History of selection of potato in the Western region of Ukraine

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Abstract

A detailed history of breeding different potato varieties in the Western Ukraine is elucidated, along with the results of researches aimed at developing methods for breeding, creating a donor source material, and using inbreeding of the original endemic potato forms found in the Carpathians, which are resistant to the late blight and reveal a high content of starch in tubers.

Key words: potato breeding, potato varieties, endemic potato forms, Ukrainian Carpathians

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1. Introduction

Ancestral homeland of potato cultivars is South America, the territory of modern Andes countries and Chile [1]. E. Rodiczky, researcher of potato history [2], referred its appearance in the Western Ukraine to 1780, when it was growing in the household of Count Potocki. After the first division of Poland in 1772, a part of the territories of the Western Ukraine, including Lviv, Ivano-Frankivsk and Ternopil regions, were included into Austria, and in 1920 it was annexed by Poland again. Both the Polish and Russian literature of the first half of the XIX century included already some allegations that a seed of a single potato berry can yield in different potato varieties.

For a long time potatoes had been extending in Europe as herb. It was cultivated in pharmacists' and botanical gardens. 150 years had passed since, under the influence of gradual selection of pharmacists, potato got from their gardens to peasants' farms [1,3,4].

V. S. Lekhnovych [1] mentioned that the two potato forms were included in the assortment in the late XIX and early XX centuries. The first was a Chilean form, like the early rose, often with male sterility, and the second was a hybrid, often fertile, Chilean-Andean form, like the Yubelya, Tsentyroliya, Knyazha Korona or Ella varieties.

Breeding of new potato varieties by sowing seeds became more and more common after diseases of potato arose. Both professional gardeners and many fans of various specialities admired sowing potato with seeds.

In 1856 a first scientific agricultural institution was founded in Dubliany, near Lviv. Beginning from 1901, it was called as the Academy of Field Crops in Dubliany [5, 6]. The institution started its studies on the potato culture.

The fields of peasants and acres of landowners cultivated potato varieties of mostly German and Polish breeders [7, 8]. On a larger scale, potato breeding began in the Western Ukraine only after the World War II. Then the potato selection and seminal works started at the former Lviv Agricultural Institute (O. I. Zhurbin and I. D. Nechyporchuk), the former Transcarpathian State Agricultural Experimental Station (A. P. Kryvolalova), the Chernivtsi State Research Station (O. I. Kopylovych), and the Agrobiology Institute (D. F. Lykhvar and I. P. Kodymskyi). The latter institution, which has been transformed into the Scientific Research Institute of Agriculture and Livestock of Western regions of Ukraine in 1956 [7-10], now represents the Western Regional Institute of Agriculture and Livestock of NAAN.

Up to 1975, the most intense selection work was conducted at the Lviv Agricultural Institute (now the Lviv State Agricultural University). Originally, only intraspecific hybridization was used. So, a mid-season Lvivska Bila was developed using crossbreeding of the varieties Berlihinhen x Siyanets 56 or Alma x Mavka (the author I. D. Nechyporchuk). In 1963 this variety was zoned in Lviv, Rivne, Ternopil, Ivano-Frankivsk, Chernivtsi, and Zhytomyr regions. As a result of intraspecific hybridisation, such the varieties as Lvivska Vyrivnyana, Lvivska Kolektyvna, Lvivska Piznya, Lvivska Rozheva, Lvivska Synyovichkova, Lvivska Universalna, Perspektyvna and Lvivska Uvileyna [11] were created, though they were not included to the zoned varieties. The varieties like the Mayak, Obroshynska, Pykulovytska were also not zoned. They were obtained by inter-variety crossbreeding at the former Institute of Agriculture and Livestock of the Western regions of the Ukrainian SSR [7] (the author A. U. Romanyuk).

The issues related to correlation of some characteristics of inter-variety potato hybrids were studied, too [12]. Later on, interspecific hybridisation was started, basing mostly on the varieties and hybrids of potato originated from crossbreeding of *S. demissum* with the wild South American species [7, 9, 10]. A particular attention was paid to studies of important theoretical issues, including the general laws of inheritance of the economic, biological and morphological characteristics, genetic variability characteristics of the hybrid populations of potato [13], and the influence of hybridisation on succession of economic and biological characteristics by a plant [14-16]. Studies for the artificial mutagenesis were also performed [17], along with searches for techniques capable of creating heterotic hybrid forms with a large number of valuable features.

The selection work done in the Western region of Ukraine was directed at creating highly productive varieties of food destination, with high contents of starch and protein, and different vegetation periods. A great attention was paid to developing the early and mid-season varieties, with round and round-oval tubers. Breeding varieties possessing group immunity to the potato canker, Irish potato famine fungus, ring rot, blackleg, scab and virus diseases were a subject of especial attention, too.

Beginning from 1954, a selection work was started aimed at local potato varieties selected mainly in Lviv, Ivano-Frankivsk and Bukovyna regions, as well as in Transcarpathian mountain areas. Since 1957, A. M. Favorov, A. U. Romanyuk,

T. R. Nikolenko and the present author concentrated their work on creating new phytophthora-resistant varieties of potato. The raw materials for the selection were local forms found in the Ukrainian Carpathians, foreign-bred varieties, inter-variety hybrids derived from crossbreeding of local Lviv varieties, and seeds obtained from Academician P. I. Alsmika (Belarus) [7-9]. An early ripening Lvivska 6 variety (of the Rozofoliya type) was chosen from the local samples of potatoes, while the forms of the mountain origin (from the town of Rahiv, Transcarpathian region) were represented by the Trembita variety, which is late ripening, has a high content of starch and remains virtually resistant to the phytophthora. Since 1961, the latter variety was being under verification at the experimental fields of the Western Ukraine [7, 17, 18]. In 1958 T. R. Nikolenko conducted crossing among different ecologically distant varieties. The corresponding components were some local varieties and the selective varieties originated from the Far East, Czechoslovakia, Korea, and the other places [8].

2. Materials and methods of research and analysis

Under direction of the Corresponding Member of the USSR Academy of Sciences, Doctor of Agricultural Sciences, Professor A. M. Favorov, we started extensive researches on the methods of breeding and genetics of potato in 1958. Basing on the hybridological analysis, very interesting theoretical and practical results were then obtained, along with the data valuable for breeding and production. Issuing from the fact that the Western Ukraine embraces quite different soil-climatic zones and high-altitude conditions for the development of potato plants, due to various environmental factors and geographical locations, we conducted our researches on some other basis when compare with the corresponding studies performed at that time at the research institutions of the former USSR and abroad [14, 16, 19, 20]. The importance of that work was that, in order to obtain the hybrid seeds, much attention was paid not only to the selection of parental pairs with certain characteristics, but also to the aimed growth of sexual generation hybrids and, moreover, to the cultivation of plants used in crossing.

The seedlings obtained from self-fertilisation were studied using inbreeding of the original endemic forms of potatoes we found in the Carpathian Mountains, which were not struck by the late blight in epiphytic years. The further studies were performed aimed at selecting parent plants for breeding, by establishing the nature of genetic inheritance of practically useful traits in different cross combinations. Moreover, we assessed both the methods for preparation of the initial material and the time of sowing of hybrid seeds (spring, summer, etc.). Our hibrydological analysis included a value of economically important traits [15, 16, 20]. We appreciated most of all the seedlings that yielded berries and did not give appreciable splitting for certain features in the first and subsequent sexual generations. In those studies the researchers paid their attention to the fact that the potato varieties, which do not yielded berries in the low-lying areas, behaved otherwise in the foothills and, especially, in the mountain areas of the Carpathians, and were very fruitful. A resistance of the selected material to the viral diseases was assessed, too.

O. G. Demkiv in 1964–1966 [21] and N. I. Svereda in 1989–1998 [22] studied a race composition of the potato phytophthora pathogen, using different potato varieties and hybrids and paying especial attention to the value of the latter for breeding in the Western Ukraine.

The next stage of the studies conducted mainly by S. I. Liorek at the former Research Institute of Agriculture and Livestock of the Western regions of Ukraine [8, 23-25] was cytological studies of several varieties, depending on the conditions of their cultivation. In particular, a blossom biology taking into consideration the nature of reduction division was studied for different potato varieties. M. N. Koptev (see [16, 26]) also studied various growth conditions for parental and maternal plants and their role in obtaining potato hybrids.

The studies performed by us enabled developing a number of viable selection methods in the conditions of the Western Ukraine. In particular, these were concerned with formation of the initial material for early-ripening varieties, which was associated not only with the selection of parental pairs, but also their place of cultivation and techniques for germination of seedlings of the first year, starting from the hybrid seeds [14, 27]. A big role of local endemic phytophthora-resistant forms, found in the Carpathians, in breeding potato was proven, too [20, 24, 28]. Many potato varieties of different destinations and vegetation periods were created on the basis of our methods, e.g. Peremozhets [29, 30], Karpatskyi [24], Verkhovyna [31], Voryna [9], Polonyna [32], Mavka [32, 33], and Slava.

In 1975, a mid-ripening variety Gibrydna 14 was zoned in the Lviv and some other regions (the author I. D. Nechyporchuk). It was created [31] with a complex interspecific hybridisation, involving crossing of *S. demissum* and *S. vallis mexici* with the varieties Kuryer, Pryyekulska Rannya, Katadin, Shterkerahis, Edelgard and Fryugold. In 1976 the variety Prykarpatska 96 was zoned in the Lviv region, which was created by a complex interspecific hybridisation crossing of *S. demissum* and *S. phureja*. Beginning from 1998, the variety Zahidna was also zoned [34] (Lvivyanka x 200-143). The varieties such as Fitoftorostiyka (formed by crossing Gibrydna 14 x Karpatska), Ukrainska 111 (Prykarpatska 96 x Gibryd 10-45), Tetyanka (Gibryd 10-116 x Pryyekulska Rannya), Galychanka (Nesterovska x Kardio) and Student (Nesterovska x Gibryd 346-91 [35] were testified in the public state tests.

As a result of our researches performed at the former Mountain-Carpathian Agricultural Experimental Station, situated in the village of Nyzhni Vorota, a potato breeding laboratory was organised, which is still working successfully and has some achievements in the creation of new potato varieties. In particular, a phytophthora-resistant Nyzhnyovoritska variety was obtained with participation in the crossing of Karpatska variety [36, 37], which was further zoned in the Transcarpathian region.

In order to grow hybrid potato seeds in the conditions of Carpathian mountains (the village of Tuholka, Lviv region), O. M. Favorov and V. G. Vlokh suggested to organise a base station of the Institute for Potato near the research station. Soon this base station was

relocated at the territory of the former Carpathian Mountain agricultural station.

Basing on our research results [14, 38], in 1971 the Institute for Potato organised, with our participation [39], a scientific expedition to the Ukrainian Carpathian areas for examining and collecting the local forms of potato. The samples collected there were studied afterwards at the mentioned base station of the Institute for Potato.

In recent years, the potato breeding in the Western region of Ukraine is performed on the basis of local potato forms of the Carpathians [24, 40, 41] and the varieties of different origin [42], using widely interspecific hybridisation. The latter has become possible due to a genetic fund collected by the earlier scientific expeditions [43-50].

Now the technological process of breeding potato varieties is founded on the long-term experimental studies related to biological bases of the selection theory in relation to the Western region of Ukraine. It begins with organisation of the breeding work involving application of efficient techniques, with knowledge of genetic nature of the plant. An important precondition is creating of a desired material and its in-depth studies embracing environmental factors, methods of cultivation, proper evaluation, selection, and reproduction. It is very important in practical implementation of biotechnology to provide the seeds for the selection process and select the plants used in appropriate combinations of parental pairs in the hybridisation, thus ensuring reliability of obtaining a more productive form when compare with the existing varieties. High-mountain conditions of the Carpathians should be used in the selection. According to our researches, these conditions are favourable for the formation of phytophthora-resistant plants, their high yield, starchiness of their tubers, pollen fertility, and a possibility for natural appearance of some new forms. Inbreeding of the endemic potato forms found by us in the Carpathians, their resistance to the late blight and high starch content in tubers are widely used in the theory and practice of the selection process. With the participation of those forms, "donors" of a set of economically important features are created, which enrich the national gene pool of potato breeding with the source material. These "donors" enable a reliable technique for creating new potato varieties and resource-saving technology of the selection process.

The varieties created by us (Karpatskyi, Verkhovyna, Voryna, Polonyna, Mavka, Slava, Lysonya, Pyshna) and the other breeders (Svitanok Kyivskyi, Lugovska, Kobza, Nyzhnyovoritska, Malych, etc.) have both theoretical and practical values for the selection. They are of different ripeness and most of them are now recommended for cultivation in Ukraine and abroad.

Issuing from a set of commercially valuable features, the variety Karpatskyi has a unique value as a form of source material for the potato breeding. Many varieties listed in this work have been created with its participation. The genealogy of the varieties of Carpathian origin is schematically presented in Fig. 1.

It is worthwhile that the Karpatskyi variety has been used in the potato breeding not only in Ukraine but also in Russia, Belarus, German Democratic Republic, Czechoslovakia, Hungary, and Mongolia. The variety Verkhovyna is used in the selection

of high-yield early-ripening varieties with high starch content in tubers and good culinary properties. A hybrid has been created on the basis of the Verkhovyna variety, which is characterised by the formation of plentiful berries and does not split by the form, colour of tubers, eyes' depth and type of slot. Now it is used to develop economically valuable, strenuously homozygous forms which would not result in significant depression of different properties under long-term reproduction by seeds. For some of its hybrids, high field resistance to the late blight is found, besides of the formation of abundant berries.

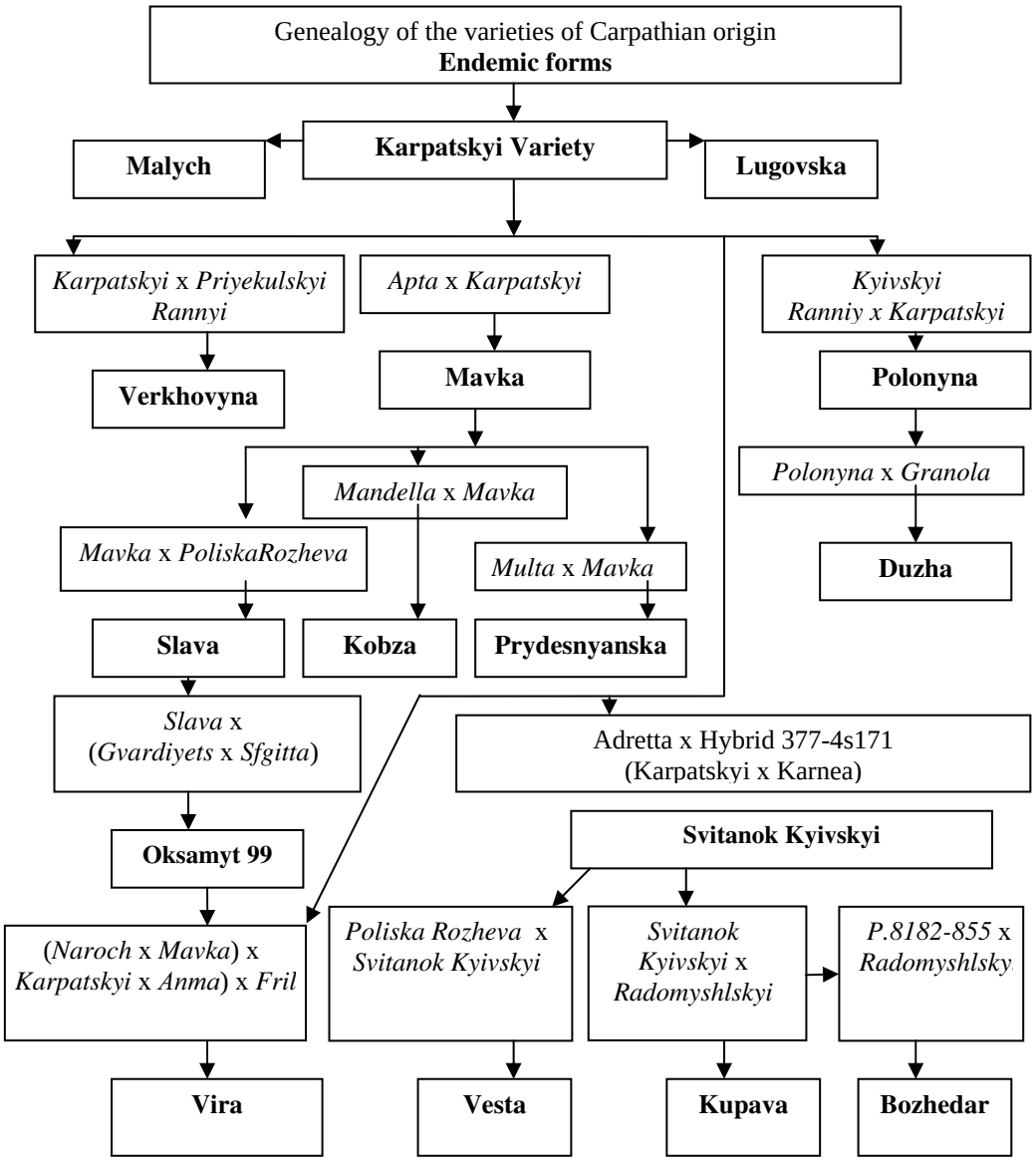

Fig. 1. Genealogy of potato varieties created with the endemic form found in the Ukrainian Carpathians.

In recent years a canker-resistant, hookworm-resistant and phytophthora-resistant form of potato has been created, which is successfully reproduced and implemented in production under the brand of Lysonya. The potential yield of the Lysonya variety is 50 ton/hectare, the starch content in tubers 15 per cent, while the taste is graded as 4.3 points.

The early-ripening or mid-season variety Duzha of a dining destination is now being implemented in production and submitted to the official state test. It has been formed with the participation of the Karpatskyi variety. Duzha is resistant to the canker, potato nematodes, late blight, scab, and virus diseases. Its potential yield is equal to 60 ton/hectare, the starch content in tubers 15.4–17 per cent, and the taste 4.2–4.8 points.

Since 1982, the early-ripening or mid-season variety Mavka has entered in the Register of Plant Varieties of Ukraine and is widely implemented in areas of the Forest and the Woodlands of Ukraine and abroad. It has also been formed using the Karpatskyi variety. The universal-destination variety Mavka is known for its high content of starch (15.5–20 per cent) and rich flavour (4.3–4.8 points). It is resistant to the canker, late blight, and virus diseases. The corresponding potential yield amounts to 60 ton/hectare. Furthermore, this variety is characterised by minimal accumulation of nitrates in the tubers (76.9 mg per kg of wet weight), which is notably less than the adopted standard (135.1 mg per kg of wet).

The Mavka variety is also widely used in breeding for creating high-yielding, both early-ripening and mid-season, potato varieties, which are resistant to the late blight and virus diseases, have high contents of the starch and the essential amino acids and low content of nitrates in the tubers, along with good culinary qualities of the latter.

With the participation of Mavka, the mid-season Slava variety has been developed, which is resistant to the canker, late blight and virus diseases, and has a good taste. It has also a high potential yield (60 ton/hectare) and weakly accumulates nitrates in its tubers (99 mg per kg of wet weight, i.e. less than the standard, 118 mg per kg of wet weight. Slava is well preserved after mechanised harvesting of tubers. The Slava variety is listed in the Register of Plant Varieties of Ukraine since 1992. It is successfully reproduced and implemented in production in the Woodlands of Ukraine.

The Kobza variety has been developed at the Institute for Potato of NAAN with the participation of Mavka. Kobza is early-ripening variety, with a high content of starch and essential amino acids in its tubers. It is characterised by good taste, low accumulation of nitrates, as well as high resistance of tubers to the late blight and stem nematodes. Kobza is listed in the Official Register of Plant Varieties of Ukraine since 1996.

3. Conclusion

Using inbreeding that involves some local endemic Carpathian mountain forms of potato, the potato variety Karpatskyi has been created. It is widely used in the technologies aimed at creating new potato varieties in Ukraine. Karpatskyi represents the ancestor of many new potato varieties and promising potato hybrids, which are of theoretical interest and

have significant practical value for the potato selection as "donors" of a whole complex of economically valuable features, including a resistance to the late blight. Combination of those varieties with the other genetically different varieties 'chips off' further potato forms revealing a heterotic effect of certain traits.

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Анотація. *В роботі висвітлено історію селекції сортів картоплі в західному регіоні України. Крім цього описані також результати досліджень і розробки методики селекції, створення донорів вихідного матеріалу та використання інцухту оригінальних ендемічних форм картоплі, виявлених у Карпатах, які є стійкими до фітофторозу і володіють високим вмістом крохмалю в бульбах.*