POTATO TESTING FOR WART RESISTANCE IN BELARUS

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Abstract
The analysis of studying in Belarus the most dangerous and quarantine-important fungus *Synchytrium endobioticum (Schilb.) Perc*. – potato wart agent is presented in the article. The necessity of the immunological evaluation of the potato seed material for wart resistance is fortified. The conditions of preliminary and state testing of selection samples in the quarantine stationary plot of the RUC "Institute of plant protection" in accordance with the methods of potato testing for wart resistance are examined in this paper.
It is shown that in preliminary and state testing for resistance to the (D1) potato wart agent pathotype among the studied hybrid potato material from the leading breeding institutions of Belarus and Russia for the period of 2003-2007, 89,8% resistant samples were isolated.
While determining the wart disease resistance of the breeding material on susceptible sample tubers beside the usual incrustation form of potato wart affection the infestation of three non-typical forms: leaf, scab and corrugated are observed.
Considering the variations of wart-resistant potato samples injury, the necessity of carrying out not less than two years selection material state testing to wart resistance under different field conditions was undertaken in Belarus.

Key words: potato, potato wart disease, resistance

Introduction
Among potato diseases the wart disease is distinguished by its harmfulness caused by the fungus *Synchytrium endobioticum* (*Schilb.) Perc*., and is a quarantined object in Belarus. The potato wart focus was discovered for the first time in 1939 in Belarus. In 1956 potato crops inspected for quarantine object contamination showed that the disease was spread in all six districts in private plots and on 90 collective farms and state farms.
The demand for wart resistance variety breeding was put ahead at the State level by the ex-USSR government decree dated October 20, 1947. According to this regulation the period (till 1951) was determined as a transition to the growing of wart-resistant varieties (Krishtofik,1998). Undertaking the directed measures of wart elimination, including a set of preventive and chemical measures and also the introduction of agent-resistant varieties, gave an opportunity to remove harmful disease focuses in the rotation fields by the beginning of the 1980s. However, the solving of this problem in the private sector turned out to be significantly complicated. At present wart natural focuses are not numerous, being observed in private plots only. It demands constant monitoring of the *S. endobioticum* fungus population condition.
The history of potato wart studies shows that the most economical and ecologically safe method for overcoming losses caused by the disease is the creation of wart-resistant varieties and their application into production. The resistance trait has not lost its importance in Belarus till nowadays and it is compulsory for new variety breeding and their inclusion into the State Register of varieties and wild breeds.
One should point out that the first scientific researches in the potato studies on wart harmfulness on the territory of Belarus were carried out in the Zonal Minsk Scientific-Research Station on potato wart. It was founded in 1947 by the collective of Belarusian phytopathologists under the guidance of Academician N.A. Dorozhkin (Dorozhkin, 1948, 1953; Dorozhkin and Remneva, 1948; Gandelman, 1950, 1953; Dorozhkin and Sharikov, 1951; Sharikov, 1951; Gorlenko, 1954).
By the foundation of the Immunity Lab at the Institute of Plant Protection the main direction of potato wart research in Belarus was improvement of variety sample evaluation methods for disease resistance in the pathogen infected backgrounds, carrying out search of resistance sources to the noxious disease. By evaluating wart resistance this was the main demand according to which the infected material should display the realistic pathogen condition observed in the region.

As a result of the intra-specific diversity studies of a fungus *S. endobioticum* on the territory of the Republic of Belarus in different agro climatic zones its non-equivalence was determined with the discovering of not less than 7 geographic populations differed by pathogen activity. Though, the fact of their belonging to the same race was strictly established (Danchenko, 1974; 1978).

One of the stages of subsequent immunological evaluation improvement of selection potato samples for wart-resistance was the development and use of the infected background with wart and cyst-formating golden potato nematode at the Institute of Plant Protection. It was giving an opportunity to carry out simultaneously the evaluation of resistance to two quarantine pathogens (Tolkachiov, 1998; Portyankin, 2000) within one and the same experiment. However, it was determined that the resistance evaluation at the combined background can not give 100% of coincidence with the separate evaluation to every pathogen. That is why it is preferable to use it for preliminary testing of the first year hybrids.

At present all the public sector potato growing areas are occupied only with the wart resistant potato varieties.

For the necessity of immunological protection of growing potato varieties in relation to wart agent the objective of the present research is selection of potato varieties by testing their resistance to wart disease in preliminary and state tests. This is undertaken and should be considered as an inseparable part of the final stage of variety creation.

Materials and Methods

Potato samples used as a material for the research were presented from breeding institutions of Belarus and Russia.

The research was carried out at potato protection lab of the RUC «Institute of Plant Protection» during the period of 2003-2007. The agro-meteorological parameters of growing seasons of the research period are presented in Table 1.

The preliminary testing was done in lysimeters in quarantine stationary plot by starting laboratory and vegetation experiments according to the methods of potato testing for wart resistance (Saltykova and Tarasova, 1979; Portyankin and Tolkachiov, 2001).

The samples were planted in lysimeters in the order of ordinal number increase. In preliminary first year testing 5 tubers were used, in the second one – 10 tubers. The tubers were located in equal rows (taking 20 pieces), tops upwards. A susceptible variety Voltman served as a control basics that followed 10 samples. The planted tubers were infected with zoosporangium powder from the calculation 0,5-0,75 g per every tuber. The amount was corrected depending on zoospangium viability. The experiments were started in the end of April till the first decade of May. Wart infection of potato tubers was recorded at harvest after the disease expression on the sensitive control variety.

Table 1. Agrometeorological parameters of vegetation period of potato testing to wart resistance

Year	Month								
	May			June			July		
	I	II	III	I	II	III	I	II	III
	Average air temperature, ˚C								
2003	13.4	15.1	17.9	16.3	15.0	14.9	17.5	19.4	21.2
2004	13.4	8.9	10.4	14.7	13.9	16.5	15.9	16.8	21.2
2005	9.4	10.2	17.9	14.0	16.4	16.2	18.8	20.6	19.3
2006	13.0	12.4	11.9	12.7	17.4	20.4	20.6	19.7	19.5
2007	7.0	14.0	22.0	19.3	20.7	15.9	16.1	18.9	17.8
	Rainfall amount, mm								
2003	11.4	45.6	6.5	55	18.7	19.2	94.8	24.3	29.2
2004	14	15	8	6	30	38	23	4	104
2005	28	75	26	47	18	17	6	12	30
2006	0	12.1	62.5	21.5	17.1	33.9	0	53.4	24.6
2007	22.0	29.0	21.0	0.1	10.0	39.0	35.0	17.0	69.0

Note – I – the first decade, II – the second decade, III – the third decade

A year long State testing was accomplished under field conditions on the infected background by checking the hybrids showing themselves as resistant. It was based on comparison to the preliminary evaluation data. Variety samples were tested on uniform relief quarantine stationary plot, where a field infected background with the equal and strong wart agent infection was formed. The experimental plot soil was soddy-podzolic, light loam: humus content – 1.97%, soil pH -5.0.
Planting of the potato samples was accomplished in the first half of May on one-row plots by the scheme 70 × 30 cm, taking 20 tubers in three replications. In every four tested samples a susceptible control – cv Voltman was planted. During the planting water moistened tubers were additionally powdered. Zoosporangium powder was used, mixed with sand in a ratio 1:1 from the calculation 1–1.5 g per one tuber.
The infected variety samples were considered the ones the plants of which have got the typical symptoms for the disease - knots on tubers, stolons, root neck or outside parts. The susceptible one considered to be hybrids having infection on one tuber, at least, the resistant one – if not a single sample tuber was infected.
Meteorological data of the Republican Meteorological Centre were used for the analysis of hydrothermal resources of vegetation period favorable for potato wart development.

Results and Discussion

By the results of the research done in preliminary testing for resistance to common (D1) potato wart pathotype among the hybrid material in 2003-2007 there were isolated from 82.3 to 100% resistant samples depending on year (Table 2).

Table 2. Resistance of breeding samples to common potato wart pathotype (quarantine stationary plot, p. Priluki Minsk region)

Type of testing	Year	Resistant samples observed, %
Preliminary	2003	86.4
	2004	85.6
	2005	85.7
	2006	100
	2007	82.3
State	2003	91.3
	2004	92.5
	2005	93.8
	2006	94.1
	2007	866
Preliminary and State	2003-2007	89.8

For the period 2003 - 2007 more than 90 potato variety samples from the leading breeding institutions of Belarus and Russia were under State testing to the common wart pathotype. As one can see in Table 2, 86.6-94.1% among the varieties turned out to be resistant to quarantine disease. One should point out that a significant amount of valuable selection material was presented from the Scientific and Practical Centre of the NAS of Belarus on Potato, Fruit and Vegetable Growing.
So, for years of research in preliminary and State trials nearly 89.8% of potato varieties have determined their resistance to the disease.
It should point out that under lysimeter conditions on tubers besides usual knot form of wart infection, three non-typical forms of wart infection were detected: leaf, scab-like and corrugated. Such forms of disease expression were observed on the tested hybrid material.
There was also a control checking of wart-resistance stability among the regionalized Belarus potato varieties in 2006-2007. By such a symptom on the infectious background in lysimeters and following the methods of preliminary testing they were evaluated from the early group - Axamit, Dolphin; semi-early – Archids, Dina, Odissey, Yavar; semi-ripening Zhivitsa, Krinitsa, Rosinka, Scarb, Talisman; semi-late – Zarnitsa, Vetraz, Lasunak and late ripening – Alpinist, Orbit, Zdabytak, Atlant, Temp, Vytok. There were no typical signs

for the disease in the form of wart knots formation in the radical stem zone and in formed tuber yield on plants of all tested variety samples. This proves the expression of resistance sign to the quarantine object in the varieties belonging to wart-resistant ones in relation to the common pathotype of potato wart agent.

The analysis of detected resistance to wart among potato variety samples in State testing shows the variation of the given index from 86.6 to 94.1% against the expected 100% as only the samples having resistance in preliminary tests had been under testing. Meanwhile, by testing potato variety samples to wart resistance one should evaluate the conditions it has been carried out, as well as, the physiological condition of plants being analyzed. This can be determined by many factors: temperature and moisture parameters, planting time, seed material size and reproduction, its phytosanitary condition and etc. The possible influence of such factors on plant and the process of its infection by obligate parasite were noticed by English scientist S.Tarr (Tarr, 1975). The importance of scientific studies on this question was proved by the research carried out in the Ukraine (Melnik, 2005). It showed that under the influence of different conditions of the environment not only the expression of the disease but also the parasitic activity of potato wart agent has been changed as well. This includes expression of aggressive races and also its specialization, both, the biological one and the genotype specific.

The results of our research have proved the benefits of above-mentioned positions. Considering weather changes analysis based on the average air temperature data and rainfall amount in July, soil temperature at the depth of 10 cm during vegetation it follows (Figure 1), their parameters were not always suitable for potato wart development (the literature data optimums are averaged) and varied by years. As it is known, the influence of environmental conditions may stimulate the differences in potato sample reaction to wart infection, the varieties both from resistant and susceptible group. An important role in pathogens development can be played by average air temperature, especially the one higher than 18˚C what is of optimal for the fungus development. Browning and Darling (2005) indicate a change of host-plant susceptibility to *S. endobioticum* infection at different temperatures of inoculation (10˚C, 15˚C and 20˚C). So, a year's field testing of potato samples to wart-resistance is not enough for the final evaluation based on the given trait as it is accepted in the Republic in State testing practices at present. It stipulates the necessity of introduction potato selection samples testing for potato wart resistance under field conditions in different by hydrothermal resources vegetation periods (Sereda and Zhukova, 2006) in State testing in Belarus for the period of not less than two years.

Moreover, as a result of presence the ecological and biological prerequisites for new pathotypes of wart can be observed in the Republic of Belarus. This regards a possible change of potato varieties reaction to contamination by phytopathogen due to unfavorable for the disease physiological conditions inside host plant cell what perhaps stimulate the expression of three more non-typical forms apart the common knot form of wart infection – leaf, scab-like and corrugated. A systemic control of wart resistance among the varieties cultivated in the Republic of Belarus will possibly become an outstanding and pending matter in the near future.

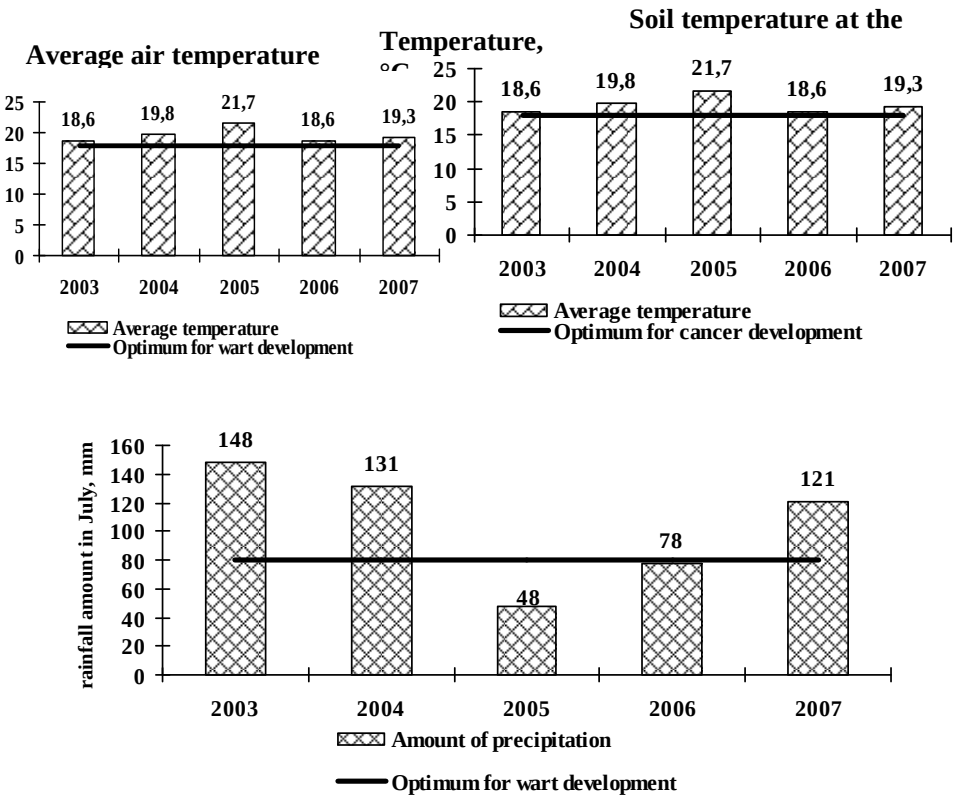

Figure 1 Variation of weather conditions during testing breeding samples to wart resistance

Conclusions

Concerning the results of testing of breeding material to wart-resistance for the period 2003-2007 in preliminary and state testing, 89.8% wart-resistant potato variety samples were detected.

Finding out wart resistant varieties among the variety samples in State testing has varied by years. This stipulates a necessity of introduction of not less than two years State testing of potato breeding samples under different hydrothermal field conditions vegetation periods in Belarus.

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KARTUPEĻU PĀRBAUDES IZTURĪBAI PRET VĒZI BALTKRIEVIJĀ

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Rakstā atspoguļota Baltkrievijā bīstamākā patogēna - *Synchytrium endobioticum (Schilb.) Perc*. – kartupeļu vēža izraisītāja - pētījumu analīze, pamatojot nepieciešamību pēc kartupeļu sēklas materiāla izturības izvērtēšanas. Rakstā aprakstīti sagatavošanas un valsts pārbaužu apstākļi paraugu atlasei karantīnas stacionāra laukā RUC „Augu aizsardzības institūtā" saskaņā ar kartupeļu izturības pret vēzi metodēm. Sagatavošanas un valsts pārbaudēs, kurās nosaka izturību pret kartupeļu vēža izplatītāko patotipu (D1), izvērtējot no vadošajiem Baltkrievijas un Krievijas selekcijas institūtiem saņemto hibrīdo kartupeļu materiālu, laika posmā no 2003. līdz 2007. gadam tika atlasīti 89.8 % izturīgu paraugu. Selekcijas materiāla izturības izvērtēšanas laikā uz paraugu bumbuļiem, kuri uzrādīja jutību pret kartupeļu vēzi, bez zināmiem infekcijas bojājumiem tika novēroti vēl trīs netipiski bojājumu veidi: plēksnes, kārpveida izaugumi un rievojumi. Pamatojoties uz kartupeļu paraugu izturības pret vēzi mainību, kartupeļu selekcijas materiāla izturības pret vēzi pārbaudes Baltkrievijā jāveic ne mazāk kā divus gadus lauka apstākļos, vēlams dažādos audzēšanas apstākļos pēc mitruma nodrošinājuma un temperatūras režīma.