ЗБЕРЕЖЕННЯ БІОЛОГІЧНОГО ТА ЛАНДШАФТНОГО РІЗНОМАНІТТЯ

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EXOMETALOBITE OF THE VARIETIES OF CULTURAL PLANTS IN ALLELOPATIC RELATIONSHIPS WITH MICROMYCETES OF *FUSARIUM* LINK GENUS

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The analysis of the seed material of the studied crops showed certain contamination with pathogenic micromycetes, from which 150 isolates were specified. Among the identified micromycetes, the dominant species were: *Fusarium incarnatum*, *F. solani, F. culmorum, F. oxysporum*, *F. proliferatum*, *F. graminearum*, *F. verticillioides*, *F. langsethiae.* It was established that the highest occurrence frequency of more than 60% characterized by mycomycetes of the species *F. oxysporum* in wheat and *F. proliferatum* in onions. It was shown that the properties of the root exometabolites of cultural plants of the tested varieties depend significantly on the genotype of the variety. Exometabolites of Mulan and Skagen winter wheat varieties are able to significantly suppress the mycelial growth of colonies and the intensity of sporulation, as well as the viability of spores of pathogenic strains of *F. oxysporum*, which was almost 2 times lower than the control. At the same time, the exometabolites of winter wheat plants of Podolyanka and Natalka varieties are able to influence the growth and development of colonies of the *F. oxysporum* fungus that developed at the control level to a lesser extent.

It was found out that at the initial stages of subcultivation, plant exudates of onion cultivars stimulated the growth of *F. proliferatum* mycelium, but already on the sixth day of subcultivation, inhibition of mycelium development and a decrease in the growth rate of the pathogen were observed. In turn, inhibition of sporulation was observed in all variants compared to the control samples. The exometabolites of the sprouts of the cultivars demonstrated 1.5–2 time reduction of the sporulation of the fungus. It should be noted that the exometabolites of hot onion varieties (like Tkachenkivska, Lyubchyk, Varyag, Globus) significantly reduced sporulation compared to semi-sweet onion varieties (Mavka, Amfora), with Veselka variety, which was on par with hot varieties, being an exception. This indicates that the root exometabolites of the cultural plants of the tested varieties are characterized by fungicidal and bactericidal properties, which are caused by a complex of biologically active substances, which are able to influence the development of pathogenic mycobiota in different ways. On the basis of the research, exometabolites of cultural plants can be considered one of the mechanisms of influence of the plant variety on the intensity of the fungal phytopathogenic background formation. *Key words:* micromycetes, onions, winter wheat, plant metabolites, agrophytocenoses, biosafety.

Екзометалобіти сортів культурних рослин в алелопатичних відносинах з мікроміцетами роду *Fusarium* Link Genus. Безноско І.В., Мудрак О.В., Гаврилюк Л.В., Горган Т.М.

Аналіз насіннєвого матеріалу досліджуваних культур показав контамінацію патогенними мікроміцетами із яких було виділено 150 фітопатогенних ізолятів. Серед яких були види: *F. incarnatum*, *F. solani, F. culmorum, F. oxysporum*, *F. proliferatum*, *F. graminearum*, *F. verticillioides*, *F. langsethiae.* Встановлено, що найвищою частотою трапляння (60%) характеризувалися мікроміцети видів *F. oxysporum* на пшениці та *F. proliferatum* – на цибулі ріпчастій. Показано, що властивості кореневих екзометаболітів культурних рослин випробовуваних сортів істотно залежить від генотипу сорту. Екзометаболіти пшениці озимої сортів Мулан та Скаген в значній мірі здатні пригнічувати міцеліальний ріст колоній та інтенсивність споруляції і життєздатність спор фітопатогенних штамів *F. oxysporum*, який майже в 2 рази був нижчим за контроль. Поряд з тим, екзометаболіти рослин пшениці озимої сортів Подолянка, Наталка здатні в меншій мірі впливати на ріст і розвиток колоній гриба *F. oxysporum*, що розвивався на рівні контролю. Виявлено, що на початкових етапах субкультивування ексудати рослин сортозразків цибулі ріпчастої стимулювали ріст міцелію *F. proliferatum*, але вже на шосту добу субкультивування спостерігали пригнічення розвитку міцелію та зниження швидкості росту патогенну. В свою чергу у всіх варіантах спостерігали пригнічення споруляції у порівнянні з контролем. Екзометаболіти паростків сортів знизили споруляцію гриба в 1,5–2 раза. Слід зазначити, що екзометаболіти гострих сортів цибулі (Ткаченківська, Любчик, Варяг, Глобус) значно знижували споруляцію в порівнянні з напівсолодкими сортами (Мавка, Амфора) виняток становив сорт Веселка, що був на рівні з гострими сортами цибулі. Це свідчить про те, що кореневі екзометаболітів культурних рослин випробовуваних сортів характеризуються фунгіцидними та бактерицидими властивостями, що обумовлюються комплексом біологічно активних речовин, які здатні по-різному впливати на розвиток патогенної мікобіоти. На підставі досліджень, екзометаболіти культурних рослин можна вважати одним із механізмів впливу сорту рослин на інтенсивність формування грибного фітопатогенного фону. *Ключові слова:* мікроміцети, цибуля, озима пшениця, метаболіти рослин, агрофітоценози, біобезпека.

Formulation of the problem. In the conditions of anthropogenic load, the rate of spread of pathogenic microorganisms increases more and more intensively, their resistant forms with increased aggressiveness are formed, which causes a decrease in the biosafety of plant production [1, 2, 3].

Mycomycetes of the species including *F. graminearum, F. solani, F. oxysporum, F. proliferatum*, due to their inherent wide specialization, are able to infect various types of plants, such as peas, beans, cucumbers, onions, tomatoes, and all representatives of the cereal family [4, 5, 6]. However, one of the most common causative agents of fusarium wilt of cereal crops is *F. oxysporum* [7, 8] and recently the micromycete *F. proliferatum* dominates among onion [9, 10].

Analysis of recent research and publications. Contamination of food products with mycotoxins caused by the development of fusarium wilt of cultural plants is currently a serious problem all over the world [11, 12, 13]. From many angles, fusariosis is a unique plant disease, and this causes significant difficulties in researching it [14, 15]. A special etiology is one of these special features, which means the participation of the species *Fusarium* Link in various pathogenesis of the complex of representatives [16]. Infestation of plants by these micromycetes not only damages the crop to the point of loss, but also significantly reduces the sowing and nutritional quality of seed material, therefore it is considered one of the most dangerous diseases of agricultural crops [17, 18].

Formulation of research objectives. Therefore, the purpose of our study was to study the role of metabolites of different cultural plants of winter wheat and onion crops in allelopathic relationships with micromycetes *F. oxysporum* and *F. proliferatum*.

Statement of the main material. The 150 isolates of pathogenic micromycetes of the genus *Fusarium* Link were isolated from the seeds of the investigated crops of various varieties, among which the typical dominant species were: *F. incarnatum, F. culmorum, F. oxysporum, F. proliferatum, F. graminearum, F. verticillioides, F. langsethiae*. Due to the fact that the highest occurrence frequency of more than 60% was characterized by mycomycetes of the species *F. oxysporum* on wheat and *F. proliferatum* on onions, further studies looked closely at the influence of the exometabolites of cultural plants varieties on the cultural and morphological characteristics of these strains (Fig. 1).

The effect of exometabolites of the different varieties of cultural plants on the rate of radial growth of mycelium of the micromycete *F. oxysporum* was determined. It was established that the exometabolites of cultural plants of different varieties significantly affect the indicated indexes (Fig. 2).

The smallest diameter of the fungus *F. oxysporum* colonies was observed during subcultivation with exometabolites of winter wheat varieties Skagen, Mulan, which, on the eighth day, turned out to be 39–40 mm and was twice as low as the control one. At the same time, exometabolites of winter wheat varieties Natalka and Podolyanka stimulated the growth of the micromycete colony, the diameter of which was 65–75 mm, which is almost on a par with the control parameter which is 77 mm. This testifies to the different biochemical composition of the root secretions of the varieties and the significant influence on the physiological activity of the

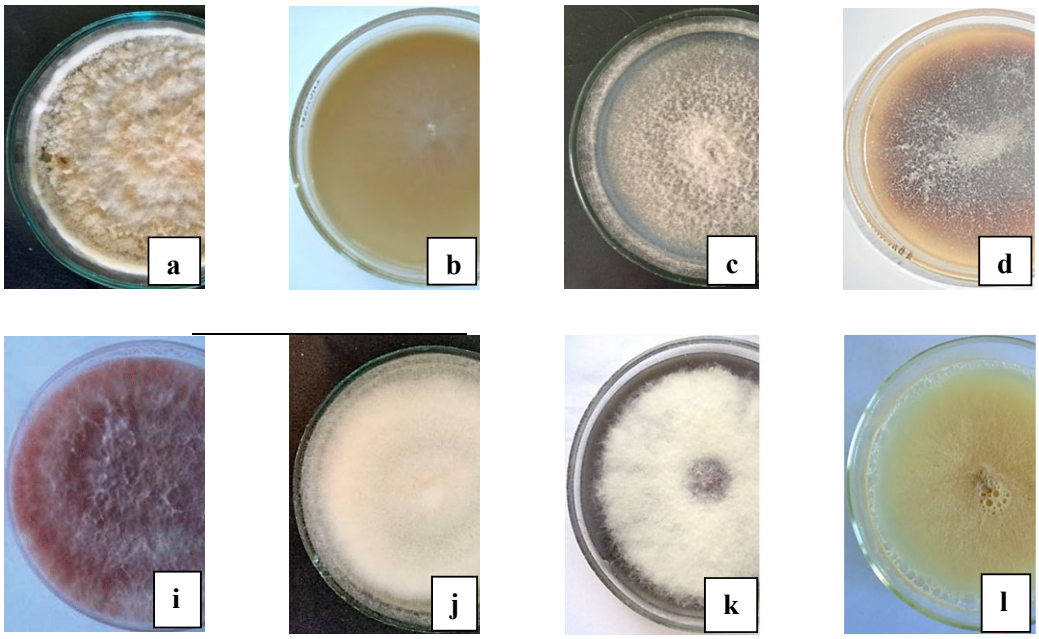

Fig. 1. The fungal colonies, isolates grown on potato dextrose agar (PDA) incubated at 25 °C. for 14 days:
a – F. incarnatum; b – F. solani; c – F. oxysporum; d – F. proliferatum;
i – F. culmorum; j – F. graminearum; k – F. verticillioides; l – F. langsethiae

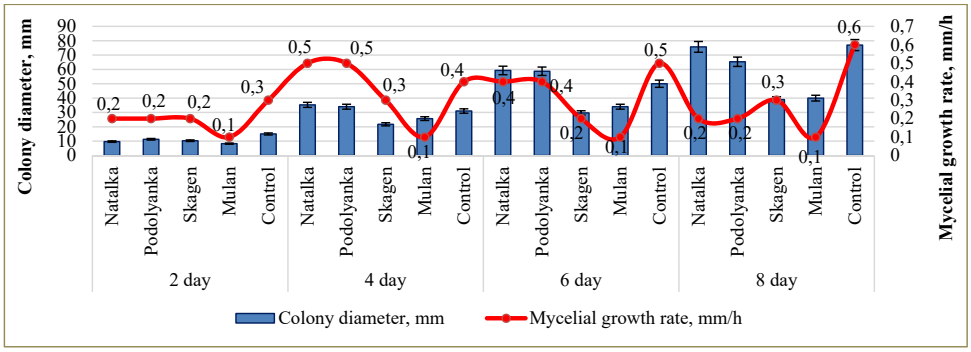

Fig. 2. The influence of metabolites of different varieties of cultural plants on the growth of the mycelium of the micromycete F. oxysporum (winter wheat)

F. oxysporum fungus. At the initial stages of subcultivation, the growth rate of the mycelium of the micromycete against the background of metabolites of winter wheat varieties was 0.1–0.2 mm/h (Fig. 2), while the growth rate of the mycelium in the control variant was almost twice as high which was 0. 3 mm/hour. During the fourth and sixth days of subcultivation of the colonies of the fungus *F. oxysporum* with root exometabolites of winter wheat plants of the above varieties, an increase in the radial growth rate of mycelium by 0.3 mm/h was observed, and a decrease during the 8th day by 0.1–0, 2 mm/hour. At the same time, on the control variant, the rate of mycelium growth increased linearly during each day and was 0.3–0.4–0.5–0.6 mm/h, respectively. (Fig. 2). The obtained results give a reason to believe that the antifungal properties of the root exometabolites of different varieties of winter wheat plants are able to restrain the growth and development of the mycelium of the fungus F. oxysporum.

The reproductive capacity of the micromycete *F. oxysporum* under the influence of exometabolites of different varieties of cultivated plants differed in different ways depending on the variety and its physiological and biochemical properties. Under the influence of the exometabolites of winter wheat varieties Skagen and Mulan, the intensity of sporulation ranged from 148.61 to 245.93 pcs. of spores, and the percentage of germinated spores was 35–40%. At the same time, under the influence of exometabolites of winter wheat varieties Natalka and Podolyanka, the intensity of sporulation was in the range of 475,495–509,111 pcs. of spores, and the percentage of the germinated spores was 55–60%. (Fig. 3).

Whereas in the control version, these indicators were 1.5–2 times higher and amounted to 578,576 pcs, respectively (80% of germinated spores). This indicates that the antifungal property of root exometabolites varieties of cultural the tested varieties of winter wheat significantly depend on the genotype of the variety and can significantly influence reproductive development micromycete *F. oxysporum* (Fig. 3).

In the study of the effect of the plant metabolites on the micromycete *F. proliferatum*, hot and semi-hot onion varieties of domestic selection were used, such as: Tkachenkivska, Mavka, Veselka, Lyubchyk, Varyag, Globus, Amfora. Changes in the growth and development of the population of the micromycete *F. proliferatum* were observed under the influence of root exudates of different varieties the onion cells. In the course of the study, it was established that exometabolites of onion varieties stimulated the growth of the mycelium the fungus at the initial stages of subcultivation. The diameter of the colony the micromycete *F. proliferatum* on the third day of subcultivation with exudates the sprouts of onion varieties

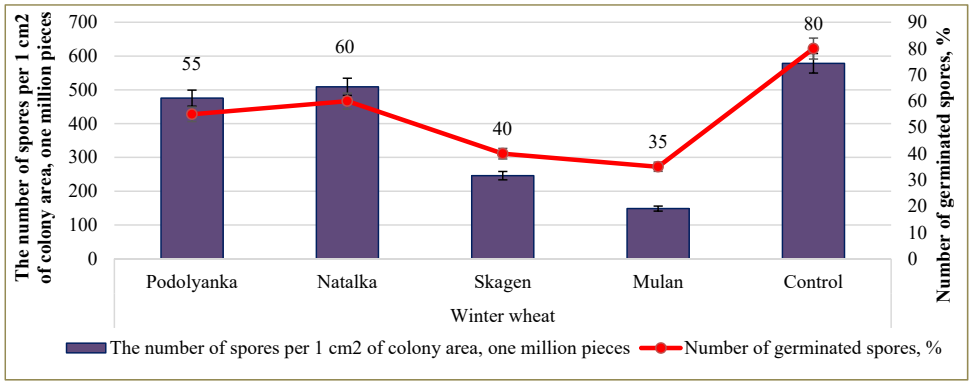

Fig. 3. The influence of metabolites of different varieties of cultural plants on the intensity of sporulation and the viability of spores of the micromycete F. oxysporum (winter wheat)

was in the range of 15.3–17.7 mm, while the size of the colony in the control variant was 15.0 mm (Fig 4).

On the sixth day, the diameter of the micromycete colony under the influence of the exudates of the sprouts of the variety samples ranged from 46.5 to 50.0 mm, while the size of the colony in the control sample was 48.0 mm. The speed of the radial growth of the mycelium gradually decreased under the influence of exometabolites of onion varieties: Tkachenkivska, Mavka, Lyubchyk, Varyag, Amfora: 0.4 mm/h. However, the influence of the exometabolites of Veselka and Globus varieties on the growth rate of the mycelium of the micromycete was at the control level: 0.5 mm/h. From the ninth day of subcultivation, a decrease in the rate of radial growth was observed in all samples within the range of 0.2–0.3 mm/h, except for the variant with exudates of the Veselka variety: 0.4 mm/h, which is at the control level. The diameter of the colonies in the variants ranged between 76.3–78.7 mm and 81.0 mm in the control variant.

On the twelfth day, the colony of *F. proliferatum* in the control sample reached the capacity of the medium and stopped its growth. Variants with sprout exudates reached the capacity of the medium on the fifteenth day. Therefore, the root metabolites of the sprouts of the studied onion varieties showed an inhibitory effect on the growth of F. proliferatum colonies.

Under the influence of metabolites of onion varieties on the micromycete F. proliferatum, it was established that all varieties suppress the reproductive capacity of the micromycete, up to 46.16–55.79 million pcs. per 1 cm² under the influence of metabolites of semi-acute (Mavka, Veselka, Amfora) varieties up to 28.33–59.26 million pcs. per 1 cm² and sharp (Tkachenkivska, Lyubchyk, Varyag, Globus) varieties compared to the control one reaching 77.86 million pcs. per 1 cm² (Fig. 5).

Metabolites of the varieties Tkachenkivska, Lyubchyk, Varyag and Globus significantly reduced the viability of micromycete spores, which was in the range of 20.5–51.1%, at the same time, under the influence of metabolites of the varieties Mavka, Veselka, Amphora, the micromycete had a viability of 42.6–61, 5% In the control version of the study of the micromycete *F. proliferatum*, high conidia viability of 84.1% was observed, which is 1.5–2 times higher than under the influence of exudates of onion varieties. It should be noted that the metabolites of the Globus variety significantly inhibited not only the intensity of sporulation of the micromycete *F. proliferatum,* but also the growth and development of mycelium. It can be assumed that onion metabolites will have a greater antifungal effect on micromycetes that do not parasitize this crop.

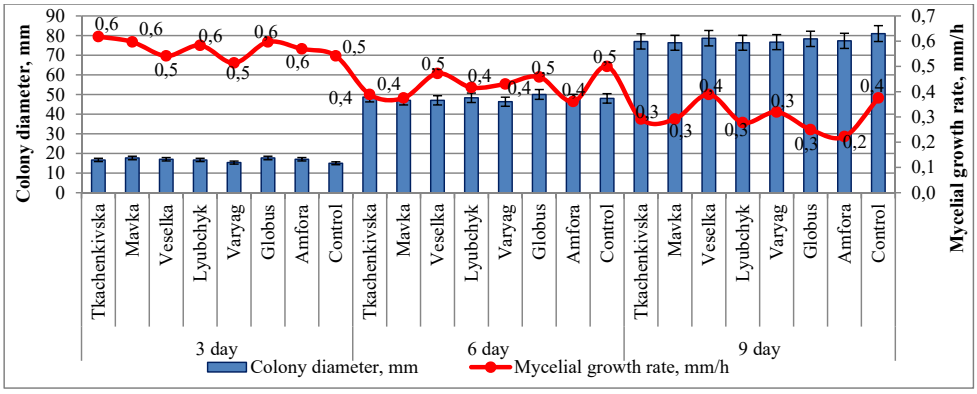

Fig. 4. The influence of metabolites of different varieties of onion on the growth of the mycelium of the micromycete F. proliferatum

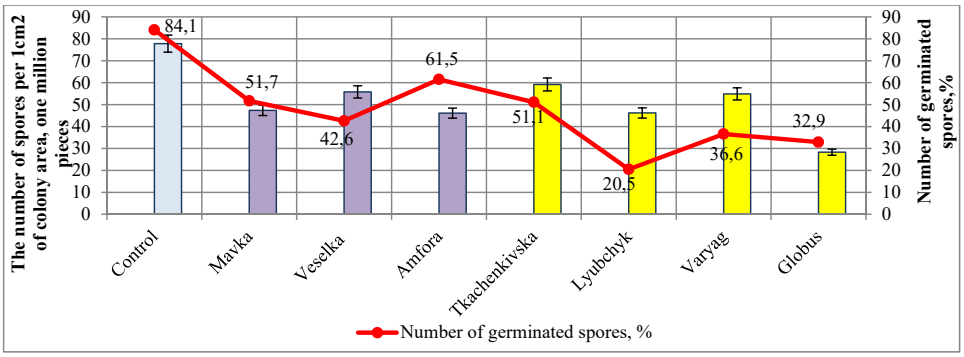

Fig. 5. The influence of metabolites of different varieties of onion on the intensity of sporulation and the viability of spores of the micromycete F. proliferatum

Therefore, the root exometabolites of cultivated plants of the tested varieties are characterized by suppressive properties caused by a complex of biologically active substances, which are able to influence the development of pathogenic mycobiota in different ways. The above research results suggest the use of water-soluble substances as an alternative to fungicides.

Conclusions. Therefore, the root exometabolites of cultivated plants of the studied varieties are characterized by fungicidal and bactericidal properties, which are caused by a complex of biologically active substances capable of different effects on the development of pathogenic mycobiota. Based on the conducted studies, the exometabolites of cultivated plants can be considered one of the mechanisms of the influence of the plant variety on the intensity of the formation of the fungal phytopathogenic background.

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