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INVESTIGATION OF THE SPECIES COMPOSITION AND HARMFULNESS OF DOMINANT PHYTOPHAGES OF ONIONS IN THE RIGHT-BANK FOREST-STEPPE OF UKRAINE

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Abstract

The research is aimed at studying the species composition, dynamics of the number and harmfulness of dominant pests, which is extremely important for the development and improvement of elements of the onion protection system. After all, the analysis of literature sources showed insufficient information about the distribution and harmfulness of the main phytophages under modern conditions of growing onions in the Right Bank Forest-Steppe of Ukraine.

We conducted the monitoring of the phytosanitary condition of onion crops during 2017–2020 and determined the species composition of dominant phytophages. We studied the complex of soil pests: larvae of *Melolontha sp.*, the population density of which over the years of research was 0.8–2.5 specimens/m^2, larvae of *Elateridae* sp., or click beetles (wireworms) – 0.9–2.2 specimens/m^2 and *Gryllotalpa gryllotalpa L.* – 2.5 specimens/m^2. Dominant species of phytophages in onion crops included onion fly (*Delia* Antigua Mg.), onion thrips (*Trips tabaci* Lind.), and *Ceuthorrhynchus jakovlevi* Schultze.

The four most vulnerable phases of growth and development of onions before colonization and damage by major phytophages were identified:

1) phase of leaf development (a primary shoot) (BBCH 1–19);

2) phase of the beginning of thickening of leaf base – bulb formation (BBCH 41–43);

3) phase of bulb formation – beginning of leaf splitting (BBCH 45–47);

4) phase of the completion of growth and development (state of physiological rest) (BBCH 48–49).

Keywords: onion phytophages, phytosanitary condition, species composition, abundance dynamics, harmfulness, growth phases.

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1. Introduction

Onions (*Allium cepa* L.) is a valuable product of human consumption, the dry matter content of which is 7.0 to 21.0 % in the bulb and 6.2–7.0 % in the leaves. Carbohydrates are represented by sugars, the amount of which in the unbound state is 7.8 %, monosaccharides 4 %, and disaccharides 3.6 %. Onions are rich in amino acids: arginine, valine, histine, isoleucine, leucine, lysine, methionine, phenylalanine. The energy value in the bulb is 43 kcal or 180 kJ and in the leaves 22 kcal, or 92 kJ [1].

Minerals are contained in onions in the form of easily digestible salts and mineral and organic acids, which include the elements potassium, phosphorus, iron, calcium, magnesium, aluminum, zinc, boron, sulfur, iodine, and others. Onions also have a rich vitamin content: vitamins C, B, B_2, B_6, B_9, PP, E, A [2].

Due to this biochemical composition and suitability for year-round use, onions are one of the leading vegetable crops in many countries [3, 4]. Its world sown area is almost 2 million hectares[5].

In Ukraine in 2000 the sown area of onions was 64.5 thousand hectares, and in 2018–2019 – 52.5–53.9 thousand hectares, which was 12 % of the total area of vegetable crops. But despite the use of modern cultivation technologies, the yield of onions remains at 17–18 ton/ha [6].

Currently, due to changes in agricultural production, the cultivation of onions has shifted to the private sector, where the complex technological methods of growing this crop have been disrupted, and as a result, the species composition of dangerous phytophages has changed.

In vegetable agrocenosis, a high-level population of both pests and beneficial organisms is formed. The number of arthropod species, living in the vegetable agrocenosis, due to its multi-year existence, is about 80 species. But the species composition of pests varies depending on the natural and climatic conditions of a particular zone[7].

Studies of the biology of phytophagous onions have so far been conducted in Ukraine, Belarus, non-chernozem zone of Russia [8–10]. But over the past 10–15 years, the varietal composition and technological methods of cultivation have changed quite a lot onion, which in turn has led to a change in the species composition of the harmful entomocomplex, their distribution, and harmfulness.

Both soil-dwelling and terrestrial pests damage onion plantations. Soil-dwelling pests mostly damage seeds and roots with bulbs in the early phases of development, which is very dangerous for plants, and terrestrial phytophages significantly cause damage during the growing season, and some are carriers of dangerous viral diseases. Damaged bulbs often rot during storage and lose their keeping quality, which leads to economic losses [11].

There has been a significant increase in the abundance of onion thrips, causing significant losses both in Ukraine and abroad [12–14]. According to the author of [15], onion thrips (*Thrips tabaci* Lind.) causes serious damage to the leaves of onions in South Texas.

The analytical review of scientific literature showed the lack of research to study the biological features of development and harmfulness of the entomocomplex of onions with modern cultivation technologies and depending on the phase of development of the crop. [16, 17]. After all, the damage to onions during the growing season by some pests leads both to reduced yields, infection with a complex of infectious diseases, and the death of young plants [18, 19].

Therefore, the aim of the research was to study the dynamics of the abundance and harmfulness of soil-dwelling phytophagous, which will establish the emergence, mass reproduction in agrocenoses and timely protective measures against pests.

2. Materials and Methods

The research was conducted at the agricultural (farming) enterprise “Zlahoda” (Kyiv region) of the Right-Bank Forest-Steppe of Ukraine and in the microbiological plant protection laboratory of the Institute of Plant Protection of National Academy of Agrarian Sciences of Ukraine in 2017–2020.

The experiments were carried out on hybrids and varieties of different maturity (Banko F_1, Daytona F_1, Antelope F_1, Globe, and Chalcedony) on an area of 10 hectares.

Onions were sown in a broadband way, the depth of seed sealing during early spring sowing was 2.5–3.0 cm, the seed sowing rate was 0.8–1.2 million/ha [20, 21].

The stages of development of onions were determined by the BBSH scale [22, 23].

Observations of the development of phytophages and accounting for their abundance were carried out, systematically following generally accepted guidelines [24].

The number of pests on onion crops was determined by the method of autumn and spring soil excavations. Accounting pits 50x50 cm and up to 50 cm deep were dug in a checkerboard pattern on each surveyed field. The soil was sifted through a sieve and the number of detected larvae was counted, the average number per 1 m^2 was calculated.

The damage to sow seeds during the emergence of new seedlings was determined by the method of selection in 20 places of the field by digging 5 seedlings and determining the number of damaged and dead seedlings and seeds.

The registration of the abundance and harmfulness of onion fly was determined by sampling from 0.5 m of the row, evenly spaced in the middle rows of the plot, or on two diagonals of the field to form the standing density of onions. After formation, we counted pests on 25 plants (with-

out plucking them) in 5 places on 5 plants in the middle rows of the plot in a chessboard pattern. All plants in the sample were carefully inspected and the number of phytophage larvae was counted.

To register onion thrips, we selected 20 plants in 5 equidistant places. Plants were inspected over white paper and the number of pests on plants and paper was counted. The registration was performed at least 2 times a week [24].

The density of phytophages was assessed by the population index, or the percentage of populated plants (*P*), which was determined by the formula:

$$P=n/N\cdot 100, \quad (1)$$

where *P* – the percentage of populated plants, %; *n* – the number of plants, inhabited by the pest in the sample; *N* – the total number of accounting plants in the samples.

The damage to onions by phytophages was determined by examination of 10 plants in 10 samples, counted the number of damaged plants and the percentage of their damage [25].

The obtained results were processed by methods of mathematical and statistical analysis [26] using the computer graphic programs: MS Excel, Statgraphics plus.

3. Results

Based on long-term monitoring of the harmful entomocomplex of onion in the Right-Bank Forest-Steppe of Ukraine, we found 12 species of the orders Coleoptera – 46.2 %, Lepidoptera – 23.1 %, Diptera – 15.4 %, Thysanoptera – 10.4 %, Orthoptera – 5.0 % and other (**Fig. 1**).

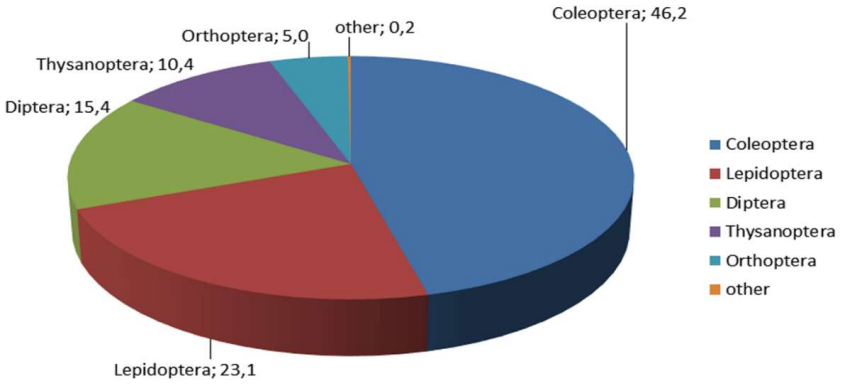

Fig. 1. Taxonomic structure of the harmful entomocomplex of onion, 2017–2020

Observations of the phenology of onions and the dynamics of the number of dominant phytophages in 2017–2020 made it possible to identify four critical stages of its organogenesis. Each stage of the growing season of onions was characterized by the dominance of different species of phytophages, inhabiting and damaging crops to a large extent. This led to economic losses and damages due to crop losses and additional protective measures.

It is investigated, that in the phase of leaf development (BBSH 1–19), the most dangerous are polyphagous pests: larvae of *Agriotes sputator L.*; *Agriotes lineatus L.*; *Melolontha melolontha L.*, *Melolontha hippocastani F.*, *Amphimallon solstitialis L.*; *Scotia segetum Schiff.* and *Gryllotalpa gryllotalpa L.*

According to the author of [27], the degree of damage to vegetable plants at different sowing dates often depends on the degree of plant development until the moment of mass flight of the pest.

Studies on the effect of sowing dates (early and late) on the degree and nature of damage to onions show that phytophages are less harmful in early planting.

Based on the early spring soil excavations before sowing onions and after sowing in the phase of germination – leaf development (BBSH 1–19), it was investigated, that during the early sowing of onions (III decade of March–I decade of April) the density of beetle larvae is within 0.8–2.5 specimens/m^2, and during the development period – 1.0–2.2 specimens/m^2 (**Fig. 2**).

The abundance of larvae of click beetles (wireworms) before sowing was on average 1.2 specimens/m^2 and during the phase BBCH 1–19 it was 1.5 specimens/m^2. The density of *Gryllotalpa gryllotalpa L.* before sowing was insignificant: 0.5–1.8 specimens/m^2, and it reached 1.5–2.7 specimens/m^2 during the phase of germination of onions. Caterpillars of *Scotia segetum* Schiff. started to colonize onion crops at the end of the phase of BBCH 1–19, with the abundance of 1.0–1.8 specimens/m^2.

During the late sowing (II–III decades of April) the density of beetle larvae before sowing was at the level of 0.9–1.9 specimens/m^2; of wireworms – 1.0–1.9 specimens/m^2, and *Gryllotalpa gryllotalpa L.* was 2.5 specimens/m^2 (**Fig. 3**).

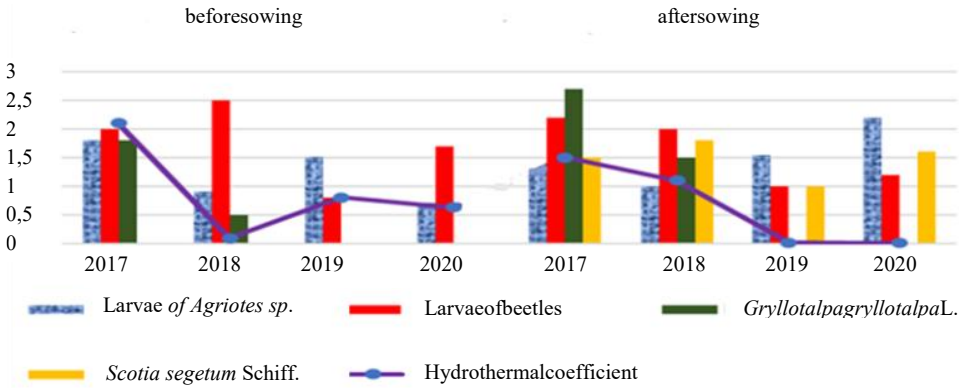

Fig. 2. Dynamics of the abundance of soil-dwelling pests with the early sowing of onions, 2017–2020

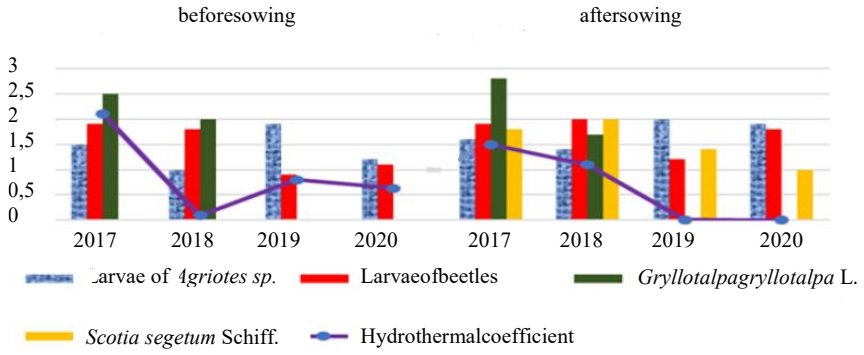

Fig. 3. Dynamics of the abundance of soil-dwelling pests with the late sowing of onions, 2017–2020

According to the results of the surveys, the population of onion crops by dominant pests increased in the phase of BBSH 1–19. Thus, the average number of dominant phytophages was 2.0 specimens/m^2, and of *Gryllotalpa gryllotalpa L.* – 2.8 specimens/m^2.

Therefore, comparing different terms of sowing of onions, one can note that crops were populated and damaged to a greater extent during late sowing compared to the earlier. The reason is the maximization of the daily activity of phytophages due to the increase in soil and air temperature, and as a consequence, their harmfulness.

The next period with the most numerous complexes of phytophages is the phase of the beginning of thickening of leaf base – bulb formation (BBCH 41–43), when, in addition to soil-dwelling pests, specialized species inhabit crops: *Delia antique Mg.*, *Ceuthorrhynchus jakovlevi Schulzer* and *Eumerus strigatus Fall.* In recent years, there has been a mass population of onion crops by polyphagous onion thrips (*Trips tabaci Lind.*).

Larvae of *Trips tabaci Lind.* cause much greater damage to crops in the phase of bulb formation – beginning of leaf splitting (BBCH 45–47). At the end of the phase, the abundance of onion flies decreases, and a new generation of *Ceuthorrhynchus jakovlevi* Schulzer appears.

The last critical stage is the phase of completion of growth and development (state of physiological rest) (BBCH 48–49). Onion thrips and *Ceuthorrhynchus jakovlevi Schulzer* remain the dominant phytophages.

According to the monitoring results, onion fly (*Delia antique Mg.*) was the main dominant pest over the years of research. Swarming of images of the phytophage after wintering occurred in the I–II decade of April, mass swarming - in the I decade of May, depending on weather conditions.

The highest abundance of the phytophage, which reached 18.9 specimens/plant, was observed in 2017, at an average daily air temperature of +16.5 °C and hydrothermal coefficient of 0.2. The population on onion crops was 32.4 %, and damage of plants was 24.6 %.

In 2018, at the beginning of the growing season of onions (II decade of May) at an air temperature of +19.3 °C and hydrothermal coefficient of 2.1, the number of larvae of onion flies reached 6.2 specimens/m^2, the population on crops 12.9 %, and damage of plants 19.6 %.

In 2019, at the beginning of the growing season of onions, the density of onion flies was 1.2 larvae/m^2. There were single larvae that inhabited crops up to 8.9 % and damaged up to 3.9 % of plants. Leaving the wintering grounds lasted for a month until June 28.

In 2020, at low daily air temperatures in the spring, slight precipitation, which is unfavorable for the development of phytophages, we noticed the suppression of their development compared to previous years. Thus, at the emersion of imagoes, with a sharp change in temperature from +11.2 °C and up to +26.7 °C, relative air humidity 50–54 %, the number was 1.2 specimens/m^2, population on crops 5.9 %, and damage of plants 3.9 %.

In the phase of bulb formation – beginning of leaf splitting (BBCH 45–47), we noticed an increase in the abundance of the phytophage. Thus, in 2017, at an average daily air temperature of +17.1–24.0 °C and hydrothermal coefficient of 0.1–0.8, the density of larvae was 21.5 larvae/m^2, population on crops 46.4 %, and harmfulness 28.9 %. Due to the accumulation of the first- and second-generation larvae of onion flies, there was a massive accumulation of the pest, which negatively affected the onion crops and led to increased damage by the end of the growing season.

In 2018, at an average daily air temperature of +19.4–22.6 °C and hydrothermal coefficient of 0.06, the number was 2 times lower compared to the previous year and amounted to 11.5 larvae/m^2, the population on crops 26.3 %, damage of plants 18.9 %. In 2019–2020, there was a decrease in the abundance of the phytophage to 9.3 larvae/m^2; population on crops and damage to crops was 10.8 and 15.4 %, respectively.

At the end of the growing season of onions (BBCH 48–49), onion fly ceases to dominate.

The density of the pest larvae was 10.3 larvae/m^2 at an average daily temperature of +21.4 °C and hydrothermal coefficient of 0.46. In 2017, the population was 15.8 %, and harmfulness 15.9 %. In 2018, at a density of 11.3 larvae/m^2 16.3 % of crops were populated and 17.2 % of onion crops were damaged. At an air temperature of +21.6 °C and hydrothermal coefficient of 1.2 in 2019, the abundance value was 8.4 larvae/m^2, and in 2020 it amounted to 1.5 larvae/m^2. The population on crops was 11.0 and 4.0 %, respectively, and harmfulness was 12.3 and 9.6 %.

Thus, we found that weather conditions are one of the main factors, influencing the development and harmfulness of the phytophage.

Based on the monitoring of onion crops under the conditions of the Right-Bank Forest-Steppe of Ukraine, we found the mass prevalence and increase in the abundance of *onion thrips*(*Trips tabaci Lind*.). The first images of the phytophage appear in the germination of onions (BBCH 1–19) at an average abundance of 7.9 specimens/plant and population on crops of 27.3 %, which is 1.4 higher than the economic threshold of harmfulness.

We found that fluctuations in air temperature in April and May have a significant impact on the development of the pest. Thus, with excessively humid April-May 2017, the hydrothermal coefficient was 2.1, air temperature +14.1 °C, and the abundance of images of the phytophage was 3.1 specimens/plant and damage to plants was 25.8 %. In 2019, at slight precipitation and dry May (hydrothermal coefficient was 0.2), the abundance was 15.8 specimens/plant, and damage to plants was 42.9 %.

In the phase of thickening of leaf base – bulb formation (BBCH 41–43), there is a significant increase in the population and harmfulness of onion thrips. The highest abundance of onion thrips at the level of 35.8 specimens/plant was noted in 2019, at an average daily air temperature of +19.6, and their harmfulness reached 63.0 %.

In the phase of bulb formation – beginning of leaf splitting (BBCH 45–47), we noticed further significant development of the polyphage on crops. Thus, the average abundance over the years of research was 34.7 specimens/plant, which led to damage to 73.1 % of plants. With such damage, bulbs lose their keeping quality, and plants are massively affected by fungal and bacterial diseases.

At the end of the growing and development of the bulb (BBCH 48–49), there is a revival of the third generation of onion thrips. The average abundance of the pest in this period was 58.4 specimens/plant, the population on crops was 80.7 %, and harmfulness was at the level of 89.5 %.

We found that the weather conditions of the growing season of onions in 2017–2020 contributed to the development and significant spread of phytophage, the harmfulness of which, starting in the early phases, leads to the development of diseases during storage.

Over the years of observations, we marked *Ceuthorrhynchus jakovlevi Schulzer* among the harmful entomocomplex of onion crops. The average abundance of the phytophage in BBCH 41–43 phase was 20.3 specimens/plant, the population on crops was 8.7 %, and harmfulness was 15.8 %. At the end of this phase, a new generation of the pest emerges, which developed at an air temperature of +21.7 °C, at the sum of effective temperatures of 1633 °C and hydrothermal coefficient of 0.05.

The abundance of the phytophage at the end of the growing and development (BBCH 48–49) was 26.9 specimens/plant, the population on crops was 11.1 % and harmfulness 19.4 %. The pest massively inhabited crops in 2020 at an average daily air temperature of +18.6 °C and hydrothermal coefficient of 0.23, with the abundance of the pest at the level of 19.5 specimens/plant, harmfulness was 17.2 % with the population on crops reaching 8.3 % of plants. On hybrids, the abundance of the pest did not exceed 0.2 specimens/plant, and harmfulness was 0.2 % during the growing season.

Damage to onions by larvae of *Ceuthorrhynchus jakovlevi* Schulzer led to a loss of keeping quality of bulbs during the storage period.

4. Discussion

Study limitation. The research did not allow to development of economic thresholds of harmful pests, because determining it requires long-term data on the cost of crop losses from each pest and the cost of protection methods per 1 ha of the crop, as well as the rate of crop profitability. This requires longer research.

Prospects for further research. The obtained results of research on the established complex of species composition, dynamics of number and harmfulness of dominant phytophages, critical periods of organogenesis of onions will help to further develop ecologically safe elements of the onion protection system in the Right Bank Forest-Steppe of Ukraine. This will reduce the pesticide load on the agrocenosis and obtain environmentally friendly vegetable products.

5. Conclusions

Based on the long-term monitoring of onion crops in the Right-Bank Forest-Steppe of Ukraine, we found 12 species of phytophages, among which *Delia Antigua Mg.*, *Trips tabaci Lind.* and *Ceuthorrhynchus jakovlevi Schultze* dominated.

In the early phase of onion development of leaf development (BBCH 1–19), 7 species of soil-dwelling phytophages were harmful.

It is established, that early sowing of onions (III decade of March–I decade of April) allows reducing the number and damage of crops by phytophages.

It is investigated, that the most critical periods of organogenesis of onions are the:

– phase of leaf development (a primary shoot) (BBSH 1–19);

– phase of the beginning of thickening of leaf base – bulb formation (BBSH 41–43);

– phase of bulb formation – beginning of leaf splitting (BBCH 45–47);

– phase of the completion of growth and development (state of physiological rest) (BBCH 48–49).

References

[1] Barabash, O. Ju., Taranenko, L. K., Sych, Z. D. (2005). Biologichni osnovy ovochivnyctva. Kyiv: Aristey, 348.

[2] Yaroviy, G. I. (Ed.) (2006). Dovidnyk z pytan' zahystu ovochevyh i bashtannyh roslyn vid shkidnykiv, hvorobta bur'yaniv. Kharkiv, 328.

[3] Hordiienko, I., Yarovyi, H., Terokhina, L., Uriupina, L. (2020). Influence of sulfur–containing fertilizers on yield and quality of onions. Vegetable and Melon Growing, 67, 57–63. doi: https://doi.org/10.32717/0131-0062-2020-67-57-63
[4] Tserkovnaya, V. S., Kobak, A. P. (2016). Zaschita luka repchatogo ot bolezney, vrediteley i sornyakov. Elementy tekhnologii vozdelyvaniya sel'skokhozyaystvennykh kul'tur v usloviyakh orosheniya: Sbornik nauchnykh trudov Mezhdunarodnoy nauchno-prakticheskoy konferentsii. Astrakhan', 196–200.
[5] Stefanjuk, S. (2021). Tcybulya ripchasta na tovarnu produkciyu. SCIENTIFIC PRACTICE: MODERN AND CLASSICAL RESEARCH METHODS VOLUME1. https://doi.org/10.36074/logos-26.02.2021.v1.49
[6] Sil's'ke gospodarstvo Ukrai'ny 2019 r. Statystychniy zbirnyk (2020). Kyiv: Derzhstat, 230.
[7] Tkalenko, H. M. (2003). Osoblyvosti biologii' ta shkodochynnist' dvokrylyh shkidnykiv cybulevyh roslyn u pryvatnyh gospodarstvah Tsentral'noho Lisostepu Ukrai'ny. Zahyst i karantyn roslyn, 49, 121–132.
[8] Tkalenko, A. N. (2011). Vrediteli luka. Nastoyaschiy khozyain, 7-8, 35–39.
[9] Mulin, Yu. I. (1990). Opasnyy vreditel' luka. Zaschita rasteniy, 3, 31–32.
[10] Shishkina, E. V. (2016). Ekobiologiya i vredonosnost' lukovogo skrytnokhobotnika v usloviyakh kolochnoy stepi Atayskogo-priob'ya. Vestnik Altayskogo gosudarstvennogo agrarnogo universiteta, 4 (138), 95–98.
[11] Ter-Simonyan, L. G., Blinova, Z. P. (1981). Vrediteli i bolezni luka. Zaschita rasteniy, 5, 49–53.
[12] Symonov, V. Ye., Romanchenko, V. O., Chelombitko, A. F., Bashyns'ka, O. V., Sarancha, L. V., Bilyakov, V. V. (2012). Osoblyvosti vyznachennya trypsiv. Karantyn i zahyst roslyn, 10, 20–23. Available at: http://kr.ipp.gov.ua/index.php/journal/issue/view/75/10-2012-pdf
[13] Duchovskiene, L. (2006). The abundance and population dynamics of onion thrips (Thrips tabaci Lind.) in leek under field conditions. Agronomy Research, 4, 163–166. Available at: https://agronomy.emu.ee/wp-content/uploads/2006/10/p4S10.pdf#abstract-1960
[14] Diaz-Montano, J., Fuchs, M., Nault, B. A., Fail, J., Shelton, A. M. (2011). Onion Thrips (Thysanoptera: Thripidae): A Global Pest of Increasing Concern in Onion. Journal of Economic Entomology, 104 (1), 1–13. doi: https://doi.org/10.1603/ec10269
[15] Liu, T.-X. (2004). Seasonal population dynamics, life stage composition of Thrips tabaci (Thysanoptera: Thripidae), and predaceous natural enemies on onions in South Texas. Southwest Entomol, 29 (2), 127–135.
[16] Emmett, B. J., Savage, M. J. (1980). Chemical control of onion fly, Delia antiqua (Meig.). Plant Pathology, 29 (4), 159–167. doi: https://doi.org/10.1111/j.1365-3059.1980.tb01206.x
[17] Ilovai, Z. (2003). Characteristics of population-dynamics of onion fly (Delia antiqueMeigen) by an area-wide monitoring system. Integrated Control in Field Vegetable Crops IOBC wprs Bulletin, 26 (3), 7–12.
[18] Mešić, A., Barčić, J. I., Barčić, J., Zvonar, M., Filipović, I. (2008). Diptera pests control in onions. Fragm. phytomed. herbol., 30 (1-2), 5–21.
[19] Knizhnikov, V. N., Fedotova, E. L. (2011). Sravnitel'naya otsenka effektivnosti bor'by s lukovoy mukhoy. Vestnik Rossiyskogo gosudarstvennogo agrarnogo zaochnogo universiteta, 10, 43–46.
[20] Bondarenko, H. L., Yakovenko, K. I. (Eds.) (2001). Metodyka doslidnoi' spravy v ovochivnyctvi i bashtannyctvi. Kharkiv: Osnova, 369.
[21] DSTU 6012:2008. Tsybulya. Tehnologiya vyroshhuvannja. Zagal'ni vymogy (2008). Kyiv: Derzhspozhyvstandart Ukrai'ny, 15.
[22] Adamczewski, K., Matysiak, K. (2005). Klucz do określania faz rozwojowych roślin jedno- i dwuliściennych w skali BBCH. Instytut Ochrony Roślin, 134.
[23] Meier, U. (Ed.) (2018). Growth stages of mono- and dicotyledonous plants – BBCH. Open Agrar Repositorium, 204. doi: https://doi.org/10.5073/20180906-074619
[24] Omeljuty, V. P. (Ed.) (1986). Oblik shkidnykiv i hvorob sil's'kogospodars'kyh kul'tur. Kyiv: Urozhaj, 296.
[25] Trybelya, S. O. (Ed.) (2001). Metodyky vyprobuvannja i zastosuvannya pestycydiv. Kyiv: Svit, 448.
[26] Dospekhov, B. A. (1985). Metodika polevogo opyta (s osnovami statisticheskoy obrabotki rezul'tatov issledovaniya). Moscow: Kolos, 335.
[27] Asyakin, B. P., Beshanov, A. V., Vytskiy, V. A. (1986). Ekologicheskie aspekty zaschity ovoschnykh kul'tur ot vrediteley, bolezney i sornyakov. Tr. VIZR. Leningrad, 102–110.

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