Saatgut Österreich

59. Tagung der Vereinigung der Pflanzenzüchter und Saatgutkaufleute Österreichs 2008, 47 – 50
ISBN: 978-3-902559-28-9

Introduction to the current results of potato breeding programme at Keszthely

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Abstract

At Keszthely a 50 years long resistance breeding program prospers based on the utilisation of wild species germplasm and strict selection for combining quality traits with complex biotic and abiotic resistance. Most of the research projects promotes this programme also. Currently the Centre has 12 released varieties being unique in their kind, where resistances are combined with high yielding ability, excellent table quality as well as a range of cooking types, flesh and skin colour.

The efficiency of breeding for PVY resistance started to be enhanced by developing of parental lines having the resistance gene in hetero duplex state where resistance genes originates from different species and by developing DNA markers linked to the gene of Ry_{sto}. Four RAPD marker and one SCAR marker was developed and tested to identify Ry_{sto} gene in crossing populations and in varieties. Using commercial and biotech breeding techniques new variety candidates were bred having complex resistance and high chipping quality.

Key words: pathogen resistance, resistance breeding, wild Solanum species, chipping quality, markers assisted selection

Variety breeding

Hungarian ecological conditions due to the high number of aphids throughout to the whole growing season are highly favourable for virological degeneration of potato. By the appearance of new potato virus Y strains, the tobacco necrotic strain in the early sixties and tuber necrotic strain in early eighties, old local varieties being susceptible for these viruses completely disappeared from production. In 1960 a breeding program was started at Keszthely to develop new varieties where quality traits are combined with wide range of biotic and abiotic stress resistance. The program intensively utilised the germplasm of different potato species by the application of artificial infection and mass selection techniques (*Table 1*). From the program currently 12 released variety is on the list of EU. These varieties are unique in their kind. All of them have extreme resistance (immunity) to PVY, PVX and PVA, high field resistance to PLRV. Out of the twelve 9 variety has resistance to cyst nematode (*G. rostochiensis*), potato wart (*S. endobioticum*) and common scab (*S. cabbies*). More over two varieties has high resistance to potato late blight (*P. infestans*) as well. As the varieties were selected under non irrigated, continental climatic conditions they show higher tolerance to heat and drought stress as well as higher physiological stability then varieties bred under more preferable conditions for potato. The resistances are combined with high yielding ability, good table quality and taste, and a variety of cooking types, flash and skin colour. In 2006, variety Vénusz Gold having one of the most complex resistance was released as specially advised for organic production by the Hungarian Agricultural Qualification Institute.

Table 1: **Main potato species used in the breeding program to introduce resistance genes into new varieties**

Species	Resistance gene for
Solanum tuberosum	PLRV
S. tub. ssp. *andigenum*	PLRV, nematodes
S. stoloniferum	PVY, PVA
S. acaule	PVX
S. demissum	Phytophtora
S. hougasii	PVY, PVS
S. vernei	nematodes
S. brevidens	PLRV, Erwinia ssp.
S. sparsiphyllum	Verticillium
S. tariense	Pests resistance

Since 12 years ago a sub breeding program was started to develop industrial varieties with complex resistances. Up till now considerable results were achieved on development of new breeding lines where virus, nematode, wart and late blight resistance is combined with wanted low sugar and high dry matter content, acceptable frying colour and round shape, yellow skin (*Figure 1*). A number of variety candidates are available now for intensive testing before entering registration process.

Enhancing selection process

Development of parental lines caring PVY resistance gene in a hetero multiplex state

By the use of parental lines having the resistance gene in duplex, triplex or even quadruplex state the ratio of resistant genotypes in their progenies from a cross with a susceptible parent can be dramatically increased. Consequently the selection process for the combination of resistance with quality traits can be more effective. In multiplex genotypes were the alleles originates from different sources (eg. different species) the achieved resistance can be more durable

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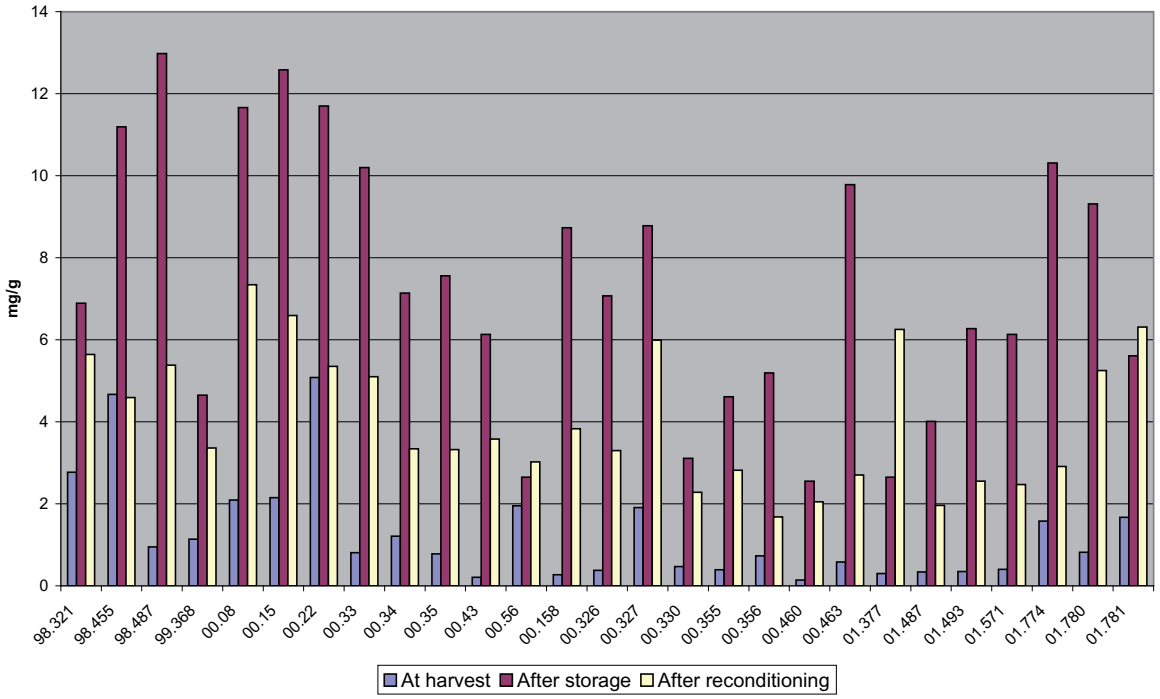

Figure 1: **Reducing sugar content of potato breeding lines at different stage of storage**

compared to genotypes were the resistance is based only on one particular allele. In the past PVY showed up its tendency to form new resistance breaking strains (N and NTN). Breeding efforts were made to develop parental lines where the PVY resistance gene is in a hetero multiplex state, where alleles are originating from different wild potato species (POLGAR et al. 2002). Currently these lines are intensively used in our breeding programme.

Development of molecular markers linked to the extreme resistance gene Ry of S. stoloniferum

The efficiency of commercial breeding for resistances can be elevated by the use of genetic markers linked to the resistance gene (MAS). For this purpose we developed four RAPD markers linked to the Rysto gene by bulk segregant

Table 2: **Segregation ratio of potato breeding lines for PVY resistance in test crosses**

Line	Tested No.	Healthy No.	Infected No.	Infected %	Ch^{i2}
89.243	275	236	39	39492	1,223*
90.315	225	187	38	39707	0,008*
90.350	62	35	27	43,5	1,032**
90.364	89	77	12	13,5	0,649*
94.1111	49	36	13	26,5	3,433*
94.1112	83	71	12	14,5	0,292*
96.322	68	57	11	16,2	0,012*
96.330	108	86	22	39558	1,067*
96.332	57	30	27	47,4	0,158**
96.345	59	47	12	20,3	0,573*
97.607	88	43	45	51,1	0,045**
Hermes	20	3	17	85	-
Desiree	100	73	27	27	-

* Not significantly different from 5:1, resistant : susceptible seggregation ratio, p 0,05

** Not significantly different from 1:1, resistant : susceptible seggregation ratio, p 0,05

Table 3: **Origin of PVY resistance gene in identified multiplex parental lines**

No.	Parental combination, source of Ry gene (Ny*) ♀ x ♂	No. of identified multiplex lines
1	*S. stoloniferum* (sto) x *S. hougasii* (hou)	3
2	*S. tuberosum* ssp. adigena (adg) x *S. tuberosum* ssp. *andigena* (adg)	2
3	*S. stoloniferum* (sto) x *S. chacoense* (chc)*	1
4	*S. stoloniferum* (sto) x *S. tuberosum* ssp. *andigena* (adg)	1
5	(*S. stoloniferum* (sto) x S. hougasii (hou)) x *S. tuberosum* ssp. *andigena* (adg)	1

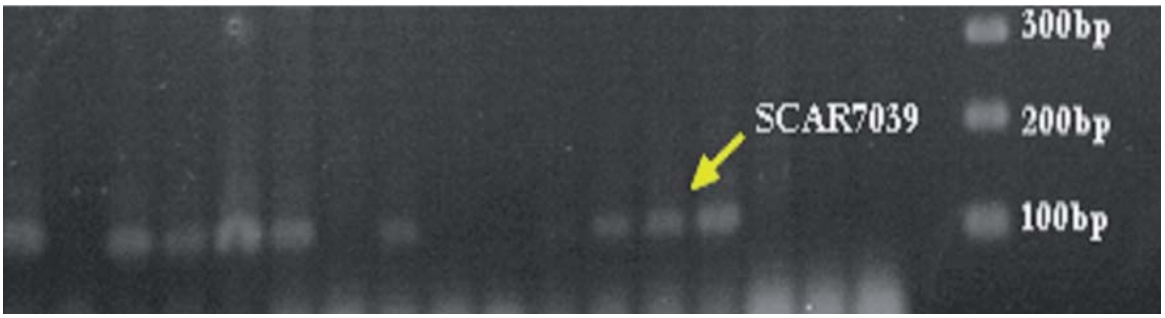

Figure 2: **Detection of presence or absence of Rysto gene in 17 potato varieties by SCAR7039 marker**

analysis (CERÁK et al. 2008). By the combined application of one of this markers with STM0003-111 marker published by MILBURNE et al. (1998) the identification of resistance genotypes in different crossing population reached the 98 % efficiency. Recently one of the markers was transformed to an even more reliable SCAR marker. This marker could be applied efficiently to identify the resistance gene in 21 potato varieties (*Figure 2*). Research is under progress for mapping the Rysto gene by saturation the gene region with physically closer markers.

Conclusions

By long term and intensive efforts it is possible to combine resistance genes of wild *Solanum* species with preferred quality traits of cultivated potato. By the use of resistant varieties higher yielding stability can be reached, the demand of environmental and food safety can be realised while production cost can be decreased. For future success newer commercial as well as modern DNA techniques like MAS are available for the breeders.

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