HETEROZES UN KOMBINATĪVĀS SPĒJAS IZVĒRTĒJUMS KUKURŪZAS VĀLĪTES SVARAM (*ZEA MAYS L.*), IZMANTOJOT DIALĒLISKO KRUSTOŠANU

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Pētījuma mērķis bija novērtēt kukurūzas 10 inbrēdo līniju (*Zea mays L.*) vispārīgo un specifisko kombinatīvo spēju. Lai veiktu novērtējumu, salīdzināts vālītes masa inbrēdajām līnijām un to F_1 hibrīdiem, kas iegūti, izmantojot dialēlisko krustošanu (bez reciprokajām kombinācijām). Ģenētiskās mainības komponenti tika aprēķināti izmantojot Grifinga (Griffing's) formulu (1956) $X_{ij}=\mu+gi+gj+s_{ij}+e$, lai noteiktu aditīvo un neaditīvo gēnu efekta ietekmi uz vālītes masu. Konstatēts, ka aditīvo gēnu efekts bija lielāks par neaditīvo gēnu efekts, jo attiecība starp vispārīgo un specifisko kombinatīvo spēju bija 0.25. Lielākais vālītes masa iegūts no hibrīdās kombinācijas L_6xL_{10} (vālītes svars vidēji 376.2 g), mazākais – kombinācijai L_1xL_{10} (vālītes masa vidēji 240.0 g); izmēģinājumā vidēji F_1 paaudzē vālītes masa bija 308.1 g. Salīdzinot ar vecākaugu līnijām, vālītes masa F_1 hibrīdiem bija būtiski lielāks nekā vecākaugiem un tas vidēji izmēģinājumā bija +68.1 grami katrai vālītei. Ar varbūtību $p\leq 0.01$ tika konstatēti būtiski vispārīgās un specifiskās kombinatīvās spējas efekti.

CONSERVATION AND EVALUATION OF EX SITU AND IN VITRO COLLECTIONS OF ESTONIAN PLANT GENETIC RESOURCES

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Abstract

The Estonian government has responded to the global efforts for conservation and sustainable use of biological diversity by ratifying international agreements and establishing the National Programme on Plant Genetic Resources for Food and Agriculture. The collection, identification and conservation of plant genetic material of Estonian origin as well establishing the network are the essential activities of the National Programme. Since genetic resources provide the initial material for plant breeders and scientists, systematic detailed investigations and the improved use of genetic resources are required.

In this study evaluation of 13 oat and 59 potato accessions conserved in the Estonian ex situ and in vitro genebank was conducted. Descriptors for evaluation were selected from the Descriptor Lists developed by the working groups of the European Cooperative Programme for Plant Genetic Resources and promoted by Bioversity International. The results of the current study will be used in updating the databases of plant genetic resources and these data are applicable in plant breeding for further utilization of accessions.

Key words: genebank, plant breeding, oats, potato

Introduction

Genebanks are dedicated to conserve plant genetic resources, which guarantee their utilization in the future (Maxted et al., 1997). According to the international commitment arising from the ratification of the Convention on Biological Diversity (Convention on …), each country is responsible for conservation and sustainable use of plant genetic diversity as a local cultural and historical heritage to enhance the expediency of crop cultivation and ensure the sustainable development of society.

To realise these goals, the Estonian Government approved the National Programme for Plant Genetic Resources for Food and Agriculture (PGRFA) in 2002. The mandate of the programme is the collection, conservation, evaluation, characterization and documentation of plant genetic

material of agricultural crops of Estonian origin, thus providing a basis for the future use of the genetic resource by plant breeders and researchers (Annamaa and Kukk, 2005).
The responsibility to conserve the Estonian PGRFA has been taken by the following institutions: the Jõgeva Plant Breeding Institute (Jõgeva PBI) – long term ex situ seed collection; the Department of Plant Biotechnology EVIKA of the Estonian Research Institute of Agriculture (EVIKA) – meristem plants in vitro; the Polli Horticultural Research Centre of the Estonian University of Life Sciences – fruits and berries; the Botanical Garden of Tartu University – medicinal and aromatic plants, ornamentals; and the Department of Gene Technology of the Tallinn University of Technology – molecular and genetic characterization of accessions. About 4500 accessions, mainly of Estonian origin, have been collected and maintained by the relevant stakeholders. All accessions are documented in accordance with the internationally agreed passport descriptors (FAO/IPGRI Multi-Crop …).
The International Treaty on PGRFA (International Treaty…) recognizes that the conservation, exploration, collection, characterization, evaluation and documentation of PGRFA are essential in meeting the goals for sustainable agricultural development for this and future generations. The Estonian Government, by approving the Treaty, has acknowledged the responsibilities and applied relevant finances for the second phase of the National Programme in the years of 2007–2013. During this period the main goal is to proceed with the characterization, evaluation and documentation of the maintained accessions. In the first place it is planned to focus on further investigation of crops whose regeneration is most urgent.
The evaluation and characterization of some crops such as oats, potato, wheat and forages has already been started during the first period of the National Programme. The varieties were characterized in field trials during which the identity of accessions was also checked in the field and in laboratories.
The aim of this study is to evaluate and characterize the oat accessions of Estonian origin conserved in the Gene Bank of the Jõgeva PBI and potato accessions conserved in vitro in EVIKA.

Materials and Methods

Oats. The oat collection was formed on the basis of breeders working collections at the genebank of the Jõgeva Plant Breeding Institute. In total, there are 13 oat varieties (Avena sativa L.) of Estonian origin conserved in the genebank.. Eight oat varieties, the oldest of which was Kehra saagirikas bred in 1929, were repatriated from the Vavilov Research Institute of Plant Industry (VIR) (Kukk and Annamaa, 2005) Safety duplicates of the accessions are maintained at the Nordic Genetic Resources Center. Descriptions of all Estonian oat varieties are presented in the publications of the Jõgeva PBI (Tamm, 2003). The evaluation, characterization and regeneration of the genebank accessions are carried out in cooperation with the breeding departments of the Jõgeva PBI.
Field experiments were conducted on 13 oat accessions at the Jõgeva PBI in the 2006 and 2007 growing seasons. 5 m2 plots were planted in two replications with the sowing rate of 600 seeds m2. The applied fertilizer level was N70P16K29 and a mixture of Lintur 70 WG (dicamba+triasulfuron) (120 g ha-1) and MCPA 750 (500 ml ha-1) was used for chemical weed control. The varieties Jaak and Villu were performed as standard varieties.
Oat accessions were characterized for 28 traits selected on the basis of biological and economical importance in Estonian conditions from the international oats descriptor list (Oats Descriptors, 1985). The accessions were visually assessed for 22 traits in the field (Table 1). Yield, grain moisture, 1000 grain weight, test weight and the percentage of husk for each accession were measured after harvesting. The protein content was determined by the Free and Open Source Software for Near Infrared Reflectance Spectroscopy (FOSSNIRS) system methods at the laboratory of the Jõgeva PBI.

Table 1. List of the descriptors of the oat collection observed in the field trial at the Jõgeva PBI during the growing season of 2006 and 2007.

1.	Growth habit	9.	Lemma colour	16.	Lodging at immature stage
2.	Plant height	10.	Kernel covering	17.	Lodging at mature stage
3.	Nodes hairiness	11.	Awnedness	18.	Crown rust
4.	Hairiness of leaf sheath	12.	Tillering	19.	Stem rust
5.	Hairiness of leaf margin	13.	Days to heading	20.	Powdery mildew
6.	Shape of panicle	14.	Days to harvest	21.	Loose smut
7.	Erectness of panicle	15.	Number of fertile tillers	22.	Spot blotch
8.	Erectness of spikelets				

Potato. Active collections of potato genetic resources are conserved at the Jõgeva PBI (field collection) and EVIKA (meristem plants in vitro). In the field collection there is a risk of germplasm loss due to unfavourable climatic conditions or pests infections and pathogens, which can be minimised by introducing germplasm into tissue culture. In the research institutions involved in the conservation activities, preservation with microtubers is widely used (Kostrica, 1987; Kwiatowski *et al.*, 1988; Espinoza *et al*., 1992; Dobranszki, 1997). In EVIKA a whole series of experiments were carried out with the aim to observe the influence of different culture medium components, growth conditions and other factors affecting plant regeneration, productivity and the prolongation of the sub-culturing interval. On the basis of these experiments, optimal preservation medium and long-term preservation conditions in vitro have been developed for many varieties. The microtubers are frozen for 1–1.5 years.

EVIKA has had the experience of preservation in vitro of potato varieties as well as breeding lines and local landraces for more than 20 years. All preserved accessions are disease-free and tested for virus infection many times. For the disease eradication the technology created in EVIKA is used (Kotkas and Rosenberg, 1999). The eradication system consists of 3 cycles: 1) the selection of the initial material, thermotherapy, the cultivation of meristem tips and testing for virus infection; 2) re-eradication and field-testing on varietal identity, quality and disease resistance; 3) renewal of the material.

Table 2. List of the evaluated descriptions of potato accessions in EVIKA in 2002–2004

1.	Growth habit	20.	Pigmentation of floral stalks	39.	Sprout shape
2.	Foliage cover	21.	Pigmentation of cork ring	40.	Sprout color
3.	Plant height	22.	Corolla size	41.	Sprout pigmentation intensity
4.	Stem thickness	23.	Corolla color	42.	Sprout pigmentation distribution
5.	Stem number	24.	Corolla color intensity	43.	Color of rootlets
6.	Wing size	25.	Size of white tips	44.	Sprout pubescence
7.	Wing shape	26.	Pigmentation of stigma	45.	Maturity
8.	Leaf size	27.	Berry set	46.	Foliage development
9.	Leaf pubescence	28.	Tuber shape	47.	Tuberization
10.	Leaf set on stem	29.	Tuber shape uniformity	48.	Number of tubers
11.	Leaf intensity of color	30.	Eye depth	49.	Tuber size
12.	Pigmentation of midrids	31.	Heel end	50.	Yield potential
13.	Number of leaflets	32.	Skin color	51.	Grading
14.	Terminal leaflet shape	33.	Skin pigmentation intensity	52.	Drought resistance
15.	Lateral leaflet shape	34.	Pattern of skin pigmentation	53.	Drought susceptibility
16.	Junction between leaflets	35.	Distribution of skin pigmentation	54.	General storage ability
17.	Secondary leaflets	36.	Skin texture	55.	Dormancy
18.	Degree of flowering	37.	Flesh color		
19.	Inflorescence size	38.	Flesh pigmentation		

The field trial was conducted on 31 potato (*Solanum tuberosum* L.) varieties and 28 valuable breeding lines of Estonian origin in 2002–2004 (Table 2). Each year of the experiment, the plant material initially preserved and propagated as *in vitro* meristem plants was used. The pre-growth and acclimatization of meristem plants was carried out in the greenhouse. Adding to in the field

collection and cultivation was accomplished with the potato cultivation technology created in EVIKA. 20 plants per accession, 1180 plants in total, were planted into the first year field collection. Rooting, quality of plants, flowering, disease resistance and true-to-typeness were estimated during the vegetation period. 40 tubers per accessions were separated during the harvest for establishment in the field collections in 2002, 2003 and 2004.
Potato accessions were characterized for 44 botanical (tubers 11; sprouts 6; plant 27) and 9 agronomical traits in accordance with the accepted evaluation method of potato accessions and international potato descriptors (Descriptors for …, 1977).

Results and Discussion

Oats. The standards of oats descriptors (Oats Descriptors, 1985) and The International Union for the Protection of New Varieties of Plants (UPOV, 2000) were followed compiling the list of characteristics evaluated in the field trial at the Jõgeva PBI in a two-year experiment. The weather conditions of both trial years were exceptionally dry, the drought considerably affected the traits of the tested varieties.
The data of economic data of plant breeders interests in particular (Table 3) are investigated hereafter.

Table 3. The evaluation of the oat accessions at the Jõgeva PBI (the average of 2006 and 2007)

Accession number	Variety	Registr. year	Yield, kg ha^{-1}	Plant Height cm	Growing period days	1000 g Weight G	Spot blotch points	Protein content g kg^{-1}	Husk content g kg^{-1}	Test weight g l^{-1}
JPBI 4	Jaak	1995	3026	76	87	36.1	3	152	254	473
JPBI 13	Villu	1999	3015	68	89	32.8	3	145	245	496
JPBI 9	Kehra saagirikas	1929	2542	86	93	33.7	5	158	248	493
JPBI 7	Jõgeva roostekindlam	1930	2574	87	93	31.6	4	175	262	474
JPBI 10	Kehra varajane	1930	2638	87	90	32.5	3	156	257	477
JPBI 5	Jõgeva agu	1939	2336	79	93	32.9	4	171	247	454
JPBI 6	Jõgeva koidukaer	1939	2402	81	90	35.0	3	148	252	481
JPBI 8	Jõgeva seisukindlam	1939	2457	79	93	30.9	3	166	252	444
JPBI 3	Hämarik	1952	2653	87	92	33.5	4	156	276	495
JPBI 2	Ella	1976	2836	74	91	35.4	4	154	273	477
JPBI 12	Viker	1980	2732	84	92	33.8	4	159	261	489
JPBI 1	Alo	1986	2732	73	91	30.5	3	153	259	471
JPBI 11	Miku	1991	2906	68	88	31.0	3	139	249	515
LSD 0.05			182	4	2	1.7	0.5	9	10	9

Due to dry conditions there was no occurrence of the most widespread plant diseases in Estonia such as crown rust and black stem rust. Spot blotch was observed to a low to moderate level in both years, 3–5 points on a 9–point scale. Most varieties displayed almost equal levels of spot blotch infection, only Kehra saagirikas was more susceptible than the others.
The grain yield of the standard varieties Jaak and Villu exceeded the old varieties by about 7–30 %. The old varieties Jõgeva agu and Koidukaer showed the lowest yielding capacity.
In normal growing conditions the average 1000 grain weight of oats at the Jõgeva trials is 38 g (Tamm and Tamm, 2002) but in the dry trial years 2006 and 2007 it was significantly smaller. The varieties Jaak, Ella and Koidukaer were distinguished for large size of their kernel.
Standard variety Jaak is the tallest listed variety in Estonia but older varieties were even taller. Previous studies have shown that oat plants are usually about 20–30 cm taller in comparison to the 2006–2007 trial years which had dry conditions. The plant height of the older varieties exceeded by 6–19 cm the medium-height standard variety Villu. Older varieties are possibly more susceptible to lodging. No lodging however was observed in any of the cultivars over the trial period.
The duration of the vegetative period (days to harvest) is a very important trait in oat cultivation and is directly correlated with grain yield and its quality (Loskutov, 2005). The earliest variety was Jaak (87 days). All older varieties had a longer growing period than the standards.

The protein content was high in comparison to the results obtained by the Jõgeva PBI in field trials during the last decades. Some obsolete varieties (Jõgeva agu, Jõgeva roostekindlam) appeared to have high protein content compared to modern varieties.
The average husk content at the Jõgeva trials has been about 25 %. The Husk content of most of the older varieties was close to standard Jaak. Some older varieties exceeded the standards. There were no varieties characterised by low husk content.
The test weight of the majority of the obsolete varieties was equal or higher than that of the standard variety Jaak but lower compared to the standard variety of Villu.
The evaluation of the Estonian accessions will continue along with the evaluation of about 600 European oat accessions at the Jõgeva PBI within the framework of the project of the European Community programme "Avena genetic resources for quality in human consumption – AVEQ" in 2008–2010 (Avena genetic resources…). In addition to the descriptors characterized in 2006–2007, color of lemma, the emergence and the number of seeds per panicle will be observed in the field in six countries. Fat content and mycotoxin contamination will be analysed in laboratories.
Potato. 44 botanical characteristics and 9 agronomical characteristics of 59 Estonian potato accessions preserved the *in vitro* genebank in EVIKA were evaluated. The evaluation of potato cultivars based on phenotypic characteristics can be affected by environmental factors, therefore the evaluation was performed for three times. The average climatic conditions for a 3 year period were quite similar and every time the same persons were involved in the evaluation process. On account of this the results differed through the years only 1…2 points in scope in the case of plant height, degree of flowering, number of tubers and tuber size.
In the field collection evaluation were performed three times. The summarized data were analyzed and used to update the database. Also a catalogue with the definitions of the evaluated descriptors and character references per accessions was assembled.
All information obtained is available for potential potato genetic resource users in Estonia and abroad at the present on request, and also soon on the internet
The results of this study provide valuable information about the influences of long-term in vitro preservation on the genetic stability of potato meristem plants. The medium-term preservation of potato genetic resources as meristem plants in vitro does not affect the genetic stability of the genotypes.
In vitro preserved accessions can be used as an initial material for breeding, research, for the propagation of disease-free material for seed production and for the establishment of field collections.

Conclusions

The conservation of the national heritage of plant genetic resources for food and agriculture is an obligation of every stakeholder confirmed by international agreements. Estonian PGR institutions have fulfilled their commitment in accordance with the International Treaty on PGRFA and the common guidelines of the European Cooperative Programme for Plant Genetic Resources (ECPGR). Passport descriptors of Estonian accessions were assessed and recorded in the national database during the first phase of the Estonian National PGR Programme in 2002–2006. The main objectives for the programme period 2007–2013 are the evaluation and characterization of maintained accessions according to the internationally agreed descriptors.
Relevant investigations were commenced on oat and potato accessions. The results of the current study are important for complementing the database of the Estoian PGR which in addition to the passport data and the evaluation and characterization data of potato and oats provides more detailed information about the accessions. Besides, the evaluation data of internationally agreed descriptors will be included in the European Crop Databases of the ECPGR and the European Plant Genetic Resources Search Catalogue (EURISCO), which makes the Estonian material more available for other institutions and at the same time it widens the genetic base of our local breeding opportunities.
The evaluation of the oat accessions of Estonian origin will continue during of 2008–2010 in the framework of the European Community project "Avena genetic resources for quality in human consumption – AVEQ".

The follow-up project was carried out in EVIKA for the evaluation the next set of 60 potato accessions, including 26 landraces and 10 older varieties in 2005–2008.

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IGAUNIJAS AUGU ĢENĒTISKO RESURSU *EX SITU* UN *IN VITRO* KOLEKCIJU SAGLABĀŠANA UN NOVĒRTĒŠANA

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Igaunijas valdība ir atsaukusies uz globālajiem bioloģiskās daudzveidības saglabāšanas un ilgtspējīgas izmantošanas centieniem, ratificējot starptautiskos līgumus un izveidojot nacionālo pārtikas un lauksaimniecības augu ģenētisko resursu programmu. Nozīmīgas programmas aktivitātes bija Igaunijas izcelsmes augu ģenētiskā materiāla savākšana, identificēšana un saglabāšana kā arī sistēmas izveidošana. Tā kā ģenētiskie resursi nodrošina izejmateriālu selekcionāriem un zinātniekiem, ir nepieciešami detalizēti pētījumi un jāpilnveido ģenētisko resursu izmantošana.
Šajā pētījumā veikta 13 auzu un 59 kartupeļu paraugu novērtēšana, kas tiek glabāti Igaunijas *ex situ* un *in vitro* gēnu bankā. Novērtēšanas deskriptori tika atlasīti no Eiropas Augu ģenētisko resursu kooperatīvās programmas darba grupu izveidotā un Bioversity International atbalstītā deskriptoru

saraksta. Šā pētījuma rezultāti tiks izmantoti augu ģenētisko resursu datu bāzu papildināšanai un šie dati ir pielietojami tālākai paraugu izmantošanai augu selekcijā.

NEW POTATO VARIETIES RESEARCH IN LITHUANIA

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Abstract
Potato breeding and seed production in Lithuania is carried out at the Voke Branch of the Lithuanian Institute of Agriculture. Potato breeding work involved Lithuanian potato varieties, varieties from various collection and hybrids. Potato crosses were done at the autotetraploid level in the glasshouse and potato variety collection field. Up to two million hybrids were tested in the trial fields. The key objective was to select the varieties immune to wart disease, cyst nematodes, with high resistance to other diseases, with exellent agronomic and cooking qualities, suitable for the processing industry. As the result of breeding work five new varieties were produced: Venta, VB Rasa, VB Liepa, Goda and VB Aista. They all are immune to the worst potato disease - wart (*Synchtrium endobioticum* Schilb.). Most of them are resistant to a local patotype of nematodes (*Globodera rostochiensis* Woll.). Other advantages such as good yield, excellent cooking qualities, good taste or attractive shape were the main items in producing Lithuanian potato varieties as well. Potato seed production from meristem tissue at biotechnologic laboratory is carried out in the Voke branch of Lithuanian Institute of Agriculture. It is the centre for potato seed production in Lithuania.

Key words: potatoes, potato breeding, resistance to nematodes and diseases

Introduction
For years potatoes have been a staple food crop in Lithuania. Potatoes were grown on every farm by everyone who had land for agricultural purposes. The main potato uses in Lithuania are for human consumption, livestock feeding and manufacturing.
Potatoes are usually bred using the hybridization method (Chauvin *et al*., 2003). Parental plants which have perfect quality features such as high yielding, earliness, resistance to diseases and pests, dry matter content and can pass on these traits to their progeny are the desired ones. In the potato breeding process the most important are the varieties and hybrids which belong to or have progeny of nine systematic groups: *Comersoniana, Glabresantia, Acaulia,* and *Transa equaatorialia, Andigena, Tuberosa, Longipedicellata, Demissa* and *Pinnatisecta*. They give proper genetic diversity for the cultivated potato varieties (Lough *et al*., 2001).
The most effective and most expensive way to fight nematodes is by breeding new varieties, resistant to nematodes. Potato varieties which have no resistance against nematodes die without yield production in soils with high number of nematodes. Resistant varieties in the infected fields decrease the number of nematodes in the soil (Razukas, 2002). Resistant variety can decrease the number of the nematodes up to 70 %. Potato nematodes are quarantined in Lithuania. The import and export of infected tubers is strictly forbidden.
Another very important quarantined potato disease is wart disease (*Synchtrium endobioticum* Schilb.). The best way to fight wart disease is to grow resistant varieties. The growing of resistant varieties decreases wart infection in the field. The infection usually disappears after ten years. It is obligatory for all new potato varieties to have wart resistance for growers in the Republic of Lithuania.
In Lithuania and in all European countries it is quite important to secure a potato harvest in order to bring it to a summer market as soon as possible, when prices are higher (Bradshaw *et al*., 2006). The developing Lithuanian potato industry also needs potatoes suitable for chips production, because the main crop variety after a long storage time. From the agrotechnic point of view potatoes are also greatly valued because of their short growing period. In crop rotation, the field