were resistant to fungal diseases. Most tulips from Single Late, Lily Flowered, Fringed, Viridiflora, Parrot, Kaufmanniana, Fosteriana, Greigii varieties and hybrids were moderately resistant to *B. tulipa*e. Among the 15 classification groups of tulip species and cultivars 40% were resistant, 32% moderately resistant, and 28% were non-resistant to *B. tulipae*.

Among the total of 15 classification groups of tulips species and cultivars, 53% were of the highest resistance to viral and fungal diseases.

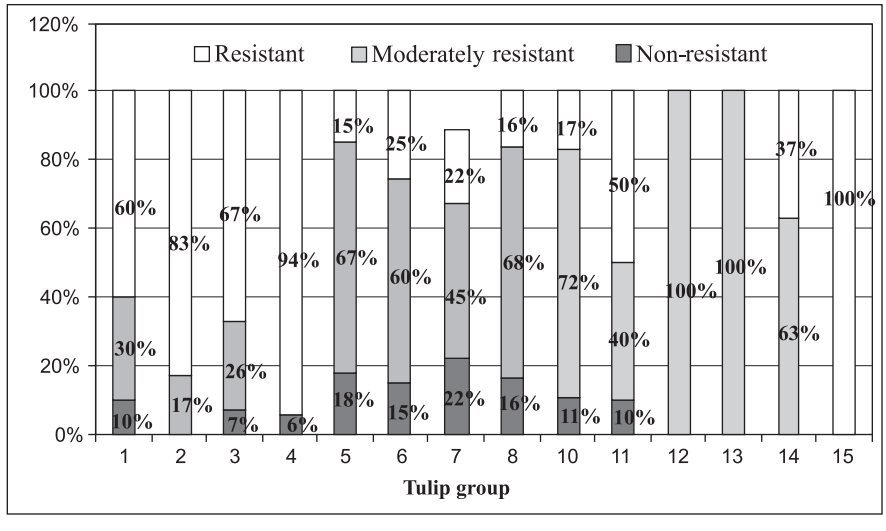

Fig. 2. Distribution (%) of tulip group species and cultivars by resistance to *Botrytis tulipae* (2005)

Assessment of tulip vegetative reproduction. The vegetative reproduction research of tulips was carried out in the first period of scientific investigations on tulip introduction. The indexed tulip bulb vegetative reproduction coefficient (IRC) is a one-dimensional criterion generalizing the data on the investigated coefficients according to the reproduction capacity of the whole mother bulb cross-section and indicating the place of the cultivars within the range of this criterion. IRC indicates a comparative reproduction value of the whole mother bulb cross-section of the tulip cultivars studied. Empirical tulip cultivar dispersion analysis has demonstrated that this coefficient most objectively reflects the reproduction capacity of all fraction bulbs of the tulip cultivars studied [20, 31, 32]. Tulip vegetative reproduction capacity was estimated in different classification groups. Based on the IRC, the investigated tulip cultivars (299) were grouped into five grades of reproduction (Table). According to the IRC, most tulip cultivars were grouped into 2nd–4th grades (correspondingly 24, 30 and 30%), whereas 8% of the cultivars belonged to the 1st and 5th grades. The cultivars of all classification groups were recorded in the IRC grades.

In the first grade of reproduction, 25 tulip cultivars were recorded. Most cultivars of Triumph (32%) and Darwin hybrid (28%) classification group tulips prevailed. The cultivar 4 'Apeldoorn' and 5 spontaneous mutants occurred among them. At the end of the 20th century, the mentioned tulips and also 'Lustige Witwe' were very popular due to a high bulb reproduction and excellent forcibility. At the second grade of reproduction, 70 tulip cultivars were registered. Triumph (34%), Single Late (24%) and Darwin hybrid (17%) classification group tulips dominated. Most wide-spread tulip cultivars are as follows: 1 'Christmas Marvel', 3 'Athleet', 3 'Garden Party', 3 'Paul Richter', 3 'Prominence', 4 'Empire State', 4 'Franklin D. Roosevelt', 4 'General Eisenhower', 4 'Golden Deutschland', 4 'Jewel of Spring', 4 'London', 4 'Oxford', 4 'Oxford's Elite', 6 'Jacqueline', 7 'Blue Heron', 11 'Miranda'. Many of them are highly ornamental. Into the third grade of reproduction 89 tulip cultivars were included. Here dominated Triumph tulip (30%), Single Late tulip (22%) and Darwin hybrid tulip (17%). The most popular cultivars are: 1 'Apricot Beauty', 1 'Prince of Austria', 3 'Abu Hassan', 3 'Bing Crosby', 3 'Golden Melody', 3 'Lucky Strike', 3 'Rosario', 4 'Beauty of Oxford', 4 'Dawnglow', 4 'Diplomate', 4 'Eric Hofsj ', 4 'Floradale', 4 'Golden Parade', 4 'Gudoshnik', 4 'Parade', 4 'Lefeber's Favourite', 4 'Striped Beauty', 4 'Vivex', 4 'Yellow Dover', 5 'Joan Cruickshank', 5 'Renown', 5 'Rosy Wings', 7 'Burgundy Lace', 7 'Fringed Elegance', 7 'Swan Wings'. In the fourth grade of reproduction 89 tulip cultivars were registered. Single Late (30%), Triumph (29%) and Darwin hybrid (18%) classification group tulips dominated. The most common cultivars are as follows: 1 'Bellona', 1 'Joffre', 4 'Big Chief', 4 'Deutschland', 4 'Kolner Dom', 4 'Nome', 4 'Olympic Flame', 4 'Striped Oxford', 5 'Dix' Favourite', 6 'West Point', 7 'Canova'. These tulips dominated because of their resistance to fungal and viral diseases as well as peculiar ornamental features. Most of them are fit for early forcing. In the fifth grade of reproduction, 25 tulip cultivars were listed. Single Late (20%) and Triumph (16%) classification group tulips dominated. Most of them are highly ornamental.

Tulip cultivars of highest quality subsequently were selected as candidates to the Lithuanian Gene Fund according to specific criteria:

1. Historically valuable tulip cultivars**:** 1 'Keiserskroone' (registered 1750), 2 'Peach Blossom' (1890), 5 'Aristocrat' (1935).

2. The most mass grown in a certain period tulip cultivars: 1 'Christmas Marvel', 3 'Lustige Witwe', 4 'Apeldoorn' (red flowering, the most widespread cultivar in Europe in the second half of the 20th century), 4 'Golden Parade' (the harmonious whole of the plant, rich yellow colour, petals do not open in sun), 4 'Parade' (the harmonious whole of the plant, resistant to viral and fungal diseases), 5 'Dix' Favourite' (red flowering).

3. Mutable cultivars: 1 'Christmas Marvel' (six cultivars have been created); 2 'Monte Carlo' (six cultivars, spontaneous mutants have been created), 3 'Lustige Witwe' (12 cultivars), 4 'Apeldoorn' (15 cultivars)

Table. **Distribution of tulip cultivars into grades of reproduction according to the indexed tulip bulb vegetative reproduction coefficient (IRC)**

Tulip group	Grades of reproduction according to IRC									
	1		2		3		4		5	
	M	*	M	*	M	*	M	*	M	*
1	1.172 ± 0.16	2	1.112 ± 0.02	8	0.988 ± 0.03	8	0.886 ± 0.03	8	0.756 ± 0.16	3
2	–	–	1.099	1	1.031	1	0.897 ± 0.08	3	0.788 ± 0.36	2
3	1.204 ± 0.03	8	1.088 ± 0.01	24	0.982 ± 0.01	27	0.888 ± 0.01	26	0.779 ± 0.06	4
4	1.216 ± 0.04	7	1.087 ± 0.01	12	0.996 ± 0.01	20	0.886 ± 0.01	16	0.789 ± 0.03	2
5	1.217 ± 0.04	2	1.086 ± 0.02	17	1.002 ± 0.01	22	0.880 ± 0.01	27	0.770 ± 0.07	5
6	1.259 ± 0.33	3	1.094 ± 0.29	2	0.968 ± 0.04	4	0.872 ± 0.01	4	0.767 ± 0.16	3
7	1.288 ± 0.06	2	1.094 ± 0.12	3	0.989 ± 0.10	3	0.900 ± 0.02	4	0.745 ± 0.17	3
8	–	–	1.067	1	–	–	–	–	–	–
10	1.196	1	–	–	0.997 ± 0.11	3	0.915	1	0.739 ± 0.13	3
11	–	–	1.085 ± 0.21	2	1.034	1	–	–	0.785	1

Tulip groups: 1 – Single Early tulips, 2 – Double Early tulips, 3 – Triumph tulips, 4 – Darwin hybrid tulips, 5 – Single Late tulips, 6 – Lily Flowered tulips, 7 – Fringed tulips, 8 – Viridiflora tulips, 9 – Parrot tulips, 10 – Double Late tulips.

M – mean of values.

* – numbers of a cultivars.

4. Cultivars with unique ornamental properties: 1 'Apricot Beauty' (a unique reddish colour of flower, stable form during all flowering period, 1 'Christmas Marvel' (the harmonious whole of ornamental properties), 1 'Princes Irene' (a unique combination of flower colour – orange petals with brownish purple flame shape ornament) (Fig. 3), 3 'Fidelio' (exclusiveness of orange tone nuance, stability of flower form), 3 'Garden Party' (an especially stable and elegant form of flower, distinct and clear contrasts of white and reddish colours, 3 'Judith Leyster' (a stable flower form, in the beginning of flowering petal colour is white with reddish edgings, which later become clearer and cover almost the whole petal area, 3 'Tambour Maitre' (one of the darkest and tallest from the red nuance Triumph group tulips), 4 'Ad Rem' (the whole of ornamental properties), 4 'Eric Hofsj ' (exceptional decorativeness, luxuriant growing) (Fig. 3), 4 'Scarborough' (harmony of ornamental properties, luxuriant growing), 5 'Aristocrat' (tallness of plant, uncommonness and clearance of flower colour, a perfect goblet form of flower), 6 'Ballade' (Fig. 3), 6 'White Triumphator', 8 'Groenland' (uncommon combination of greenish and reddish colours, stable form of flower) (Fig. 3), 10 'Black Parrot' (dark purple, almost black colour of flower, elegant form) (Fig. 3).

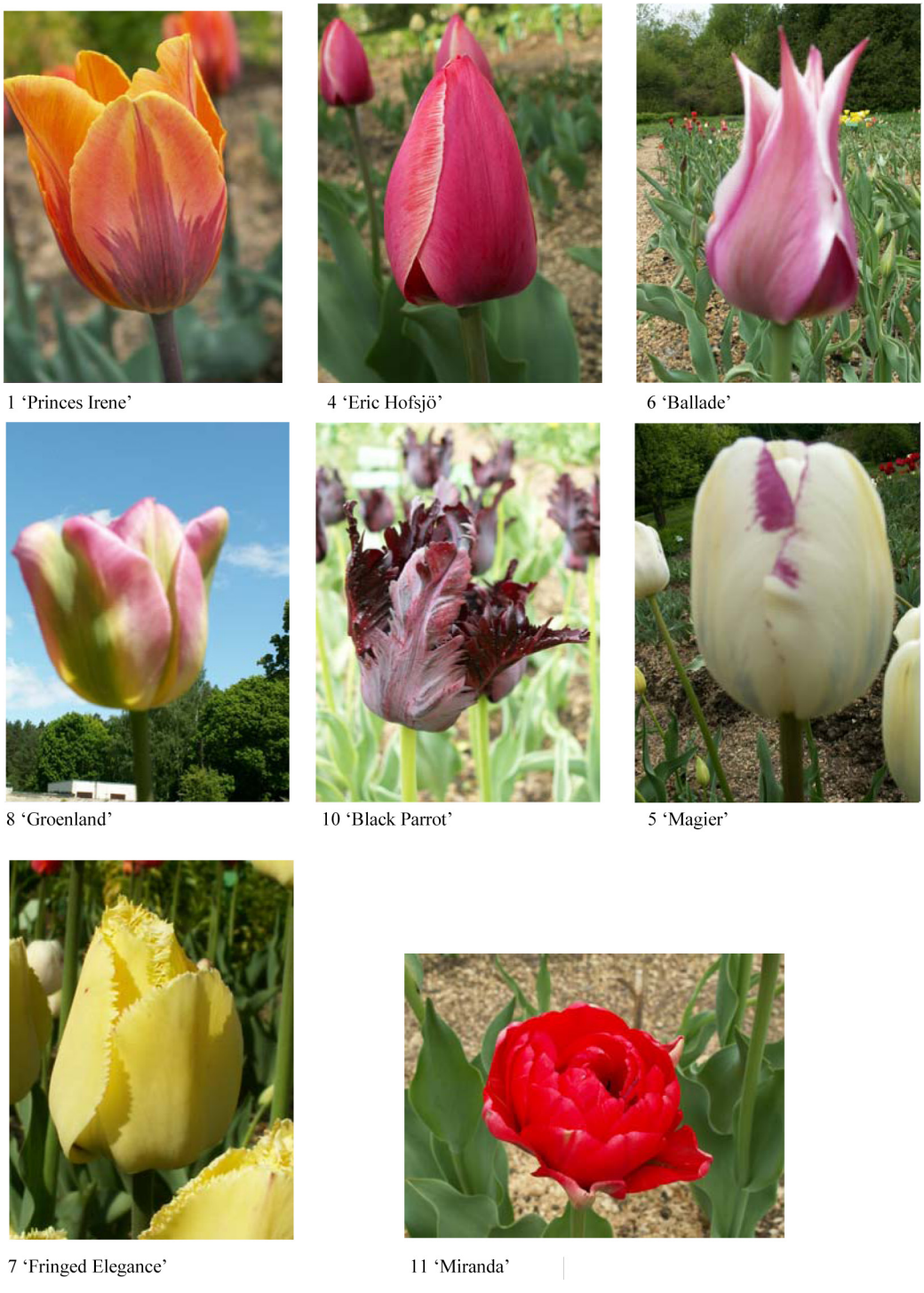

Fig. 3. Tulip cultivars of highest quality

5. Ornamental and resistant to TBV: 1 'Joffre' (a yellow flowering cultivar, long lasting flowering), 2 'Monte Carlo' (a splendid yellow flowering cultivar, long lasting flowering), 3 'Golden Melody' (tone of yellow colour remains through the whole flowering period, long lasting flowering), 5 'Magier' (Fig. 3), 5 'Maureen', 7 'Fringed Apeldorn', 7 'Fringed Elegance' (interesting changing of colour tone – yellow in the beginning of flowering, later covered with reddish shading) (Fig. 3), 7 'Maja' (one of the latest tulips, long lasting flowering), 7 'Swan Wings' (long lasting flowering, stable form of flower during all the flowering period), 11 'Miranda' (the perfect form of flower) (Fig. 3).

6. Cultivars with a high reproductive capacity: 3 'Lustige Witwe' (very productive, forcible cultivar), 4 'Apeldoorn', 7 'Fringed Apeldorn' (hardy and very reproductive).

Selected tulips will be preserved *ex situ* in the tulip collection of the Botanical Garden of Vilnius University. The research work will be continued because every year the collection is complemented with new tulip cultivars.

AKNOWLEDGEMENTS

This research work was supported by the State Scientific Programme No 8 "Investigation of plant genetic resources".

Received 7 January 2008
Accepted 19 May 2008

References

1. Baliūnienė A, Samsonaitė J, Tarvidas J. Svogūninės gėlės. Vilnius, 1983: 3–99.
2. Dash M. Tulipomania. London, 2001.
3. Hall AD. The genus *Tulipa*. London, The Royal Horticultural Society, 1940.
4. Killingback S. Tulips. London, 1991.
5. Van Eijk JP, Eikelbloom W, Hogenboom NG. Acta Hort 1986; 177: 399–403.
6. Boonekamp PM, Beijersbergen JCM, Franssen JM. Acta Hort 1990; 266: 177–81.
7. Buschman JCM, Roozen FM. Forcing Flowerbulbs. Hillegom, International Flower-Bulb Centre, 1980.
8. De Hertog AA, Blakely N, Barrett J. Sci Hort 1978; 9(2): 167–74.
9. De Hertog AA, Le Nard M. The Psysiology of Flower Bulbs. Amsterdam – London – New York – Tokyo, 1993: 617–83.
10. Gorin N, Sutfeld R, Tonecki J, Franssen JH, Haanapel N. Acta Hort 1990; 266: 221–7.
11. Hanks GR. J Hort Science 1982; 57: 109–19.
12. Hanks GR. Sci Hort 1985; 27(1–2): 153–61.
13. Inamoto K, Hase T, Doi M, Imanishi H. J of the Japanese Soc for Hort Science 2001; 69(4): 505–11.
14. Inamoto K, Sakoda S, Doi M, Imanishi H. J of the Japanese Soc for Hort Science 2000; 69(3): 353–61.
15. Jones SK, Hanks GR. Sci Hort 1985; 26(1): 87–96.
16. Kanneworff WA, Van der Plas LHW. Plant Science 1994; 104: 31–8.
17. Kuipers AM, Langens-Gerrits M. Acta Hort 1997; 430: 321–4.
18. Lambrechts H, Franssen JM, Kollöffel C. Sci Hort 1992; 52(1–2): 105–12.
19. Nelson PV, Niedziela JrCE. Sci Hort 1998; 74(3): 207–18.
20. Baliūnienė A, Juodkaitė R. Tulpės. Vilnius, 1991.
21. Anonymous. Classified List and International Register of Tulip Names. Hillegom, 1996.
22. Jundziłła XBS. Opisanie roslin. Wilno, 1791.
23. Strumiłło J. Ogrody Północne. Wilno, 1820.
24. Pabrėža A. BOTANIKA arba Taislius Auguminis. Shenandoah, 1900.
25. Dagys J, Kuprevičius J, Minkevičius A. Vadovas Lietuvos augalams pažinti. Kaunas, 1934.
26. Vailionis L. Lietuviškas botanikos žodynas. I dalis. Augalų vardynas, botaniškoji farmakognozinė nomenklatūra ir augalų sistema. Kaunas, 1938.
27. Baliūnienė A. Temperatūrinių sąlygų poveikis jacintų, narcizų bei tulpių svogūnų saugojimo metu, paspartinant jų pražydinimą. Miestų ir gyvenviečių apželdinimas. Vilnius, 1967: 283–94.
28. Балюнене А. Ботанические сады Прибалтики. Riga, 1971: 247–262.
29. Балюнене А. Интродукция растений в ботанических садах Прибалтики. Riga, 1974: 106–16.
30. Juodkaitė R, Baliūnienė A. Plant genefund accumulation, evaluation and protection in the botanical gardens. International Scientific Conference, Vilnius, 1999: 87–9.
31. Juodkaitė R, Baliūnienė A. Taikomųjų tyrimų būklė ir perspektyvos botanikos soduose. Tarptautinės mokslinės konferencijos pranešimai Vilnius, 2001: 115–17.
32. Juodkaitė R, Baliūnienė A, Jančys Z. Botanica Lithuanica 2003; 9: 209–27.
33. Juodkaitė R, Navalinskienė M. Lietuvos bioįvairovė (būklė, struktūra, apsauga). Vilnius, 2003: 33–4.
34. Juodkaitė R, Naujalis JR, Navalinskienė M, Samuitienė M. Biologija 2005; 4: 64–70.
35. Holtischer O. Pruhonicky sortiment tulipanu. Pruhonice, 1968.
36. Holtischer O. Pruhonicky sortiment tulipanu. Pruhonice, 1972.
37. Holtischer O. Pruhonicky sortiment tulipanu. Pruhonice, 1978.
38. Navalinskienė M, Samuitienė M. Dekoratyvinių augalų virusinės ligos ir jų sukėlėjai Lietuvoje. Kaunas, 2006.
39. Brunt AA, Crabtree K, Dalwitz MJ et al. Viruses of Plants. Descriptions and Lists from the VIDE Database. Cambridge, University Press, 1996.
40. Robinson DG, Ehlers U, Herken R et al. Methods of Preparation for Electron Microscopy. Springer-Verlag, Berlin, 1987.
41. Clark MF, Adams AN. J Gen Virol 1977; 34: 475–83.
42. Samsonaitė J. Žemdirbystės mokslinio tyrimo instituto darbai 1973; 16: 97–105.
43. Moore WC, Brunt AA, Price D et al. Diseases of Bulbs. Ministry of Agriculture, Fisheries and Food. 2nd edition. London, 1979.
44. Koster J, Kruijer CJ. Weekblad voor Bloembollencultuur 1981; 91: 1286–87.

R. Juodkaitė, A. Baliūnienė, J. R. Naujalis, M. Navalinskienė, M. Samuitienė

TULPIŲ (*TULIPA* L.) RŪŠIŲ IR VEISLIŲ ATRANKA IR PRISTATYMAS LIETUVOS AUGALŲ GENETINIAMS IŠTEKLIAMS

Santrauka

Straipsnyje pateikiama informacija apie tulpių (*Tulipa* L.) rūšių ir veislių auginimo Lietuvoje tradicijas, išnagrinėta introdukcinių tyrimų raida, išskirti du jos etapai. Pagal pagrindines nuostatas ir specifinius kriterijus atliktas introdukcinis tulpių rūšių ir veislių įvertinimas. Pagrindinės nuostatos: 1) dekoratyvinė vertė; 2) atsparumas virusinėms ligoms; 3) atsparumas grybinėms ligoms; 4) ištvermingumas klimatinėms sąlygoms; 5) aukštas tulpių svogūnų vegetatyvinio dauginimosi potencialas. Specifiniai tulpių atrankos kriterijai: 1) istoriškai svarbios tulpių rūšys ir veislės; 2) tam tikru laikotarpiu masiškiausiai augintos veislės; 3) mutabilios veislės; 4) tulpių rūšys ir veislės, išsiskiriančios unikaliomis dekoratyvinėmis savybėmis; 5) dekoratyvios ir ypač atsparios tulpių margligės virusui veislės; 6) mūsų krašto sąlygomis geriausiai vegetatyviai besidauginančios tulpių veislės.

Remiantis šiomis pagrindinėmis nuostatomis ir specifiniais atrankos kriterijais pagal programą „Augalų genetinių išteklių moksliniai tyrimai“ saugojimui buvo atrinktos ir darbe pristatytos tulpių rūšys bei veislės.