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Creation of potato hybrids (*Solanum tuberosum*) progeny with high field resistance against phytophotorosis

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Abstract. The creation of new potato varieties with prominent economically valuable properties and comprehensive resistance against the most common diseases is one of the main areas of crop breeding at present. First of all, this is due to the possibility of increasing the gross production of potatoes, improving its economic performance, as well as the tasks of protecting the environment from pesticide pollution, which contributes to a substantial improvement in the environment and obtaining environmentally safe products. The purpose of this study was to identify varieties with a prominent level

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of yield and resistance against potato blight in the western region of Ukraine. The study was conducted using field (assessment of disease development), laboratory, analytical, and mathematical and statistical methods. The paper provides a theoretical substantiation and a new solution to the important scientific task of establishing the specific features of the use of Ukrainian and foreign varieties, intervarietal and multispecies hybrids by parental forms in potato breeding. The study summarized the features of the manifestation of productivity components, quality traits, resistance to potato blight, correlations between economic and valuable traits, selection of new parent forms for intervarietal and interspecies hybridization, nature of high productivity, quality and potato blight resistance of breeding material, and created genetically valuable varieties with great value in potato selection and for agricultural production of Ukraine. Based on this, the possibility and effectiveness of the combination of the transfer of traits to the offspring and their inheritance was proven, which will expand the existing base of initial breeding material for further work on the creation of promising potato varieties of different maturity groups with highly valuable economic traits

Keywords: potato; variety; intersort and interspecific hybrid; descendant; productivity; potato blight; correlation

INTRODUCTION

Different components of the potato gene pool have different adaptive potential, especially those controlled by dominant genes, which are often highly efficient and highly expressed rather than polygenic. This results in different properties that are important for the farm (especially for different varieties), depending on the growing conditions and pathogenic pressure. Therefore, the expressiveness of economically valuable properties in potatoes, samples of cultivated and wild species should be investigated in conditions that are as close as possible to the growing conditions of varieties created based on the gene pool. This is the second stage of working with the gene pool after its introduction. One of the main requirements for the creation and introduction of new competitive potato varieties in modern production is not only their high productivity, but also their resistance to major diseases and pests.

The real prospect of creating potato blight resistant potato varieties becomes possible by introducing the Mexican hexaploid species *S. demissum* into the crossing combination, as the one that carries the main genes of hypersensitivity, while providing full protection of backcross hybrids of *S. demissum* × *ssp. tuberosum*, but only in the first years of their cultivation. Under the pressure of hypersensitivity genes included in the created hybrids, the causative agent of the disease begins to form its new races. Research (Hnitetskyi, 2021) found severe damage to hybrids created with the participation of *S. demissum*, which were previously considered resistant.

Numerous studies (Gryń *et al*., 2019) led to the creation of an international gene-for-gene system, within which the dominant R-genes of the host plant correspond to certain pathogen virulence genes, and 11 R-genes are known. A potato variety with R-genes or a combination of them stays stable until a common race appears.

However, potato breeding for hypersensitivity did not solve the problem of potato blight. Research (Pánková *et al*., 2019) indicated that the presence of the R-gene or a combination of both in the genotype of the variety stimulates the selection of suitable fungal races. Their insufficient role becomes noticeable when comparing the degree of resistance of varieties with and without R-genes. Thus, 64% of varieties with R-genes are assigned to the group with a score from 1 point (high) to 5 (medium). The same group includes almost the same number of varieties (62%) without R-genes.

In this regard, increasingly more attention has been paid to field sustainability in recent years. The authors (Whitworth *et al*., 2019) showed that field resistance is the result of several protective mechanisms: a long incubation period, slow spread of infection on the plant, and reduced sporulation. In plants with high field resistance, damage occurs much later and occurs more slowly; sporulation of the fungus is inhibited. This type of resistance equally protects against all races of potato blight; however, as the disease develops, plants begin to be affected with varying intensity.

Apart from the resistance of potatoes to potato blight, tuber resistance is of great importance, especially recently. As with tops, selection for tuber resistance is based on field resistance, which is controlled by small genes. Inheritance of tuber resistance in the field was studied by (Kelling *et al*., 2019). Thus, in the offspring from the crossing of resistant original forms, almost all F_1 hybrids had resistant or mildly affected tubers. When crossing resistant and susceptible forms, a small number of hybrids with susceptible tubers were found, but the main part belonged to resistant ones. Crossing of susceptible forms resulted in hatching only single genotypes that were highly resistant to tubers.

Studies (Furdyga, 2022) found that the proportion of highly resistant backcrosses valuable for breeding based on these characteristics was 16.9% and 86.3%, respectively. Analysis of the origin of backcrosses of interspecific hybrids created based on wild species (*S. acaule, S. bulbocastanum, S. phureja, S. demissum, S.andigenum*) established the resistance of hybrids against ring rot, and the sources of resistance to *Ditylenchus destructor Thorne* are wild species *S. acaule, S. andigenum, S. Demissum*.

Tubers of potato varieties should be well stored in the autumn-winter period. It is known that potato blight and fusarium dry rot are among the most harmful and common potato diseases in this period. It is caused by soil fungi of the following species *Fusarium sp.* which are assigned to the *Tubercullariase* genus. They are wound parasites. Fungi penetrate only into tubers injured mechanically and by soil pests. The disease is common wherever potatoes are grown. In terms of harmfulness, it is second only to potato blight (Methodological..., 2018).

Numerous researchers (Díaz *et al*., 2018; Bomok, 2019; Tilahun & Israel, 2021) note that losses from potato blight and dry fusarium rot when grown under optimal conditions can amount to 7.0-23.7%, at elevated temperature and humidity – up to 50%. Apart from losses caused by rotting tubers during storage, potato blight and dry fusarium rot cause a decrease in yield during the growing season. Damage to seed tubers largely leads to crop shortages (up to 26.6%).

Researchers (Sydorchuk *et al*., 2018) state that there are two types of resistance to potato blight: hypersensitivity (vertical or specific) and field (horizontal or general) resistance. Genotypes with hypersensitivity are characterized by a necrotic reaction of infected and neighbouring cells. Plant hypersensitivity is caused by the action of the main independent genes, each of which is activated by a specific race of the fungus. Field resistance is a complex of certain factors that prevent damage to a plant by a pathogen, and its inheritance occurs due to the action of small genes. Both types of resistance appear together in wild potato species *S. demissum*, *S. bulbocastanum*, *S. poliadenium*, *S. stoloniferum*, *S. vernei*, *S. verrucosum*, while non-hybridized pure forms of *S. tuberosum* have only small field resistance genes.

The main purpose of this study was to identify plant varieties that are characterized by a prominent level of yield and resistance to potato blight in the western region of Ukraine.

MATERIALS AND METHODS

Breeding experiments were carried out on the fields of the 4-field crop rotation of the crop selection department of the Institute of Agriculture of the Carpathian Region of the National Academy of Agrarian Sciences in the village of Obroshyne, Lviv district, Lviv region. The predecessor of potatoes was winter cereals, with post-harvest sowing of green manure crops.

The study investigated varieties that were included in the State Register of Plant Varieties (State register..., 2020) and hybrids created based on simple and complex intervarietal crossings and hybrids created based on species: 88.1450 c.2 – with the participation of the species *S. acaule*, *S. bulbocastanum*, *S. phureja*, *S. andigenum*, Aureliia variety; 81.386 c.4 – ((*S. acaule* × *S. bulbocastanum*) × *S. phureja*) × (*S. demissum* × *S. andigenum*); 91.765/15 – with the participation of the species *S. acaule*, *S. bulbocastanum*, *S. phureja*, *S. demissum*, Marko and Volovetska varieties; 90.841 c.2 – with the participation of the species *S. acaule, S. bulbocastanum, S. phureja, S. demissum, S. andigenum*, varieties Poliska rozheva, Lvivianka, Gidra, Gitte; 89.721 c.23 – with the participation of the species *S. demissum, S. bulbocastanum, S. andigenum*, Biloruska 3 variety; 90.674/12 – with the participation of the species *S. acaule, S. bulbocastanum, S. phureja, S. demissum*, Marko and Volovetska varieties; 86.563 c.4 – with the participation of the species *S. acaule, S. bulbocastanum, S. phureja, S. demissum*, varieties Poliska rozheva, Hibrydna 14, Gitte.

Involvement in the breeding work of various raw materials, namely, both cultural varieties and hybrids of interspecies origin, helps create potato varieties with prominent economic value and resistance to various diseases.

S. acaule (2n=48) is self-fertile. Samples of this species have complex resistance to viruses x (extreme), *S, L, Y*, cancer pathotypes, potato nematode (*G. rostochiensis* and *G. pallida*), frost, common scab, oosporosis, alternariosis, ring and brown rot. Tubers contain up to 23% starch and up to 2.8% protein. Easily crossed with wild species and varieties.

S. bulbocastanum (2n=24). Its samples are characterized by high resistance against potato blight, relative resistance against Alternaria, blackleg, potato nematode, rhizoctoniosis, Colorado potato beetle, *X* and *Y* viruses (29, 30, 31).

S. phureja (2p=24). Samples of this species are distinguished by their resistance to potato cancer, Alternaria, scab, black leg, rhizoctoniosis, ring rot, viruses *X, S, M, Y, A, L*, aphids, and nematodes. It has a high content of dry matter and protein.

S. andigenum (2n=48) is self-fertile. Individual specimens of the species are characterized by extreme resistance to viruses *X, Y* and *A*, hypersensitivity and field resistance to potato blight, resistance to potato cancer, common scab, blackleg, alternariosis, potato and stem nematodes, Colorado potato beetle.

S. demissum (2n=72) is self-fertile. Its samples are resistant to viruses *Y* and *L*, characterized by hypersensitivity and field resistance of 290 against potato blight, resistance to cancer pathotypes, potato nematode (species *G. rostochiensis* and *G. pallida*), Colorado beetle and frost, common scab, ring rot, etc. Tubers of individual samples have a high content of starch (22-33%) and protein (2.5-5.4%). It is easily crossed with other species and breeding varieties.

The study was conducted according to generally accepted methods in potato growing (Sygareva, 1986; Kutsenko *et al*., 2002; Trybel & Bondarchuk, 2013; Bondarchuk & Koltunov, 2019), experimental data were processed on a computer using the Microsoft Excel program and methods of (Ehrmantraut, 2018).

RESULTS AND DISCUSSION

The correct selection of parent pairs for hybridization is of crucial importance in the selection for potato blight

resistance of potatoes. For this, it is necessary to factor in the degree of resistance against potato blight in particular climatic conditions and the combinational ability for this feature. Comparison of field resistance against potato blight of parent pairs and offspring obtained as a result of crossing, combinations were identified that, both in terms of the average value and the number of hybrids, had different degrees of plant damage by potato blight (Table 1).

Table 1. *The influence of parental forms on the resistance of offspring, obtained based on simple intervarietal crossings, against potato blight*

Combinations of crosses	Resistance of parent forms against potato blight, points			Resistance of offspring against potato blight M±**m**	Correlation coefficient between resistance of parent forms and offspring against potato blight, r	Distribution of genotypes (%) by potato blight resistance classes, score			
	♀	♂	average M±**m**			1-2	3-4	5-7	8-9
Arkhideia x Zakhidna	6.0	7.0	6.5±**0.22**	6.4±**0.43**	-0.026	0	35.7	64.0	0.3
Leleka x Alpinist	5.5	9.0	7.2±**0.74**	8.5±**0.27**	+0.876	0	39.0	50.3	10.7
Alpinist x Teteriv	9.0	8.5	8.7±**0.16**	8.9±**0.23**	+0.781	0	31.4	67.2	1.4
Bahriana x Teteriv	8.5	6.0	7.2±**0.52**	7.3±**0.30**	+0.457	0	46.3	53.2	0.5
Brihantina x Teteriv	6.0	8.5	7.2±**0.16**	7.8±**0.28**	+0.771	0	25.9	72.8	1.3
Teteriv x Bahriana	6.0	8.5	7.2±**0.54**	6.6±**0.42**	-0.703	0	31.0	68.5	0.5
Teteriv x Krynytsia	8.5	7.5	8.0±**0.20**	8.4±**0.21**	+0.486	0	23.0	75.6	1.4
Slava x Pamir	7.5	5.0	6.2±**0.56**	7.5±**0.23**	+0.899	0	31.3	64.9	3.8
Luhovska x Kristal	7.0	5.6	6.3±**0.34**	7.1±**0.24**	+0.580	0	23.8	63.6	12.6

Source*: compiled by the author*

The combinations Alpinist x Teteriv, Leleka x Alpinist, and Teteriv x Krynytsia were the best in terms of resistance to this disease in simple intervarietal crossings. On average, the resistance of parental pairs against potato blight in these combinations was 8.7, 7.2, and 8.0 points, respectively, and in offspring – in the same combinations: 8.9, 8.5, and 8.4 points. The resistance of the offspring to potato blight was associated with the degree of manifestation of this trait in the parent forms.

The correlation between resistance of parent pairs and offspring to potato blight, depending on the combination of crossing, was weak negative, medium, and high positive. A high positive correlation coefficient was noted in the hybrid populations of Leleka × Alpinist, Alpinist × Teteriv, Brihantina x Teteriv, and Slava × Pamir – r=+0.771-+0.899. There was a weak negative correlation coefficient in only one population – Arkhideia x Zakhidna – r=-0.026.

The average percentage of genotypes obtained by simple intervarietal crossings in 9 populations in the resistance class of 3-4 points was 31.9%; 5-7 points – 64.5%, and 8-9 points – 3.6%. The largest number of offspring hybrids – from 50.3% to 75.6% – had a resistance score of 5-7, from 0.5% to 12.6% – 8-9 points, and none of the populations had low resistance to potato blight (1-2 points). We believe that the high field resistance against potato blight of the offspring of the combinations Leleka × Alpinist, Alpinist × Teteriv, Brihantina × Teteriv, Teteriv × Krynytsia is because in the pedigree of one of the parental forms, there were disease-resistant relatives of cultural varieties.

The potato blight resistance of offspring, created by crossing complex intervarietal hybrids, primarily depended on the selection of parental pairs for hybridization. Therewith, both the paternal and maternal forms played an important role. Two previously created hybrids, Sagitta × (Maritta × Igor) and Volovetska × Pamir were used as the maternal form, and Petland Scwajer, Zakhidna, Rakurs, Lybid, Suzorie and Vytok varieties were used as the parental form. The most effective combinations for resistance against potato blight were (Volovets × Pamir) × turn and (Volovets × Pamir) × Suzorie. The average resistance against potato blight in the offspring of these populations was 8.9 and 8.8 points, respectively (Table 2).

Table 2. *Influence of parental forms on the resistance of offspring to potato blight, obtained based on complex intervarietal crosses*

Combinations of crosses	Resistance of parental forms against potato blight, points			Resistance of offspring against potato blight M±**m**	Correlation coefficient between resistance of parental forms and offspring to potato blight, r	Distribution of genotypes (%) by potato blight resistance classes, score			
	♀	♂	average M±**m**			1-2	3-4	5-7	8-9
Sagitta × (Maritta × Igor) × Petland Scwajer	8.0	5.0	6.5±**0.62**	6.8±**0.27**	+0.190	1.2	18.4	75.2	5.2

Table 2, Continued

Combinations of crosses	Resistance of parental forms against potato blight, points			Resistance of offspring against potato blight M±**m**	Correlation coefficient between resistance of parental forms and offspring to potato blight, r	Distribution of genotypes (%) by potato blight resistance classes, score			
	♀	♂	average M±**m**			1-2	3-4	5-7	8-9
Sagitta × (Maritta × Igor) × Zakhidna	8.0	7.0	7.5±**0.21**	7.9±**0.22**	+0.483	0	21.9	64.4	13.7
Sagitta × (Maritta × Igor) × (Komsomolets × X Naroch)	8.0	7.0	7.5±**0.32**	7.8±**0.21**	+0.361	0	7.5	70.2	22.3
Sagitta × (Maritta × Igor) × Rakurs	8.0	8.5	8.2±**0.15**	8.5±**0.20**	+0.560	0	3.9	61.6	34.5
(Volovetska × Pamir) × Lybid	8.5	7.5	8.0±**0.27**	8.4±**0.22**	+0.638	0	12.4	49.6	38.0
(Volovetska × Pamir) × Suzorie	8.5	8.7	8.6±**0.10**	8.8±**0.12**	+0.189	0	12.7	18.6	68.7
(Volovetska × Pamir) × Vytok	8.5	8.9	8.7±**0.11**	8.9±**0.24**	+0.803	1.8	16.8	38.9	42.5

***Source**: compiled by the author*

Correlation dependence between resistance of parental forms and offspring to potato blight was positive and high in the population (Volovetska × Pamir) × Vytok (r=+0.803), positive and medium – in combinations (Volovetska × Pamir) × Lybid, Sagitta × (Maritta × Igor) × Rakurs (r=+0.560–+0.638), positive and weak – Sagitta × (Maritta × Igor) × Petland Scwajer, (Volovetska × Pamir) × Suzorie and Sagitta × (Maritta × Igor) × (Komsomolets × Naroch) – r=+0.189–+0.361.

The distribution of genotypes according to potato blight resistance classes indicated that 1.2-1.8% of hybrids of the two combinations were characterized by low (1-2 points) resistance against potato blight. The percentage of genotypes with resistance of 3-4 points was 13.4%, 5-7 points – 54.1%, 8-9 points – 32.0% on average across populations.

The combinations (Volovetska × Pamir) × Suzorie, (Volovetska × Pamir) × Vytok were characterized by the highest (8-9 points) resistance to potato blight and the largest (from 38.0% to 68.7%) number of genotypes in the class of 8-9 points, (Volovetska × Pamir) × Lybid.

Analysing the influence of parental forms on the resistance of offspring against potato blight, obtained from backcrossing of complex interspecific hybrids, it was noted that the main part of the source material that was included in hybridization, except for interspecific hybrids 90.841 c.21 and 88.1450 c.2, 86.563 c.4 and variety Lybid was characterized by average resistance against potato blight.

In terms of the resistance of offspring against late blight, obtained based on backcrossing of complex interspecies hybrids, where the second parental form was the Lybid variety, only two populations stood out, the average resistance of hybrids against potato blight in which was 8.8 and 8.5 points. The correlation coefficient between the stability of parental forms and offspring was weak and on average positive (r=+0.253–+0.566). When backcrossing complex interspecific hybrids, 0.7% to 9.4% of genotypes had low resistance against potato blight (1-2 points). The largest (53.3%) percent on average for populations was occupied by genotypes in the resistance class of 5-7 points and 15.6% – in the resistance class of 8-9 points (Table 3).

***Table 3.** Influence of parental forms on the resistance of the offspring obtained by backcrossing complex interspecific hybrids against potato blight*

Combinations of crosses	Resistance of parental forms against potato blight, points			Resistance of offspring to potato blight M±**m**	Correlation coefficient between resistance of parental forms and offspring to potato blight, r	Distribution of genotypes (%) by potato blight resistance classes, score			
	♀	♂	average M±**m**			1-2	3-4	5-7	8-9
88.1450 c.2 × Chernihivska early	8.0	5.0	6.5±**0.62**	8.2±**0.32**	+ 0.868	1.5	2.5	65.6	30.4
Chernihivska early × 89.721 c.23	5.0	7.0	6.0±**0.55**	6.4±**0.31**	+ 0.367	7.8	50.7	39.3	2.2
Chernihivska early × 90.674/12	5.0	8.0	6.5±**0.61**	7.6±**0.32**	+ 0.598	0.7	40.0	57.0	2.3
Lybid × 90.841 c. 21	7.5	9.0	8.2±**0.31**	8.8±**0.33**	+ 0.566	0	28.4	46.9	24.7
91.765/15 × Lybid	7.5	7.5	7.5±**0.12**	7.7±**0.35**	+ 0.253	9.4	45.8	40.3	4.5
Lybid × 88.1450 c.2	7.5	8.5	8.0±**0.22**	8.5±**0.21**	+ 0.538	0	17.0	59.4	23.6
86.563 c.4 × Lybid	8.5	7.5	8.0±**0.32**	8.6±**0.20**	+ 0.416	1.7	12.4	64.6	21.3

***Source**: compiled by the author*

The manifestation of field resistance against potato blight in the offspring depended on the origin of the potato source material based on which the crossing was carried out. The largest (32.1%) number of hybrids with resistance to potato blight (8-9 points) was obtained in populations when crossing complex intervarietal hybrids, while based on simple intervarietal crossings – only 3.6% and upon backcrossing complex interspecific hybrids – 15.6%, which indicates the possibility of obtaining breeding material resistant to potato blight when parental forms use source material of different origins and different types of crossing. It should be noted that saturating crosses played a role in the effectiveness of intervarietal crossings for obtaining potato blight resistant offspring. Data on the relationship between the resistance of the vegetative mass against potato blight and productivity are presented in Table 4.

Table 4. *Relationship between the resistance of vegetative mass against potato blight and the productivity of offspring of different origins*

Combinations of crosses	Resistance of offspring to potato blight, points M±**m**	Productivity of hybrid populations, g/bush M±**m**	Correlation coefficient between productivity and resistance to potato blight, r
Simple intervarietal crosses			
Archideia × Zakhidna	6.4±**0.43**	524±**29**	-0.116
Leleka × Alpinist	8.5±**0.27**	929±**47**	-0.556
Alpinist × Teteriv	8.9±**0.23**	1,067±**29**	+0.810
Bahriana × Teteriv	7.3±**0.30**	553±**27**	+0.351
Brihantina × Teteriv	7.8±**0.28**	967±**10**	+0.532
Teteriv × Bahriana	6.6±**0.42**	659±**19**	-0.688
Teteriv × Krynytsia	8.4±**0.21**	598±**14**	+0.643
Slava × Pamir	7.5±**0.23**	1,203±**10**	+0.403
Luhovska × Kristal	7.1±**0.24**	1,058±**27**	+0.764
Complex intersort crosses			
Sagitta × (Maritta × Igor) × Petland Scwajer	6.8±**0.27**	433±**48**	-0.196
Sagitta × (Maritta × Igor) × Zakhidna	7.9±**0.22**	565±**11.6**	-0.106
Sagitta × (Maritta × Igor) × (Komsomolets × X Naroch)	7.8±**0.21**	877±**25**	+0.924
Sagitta × (Maritta × Igor) × Rakurs	8.5±**0.20**	695±**48**	-0.538
(Volovetska × Pamir) × Lybid	8.4±**0.22**	622±**39**	-0.254
(Volovetska × Pamir) × Suzorie	8.8±**0.12**	897±**28**	+0.215
(Volovetska × Pamir) × Vytok	8.9±**0.24**	1,026±**25**	+0.670
Backcrossing complex interspecific hybrids			
88.1450 c.2 × Chernihivska early	8.2±**0.32**	676±**28**	+0.768
Chernihivska early × 89.721 c.23	6.4±**0.31**	596±**11**	+0.265
Chernihivska early × 90.674/12	7.6±**0.32**	457±**29**	+0.464
Lybid × 90.841 c. 21	8.8±**0.33**	569±**32**	-0.705
91.765/15 × Lybid	7.7±**0.35**	504±**16**	-0.088
Lybid × 88.1450 c.2	8.5±**0.21**	903±**35**	+0.296
86.563 c.4 × Lybid	8.6±**0.20**	700±**23**	+0.232

Source*: compiled by the author*

The established correlation coefficients between the resistance of vegetative mass to potato blight and productivity indicate independent inheritance of these traits. With different types of crossings used in this study, the correlation coefficients primarily depended on the selection of parental pairs. A high positive correlation between the resistance of the vegetative mass to potato blight and the productivity of offspring was found in combinations involving starting material of different origins in hybridization. Specifically, upon crossing the following varieties: Alpinist × Teteriv, Luhovska × Kristal, Teteriv × Krynitsia, correlation coefficients were r=+0.643-+0.810, complex intervarietal hybrids: Sagitta × (Maritta × Igor) × (Komsomolets × Naroch), (Volovetska × Pamir) × Vytok – r = +0.670–0.924, and complex interspecific hybrid 88.1450 c.2 × Chernihivska early – r=+0.768. In the remaining populations, the relationship between potato blight resistance and

productivity was weak, moderately positive, the correlation coefficient was from r=+0.215 to r=+0.532, and weak and moderately negative, the correlation coefficient was from r=-0.088 to r=-0.705.

The largest number of genotypes with high resistance to potato blight (8-9 points) was obtained based on complex intervarietal crossings (32.1%), when backcrossing complex interspecific hybrids (15.6%). The absence of a correlation between potato blight resistance and productivity in a number of combinations indicates independent inheritance and the possibility of combining high indicators of these traits.

Combinations were found in the offspring that combine high resistance against potato blight (7.1-8.9 points) with high productivity (700-1203 g/bush). These include Alpinist × Teteriv, Leleka × Alpinist, Slava × Pamir, Luhovska × Kristal, Sagitta × (Maritta × Igor) × (Komsomolets × Naroch), (Volovetska × Pamir) × Suzorie, (Volovetska × Pamir) × Vytok, Lybid × 88.1450 c.2. Thus, the manifestation of productivity in offspring of different origins depended on the parent pairs and was divided into types: intermediate, heterosism, and depression.

To obtain breeding material with a yield of up to 1,000 g/bush, promising combinations are Leleka × Alpinist, Alpinist × Teteriv, Brihantina × Teteriv, Slava × Pamir, Luhovska × Kristal, Sagitta × (Maritta × Igor) × (Komsomolets × Naroch), (Volovetska × Pamir) × Suzorie, (Volovetska × Pamir) × Vytok, Lybid × 88.1450 c.2. The productivity of offspring created from simple intervarietal crossings was 524 to 1,203 g/bush and exceeded the parental forms by 16.5%, from complex intervarietal crossings – from 433 to 1,026 g/bush, or by 17.6%, from backcrossing of complex interspecific hybrids – 457-903 g/bush, or by 27.2%.

Analysis of the distribution of hybrids by performance classes showed that the percentage of highly productive hybrids primarily depends on the selection of parent pairs and the origin of the source material used in hybridization. In simple intervarietal crossings, the highest percentage (42.0) of offspring with a yield of up to 1,000 g/bush was obtained in the combination of Leleka × Alpinist, in complex intervarietal crossings (45-58%) – in combinations (Volovetska × Pamir) × Vytok, (Volovetska × Pamir) × Suzorie and Sagitta × (Maritta × Igor) × (Komsomolets × Naroch), when backcrossing complex interspecies hybrids (50%) – in combination Lybid × 88.1450 c.2.

The highest average weight of tubers was obtained from simple intervarietal crossings of 101-125 g, the lowest – 48-72 g – from backcrossing of complex interspecific hybrids. The identified combinations that are promising for obtaining high-yielding offspring (700-1,203 g/bush) together with high resistance to potato blight (7.8-8.9 points) are Alpinist × Teteriv, Slava × Pamir, Luhovska × Kristal, Sagitta × (Maritta × Igor) × (Komsomolets × Naroch), (Volovetska x Pamir) × Suzorie, (Volovetska × Pamir) × Vytok, Lybid × 88.1450 p.2.

It was established (Borodai & Parthenyuk, 2018) that potato blight, alternariasis, rhizoctoniosis, bacteriosis, and viral diseases dominate potato plants during the growing season. The share of areas affected by them varied between 6.1-91.5%, and in some regions it reached 100%. The proportion of plants affected by potato blight, alternariasis, and fomosis was 30.0-67.8%, and the development of diseases — 2.1-42.3%. The prevalence and development of other diseases varied within 0.2-5.2 and 0.1-2.1%, respectively.

Scientists (Nevmerzhitska *et al.*, 2019) conducted experiments on the isolation and identification of the species composition of phytopathogens from tubers affected by fusariosis, studying the yield of potato varieties of different maturity groups depending on fusariosis damage during 2019-2020 at PE "Zherm" of Chernyakhiv district of Zhytomyr region and in laboratories of the department of plant protection of the Polish National University. It was found that considerable yield losses were observed in the susceptible temp variety in the variant where potato tubers affected by fusarium rot were used as planting material. Thus, on average, over the years of research from dry fusarium rot, crop losses reached up to 5 t/ha, which is almost 37%. Relatively resistant varieties (Povin, Mavka) also had crop losses, but they did not exceed 4 t/ha. The damage to the planting material by fungi of the genus *Fusarium* had less effect on the productivity of the Povin variety because its yield losses did not exceed 3.7 t/ha, which was only 18.1% compared to the control.

According to V. Martynenko (2016), based on research carried out at the Educational Scientific Production Centre of the V.V. Dokuchaev Kharkiv National Agrarian University resistance to potato blight, based on the study of varieties of the world assortment, it was found that about 40-45% of them are distinguished by field resistance to a certain degree, and the vast majority of them are intervarietal hybrids, where the parent original forms have a sufficiently high resistance score against potato blight.

The analysis of research carried out by scientists made it possible to involve in crossbreeding some potato varieties that stood out with high points of resistance to such harmful diseases as potato blight and fusariosis, namely Slava, Teteriv, Krynytsia, Bahriana, Zakhidna, Luhovska, etc. Some varieties included in the crossbreeding combination were created by breeders of the Institute of Agriculture of the Carpathian Region and the Lviv National University of Nature Management, i.e., in the western region, which is characterized by frequent epiphytotia of a disease such as potato blight, and therefore the hybrid offspring obtained from the crossbreeding was characterized by high resistance scores against potato blight (from 6.6 points) in combination with high productivity (over 500 g/bush).

Some breeding scientists (Kravchenko *et al.*, 2019) claim that the resistance against potato blight of the

resulting hybrid generation results in the formation of certain economic traits and culinary parameters in the latter. An increase in the resistance score against potato blight leads to an improvement in these signs.

Scientists (Podhaietskyi *et al*., 2019) revealed the specific effect of crossbreeding components on the germination of hybrid seeds for 5-9 days and the subsequent resistance of plants against potato blight damage. The best results were obtained among seeds with the origin of 86.96s32 × *S. andigenum* – 28.3%. They were quite high in three other populations of this species. The exception was the use of the maternal form of the six-species double backcross hybrid 89.721s81 – 9.2%. In 54.1% of combinations, laboratory seed germination was 90% or more, with the maximum manifestation of Shchedryk × Podoliia hybrid seeds – 96.8%. In another population involving the mentioned maternal form, high results were also obtained – 95.4%.

The obtained research results indicate that carrying out both simple and complex intervarietal crossings, as well as backcrossing of complex interspecific hybrids created involving the species *S. acaule, S. bulbocastanum, S. phureja, S. demissum, S. andigenum* and cultural varieties helps obtain hybrid offspring with high parameters of resistance to potato blight (6.6-8.9 points) with economic and valuable indicators (bush productivity – 457-1,203 g).

The difficulties that scientists face when breeding potatoes for resistance to one of the most harmful diseases – potato blight, and especially when highly virulent and aggressive races of the fungus appear, and the subsequent creation of varieties with high resistance can be overcome, and the selection itself is well-achievable. But for this, it is necessary to constantly replenish the arsenal of breeders with a variety of source material with effective genetic control of this trait and to improve its evaluation methods in relation to the soil and climatic conditions of breeding work.

CONCLUSIONS

The difficulty of involving relatives of cultural varieties in practical selection is based on the specificity of carrying out research on the creation of initial selection material on an interspecies basis, the duration of the process of obtaining primary and secondary interspecies hybrids, their backcrosses, and therefore, the practical absence of the possibility of combining this and the selection area of research in one structural subdivision. The promising use of backcrosses of three- and four-species and, especially, six-species hybrids in breeding practice was proven. According to the methods of creation, they can be backcrosses, offspring from self-pollination, or from crossing hybrids with each other. The high adaptive potential of interspecies hybrid varieties, created from the original selection material according to certain agronomic characteristics, was established.

The nature of the inheritance of resistance to potato blight by offspring was established, and the possibility of combining high indicators of resistance to potato blight and productivity was proven.

Combinations were identified, which are promising for obtaining high-yielding offspring (700-1,203 g/bush) in combination with high resistance to potato blight (7.1-8.9 points): Alpinist × Teteriv, Leleka × Alpinist, Slava × Pamir, Luhovska × Kristal, Sagitta × (Maritta × Igoer) × (Komsomolets x Naroch), (Volovetska × Pamir) × Suzorie, (Volovetska × Pamir) × Vytok, Lybid × 88.1450 c.2.

Using different types of crossings based on complex interspecies and intervarietal hybrids, varieties of Ukrainian and foreign selection, a new genetically diverse selection material was created with a productivity exceeding 1,000 g/bush, a starch content of more than 20.0%, resistance to potato blight of 8.0-9.0 points, high in crude protein, protein, amino acids, vitamin C, low in reducing sugars and nitrates.

Therefore, one of the main factors of breeding work with potato culture in different agro-climatic zones of Ukraine is a sufficient amount of newly created highly productive hybrid material, which enables the breeder to select the best samples with high economic and valuable indicators for further work on the creation of new potato varieties.

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CONFLICT OF INTEREST

None.

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Створення потомства гібридів картоплі (*Solanum tuberosum*) з високою польовою стійкістю проти фітофторозу

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Анотація. Створення нових сортів картоплі з високими господарсько цінними властивостями та комплексною стійкістю проти найбільш поширених хвороб є одним з основних напрямів селекції сільськогосподарських культур на даний час. Насамперед це пов'язано із можливістю збільшення валового виробництва картоплі, покращенню її господарських показників, а також завданнями охорони навколишнього середовища від забруднення пестицидами, що сприяє суттєвому покращенню навколишнього середовища і отриманню екологічно безпечної продукції. Метою цього дослідження було виділити сортозразки з високим рівнем урожайності та стійкості проти фітофторозу в умовах західного регіону України. Дослідження проведено з використанням польових (оцінка розвитку хвороб), лабораторних, аналітичних і математично-статистичних методів. Наведено теоретичне обґрунтування і нове вирішення важливого наукового завдання встановлення особливостей використання батьківськими формами вітчизняних і зарубіжних сортів, міжсортових та багатовидових гібридів в селекції картоплі. Узагальнено особливості прояву складових продуктивності, якісних ознак, стійкості проти фітофторозу, кореляційних зв'язків між господарстько-цінними ознаками, підбору нових батьківських форм для міжсортової та міжвидової гібридизації, характеру високої продуктивності, якості і фітофторостійкості селекційного матеріалу та створено генетично цінні сорти, що має велике значення в селекції картоплі та для сільськогосподарського виробництва України. На основі цього доведено можливість і ефективність поєднання передачі ознак потомству та їх успадкування, що розширить наявну базу вихідного селекційного матеріалу для подальшої роботи щодо створення перспективних сортів картоплі різних групп стиглості з високо-цінними господарськими ознаками

Ключові слова: картопля; сорт; міжсортовий та міжвидовий гібрид; нащадок; продуктивність; фітофтороз; кореляція