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Evaluation of onion protection against diseases

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Abstract. The destruction of pathogenic microflora on vegetable plantations improves the phytosanitary condition of cenoses, and quality control of disease pathogens allows onion plants to realise their varietal yield potential. The aim of the experiment was to compare the effectiveness of synthetic preparations for phytosanitary control of peronosporosis, alternariosis and fusariosis pathogens: Ridomil Gold MZ 68 WG and Quadris 250 SC, as well as to consider the biological preparation Phytocide as an alternative to chemical protection. During the experiment, the dynamics of the leaf surface area was determined by the method of cutting and subsequent weighing, the height of onion plants was determined by measuring with a ruler, and the incidence of plant diseases was determined according to the methodology for recording diseases of vegetable and melon crops. The results of studies on the protective effect of fungicides were analysed. Spraying the plots with a mixture of Ridomil Gold MZ 68 WG 2.0 kg/ha (three times at 10-day intervals) + Quadris 250 SC 0.4 l/ha (twice at 10-day intervals) allowed onion plants to grow taller than the control plants – by 4.5 cm – and to exceed the control plants in terms of leaf area dynamics by 37.4-59.6%. Treatment with this mixture contributed to the best control of onion disease pathogens and ensured the formation of bulb yield on average over two years of research at the level of 55.7 t/ha with a marketability index of 85.3%. Treatment of the plots with a biofungicide also provided high-quality protection against diseases, high biometric indicators in plants and a significant increase in onion yield. The highest marketability of bulbs – 85.5% – was observed in the variant with the application of the biological preparation Phytocide, which exceeded the control by 8.7%. The biological fungicide was slightly inferior to synthetic preparations in terms of protecting onions from pathogens, but the slight lag in yield was offset by higher marketability of the product. The analysis of the obtained results provides practical guidance for vegetable growers on how to effectively protect onion plants from diseases using various preparations or their combinations

Keywords: *Allium cepa*; fungicides; pathogens; marketability; onion yield

INTRODUCTION

Diseased onion plants differ from healthy ones in that their physiological processes are slowed down due to the body's resistance to pathogens. The presence of toxins produced by fungi inside the affected plants leads to tissue destruction. As a result, crop yields decrease and product quality deteriorates. Protection against infection and treatment of plants against diseases preserves a significant part of the formed organic matter.

According to research by S.Ye. Okrushko & L.A. Yakovets (2025), phytoncidal protection against diseases was not sufficient to achieve a significantly higher onion yield. The research was conducted on binary crops of vegetables: onions, carrots and peas. Among other things, it was noted that onion phytoncides had a positive effect on the protection of carrots. Constant phytosanitary monitoring, together with forecasting

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the incidence and development of diseases in onion fields, provides the opportunity for rapid intervention to protect cultivated plants. According to research by H. Van der Heyden *et al*. (2020), forecasting systems are important for making informed decisions about treating diseases on a short-term basis. This type of decision-making is often referred to as tactical because it occurs during the harvest season with the intention of protecting the current crop.

The presence of morning dew is a favourable factor for the germination of spores of the fungus *Peronospora destructor*, which belongs to the oomycetes. The incubation period of the disease after infection of the plant lasts from 3-5 to 15 days. A significant problem in onion cultivation is that the fungus can form up to six generations per season. The only advantage is that in dry, hot weather, the development of the disease is suspended, but with an increase in humidity, it continues. Usually, during June of both experimental years, peronosporosis spread and developed moderately in the experimental plots, becoming more active after precipitation (Goryainova *et al.*, 2023). The causative agent of alternaria is *Alternaria porri*. The first symptoms of this disease appear on old onion leaves in the form of water-saturated spots with a white centre. The spots develop at the tips of the onion feathers or in the middle part. Then the leaf breaks at the spot where the spot formed, and the edges of the affected parts turn brown, and the yellowing spreads above and below the feather. Eventually, the scales of the bulb are affected. Onion bulbs become infected with alternaria through the neck. The disease begins to develop on leaves that have already been affected by downy mildew or grey rot, as well as on those damaged by thrips. The fungus can develop within a fairly wide temperature range: from +6 to +32°C. The presence of moisture droplets or air humidity above 90% for 12 hours also contributes to plant infection. Alternaria infection leads to the death of the photosynthetic apparatus, which in turn reduces the size of the bulbs and causes them to rot during storage (Goryainova *et al.*, 2023). Fusarium wilt of onion leaves appears at all stages of plant growth. The causative agent of the disease is *Fusarium oxysporum* or *Fusarium culmorum*, and the development of fusarium wilt is facilitated by high air and soil humidity and high air temperature.

Onions are vulnerable to certain groups of microorganisms that cause plant diseases. Scientists E.R. Araújo *et al*. (2020) studied the protection of onion plants against downy mildew using various preparations. They controlled the disease by applying fungicides weekly and concluded that fungicides consisting only of systemic molecules are not recommended for controlling downy mildew in onions under Brazilian conditions. According to T.A. Bhatti *et al*. (2021), the use of the fungicide Cabrio Top reduced the number of affected plants more than other fungicides compared to the control, regardless of their concentration; however, the number of affected plants decreased with increasing fungicide concentration. They obtained these data as a result of field studies. This is particularly valuable because the results of laboratory or vegetation studies may differ significantly from those obtained in field conditions. A. Yağmur *et al*. (2024), after studying the biological control of onion fusarium wilt, concluded that *F. mosseae* and a combination of AMF with *T. harzianum* have significant potential for use in controlling FOC in onions. According to their data, arbuscular mycorrhizal fungi and *Trichoderma harzianum* had a positive effect on the root system, onion height and weight. According to researchers O. Borzykh *et al*. (2023), fungicide treatments, by reducing plant damage from diseases, contributed to an increase in onion yield by 1.3-6.9 t/ha, depending on the variety and preparation. Fungicides were 45.8-89.1% effective against leaf spots (alternaria and stemphylosis) and 57.9-70.5% effective against fusarium wilt. Among the varieties studied, the highest yield was obtained with the Medusa variety (40.7 t/ha), and among the fungicides, the highest yield increase was provided by the fungicide Fandango 200 EC, KE (1.25 l/ha).

Different fungicides with different application rates depending on weather conditions and onion variety characteristics have different effects on pathogen control. Therefore, scientists and farmers continue to search for high-quality protection for onion plants against diseases. The two-year cycle of growing this crop requires significant material costs, which do not always lead to the formation of high-quality products. According to researcher V. Shvets (2025), the strategic directions for the development of vegetable growing in Ukraine include expanding the area under vegetable crops and increasing yields. Given the high ploughing intensity of land in Ukraine, in order to increase the area under vegetable cultivation, it is necessary to reduce the area under other crops. Changing crop rotation patterns requires a transition period and the selection of high-quality predecessors for vegetable crops, and the formation of the onion crop, like any other crop, depends on the combined action of a set of factors (Lohosha *et al.*, 2025). Each factor can either strengthen or weaken the overall effect of the combination. However, the harmful activity of pathogens can significantly interfere with physiological processes in plants and nullify several months of human labour. The aim of this article was to investigate the impact of fungicidal plant protection against diseases in onion cultivation technology on the formation of yield and marketable product output and to assess the economic efficiency of these measures.

MATERIALS AND METHODS

Field studies were conducted during 2023-2024 at Vinnytsia National Agrarian University in four replicates. The object of the study was onion plants, their development processes, and the effect of disease protection options. In accordance with the Convention on Biological Diversity (1992), ethical standards for the treatment of plants were observed in the study. The 'Forum' variety was grown, which belongs to the mid-season group and has a growing season of 110-120 days. The total area of the experimental plot was 12 m^2, and the recorded area was 10 m^2. Potatoes were the predecessor crop to onions. The recording of onion plant diseases was carried out in accordance with Methods for recording diseases of vegetable and melon crops (n.d.). The onion plots were examined for peronosporosis, alternariosis and fusariosis at each repetition of the experimental variants in two places equally distant from each other. At each point, 10 plants were examined in a row (20 in total). The counts were carried out when the first signs of disease appeared, as well as during the period of mass infection of onion plants, using a universal scale: 0 – onion feathers are healthy; 1 point – up to 10% of the leaf surface is affected; 2 points – 10 to 35% of the leaf surface is affected; 3 points – 36 to 60% of the leaf surface affected; 4 points – 61 to 95% of the leaf surface affected; 5 points – plant dies, more than 95% of the leaf surface affected. The leaf surface area was determined by weight (first, cuttings were made, weighed and calculated proportionally).

To accelerate the process of nutrient outflow, 10 kg/ha of monopotassium phosphate was applied to the bulbs by fertigation. The bulb yield was recorded, divided into marketable and non-marketable fractions, in accordance with the requirements of DSTU 3234-95 (1996). Synthetic fungicides were selected for the experiment: Ridomil Gold MZ 68 WG and Quadris 250 SC, as well as the biological fungicide Phytocide. During the development of the experimental design, scientific and practical recommendations developed by a group of authors from Ukraine (Mohylna *et al.,* 2021) were taken into account. The fungicide Ridomil Gold MZ 68 WG was recommended for protecting onions from disease pathogens. It is a combined preparation with systemic and contact action due to the active ingredients mancozeb and metalaxyl-M. Ridomil Gold MZ 68 WG is available in the form of water-soluble granules. The fungicide provides not only curative but also eradicative, antisporulant and protective action. It is recommended to apply it at the onset of disease development, when only 3% of plants are affected. Ridomil Gold MZ 68 WG belongs to the class of low-toxicity preparations (LD_{50} > 2000 mg/kg). The fungicide Quadris 250 SC is advertised by Syngenta as an effective product for controlling four classes of fungi that are the most common causative agents of plant diseases: *Deuteromycetes, Basidiomycetes, Ascomycetes,* and *Oomycetes*. Its mechanism of action on pathogens ensures that there is no cross-resistance, and it destroys not only hyphae but also fungal spores. Quadris 250 SC is safe not only for plants but also for the environment. The waiting period for the product to take effect on vegetables is 5 days. The following scheme was developed for the research (Table 1).

Table 1. *Scheme of the experiment on protection against onion diseases*

Option	Protection against diseases
1 control	Without fungicide
2	Ridomil Gold MZ 68 WG 2.5 kg/ha three times at 10-day intervals
3	Quadris 250 SC 0.6 l/ha twice at 10-day intervals
4	Ridomil Gold MZ 68 WG 2.0 kg/ha (three times at 10-day intervals) + Quadris 250 SC 0.4 l/ha (twice at 10-day intervals)
5	Phytocide 2.5 l/ha (three times at 10-day intervals)

Source: *compiled by the author*

The control variant consisted of plots where no fungicides were applied after the planting of onion sets. In the fourth variant, a reduced amount of a mixture of Ridomil Gold MZ 68 WG and Quadris 250 SC was applied twice per season, and the third treatment was with Ridomil Gold MZ 68 WG alone. In the fifth variant, onion plants were sprayed with the biological product Phytocide to protect them from pathogens. This biofungicide is recommended for protection not only against fungal but also bacterial diseases. It contains live *Bacillus subtilis* bacteria (at least 1.0×10^9 CFU/cm^3), which inhibit the development of a wide range of pathogens and simultaneously stimulate plant growth. It was planned to grow onions under drip irrigation conditions for better and timely provision of moisture and nutrients, with drip irrigation tubes placed every 2 rows. Since semi-rotted manure was applied to the plots at a rate of 20 t/ha for the previous crop, a universal complex fertiliser $N_{20}P_{20}K_{20}$ was used for pre-sowing cultivation. During the period of active bulb growth, $N_{25}P_{25}K_{25}$ was applied with irrigation water. Every 10 days, three times per season, Ridomil Gold MZ 68 WG (Metalaxyl-M, 40 g/kg + mancozeb 640 g/kg) was applied at a rate of 2.5 kg/ha to protect onion plants from downy mildew. Quadris 250 SC (azoxystrobin, 250 g/l) was also applied at a rate of 0.6 l/ha to protect against downy mildew and fusarium wilt. Thirty days before harvesting, it was recommended to stop treating with these fungicides, which was followed in the experiment. To maintain soil moisture at 75-80%, drip irrigation was used during the growing season of onions.

According to V.M. Svyrydovskyi (2019), in order to achieve high bulb yields, the leaf area of onions must reach 35-40 thousand m^2/ha and remain active for as long as possible. During the growing season, according to the research plan, measurements of onion height were taken and the leaf area was periodically determined in order to understand how comfortably the plants were growing and forming a yield, and how disease control measures affected the intensity of growth processes. Despite the fact that drip irrigation was used instead of sprinkler irrigation, signs of peronosporosis, alternariosis and fusariosis appeared on onion plants in the experimental plots. Weather conditions during the growing season contributed to the development of these diseases: initially, moderate daytime temperatures and cold nights against a backdrop of high humidity, and later, high soil temperatures and dry air. Therefore, based on monitoring and forecasting of the phytosanitary condition of the experimental plots, measures to protect against these diseases were periodically carried out, and one treatment against onion flies and thrips was performed with the insecticide Engeo 247 CS 0.18 l/ha using a backpack sprayer. The water consumption rate was 250 l/ha. Table 2 presents information on the average daily temperature and precipitation for each month over the years of research.

Table 2. *Weather conditions characteristics*

Months	2023		2024	
	Precipitation, mm	Average temperature, °C	Precipitation, mm	Average temperature, °C
January	20.1	0.9	71.6	-1.6
February	35.5	0.2	38.2	4.8
March	35.0	5.4	35.5	5.2
April	92.7	8.5	84.5	12.2
May	2.7	15.5	22.9	15.8
June	71.6	19.2	80.0	21.1
July	64.5	21.3	57.2	23.5
August	36.0	22.8	32.6	22.2
September	34.6	17.8	30.7	18.8
October	34.0	11.5	43.7	9.7
November	57.0	4.4	46.3	2.5
December	51.4	1.1	49.0	0.6
Total for the year	501.1		592.2	

Source: *compiled by the author based on Vinnytsia Regional Hydrometeorological Centre (n.d.)*

In total, from April to June inclusive, 167 mm of precipitation fell in 2023, and 187.4 mm in 2024. However, their distribution over the growing season was quite uneven. In particular, it should be noted that in April 2023, the average monthly temperature was 3.7°C lower than in April 2024 (Meteopost, n.d.). Although onions are a cold-resistant crop, low temperatures are conducive to the growth of pathogens. The average monthly temperature in June 2024 was 1.9°C higher than in 2023. The hot weather during the bulb growth period was compensated for by irrigation to create favourable conditions for cultivated plants.

RESULTS AND DISCUSSION

Weather conditions had a significant impact on the development and spread of onion pathogens. Onions are a crop that requires early planting, so both the amount of precipitation and the average monthly temperature in March had a significant impact on the initial conditions for plant growth and development. The temperature regime and precipitation during the growing season influenced the emergence and development of diseases in the test crop and also significantly affected the microclimate conditions in the phytocenosis. Since moisture is necessary for the germination of fungal spores, their epiphytotic development was observed during increased atmospheric precipitation in the first half of the growing season. Critical for the infection of onion plants was the condition of high relative air humidity (90-100%) lasting at least 10 hours and a temperature regime within 13-18°C. The average results of biometric indicators of onions for two years of research are presented in Table 3.

Table 3. Biometric indicators of 'Forum' onions depending on the disease protection system (2023-2024)

Option	Plant height, cm	Dynamics of leaf surface area, m^2/ha					
		I decade of May	II decade of May	III decade of May	I decade of June	II decade of June	III decade of June
1	37.1	354	1,494	6,484	12,042	20,484	27,161
2	40.2	492	2,987	8,158	17,118	27,418	35,499
3	40.5	508	2,999	8,226	17,848	28,110	36,187
4	41.6	565	3,155	8,715	18,034	29,016	37,311
5	40.7	510	2,998	8,311	17,954	28,107	35,945

Source: *compiled by the author*

The lowest plant height was observed in the control variant – an average of 37.1 cm over two years of research. Variants protected against onion diseases with only one synthetic fungicide showed almost no difference in plant height. Treatment of the plots with a mixture of fungicides resulted in the highest onion height, exceeding the control by 4.5 cm. The difference from the control variant in the plots with biological protection of onions with the Phytocide preparation was +3.6 cm, and with the variant of combined use of fungicides, the difference was +0.9 cm. Thus, the greater plant height and leaf area in variant 4 is evidence of successful phytosanitary control, which allowed the plants to fully realise their varietal potential. In other words, plant health was a key factor in its productivity.

Protecting onions from diseases in the experimental plots allowed for the formation of a larger leaf surface area than in the control. In terms of dynamics during the growing season, onion plants in the treatment variant with Ridomil Gold MZ 68 WG 2.0 kg/ha (three times at 10-day intervals) + Quadris 250 SC 0.4 l/ha (twice at 10-day intervals) had the highest leaf surface area. Plant protection in the fifth variant with the biofungicide Phytocide 2.5 l/ha (three times at 10-day intervals) showed a leaf area in the second decade of May of 2,998 m^2/ha, which was almost the same as in variants 2 and 3, where chemical protection of onions was used. At that time, the application of a tank mixture of pesticides provided higher leaf area indices – 3,155 m^2/ha, which exceeded the control by 2.1 times. At the end of June, in variant 3, where Quadris 250 SC 0.6 l/ha was applied twice at 10-day intervals, the leaf area was 36,187 m^2/ha, which is 10,120 m^2/ha less than in the fourth variant, but 9,026 m^2/ha more than in the control. The last count before harvesting showed that the control indicators for leaf area were exceeded by 8,338 m^2/ha in the second variant. The degree of onion plant damage by peronosporosis in the control variant was 15% in 2023 and 12% in 2024; and by alternariosis and fusariosis – 11% and 10% respectively for each year. At the research planning stage, the idea of T. Belo *et al.* (2023) was taken into account, namely that in drier climates, drip and furrow irrigation reduce the risk of onion disease compared to overhead irrigation. Despite spraying the experimental plots with fungicides, diseased plants were found during the surveys. Their presence did not exceed 3% by year and experimental variant (Table 4), but they served as a source of infection.

Table 4. Damage to 'Forum' onions depending on the plant disease protection system (2023-2024), points

Option	Peronosporosis		Alternariosis		Fusariosis	
	2023	2024	2023	2024	2023	2024
1	2	2	2	2	2	2
2	1	0	0	0	1	1
3	0	0	1	1	1	1
4	0	0	0	0	0	0
5	1	1	0	0	0	0

Source: *compiled by the author*

As shown in the data in Table 4, spraying onions with Phytocid proved to be less effective against downy mildew compared to other disease protection methods. Also, in 2023, Ridomil Gold MZ 68 WG 2.5 kg/ha applied three times at 10-day intervals was less effective against downy mildew than Quadris 250 SC 0.6 l/ha applied twice at 10-day intervals. However, in 2024, its effect was excellent. As for the control of Alternaria, two years of research revealed signs of the disease in the variant with Quadris 250 SC 0.6 l/ha applied twice at 10-day intervals. Fusarium affected plants in variants with single applications of synthetic pesticides. Treatment with a tank mixture of Ridomil Gold MZ 68 WG 2.0 kg/ha (three times at 10-day intervals) + Quadris 250 SC 0.4 l/ha (twice at 10-day intervals) effectively controlled the pathogens of all onion diseases studied.

When the plants began the active process of transferring plastic substances from the leaves to the bulb, the onion feathers began to lodge. The application of monopotassium phosphate by fertigation accelerated this process. Ten days after such treatment, the experimental crop was ready for harvesting.

High-quality protection against peronosporosis, alternariosis and fusarium wilt of onion leaves ensured an increase in the marketability of bulbs and an increase in yield. This is consistent with the data of M.I. Fedorchuk & V.M. Svyrydovskyi (2018). The dispersion analysis they conducted allowed them to establish that plant protection has a decisive impact on plant productivity, accounting for 63.5% of the effect, while irrigation regimes also had a significant impact on the indicator under study (12.9%), as did the interaction of the factors under study. The content of sugar, vitamin C and dry matter varied to different degrees depending on the irrigation regime and plant protection. Statistical analysis of the data obtained showed a significant increase in onion yield in all experimental variants. On plots with three applications of Ridomil Gold MZ 68 WG at a rate of 2.5 kg/ha three times at 10-day intervals, marketability was 3.3% higher than in the control variant. Over two years of research, protecting onions with the Quadris 250 SC fungicide at a rate of 0.6 l/ha twice at 10-day intervals increased the marketability of bulbs by 3.6%. Treatment of plots with a mixture of Ridomil Gold MZ 68 WG 2.0 kg/ha (three times at 10-day intervals) + Quadris 250 SC 0.4 l/ha (twice at 10-day intervals) sharply reduced the yield of non-marketable products to 14.7%.

The differences in the yield of 'Forum' onions significantly exceed the smallest significant difference over the years of research. The highest yield was obtained in 2024, when weather conditions were more favourable for the growth and development of this crop. Protecting onions with the biofungicide Phytocid also showed not only high biometric indicators, but also high yields. The 2.7 t/ha yield lag in this variant from the combined application of Ridomil Gold MZ 68 WG 2.0 kg/ha (three times at 10-day intervals) and Quadris 250 SC 0.4 l/ha is compensated by higher product quality (not only in terms of marketability, but also in terms of the absence of residual pesticides) and a reduction in the pesticide load on the environment. It should not be forgotten that biological products also have a certain impact on the environment. As confirmed by a study conducted by S.B. Tagele & E.W. Gachomo (2025), the chemical and biological fungicides SoilGard and Ridomil significantly affected the diversity of soil bacteria, but their effects varied and depended on time. It is also important to consider the condition of the onions during storage. If the infection persists on the surface or inside the harvested product, these harmful microorganisms will cause the emergence and development of diseases in the autumn-winter period under favourable conditions in the storage facility. In particular, according to G.I. Yarovyi *et al.* (2023), during storage, onions were most affected by neck rot (*Botrytis allii*) and less by root rot (*Fusarium oxysporum*), with onion losses from disease ranging from 3.1 to 5.2%.

The impact of irrigation and plant protection regimes on onion productivity and quality was studied by M.I. Fedorchuk & V.M. Svyrydovskyi (2018), according to which the maximum crop yield in the experiment at the level of 83.5-84.2 t/ha was formed in variants with irrigation of 80-90% of the field capacity and the use of chemical plant protection. The best marketability within the range of 85.3-90.7% was achieved with irrigation at 90% of field capacity, and the highest average bulb diameter – 64.8 mm – was also achieved with this irrigation regime and the use of chemical plant protection. According to A.O. Lymar (2012), onion plants are characterised by a photoperiodic response, which determines the basis of their biological characteristics and economically valuable traits: the duration of the growing season, the rate of growth of the assimilation apparatus and bulb formation, resistance to pathogens, bolting, and plant productivity. Also, H. Myronova *et al.* (2023) proved that improving the agricultural background of cultivation resulted in a slight reduction in potato tuber damage. Since onions also form their yield underground, it is worth considering that fertilising the crop has a positive effect on its resistance to diseases. That is why this study determined the biometric indicators of plants in the experimental plots. Although the absolute yield indicators differ, the study data correlate with the results of the article and agree on a key point: the use of chemical protection is one of the important factors for increasing both the yield and marketability of onions.

In order to transition to biological methods of protecting vegetable crops in modern agriculture, the use of biological preparations, in particular biofungicides, is becoming increasingly widespread, but their effectiveness is usually lower than that of chemical preparations due to their narrow spectrum and slow action. Due to the absence of phytotoxicity and harm to the environment, a certain part of farmers refuse to use pesticides in favour of biological protection. Unlike synthetic pesticides, the use of biological products is accompanied by the stabilisation of biocenotic relationships in the ecosystem, the preservation and restoration of soil fertility, and the improvement of the ecological state of the environment. Chemical fungicides, in turn, provide powerful, comprehensive and long-lasting protection for cultivated plants, but they have a phytotoxic effect and harm the environment. As stated by O.M. Mohylna *et al.* (2021), modern crop cultivation technologies require the mandatory use of pesticides. It is also important to consider the negative impact of pesticides and mineral fertilisers on soil fertility. According to research by O.P. Tkachuk & V.I. Verhelis (2023), the use of green manure has a positive effect on the agroecological condition of the soil. Fertilisation and irrigation are also important in the process of plants realising their genetic potential. The introduction of mineral fertilisers into the soil environment changes the conditions for the life of microflora, including pathogenic microflora, and artificial improvement of the soil water regime through irrigation can significantly activate the microbiota. The results obtained by I.V. Honcharuk & Ya.V. Hontaruk (2024) on the effectiveness of fertilisation using soil and foliar application schemes indicated the need for an individual approach to each crop and specific growing conditions, which directly correlates with the data of this study, since high-quality fungicide protection that maximises yield can only be effective against the background of optimal nutrition and water regime. As indicated by S. Kalogiannidis *et al.* (2022), in order to ensure modern food security, it is necessary to improve existing technologies so that moisture is not a limiting factor in yield formation. Calculations of the economic efficiency of protecting onions from diseases confirmed the feasibility of using fungicides (Table 5).

Table 5. *Yield of 'Forum' onions depending on the plant disease protection system (2023-2024), t/ha*

Option	2023	2024	Average	Deviation, +	Marketability, %
1	45.1	47.5	46.3	-	76.8
2	50.8	54.9	52.9	6.6	80.1
3	51.0	55.1	53.1	6.8	80.4
4	54.3	57.0	55.7	9.4	85.3
5	50.9	55.0	53.0	6.7	85.5
HIP_{05}	2.1	2.3			

Source: *compiled by the author*

In the fourth variant, where the plots were treated with a mixture of Ridomil Gold MZ 68 WG 2.0 kg/ha (three times at 10-day intervals) + Quadris 250 SC 0.4 l/ha (twice at 10-day intervals), the net profit was 48.8 thousand UAH with a profitability level of 128%. Other experimental options showed slightly lower economic indicators. As noted by L. Fenta & H. Mekonnen (2024), improving methodologies and interdisciplinary research will be the focus of future research to create high-quality, safe and cost-effective plant protection solutions. The calculation of economic indicators reflected the success of the agrotechnical measures carried out in the experiment. The highest net profit and profitability were achieved through a combination of high yield and crop protection efficiency in option 4. At the same time, it is worth highlighting the advantages of the biological product Phytocide, because despite worse economic indicators and lower yields compared to the combined application of Ridomil Gold MZ 68 WG 2.0 kg/ha (three times at 10-day intervals) + Quadris 250 SC 0.4 l/ha (twice at 10-day intervals), its choice may be justified in the context of reducing pesticide load and obtaining environmentally friendly products.

CONCLUSIONS

Onion plants grown in the control variant without fungicide treatment were affected by peronosporosis, alternariosis and fusariosis (over the years of research, 10 to 35% of the leaf surface was affected). Accordingly, diseased plants produced the lowest yield in the experiment – 46.3 t/ha with the lowest marketability – 76.8%. High-quality protection of 'Forum' onion plants from the most common diseases contributed to higher plant height, better leaf surface growth dynamics, and, accordingly, higher marketability and yield of onions. Spraying the plots with a mixture of Ridomil Gold MZ 68 WG 2.0 kg/ha (three times at 10-day intervals) + Quadris 250 SC 0.4 l/ha (twice at 10-day intervals) contributed to better functioning of the photosynthetic apparatus of cultivated plants, which ensured the formation of onion yield on average for 2023-2024 studies at the level of 55.7 t/ha. The marketability index for the fourth variant was 85.3%, which exceeded the control variant by 8.5%. The highest net profit – 48.8 thousand UAH – and the highest level of profitability – 128% – were obtained for this variant.

The results of using the biological fungicide Phytocide were slightly lower compared to the chemical control with a mixture of onion disease preparations. The decrease in yield compared to the fourth option was 2.7 t/ha over two years of research. However, when comparing onion yields with single applications of synthetic preparations, i.e. with options 2 and 3, the deviation from the control option is close to their level. In other words, the quality of protection provided by the biological fungicide Phytocide can compete with the chemical method. It should also be noted that the option of biological protection of onion plants against diseases ensured a reduction in the pesticide load on the territory. The direction of further research is to study the effectiveness of biological preparations for the protection of other vegetable crops against diseases in the Vinnytsia region.

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REFERENCES

[1] Araújo, E.R., Resende, R.S., Alves, D.P., & Higashikawa, F.S. (2020). Field efficacy of fungicides to control downy mildew of onion. *European Journal of Plant Pathology*, 156, 305-309. doi: 10.1007/s10658-019-01874-0.
[2] Belo, T., du Toit, L.J., & LaHue, G.T. (2023). Reducing the risk of onion bacterial diseases: A review of cultural management strategies. *Agronomy Journal*, 115, 459-473. doi: 10.1002/agj2.21301.
[3] Bhatti, T.A., *et al*. (2021). Management of downy mildew of onion through selective fungicides in the field condition. *Journal of Applied Research in Plant Sciences*, 2(1), 92-107. doi: 10.38211/joarps.2021.2.1.13.
[4] Borzykh, O., Serhiienko, V., Dzham, M., Shyta, O., & Mykhaylenko, S. (2023). Sungicidal control of the most common onion mycoses during the growing season. *Quarantine and Plant Protection*, 2, 3-9. doi: 10.36495/2312-0614.2023.2.3-9.
[5] Convention on Biological Diversity. (1992, June). Retrieved from https://www.cbd.int/convention/text.
[6] DSTU 3234-95. (1996). *Fresh onion. Technical specifications*. Retrieved from https://online.budstandart.com/ua/catalog/doc-page.html?id_doc=85004.
[7] Fedorchuk, M.I., & Svyrydovskyi, V.M. (2018). The influence of irrigation and plant protection regimes on the productivity and quality of onion under drip irrigation. *Scientific Bulletin of the NUBiP of Ukraine. Series: Agronomy*, 3(73). doi: 10.31548/dopovidi2018.03.019.
[8] Fenta, L., & Mekonnen, H. (2024). Microbial biofungicides as a substitute for chemical fungicides in the control of phytopathogens: Current perspectives and research directions. *Scientifica*, article number 5322696. doi: 10.1155/2024/5322696.
[9] Goryainova, V.V., Stankevych, S.V., Batova, O.M., & Zhukova, L.V. (2023). *General phytopathology*. Zhytomyr: PE "Ruta".
[10] Honcharuk, I.V., & Hontaruk, Ya.V. (2024). Assessing the efficiency of fertilization according to the schemes of soil and foliar application in the cultivation of agricultural crops. *Business-Inform*, 11, 170-176. doi: 10.32983/2222-4459-2024-11-170-176.
[11] Kalogiannidis, S., Kalfas, D., Chatzitheodoridis, F., & Papaevangelou, O. (2022). Role of crop-protection technologies in sustainable agricultural productivity and management. *Land*, 11(10), article number 1680. doi: 10.3390/land11101680.
[12] Lohosha, R., Lutkovska, S., Pidvalna, O., Pronko, L., & Kolesnyk, T. (2025). Ecological optimisation of vegetable production as a factor of the industry capitalisation. *Agricultural and Resource Economics-International Scientific E-Journal*, 11(1), 74-101. doi: 10.51599/are.2025.11.01.03.
[13] Lymar, A.O., Lymar, V.A., & Naumov, A.O. (2012). The influence of irrigation regimes, watering methods and fertilizer doses on onion yield in the zone of sandy soils of the Lower Dnieper. *Taurida Scientific Herald. Series: Rural Sciences*, 81, 92-98.
[14] Meteopost. (n.d.). Retrieved from https://meteopost.com/weather/climate/.
[15] Methods for recording diseases of vegetable and melon crops. (n.d.). Retrieved from https://buklib.net/books/34609/.
[16] Mohylna, O.M., Onyshchenko, O.I., Shcherbyna, S.O., Datsenko, S.M., Bilenka, O.M., & Ivanin, D.V. (2021). A comprehensive system of measures to protect onions and garlic from pests, diseases and weeds: Scientific and practical recommendations. Kyiv: Agrarian Science.
[17] Myronova, H., Honcharuk, I., Mazur, O., Tkachuk, O., Vradii, O., Mazur, O., Shkatula, Y., Pelekh, L., & Okrushko, S. (2023). Optimization of measures to increase disease resistance of potato varieties as a factor of reducing environmental pollution. *International Journal of Ecosystems and Ecology Science (IJEES)*, 13(2), 163-170. doi: 10.31407/ijees13.218.
[18] Okrushko, S.Ye., & Yakovets, L.A. (2025). Disease infection of vegetable crops in binary crops. *Agriculture and Forestry*, 2(37), 143-159. doi: 10.37128/2707-5826-2025-2-14.

[19] Shvets, V. (2025). Experience in regulating and analyzing state support for vegetable production. *Economy and Society*, 73. doi: 10.32782/2524-0072/2025-73-68.
[20] Svyrydovskyi, V.M. (2019). *Onion productivity depending on irrigation and plant protection regimes in Southern Ukraine*. (Doctoral dissertation, Kherson State Agricultural University, Kherson, Ukraine).
[21] Tagele, S.B., & Gachomo, E.W. (2025). A comparative study: Impact of chemical and biological fungicides on soil bacterial communities. *Environmental Microbiome*, 20, article number 44. doi: 10.1186/s40793-025-00713-6.
[22] Tkachuk, O.P., & Verhelis, V.I. (2023). Influence of fertilizers on indicators of the agro-ecological condition of the soil. *Taurida Scientific Herald. Series: Rural Sciences*, 132, 210-224. doi: 10.32782/2226-0099.2023.132.26.
[23] Van der Heyden, H., Dutilleul, P., Charron, J.-B., Bilodeau, G.J., & Carisse, O. (2020). Factors influencing the occurrence of onion downy mildew (*Peronospora destructor*) epidemics: Trends from 31 years of observational data. *Agronomy*, 10(5), article number 738. doi: 10.3390/agronomy10050738.
[24] Vinnytsia Regional Hydrometeorological Centre. (n.d.). Retrieved from https://meteo.vn.ua/.
[25] Yağmur, A., Demir, S., Canpolat, S., Rezaee Danesh, Y., Farda, B., Djebaili, R., Pace, L., & Pellegrini, M. (2024). Onion *Fusarium* basal rot disease control by *Arbuscular Mycorrhizal Fungi* and *Trichoderma harzianum*. *Plants*, 13(3), article number 386. doi: 10.3390/plants13030386.
[26] Yarovyi, G.I., Hordiienko, I.M., & Kalashnyk, I.M. (2023). Yield, quality and preservation of onion hybrids. *Agricultural Innovations*, 21, 132-137. doi: 10.32848/agrar.innov.2023.21.20.

Оцінка захисту цибулі ріпчастої від хвороб

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Анотація. Знищення патогенної мікрофори на овочевих плантаціях поліпшує фітосанітарний стан ценозів, а якісний контроль збудників хвороб дозволяє рослинам цибулі реалізувати сортовий потенціал врожайності. Метою експерименту було порівняти ефективність синтетичних препаратів для фітосанітарного контролю збудників пероноспорозу, альтернаріозу та фузаріозу: Ридоміл Голд МЦ 68 WG та Квадріс 250 SC, а також розглянути як альтернативу хімічному захисту – біологічний препарат Фітоцид. Під час експерименту методом висічок із подальшим зважуванням визначили динаміку площі листової поверхні, методом вимірювання лінійкою визначали висоту рослин цибулі та згідно з методикою обліку хвороб овочевих і баштанних культур визначали ураженість рослин хворобами. Проаналізовано результати досліджень щодо захисної дії фунгіцидів. Обприскування ділянок сумішшю препаратів Ридоміл Голд МЦ 68 WG 2,0 кг/га (тричі з інтервалом в 10 днів) + Квадріс 250 SC 0,4 л/га (двічі з інтервалом в 10 днів) дозволило рослинам цибулі сформувати вищу висоту ніж на контролі – на 4,5 см та перевершувати в динаміці площі листкової поверхні на 37,4-59,6 % контроль. Обробка цією сумішшю сприяла найкращому контролю збудників хвороб цибулі, та забезпечила формування урожайності цибулин в середньому за два роки досліджень на рівні 55,7 т/га із показником товарності 85,3 %. Обробка ділянок біофунгіцидом теж забезпечила якісний захист від хвороб, високі біометричні показники у рослин та істотне зростання урожайності цибулі. Найвища товарність цибулин – 85,5 % була на варіанті внесення біологічного препарату Фітоцид, що перевищила контроль на 8,7 %. Біологічний фунгіцид за ефективністю захисту цибулі від патогенів дещо поступався синтетичним препаратам, але незначне відставання урожайності компенсувалося вищою товарністю продукції. Аналіз отриманих результатів показує овочівникам як на практиці якісно захистити рослини цибулі від хвороб різними препаратами або їх комбінацією

Ключові слова: *Allium cepa*; фунгіциди; патогени; товарність; урожайність цибулі