

MODERN TRENDS IN THE DEVELOPMENT OF AGRICULTURAL PRODUCTION

PROBLEMS AND PERSPECTIVES



**EDITED BY
S. STANKEVYCH,
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OF AGRICULTURAL PRODUCTION:
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The monograph presented for review is a collection of the results of actual achievements of domestic agricultural scientists, obtained directly in real conditions. The authors are recognized experts in their fields, as well as young scientists and postgraduate students of Ukraine. Research is conceptually grouped into 5 sections: modern technologies in crop production and fodder production; economy of the agro-industrial complex; breeding and breeding in the 21st century; protection and quarantine of plants; agrochemistry and soil science. The monograph will be interesting for experts in plant breeding, economics, plant protection, selection, agrochemistry, soil science, scientific workers, teachers, graduate students and students of agricultural specialties of higher education institutions, and for all those who are interested in increasing the quantity and quality of agricultural products.

Keywords: modern technologies, crop production, fodder production, plant protection, quarantine, agrochemistry, soil science, economy of agro-industrial complex.

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EVALUATION OF POTATO VARIETIES AND HYBRIDS ON THE RESISTANCE AGAINST BLACK SCAB UNDER CONDITIONS OF UKRAINE'S POLISSIA

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*To estimate the potato cultivars and hybrids on their resistance against black scab as well as to select the highly resistant cultivar-forms. On the European level there is no standard method as to estimating and selecting of both starting and selection materials of potato on their resistance against black scab. However, the main principle of the existing methodology resolves itself to testing the cultivars, hybrids and varieties of potato on the natural or artificial infection backgrounds when using pure culture of fungus *Rhizoctonia solani* Kuhn. The culture, which was grown in a double-dish, was introduced into soil when the potatoes were planted out. The degree of tuber and stem infection was estimated on the basis of the affection of underground organs of plants and potato yield, further the cultivar samples were assessed according to susceptibility, tolerance and*

resistance to infection. When estimating the cultivars and hybrids of potato on their resistance against the disease agent *Rhizoctonia solani* Kuhn, a nine-grading scale was used, where grade 9 means that there is no affection of tubers and stems, grade 7 means that disease affection equals 10 % (high resistance), grade 5 – the disease affection equals 11–25 % (medium resistance), grade 3 – the disease affection equals 26–50 % (low resistance). On the basis of testing the potato cultivars and hybrids on their resistance against black scab, relatively resistant are considered 19 or 12.3 % (Dubravka, Vesta, Lugovska, Obriy, Serpanok, Yavir, Scarbnytsia, Tyras and the hybrids II.207.407 (Polisska Rozheva); 205.17-24 (Adretta x 23-16c/73) and others, 85 cultivar samples or 54.8 % belong to mid-resistant (5grades), in particular – Chervona Ruta, Povin, Vodogray, Horlytsia, Zov, Cupava, Nadiyna, Belarossa, Olivia, Svitanok Kyivskyi, Ukrainska Rozheva, Beregynia, Charunka, Okolytsia, Slutch and the hybrids II.210.14-23 (Adretta x Posvit); 211.20-31 (Prolisok x Lugovska) and 51, or 32.9 % belong to susceptible ones. We have proved that mid-early ripening and early ripening cultivars as well as selection hybrids are more infected with black scab than mid-ripening, mid-late ripening and late ripening cultivars. These relatively resistant potato cultivars and hybrids are expedient to use in the selection on the resistance against black scab.

Key words: potato, black scab, disease agent, cultivars, hybrids.

Black scab is one of the most spread and harmful potato diseases.

It has been proved that fungus *Rhizoctonia solani* Kuhn can infect more than 230 species of plants, but this pathogen can be more often observed on potato (Markov, Bashta, Gentosh & Glimyazny, 2017). As follows from the researchers' reports black scab of potato was found in England, USA, Russia, Poland, Holland, Bolgaria, Japan and others (Breginets, 2017). In the countries of Western and Eastern Europe, in particular, sclerotium of the agent of *Rhizoctonia solani* Kuhn is observed within 15–30 % depending on the resistance degree to the pathogen (Markov & Ruban, 2014).

According to A. S. Volovyk and colleagues (1995) the potato on the whole territory of Russian Federation is infected with black scab, and the amount of tubers with the symptoms of infection with the agent of *Rhizoctonia solani* Kuhn during the years which are favourable for pathogen development, equals 38 % (Markov & Ruban, 2014).

The results of research in Belarus show that the fungi *Rhizoctonia solani* Kuhn is capable of infecting potato on all stages of ontogenesis (Korniychuk, 2013). The researchers inform that the agent development depends on weather conditions of a year. Thus, under favourable temperature and humidity the development of fungi on sprouts equals – 25.6–43.3 %; on stolons – 23.5–48.2 %, on roots – 8.2–27.9 % (Markov, 2012).

It has been proven that black scab on potato tubers manifests itself in the form of convex black tubercles, which are sclerotia of the fungus *Rhizoctonia solani* Kuhn, which are easily separated from the periderm of tubers. During the growing season of plants, the disease often manifests itself on the stems in the form of a white stalk, which leads to a violation of the process of photosynthesis, causing the formation of axillary microbulbs of green color (Nedilska & Semenchuk, 2015). Manifestation of symptoms of black scab on potato tubers is presented in Fig. 1.

The latest official publications with the description of potato cultivars contain some information as to their resistance to many diseases, in particular to potato tuber eelworm, potato blight, brown scab, Irish blight, but there is no information as to black scab. The main publications as to potato black scab do not contain the information as to the resistance of most potato cultivars against this disease. The information as to potato resistance against potato blight can not be used for black scab, because there is some difference between the agents of these diseases (Dyakov, 2012).



Fig. 1. External signs of damage to potato tubers by the fungus *Rhizoctonia solani* Kuhn (Prolisok variety)

Shaping the goals of the paper – to estimate the resistance of potato cultivars and hybrids against black scab both on the artificial and on natural infection backgrounds under conditions of Ukraine's Polissia as well as to analyze and generalize the results.

Methods

The experiments were conducted at the National University of Life and Environmental Sciences of Ukraine in 2018–2020. Laboratory studies were conducted at the Department of Phytopathology named after Academician V.F. Peresyphkin, and field – on the basis of the research farm «Verzel».

The territory of the experimental field is represented by sod-podzolic gley sandy soil. The particle size distribution of the soil of the experimental field is as follows: 40.5–53.4 % sand; 42.4–53.3 % dust; 3.7–5.6 % mule.

The climate in the experimental field is temperate continental. Perennial amounts of active temperatures are in the range of 2400–2600 °C, and the duration of the frost-free period is 150–160 days. The average long-term temperature of the coldest month fluctuates around – 6.4 °C. Spring frosts usually end in late April, and the first autumn frosts begin in October. The temperature regime of the summer period is formed under the influence of high pressure coming from the west.

The annual amount of precipitation in the Polissya area of Ukraine is on average 550–650 mm, but in the central part due to the influence of the relief their amount may increase to 900 mm per year. In the cold period (December-March) precipitation is 140-180 mm (20–25 % of the annual amount). The lowest amount of precipitation is observed in February and March. The annual amount of precipitation (over the years of research) for the experimental field was 610–680 mm.

Evaluation of potato varieties and breeding hybrids for resistance to black scab was performed on an artificial infectious background using pure culture of the pathogen *Rhizoctonia solani* Kuhn. The fungus of this pathogen was cultured in Petri dishes on potato-glucose medium with the addition of oat extract (1.5 %). The five-day-old crop was divided into four parts, and then one of them was applied to the soil next to the tubers during planting.

Rating of the degree of tuber damage by black scab was performed on a nine-point scale, where at score 9 – no damage to stems and tubers, score 7 – disease development is up to 10 % (high resistance); score 5 – disease

development 11–25 % (average resistance); score 3 – disease development 26–50 % (low resistance) (Kutsenko, Osipchuk & Podgaetsky et al., 2002).

The presentation of the basic material of the research

Most researchers claim that in the purpose of targeted selection of potatoes for resistance to black scab, varieties with extremely high resistance to black scab were not obtained (Gentosh, Kyryk, Gentosh & Pikovskyi, 2020; Zakharchuk, Dolya, Tsuman & Stankevych, 2020).

We believe that these circumstances may be due to the broad specialization of the pathogen *Rhizoctonia solani* Kuhn, capable of infecting plants of different families, and therefore it is advisable to select for resistance in the direction of creating varieties with relative resistance to this pathogen.

For field experiments, an artificial infectious background was created by introducing into the soil from Petri dishes an inoculum of the pathogen *Rhizoctonia solani* Kuhn with a load of 8–10 g of pathogen per tuber of the cultivar.

The cultivars of domestic as well as of foreign selection, perspective selection hybrids as well as some wild, cultural and primitive species (155 cultivar samples in the numbers) were used in testing for estimating of potato cultivars and hybrids resistance against black scab.

From among the tested potato cultivar samples and hybrids 19 or 12.3 % belong to relatively resistant ones (7 grades), in particular – Dubravka, Vesta, Lugovska, Obriy, Serpanok, Yavir, Scarbnytsia, Tyras and the hybrids П.207.407 (Polisska Rozheva); 205.17-24 (Adretta x 23-16c/73) and others, 85 cultivar samples or 54.8 % belong to mid-resistant (5 grades), in particular – Chervona Ruta, Povin, Vodogray, Horlytsia, Zov, Cupava, Nadiyna, Belarossa, Olivia, Svitanok Kyivskyi, Ukrainska Rozheva, Beregynia, Charunka, Okolytsia, Slutch and the hybrids П.210.14-23 (Adretta x Posvit); 211.20-31 (Prolisok x Lugovska) and 51, or 32.9 % belong to susceptible ones (table 1).

The selected cultivar samples of potato with a high resistance degree against black scab are a precious starting material for conducting a goal-oriented selection on the resistance to *Rhizoctonia solani* Kuhn agent (Fig. 1).

The results of the experiments show that the testing of potato varieties for resistance to black scab on an artificial infectious background quite objectively characterizes their genetic resistance to the above trait.

Table 1

The list of potato cultivars and hybrids with different degree of resistant to black scab on the artificial infection background (2018–2020)

Cultivar sample	Group of ripening	Degree of tubers infection with black scab		Potential infection, t/ha
		%	бал	
1	2	3	4	5
Relatively resistant				
Dubravka	Mid-ripening	10.4	7.9	40.0–46.0
Lugovska	Mid-ripening	11.3	7.5	47.0–64.0
Obriy	Middle-early	11.5	7.8	45.0–50.0
Serpanok	Early	11.6	7.7	40.0–45.0
Yavir	Mid-ripening	12.0	7.6	40.0–45.0
Scarbnysia	Early	12.5	7.5	41.0–44.0
Tyras	Early	12.8	7.3	35.0–40.0
П.207.4–7	Middle-early	15.4	7.1	40.0–46.0
П.205.17–24	Mid-ripening	16.0	7.0	42.0–50.0
<i>HIP₀₅</i>		0,08		1,0–1,1
Mid-resistant				
Chervona Ruta	Middle-late	22.3	6.0	40.0–43.0
Povin	Middle-late	22.4	5.9	41.0–46.0
Vodogray	Mid-ripening	22.7	5.9	40.0–44.0
Gorlytsia	Mid-ripening	22.9	5.7	40.0–46.0
Zov	Early	25.3	5.6	42.0–46.0

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Kupava	Middle early	25.9	5.5	41.0–45.0
Nadiyna	Mid-ripening	26.1	5.4	40.0–46.0
Bellarossa	Mid-ripening	26.4	5.4	45.0–55.0
Svitanok Kyiyskyi	Middle-early	26.5	5.5	45.0–50.0
Ukrainska Rozheva	Mid-ripening	27.0	5.4	45.0–50.0
Beregynia	Middle early	28.0	5.3	35.0–45.0
П.210.14.13	Middle early	28.3	5.3	40.0–43.0
П.211.20.31	Middle early	28.6	5.2	34.0–41.5
Okolytsia	Mid-ripening	28.8	5.2	41.0–48.0
Sluch	Mid-ripening	29.0	5.1	45.0–50.0
<i>HIP₀₅</i>		0,07		0,8–0,9
Susceptive				
Gart	Early	30.6	4.0	35.0–44.0
Posvit	Early	31.4	3.5	33.0–42.0
Prolisok	Early	32.0	3.2	45.0–50.0
Olivia	Mid-late	33.1	3.1	48.5–50.0
Poran	Early	33.9	3.0	41.5–45.0
Ivankivska Rannia	Mid-early	38.0	2.9	40.0–46.0
Slavuta	Under-early	40.2	2.8	39.0–43.0
Kimeria	Early	42.4	2.8	42.0–49.0
<i>HIP₀₅</i>		0,09		0,7–0,8

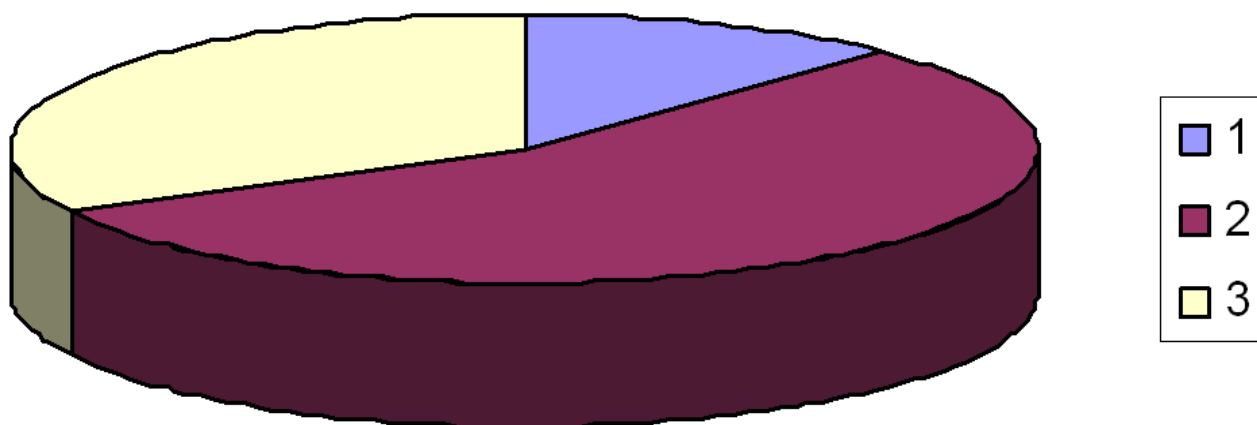


Fig. 1. Correlation analysis of the resistance degree in the process of agent *Rhizoctonia solani* Kuhn development among potato cultivars and hybrids:

1 – relatively resistant (12.3 %); 2 – mid-resistant (54.8 %); 3 – susceptible (32.9 %)

Conclusions. 1. It is advisable to evaluate potato varieties and hybrids for resistance to black scab against an artificial infectious background, which makes it possible to objectively determine the genetic resistance against black scab.

2. On the basis of testing of varieties and hybrids of potatoes for resistance to *Rhizoctonia solani* Kuhn, 19 or 12.3 % are classified as resistant (7 grades), in particular: – Dubravka, Vesta, Lugovska, Obriy, Serpanok, Yavir, Scarbnytsia, Tyras and the hybrids П.207.407 (Polisska Rozheva); 205.17-24 (Adretta x 23-16c/73) and others, 85 cultivar samples or 54.8 % belong to mid-resistant (5 grades), in particular – Chervona Ruta, Povin, Vodogray, Horlytsia, Zov, Cupava, Nadiyna, Belarossa, Olivia, Svitanok Kyivskyi, Ukrainska Rozheva, Beregynia, Charunka, Okolytsia, Slutch and the hybrids П.210.14-23 (Adretta x Posvit); 211.20-31 (Prolisok x Lugovska) and 51, or 32.9 % belong to susceptible ones.

Perspectives of a further studies in this direction. A further investigation in this direction lies in a broader studies of other potato cultivars and hybrids as well as in a comparative and complex estimation of the resistance of potato cultivars against black scab which was received by means of other techniques.

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