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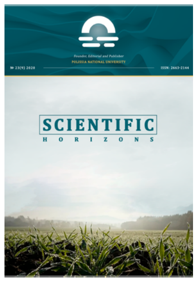

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Onion stemphiliosis in the South of Ukraine

Yurii Klechkovskyi

Doctor of Agricultural Sciences, Senior Researcher

Quarantine station of grape and fruit cultures of Institute of plant protection of NAAS

65049, 49 Fountain Road Str., Odesa, Ukraine

https://orcid.org/0000-0003-4404-5553

Natalia Mogilyuk

Candidate of Agricultural Sciences, Scientific Secretary

Quarantine station of grape and fruit cultures of Institute of plant protection of NAAS

65049, 49 Fountain Road Str., Odesa, Ukraine

https://orcid.org/0000-0001-6574-0905

Kateryna Shmatkovska*

Candidate of Agricultural Sciences

Quarantine station of grape and fruit cultures of Institute of plant protection of NAAS

65049, 49 Fountain Road Str., Odesa, Ukraine

https://orcid.org/0000-0002-3884-7595

Irina Sidorova

Candidate of Agricultural Sciences, Associate Professor

National Agrarian University

09117, 8/1 Soborna Sq., Bila Tserkva, Ukraine

https://orcid.org/0000-0002-0224-2981

Svitlana Kubrak

Candidate of Agricultural Sciences, Associate Professor

National Agrarian University

09117, 8/1 Soborna Sq., Bila Tserkva, Ukraine

https://orcid.org/0000-0002-3836-5940

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Abstract. Onion stemphiliosis is a relatively new disease in Ukraine, so a deeper study of *Stemphylium*, the species composition of the pathocenosis, and isolation and determination of the species belonging of pathogens of the disease are relevant. The purpose of the study was to examine the species composition of pathocenosis, the biofenology of the causative agent of stemphiliosis, and determine the effectiveness of fungicides for further control of stemphiliosis in onion crops. The main research methods were: field – to determine the spread, development, and harmfulness of stemphiliosis; laboratory – to examine pathogens of onion diseases; visual and mathematical – statistical. The method of mycological crops on potato-dextrose agar (PDA) was used in the work. Field surveys in 2019-2021 established the spread and development of

*Corresponding author

stemphiliosis in onion plantings in the Odesa District of the Odesa region. It was identified that the growing season of 2021 was the most favourable for stemphiliosis, when against the background of high humidity and air temperatures, the spread of the disease was 100%, and the development of the disease reached 79%. In onion crops, the disease developed unevenly, its spread was low in June, with rapid growth in July. At the beginning of August, the percentage of the disease reached 80%. Eight types of fungi were identified, of which *Stemphylium vesicarium (Wallr.) Simm, Stemphylium botryosum Wallr, Stemphylium herbarum Simm*. – are pathogens of onion stemphiliosis. Laboratory studies established the frequency of their distribution in samples. It is proved that five-time spraying with fungicides helps to reduce the further development of stemphiliosis in onion plantings. The high effectiveness of spraying plants with appropriate fungicides with the active substance fluopyram (200 g/l) + tebuconazole (200 g/l) and fluoxastrobin (100 g/l) + prothioconazole (100 g/l) to suppress the development of spores of pathogens is proven. The provisions and conclusions on the phytosanitary condition of onion plantations in the Odesa region are further developed. The results of the research can serve to develop recommendations for production on the implementation of measures to protect onions from stemphiliosis

Keywords: *Allium cepa* L.; monitoring; fungal mycoflora; Stemphylium vesicarium; effectiveness of fungicides

INTRODUCTION

Onion (onion *Allium cep*a L.) is one of the most important crops in the world, which is the second most valuable after tomatoes. The yield of onions can substantially decrease due to a number of factors, in particular, disease damage. Stemphiliosis is the most harmful and poorly investigated disease in Ukraine, the study of which is an urgent issue.

In recent years, there has been a substantial spread of stemphiliosis or black-grey spotting of onions. Stricker *et al*. (2021) indicate that stemphiliosis, causing premature leaf death, shortening the period of mass growth and maturation, can lead to a loss of onion yield by 28-38%, in the case of epiphytotics – up to 74%. Hausbeck & Werling (2018) notes that the disease has been reported sporadically on onion leaves over the past 30 years and has been considered a secondary pathogen, but in recent years *Stemphylium vesicarium* became the dominant pathogen that presumably displaced *Alternaria porri*, the causative agent of purple spotting. A study by Hay (2018) attributes this to the development of resistance to the fungicides used.

Hay *et al*. (2019) report that onion stemphiliosis is common in many regions of the world where onions and garlic are grown. However, it causes the most problems in warm regions. *S. vesicarium* can infect a wide range of plants: garlic, onion, asparagus, tomato, soy, alfalfa, lupine, mango, pear, etc. (CABI, 2021).

Effective control of stemphiliosis can be achieved only if a comprehensive approach is provided, including agrotechnical techniques, biological, chemical, and other methods. There are no varieties of onions that are resistant to stemphiliosis. Singh *et al*. (2018) in their research conducted in Taiwan, report that all onion varieties were susceptible to infection with *S. vesicarium* however, the degree of susceptibility was different.

Agrotechnical methods of controlling stemphiliosis are aimed at reducing the pathogen load on seed material and creating conditions less favourable for infection. Du Toit (2017) noted that drip irrigation reduces the risk of stemphiliosis infection by reducing the crop moisture period. Ways to reduce the duration of leaf moisture also include: reducing the density of standing plants, planning the rows of crops in the direction of prevailing winds, and irrigation late in the morning or early in the afternoon.

Biologics containing *Bacillus subtilis, Saccharomyces cerevisiae, Pseudomonas uorescens*, and *Trichoderma* spp are used to control stemphiliosis. Their use is possible only in combination with other methods of protection since they are not able to independently provide effective disease control in the field (Meena & Verma, 2017).

Treatment of plants with fungicides can substantially reduce the level of disease development, but studies by Tayviah (2017) report that *S. vesicarium* is at risk of developing resistance to fungicides since it has a short asexual reproductive cycle, produces several generations per season, forms many spores by sexual and asexual reproduction, in addition, it is necessary to repeatedly use fungicides during each growing season. Today, most publications about the resistance of *S. vesicarium* to fungicides are dedicated to pear stemphiliosis, but the same risk factors are characteristic of onion stemphiliosis.

Leach *et al*. (2020) examined the relationship between nutrition and thrips movement in the development of stemphiliosis on onions in a series of laboratory and field experiments. In laboratory studies, onion plants with varying degrees of thrips damage were infected with *S. vesicarium*. The results showed that reducing the number of thrips reduced the colonisation of onion plants by *S. vesicarium* by 2.3-2.9 times and leaf death – by 40-50%.

The purpose of the study was to investigate the epidemiology of stemphiliosis in onion plantings in the Odesa region. The objectives of the study were to examine the influence of climatic conditions on the development of the disease and assess the effectiveness of fungicides in protecting plants from it.

MATERIALS AND METHODS

Field experiments were conducted on planting onions of the Banco variety on the farm of the Ahrofirma "Petrodolynske" of the Odesa district of the Odesa region in 2019-2021. The crop was sown in the second decade of March. The soil is southern loamy chernozem, with a humus content of 3.67% and a pH of about 6.7. The seeding rate is 11 thousand seed/ha. Seeds sprouted 20-22 days after sowing.

The Totril 225 EC herbicide was used to control weeds in accordance with the recommendations: the first spraying – in the phase of 1-2 leaves of the crop, the consumption rate is 1.0-1.5 l/ha, the second spraying – as the weeds grow back, the consumption rate is 1.0-1.5 l/ha. In the second half of the growing season, 2 manual weeding operations were conducted.

Methods of mycological sowing on potato-dextrose agar (PDA) were used to examine the species composition of onion mycoflora. Isolates were collected from the leaves of 20-30 bulbs. Small leaf fragments with visible lesions were placed on potato agar and incubated at 22°C for two weeks in a thermostat. After the formation of mycelium, pathogens were identified by morphological characteristics. Identification of phytopathogens was conducted in accordance with the papers (MycoBank Database, 2022). Monitoring of the spread and development of stemphiliosis was conducted in dynamics during the growing season, starting from the moment the first signs of the disease appeared. 3 leaves were examined on 20 randomly selected plants from the accounting area on a 5-point scale: 0 points – no damage; 1 – affecting up to 10% of the surface; 2 – affected from 11 to 25% of the surface; 3 – affected from 26 to 50% of the surface; 4 – affected over 51% of the surface. The spread of the disease was determined by the following formula:

$$S = \frac{n * 100}{N} \quad (1)$$

where S – the spread of the disease; n – the number of affected plants; N – the total number of plants examined.

The development of the disease was determined by the following formula:

$$P = \frac{100 \sum(a \times b)}{n * S} \quad (2)$$

where $\Sigma(a \times b)$ – the sum of the products of the number of plants (a) and the corresponding infection score (b); n – the total number of plants in the sample, pcs.; S – the highest infection score on the scale.

Table 1 shows the fungicides and their consumption rates that were used on onions from stemphiliosis. Preparations were applied using a mounted satchel sprayer with 6 flat-jet nozzles, the distance between the nozzles is 50 cm, calibrated for applying 400 l/ha. The size of the experimental plot is 24 m^2, repetition is fourfold. Accounting for leaf damage began with the appearance of the first signs of the disease, the following before each spray, and even 10-15 days after the last treatment.

***Table 1**. Fungicides, active ingredients and consumption rates used to evaluate effectiveness in field trials for stemphiliosis on onions, 2019-2021*

Active ingredient	Consumption rate
Difenoconazole (250g/l)	0,5 l/ha
Azoxystrobin (250 g/l)	1.0 l/ha
Praklostrobin (67 g/kg) + boscalid (267 g/kg)	1.5 kg/ha
Ciprodinyl (375 g/l) + fludioxonil (250 g/l)	1.0 kg/ha
Fluoxastrobin (100 g/l) + prothioconazole (100 g/l)	1,25 l/ha
Floupiram (200 g/l) + tebuconazole (200 g/l)	0,75 l/ha

***Source:** developed by the authors based on (Letter from the State Customs Service of Ukraine No. 18/18-1159-EP, 2005)*

The effectiveness of the drugs under study was determined by the formula:

$$E = \frac{100 * (D_c - D\partial)}{D_c} \quad (3)$$

where D_c – indicator of the development of the disease in control; $D\partial$ – indicator of the development of the disease in the experimental version.

The obtained experimental data were processed using the variance analysis method.

RESULTS AND DISCUSSION

Onions are one of the most popular vegetable crops in Ukraine, with acreage ranging between 30-40 thousand hectares. The main volume of production is concentrated in the southern regions of Ukraine, where soil, climatic conditions, and modern cultivation technologies allow obtaining commercial bulbs during one growing season. The main problems with growing onions are diseases, insects, and adverse weather conditions. Leaf stemphiliosis, which is caused by *S. vesicarium*, is a relatively new onion disease in Ukraine, which is observed in onion fields from about mid-June to harvest and leads to substantial crop losses, requiring repeated use of fungicides (Fig. 1).

On the green parts isolated from Onion plantings, 8 species of mushrooms were identified, including various species of *Stemphylium* spp. (*Stemphylium* *vesicarium* (Wallr.) Simm., *Stemphylium botryosum* Wallr., *Stemphylium herbarum* Simm.), which are pathogens of onion stemphiliosis and pathogens of other diseases: fusarium rot (*Fusarium oxysporum*), head powdery mildew or peronosporosis (*Peronospora destructor*), alternariosis (*Alternaria* spp.). The data of the study of the morphology features of fungal mycoflora of onions are summarised and presented in Table 2.

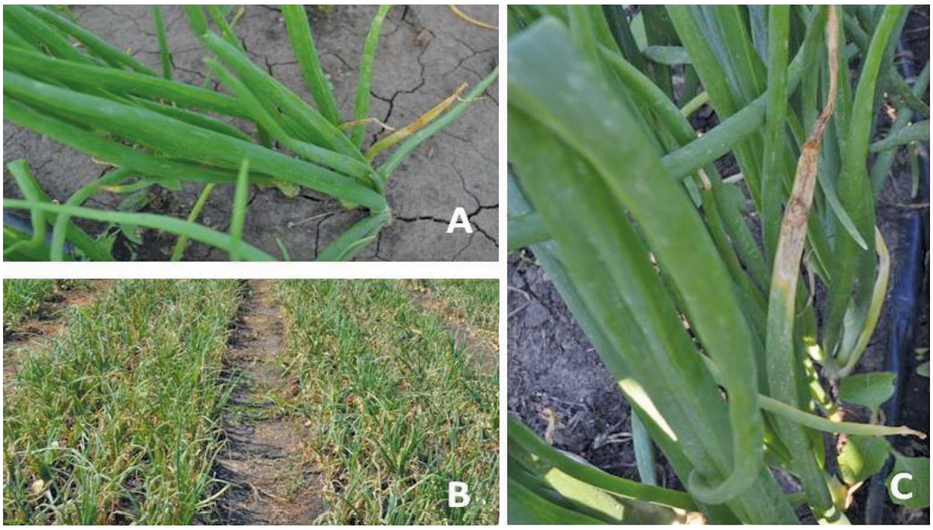

***Figure 1**. Symptoms of stemphiliosis on onion plants – A – necrotic tips (onset of the disease); B – general appearance of the affected areas of onion plantings; C – necrotic lesions spreading upwards by leaves*
***Source:** photo N.T. Mogyliuk, G.A. Horokhoryna*

***Table 1**. Cultural features of onion fungal mycoflora (Ahrofirma "Petrodolynske", Odesa district, Odesa region, Banco variety)*

Pathogen	Cultural features of the colony	Morphology features
Stemphylium spp.	Dirty-white, light grey colour of colonies, subsequently changes from light brown to dark brown with white and brown stripes.	Conidia are olive-brown, oval to ovate, oblong on conidiophores. The length of conidia varies from 146 to 306 microns (μ). The width of conidia varies from 47 to 157 μ .
Fusarium oxysporum	Colonies range from white to pale lilac, and the airy mycelium ranges from almost absent to abundant and fluffy. In the central part of the colonies, abundant macroconidia are often formed, and sometimes brown, blue, or purple sclerotia are formed. It often emits a dark purple to dark crimson pigment.	Macroconidia are fusiform-sickle-shaped, slightly curved to almost straight, with 3–5 septa (mostly with 3). The upper cell is short, sometimes slightly hooked, and the lower cell with a pedicel or papilla.
Aspergillus niger Thieg.	The fungus forms a loose mycelium. The conidionic zone is black in colour.	Sterigmas, 20×7 μ, 7×3 μ Spherical conidia, 3 μ connected in chains.
Peronospora destructor	Colonies range from white to pale grey, and the airy mycelium is abundant and fluffy.	Asexual reproduction occurs with the formation of zoosporangia, which develop into a tube-like conidia. Dichotomically branched conidiophores are formed. Conidia always sprout hyphae.
Alternaria spp.	Grey-purple or olive colour of colonies, velvety coating of conidial sporulation of the fungus	Conidiophores are single 150×3.5 6.5 μ Pear-shaped spores are multicellular with septa, olive in colour, 150×3.5–6.5 μ
Penicillium Link.	Mycelium is yellow-green with a yellow-white border, on the surface with fine colourless speckling.	Conidiophores are smooth, 3–4 μ thicknesses that carry two-tiered brushes. Conidia are ellipsoidal, slightly narrowed at the end, 3-4×2.5–3.5 μ, small-warty.

***Source:** MycoBank Database, 2022*

The frequency of spread in samples (intensity of spread, %) of isolated pathogens on average was: *Stemphylium* spp. – 13,9%, *Fusarium oxysporum* – 20,7%, *Aspergillus niger* – 18,6%, *Penicillium* – 19,4%, *Peronospora destructor* – 9,5%, *Alternaria* spp. – 17.9% (Fig. 2).

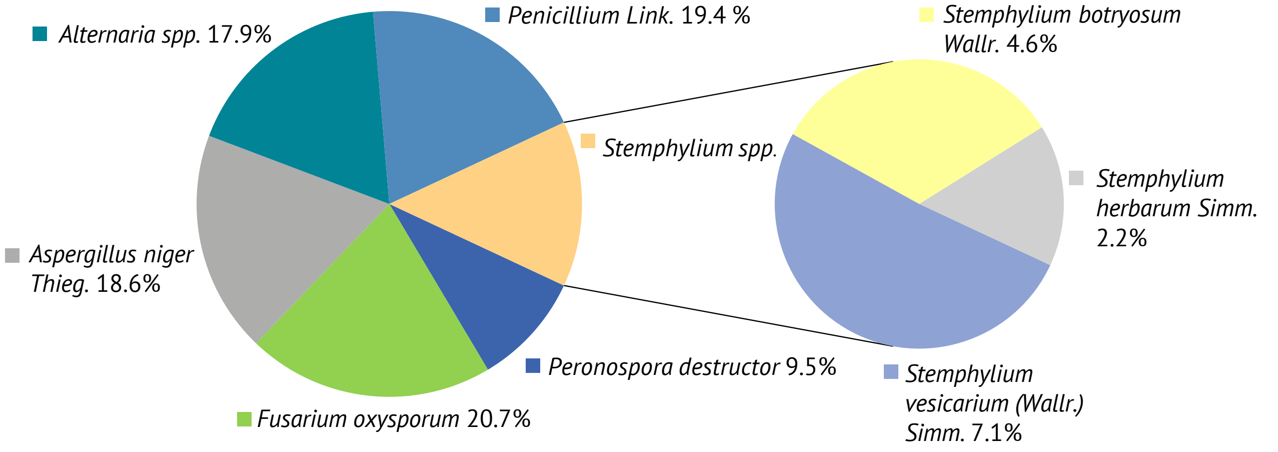

Figure 2*. Species composition of onion fungal mycoflora (% of the number of samples)*

Among the identified eight types of fungi, only *Alternaria* and *Stemphylium* are representatives of closely related species, so they need to be identified based on colony culture and conidia morphology (Fig. 3).

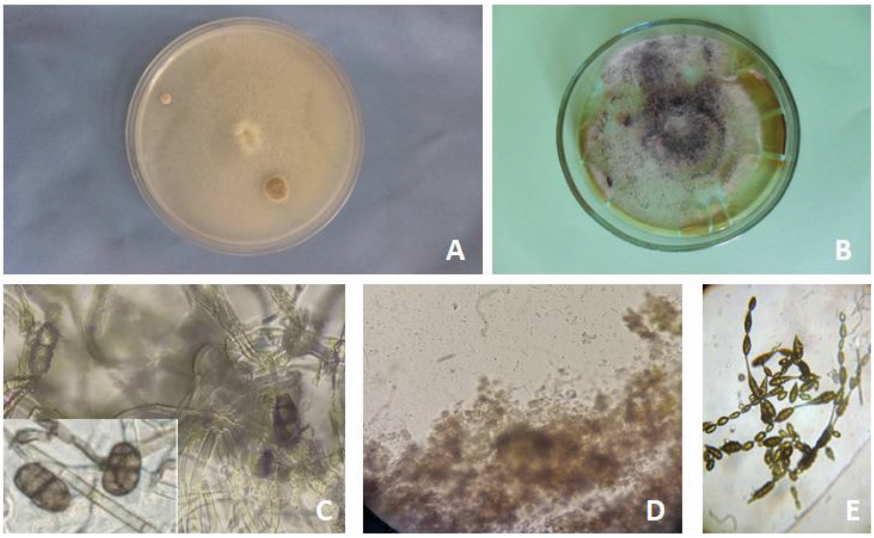

Figure 3*. Mycelial colonies on potato dextrose agar (PDA) (A) Stemphylium spp, (B) Alternaria spp; conidiophores with conidia (C) (D) Stemphylium spp, (E) Alternaria spp*
Source: *photo by K.A. Shmatkovska*

In the second stage, pathogens of onion stemphiliosis were identified from the spectrum of isolated fungi. Identification of members of the genus *Stemphylium* based on the cultural characteristics of the colony and the morphology of conidia showed the presence of three of its representatives in the samples: *Stemphylium vesicarium* (Wallr.) Simm., *Stemphylium botryosum* Wallr., *Stemphylium herbarum* Simm., which are similar in shape to conidia, but other characteristics, such as size, make them different.

Conidia *S. vesicarium* – oblong or oval with 1-5 transverse partitions, sometimes narrowed in the middle, one or three of the most central of them, with a full or almost complete row of longitudinal partitions. The size of conidia varies from 25 to 42 μ in length, 12-22 μ in width. *S. botryosum* has spores from subspherical to oblong in shape, strongly narrowed in the middle septum, 33-35 μ in length and width of 24-26 μ (Das *et al.*, 2019).

Culture *S. herbarum* was characterised by rapid growth on the medium, compared to the species described above. The colonies had a round shape, a fluffy texture, and the colour of the mycelium ranged from brown-orange to dark brown. *S. herbarum* produced unripe fruit bodies and many conidia. Spore size range: length – 20-30 μ; width – 10-15 μ (Das *et al.*, 2019). The micromycetes listed above also differed in the frequency of distribution in the samples – *Stemphylium vesicarium* (Wallr.) Simm. – 7,1%, *Stemphylium botryosum* Wallr. – 4,6%, *Stemphylium herbarum* Simm. – 2,2%.

Influence of weather conditions on the development of stemphiliosis. It is known from literary sources (Wright *et al.*, 2019) that the conditions of the year affect, first of all, the causative agent of the disease, and the degree of this influence depends on its biological characteristics. The maximum infection of onion with stemphiliosis was observed in 2021 with warm and humid spring and summer periods. However, the weather conditions of the growing seasons of 2019 and 2020 were also favourable for the development of the disease.

In 2019, during the growing season, precipitation was 182.8 mm or 85.4% of the climatic norm (214 mm) (Fig. 4). The highest amount of precipitation was observed in the second decade of April (33 mm), the second decade of June (29 mm), and the first decade of August (63 mm). The average air temperature for the test period was 19.6°C, which is 2.4°C above the long-term average (17.2°C). Relative humidity averaged 65%, which was 4% lower than long-term data for this period (69%). In 2020, during the growing season, precipitation was 152.0 mm, which is 29% lower than the climatic norm. The highest amount of precipitation was observed in the third decade of May (58.0 mm) and the second decade of June (24.0 mm) in the form of heavy rains. The average air temperature for the test period was 18.7°C, which is 1.5°C above the long-term average. Relative humidity averaged 61.0%, which was 8% lower than long-term data for this period. In 2021, during the growing season, precipitation was 344.0 mm, which is 74.0% higher than the climatic norm. The highest amount of precipitation was observed in the second decade of May (29.0 mm), the first and second decades of June (45.0 and 52 mm), and in the first and third decades of July (39.0 and 60 mm) in the form of heavy rains. The average air temperature for the test period was 18.4°C, which is by 1.2°C above the long-term average. Relative humidity averaged 71.0%, which was 2.0% higher than long-term data for this period.

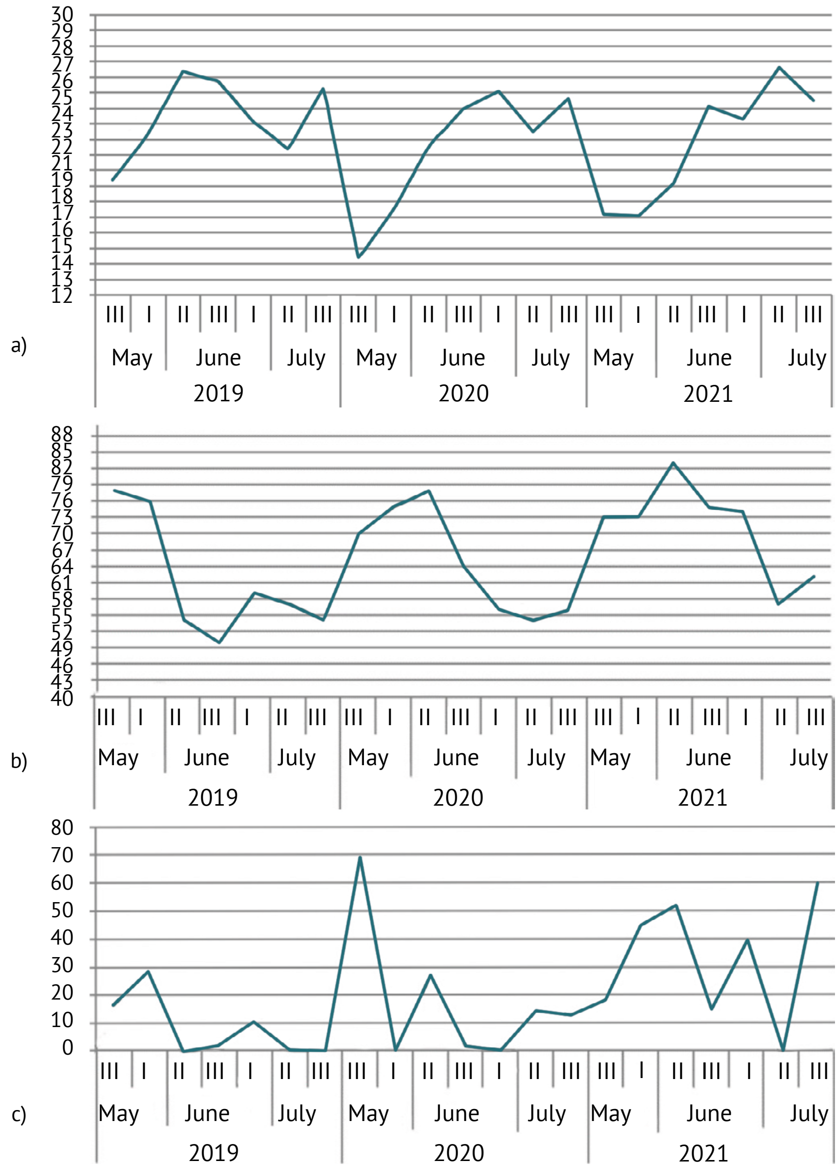

Figure 4. *Weather conditions of the onion growing season, 2019–2021 a) t, °C, b) relative humidity, %,c) precipitation, mm*

Evaluating the effectiveness of fungicides. Phytosanitary monitoring showed that stemphiliosis in the industrial conditions of the south of Ukraine is a fairly common and harmful disease of onions. In onion crops, the disease develops according to the following scheme: low incidence in June (<10%), followed by rapid growth in July. In late July and early August (in the onion phase of BBCH 43-45), the incidence can reach from 50 to 80% (Fig. 5).

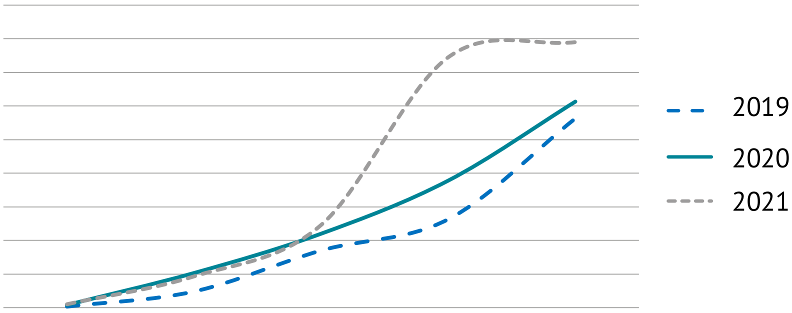

***Figure 4**. Development of stemphiliosis on onion plantings (2019-2021)*

Hay *et al.* (2021) note that at this time there is a rapid increase in the vegetative mass of plants, which contributes to a decrease in the movement of air between plants, an increase in its humidity and the further development of stemphiliosis. This is usually accompanied by necrosis of the tips and death of the outer leaves.

In 2019-2021, field studies were conducted to determine the most effective fungicides. During the growing season, five fungicide treatments were performed: difenoconazole (250 g/l), azoxystrobin (250 g/l), pyraclostrobin (67 g/kg) + boscalid (267 g/kg), cyprodinil (375 g/l) + fludioxonil (250 g/l), fluopyram (200 g/l)+ tebuconazole (200 g/l), and fluoxastrobin (100 g/l)+ prothioconazole (100 g/l). The first treatment was conducted to identify the first symptoms that were observed in the second decade of June in the onion phase of BBCH 13-14 in the form of single spots, the next – with an interval of 10-14 days, the last treatment was conducted at the stage of BBCH 47 (the beginning of feather lodging: up to 10% of plants died). The use of difenoconazole (250 g/l), azoxystrobin (250 g/l), pyraclostrobin (67 g/kg)+ boscalid (267 g/kg), cyprodinil (375 g/l)+ fludioxonil (250 g/l) was not effective enough. The fungicides fluopyram (200 g/l)+ tebuconazole (200 g/l) and fluoxastrobin (100 g/l)+ prothioconazole (100 g/l) were the most effective for disease control. Their use during the growing season reduced the infection of onion plants with stemphiliosis by 66.3-73.5% and 65.7-77.4%, respectively (Table 3).

***Table 3**. Effectiveness of fungicides to protect onions from stemphiliosis (2019-2021)*

Experiment option	Year	Effectiveness of fungicides by accounting period, %			
		2nd accounting	3rd accounting	4th accounting	Average
Difenoconazole (250g/l)	2019	57.9	70.6	69.5	66.0
	2020	56.1	67.1	68.9	64.0
	2021	56.8	44.4	48.0	49.7
Azoxystrobin (250 g/l)	2019	52.6	64.7	67.6	61.6
	2020	46.3	60.2	66.9	57.8
	2021	48.7	55.6	48.0	50.8
Pyraclostrobin (67 g/kg) + boscalid (267 g/kg)	2019	57.6	67.6	71.4	65.5
	2020	58.5	59.1	64.2	60.6
	2021	56.8	51.5	46.0	51.4
Ciprodinyl (375 g/l) + fludioxonil (250 g/l)	2019	52.6	69.1	70.5	64.1
	2020	63.4	64.8	68.9	65.7
	2021	56.8	51.5	46.0	51.4
Fluoxastrobin (100 g/l) + prothioconazole (100 g/l)	2019	68.4	75.0	77.1	73.5
	2020	70.7	73.9	72.9	72.5
	2021	70.3	61.6	67.1	66.3
Azoxystrobin 120 g/l + tebuconazole 200 g/l	2019	73.7	79.4	79.1	77.4
	2020	73.2	75.0	74.2	74.1
	2021	67.6	62.6	66.8	65.7

***Source:** developed by the authors based on the studies by N.T Mogyliuk, G.A. Horokhoryna (2019-2021)*

The effectiveness of fungicides in the third year (2021) of application decreased compared to 2019 and 2020, which may indicate the emergence of resistance to these drugs.

One of the serious reasons that hinder the cultivation of crops is the spread of diseases. Stemfilium is also known to cause premature ageing of the leaves, which makes the harvested onion crop more susceptible to post-harvest losses. The disease was detected on all onion plantings under study, which makes it epiphytotic, which is consistent with data from other researchers (Hay *et al.*, 2021; Khar *et al.*, 2022).

Pathogens of plant diseases – phytopathogenic micromycetes, cause damage to agriculture, thereby arousing the natural interest of researchers in the field of mycology and phytopathology. Separate information about the presence of micromycetes-pathogens of onion diseases can be identified in the studies by Rahul *et al.* (2022), which provide data on the detection of the composition of onion diseases in the fields of farms in the Tashkent region. As a result of investigating the composition of pathogens of fungal diseases of onions, only 57 species from 29 genera, 11 families, 7 orders, and 4 classes of fungi were identified, with different frequencies of occurrence.

Such papers confirm that the mycoflora of onions is extremely diverse. The *Stemphylium* genus is rich in species, has a wide range of hosts, and is pathogenic to over 43 plant genera worldwide. Morphologically *Stemphylium* genus can be distinguished from other related genera, such as *Alternaria*, using the cultural characteristics of colonies and morphological features. Recent studies on the definition of species of the *Stemphylium* genus demonstrated the match of morphological features, which makes it difficult to identify and describe species (Das *et al.*, 2019; Foster *et al.*, 2019; Sharma *et al.*, 2020).

A study was conducted to examine the features of fungal mycoflora of onions to identify pathogens that cause stemphiliosis. Identification of pathogens of stemphiliosis showed the presence of three of them with different frequencies of spread in the samples. The largest percentage of distribution in samples was identified in *Stemphylium vesicarium* (Wallr.) Simm. – 7,1%. Such results allow highlighting *Stemphylium vesicarium* as the main pathogen causing stemphiliosis in onion plantings of the Odesa region.

Studies showed that the maximum damage to onion stemphiliosis was observed in 2021, which was characterised by high humidity, heavy precipitation, and elevated air temperature. These results are consistent with previous experiments conducted by various authors using onion cultures (Wang *et al.*, 2021; Wright *et al.*, 2019). Gossen *et al.* (2021) identified that the first symptoms of onion stemphiliosis coincided with the appearance of a large number of conidia, precipitation, leaf moisture duration of ⩾8 hours, and days with an average daily temperature of ⩾18°C.

Agha (2022) and Hassan *et al.* (2020) investigated the effects of mineral salt – as an alternative to fungicides. The authors investigated the effect of salicylic acid, potassium dibasic phosphate, sodium bicarbonate salt, potassium carbonate, and sodium carbonate on reducing the incidence and severity of natural infection with stemphiliosis with improving the vegetative growth of onions. The authors concluded that the use of the above-mentioned treatments can be an economic and environmental alternative in controlling the spread and development of stemphiliosis.

Roylawar *et al.* (2021) identified that the root endophytic fungus *Piriformospora indica* (*Serendipita indica*) stimulates growth and the ability to induce resistance in a wide range of host plants. The effectiveness of biocontrol of *P. indica* was evaluated against stemphiliosis caused by the necrotrophic fungal pathogen *Stemphylium vesicarium*. The authors note that *P. indica* was also effective in reducing the severity of leaf stemphilium damage, which was evaluated in greenhouses and confirmed by field tests.

The possibility of controlling pathogens of stemphiliosis in onion plantations using fungicides was described by Mishra *et al.* (2017), Stricker *et al* (2021), Hausbeck *et al.* (2018), Hoepting *et al.* (2018). They note the appearance of resistance of pathogens of stemphiliosis to the fungicides under study.

Mishra *et al.* (2017) conducted a number of experiments on the effectiveness of fungicides in protecting onions from *Stemphylium vesicarium*. The combined substances azoxystrobin + flutriafol are highly effective in disease control. Wang *et al.* (2021) note the sensitivity of isolates *Stemphylium vesicarium* to difenoconazole. Recent research Hay *et al.* (2019) from Cornell University and the University of Guelph identified reduced sensitivity in laboratory and field studies to boscalid, fluopyram, and fluxapyroxad group fungicides.

There is growing evidence that the fungicides currently used by producers do not provide an economic level of suppression of stemphiliosis on onions. Mishra *et al.* (2017) note that high concentrations of mancozeb, azoxystrobin, propiconazole, and propineb in vitro inhibit the growth of *S. Vesicarium*. but practically did not affect stemphiliosis in the field

Among the ways to solve the problem of controlling stemphiliosis with fungicides, to overcome resistance to them, it is proposed to examine the effectiveness of the latest drugs regulated for use in onion plantings. These studies showed high efficiency of tank mixtures in the control of onion stemphiliosis. Fungicides with the active substance fluopyram (200 g/l) + tebuconazole (200 g/l) and fluoxastrobin (100 g/l) + prothioconazole (100 g/l) were the most effective for disease control.

Thus, according to the results of the conducted studies, the widespread fungal diseases of onions in the plantings of the Odesa region were established. The most common and harmful is stemphiliosis, or black-and-grey onion spotting, which has recently become a serious obstacle to onion cultivation in major growing areas around the world.

CONCLUSIONS

The features of the fungal microflora of onions were examined in laboratories. Eight species of micromycetes belonging to different systematic groups were identified. The most common ones are *Peronospora destructor* – 9.5%, *Stemphylium vesicarium* (Wallr.) Simm. – 7.1%. They dominate in terms of development intensity *Fusarium oxysporum* – 20.7%, Aspergillus niger – 18.6%, *Penicillium* – 19.4%, *Alternaria* spp. – 17.9%.

Based on the cultural characteristics of the colony and the morphology of conidia, three pathogens of onion stemphiliosis were identified – *Stemphylium vesicarium* (Wallr.) Simm, *Stemphylium botryosum* Wallr, *Stemphylium herbarum* Simm. Meteorological conditions during the research years were characterised by the exceeding sum of active temperatures and the amount of precipitation that was higher than the climatic norm.

It was identified that the growing season of 2021 was the most favourable for stemphiliosis. The amount of precipitation and an increase in air temperature caused the maximum manifestation of the disease, the spread of which in onion plantings was 100%, and the development of the disease reached 79%. It was identified that fungicides with the active substance fluopyram (200 g/l) + tebuconazole (200 g/l) and fluoxastrobin (100 g/l) + prothioconazole (100 g/l) were the most effective in disease control in the field.

In this regard, to develop recommendations for controlling onion stemphiliosis, it is necessary to continue the study of the effectiveness of new fungicides in the field to warn manufacturers against using ineffective drugs.

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CONFLICT OF INTEREST

None.

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Стемфіліоз цибулі ріпчастої на півдні України

Юрій Едуардович Клечковський

Доктор сільськогосподарських наук, старший науковий співробітник
Дослідна станція карантину винограду і плодових культур ІЗР НААН
65049, вул. Фонтанська дорога, 49, м. Одеса, Україна
https://orcid.org/0000-0003-4404-5553

Наталія Тимофіївна Могилюк

Кандидат сільськогосподарських наук, учений секретар
Дослідна станція карантину винограду і плодових культур ІЗР НААН
65049, вул. Фонтанська дорога, 49, м. Одеса, Україна
https://orcid.org/0000-0001-6574-0905

Катерина Андріївна Шматковська

Кандидат сільськогосподарських наук
Дослідна станція карантину винограду і плодових культур ІЗР НААН
65049, вул. Фонтанська дорога, 49, м. Одеса, Україна
https://orcid.org/0000-0002-3884-7595

Ірина Марківна Сидорова

Кандидат сільськогосподарських наук, доцент
Білоцерківський національний аграрний університет
09117, вул. Соборна площа, 8/1, м. Біла Церква, Україна
https://orcid.org/0000-0002-0224-2981

Світлана Миколаївна Кубрак

Кандидат сільськогосподарських наук, доцент
Білоцерківський національний аграрний університет
09117, вул. Соборна площа, 8/1, м. Біла Церква, Україна
https://orcid.org/0000-0002-3836-5940

Анотація. Стемфіліоз цибулі є відносно новою хворобою в Україні, тому глибше вивчення *Stemphylium*, видового складу патоценозу, виділення та визначення видової належності збудників хвороби є актуальним. Метою роботи було вивчення видового складу патоценозу, біофенології збудника хвороби стемфіліозу, визначення ефективності фунгіцидів для подальшого контролювання стемфіліозу на посівах цибулі ріпчастої. Основними методами досліджень були: польовий – для визначення розповсюдження, розвитку і шкідливості стемфіліозу; лабораторний – для вивчення збудників хвороб цибулі ріпчастої; візуальний та математично-статистичний. В роботі було використано метод мікологічних посівів на картопляно-декстрозний агар (PDA). Польовими обстеженнями у 2019-2021 роках було встановлено поширення та розвиток стемфіліозу в посадках ріпчастої цибулі Одеського району Одеської області. Встановлено, що найбільш сприятливим для стемфіліозу був вегетаційний період 2021 року, коли на фоні високої вологості та високих температур повітря, поширення хвороби становило 100%, а розвиток хвороби досягав 79%. У посівах цибулі хвороба розвивалась нерівномірно, поширення її було низьким у червні, з швидким зростанням в липні. На початку серпня відсоток хвороби сягав 80 %. Виявлено та ідентифіковано вісім видів грибів, з яких *Stemphylium vesicarium (Wallr.) Simm, Stemphylium botryosum Wallr, Stemphylium herbarum Simm.*, – є збудниками стемфіліозу цибулі. Лабораторними дослідженнями встановлено частоту їх поширення у пробах. Доведено, що п'ятиразове обприскування фунгіцидами, сприяє зменшенню подальшого розвитку стемфіліозу в посадках цибулі ріпчастої. Для пригнічення розвитку спор збудників хвороби доведена висока ефективність застосування обприскувань рослин відповідними фунгіцидами, з діючою речовиною флуопірам (200 г/л) + тебуконазол (200 г/л) та флуоксастробін (100 г/л) + протиоконазол (100 г/л). Подальшого розвитку набули положення і висновки про фітосанітарний стан насаджень цибулі ріпчастої Одеської області. Результати досліджень можуть служити для розробки рекомендацій виробництву щодо ведення заходів захисту цибулі ріпчастої від стемфіліозу

Ключові слова: *Allium cepa* L.; моніторинг; грибна мікофлора; Stemphylium vesicarium; ефективність фунгіцидів