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**THE CHOICE OF WART VARIETIES WITH COMPLEX RESISTANCE TO
WART AND NEMATODES IN WESTERN REGION OF UKRAINE AND
DISTINGUISHING SOURCES OF RESISTANCE**

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Abstract. *There were proposed the results of potato breeding material study on wart resistance during 2011 -2016 in Western region of Ukraine with the distinguishing sources of resistance. There were distinguished 3001 samples of potato from 3331 tested samples of resistant to wart during the previous testing and 108 samples during the state testing, There were evaluated 43 varieties of potato resistant to wart pathotypes and isolates of golden cyst nematodes. There were distinguished 16 varieties of potato with complex resistance to wart and glodoberosis. They may be improved in the disease sources and use breeding for crossing as a source of resistance.*

Keywords: *wart, golden potato nematode, potato, testing, resistance, source of resistance.*

Potato is one of the main food, feed and technical cultivars, which grow in the different countries of the world. This plant is a feeder for many diseases pathogens. [1].

The most dangerous potato diseases are: wart, which pathogen is intracellular obligate pathogen (*Synchytrium endobioticum* Schilbercky Perc) [7]; Yellow potato cyst (*Glodoberarestochiensis* (Wollenwber) and white potato cyst nematode (*Glodobera pallida*) (Stone). These nematodes cause the potato glodoberoz. [11, 13]. These diseases harm potato in 53 countries of the world, as per data from European

and Mediterranean Plant Protection Organization, the wart potato was determined in 53 countries of the world [15,16], yellow potato cyst nematode in 69 [11]. These diseases harm potato in 33 countries of Europe where the new aggressive pathotypes were distinguished [19, 20, 21].

The implementation resistant varieties in agriculture are the most economically profitable and effective way for the struggle with the potato quarantine diseases [2, 3, 4].

The object of investigation is to evaluate the potato breeding materials resistance to wart and yellow potato cyst nematode and to extract the resistance varieties, which may be the sources resistance to diseases.

Materials and methods. There were used 3311 samples of potato and 108 potato hybrids for the state testing and researching potato resistance to the wart pathogens in 2011-2016. They were received from 6 breeding- research institutions of Ukraine. There were studied more than 43 varieties of potato from 3 Ukrainian breeding- research institutions on resistance to wart pathotypes and yellow potato cyst nematode.

The evaluation of breeding material on resistance to common and aggressive pathotypes of wart potato made as per requirements of the “Evaluation technique and breeding material selection of potato resistant to wart *Synchytrium endobioticum* (Schlib.) Perc. harmonized with EC requirements.” [5].

The technique of potato’s tubers infecting by winter’s zoospores, which were in stable position

The potato samples infection made by the zoospores from winter zoosporangii of wart pathogen in laboratory conditions in special containers (30x40 cm) by A. Spieckermann technique [24]. These containers have substrate with soil: perlite(1:1), the soil was specially selected in the diseases sources. There were from 40 to 50 winter zoosporangia pathogens on 1 g of soil. The investigated samples of potato and inspecting varieties of potato were defeated by all wart potato pathogens put into the containers (Polisska rozheva, Lorch). [10]. Containers saved at the temperature 17-18⁰C, they watered through every 3 days. The bursting made once a week. The

potato's sample reaction to the infection by wart pathogen was determined through 75 days. The samples dig out of containers and accounted wart growths from every sample and also from the reference varieties of potato (Figure 2). The results were considered, if the defeating of reference variety consisted not run less 75% [10].

The technique of defeating potato shoots by summer zoospores from fresh wart tumors

The M. Glynne [17], J. Lemmerzähl [22], E. Kohler [18] and J. Potocek [23] techniques were used. The potato samples were infected from the fresh warts growings. The paper ring fixed with the help of heated mixture of paraffin and vaseline (1:1) (fig.1). The distilled water run into the ring and added 0,5 cm³ of fresh wart's growing with the summer zoospores. Samples left for the pathogen's defeating in darkness in growth chamber at temperature: +11 °C. The exposure time is 24 hours (fig. 2, 3). The infectious paper rings removed from tubers and potato's samples left in the growing chamber at the temperature +17 -18⁰ C during 20 days, after the determining the shoots of potato samples by pathogen defeating.[6, 8] It is necessary to analyze them under the binocular lens and determine the degree of its pathogen defeating:

- 1-st stage- necrotizing tissue, single soruses (to 5 pieces);
- 2-nd stage- dispersed soruses (if it is more 5);
- 3-rd stage - flight junction without deformation -shoot potato;
- 4-th stage- flight junction;
- 5-th stage -shoot deformation; wart [8, 9].



Figure 1. The defeating of potato samples by summer zoospores from fresh warts

The study of wart resistance and cyst nematode resistance in field conditions

The evaluation and selecting of breed material made on the natural infectious background in the sources of pathogen spread in western region of Ukraine by the common pathotype (D1) in the village Beregomet Vizhnitza district Chernivtsi region; aggressive pathotypes in village Maydan Mizhgirsky district Zakarpattia region and v. Bystrests (pathotype 22) Verkhovyna district Ivano-Frankivsk region in three times repeatability [5].

The selection of potato breeding material resistant to golden potato cyst nematode in field conditions made in natural infectious background in the sources of glodoberosis spreading v.Porkulyna Putyla district Chernivtsi region, v. Maydan Mizhgirsky district Zakarpattia region, in town Rachiv, v. Yasynya Rachiv district, Zakarpattia region in three times repeatability according to the statement for potato testing to wart and golden potato cyst nematode [12].

The investigation's results and their discussion. There were made evaluation of 3314 potato samples in laboratory conditions during 2011-2016. 3301 potato samples were selected as resistant to disease. 108 of them were allowed to state testing. 310 samples were received the susceptible evaluation and distracted (table 1,

fig. 2, 3) according to the evaluation results during the period 2011-2016.

1. The potato breeding material testing on wart resistance to common pathotype (D1) wart pathotype during 2011-2016

№ items	Institution's name	All received samples	All resistant	All susceptible
1.	Institute of potato research NAAS of Ukraine	1281	1136	145
2.	Institute of agriculture of Carpathian region NAAS of Ukraine	205	191	14
3.	Institute of agriculture In Polissya NAAS of Ukraine	274	262	12
4.	Mountainous scientific division of Carpathian regions NAAS of Ukraine	110	89	21
5.	PJSC "Chernihivelitkartoplya"	572	529	43
6.	Polissyan research division Institute for potato research NAAS	869	794	75
Total:		3311	3001	310



Figure 2. The testing of potato breeding material on resistant to wart (infected by winter zoospores in substrate with perlite)



Figure 3. The potato variety Poliska rozheva defeated by the summer zoospores wart pathogens (in laboratory conditions)

The choice of potato breeding material resistant to wart in state testing

All 108 potato samples were not defeated by the common wart pathotype by the results of state testing in 2011-2016. They were given into the Ukrainian institute for plant variety examination with the following input into the National register, into the list of wart resistant, their following zoning in pathogen disease sources.

3 samples of potato breeding by the Institute for Potato Research NAAS of Ukraine (08-40-14p.10 and F.15) were selected from 108 samples by the results of testing to aggressive wart potato pathogens. They were not defeated by any wart potato pathogens. 52 samples of potato were resistant to 11 Mizhgirya31 samples were resistant to 13 (Rachiv), 30 samples were resistant to 18(Yaseniv) and 49 samples were resistant to (Bystrytsa)aggressive wart pathotype. (Table2). Other potato samples as inspecting samples were suffered by pathotypes of wart pathogen (fig.4, 5).

2. The results of potato state testing on resistance to all pathotypes of wart pathogens in 2011-2016.

№ items	Institution's name	All samples	D1 (common)		11 (Mizhgirya)		13 (Rachiv)		18 (Jasinya)		22 (Bystrets)	
			resistant	susceptible	resistant	susceptible	resistant	susceptible	resistant	susceptible	resistant	susceptible
1.	Institute for potato research NAAS of Ukraine	48	48	0	28	20	12	36	12	36	28	20
2.	Institute of agriculture for Carpathean region NAAS of Ukraine	8	8	0	1	7	1	7	0	8	0	8
3.	Mountainous scientific division of Carpathean regions NAAS of Ukraine	17	17	0	6	11	3	14	4	13	5	12
4.	PJSC "Chernihivelitkartoplya"	8	8	0	4	4	3	5	4	4	3	5
5.	Polissyan research division Institute for potato research NAAS	27	27	0	13	14	12	15	10	17	13	14



Figure 4. The potato variety Polisska rozheva defeated by common pathotype of wart pathogen (in field conditions -settlement Beregomet Vizhnitza district, Chernivtsi region)



Figure 5. Hybride of potato P 08 86-11, defeated by Yaseniv (18) aggressive pathotype of wart potato pathogen (in field conditions- village Yasynya Rachiv district, Zakarpattia region)

The choice of breeding material resistant to golden cyst nematode

There were not determined the disease infection on 43 varieties of potato by the

results of testing breeding material on resistance to common wart pathogen (settlement Beregomiet Vyzhnytza district, Chernivtsi region) during 2011-2016. All tested varieties received the resistant marks. The isolate from village Parkulyna Putyla district was used for the selecting resistant to golden cyst nematode. There is the lowest infectious load of soil by glodobera (2-3 cysts/100 cm³, fig.6). There were not determined any cysts on root system of potato varieties Basis, Skarbnytsya, Solocha, Slovyanka, Chortytsya, PoliskeDzerelo, Vernisazh, Vodogray, Zelenyi Gay, ChervonaRuta (they are from selection Institute of potato research NAAS); Dyvo, Legend, Mukachivska, Pirovska, Oxamyt-99, Uzhgorodska (they are from selection Institute of agriculture for Carpathean region NAAS); Bozhedar, Dobrochyn, Dorogyn, Karlyk, Malynskabila, Teteriv, Tyras, Zavia, Zvizdal, (they are from selection Polysian research division Institute for potato research NAAS (table 3).



Figure 6. The zysts of golden potato zyst nematode were extracted on the variety Poliska rozheva in village Parkulyna Chernivtsi region

3. The reaction of potato varieties Ukrainian breed on the infecting by the wart pathotypes pathogens and golden potato cyst nematode in western region of Ukraine

№ Ofit ems	Name of variety	War tpathtypes					Golden Zyst Nematode			
		D1-common	v.Maydan (11)	t.Rachiv (13)	v. Yasinya (18)	v. Bystrets (22)	v. Parkulyna	v.Maydan	t.Rachiv	v. Yasinya
Institute for potato research NAAS of Ukraine										
1.	Basys	-	-	-	-	-	-	-	+	+
2.	Kimmerya	-	-	-	+	+	-	-	-	+
3.	Chervona Ruta	-	-	-	+	+	-	+	+	+
4.	Galzurna	-	-	-	-	-	-	-	-	+
5.	Yavir	-	+	+	+	+	-	-	-	+
6.	Fantasy	-	-	+	+	-	-	-	-	+
7.	Levada	-	-	+	+	+	-	-	-	+
8.	Lilea	-	+	+	+	+	+	+	+	+
9.	Kalynivska	-	+	-	-	-	-	-	-	-
10.	Melody	-	+	+	+	+	-	+	+	+
11.	Oberig	-	-	-	+	+	-	-	-	+
12.	Obriy	-	-	+	+	-	-	-	-	-
13.	Serpanok	-	+	+	+	+	+	+	+	+
14.	Skarbnytsya	-	+	+	+	+	+	+	+	+
15.	Slovyanka	-	-	+	+	+	-	-	-	-
16.	Solokha	-	-	-	-	-	-	-	-	-
17.	Chortytsya	-	-	-	-	+	-	-	-	+
18.	Poliskederelo	-	+	-	+	-	-	+	+	+
19.	Vernisazh	-	-	+	-	-	-	-	-	+
20.	Vodogray	-	-	+	+	-	-	-	-	-

21.	Zelenyigay	-	+	+	+	+	,	,	,	+
	Institute of agriculture for Carpathean region NAAS of Ukraine									
22.	Dyvo	-	-	-	+	-	-	-	-	+
23.	Legend	-	-	+	+	+	-	+	+	+
24.	Mukachivska	-	+	+	+	+	-	+	+	+
25.	Oxamyt-99	-	+	+	+	+	-	+	+	+
26.	Pirovska	-	+	+	+	+	-	+	+	+
27.	Uzgorodska	-	+	+	+	+	-	+	+	+
28.	Vira	-	+	+	+	+	-	+	+	+
	PolissyanresearchdivisionInstitute for potato research NAAS									
29.	Bozhedar	-	-	-	-	-	-	-	-	+
30.	Dobrochyn	-	-	+	+	-	-	-	-	+
31.	Dorogyn	-	+	+	+	+	-	+	+	+
32.	Karlyk	-	+	+	+	+	-	+	+	+
33.	Malynskabila	-	-	+	-	-	-	-	+	+
34.	Santarka	-	-	-	-	-	-	-	+	+
35.	Partner	-	-	-	+	-	-	-	-	-
36.	Poliskarozheva	+	+	+	+	+	+	+	+	+
37.	Poliskajubeliu m	-	-	+	+	+	+	+	+	+
38.	Teteriv	-	+	+	+	+	-	-	-	-
39.	Tyras	-	-	+	+	+	-	+	+	+
40.	Zheran	-	-	+	+	+	+	+	+	+
41.	Zaviya	-	+	+	+	-	-	-	-	+
42.	Zvizdal	-	-	+	+	+	-	+	+	+
43.	Lorch	+	+	+	+	+	+	+	+	+

Note:

«+» - the presence of defeating on the testing variety to wart pathogen and Golden potato cyst nematode;

«-» - the absence of testing variety to pathogen disease.

The following varieties of potato are extracted as resistant to 11 (Mizhgirska) to wart potato aggressive pathotype by the results of variety selection: Basys, Kimmerya, Glazurna, Chervona Ruta, Levada, Solokha, Chortytsya, Obriy, Oberig, Vernisazh, Vodogray (they are from selection of institute of potato research NAAS),

Dyvo, Legend (they are from selection Institute of agriculture Carpathean region NAAS) Bozhedar, Dobrochyn, Malynskabila, Santarka, Partner, Poliska Jubiley, Zheran and Zvizdal (they are from selection Polyssyan research division Institute for potato research division NAAS) (table 3). There were any cysts determined in the following varieties: Slovyanka, Teteriv, Vodogray, Legend, Chervona Ruta, Schedryk, Dyvo, Kalynivska, Bozhedar, Glazurna and Santarka (table 3) [4].

There were any wart infections determined on the resistant to 13 (Rachiv) aggressive pathotype on the following potato varieties: Basys, Chervona Ruta, Glasurna, Kalynivska, Solokha, Chortytsya, Oberig, Poliske Dzerelo (they are from selection of Institute of potato research NAAS); Dyvo and Legend (they are from selection of Institute of Agriculture for Carpathean region of NAAS); Bozhedar, Santarka, Partner (they are from selection of Polyssyan research division Institute for potato research NAAS).

The globodera was not determined on the testing plot in town Rachiv Rachiv district, Zakarpattia region (60 cyst/100cm³ soil) in the following varieties: Kimmeria, Glazurna, Javir, Fantasy, Kalynivska, Melodia, Oberig, Obriy, Slovyanka, Solokha, Chortytsya, Vernisazh, Vodogray, Zelenyi gay, Dyvo, Bozhedar, Dobrochyn, Partner and Zaviya.

The following varieties of potato were chosen for the testing on resistance to 18 (Yasinya) aggressive pathotypes: Basys, Glazurna, Kalynivska, Solokha, Chortytsya, Vernisazh, Malynskabila, Santarka.

The highest infectious soil load by nematode cysts (98-120 cysts/100cm³) in the village Jasinya Rachiv district Zakarpattia region. There were any cysts determined on potato roots of the following varieties: Kalynivska, Slovyanka, Vodogray, Solokha and Teteriv.

There were determined varieties resistant to 22 (Bystrets) aggressive pathotype: Basys, Glazurna, Fantasy, Kalynivska, Obriy, Solokha, Poliske Dzerelo, Vernisazh, Vodogray, Dyvo, Bozhedar, Dobrochyn, Malynskabila, Santarka and Partner (see Table 3).

The analyzing of the resistant data to golden potato zyst nematode and wart

potato pathotypes for 2011-2016 the following varieties with complex resistance to diseases: Basis, Kimmeria, Glazurna, Kalynivska, Oberig, Obriy, Slovyanka, Vernisazh, Vodogray, Zelenyi Gay, Bozhedar, Dobrochyn, Malynivskabila, Santarka, Partner and Teteriv.

The present varieties are recommended for the usage in breeding process as a source of resistance for receiving resistant progenies and it's improving in the source of wart potato pathogens and golden cyst potato nematode in western region of Ukraine.

Conclusions

1. There were extracted 3001 samples resistant to common wart potato pathotype during the previous testing (2011-2016).

2. There were chosen 108 potato samples for the state testing. They were resistant to the common pathotype. They were sent to the Ukrainian institute for plant variety examination with the next input into the National register.

3. There were chosen 3 samples of potato selection from Institute for potato research NAAS (08 40-14, 208ч.10 and Ф.15). They are resistant to all aggressive pathotypes of wart potato pathogens. There were chosen 52 samples of potato resistant to 11- Mizhgirya aggressive pathotype. 31 potato samples were resistant to 13 (Rachiv). 30 samples were resistant to 18 (Yaseniv) and 49 samples were resistant to 22 (Bystrytsa) aggressive pathotype of wart pathogen. So they are recommended for the growing in the disease sources.

4. There were extracted 16 varieties with complex resistance to wart potato pathotypes and Golden potato cyst nematode: Basys, Kimmeria, Glazurna, Kalynivska, Oberig, Obriy, Slovyanka, Verniszh, Vodogray, Zelenyi Gay, Bozhedar, Dobrochyn, Malynska bila, Santarka, Partner and Teteriv. These varieties are recommended for the usage breeding process as a source of resistance for receiving resistant protogenies.

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ВІДБІР СОРТІВ КАРТОПЛІ З КОМПЛЕКСНОЮ СТІЙКІСТЮ ДО РАКУ ТА НЕМАТОД У ЗАХІДНОМУ РЕГІОНІ УКРАЇНИ ТА ВИДІЛЕННЯ ДЖЕРЕЛ СТІЙКОСТІ

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Анотація. Наведено результати досліджень із вивчення стійкості селекційного матеріалу картоплі до раку за 2011 – 2016 рр. у західному регіоні України та виділення джерел стійкості. Із тестованих 3311 зразків картоплі, отриманих із шести науково-дослідних та селекційних установ України, виділено 3001 зразок картоплі, стійкий до раку у попередньому випробуванні,

та 108 – у державному. Оцінено 43 сорти картоплі щодо стійкості до патотипів раку та ізолятів золотистої картопляної цистоутворюючої нематоди. Виділено 16 сортів картоплі з комплексною стійкістю до раку та глободерозу, які рекомендовано впровадити у вогнищах хвороб та використовувати у селекційному процесі як джерела стійкості до даних хвороб.

Ключові слова: рак, золотиста картопляна нематода, картопля, тестування, стійкість, джерело стійкості

**ОТБОР СОРТОВ КАРТОФЕЛЯ С КОМПЛЕКСНОЙ УСТОЙЧИВОСТЬЮ
К РАКУ И НЕМАТОД В ЗАПАДНОМ РЕГИОНЕ УКРАИНЫ И
ВЫДЕЛЕНИЕ ИСТОЧНИКОВ УСТОЙЧИВОСТИ
Г. В. Зеля, Т. Н. Олейник, Н. Н. Кирик**

Аннотація. *Изложены результаты исследований по изучению устойчивости селекционного материала картофеля к раку за 2011-2016 гг. в западном регионе Украины и выделение источников устойчивости. Из тестированных 3311 образцов картофеля выделено 3001 образец картофеля устойчивый к раку в предварительном испытании и 108 – в государственном. К патотипам рака и изолятам золотистой картофельной цистообразующей нематоды оценено 43 сортов картофеля. Выделено 16 сортов картофеля с комплексной устойчивостью к раку и глободерозу, которых можно внедрять в очаги болезней и использовать в селекции для скрещивания в качестве источников устойчивости.*

Ключевые слова: *рак, золотистая картофельная нематода, картофель, тестирование, устойчивость, источник устойчивости.*