

Selekcija ir sėklininkystė *Selection and Seed Growing* *Селекция и семеноводство*

Potato breeding for nematode and disease resistance

Almantas Ražukas,

Juozas Jundulas

*Vokė Branch of the Lithuanian
Institute of Agriculture,
Žalioji a. 2, LT-02232 Vilnius,
Lithuania,
e-mail sekretoriatas@voke.lzi.lt.*

Potato breeding has been performed at the Vokė Branch of the Lithuanian Institute of Agriculture since 1958. The key objective of potato breeding is to produce early potato cultivars immune to wart disease *Synchytrium endobioticum* (Schilb.), resistant to *Globodera rostochiensis* (Woll.) pathotype of nematodes and major potato diseases. As a result of the breeding work seven potato cultivars of different maturity have been selected. Based on the high disease and pest resistance records, the cultivars and promising hybrids from this breeding program have been recommended for cultivation on ecological farms.

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

INTRODUCTION

In Lithuania potatoes are one of the staple food crops. They have been very popular since olden times. Per capita potato production over the last years has reached up to 500 kg annually. Average potato yields in the past years were low in the country because of bad soil management, late fungicide applications and low quality potato seed [5, 7, 11].

Breeding is one of the main ways to produce stable potato cultivars with good resistance to unfavourable climate conditions, fungal and bacterial diseases, virus infection and pests [1, 2, 6]. Cultivation of high quality seed potato, stable cultivars, timely applications of fungicides provide a possibility of achieving good results. Theoretically, there are ways to increase potato yields up to 80 tons per hectare. Such yields were obtained in a potato breeding field without any special fertilization [4].

Breeding of new potato cultivars is time-consuming and expensive work. But if a stable cultivar is created, it covers many years' expenses [3]. The main targets in the potato breeding program were resistance to potato cyst nematodes, immunity to wart disease, good farming and marketing characteristics of the new hybrid clones [10, 12]. Genetic methods were also employed in the breeding of the new cultivars to achieve higher frost and disease resistance [8].

MATERIALS AND METHODS

The potato breeding work was performed at the Vokė Branch of the Lithuanian Institute of Agriculture with the potato collection including cultivars and clones from the Russian Plant Institute of Saint Petersburg, modern cultivars from private companies and other world collections. During the twelve experimental years, over 300.000 hybrids were tested in the trial fields. All seed-lings were grown on a sod podzolic sandy loam soil in the crop rotation field. The potato trial was fertilized with organic manure and mineral fertilizers (N₉₀P₉₀K₉₀). For crossings, tubers of parent plants were planted in a greenhouse in the peat and organic manure mixture on the bricks. After crossings potato plants produced berries. They were collected and seeds were selected. The following year potato seeds were planted in a growth chamber with a controlled climate and photoperiod. After a month the plants were transferred to the greenhouse and planted in the peat pots. When the danger of spring frosts had passed, the plantlets were trans-planted in the potato breeding field. Each plantlet was inspected during the first vegetation period. The main quality indicators were estimated: foliage growth and development habit, resistance to bacterial and fungal diseases, number, uniformity and shape of tubers. In the second and subsequent years potato hybrids were grown in the trial plots. They were planted by hand in rows. All plots were fully randomi-

zed and replicated four times. Plot size differed between years, but the feeding area per plant was always the same (0.7 m × 0.35 m). During the first three years after crossing potatoes were harvested by hand, in later trials by a potato digging machine. Tubers were stored in the potato storage during the winter season.

One of the main potato breeding factors is the yielding capacity of a new cultivar. Potato yield was determined using scales Hana Giant KV-200, dry matter content by modified scales Kern EW 600-2M. Disease evaluation was performed using certified methodology. Immunity to potato wart disease and resistance to cyst nematodes tests were performed at the Plant Protection Institute of Belarus. Virus tests were performed by an electronic microscope at the Institute of Botany.

RESULTS AND DISCUSSIONS

Potato breeding was started at the Vokė Branch of the Lithuania Institute of Agriculture in 1958. Research on the new potato cultivars' resistance to diseases and pests has been performed since 1965. Since 1990 there have been tested 226,300 potato seedlings in the first year after crossing. The breeding lines characterised by the best shape, yield, tuber size and good resistance to potato blight and other fungal diseases were selected for the second year potato seedlings. Only 54,724 plantlets (24%) were left from the first year seedlings. All plantlets from the second year trial were tested at the Institute of Plant Protection of Belarus. The plantlets that exhibited resistance to potato cyst nematode (*Globodera rostochiensis* R₀₁) and immunity to potato wart disease (*Synchytrium endobioticum*) were selected for further trials. After the second year of trials and tests, there were left only 589 promising seedlings, or only 1% of the second year seedlings. The seedlings were tested in the control trials (third year hybrids). From this trial field there were selected 223 clones (38% from the last year trial) for promising variety trials for 1–2 years. After that, there were tested 102 promising tubers (46% from the promising variety trials) in the competitive trials for 2–3 years. During potato trials the main attention was focused on the yield, tuber uniformity, size, and shape, eye depth, resistance to the diseases such as common scab (*Streptomyces scabies*), rhizoctonia (*Rhizoctonia solani*), late blight (*Phytophthora infestans*), viruses, immunity to the wart disease (*Synchytrium endobioticum*), and potato cyst nematode (*Globodera rostochiensis*) [3].

The most promising cross-breeds of the potato breeding program resulted in the new potato cultivars of different maturity groups: first early 'Venta', second early 'Vokė', 'Goda' and 'Vaiva', maincrop 'Nida' and 'Mirta' and late 'Aistės'. Technical description characteristics of the selected potato cultivars are presented in Table 1.

The potato cultivars 'Vokė', 'Aistės', 'Nida', 'Mirta', 'Venta', 'Vaiva' and 'Goda' were developed at the Vokė Branch of the Lithuanian Institute of Agriculture [9]. The mean quality data of these cultivars are pre-

sented in the Table 2. The last five years of testing in the competitive potato trials showed that the lowest tuber yield (27.9 tones per hectare) was produced by the cultivar 'Venta', whereas longer maturity potato cultivars 'Goda', 'Nida', 'Mirta' produced over 30 tones per hectare. The highest mean potato yield was recorded when growing potato cultivar 'Goda' in the Lithuanian potato breeding program. It produced a yield of 35.2 tones per hectare of seed potatoes. Potato quality data suggest that starch content depended on the cultivar's genetic pedigree and growing purpose. The highest starch content (over 20%) was identified in the potato cultivar 'Aistės', whereas in the shorter maturity potato cultivars the content of starch amounted to up to 18%. The cultivars tested differed in the number of tubers per plant. The potato cultivar 'Goda' produced over 16 tubers per plant. The cultivar was also characterised by the greatest mean weight per tuber amounting to over 63 g. The tested cultivars exhibited good disease resistance. The cultivars 'Vokė', 'Nida' and 'Aistės' were found to be more susceptible to common scab. Over 60% of the potato tubers of these cultivars had common scab injuries. The tubers of the cultivar 'Mirta' exhibited the lowest resistance to late blight. All cultivars produced high quality table tuber yield not only on large-scale potato production farms but also on smaller plots and hobby growers' gardens [10]. The significance of the results of the Lithuanian potato breeding program is high. One potato cultivar was selected from about 200 hybrid crosses and 200 thousand of the first year hybrid seedlings, whereas in the world practice one potato cultivar is selected from one million seedlings [4].

All cultivars are immune to wart disease, which is one of the main quarantine objects in Lithuania. The potato cultivars 'Goda', 'Mirta', 'Nida', 'Aistės', 'Vaiva' exhibited resistance to potato cyst nematode *Globodera rostochiensis* R₀₁ pathotype. Wart disease and nematode tests were performed at the Plant Protection Institute of Belarus. The cultivars showed good field resistance to the most widespread diseases black leg, viruses, common scab, rhizoctonia and others. Their foliage is fairly resistant and tubers have comparatively good resistance to the late blight. Storage characteristics under controlled conditions are good.

The main research objective of the Lithuanian potato breeding program is to develop potato cultivars immune to wart and resistant to nematodes using hybrid cross and further selection methods. Resistance and immunity were in the progeny of parental material of the new cultivars. Based on the high disease and pest resistance records the Lithuanian potato cultivars are recommended for cultivation on ecological farms [12].

CONCLUSIONS

The potato cultivars 'Venta', 'Vokė', 'Vaiva', 'Goda', 'Nida', 'Mirta', 'Aistės' have been developed at the

Table 1. Technical description of the Lithuanian potato cultivars

Characteristics	Vokė	Aistės	Nida	Mirta	Venta	Vaiva	Goda
Parentage	Majestic x No. 323	(Olympia x Olev) x (Severnaja x Sagitta)	Amaryl x (Sagitta x Olev)	Fryla x No. 17/6	Priekulu visagrie x Pirmūnės	Hanibal x Anosta	Ausonia x Franzi
Agronomic – foliage characteristics							
Early yield	8	3	6	6	9	7	8
Mature yield	8	8	9	9	8	6	9
Number of tubers	9	8	8	8	8	6	9
Foliage height	3	3	5	5	5	5	3
Foliage maturity	8	3	6	6	9	7	8
Foliage development	8	7	9	9	8	6	8
Drought resistance	7	1	8	9	8	7	7
Sprout colour	7	3	7	5	7	7	7
Flowers number/colour	3/2	7/1	7/2	3/1	3/3	4/2	7/2
Setting of berries	1	2	9	2	5	3	3
Tuber depth	m	m	m	m	m	m	m
Tuber distribution	CL	CL	CL	CL	CL	CL	CL
Stolon attachment	L	L	L	L	L	L	L
Tuber characteristics							
Skin colour	2	1	1	1	1	2	1
Flesh colour	4	3	1	4	3	5	4
Tuber shape	5	3	1	3	1	5	3
Shape, uniformity of shape	6	9	7	8	8	7	9
Tuber size	9	6	7	8	8	6	8
Uniformity of size	6	9	8	8	8	6	8
Eye depth	5	3	3	3	5	3	3
Internal bruising	8	8	8	8	8	8	8
Second growth	8	8	8	8	8	8	8
Skin texture	Sm	Sm	N	Sm	Sm	Sm	Sm
Appearance	8	9	8	9	9	8	8
Pests and disease characteristics							
Foliage blight	4	9	5	5	3	5	5
Tuber blight	8	8	8	8	8	8	8
Blackleg	8	8	8	8	8	8	8
Common scab	7	7	7	7	7	8	8
Viruses	8	8	8	8	8	8	8

Key: 0 – low (bad) – 9 – high (good); tuber depth: m – medium; tuber distribution: CL – clustered; stolon attachment: L – loose; skin colour: 1 – yellow, 2 – red; flesh colour: 1 – white, 3–5 – yellow; tuber shape: 1 – round oval, 3 – flatly round, 5 – oblong; skin texture: Sm – smooth.

Table 2. Quality parameters of the Lithuanian potato cultivars in the competitive trials, 2000–2005

No.	Variety	Yield, t ha ⁻¹	Starch, %	Dry matter, %	Number of tubers per plant	Mean weight per tuber, g	Susceptibility to common scab, %	Tubers vulnerability to late blight, %
1.	Venta	27.9	15.0	20.2	11.9	55.7	25.2	0.3
2.	Vokė	33.4	16.8	20.5	15.6	45.4	67.3	0.3
3.	Vaiva	30.4	17.3	21.4	12.6	43.2	0.5	0.2
4.	Goda	35.2	17.0	21.0	16.3	63.1	20.8	0.2
5.	Nida	25.1	16.1	23.2	9.3	71.3	62.0	0.3
6.	Mirta	22.2	16.6	21.3	13.4	48.2	40.6	0.5
7.	Aistės	28.4	20.3	24.7	10.5	46.5	60.4	0.4
	LSD ₀₅	3.4	1.3	1.8	4.3	19.4	33.8	0.2

Vokė Branch of the Lithuanian Institute of Agriculture. The cultivars produce high quality yield not only on large scale potato production farms but also on small garden plots.

All cultivars are immune to wart disease, which is one of the main quarantine objects in Lithuania. The potato cultivars 'Goda', 'Mirta', 'Nida', 'Aistės', 'Vaiva' are resistant to potato cyst nematode *Globodera rostochiensis* Ro₁ pathotype. All cultivars exhibit good field resistance to the most widespread diseases black leg, viruses, common scab, rhizoctonia and others. Their foliage is fairly resistant and tubers exhibit higher resistance to late blight. Storage characteristics under controlled conditions are good. Due to the high disease and pest resistance all Lithuanian potato cultivars are well-suited for cultivation on ecological farms.

Received 7 February 2006

Accepted 25 August 2006

References

1. Bujauskas A. V. Bulvių selekcija. Vilnius, 2001. P. 36–41.
2. Bujauskas A., Lazauskas J. Atsparių nematodams, ūkiškai vertingų bulvių veislių sukūrimas Vokėje // Žemės ūkio mokslai. 1995. P. 45–51.
3. Bujauskas J., Jundulas J., Ražukas A. Breeding potatoes with resistance to potato cyst nematodes // Biologija. 1996. P. 31–32.
4. Jundulas J., Ražukas A. Bulvių biologija ir jų auginimas. Vilnius, 1997. P. 7–13, 38.
5. Lazauskas J. Augalininkystė Lietuvoje. Vilnius, 1987. P. 15–40.
6. Lazauskas J., Dapkus R. Lauko augalų selekcija Lietuvoje. Vilnius, 1992. P. 123–132.
7. Lazauskas J., Simanavičienė O. Bulvės. Vilnius, 1995. P. 4–124.
8. Proševičius J., Staševskij Z., Jundulas J. Somatic hybrids between potato *Solanum tuberosum* L. and frost-resistant species. Comersonii dun // Horticulture and vegetable growing. 1998. Vol. 17. N 3. P. 91–98.
9. Ražukas A. Bulvės. Biologija, selekcija, sėklininkystė. Vilnius, 2003. P. 20–36.
10. Ražukas A., Jundulas J. Achievements in potato breeding in Lithuania // Agriculture. Scientific Articles. 2002. Vol. 78. N 2. P. 193–200.
11. Tyla J. Bulvių kultūra Lietuvoje. Vilnius, 1979. P. 19–28.
12. Букасов С., Камераз А. Селекция и семеноводство картофеля. 1972. С. 56–58.

Almantas Ražukas, Juozas Jundulas

NEMATODAMS IR LIGOMS ATSPARIŲ BULVIŲ SELEKCIJA

S a n t r a u k a

Bulvių selekcija Lietuvos žemdirbystės instituto Vokės filiale vykdoma nuo 1958 m. iki šiol. Šio darbo rezultatas – sukurtos skirtingos vegetacijos bulvių veislės: 'Venta', 'Vokė', 'Vaiva', 'Mirta', 'Nida', 'Aistės' ir 'Goda'.

Bulvių veislės pasižymi pakankamai dideliu prekinių gumbų skaičiumi, geru derliumi, pakankamai dideliu krakmolo ir mažu redukuojančio cukraus kiekiu, todėl jos tinkamos perdirbimo pramonei, turi gerų kulinariinių ir skonio savybių.

Visos veislės turi imunitetą pagrindinei bulvių karantininei ligai Lietuvoje – bulvių vėžiui. Bulvių veislės 'Aistės', 'Mirta', 'Nida', 'Goda', 'Vaiva' atsparios ir Lietuvoje paplitusiai bulvių nematodų rasei – *Globodera rostochiensis* Ro₁ patotipui. Šių veislių bulvių augalai ir gumbai mažai pažeidžiami grybinių ir bakterinių ligų, todėl rekomenduojama auginti ir ekologiškuose ūkiuose.

Raktažodžiai: bulvės, bulvių selekcija, atsparumas nematodams ir ligoms

Алмантас Ражукас, Юозас Юндулас

СЕЛЕКЦИЯ КАРТОФЕЛЯ НА УСТОЙЧИВОСТЬ К НЕМАТОДАМ И БОЛЕЗНЯМ

Р е з ю м е

Селекция картофеля в Литве в Вокеском филиале Литовского института земледелия начата в 1958 г. и непрерывно ведется до наших дней. В процессе селекционной работы созданы следующие сорта различной скороспелости: 'Вента', 'Воке', 'Вайва', 'Мирта', 'Нида', 'Айстес' и 'Года'.

Все эти сорта высокоурожайные, отличаются хорошими товарными и вкусовыми качествами, имеют много крахмала и мало редуцированного сахара. Клубни всех сортов Литовской селекции обладают хорошими кулинарными и вкусовыми качествами, пригодны для переработки на полуфабрикаты и другие пищевые продукты.

Все эти сорта картофеля устойчивы к раку картофеля. Сорта 'Айстес', 'Мирта', 'Нида', 'Года', 'Вайва' имеют иммунитет к картофельным нематодам – патотипу *Globodera rostochiensis* Ro₁.

Вышеназванные сорта, как имеющие высокий иммунитет к основным грибным бактериальным болезням, вполне пригодны для выращивания в экологических хозяйствах.

Ключевые слова: селекция картофеля, устойчивость к нематодам и болезням