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SYMPTOMATOLOGY OF FUSARIUM DRY ROT OF POTATO TUBERS

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Abstract. *Diagnosis of fusarium dry rot of potato was carried out and specifics of disease manifestation with coinfections was determined. Phytopathology researches were carried out in conformity with the generally accepted methods. The test samples of potato tubers were collected during the harvesting period and potato grading in the spring. It was determined that the signs of the potato tuber infection with Fusarium spp. are manifested when harvesting from a stolon part of the tuber in the form of depressions with the surface being even or wrinkled, and the pads of morphological pathogen patterns were formed on the affected area due to the increased humidity.*

Storage of potato tubers under different conditions results in variability of the symptoms of fusarium dry rot. Thus, the diseased tissue dried out and turned brown under the conditions of low air humidity. There was no pathogen sporulation on the tuber surface, but it appeared inside. Fungal mycelium was intensively formed on the diseased tuber surfaces due to the high air humidity, and the affected tuber pulp became brownish, friable and the cavities filled with pathogen mycelium were formed in it.

Visual diagnosis of fusarium dry rot of potato can be complicated in the event of concurrent infection with different phytopathogens. During the years of researches, we have selected potato tubers and diagnosed the following mixed rots of mycotic-bacterial and mycotic-nematode nature: Phoma-fusarium blight, fusarium-nematode, fusarium and bacterial wet rot, and Ditylenchus destructor, fusarium and bacterial wet rot.

Over the years of researches, the quantity of potato tubers infected with fusarium dry rot made up 7 %. Fusarium coinfections were observed on 5,5 % of the tubers analysed.

The obtained research results can be used for phytopathology examination of seed tubers.

Keywords: *potato, fusarium dry rot, symptoms, mixed rots*

Relevance. Potato (*Solanum tuberosum* L.) takes the fourth place among the basic food crops. At the same time, it is affected by a great number of pests (fungi, bacteria, viruses, nematodes) which contribute to considerable yield losses on the field and during storage. The most dangerous

pathogens, which provoke different diseases, are *Phytophthora infestans*, *Alternaria solani*, *Phoma spp.*, *Spongospora subterranea*, *Synchytrium endobioticum*, *Pythium ultimum*, *Helminthosporium solani*, *Phytophthora erythroseptica*, *Fusarium spp.*, *Rhizoctonia solani*, *Polyscytalum pustulans*, *Verticillium sp.*, *Macrophomina phaseolina* [3].

Fusarium dry rot caused by different types of Fusarium micromycetes [8, 9] makes potato infected in the different regions of cultivation. At the same time, pathologies of different etiology are shown up on potato tubers [7] which makes hard to diagnose them. However, control over potato diseases depends on proper diagnosis associated with the identification of pathogens. Therefore, the study of the symptoms and diagnostic properties of fusarium dry rot of potato is crucial.

Analysis of recent researches and publications. Fusarium dry rot starts to be developed during potato storage and also on the field [5, 10]. Losses associated with diseases during long-term storage may reach 6 to 25 %, and sometimes up to 60 % [6, 8]. Typical symptoms of fusarium dry rot are the development of greyish-brownish spots on the tubers; the formation of pulp cavities filled with fluffy white, yellowy or reddish fungal mycelium; the appearance of pads from conidial sporulation on the tubers; mummification of the heavily affected tubers [7]. It happens often that potato tubers are infected concurrently with different phytopathogenic organisms provoking various symptoms and this creates a problem in the future in diagnosing a disease [4]. Consequently, a number of aspects of visual diagnosis of fusarium dry rot of potato and coinfections are insufficiently studied.

Research objectives: To perform diagnosis of fusarium dry rot of potato and define specifics of disease manifestation with coinfections.

Materials and research methods. Phytopathology researches were carried out in conformity with the generally accepted methods. The test samples of potato tubers were collected during the harvesting period and potato grading in the spring (Zhytomyrska Oblast, Brusylivskyi raion, 2018-2019р.). The conventional methods were applied for extraction of micromycetes [1]. Pathogens were identified using descriptions provided in the publication of Khokhriakov M.K. et al. [2]. The generic identity of the isolates was determined by morphologic patters using the microscopic analysis.

Research results and discussion. First signs of potato tuber infection with *Fusarium spp.* were discovered during the harvesting period. The disease was manifested from a stolon part of the tuber in the form of depression. Its size varied from 0.5 to 2.5 cm in diameter depending on infection intensity. The surface of diseased tissue was even or wrinkled. The pads of morphological

pathogen patterns were formed on the affected area due to the increased humidity (fig. 1a). The diseased tissue on a tuber cut turned brownish and exposed to destruction (fig. 1b).

a b

Fig. 1. Symptoms of fusarium dry rot of potato during the harvesting period: a – disease manifestation from a stolon part of the tuber; b – a diseased tuber in section

During the autumn, winter and spring seasons, the symptoms of fusarium dry rot of potato tubers varied depending on the conditions under which they were stored. Considering the tubers storage under the low humidity conditions, the exterior affected areas enlarged, the tissue dried out and turned brownish. There was no pathogen sporulation on the tuber surfaces (fig. 2a). At the same time, the affected internal tissues turned brown and small cavities filled with pathogen mycelium formed in them (fig. 2b).

a b

Fig. 2. Peculiarities of fusarium dry rot manifestation under the conditions of low air humidity: a – general view of the diseased tuber; b – internal tuber tissues from pathogen mycelium

The change in fusarium dry rot symptoms on potato tubers during storage under the high air humidity conditions is characterized by the appearance of clearly visible fungal mycelium on the surface of affected areas and which is developed more intensively at the increased humidity

level and colonizes the surface of diseased tubers (fig. 3). The pulp of affected tuber was turning brownish, friable and the cavities filled with pathogen mycelium were formed in it.

Fig. 3. Mycelium and *Fusarium spp.* sporulation on the potato tuber surfaces at the high air humidity

Regardless of the well-known symptoms of fusarium dry rot of potato tubers, its visual diagnosis might be complicated in the event of mixed infection with different phytopathogens. Over the years of researches, we have selected potato tubers and diagnosed the following mixed rots of mycotic, mycotic-bacterial and mycotic-nematode nature: Phoma and fusarium blight, fusarium and *Ditylenchus destructor*, fusarium and bacterial wet rot, and *Ditylenchus destructor*, fusarium and bacterial wet rot.

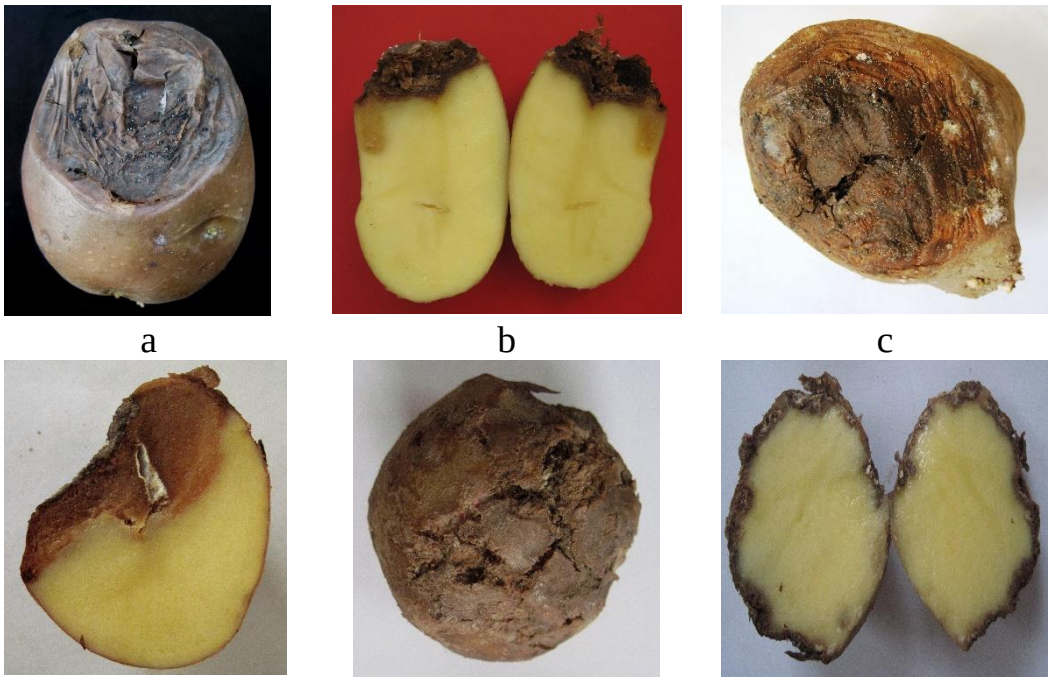
The symptoms of Phoma and fusarium blight are characterized by the appearance of greyish-brownish depressed, round and dry spots of different size on the tuber surfaces. The tuber tissue may crack (fig. 4a). The cavities covered with dark or light mycelium are observed in the affected tubers. The availability of pycnid cavities of Phoma blight infestants in the form of small black dots under the skin and on the surface was an important diagnostic sign of Phoma blight.

Diagnostic signs of *Ditylenchus destructor* (potato rot nematode) and fusarium dry rot are characterized by the availability of the lead-coloured spots on the tuber surface, skin cracks, rottenness of internal tissues and formation of fusarium infestant mycelium in their cavities (fig. 4b).

Fusarium and bacterial rot was characterized by the change in coloration of the internal tuber tissues from light to dark brown. Moreover, they got softer and turned into slimy putrefactive mass with a strong unpleasant odour. The pads of *Fusarium spp.* sporulation were formed on the tuber surfaces, and mycelium may form inside of the tissue cavities (fig. 4c, d).

Co-manifestation of *Ditylenchus destructor*, fusarium and bacterial wet rot on potato tubers was characterized by

the formation of deep cracks on the tuber surfaces (fig. 4e) and softening of some areas. On the diseased tuber cuts, the tissue under the skin turned brownish, white pathogen mycelium was developing in the cavities formed (fig. 4f), and the pulp was transformed into mushy mass.



a b c d e f

Fig. 4. Diagnostic signs of co-infection of potato tubers with different pathogens: a – Phoma and fusarium blight; b – fusarium and *Ditylenchus destructor*; c, d – fusarium and bacterial soft rod; e, f – *Ditylenchus destructor*, fusarium and bacterial soft rod

In a span of the researches, the quantity of potato tubers infected with a stolon form of fusarium dry rot made up 3,0 % (fig. 5). The spread of fusarium dry rot of potato tubers was within the range of 7,0 %. The quantity of tubers infected with mixed rots was as follows: Phoma-fusarium blight and fusarium-nematode-bacterial – 1,0 %, fusarium-nematode – 1,5 % and fusarium-bacterial – 2,0 %.

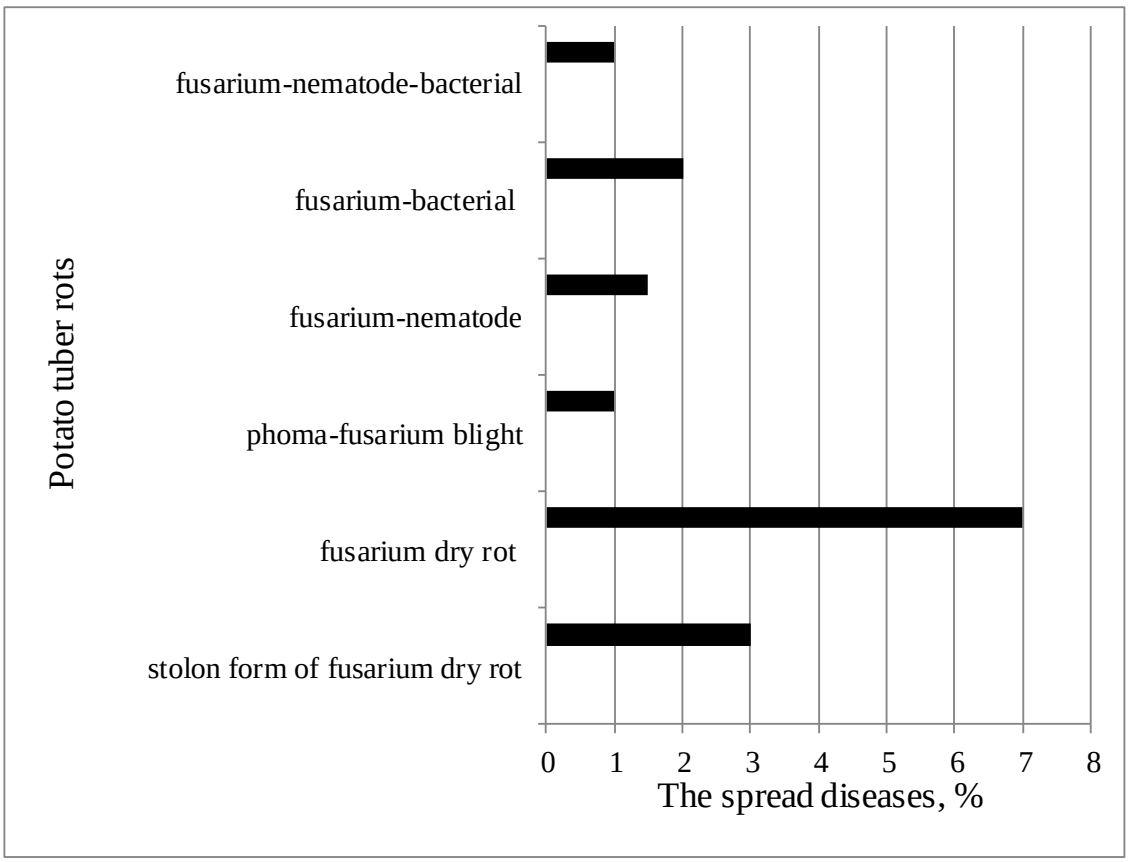


Fig. 5. The spread of potato tuber rots

Conclusions. The initial signs of infection of potato tubers with *Fusarium spp.* were discovered during the harvesting period. The disease was developed from a stolon part of the tuber in the form of depressions with the surface being even or wrinkled, and the pads of morphological pathogen patterns were formed on the affected area due to the increased humidity.

Storage of potato tubers under different conditions results in variability of the fusarium dry rot symptoms. Thus, the diseased tissue dried out and turned brown under the low air humidity. There was no pathogen sporulation on the tuber surface, but it appeared inside of the tubers. Fungal mycelium was intensively formed on the diseased tuber surfaces due to the high air humidity, and the affected tuber pulp became brownish, friable and the cavities filled with pathogen mycelium were formed in it.

Visual diagnosis of fusarium dry rot of potato can be complicated in the event of concurrent infection with different phytopathogens. During the years of researches, we have selected potato tubers and diagnosed the following mixed rots of mycotic-bacterial and mycotic-nematode nature: Phoma-fusarium blight, fusarium-nematode, fusarium and bacterial wet rot, and *Ditylenchus destructor*, fusarium and bacterial wet rot.

Over the years of researches, the quantity of potato tubers infected with fusarium dry rot made up 7,0 %. Fusarium coinfections were observed on 5,5 % of the tubers analysed.

The obtained research results can be used for phytopathology examination of seed tubers.

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СИМПТОМАТИКА ФУЗАРИОЗНОЙ СУХОЙ ГНИЛИ КЛУБНЕЙ КАРТОФЕЛЯ

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Аннотация. *Проведена диагностика сухой фузариозной гнили клубней картофеля и установлено особенности проявления болезни при смешанных инфекциях. Фитопатологические исследования проводились согласно общепринятых методик. Для анализа образцы клубней картофеля отбирали при уборке урожая и во время переборки картофеля (февраль-март). Установлено, что начальные признаки поражения клубней картофеля Fusarium spp. заметно проявляются во время уборки урожая. Болезнь выявлялась в столонной части клубня в виде вдавленных пятен, поверхность которых была равной или морщинистой, а при повышенной влажности на пораженном участке формировались подушечки морфологических структур патогенов.*

Хранение клубней картофеля при различных условиях приводит к изменчивости симптоматики сухой фузариозной гнили клубней. Так, при низкой влажности воздуха пораженная ткань ссыхалась и приобретала бурый оттенок. Спороношение патогенов на поверхности больных клубней отсутствовало, однако оно образовывалось внутри. В условиях высокой влажности воздуха на поверхности пораженных клубней интенсивно

формировался мицелия грибов, мякоть в пораженной клубне приобретала буроватый оттенок, становилась рыхлой, в ней образовывались пустоты, которые заполняла грибница патогена.

Визуальная диагностика сухой фузариозной гнили клубней может осложняться в случаях одновременного поражения различными фитопатогенами Нами отобраны клубни картофеля и диагностировано следующие смешанные гнили микозной, микозно-бактериальной и микозно-немадотозной природы: фомозно-фузариозную; фузариозно-нематодозную; фузариозную и мокрую бактериальную, дитиленхоз; фузариоз и мокрую бактериальную гниль.

За время исследований количество клубней картофеля, пораженных сухой фузариозной гнилью составляло 7%. Совместимые с фузариозной инфекции выявлено на 5,5 % проанализированных клубнях.

***Ключевые слова**: картофель, сухая фузариозная гниль, симптоматика, смешанные гнили*

СИМПТОМАТИКА ФУЗАРІОЗНОЇ СУХОЇ ГНИЛІ БУЛЬБ КАРТОПЛІ

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***Анотація.** Проведено діагностику сухої фузаріозної гнилі бульб картоплі та встановлено особливості прояву хвороби за змішаних інфекцій. Фітопатологічні дослідження проводилися згідно загальноприйнятих методик. Для аналізу зразки бульб картоплі відбирали при збиранні врожаю та під час перебирання картоплі (лютий-березень). Встановлено, що початкові ознаки ураження бульб картоплі Fusarium spp. помітно проявляються під час збирання врожаю. Хвороба виявлялася із столонної частини бульб у вигляді вдавлених плям, поверхня котрих була рівною або зморшкуватою, а за підвищеної вологості на ураженій ділянці формувалися подушечки морфологічних структур патогенів.*

Зберігання бульб картоплі за різних умов призводить до мінливості симптоматики сухої фузаріозної гнилі бульб. Так, за низької вологості повітря уражена тканина зсихалася та набувала бурого відтінку. Спороношення патогенів на поверхні бульби було відсутнє, однак воно виявлялося усередині ураженого органу. За умов високої вологості повітря на поверхні уражених бульб інтенсивно формувався міцелію грибів, м'якоть в ураженій бульбі набувала буруватого відтінку, ставала рихлою, у ній утворювалися пустоти, які заповнювала грибниця патогену.

Візуальна діагностика сухої фузаріозної гнилі бульб може ускладнюватися у випадках одночасного ураження різними фітопатогенами. За роки досліджень нами відібрано бульби картоплі та діагностовано змішані мікозні гнилі, мікозно-бактеріальної і мікозно-немадотозної природи: фомозно-фузаріозну, фузаріозно-нематодозну, фузаріозну та мокру бактеріальну, дитиленхоз, фузаріоз та мокру бактеріальну гниль.

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За роки досліджень кількість бульб картоплі, уражених сухою фузаріозною гниллю становила 7 %. Сумісні з фузаріозною інфекції траплялися на 5,5 % проаналізованих бульб.

Ключові слова: *картопля, суха фузаріозна гниль, симптоматика, змішані гнилі*