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ORIGINAL ARTICLE

Analysis of potato source material-main stage of selection work

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The aim of the research was to analyze the source material nursery (hybridization nursery) in order to identify and involve in the selection the most suitable cultivars of potatoes and interspecific hybrids created on the basis of phylogenetically remote species. The intention was to create new potato varieties in relation to soil and climatic conditions of Ukrainian Western Forest-Steppe. It is established that the source material, created on the basis of phylogenetically distant species, is similar to cultivars in appearance of the bush and its morphological features. However, interspecific hybrids are inferior to breeding varieties in productivity and average tuber weight. They have longer stolons, more stems-from 6 to 13 pcs and relatively longer growing season, which corresponds to the group of late-maturing varieties of potatoes. The length of stolons in interspecific hybrids that we studied ranged from 17 to 24 cm, the growing season-from 120 to 145 days. Interspecific hybrids are characterized by high marketability of tubers, higher starch content, show high resistance of vegetative mass against late blight. Therefore, the introgression of the genes of these traits in newly created potato varieties is of practical importance for potato breeding. Regarding varieties in the hybridization nursery, we should pay attention to the varieties of potatoes created in the Western region of Ukraine and the varieties of selection of the Scientific Research Center for Potato and Vegetable Growing of the National Academy of Sciences of Belarus. The variety of selection of the Institute of Potato NAAS-Shchedryk deserves special attention. High resistance to late blight in combination with high yields showed varieties Kniahynia, Myroslava, Lehenda, Oksamyt-99, Krinitsa, Skarb, Padarunok, Talisman, Brihantina, Harant, Atlant, Zakhidna, Svaliavska and others.

Keywords: Potato, Variety, Hybrid, Yield, Resistance, Disease.

Introduction

Extremely important task of potato breeding is to combine in varieties resistance to diseases and pests with the main economic and valuable traits (Bondarchuk et al., 2015).

The task can be solved through purposeful selection, which is based on the use of various source material, knowledge of the genetic nature of parental pairs, the use of effective methods of assessment and selection of desired genotypes (Oliinyk et al., 2017).

For the theory of selection is important generalization obtained in population biology, namely: the presence of specific systemic mechanisms that relate to the integrity of the superorganism of biological systems (Osypchuk, 2012). That's why we conducted analysis of recent research and publications.

The object of breeders' research is a macrosystem plant, in our case a potato plant, which is programmed to a certain level of formation of macro-features as a means of obtaining production. The efforts of breeders focus on the functional organization of this macrosystem, in particular on the phenotypic manifestation of the production process, genetic protection and quality of products (Osypchuk, 2011).

The current level of biological knowledge allows to form the theoretical basis of selection, the main postulate of which is the creation of source material using various methods and as a result of all selection work-created variety. To ensure the scientific implementation of these provisions, it requires the integration of knowledge of genetics, individual development, population biology and ecology (Osypchuk, 2014).

The main areas of potato breeding in Ukraine are: the creation of varieties of table potatoes, table and technical as well as potatoes of universal purposes, highly productive, with good taste and culinary qualities, resistant to diseases and pests, adapted to growing conditions.

High and stable yields are in varieties: very early-Duma, Radomysl; early-Serpanok, Skarbnytsia, Slauta, Povin, Tiras, Shchedryk; middle-early-Ariia, Obrii, Vodograi, Zhytnytsia, Strumok; medium-ripe-Avangard, Alians, Vira, Dorohyn, Ivankivska early, Kniahynia, Lehenda, Myroslava, Olexandryt, Opillia, Predslava, Slovianka, Factor, Feia, Fotyniia, Yavir; mid-late-Oksamyt-99, Veresivka, Poliske dzherelo, Rodynna, Teteriv, Chervona Ruta and others (Derzhavnyi reiestr, 2016).

In the selection for high yields the main role belongs to the selection of parent pairs for hybridization, which is carried out by the combination ability, yield structure, the effectiveness of selection by economically valuable forms (Hospodarenko et al.,2018; Andriushko and Solohub, 2014).

It is possible to get offspring with a combination of high starch content and yield if the starch content of both parents is not below a certain limit. For selection by high starch content, parental forms are selected according to their phenotype and offspring. Saturating crosses are effective. The original forms can be varieties: Zarevo, Verba, Erdkraft, Bekra, Svitanok kyivskyi, Chervona ruta, Volovetska, Ikar, Rodynna, Solokha, Khortytsia, Sluch, as well as a number of interspecific hybrids. High-starch forms are distinguished by the stability of the trait both over the years and during testing in different soil and climatic zones (Yakovleva et al., 2018; Oliinyk, 2018; Sydorchuk et al., 2017; Parkhuts, 2017).

The creation and use of resistant varieties plays an important role in protecting potatoes from late blight. In the selection by this trait two types of resistance must be taken into account: field and hypersensitivity. It is important to combine the stability of the aboveground mass with the stability of the tubers (Kozlov et al., 2017).

Combining different types of resistance: hypersensitivity to the most common races in a given area and field resistance can provide high resistance to disease for a long time (Popravko, 1971; Litun et al., 2007).

To do this, use interspecific hybridization and source material of interspecific origin. Selection of parental forms is carried out according to their phenotype and offspring (Shanina et al., 2017; Cheremysyn and Derhacheva, 2016).

High field resistance against late blight are in potato varieties created in Ukraine: Luhovska, Rakurs, Zakhidna, Chervona ruta, Dorohyn, Olviia, Ariia, Bazaliia, Kniahynia, Lileia, Lietana, Myroslava, Okolytsia, Oleksandryt, Predslava, Rodynna, Slovianka, Sluch, Feia, Fotyniia, Yavir and others (Tesliuk et al., 2016).

Potatoes are too time consuming for genetic research. Any variety of this culture is heterozygous, if not for all, then for most traits. In crosses there is a split by many genes and accordingly by the traits, what considerably complicates the hybridological analysis. However, the widespread use of remote hybridization involving wild and cultured diploid species, the use of polyploidy and haploidy in recent decades has stimulated the development of genetic research on potatoes.

Potatoes are characterized by a rich variety of genetic resources that can be used as a source material for breeding. These are wild, primitive and cultivated species, breeding and local varieties, interspecific hybrids. About 180 tuber-forming species are known. All species, with some exceptions, form tubers at the ends of stolons. Samples of many species have a wide range of resistance to diseases and pests, frost, drought, biochemical quality indicators and more.

Old and modern domestic and foreign varieties of potatoes have a significant genetic diversity. They are used in breeding as genetic sources or donors of high yields, precocity, resistance to viral diseases, good taste and others.

Of great importance for use as a source material are local varieties, as well as varieties created on a multi-species basis, which are characterized by resistance to adverse growing conditions and high adaptability to cultivation in different soil and climatic zones.

Among the cultivated species, *S. tuberosum and S. andigenum, S. rybinii and S. phureja* were widely used.

S. tuberosum (2n=48) is characterized by high yields, good taste, good tuber shape, relative resistance to viral diseases, high content of starch and protein. Breeding varieties of the species are also resistant to cancer of potatoes, nematodes, certain viruses and others.

In the pedigree of all breeding varieties there are a species of *S. tuberosum, S. andigenum* (2n=48). Polymorphic species, among the samples of which are possible sources of resistance to various pathotypes of cancer, potato nematode, alternariosis, scabies, blackleg, X-Y-A-L-viruses, late blight, cyst nematodes, aphids, frost. The tubers contain up to 32% dry matter and up to 4% protein. It is characterized by high yields, has good taste.

S. rybinii (2п=24, 36). Samples are distinguished by resistance to potato cancer, alternariosis, scabies, blackleg, ring rot, late blight, viruses X, M, Y. The tubers contain up to 26% dry matter, up to 4.5% protein.

S. phureja (2п=24). Samples of this species are distinguished by resistance to potato cancer, alternariosis, scabies, blackleg, rhizoctonia, ring rot, viruses X, S, M, Y, A, L, aphids, nematodes. Has a high content of dry matter and protein.

The centers of genetic resources have a collection of native Chilean varieties that are important for selection. Aboriginal Chilean potatoes are represented by a large number of species, varieties and clones that differ in morphological, genetic traits and properties. Some of them have a complex of genes that provide high productivity, resistance to disease, high starch content-19-21%, protein content-2.4-3%, good shape of tubers, good taste.

Widely used in breeding wild potato species: *S. demissum, S. acaule, S. chacoense, S. spegazzinii, S. stoloniferum, S. vemei* and others. *Solanum demissum* (2n=72)-self-fertile. Its samples are resistant to viruses Y and L, are characterized by hypersensitivity and field resistance against late blight, resistance to cancer pathotypes, potato nematode (species *G. rostochiensis and G. pallida*), Colorado potato beetle and frost, scabies, ring rot, etc. Tubers of individual samples have a high content of starch (22-33%) and protein (2.5-5.4%). Easily crossed with other species and breeding varieties.

S. acaule (2n=48)-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, scabies, oosporosis, alternariosis, ring and brown rot. The tubers contain up to 23% starch and up to 2.8% protein. Easily crossed with wild species and varieties.

S. chacoense (2n=24). Its samples are extremely resistant to viruses A and Y, resistant to S and M viruses, leaf curl, late blight, Colorado potato beetle, potato moth, common scabies, blackleg, ring rot. The tubers contain up to 29% starch and 3.3% protein. Relatively resistant to frost and drought.

S. spegazzinii (2n=24). Specimens of this species are resistant to the pathotypes of cancer, potato nematode (*G. rostochiensis and G. pallida*), stem and root nematode, relatively resistant to fusariosis.

S. stoloniferum (2n=48)-self-fertile. Some specimens of the species are characterized by extreme resistance to viruses X, Y and A, hypersensitivity and field resistance against late blight, resistance to potato cancer, scabies, blackleg, alternariosis, potato and stem nematodes, Colorado potato beetle.

S. vernei (2n=24). Samples of this species are distinguished by protein and starch content, low sugar content, resistance to late blight (hypersensitive and field), potato nematode (all known races), potato cancer, alternariosis, rhizoctonia, scabies, blackleg, frost.

S. bulbocastanum (2n=24). Its samples are characterized by high resistance to late blight, relative resistance to alternariosis, blackleg, potato nematode, rhizoctonia, Colorado potato beetle, viruses X and Y (Bakunov, 2003; Ermyshyn, 1998; Bradshaw, 1994; Ross, 1989; Budin, 1986; Tai, 1976; Overchuk et al., 1973; Popravko, 1971; Yashyna, 1970;).

Involvement of various source material in selection work, namely, both cultivars and hybrids of interspecific origin will make it possible to create varieties of potatoes with high economic value and resistant to various diseases.

The aim of the research was to analyze the source material nursery (hybridization nursery) in order to identify and involve in the selection the most suitable cultivars of potatoes and interspecific hybrids created on the basis of phylogenetically remote species with intention to create new potato varieties in terms of soil and climatic conditions of Ukrainian Western Forest-Steppe.

Materials and Methods

Breeding experiments were conducted in the fields of 4-field crop rotation of the Department of Agricultural Breeding of the Institute of Agriculture of the Carpathian region of NAAS, which is located in the village Obroshyne, Lviv district, Lviv region. The predecessor of potatoes were winter cereals with post-harvest sowing of green manure crops.

Mineral fertilizers were applied in the form of nitroammophoska ($N_{16}P_{16}K_{16}$), potassium deficiency was balanced by potassium magnesium ($K_{28}Mg_8S_{15}$).

Soils in experiments are gray forest surface-carbonated coarse-grained light-loamy on les-like deposits. They are heterogeneous in profile of mechanical composition, and this largely depends on the mode of their humidification. The upper horizons have higher humidity than the lower ones. For this reason, soils in rainy seasons or years with high rainfall are subject to excessive moisture and gleying. In dry years, they are well supplied with productive moisture. In addition, groundwater has a significant impact on gleying, the depth of which varies between 1.5 and 1.8 m.

Based on the conducted agrochemical analyzes, it was found that the soils under the experiments are poor in humus (1.58-1.67%), have an acid reaction of the soil solution (pH 4.80-5.17), the amount of absorbed bases 6.20-7, 22, hydrolytic acidity 2.87-3.29 mg-eq. per 100 g of soil.

The research was carried out according to generally accepted methods in potato growing (Bondarchuk and Koltunov, 2019; Ermantraut et al., 2018; Metodychni nastanovy, 2018; Trybel et al., 2013). Experimental data were processed using Microsoft Excel (Perehudov, 2018).

Results and Discussion

The selection of parental forms for crossbreeding largely determines the process of selection work. In the process of creating hybrids, heredity is the basis for creating a new form. The role of parent pairs in creation of hybrid plant is that they have some opportunities to create a new form of plant that combines the characteristics of both parents.

The difficulty is that every trait or property of the parental organisms is not transmitted directly to their offspring. In a hybrid organism the traits and properties of parental forms are combined in different ways. They can be recombined in each hybrid individually (Zakharchuk, 2014).

Successful selection of pairs requires in-depth study of all valuable economic traits and biological properties of the components intended for crossing, their history, as well as the conditions under which they better develop the traits and properties of interest to the breeder. Only then you can stop choice on a certain parental pair (Zakharchuk, 2020; Sydorchuk, 2018).

Breeding work during 2021 was carried out according to the full scheme of the selection process. Scientific researches on formation of a characteristic nursery of initial material of potatoes of various origin were carried out. Its complex estimation on productivity and qualitative indicators, and also on resistance of available material against late blight were carried out also.

Potato late blight is caused by the fungus *Phytophora Infestans (mont.) De bary* and is one of the most harmful diseases of the crop and causes loss of photosynthetic apparatus of plants during the growing season and tuber rot during storage.

Harmfulness of the disease largely depends on the area of cultivation, and losses in the years of epiphytosis are 50-60% or more. Located territorially in the area where outbreaks of this disease are observed almost annually, we analyzed all available breeding material for resistance to this disease.

Samples of *S. andigenum, S. Bulbocastanum, S. Berthaultii, S. brachycarpum* and others are considered to be promising for selective use in terms of resistance to late blight (Elanskii, 2017; Zhuchenko, 2015; Zelia, 2012; Yashyna, 1990; Dobrovolskyi, 1983;).

In addition to 225 varieties, hybrids created on the basis of species were studied in the collection nursery (hybridization nursery): 88.1450 c.2-with the participation of species *S. acaule*, *S. bulbocastanum*, *S. phureja*, *S. andigenum*, variety Aureliia; 81.386 c.4-((*S. acaule* × *S. bulbocastanum*) × *S. phureja*) × (*S. demissum* × *S. andigenum*); 91.765/15-participation of species *S. acaule*, *S. bulbocastanum*, *S. phureja*, *S. demissum*, varieties Marko and Volovetska; 90.841 c.2-participation of species. *acaule, S. bulbocastanum, S. phureja, S. demissum, S. andigenum*, varieties Poliska rozheva, Lvivianka, Gidra, Gitte; 89.721 c.23-participation of species *S. demissum, S. bulbocastanum, S. andigenum*, variety Biloruska 3; 90.674/12-participation of *S. acaule, S. bulbocastanum, S. phureja, S. demissum*, Marko and Volovetska varieties; 86.563 c.4-participation of species *S. acaule, S. bulbocastanum, S. phureja, S. demissum*,, varieties Poliska rozheva, Hibrydna 14, Gitte.

Characteristics of interspecific hybrids created on the basis of phylogenetically distant species by individual qualitative indicators are shown in Table 1.

Evaluation of potato samples by resistance to late blight on leaves was carried out in the field on a natural infectious background by visual records of plant damage (three times during the growing season) from the time of disease appearance (first signs were observed 03.06.2021).

The source material, created on the basis of phylogenetically distant species is similar to common cultivars in appearance of the bush and its morphological features. However, interspecific hybrids are inferior to breeding varieties in productivity and average tuber weight. They have longer stolons, more stems-from 6 to 13 pcs and a relatively longer growing season, which corresponds to the group of late-maturing varieties of potatoes.

The length of stolons in interspecific hybrids that we studied ranged from 17 to 24 cm, the growing season-from 120 to 145 days.

Table 1. The results of hybrids' evaluation created on the basis of phylogenetically distant species, 2021.

Interspecific hybrids	Number of tubers, pcs/bush	Length of stolons, cm	Number of stems in the bush, pcs	Productivity, g/bush
88.1450 c.2	19.5	18	9	523
90.841 c.21	11.4	22	6	401
91.765/15	16.2	20	10	478
89.721 c.23	18.7	17	6	460
90.674/12	22.3	23	9	427
86.563 c.4	27.2	24	13	570

However, interspecific hybrids are characterized by a large number of tubers in the bush (11.6-28.0 pcs) and low weight (20-28 g), except for the hybrid 89.721 c.23, created on the basis of *S. demissum*, *S. bulbocastanum, S. andigenum*, variety Biloruska 3. This hybrid has all the characteristics of a cultivar, provides relatively high productivity, average weight and marketability of tubers, which are respectively 570 g/bush and 95.4%. Its growing season is shorter-120-130 days.

Interspecific hybrids are characterized by high marketability of tubers, higher starch content, high resistance of vegetative mass against late blight (Table 2). Therefore, the introgression of the genes of these traits in newly created potato varieties is of practical importance for potato breeding.

The starch content in the tubers of interspecific hybrids created on the basis of phylogenetically distant species averages 20.1-25.4%. The highest starch content (24.8%) had a hybrid 86.563 c.4, obtained with the participation of species *S. acaule, S. bulbocastanum, S. phureja, S. demissum*, varieties Poliska rozheva, Hibrydna 14, Gitte.

Table 2. The results of the study of hybrids created on the basis of phylogenetically distant species, 2021.

Interspecific hybrids	Marketability of tubers, %	Starch content, %	Vegetation period, days	Resistance to late blight, score
88.1450 c.2	84.1	23.3	126-140	7.9
90.841 c.21	76.6	25.4	130-145	8.7
91.765/15	83.9	20.1	126-140	7.7
89.721 c.23	95.4	23.0	120-130	7.4
90.674/12	71.7	21.4	125-135	8.2
86.563 c.4	76.8	24.8	130-145	8.4

Summing up the analysis of interspecific hybrids we can conclude that the involvement in the selection of such source material, will create varieties with high starch content in combination with high resistance to disease, as the latter carry R-genes for resistance to late blight and tops and tubers are high in starch.

Regarding varieties in the hybridization nursery, we should pay attention to potato varieties created in the Western region of Ukraine and varieties of selection of the Scientific Research Center for Potato and Vegetable Science of the National Academy of Sciences of Belarus (Table 3). The variety of selection of the Institute of Potato NAAS-Shchedryk deserves special attention. Although by the group of maturity it belongs to the early ripening, but in the Western Forest-Steppe already for six years is characterized by high resistance to late blight and fairly high yields (according to various studies the lowest yield was 28.0 t/ha).

Table 3. The results of the evaluation of hybrid nursery varieties, 2021.

Variety name	Number of tubers, pcs/bush	Average tuber weight, g	Commodity tubers,%	Resistance to late blight, score	Yield, t/ha
		Varieties of IACR NAAS			
Mavka	7.2	67	80.0	7.9	21.6
Slava	6.7	77	78.0	7.8	35.4

Vira	7.8	78	79.0	7.3	30.9
Oksamyt-99	6.6	74	80.0	8.0	28.0
Lehenda	8.0	89	79.8	8.1	38.0
Varieties LNAU					
Zakhidna	8.1	78	77.0	8.0	25.6
Student	5.6	77	79.4	7.8	26.5
Duzha	7.1	80	90.0	7.7	31.0
Varieties of Transcarpathian SARS NAAS					
Svaliavska	7.8	80	75.4	8.2	27.0
Perechynska	7.6	63	78.9	8.7	25.3
Varieties of IP NAAS					
Chervona ruta	7.4	81	80.9	8.8	33.0
Myroslava	6.5	89	89.0	7.9	37.9
Sluch	6.9	80	87.6	7.9	32.9
Shchedryk	8.0	90	91.0	7.5	41.0
Varieties of SPC (Belarus)					
Aksamit	7.8	76	78.0	5.8	19.3
Delfin	6.9	67	75.5	5.9	16.2
Yavar	9.1	78	78.2	6.1	17.6
Arkhideia	8.9	81	80.1	6.3	15.6
Krinitsa	14.5	83	84.1	6.9	28.7
Skarb	12.4	87	76.6	6.8	29.9
Padarunok	16.2	85	83.9	7.0	26.4
Talisman	18.7	82	95.4	7.6	31.8
Brihantina	22.3	91	81.7	7.9	29.7
Harant	19.4	94	86.8	8.1	28.7
Lan	20.1	89	85.0	8.2	33.0
Atlant	16.7	87	79.9	8.3	37.4
Vytok	16.9	88	90.1	8.0	30.4
Suzorie	14.5	91	89.4	8.1	45.2

High resistance to late blight in combination with high yields showed varieties-Slava, Duzha, Svaliavska, Shchedryk, Suzorie, Atlant-various originators.

Analyzing the data in Table 3 by the economic characteristics of varieties, it should be noted that these varieties are recommended to be involved in the selection process as donors of resistance to late blight and high economic value in terms of soil and climatic conditions of Western Forest-Steppe of Ukraine.

Conclusion

The source material, created on the basis of phylogenetically distant species, is similar to cultivars in appearance of the bush and its morphological features. However, interspecific hybrids are inferior to breeding varieties in productivity and average tuber weight. They have longer stolons, more stems-from 6 to 13 pcs and a relatively longer growing season, which corresponds to the group of late-maturing varieties of potatoes.

The length of stolons in interspecific hybrids that we studied ranged from 17 to 24 cm, the growing season-from 120 to 145 days.

Interspecific hybrids are characterized by high marketability of tubers, higher starch content, high resistance of vegetative mass against late blight. Therefore, the introgression of the genes of these traits in newly created potato varieties is of practical importance for potato breeding.

Regarding varieties in the hybridization nursery, worth noting are varieties of potatoes created in the Western region of Ukraine and the varieties of selection of the Scientific Research Center for Potato and Vegetable Growing of the National Academy of Sciences of Belarus.

The variety of selection of the Institute of Potato NAAS-Shchedryk deserves special attention. Although by the group of maturity it belongs to the early ripening, but in the Western Forest-Steppe for six years was characterized by high resistance to late blight and fairly high yields (according to various studies, the lowest yield was 28.0 t/ha).

High resistance to late blight in combination with high yields showed varieties Kniahynia, Myroslava, Lehenda, Oksamyt-99, Krinitsa, Skarb, Padarunok, Talisman, Brihantina, Harant, Atlant, Zakhidna, Svaliavska and others.

References

Andriushko A., Solohub, Yu. (2014). Zahalni aspekty suchasnykh tekhnolohii vyroshchuvannia kartopli. Ahronom, p:10-12.

Bakunov, A.L., Symakov, E.A. (2003). Effektivnost podbora roditelskikh form v selektsii kartofelia na ustoichivost. Mater Mezhd Iub n Prakt Konf Posviashchennoi 75-letiu Belarusi. Minsk, p:150-159.

Bondarchuk, A.A., Koltunov, V.A. (2019). Kartopliarstvo: metodyka doslidnoi spravy. Vinnytsia: TOV Tvory, p:652.
Bondarchuk, A.A., Oliinyk, T.M., Azaiki, S.S., Zakharchuk, N.A., Furdyha, M.M., Vyshnevska, O.V. (2015). Methodological aspects of investigation of potato crop. Kyiv:Phoenix, p:101.
Bradshaw, J.E. (1994). Breeding strategies for clonally propagated potatoes. Potato Genetics. Wallingford (UK), p:109-132.
Budin, K.Z. (1986). Henetcheskie osnovy selektsii kartofelia. Leninhrad: Ahropromizdat, p:192.
Cheremysyn, A.Y., Derhacheva, N.V. (2016). Sravnitelnaia otsenka sortov kartofelia otechestvennoi i zarubezhnoi selektsii po produktivnosti i kachestvu v usloviiakh Omskoi oblasti. Kartofelevodstvo: sb. nauch. tr. RUP Nauch.-prakt. tsentr Nats Akad Nauk Belarusi po Kartofelevodstvu i Plodoovoshchevodstvu, 24:50-56.
Derzhavnyi reiestr sortiv roslyn, prydatnykh dlia poshyrennia v Ukraini. (2016).
Dobrovolskyi, R.S. (1983). Do pytanyia pro kombinatsiinu zdatnist deiakykh sortiv i hibrydiv kartopli. Kartopliarstvo: zb. Nauk Prats Kyiv, 14:8-11.
Elanskii, S.N., Diakov, Yu.T., Myliutyna, D.Y. (2017). Populiatsii vozbuditelia fitoftoroza kartofelia v Rossii. Kartofelevodstvo Rossii, 56:103-111.
Ermantraut, E.R. (2018). Metodyka naukovykh doslidzhen v ahronomii. Bila Tserkva, p:104.
Ermyshyn, A.P. (1998). Heneticheskie osnovy selektsii na heterozis. Minsk: Tekhnolohiia, p:183.
Hospodarenko, H.M., Nevlad, V.I., Prokopchuk, I.V., Prokopchuk, S.V. (2018). Symbiotychna azotyfikatsiia ta vrozhai.
Kozlov, V.A., Rusetskyi, N.V., Chashynskyi, A.V. (2017). Rezultaty raboty po sozdaniiu iskhodnoho materiala kartofelia. Kartofelevodstvo: sb Nauch tr RUP. Nauch-prakt Tsentr Nats Skad Nauk Belarusi po Kartofelevodstvu i Plodoovoshchevodstvu. 25:153-165.
Litun, P.P. (2007). Teoretychni osnovy bazovoi tekhnolohii selektsii. Shkola akademika Yurieva V. Ya., Teoretychni osnovy selektsii poliovykh kultur. Kharkiv, pp:9-12.
Metodychni nastanovy z vprovadzhennia vymoh standartu Global gap u kartopliarstvi. (2018). Proekt USAID, Pidtrymka ahrarnoho ta silskoho rozvytku. Kyiv, p:80.
Oliinyk, T.M. (2018). Instytut kartopliarstva. Buklet. Nemishaieve, p:40.
Oliinyk, T.M., Sidakova, O.V., Zakharchuk, N.A., Symonenko, N.V. (2017). Vyvchennia potentsialu vykhidnoho materialu kartopli dlia selektsii na posukhostiikist. Sortovyvchennia ta Okhorona Prav na Sorty Roslyn, 14:361-366.
Osypchuk, A.A. (2012). Selektsiia kartopli v Ukraini. Kartopliarstvo: mizhvid Temat Nauk zb IK NAAN, 39:35-41.
Osypchuk, A.A. (2011). Selektsiia kartopli v Ukraini z urakhuvanniam zon vyroshchuvannia. Kartopliarstvo: Mizhvid Temat Nauk zb IK NAAN, 38:25-31.
Osypchuk, A.A., Furdyha, M.M. (2014). Selektsiia kartopli na stiikist do nespryiatlyvykh umov. Kartopliarstvo Ukrainy, 2:6-10.
Overchuk, B.I., Pika, M.A., Tarasenko, V.A. (1973). Vyvchennia kombinatsiinoi zdatnosti sortiv kartopli. Kartopliarstvo: Zb Nauk Prats. Kyiv: Urozhai, 4:3-9.
Parkhuts, I.M. (2017). Rekomendatsii shchodo udobrennia kartopli na dernovopidzolystykh i temno-sirykh opidzolenykh gruntakh. Vcheni Lvivskoho Natsionalnoho Ahrarnoho Universytetu Vyrobnytstvu: Kataloh Naukovykh Rozrobok, 7:83-84.
Perehudov, V.N. (2018). Planirovanie mnohofaktornykh polevykh opytov s udobreniami i matematicheskaia obrabotka iikh rezultatov. Moskva: Kolos, p:184.
Popravko, M.Y. (1971). Dobir batkivskykh form i kombinatsii v selektsii kartopli. Kartopliarstvo: zb nauk prats Kyiv: Urozhai, 2:23-27.
Ross, Kh. (1989). Selektsiia kartofelia. Problemy i perspektivy/per. s anhl. V.A. Lebedeva. Moskva: Ahropromizdat, p:184.
Shanina, E.P., Kliukina, E.M., Stafeeva, M.A. (2017). Analiz kombinatsionnoi sposobnosti iskhodnykh roditelskikh form kartofelia po priznaku produktivnosti. Kartofelevodstvo: sb. nauch. tr. RUP «Nauch.-prakt. tsentr Nats. akad. nauk Belarusi Po Kartofelevodstvu I Plodoovoshchevodstvu, 25:56-63.
Sydorchuk, V.I., Pysarenko, N.V., Tymko, M.H., Lysak, O.A., Andriienko, T.M., Tymko, L.V. (2017). Novi sorty kartopli selektsii Poliskoho doslidnoho viddilennia IK NAAN. Kartopliarstvo Ukrainy: Nauk Vyrob Zh, 2:2-4.
Sydorchuk, V.I., Pysarenko, N.V., Tymko, M.H., Zelia, A.H., Zelia, H.V. (2018). Vidbir selektsiinoho materialu ta stvorennia sortiv stiikykh proty zvychainoho ta ahresyvnykh patotypiv raku kartopli. Kartopliarstvo Ukrainy: Nauk Vyrob Zh, 2:2-10.
Tai, G.C.C. (1976). Estimation of general and specific combining abilities in potato. Canadian Journal of Genetic Cyton, 18:463-470.
Tesliuk, P.S. (2016). Ukraincka kartoplia. Kyiv: Rydzhy, p:244.
Trybel, S.O. (2013). Metodolohiia otsiniuvannia sortozrazkiv kartopli na stiikist proty osnovnykh shkidnykiv i zbudnykiv khvorob; za nauk. red. S. O. Trybelia i A. A. Bondarchuka. Kyiv : Ahrarna Nauka, p:264.
Yakovleva, H.A., Semaniuk, T.V., Kondratiuk, A.V. (2018). Selektsia henerativnoho potomstva somaticheskikh hibridov i sozdanie novykh iskhodnykh form kartofelia. Kartofelevodstvo: sb. nauch. tr. RUP Nauch.-prakt. tsentr Nats Akad Nauk Belarusi Po Kartofelevodstvu I Plodoovoshchevodstvu, 25:94-105.
Yashyna, Y.M. (1970). Heneticheskie osnovy sovremennoi selektsii kartofelia. Kartofel: pod red. S.N. Batsanova. Moskva, p:73-75.
Yashyna, N.M. (1990). Otsenka rodtelskikh form kartofelia po kombinatsyonnoi sposobnosti i effektivnosti selektsionnoho otbora. Selektsia i biotekhnolohia kartofelia: nauchn. tr. NYYKKh. Moskva, p:14-21.
Zakharchuk, N.A. (2014). Mozhlyvosti klitynnoi selektsii ta somaklonalnoi variabelnosti henotypiv kartopli dlia stvorennia sortiv stiikykh do fuzariozu. Visn. Zhytomyrskoho Nats. Ahroekolohich. Un-tu, 2:125-130.
Zakharchuk, N.A., Dolya, M.M., Polozhenets, V.M. (2020). Producing of potato varieties resistant to fusarial wilt by cell selection. Ukrainian Journal of Ecology, 10:289-291.

Zelia, A.H., Melnyk, A.T., Oliinyk, T.M. (2012). Metod vyznachennia stiikosti kartopli do zbudnyka raku Synchytrium endobioticum (Schilb.) Perc *in vitro*. Kartopoliarstvo Ukrainy, 4:22-23.
Zhuchenko, A.A. (2015). Stratehiia adaptivnoi intensifikatsii selskokhoziaistvennoho proizvodstva. Kyshynev:Shtiintsa, p:303.

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