Food and Agriculture Organization of the United Nations

PESTS OF ECONOMIC IMPORTANCE IN UKRAINE

Integrated pest management manual

Pests of economic importance in Ukraine

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This manual was developed in the context of the implementation of the activities of the project dedicated to strengthening the national capacities to protect from plant pests some of the most economically important crops in Ukraine, under the overall coordination of Mr Piotr Wlodarczyk, FAO REU Agricultural Officer and Lead Technical Officer for the project.

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The authors would like to acknowledge the roles of the team which contributed at all stages to the process of development of this manual aiming at increasing awareness of the readers on the economically important pests in Ukraine, as well as on the methods of their control, taking into account not only the effectiveness of measures undertaken, but also the protection of natural environment and the health of consumers.

Acronyms

BYDV	Barley yellow dwarf virus
FAO	Food and Agriculture Organization of the United Nations
IPM	Integrated pest management
REU	FAO Regional Office for Europe and Central Asia
WHO	World Health Organization

Introduction

Integrated pest management (IPM) has been known for some decades but is often used and understood in different ways by different people.

The FAO definition of IPM:

"Integrated pest management (IPM) means the careful consideration of all available pest control techniques and subsequent integration of appropriate measures that discourage the development of pest populations and keep pesticides and other interventions to levels that are economically justified and reduce or minimize risks to human and animal health and the environment. IPM emphasizes the growth of a healthy crop with the least possible disruption to agro-ecosystems and encourages natural pest control mechanisms."

In other words, all available control options (e.g. cultural, physical, biological, chemical) should be considered and applied reasonably by farmers. Nevertheless, IPM is not simply a toolbox and integration of control options. It also involves measures (e.g. prevention, monitoring, forecasting, early diagnosis) which help slow the development of pest populations. An important aspect in IPM is adequate decision-making for any intervention. All decisions should be justified both economically and ecologically. Therefore, management programmes with the regular application of chemicals are not acceptable in IPM. Instead, priority should be given to prevention and alternative control tactics. Principles and more detailed examples in IPM implementations are discussed below.

Putting IPM into context

IPM has been implemented in various regions and countries that are different in terms of their natural and socio-economic conditions as well as their level of agricultural development. However, progression in plant production and protection may be achieved in any existing situations by implementing IPM. The application of IPM is not simply strict compliance with rules and regulations, but rather it means actions taken with an environmental approach including principles, strategies and tactics that contribute to the reduced use of chemicals as well as to higher food security for sustainable production. In order to make IPM as effective as possible, it should be adapted to local/regional conditions.

IPM in a spatial scale: thinking of landscapes instead of individual farms

Various types of habitats (e.g. agricultural areas, semi-natural environments) may be identified on a spatial level (i.e. farms, landscapes). They serve as spaces for living, reproduction and overwintering for many living organisms, including pests. Pests can invade newly-established crops, spread among different habitats, and build up significant populations therein. The same is true for their natural enemies and antagonists. Thus, the occurrence and distribution of different species, including pests and beneficial organisms, at a given site will be affected by the surrounding habitats and the management practices applied in these habitats.

IPM in a temporal scale: thinking of cropping systems instead of one single season

Cultivated annual and perennial plants host various pests and diseases and allow the emergence of weeds in the field. In the case of arable crops, the alternation of plant species over time at the same site (crop rotation) may break the life cycle of pests resulting in reduced pest pressure in the subsequent crop. In perennial crops, including orchards, the density of pests in a given year is a major determining factor in the initial infestation level in the subsequent year. Both crop rotation and/or other pest management measures will thus have an impact on the occurrence of pests in any cultivated plants in a temporal scale. In this context, IPM is the rational regulation of pests, present at the same site, not only in one plant species grown in a given year, but also in cropping systems over several years. This approach is also valid and applicable for beneficial organisms. Therefore, IPM should be considered in a spatio-temporal context.

General principles for the implementation of integrated pest management

1. Prevention and/or suppression of harmful organisms should be targeted and achieved by combining various options such as:

- Crop rotation and intercropping;
- Use of adequate cultivation techniques (e.g. seedbed sanitation, sowing/planting time and plant densities, under-sowing, conservation tillage, pruning and direct sowing);
- Where appropriate, use of resistant/tolerant cultivars and standard/certified seed and planting material;
- Providing balanced nutrient supply and optimal water management;
- Preventing the spread of harmful organisms through field sanitation and hygiene measures (e.g. removal of infected plants, plant parts and plant debris and regular cleaning of machinery and equipment); and
- Protecting and enhancing beneficial organisms (e.g. utilization of "ecological services" inside and outside production sites).

2. Monitoring

Harmful organisms should be monitored with adequate methods and tools, where available. These should include observations in the field (e.g. occurrence of pests, appearance of symptoms) and, where feasible, scientifically sound warning, forecasting and early diagnosis systems (consisting of traps, weather stations etc.). Regular consultation with professionally qualified advisors is also recommended. (For further information on monitoring see the next chapter.)

3. Adequate decision-making

Based on the results of monitoring and the consideration of local conditions (e.g. cropping system, weather), proper decisions should be made about the need for, the timing, and methods of pest management. Where feasible, threshold values for harmful organisms should be defined and considered, taking into account the given growing conditions before any treatments.

4. Non-chemical plant protection measures

Sustainable physical, biological and other non-chemical methods should be preferred to chemical ones especially if they can also provide satisfactory pest control. As chemical pesticides are designed to be toxic to living organisms, are dispersed in the environment and are applied to food crops, their use should only be a last resort; used only if there are no adequate non-chemical alternatives and if it is economically justified. If the application of pesticides is foreseen, a pest management plan needs to be prepared.

5. Specific pesticides

If, after the consideration of available IPM approaches, the use of chemical pesticides is deemed to be justified, then careful and informed consideration should be given to the selection of pesticide products. Factors to be taken into account include hazards and risks to users, selectiveness and risks to non-target species, persistence in the environment, efficacy and the likelihood of development or presence of resistance in the target organism. The pesticides to be applied should be as specific to the target pest as possible and should have minimal effects on human health, non-target organisms (e.g. predators, parasitoids, pollinating insects) and the environment (e.g. water, soil). Their use should be kept to a minimum such as by reducing the application frequency or using partial applications. If repeated application of chemicals is justified, pesticides with different modes of action (see WHO and United States Environmental Protection Agency toxicity classification schemes) should be applied as part of an anti-resistance strategy to maintain the effectiveness of the available products.

The products to be applied should be registered in the country of use, or specifically permitted by the relevant national regulatory authority if no registration exists. The use of any pesticides should comply with all the registration requirements including the crop and pest combination for which it is intended.

6. Evaluation

The efficacy of the applied plant protection measures should be checked and evaluated based on the records on use of pesticides and on the monitoring of harmful organisms. This will help farmers improve future pest management methods by making use of their knowledge and experience gained.

In addition to the principles above, key factors for the implementation and development of IPM are the knowledge and capacity of farming communities. Without understanding local agro-ecosystems, mechanisms, biology of pests and their natural enemies etc., IPM cannot be successfully implemented. Farmers should improve their knowledge by participating in training courses and professional consultancy, and they should be involved in the development process. Communication, discussion of problems as well as sharing experiences with each other (community-based learning) are also important, and all contribute to proper decision-making.

Key benefits of using IPM

1. Lower risks to human health and the environment (e.g. water resources, pollinating insects);
2. Delayed development of pesticide resistance;
3. Money can be saved on plant protection; and
4. Improved public image of agricultural production.

4

Monitoring in integrated pest management

Any decisions about pest management tactics to apply should be preceded by the proper identification of the organisms and conditions occurring in the field. Moreover, careful consideration is required to classify the organisms, and determine any of them as a pest.

The FAO definition of a pest

"Pest means any species, strain or biotype of plant, animal or pathogenic agent injurious to plants and plant products, materials or environments and includes vectors of parasites or pathogens of human and animal disease and animals causing public health nuisance."

Complete control of all pests is neither necessary in most cases nor appropriate for IPM. Almost all crops can tolerate a certain amount of damage without appreciable effects on vigour and yield. In light of this, it is necessary to make estimations on the pest densities that can be tolerated. A number of economic concepts are helpful in determining the point at which it pays to apply certain control methods:

- Economic Damage (ED): begins at the point at which the cost of crop damage equals the cost of control.
- Economic Injury Level (EIL): the lowest pest population density that will cause ED.
- Economic Threshold (ET) or Action Threshold (AT): the population density at which control action should be determined (initiated) to prevent an increasing pest population (injury) from reaching the EIL. To make a control practice profitable, or at least break even, it is necessary to set ET below EIL.

A pest can be non-economic (consistently remaining below economic levels), occasional (normally remaining below EIL but sporadically exceeding the threshold levels), and severe (occurring at high levels regularly and causing major damage without control). Most actual thresholds used in IPM today are more complicated and dynamic than a simple fixed level. Action thresholds can be expressed as the number of pest stages in the crop, damage, or a relative measure of pest activity by trapping or other indirect sampling methods.

Monitoring

Once precautions have been taken to prevent infestations, it is important to regularly check the occurrence of species identified properly and considered to be pests or beneficial organisms, the damage caused by the pests, the crop characteristics, and the environmental factors. This monitoring procedure is a key element of IPM programmes. It helps early detection, ranking of the severity of infestations and estimation of future populations. Therefore, it provides a better chance to avoid economic losses. In addition, regular monitoring works well for evaluating the results of a

control strategy used. However, the methods of monitoring vary depending on the pest and the situation. These methods, developed for several species, should thus be adapted to local conditions. If monitoring has been carried out carefully, decision-making about any pest control tactics to (or not to) apply and/or evaluation of pest management actions taken formerly may become adequate.

Upon entering any fields there are certain general procedures that should always be followed:

- Identify the field on the scouting report form properly indicating all available data;
- Record date and time of the day;
- Record weather conditions;
- Record crop growth stage;
- Record general soil and crop conditions;
- Sample the field using the method and pattern recommended for the particular pest(s), and, if necessary, collect samples of (potential) pests and/or damaged (parts of) cultivated plants for later identification; and
- Record the scouting results using the recording units for the particular pest(s).

Nowadays, there are many tools and techniques − from rather simple to more complex ones − available for the scout that carries out monitoring in the field. It is very important to be aware that the equipment and the method to be used basically depends on the situation. Therefore, specific knowledge and the choice of adequate devices are required for the monitoring to be effective and reliable.

Traps (light, coloured, pheromone etc.) are an example of devices which are widely used in practice to help monitor certain pests. If applied properly, they can be suitable tools for checking population activity and getting information for taking the action when the economic threshold has been exceeded.

This brochure frequently mentions pheromone traps as being the recommended trap type in monitoring. In light of this, the most important instructions for their use are summarized as follows:

- Carefully choose the target species that should be trapped in your field.
- Search for information (literature, local data etc.) about the time of emergence of the species and set the traps in the field 1–2 weeks prior to the expected start of emergence.
- Use original traps and lures (and keep the lures in a deep freezer before use).
- Assemble the traps on the spot.
- Read the specific instructions for setting the given pheromone trap (e.g. crop height).
- Consider the size of the area when determining the number of traps to be set (at least two traps for the same species located at minimum 10–15 m apart are recommended to operate in a given crop).
- Check and record the catches at regular intervals and as frequently as possible (at least once a week).
- Change traps and/or its components (e.g. sticky insert, lure) according to the special instructions, and do not reuse them later.
- Remove all traps from the field when the period of observation (trapping) is finished.

Pests of potatoes

Soil pests

Common click beetle *(Agriotes sputator* L.*)*

General introduction

Host plants

The larvae of the common click beetle damage potatoes and many other agricultural plants (corn, sunflower, sugar beet, peanuts).

Morphological features

Adults

Body length is 6–9 mm, its width 1.8–2.8 mm.

Where can they be found?

They feed on the leaves of grasses or on pollen and are often seen on the flower-heads of umbelliferous plants.

Eggs

Eggs are white, oval, about 0.5–1.5 mm in length.

Where can they be found?

The eggs develop in soil.

Larvae

Larvae are yellow, about 18 mm in length.

Where can they be found?

The larvae develop in soil.

Pupae

The pupae are milky white.

Where can they be found?

Pupae develop in soil.

Damage

Damage by larvae, often called 'wireworms', can be seen from germination until the eight-leaf stage. Larvae attack germinating tubers, stem base and young roots. Damage from wireworms can lead to growth reduction of plants, abnormal tillering, and discolouration of leaves. In severe attacks, damage can cause death of potato plants, and lead to total yield loss.

Another factor that leads to an increase in the number of pests is the lack of crop rotation and constant cultivation of potatoes in the same field.

Biology

The adult's body is completely covered with thick greyish hairs. Larvae are yellow, up to 18 mm in length and up to 1.5 mm in width, elongated and stiff. Mandibles carry a small tooth in the middle. The pest hibernates as both adult and larva. Beetles are active from late April to mid-June. The period of adult activity lasts 1–2 months. Fertility rate is 100 or more eggs per female. Eggs develop within 12–18 days. Depending on temperature and humidity, larval development lasts from two to four years. Pupation occurs in July and August and pupae develop within 2–3 weeks. The entire generation development cycle lasts from 3 to 5 years.

Monitoring

Monitoring of the presence of wireworms can be done through soil sampling or with bait traps. For the monitoring of adult beetles, pheromone traps can be used. Using a single method to monitor larvae or adults in a field does not necessarily reflect the true amount and distribution of the pest. As wireworms appear unevenly in a field, traps can happen to be put in places with no or many larvae, which can lead to inaccurate results and not always show the actual probability of potential damage in a particular field. Damage is not only related to the number of wireworms but also to climatic and agronomic conditions and to the pest species present in that specific location.

Pheromone traps

Pheromone trapping is a method where female-produced pheromone is used to monitor male click beetles. The method has not been studied extensively but could in the future be a tool for long-term monitoring of click beetles, which is needed due to their long life cycle.

Field control

Wireworms can spend up to five years before pupation and emergence of adult beetles, therefore long-term strategies are needed to control the larvae.

Agrotechnical methods

The following activities may help reduce the number of click beetles in the field:

- ploughing;
- crop selection and crop rotation: crops with low numbers of plants per area unit tend to reduce the wireworm populations;
- trap crops: plants that can divert a pest from a cash crop and can be used in intercropping systems.

Biological methods

Principal biological control agents include the green muscardine fungus (*Metarhizium anisopliae*), *Beauveria bassiana* and bacterium *Bacillus suturalis*. Larvae are parasitized by the nematode *Leptodera dentata*. *Metarhizium anisopliae* enters the larva through any area of the body. Once inside the insect, the fungus produces a lateral extension of hyphae, which eventually proliferate and consume the haemocoel of the insect.-

Chemical methods

The key method for chemical control of the pest is seed treatment before sowing.

Insecticides containing active ingredients (a.i.) belonging to the following chemical groups can be recommended:

1. Synthetic pyrethroids (a.i. bifethrin);
2. Neonicotinoids (a.i. imidacloprid or thiamethoxam).

These insecticides are registered in Ukraine.

Always follow the label instructions for dosage, application and safety!

Lined click beetle *(Agriotes lineatus L.)*

General introduction

Host plants

The larvae of the lined click beetle damage potatoes and many other agricultural plants (corn, sunflower, sugar beet, peanuts).

Morphological features

Adults

Body length is 7.5–11 mm, light brown to dark brown.

Where can they be found?

They feed on the leaves of grasses and also on pollen and are often seen on the flower-heads of umbelliferous plants.

Eggs

The eggs are white, oval, about 0.5–1.5 mm in length.

Where can they be found?

Eggs develop in soil.

Larvae

Larvae are light yellow, about 27 mm in length.

Where can they be found?

Larvae develop in soil.

Pupae

The colour of the pupae is milky white.

Where can they be found?

Pupae develop in soil.

Damage

Damage from larvae, often called 'wireworms', can be seen from germination until the eight-leaf stage. Larvae attack germinating tubers, stem bases and young roots. Damage by wireworms can lead to growth reduction of plants, abnormal tillering and discolouration of leaves. In severe attacks, damage can cause the plant to die, leading to total yield loss.

Another factor that leads to an increase in the number of pests is the lack of crop rotation and repeated cultivation of potatoes in the same field.

Biology

Imago and larvae overwinter. Beetles are active from late April or early May to late July, with mass flight from the second half of May to June. Beetle activity period is 1–2 months. Fertility rate per female is from 75 to 135, with a maximum of 200 eggs. Eggs are deposited in the upper layers of the soil in small groups in moist places. They develop for 14–30 days, depending on the soil temperature. Larval development takes from two to four years, depending on air temperature and humidity.

Monitoring

Detection of wireworms can be achieved through the testing of soil samples or the use of bait traps. For adult beetles, pheromone traps can be used. Using a single method to monitor larvae or beetles in a field does not necessarily reflect the actual amount and distribution of the pest in soil. Because wireworms appear unevenly in a field, traps may happen to be put in places with none or many larvae, which can lead to inaccurate results and not always show the actual probability of potential damage in that field. Damage is not only related to the number of wireworms but also to climatic and agronomic conditions and depends on the pest species present in the specific location.

Pheromone traps

Pheromone trapping is a method where female-produced pheromone is used to monitor male click beetles. The method has not been studied much but could in the future be a tool for long-term monitoring of click beetles, which is needed due to their long life cycle.

Field control

Wireworms can spend up to five years before pupation and emergence of the adult beetles. Therefore, long-term strategies are needed to control the larvae.

Agrotechnical methods

The following activities may help reduce the number of click beetles in the field:

- ploughing;
- crop selection and crop rotation: crops with low numbers of plants per area unit tend to reduce the wireworm populations
- trap crops: plants that can divert a pest from a cash crop and can be used in intercropping systems.

Biological methods

Principal biological control agents include the green muscardine fungus (*Metarhizium anisopliae*), *Beauveria bassiana* and bacterium *Bacillus suturalis*. Larvae are parasitized by the nematode *Leptodera dentata. Metarhizium anisopliae* enters the larva through any area of the body. Once inside the insect, the fungus produces a lateral extension of hyphae, which eventually proliferate and consume the haemocoel of the insect.

Chemical methods

The key method for chemical control of the pest is seed treatment before sowing.

Insecticides containing active ingredients (a.i.) belonging to the following chemical groups can be recommended:

1. Synthetic pyrethroid (a.i. bifethrin);
2. Neonicotinoids (a.i. imidacloprid or thiamethoxam).

These insecticides are registered in Ukraine.

Always follow the label instructions for dosage, application and safety!

Pests of leaves and stems

Colorado potato beetle (*Leptinotarsa decemlineata* Say.)

General introduction

Host plants

Potato, tomato, eggplant, pepper, and other solanaceous crops.

Morphological features

Adults

The adults measure about 9.5 mm long and are yellowish orange with multiple black stripes down the back, with five per elytron.

Where can they be found?

On leaves.

Eggs

The eggs are bright orange and football-shaped, about 1.7–1.8 mm long and 0.8 mm wide.

Where can they be found?

Under field conditions, females can lay 200–500 eggs.

The eggs are laid on the underside of host leaves.

Larvae

The larvae go through four stages of development. Younger larvae are 1.5 mm long; the last fourth one - about 8 mm.

Where can they be found?

The larvae feed on leaves

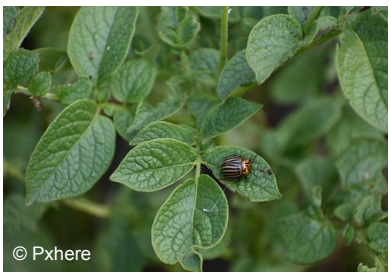
Pupae

Colorado potato beetle pupae are oval and orangish in colour.

Where can they be found?

The pupae develop in soil.

Damage



Larvae and adults feed on the foliage of host plants. They can cause extensive damage if population numbers are high.

Although both adults and larvae feed on the leaves of potato and related plants (tomato, eggplant), the most damage is caused by the third and fourth instar larvae. These larvae are large (ca. 12 mm) and can defoliate a plant within 1–2 days. Potatoes can be defoliated by as much as 30 percent before flowering or during tuber fill, and yields are unaffected. However, when potatoes are flowering, they cannot tolerate more than 6–8 percent defoliation.

Biology

The life cycle of the Colorado potato beetle starts with the adult as the overwintering stage. Adults overwinter in the soil at a depth of 10-30 cm. They feed on newly sprouted host plants where they mate. Females deposit eggs on the surface of the host plant's leaves, usually on the undersurface, protected from direct sunlight. Overwintering adults usually feed for five to ten days before mating and producing eggs. An adult female can deposit over 300 eggs during a period of four to five weeks. Eggs hatch in four to ten days, depending in part on air temperature and humidity.

The four larval instars last a total of 21 days. The larvae feed almost continuously on the leaves of the host plant, stopping only when moulting.

Larvae drop from the plants and burrow into the soil where they construct a spherical cell and transform into yellowish pupae. This lasts from five to ten days. There are one to three generations per season.

Monitoring

The density of egg, larval and adult stages can be estimated visually.

Field control

Agrotechnical methods

The following activities may help reduce the number of the Colorado potato beetles in the field:

- crop rotation; and
- ploughing.

Biological methods

The best known entomophagous insects capable of reducing the populations of Colorado potato beetle are: predatory beetles - *Lebia* spp. and *Pterostichus* spp., bug *Perillus bioculatus* (Fabricius), seven-spotted ladybug - *Coccinella septempunctata*, and the parasite *Myiopharus doryphorae*. Preparations based on strains of the bacterium *Bacillus thuringiensis* can also be used.

Chemical methods

The key method for chemical control of the pest is the seed treatment before sowing.

Pesticides containing active ingredients (a.i.) belonging to the following chemical groups can be recommended:

1. Neonicotinoids (a.i. thiamethoxam);
2. Synthetic pyrethroid (a.i. lambda-cyhalothrin);
3. Neonicotinoids+ pyrethroid (a.i. lambda-cyhalothrin + thiamethoxam);
4. Organophosphorus insecticides (a.i. phosalone).

These insecticides are registered in Ukraine.

Always follow the label instructions for dosage, application and safety!

Potato tuber moth (*Phthorimaea operculella* Zell.)

General introduction

Host plants

Potato and other species of Solanaceae (e.g. tomato, aubergine, pepper, tobacco)

Morphological features

Adults

Body length is 10 mm, wingspan is 12–17 mm; forewings are greyish-brown with dark spots (a characteristic "X" pattern on females and 2–3 dots on males) and both pairs of wings have fringed edges; slender appearance at rest.


©D. Agassiz

Where can they be found?

On the plant

Eggs

Eggs are up to 0.44 mm in size.

Where can they be found?

The eggs are on the underside of leaves, on stalks, stems, potato tubers (often at buds), in the soil or on bags (in stored potatoes)

Larvae

Older larvae are 10–15 mm in length, pink or yellowish green, with a pale longitudinal stripe along the middle of the back.


©G.R. Carner & P.A.C Ooi, Bugwood.org/ M. Shepard

Where can they be found?

In the leaf mines, petioles, stems, tubers of potato

Pupae

Pupae are 5.5–6.5 mm long, brown, in a cocoon.

Where can they be found?

In the soil, tubers or stems.

Damage

The females lay about 150 eggs singly or in batches of 3–4. When they are laid on the lower surface of the leaves or on the shoots, the larvae cause the formation of dry, brown, blistered areas.

When the eggs are laid on the tubers, in cracks in the skin or around the eyes, the larvae create tunnels, at first near the surface but later more deeply, which facilitate the entrance of fungi and bacteria. Successive generations are able to breed within the tubers – and are most devastating during storage. The presence of the larvae is usually indicated by small mounds of frass ejected from the burrows.

Biology

The pest is able to cause damage in the field, in storehouses. Under field conditions, emergence of moths begins at the end of April. They are active after sunset and at dawn and are attracted to light. Females lay their eggs singly or in batches of 2–3 on the underside of leaves, sometimes on stalks, stems, exposed potato tubers or lumps of soil. Caterpillars hatch in 3–15 days, and they penetrate into the leaves, where they make blotches while mining or bore into the petioles or stems. If they bore into the tubers (usually at eye buds), they make long, irregular galleries inside. Tunnels gradually get filled with excrement.

Pathogenic organisms can develop inside the tunnels made by the larvae, which causes the tubers to rot and emit an unpleasant smell. Larval development may last several weeks. Pupation takes place in a cocoon, normally in the soil. Development of all stages and consequently the number of generations are highly influenced by temperature. Optimum conditions for the development are temperatures between 22 °C and 26 °C and humidity of 70–80 percent. Lethal temperatures for all stages of the pest are below -4 °C and above 36 °C. In storehouses, eggs are laid directly on the tubers or on bags and the larvae damage the tubers. Pupation may occur in various sheltered places. The pest can reproduce continuously in storehouses as well as in greenhouses under suitable climatic conditions and in the presence of food.

Monitoring

Pheromone traps are suitable for detecting the potato tuber moth activity and helping to time insecticide applications. One option is to use pan traps filled with soapy water (the soap helps break the surface tension of the water) and fixed with a protective lid from which the lure is suspended. The traps should be placed on the top of the bed, and they should be checked and serviced at least once a week. Homemade bottle traps may also be applied similarly to pan traps. A further option is to place the lure in a sticky trap. The advantage of sticky traps is that they do not dry out like pan traps, but they can become dusty, rendering them ineffective. Catches from traps may help determine action thresholds. Light traps may also be used in monitoring.

Field control

Agrotechnical methods

The following activities may help reduce the number of potato tuber moths in the field:

- Crop rotation;
- Use of healthy seed tubers;
- Use of potato cultivars that set tubers deep;
- Deep planting and good coverage of potato seed tubers with soil (more than 5 cm) during hilling;
- Taking action to prevent cracks from developing more than 5 cm in the soil (e.g. by sprinkle irrigation instead of furrow irrigation);
- Removal of any weeds belonging to the Solanaceae family;
- Appropriate and rapid harvest of tubers as soon as the skin sets, without leaving the tubers in the field even for the night;
- Removal of all plant residues after harvest;
- Selecting and destroying damaged tubers before storage.

Biological methods

- Use of biological products where the active substance is *Bacillus thuringiensis* serovar. *kurstaki* against young larvae, both under field conditions and during storage.
- Use of *Phthorimaea operculella granulosis virus* (PhopGV) against the larvae.

Chemical methods

Pesticides containing active ingredients (a.i.) belonging to the following chemical groups can be recommended:

1. Organophosphate insecticides (a.i. phosalone, dimethoate);
2. Synthetic pyrethroids (a.i. cypermethrin, deltamethrin).

These insecticides are registered in Ukraine.

Always follow the label instructions for dosage, application and safety!

Pests of Sunflower

Soil pests

Common click beetle (*Agriotes sputator* L.)

General introduction

Host plants

The larvae of the common click beetle damage many agricultural plants (e.g. sunflower, corn , sugar beet, peanuts, and potatoes).

Morphological features

Adults

Body length is 6–9 mm, its width 1.8–2.8 mm.

Where can they be found?

They feed on the leaves of grasses or on pollen and are often seen on the flower-heads of umbelliferous plants.

Eggs

Eggs are white, oval, about 0.5–1.5 mm in length.

Where can they be found?

The eggs develop in soil.

Larvae

Larvae are yellow, about 18 mm in length.

Where can they be found?

The larvae develop in soil.

Pupae

The pupae are milky white.

Where can they be found?

Pupae develop in soil.

Damage

Damage is caused by larvae, often called 'wireworms'. Larvae attack germinatingseeds, stem base and young roots. Damage from wireworms can lead to growth reduction of plants, abnormal tillering, and discolouration of leaves. In severe attacks, damage can cause death of sunflower plants, and lead to total yield loss.

Another factor that leads to an increase in the number of pests is the lack of crop rotation and repeated cultivation of sunflower in the same field.

Biology

The adult's body is completely covered with thick greyish hairs. Larvae are yellow, up to 18 mm in length and up to 1.5 mm in width, elongated and stiff. Mandibles carry a small tooth in the middle. The pest hibernates as both adult and larva. Beetles are active from late April to mid-June. The period of adult activity lasts 1–2 months. Fertility rate is 100 or more eggs per female. Eggs develop within 12–18 days. Depending on temperature and humidity, larval development lasts from two to four years. Pupation occurs in July and August and pupae develop within 2–3 weeks. The entire generation development cycle lasts from 3 to 5 years.

Monitoring

Monitoring of the presence of wireworms can be done through soil sampling or with bait traps. For the monitoring of adult beetles, pheromone traps can be used. Using a single method to monitor larvae or adults in a field does not necessarily reflect the true amount and distribution of the pest. As wireworms appear unevenly in a field, traps can happen to be put in places with no or many larvae, which can lead to inaccurate results and not always show the actual probability of potential damage in a particular field. Damage is not only related to the number of wireworms but also to climatic and agronomic conditions and to the pest species present in that specific location.

Pheromone traps

Pheromone trapping is a method where female-produced pheromone is used to monitor male click beetles. The method has not been studied extensively but could in the future be a tool for long-term monitoring of click beetles, which is needed due to their long life cycle.

Field control

Wireworms can spend up to five years before pupation and emergence of adult beetles, therefore long-term strategies are needed to control the larvae.

Agrotechnical methods

The following activities may help reduce the number of click beetles in the field:

- ploughing;
- crop selection and crop rotation: crops with low numbers of plants per area unit tend to reduce the wireworm populations;
- trap crops: plants that can divert a pest from a cash crop and can be used in intercropping systems.

Biological methods

Principal biological control agents include the green muscadine fungus (*Metarhizium anisopliae*), *Beauveria bassiana* and bacterium *Bacillus suturalis*. Larvae are parasitized by the nematode *Leptodera dentata. Metarhizium anisopliae* enters the larva through any area of the body. Once inside the insect, the fungus produces a lateral extension of hyphae, which eventually proliferate and consume the haemocoel of the insect.-

Chemical methods

The key method for chemical control of the pest is seed treatment before sowing.

Insecticides containing active ingredients (a.i.) belonging to the following chemical groups can be recommended:

1. Synthetic pyrethroids (a.i. bifethrin);
2. Neonicotinoids (a.i. imidacloprid or thiamethoxam).

These insecticides are registered in Ukraine.

Always follow the label instructions for dosage, application and safety!

Lined click beetle (*Agriotes lineatus* L.)

General introduction

Host plants

The larvae of the lined click beetle damage many agricultural plants (e.g. sunflower, corn, , sugar beet, peanuts and potatoes).

Morphological features

Adults

Body length is 7.5–11 mm, light brown to dark brown.

Where can they be found?

They feed on the leaves of grasses and also on pollen and are often seen on the flower-heads of umbelliferous plants.

Eggs

The eggs are white, oval, about 0.5–1.5 mm in length.

Where can they be found?

Eggs develop in soil.

Larvae

Larvae are light yellow, about 27 mm in length.

Where can they be found?

Larvae develop in soil.

Pupae

The colour of the pupae is milky white.

Where can they be found?

Pupae develop in soil.

Damage

Damage is caused by larvae, often called ‘wireworms’. Larvae attack germinatingseeds, stem bases and young roots. Damage by wireworms can lead to growth reduction of plants, abnormal tillering

and discolouration of leaves. In severe attacks, damage can cause the sunflower plant to die, leading to total yield loss.

Another factor that leads to an increase in the number of pests is the lack of crop rotation and repeated cultivation of sunflower in the same field.

Biology

Imago and larvae overwinter. Beetles are active from late April or early May to late July, with mass flight from the second half of May to June. Beetle activity period is 1–2 months. Fertility rate per female is from 75 to 135, with a maximum of 200 eggs. Eggs are deposited in the upper layers of the soil in small groups in moist places. They develop for 14–30 days, depending on the soil temperature. Larval development takes from two to four years, depending on air temperature and humidity.

Monitoring

Detection of wireworms can be achieved through the testing of soil samples or the use of bait traps. For adult beetles, pheromone traps can be used. Using a single method to monitor larvae or beetles in a field does not necessarily reflect the actual amount and distribution of the pest in soil. Because wireworms appear unevenly in a field, traps may happen to be put in places with none or many larvae, which can lead to inaccurate results and not always show the actual probability of potential damage in that field. Damage is not only related to the number of wireworms but also to climatic and agronomic conditions and depends on the pest species present in the specific location.

Pheromone traps

Pheromone trapping is a method where female-produced pheromone is used to monitor male click beetles. The method has not been studied much but could in the future be a tool for long-term monitoring of click beetles, which is needed due to their long life cycle.

Field control

Wireworms can spend up to five years before pupation and emergence of the adult beetles. Therefore, long-term strategies are needed to control the larvae.

Agrotechnical methods

The following activities may help reduce the number of click beetles in the field:

- ploughing;
- crop selection and crop rotation: crops with low numbers of plants per area unit tend to reduce the wireworm populations;
- trap crops: plants that can divert a pest from a cash crop and can be used in intercropping systems.

Biological methods

Principal biological control agents include the green muscardine fungus (*Metarhizium anisopliae*), *Beauveria bassiana* and bacterium *Bacillus suturalis*. Larvae are parasitized by the nematode *Leptodera dentata*. *Metarhizium anisopliae* enters the larva through any area of the body. Once inside the insect, the fungus produces a lateral extension of hyphae, which eventually proliferate and consume the haemocoel of the insect.-

Chemical methods

The key way for chemical control of the pest is seed treatment before sowing.

Insecticides containing active ingredients (a.i.) belonging to the following chemical groups can be recommended:

1. Synthetic pyrethroid (a.i. bifethrin);
2. Neonicotinoids (a.i. imidacloprid or thiamethoxam).

These insecticides are registered in Ukraine.

Always follow the label instructions for dosage, application and safety!

Pests of stems

Beetle sunflower barbel *(Agapanthia dahli* Richt.*)*

General introduction

Host plants

Sunflower

Morphological features

Adults

Body 9.5–20 mm long, fluffy with a fuzzy pattern and with rusty hairs.

©V. Hanzlik

Where can they be found?

On stalks and leaves of sunflower.

Eggs

Milky white, dull, cylindrical.

Where can they be found?

Females gnaw the stem of a host plant at a height of up to 90 cm and lay eggs into the cavity, one by one.

Larvae

Larvae are 20–27 mm long, yellow-white, legless, long and narrow; the head is dark yellow or almost black.

Where can they be found?

Inside the stem.

Pupae

The body is large, elongated, up to 18–20 mm long, abdomen width is up to 4 mm.

Where can they be found?

In the middle of the underground stem.

Damage

The pest causes damage mainly in the larval stage. Damage is higher in sunflower crops of later sowing time. After damage by the pest, stems often crack. Seed yield and seed-oil content decrease.

Biology

This species is found in forest-steppe and steppe zones, developing in stems of *Carduus* sp., *Cirsium* sp., *Helianthus* sp. or *Heracleum* sp. Adults are active in daytime, from May to July. Females gnaw stems of host plants at a height of up to 90 cm and lay eggs into the cavities, one by one. Fertility rate is about 50 eggs. Larvae gnaw a gallery inside the stem, moving down. It forms a cradle before hibernation inside the stem at a height of 8 to 80 cm, preliminarily cutting the stem on the inside above its cradle. Some authors have noted the cradle inside the root system under the ground. Some larvae pupate in the following spring, in May–June, while others hibernate twice. Generation development lasts 1–2 years.

Monitoring

Monitoring is carried out after harvest. In 20 sites in the field, in sections 1 m × 1 m in size, stems with roots are collected, cut open with a knife and the number of larvae in each stalk is counted. The average number of larvae per 1 m^2 is calculated. To determine the stock of pests in the fields where the sunflower will be sown the following year, an excavation is carried out.

Field control

Agrotechnical methods

The following activities may help reduce the number of the beetle sunflower barbels in the field:

- ploughing;
- early sowing time; and
- systematic destruction of weeds.

Biological methods

The most common method is the use of natural predators, such as *Coccinella septempunctata* L., *Chrysopa carnea* Stem., *Harpalus rufipes* Deg or *Poecilus cupreus* L.

Chemical methods

The key method for chemical control of the pest is seed treatment before sowing and spraying during the growing season.

Pesticides containing active ingredients (a.i.) belonging to the following chemical groups can be recommended:

Chemical group:

1. Neonicotinoids (a.i. lambda-cyhalothrin + thiamethoxam);
2. Synthetic pyrethroid (a.i. chlorantraniliprole + lambda-cyhalothrin).

These insecticides are registered in Ukraine.

Always follow the label instructions for dosage, application and safety!

Mordellistena parvula Gyll.

General introduction

Host plants

Sunflower.

Morphological features

Adults

Body length 2.5–3.3 mm.

Where can they be found?

On sunflowers.

Eggs

Eggs are milky white.

Where can they be found?

Inside the stem.

Larvae

Body length is 7–10 mm, lemon yellow.

Where can they be found?

Inside the stem.

Pupae

Brilliant yellow.

Where can they be found?

Inside the stem.

Damage

The larvae damage the vessels of the conductive tissue and the core of the sunflower stem, constantly fed by the loose core inside the stem. When the number of larvae exceeds 15 individuals per stem, the productivity of sunflower decreases sharply.

Damaged plants give lower yields and insufficiently filled small or empty seeds. Damaged stems, in which the larvae destroyed the core, are not able to withstand gusts of wind.

All galleries in the stems are directed towards the base of the plants.

Biology

Mordellistena parvula Gyll. is an exclusively phytophagous species in the larval stage. The adult stage feeds with pollen from different plants, particularly from Umbelliferae. Imago emerge from the pupae which are in plant residues. The females are more numerous and the males are rare. After a period of feeding they pair, and after a short while lay eggs gradually. The eggs are laid under the top layer of sunflower stalks.

A female can lay 1–3 eggs on a single plant. The pest has three larval stages. First instar larvae of *Mordellistena parvula* Gyll. are 3 mm long. The larvae of the second instar are 6–8 mm long, milky white, apodal, with the cephalic capsule light brown in colour. As the larvae feed, they turn yellow. The third instar larvae are 10 mm long and they reach the maturity towards the end of October.

Monitoring

Pest monitoring is carried out after harvest. In 20 sites, collect stems and root parts from 1 m × 1 m plots, cut the stems open with a knife and count the number of larvae in each stem.

Field control

Agrotechnical methods

The following activities may help reduce the number of the pest in the field:

- Deep ploughing in autumn;
- Harrowing in spring; and
- Elimination of weeds.

Biological methods

The main biological means of control is the use of entomophages, which play an important role in pest control. The most common are predators such as beetles (Coleoptera: Coccinellidae), spiders (Araneae), terrestrial beetles (Coleoptera: Carabidae).

Chemical methods

The key way for chemical control of the pest is seed treatment before sowing and spraying during the growing season.

Insecticides containing active ingredients (a.i.) belonging to the following chemical groups can be recommended for insecticide spraying.

Chemical groups:

1. Neonicotinoids + pyrethroid (a.i. lambda-cyhalothrin + thiamethoxam);
2. Synthetic pyrethroids (a.i. deltamethrin).

These insecticides are registered in Ukraine.

Always follow the label instructions for dosage, application and safety!

Pests of seeds

Sunflower moth (*Homoesoma nebulellum* Den. et Schiff.)

General introduction

Host plants

Oligophagous pest of Asteraceae. The main pest of sunflower.

Morphological features

Adults

Wingspan 18–27 mm, forewings are narrow and grey, with 3–5 dark spots in the middle, hind wings are wider and lighter, with dark veins.

Where can they be found?

On the plants.

Eggs

White, about 0.8 mm in length, oval.

Where can they be found?

Females lay their eggs in inflorescence of asteraceous plants.

Larvae

Larvae are 9–18 mm in length, yellow-green, with brown-red bands on the body, and with umber head and scutum.

Where can they be found?

On sunflower baskets.

Pupae

Pupae are 9–13 mm long, brown.

Where can they be found?

The pupae develop in soil.

Damage

Originally sunflower moth was associated with wild Asteraceae only, but after the start of cultivating sunflowers, it quickly shifted to feeding on that crop. By the end of the nineteenth century, the sunflower moth became the primary pest of the crop, causing losses of between 20 and 60 percent. The sunflower moth causes damage by direct eating of achenes, and also by covering baskets with web and contaminating them with excrement; the baskets often rot after rainwater penetration into the larval tunnels. Presently, the damage to the sunflower is much less insignificant due to the introduction of "testaceous" varieties. However, the pest still remains dangerous to other Asteraceae plants.

Biology

Females lay eggs in inflorescence of asteraceous plants. Fertility is about 100–300 eggs, maximum 400. Eggs are laid one by one or in small batches. Embryonic development lasts 3 to 7 days. The larval stage lasts 13 to 20 days. After the completion of feeding, the larva usually goes down into the ground, where it spins a cocoon. Development of pupa lasts about 17 days. Depending on latitude and on the presence of suitable host plants, it can develop from 1 to 4 generations a year, and the fifth incomplete generation may occur. Adults usually appear at the end of May or in June.

Monitoring

Monitoring can be done visually, as well as using pheromone traps.

Field control

Agrotechnical methods

The following activities may help reduce the number of sunflower moths in the field:

- growing of "testaceous" varieties of sunflower; and
- deep ploughing after sunflower harvest.

Biological methods

Natural biological enemies influence population dynamics of the pest, and specifically the fungus *Metarrhizum anisopliae* and a number of parasitic insect species of Hymenoptera and Diptera.

Chemical methods

The key method of the chemical control of the pest is the seed treatment before sowing.

Pesticides containing active ingredients (a.i.) belonging to the following chemical groups can be recommended for insecticide spraying.

Chemical groups:

1. Neonicotinoids + pyrethroids (a.i. lambda-cyhalothrin + thiamethoxam);
2. Anthranilamide + synthetic pyrethroid (a.i. chlorantraniliprol, lambda-cyhalothrin).

These insecticides are registered in Ukraine.

Always follow the label instructions for dosage, application and safety!

Pests of maize

Soil pests

Common click beetle (*Agriotes sputator* L.)

General introduction

Host plants

The larvae of the common click beetle damage many agricultural plants (e.g. corn, sunflower, sugar beet, peanuts and potatoes).

Morphological features

Adults

Body length is 6–9 mm, its width 1.8–2.8 mm.

Where can they be found?

They feed on the leaves of grasses or on pollen and are often seen on the flower-heads of umbelliferous plants.

Eggs

Eggs are white, oval, about 0.5–1.5 mm in length.

Where can they be found?

The eggs develop in soil.

Larvae

Larvae are yellow, about 18 mm in length.

Where can they be found?

The larvae develop in soil.

Pupae

The pupae are milky white.

Where can they be found?

Pupae develop in soil.

Damage

Damage is caused by larvae, often called 'wireworms'. Larvae attack germinating seeds, stem base and young roots of corn. Damage from wireworms can lead to growth reduction of plants, abnormal tillering, and discolouration of leaves. In severe attacks, damage can cause death of corn plants, and lead to total yield loss.

Another factor that leads to an increase in the number of pests is the lack of crop rotation and repeated cultivation of maize in the same field.

Biology

The adult's body is completely covered with thick greyish hairs. Larvae are yellow, up to 18 mm in length and up to 1.5 mm in width, elongated and stiff. Mandibles carry a small tooth in the middle. The pest hibernates as both adult and larva. Beetles are active from late April to mid-June. The period of adult activity lasts 1–2 months. Fertility rate is 100 or more eggs per female. Eggs develop within 12–18 days. Depending on temperature and humidity, larval development lasts from two to four years. Pupation occurs in July and August and pupae develop within 2–3 weeks. The entire generation development cycle lasts from 3 to 5 years.

Monitoring

Monitoring of the presence of wireworms can be done through soil sampling or with bait traps. For the monitoring of adult beetles, pheromone traps can be used. Using a single method to monitor larvae or adults in a field does not necessarily reflect the true amount and distribution of the pest. As wireworms appear unevenly in a field, traps can happen to be put in places with no or many larvae, which can lead to inaccurate results and not always show the actual probability of potential damage in a particular field. Damage is not only related to the number of wireworms but also to climatic and agronomic conditions and to the pest species present in that specific location.

Pheromone traps

Pheromone trapping is a method where female-produced pheromone is used to monitor male click beetles. The method has not been studied extensively but could in the future be a tool for long-term monitoring of click beetles, which is needed due to their long life cycle.

Field control

Wireworms can spend up to five years before pupation and emergence of adult beetles, therefore long-term strategies are needed to control the larvae.

Agrotechnical methods

The following activities may help reduce the number of click beetles in the field:

- ploughing;
- crop rotation: crops with low numbers of plants per area unit tend to reduce the wireworm populations;
- trap crops: plants that can divert a pest from a cash crop and can be used in intercropping systems.

Biological methods

Principal biological control agents include the green muscardine fungus (*Metarhizium anisopliae*), *Beauveria bassiana* and bacterium *Bacillus suturalis*. Larvae are parasitized by the nematode *Leptodera dentata*. *Metarhizium anisopliae* enters the larva through any area of the body. Once inside the insect, the fungus produces a lateral extension of hyphae, which eventually proliferate and consume the haemocoel of the insect.-

Chemical methods

The key method for chemical control of the pest is seed treatment before sowing.

Insecticides containing active ingredients (a.i.) belonging to the following chemical groups can be recommended:

1. Synthetic pyrethroids (a.i. bifethrin);
2. Neonicotinoids (a.i. imidacloprid or thiamethoxam).

These insecticides are registered in Ukraine.

Always follow the label instructions for dosage, application and safety!

Lined click beetle (*Agriotes lineatus* L.)

General introduction

Host plants

The larvae of the lined click beetle damage many agricultural plants (e.g corn, sunflower, sugar beet, peanuts and potatoes).

Morphological features

Adults

Body length is 7.5–11 mm, light brown to dark brown.


©P. Kirillov

Where can they be found?

They feed on the leaves of grasses and also on pollen and are often seen on the flower-heads of umbelliferous plants.

Eggs

The eggs are white, oval, about 0.5–1.5 mm in length.

Where can they be found?

Eggs develop in soil.

Larvae

Larvae are light yellow, about 27 mm in length.


©T.Topchii

Where can they be found?

Larvae develop in soil.

Pupae

The colour of the pupae is milky white.

Where can they be found?

Pupae develop in soil.

Damage

Damage is caused by larvae, often called 'wireworms'. Larvae attack germinating seeds, stem bases and young roots. Damage by wireworms can lead to growth reduction of plants, abnormal tillering

and discolouration of leaves. In severe attacks, damage can cause the plant to die, leading to total yield loss.

Another factor that leads to an increase in the number of pests is the lack of crop rotation and repeated cultivation of maize in the same field.

Biology

Imago and larvae overwinter. Beetles are active from late April or early May to late July, with mass flight from the second half of May to June. Beetle activity period is 1–2 months. Fertility rate per female is from 75 to 135, with a maximum of 200 eggs. Eggs are deposited in the upper layers of the soil in small groups in moist places. They develop for 14–30 days, depending on the soil temperature. Larval development takes from two to four years, depending on air temperature and humidity.

Monitoring

Detection of wireworms can be achieved through the testing of soil samples or the use of bait traps. For adult beetles, pheromone traps can be used. Using a single method to monitor larvae or beetles in a field does not necessarily reflect the actual amount and distribution of the pest in soil. Because wireworms appear unevenly in a field, traps may happen to be put in places with none or many larvae, which can lead to inaccurate results and not always show the actual probability of potential damage in that field. Damage is not only related to the number of wireworms but also to climatic and agronomic conditions and depends on the pest species present in the specific location.

Pheromone traps

Pheromone trapping is a method where female-produced pheromone is used to monitor male click beetles. The method has not been studied much but could in the future be a tool for long-term monitoring of click beetles, which is needed due to their long life cycle.

Field control

Wireworms can spend up to five years before pupation and emergence of the adult beetles. Therefore, long-term strategies are needed to control the larvae.

Agrotechnical methods

The following activities may help reduce the number of click beetles in the field:

- ploughing;
- crop selection and crop rotation: crops with low numbers of plants per area unit tend to reduce the wireworm populations;
- trap crops: plants that can divert a pest from a cash crop and can be used in intercropping systems.

Biological methods

Principal biological control agents include the green muscadine fungus (*Metarhizium anisopliae*), *Beauveria bassiana* and bacterium *Bacillus suturalis*. Larvae are parasitized by the nematode *Leptodera dentata*. *Metarhizium anisopliae* enters the larva through any area of the body. Once inside the insect, the fungus produces a lateral extension of hyphae, which eventually proliferate and consume the haemocoel of the insect.-

Chemical methods

The key way for chemical control of the pest is seed treatment before sowing.

Insecticides containing active ingredients (a.i.) belonging to the following chemical groups can be recommended:

1. Synthetic pyrethroid (a.i. bifethrin);
2. Neonicotinoids (a.i. imidacloprid or thiamethoxam).

These insecticides are registered in Ukraine.

Always follow the label instructions for dosage, application and safety!

Pests of Seedlings

Maize leaf weevil (Southern grey weevil) (*Tanymecus dilaticollis* Gyll.)

General introduction

Host plants:

Pest of maize, sunflower, and beet.

Morphological features:

Adults

Body length 5.1–9.6 mm, brown, densely covered with grey scales and short subrecumbent setae.


©G.E. Davidyan

Where can they be found?

On the seedlings of maize.

Eggs

The eggs are oblong-oval, yellowish white, 1 mm long.

Where can they be found?

Eggs are laid in the soil, at a depth of 2 cm.

Larvae

Larvae are yellowish white, legless, curved, and 8–10 mm long.

Where can they be found?

Larvae develop on the roots of maize.

Pupae

The colour of the pupae is white.

Where can they be found?

The pupae develop in soil.

Damage

Beetles gnaw at the edges of leaves and destroy the growth cone, and often destroy plants completely immediately after emergence. At later stages of maize development, beetles eat leaves through to the main vein and damage the stems.

Biology

Body length is 5.1–9.6 mm.

Body densely covered with grey scales and short subrecumbent setae. In spring, about 90 percent of adults appear on the surface of soil 3 weeks after the average air temperatures increase to 10 °C.

Adults need additional feeding before reproduction. Mating continues from early spring to the middle of June. Females lay eggs one by one in soil at a depth of 2 cm. Fertility rate is about 150–350 eggs. Eggs develop over 10–12 days at a temperature of 20 °C. Larvae live in the soil at a depth of 20–60 cm, eating roots of maize. Larvae have four instars, which take 2–3 months to develop. Body length of the last instar larva is 9.6 mm. Pupation occurs in soil cradles at a depth of about 60 cm from mid-July to mid-September. Young adults hibernate in soil cradles.

Monitoring

From the end of October to the beginning of November, the number of weevils that go for overwintering is determined by excavation (excavate the soil to a depth of 60–80 cm).

Field control

Agrotechnical methods

- Destruction of weeds – reduces the lifespan of adults and their prolificity, because they no longer have food available during the deprivation period, until the dawn of maize.
- Pre-sowing treatment of seed material with a pesticide.
- Stubble peeling.
- The right choice of predecessor, compliance with crop rotation rules.
- Autumn ploughing after cereals.
- The application of nitrogen fertilizers.
- Post-emergence harrowing.

Resistant varieties

Sowing pest-resistant hybrids of maize.

Biological methods

Principal biological control agents include the green muscardine fungus (*Metarhizium anisopliae*), *Beauveria bassiana* (Bals.) Vuil. and bacterium *Bacillus suturalis*. Larvae are parasitized by the nematode *Leptodera dentata*. *Metarhizium anisopliae* enters the larva through any area of the body.

Chemical methods

Seed treatment before sowing.

Chemical groups:

1. Synthetic pyrethroids (a.i.: bifethrin);
2. Neonicotinoids (a.i.: imidacloprid or thiamethoxam).

When the number of beetles is 4–5 individuals/m² in the seedling phase, spraying with a synthetic pyrethroid (a.i.: imidacloprid, beta-cyfluthrin) insecticide is recommended.

These insecticides are registered in Ukraine.

Always follow the label instructions for dosage, application and safety!

Frit oat fly (*Oscinella frit* L.)

General introduction

Host plants:

Wheat is the primary host. Cereals and many other grasses are secondary hosts.

Morphological features

Adults

The adult is small (about 1.5–2 mm long), shiny and black.

Where can they be found?

Adults can be found on cereal and grass plants.

Eggs

The eggs are white and about 1–1.5 mm long.

Where can they be found?

Eggs can be found on stems and leaves.

Larvae

Adult larvae are 3.5–4.5 mm long.

Where can they be found?

The larvae are usually found inside the damaged shoots.

Pupae

The false cocoon is brown, its length is 2–3 mm.

Where can they be found?

Pupae can be found inside the stem.

Damage

Damage in cereals is most evident as 'dead hearts', where the central leaf of the plant turns yellow, withers and dies, often dropping off completely. Very young plants can be killed. Older plants can produce several tillers in response to the death of the main shoot. This leads to plants with a large number of weak shoots, which produce poor yield.

Biology

Larvae hibernate inside winter shoots and cereal weeds. In spring, the larvae pupate. After 5–12 days, at the end of April or beginning of May, adult insects fly out. Flies live 1–1.5 months, eating nectar of flowers. A female lays 50–60 eggs on young shoots of cereals with 2–3 leaves, usually on coleoptile. After 3–8 days, hatching larvae crawl towards a leaf sheath and penetrate the shoots. After 18–28 days, the larvae pupate in the shoots. After 11–25 days, adults emerge. One to five generations can develop during the year.

Monitoring

A risk assessment can be made by sampling the grass or stubble for frit fly eggs/larvae before ploughing. Key monitoring takes place after full emergence.

Field control

Agrotechnical methods

- disking or burning remains;
- practising crop rotation.

Host plant resistance

Resistant varieties (varieties with high energy of growth and tillering.

Biological methods

The number of cereals is reduced by endoparasites from the family Braconidae, e.g. *Coelinidea nigra* Nees.

Chemical methods

Control of the flies is carried out in the phases from seedling to tillering, during the period of mass flight and laying of eggs.

Chemical treatment of crops in critical phases of growth.

Seed treatment

Chemical group:

1. Neonicotinoids (a.i.: imidacloprid or imidacloprid+clothianidin).

Insecticides:

2. Synthetic pyrethroids (a.i.: lambda-cyhalothrin, deltamethrin or imidacloprid+ beta-cyfluthrin);
3. Neonicotinoids+synthetic pyrethroid (a.i.: thiacloprid + deltamethrin).

These insecticides are registered in Ukraine.

Always follow the label instructions for dosage, application and safety!

Lesser frit fly *(Oscinella pusilla* Mg.*)*

General introduction

Host plants:

Poaceae

Morphological features

Adults

The body is black and is 1.5–2 mm long.

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Where can they be found?

High harmful activity of O. pusilla is reported in forest-steppe and steppe zones.

Eggs

White or cream cylindrical eggs reach 0.7 mm in length.

Where can they be found?

Eggs are laid one at a time or in groups (1–15 eggs) on the coleoptile, the leaf blade, behind the shell of the first leaf or on the ground.

Larvae

Adult larvae are white-yellow, have a cylindrical shape and are 3.5–4.5 mm long.

Where can they be found?

In the stems of winter and wild grasses.

Pupae

The length of the puparia is 1.75–3.0 mm and the width is 0.8–1.3 mm. Their form is cylindrical and they are brown.

Where can they be found?

Pupation occurs at the feeding site.

Damage

Younger larvae penetrate the stem nucleus, crawl to the tillering node, forming a brown channel. Older larvae feed on the tissues of growth points. First generation pests are very harmful, damaging the main shoot.

Biology

The female is much larger than the male. Pupation is observed in spring at an air temperature of 12 °C, lasting 10–14 days. The first generation flies appear in early to mid-May (depending on the zone), and continue until the end of June at a temperature of about 16 °C. The maximum flight is observed at the end of June (in the zone of severe damage) when the plants have 1–3 leaves. Supplementary feeding with pollen and nectar of wild plants is necessary for the insects. Oviposition begins 9–13 days after emergence. Males die after mating. Eggs are laid one at a time or in groups (1–15 eggs) on the coleoptile, the leaf blade, behind the shell of the first sheet or on the ground. Fertility rate reaches 25–30 eggs. Embryonic development lasts 4–10 days. Pests of the first generation are very dangerous, damaging the main shoot or the stems of the main shoots. The larval period lasts 13–20 days. There is only one larva per stalk and before pupation, the larva gnaws the through the stem to the epidermis. Second generation flies appear in July. Second generation larvae are less harmful because they only damage the stems of the secondary shoots. Third generation flies appear from late July to September. Eggs are laid in August on discarded grain of spring crops, on young winter crops or on wild grasses. Life expectancy is 22–46 days.

Monitoring

Risk assessment can be made by sampling the grass or stubble for frit fly eggs/larvae before ploughing. Key monitoring takes place after full emergence.

Field control

Agrotechnical methods

Control measures include deep (20–25 cm) early winter ploughing, using ploughs with coulters, packing the ground by rollers before sowing, early sowing, and eradication of weeds.

Resistant varieties

Resistant varieties (varieties with high energy of growth and tillering).

Biological methods

Most important predators are *Triaspis obsaerellus* Nees., *Bracon longillus* Wesm., *Ganaspis* sp., *Trichomalus statutus* Forst., *Spalangia fuscipes* Nees., *Halticoptera circulus* Walk., *Ophonus rufipes* Deg., *Broscus cephalotes* L., *Pterostichus cupreus* L., *Pt. punctulatus* Sch. and *Carabus convexus* F.

Chemical methods

Control of the flies is carried out in the phases from seedling to tillering, during the period of mass flight and egg-laying.

Chemical treatment of crops in critical growth phases of corn.

Seed treatment

Chemical groups:

1. Neonicotinoids (a.i.: imidacloprid or imidacloprid+clothianidin);

Insecticides

2. Synthetic pyrethroid (a.i.: lambda-cyhalothrin); (a.i.: deltamethrin); (a.i.: imidacloprid + beta-cyfluthrin);
3. Neonicotinoids + synthetic pyrethroid (a.i.: thiacloprid + deltamethrin).

These insecticides are registered in Ukraine.

Always follow the label instructions for dosage, application and safety!

Pests of leaves and stems

Barley flea beetle (*Phyllotreta vittula* Redt.)

General introduction

Host plants

Corn and other cereals.

Morphological features

Adults

Body length is 1.5–1.8 mm. Body is slightly convex, elongated and oval, dark green in colour; elytron with wide light yellow band that slightly curves towards the suture near apex. Head and pronotum with metallic green shine.

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Where can they be found?

On leaves of corn, wheat and other cereals.

Larvae

Larvae feed on small roots of cereals. Body length of last instar larva is 3.5 mm; integument covered with sparse hairs; apex of last abdomen segment with spine.

Where can they be found?

Pupation occurs in soil cradles; pupa development lasts 2 weeks.

Eggs

Females lay eggs under the soil surface at a depth of 3 cm.

Where can they be found?

Eggs can be found in the soil at a depth of 2–3 cm.

Pupae

Light yellow, 3 mm long.

Where can they be found?

Pupae occur several inches deep in the soil.

Damage

Beetles eat parenchyma on the upper side of the leaves, leaving narrow bands.

Biology

Beetles overwinter under leaves in different places: e.g. forests or beams. In spring, they fly to the field and damage the leaves of corn. Shoots become inconspicuous, looking sick. Females lay eggs in the ground to a depth of 2–3 cm. Larvae pupate in the ground at a depth of 5–7 cm. New beetles fly in July.

Monitoring:

Scout Plants. It is important to look for flea beetles on susceptible plants, especially in the spring.

Sticky Traps. Sticky traps are monitoring tools that provide a guideline on when beetles are present and in what quantity, but are ineffective in reducing their populations. Either yellow or white sticky traps can be used. They should be placed around susceptible host plants just after planting but before seedlings emerge. Replace them when the adhesive is covered by insects or no longer sticky. Sticky traps can be used until plants are well established or until harvest. They will also attract some beneficial insects, including pollinators, so consider this negative attribute when planning to use them.

Field control:

Agrotechnical methods

- Crop rotation;
- Early harvest of grain crops;
- Exclusion of grain losses;
- Immediate and careful removal of straw from the field; and
- Elimination of volunteer plants from summer to early autumn.

Resistant varieties

Plant varieties resistant to infestation by the pest may be used.

Biological methods

Parasites and Predators. Generalist predators such as larvae of lacewing (*Chrysopa* spp.), adult big-eyed bugs (*Geocoris* spp.) and damsel bugs (*Nabis* spp.) feed on adult flea beetles. Additionally, a parasitoid wasp (*Microctonus vittatae*) can kill some species of adult flea beetles. These beneficial insects are attracted to nectar and pollen-producing plants such as anise, chamomile, clover, dill and marigold.

Nematodes. Entomopathogenic nematodes (*Steinernema* spp. and *Heterorhabditis* spp.) can attack the flea beetle larvae, reducing the subsequent adult populations.

Soil microorganisms. White muscardine, a disease that can reduce flea beetle populations, is caused by the fungus *Beauvaria bassiana*. When insects come into contact with the fungal spores, the spores attach to the insect, germinate, and penetrate the insect's body. The fungus releases toxins that kill the insect. Since sunlight can dry out and kill spores, applying commercially formulated *B. bassiana* products in the evening and in humid conditions will improve their efficacy.

Chemical methods

Spraying crops with insecticides to control adult beetles (treatments should be done at sunset).

Chemical group:

1. Synthetic pyrethroids (a.i.: lambda-cyhalothrin); (a.i.: deltamethrin).

These insecticides are registered in Ukraine.

Always follow the label instructions for dosage, application and safety!

Western corn rootworm *(Diabrotica virgifera virgifera* Le Conte.*)*

General introduction

Host plants

Maize and some other plant species

Morphological features

Adults

Body length is approximately 4.5–7 mm, with a dark head, with yellow pronotum and yellow abdomen; the elytra (forewings) are yellowish, often with three distinct darker stripes; males and females differ to some extent in their markings: on males, nearly the entire posterior half of the elytra is black, whereas on females, the dark stripes are more pronounced; generally, males are smaller than females, have longer antennae and are darker.

Where can they be found?

On the aerial parts of the plant.

Eggs

Eggs are 0.5 mm in length, oval, and flattened.

Where can they be found?

In the soil.

Larvae

Larvae are 10 mm long (full-grown), slender, white to pale yellow, with a yellowish brown head capsule and a brownish plate on the last abdominal segment.

Where can they be found?

On or in the roots.

Pupae

Pupae are 3–4 mm long, white, turning brownish before adult emergence.

Where can they be found?

In earthen cells in the soil near plant roots.

Damage

Damage to root system.

- One of the most common symptoms of corn rootworm is root rot. This results from the creation of tunnels in the roots, which attracts pathogens and will eventually damage the plant. It also compromises the capability of the plant to absorb nutrients.
- Damage to the roots will also weaken the foundation of the plant. It affects the stability of the plant, making it fall. This becomes even a bigger problem if the soil is moist and if there is strong wind.
- Silk clipping is another sign of damage that will be evident. It causes damage on the tip of the ear, which does not only result in cosmetic damage, but can also restrict the flow of nutrients.
- The crop yield will be affected by the corn rootworm, especially when plants are infested in later stages. It will lead to the reduction of kernel production. Kernels may also end up being flat.

Biology

The species has one generation per year. The overwintering eggs are generally concentrated in the top 5–20 cm of soil (or deeper in dry soils). The larvae usually hatch in May–June, depending on several environmental factors. There are three larval instars, which feed on the roots of maize. Newly-

hatched larvae feed primarily on root hairs. As the larvae grow and their food requirements increase, they burrow into roots. Larval damage is usually most severe after the secondary root system is well established and brace roots are developing. Root tips appear brown and often contain tunnels. In many cases, they are chewed back to the base of the plant. Larvae may be found tunnelling in larger roots and occasionally in the plant crown. Larvae may burrow through plants near the base, causing stunting or death of the growing point and frequently causing tillering. Root feeding commences shortly after plant emergence and early symptoms are expressed as drought or nutrient deficiencies. Plant lodging occurs later in plant development. The rate of development of immature stages depends on temperature, which is optimal at between 21 °C and 30 °C. The pest cannot continue its development in the soil at temperatures either below 9 °C or above 33 °C, the latter causing the death of second instar larvae. In central and eastern Europe (e.g. in Hungary and Serbia), adult emergence may begin in late June to early July, with a peak emergence often occurring during July. Adult beetles can be observed in the field for many weeks. They cause damage by feeding principally on pollen, silk and young kernels. Silk clipping near the husk during anthesis can cause reduced seed set in maize, which is only visible at the time of harvest. Females prefer to lay their eggs in moist soil. The pest can spread both actively and passively over large distances. This can take place in several ways such as by natural dispersal of flying beetles, with the help of weather features (e.g. adults carried by the wind), or possibly by consignments of maize.

Monitoring:

Presence of the pest can be verified through systematic inspection of crops for damage to the root system (soil excavations for the detection of larvae or eggs) or by the use of pheromone traps and identification of adults.

Field control:

Agrotechnical methods

The best way to deal with corn rootworms is to prevent their appearance. One of the best methods is crop rotation. The right planting time is also a preventive measure that will work. As much as possible, plant the crop early.

Resistant hybrids

Sowing hybrids resistant to the pest.

The prevailing mechanism of resistance is tolerance, not antibiosis or antixenosis. For example, some maize hybrids exhibit resistance to drought and larval nutrition due to their ability to regenerate roots. Hydroxamic acids have been identified as resistance factors to *D. virgifera virgifera* larvae in corn root tissue.

Genetically modified resistance

Genetically modified maize varieties with Bt toxin expressed in their roots (Cry3Bb1, Cry34Ab1/Cry35Ab1 and mCry3A) can avoid damage to larvae and have been commercialized in the United States since 2003.

Biological methods

D. virgifera virgifera has few effective natural enemies in its region of origin in Central America. In Europe, host-specific or effective local natural enemies do not attack any of the life stages of *D. virgifera virgifera*.

Reduce the amount of pest with:

- entomopathogenic nematodes;
- entomopathogenic fungi *Beauveria bassiana* and *Metarhizium anisopliae*.

Pheromonal control

As *D. virgifera virgifera* is a very actively moving beetle with the ability to mate throughout its entire lifespan, so options for pheromonal control are limited.

Among natural enemies are e.g. *Argiope bruennichi*, *Theridion impressum*, *Coccinella* sp. and *Pseudophomus rufipes*.

Chemical methods

Seed or soil treatments with adequate insecticides are possible pest control methods.

Chemical group:

1. Synthetic pyrethroid (a.i.: lambda-cyhalothrin; bifethrin);
2. Neonicotinoids (a.i.: imidacloprid; thiamethoxam);

Adults can be controlled by spraying with insecticides:

3. Synthetic pyrethroids (a.i.: lambda-cyhalothrin).

These insecticides are registered in Ukraine.

Always follow the label instructions for dosage, application and safety!

Cotton bollworm (*Helicoverpa armigera* Hb.)

General introduction

Host plants

Polyphagous (e.g. maize , cotton, tomato, , legumes, tobacco, sorghum).

Morphological features

Adults

Body length is 12–20 mm, wingspan is 30–40 mm. Wings are variable in colour, but forewings are usually orange-brown in females, and lighter, greenish-grey in males, with a black or dark brown kidney shaped marking near the centre, while hindwings are creamy white with a dark brown or dark grey band on the outer margin. The identification of adult *H. armigera* requires dissection of genitalia.

Where can they be found?

Adults can be found on the plants.

Eggs

Eggs are 0.4–0.6 mm in diameter, white, glistering at first, later greenish, changing to dark brown before hatching, spherical in shape, with a costate surface.

Where can they be found?

Eggs are distributed on various parts of the plant (e.g. on the leaves and reproductive organs).

Larvae

Larvae are up to 35–42 mm long (a fully-grown caterpillar), highly variable in colour (greenish to red-brown), with three dark dorsal stripes, and one light stripe under spiracles on the lateral side.

Where can they be found?

Larvae can be found on the plants, often in the reproductive organs.

Pupae

Pupae are 14–22 mm long, dark brown to red-brown.

Where can they be found?

Pupae are most frequently in the soil.

Damage

Larvae of *Helicoverpa armigera* prefer to feed on reproductive parts of hosts but may also feed on foliage. Feeding damage results in holes bored into reproductive structures and feeding within the plant. Secondary pathogens (fungi, bacteria) may develop due to the wounding of the plant.

Biology

Several hundred eggs can be laid one by one or in small batches of 2–3 by a single female on different parts of the plant. Larvae hatch in three days at 23–25 °C, while egg development may take more than a week during colder periods (spring and autumn). Once hatched, the larva usually eats some or all of the empty eggshell before moving some distance and starting to feed on the plant, usually in a secluded place such as a flower, flower bud, or the underside of a leaf. Larger larvae prefer to feed on immature ear of corn– hollowing them out – but feeding on leaves also occurs in the absence of reproductive organs. Larvae often move about between feeding sites on or between adjacent plants. The time of development is affected by the temperature, precipitation as well as the food source. When fully fed, the larva enters the soil to pupate, at a depth which depends on the hardness of the soil. Pupae are generally formed at a depth of 2–18 cm, but occasionally may be found in litter

or at the last feeding site on the plant (e.g. cotton boll, maize ear). Emerging females must feed on flowers before oviposition, and they can migrate over large distances. The moths are active at twilight and night. Depending on the climatic conditions, the pest may have many generations a year. It overwinters as pupae in the soil.

Monitoring

Pest monitoring through light traps or pheromone traps.

Field control

Agrotechnical methods

Removal of susceptible crop residues and weeds and deep ploughing in autumn, intended to destroy the overwintering insects.

Resistant varieties

There is low resistance to the pest in some varieties and hybrids.

Biological methods

There are about 50 species of entomophagous, which regulate the number of cotton bollworm. For example, bugs (Anthocoridae, Chrysopidae) or ants (Formicidae) that feed on pest eggs and larvae. Some success has been achieved in the use of microorganisms, in particular *Bacillus thuringiensis*, *Metarhizium anisopliae*, entomophagous *Trichogramma* and *Helicoverpa armigera* virus (HaNPV), which are used as agents to control populations of cotton bollworm larvae.

Chemical methods

Adults can be controlled by spraying with insecticides:

Chemical groups:

1. Synthetic pyrethroids (a.i.: lambda-cyhalothrin);
2. Organophosphorus insecticides (a.i.: pyrimifos-methyl).

These insecticides are registered in Ukraine.

Always follow the label instructions for dosage, application and safety!

European corn borer (*Ostrinia nubilalis* Hbn.)

General introduction

Host plants:

Polyphagous (e.g. maize, hop, millet, hemp, sorghum, pepper).

Morphological features:

Adults

Body length is 13–15 mm, wingspan is 23–32 mm, colouration varies from pale yellow to light brown (males are smaller in size and coloured darker than females), with wavy bands across the wings.

Where can they be found?

Moths can be found on the plants.

Eggs

Eggs are 0.5 mm in diameter, flat in shape, white at first but later turning to yellow.

Where can they be found?

Eggs are usually laid on the underside of leaves.

Larvae

When full-grown: 20–28 mm long, grey to light brown or pink, dorsally in each segment there is a series of four anterior spots followed by two small posterior spots, and each spot has a seta; the ventral side of the body is cream-coloured and unmarked.

Where can they be found?

Inside the stem.

Pupae

Pupae are 13–20 mm in length, brown or yellow.

Where can they be found?

Inside the stem.

Damage

Caterpillars penetrate leaf petioles, stems, damage the panicles of corn, and crawl into the wrapper of the ears, damaging them. In the stems, the caterpillar gnaws passages and cavities with openings opening outwards. On maize, caterpillars move easily between plants. Damaged stems break off or dry out, seed yield is reduced, and diseases affect plants more easily.

Biology

The minimum threshold temperature for flight activity of the species is 13–15 °C. Adults are active at twilight and night. They can fly over large distances, and females need water to begin oviposition. They lay their eggs in batches of about 20–40, usually on the underside of leaves. Eggs (as well as early instar larvae) are sensitive to and can be desiccated by warm and dry winds.

The larvae hatch 3–9 days after laying eggs.

The newly-hatched larvae disperse and can drop from the leaves on silk threads. When the leaf expands, the holes made by the larvae appear in a typical transverse line. Boring into the stem takes place soon in case of dry weather (low relative humidity). Larval feeding inside the maize stem destroys the vascular tissue. As a result, heavily attacked plants are smaller and produce fewer kernels per ear.

Damaged stems can be easily broken by wind. Larvae develop for 3–7 weeks. Pupation takes place in a ~~loose~~ cocoon in a stem, and lasts 10–25 days, depending on the temperature. The species may have one to several generations per year, and it overwinters in the larval stage inside the stem. Overwintering larvae can withstand heavy frosts.

Monitoring

Moths can be captured using light and pheromone traps. When pheromone traps are used for monitoring, it is crucial that the pheromone blend applied as a bait represents the blend being used by the local population of the pest. Catches of adults in traps should initiate intensive scouting for egg masses and for the signs of early damage from larvae ("shot holes" on leaves of maize).

Field control

Agrotechnical methods

- Adjusting the sowing date (in areas characterized by more than one generation of *O. nubilalis*, early sown corn may escape appreciable damage to the ears);
- Cutting the stems close to the ground during harvest;
- Stalk shredding (the overwintering site of larvae); and
- Ploughing to a depth of 20 cm.

Resistant varieties

Use of maize hybrids resistant or less susceptible to the pest, if available.

Biological methods

There are about 50 species of entomophagous, which regulate the number of the European corn borer, such as bugs (Anthocoridae), (Chrysopidae), ants (Formicidae), that feed on pest eggs and larvae. Some success has been achieved in the use of microorganisms, in particular *Bacillus thuringiensis*,

entomophages *Trichogramma* spp, which are used as agents to control populations of the European corn borer larvae.

Chemical methods

Chemical treatments should aim the young larvae when they hatch and wander on the plant before boring into the stem.

Adults can be controlled by spraying with insecticides.

Chemical groups:

1. Synthetic pyrethroid (a.i.: lambda-cyhalothrin);
2. Organophosphorus insecticides (a.i.: pyrimifos-methyl).

These insecticides are registered in Ukraine.

Always follow the label instructions for dosage, application and safety!

Meadow moth (*Margaritia sticticalis* L.)

General introduction

Host plants

Polyphagous (maize, sugar beet, hemp, legumes, sunflower, mustard, cotton, , tobacco, melon and watermelon).

Morphological features

Adults

Brownish, mottled; adults show sexual dimorphism: males are smaller in size than females: wingspan of males is 18–20 mm, and that of females is 20–26 mm; antennae of males are serrate while those of the female are filiform.

Where can they be found?

On the leaves of different plants.

Eggs

Eggs are white, 0.8–1 mm in height, 0.4–0.5 mm in diameter.

Where can they be found?

On the underside of the leaves or on dried plant parts on the soil, usually in batches.

Larvae

Larvae are 25–35 mm long (full-grown), greenish or greenish-grey to black, marked by a black stripe down the middle of the back and with a row of dark circles on each side. Head is black with light pattern.

Where can they be found?

Larvae can be found on the leaves.

Pupae

Pupae are yellowish to dark brown, in cocoons 20–70 mm long.

Where can they be found?

Pupae can be found in the soil.

Damage

Caterpillars of a meadow moth skeletonize leaves, leaving a web on them; older caterpillars can eat a leaf completely, leaving only coarse veins and petioles.

Biology

The first adults of the species may appear in May and June. Females need extra food before laying eggs, so they can fly long distances in search of nectar. Eggs are laid on the underside of the leaves of young plants or on dried plant parts on the soil, either in batches (2–3 or more, sometimes up to 20 eggs) or singly. Development of eggs lasts 2–15 days. Larvae (caterpillars) develop for 10–30 days, depending on the temperature. Young larvae spin webs, remain in the webs, and feed on leaves. Older larvae disperse and creep around to feed, and they can skeletonize plant leaves leaving only the veins.

Adult caterpillar pupates in a cocoon in the soil or on the leaf. The number of generations varies depending on the climatic zone. The overwintering life stage is larva inside a cocoon in the soil.

Monitoring

Presence of the pest and the determination of its numbers can be done visually. The use of traps is suitable for adult fishing.

Field control

Agrotechnical methods

- Deep ploughing in autumn;
- Harrowing in spring;
- Elimination of weeds; and
- Early sowing.

Resistant varieties

Use of maize hybrids resistant or less susceptible to the pest.

Biological methods

There are about 50 species of entomophagous, which regulate the number of meadow moth, for example bugs (Anthocoridae), Chrysopidae, ants (Formicidae), that feed on pest eggs and larvae. Some success has been achieved in the use of microorganisms, in particular *Bacillus thuringiensis*,

Metarhizium anisopliae or entomophages *Trichogramma* spp., which are used as agents to control populations of meadow moth larvae.

Chemical methods

Chemical treatments should aim at the control of young larvae when they hatch and wander on the plant, before boring into the stem.

Adults can be controlled by spraying with insecticides.

Chemical groups:

1. Synthetic pyrethroids (a.i.: lambda-cyhalothrin);
2. Neonicotinoids (a.i.: lambda-cyhalothrin + thiamethoxam or thiamethoxam).

These insecticides are registered in Ukraine.

Always follow the label instructions for dosage, application and safety!

Wheat aphid (*Schizaphis graminum* Rond.)

General introduction

Host plants

This aphid feeds almost exclusively on a range of grasses in the Poaceae family.

Morphological features

Adults

The body of the female is light green, with a longitudinal stripe along the dorsal side. Body length ranges from 2.7 to 2.9 mm. The antenna is twice as long as the body. There are two forms of aphids: winged and wingless females and males. Reproduction in the spring is parthenogenetic, sexual in the winter.

Where can they be found?

The aphids feed on both lower and upper sides of leaves. Both wingless and winged forms of aphids can be found on their host plants.

Eggs

Eggs are 0.6 mm in size, black and shiny.

Where can they be found?

On leaves of the cereals.

Larvae

Larvae are oval shaped, with light green bodies and a darker green stripe along the back. Larvae and nymphs are similar to adults.

Damage

Feeding by *S. graminum* causes chlorosis and necrotic spots.

Biology

Maximum numbers of aphids are observed at the end of June and in July. Aphid infestation is very dangerous when the plants are at the stage of stem elongation. During the ripening of cereals, the number of aphids rapidly decreases. The most favourable conditions for the insect are temperatures of 20–21 °C with a relative humidity of 65–70 percent for apterous females, and 25.8 °C and 70 percent for winged females. The appearance of sexual generation depends on temperature and photoperiod. Aphid populations can be particularly abundant after years with moist and damp summers.

Monitoring

Populations of the aphid can be monitored in spring on seedlings of crops, and the overwintering populations – in late October and in early spring. Abundance can be determined by analysis of plant samples. A single sample should be made up of plants collected along 0.5 m of the sowing line, and the sum of all samples should be equal to the number of plants per square metre. In each field, 16 samples should be taken and labels should be attached to the samples.

Field control:

Agrotechnical methods

- Crop rotation;
- Early harvest of grain crops;
- Exclusion of grain losses;
- Immediate and careful removal of straw from the field; and
- Elimination of volunteer plants from summer to early autumn.

Resistant varieties

Resistant varieties may be used, if available.

Biological methods

Natural enemies include predators such as ladybirds (Coleoptera: Coccinellidae), lacewings (Neuroptera: Chrysopidae), damsel bugs (Hemiptera: Nabidae), spiders (Araneae), ground beetles (Coleoptera: Carabidae) and syrphid flies (Diptera).

It has been found that the bacteria *B. thuringiensis* Berliner (strains V-6066 and V-5689) are able to suppress the vital activity of the greenbug aphid *Schizaphis graminum* Rond.

Chemical methods

Chemical groups:

1. Synthetic pyrethroids (a.i.: lambda-cyhalothrin);
2. Combined insecticides (a.i.: lambda-cyhalothrin + thiamethoxam);
3. Neonicotinoids (a.i.: thiamethoxam);
4. Synthetic pyrethroids (a.i.: deltamethrin).

These insecticides are registered in Ukraine.

Always follow the label instructions for dosage, application and safety!

Corn leaf aphid (*Rhopalosiphum maidis* Fitch.)

General introduction

Host plants:

The pest feeds on wheat, barley, rye, oats, maize, millet, sorghum, and wild cereals.

Morphological features:

Adults

The wingless forms have elongated, light green or blue coloured bodies, 1.8–2.2 mm long, with body length twice the width. The winged insects are 1.7–2.2 mm long, with black head and thorax, and green-shaded darker areas are located on the abdomen.

Where can they be found?

Aphids can be found on maize and other cereals.

Nymphs

Nymphs are 1.2–2.0 mm long.

Where can they be found?

Nymphs can often be found on the tops of corn plants.

Damage

Sorghum aphid is most often found deep in folded leaves, on the reverse side of leaves, on the stems or on the panicle. Adult and nymph corn leaf aphids feed on plant juices. The most apparent symptoms of corn leaf aphid feeding is a yellow mottling of leaves. Sometimes moulds grow on the honeydew, which corn leaf aphids produce in abundance. Honeydew on the panicle can hinder harvest. The aphid also transmits maize dwarf mosaic virus. High level of damage from the pest can be observed in steppe and forest-steppe zones in Ukraine.

Biology

The first spring adults are winged females, which fly in search of host plants. Shortly thereafter, they give birth to live nymphs, which usually develop into wingless females. Under favourable conditions, more winged females. Males are rarely found but females continue to reproduce without mating. No egg stage is known. The number of generations per year varies from 9 to 50.

Monitoring

Regular monitoring should begin in early spring, especially during the period of mass infestation by the pest. Aphids usually move to the field from the side of the road, so damage first appears at the edges of crops. Pest infestation can be heterogeneous. Aphids should be recorded by systematic inspection of plants. During the accounting determine the number of inhabited plants and the degree of their population.

Field control

Agrotechnical methods

- Crop rotation;
- Early harvest of grain crops;
- Exclusion of grain losses; and
- Immediate and careful removal of straw from the field.

Resistant varieties

The use of maize hybrids resistant against aphids may be recommended, if available.

Biological methods

The most important predators are *Chrysopa californica* Coq., *Ch. lanata* Bks., *Ch. plorabumpunctata* Fitch., *Adalia bipunctata L.*, *Coccinella arcuata* F., *C. septempunctata* L., *Coelophora inaequalis* F., *Cycloneda sanguinea* L., *Cydonia lunata* F., *C. vicina* Muls., *Scymnus constrictus* Muls., P*haenobremia meridionalis* Felt., *Allograpta fracta* O.S., *A. obliqua* Say., *A. venusta* Curr., *Baccha clavata* F., S*yrphus vitripennis* Meig., *Aphidius exiguous* Hal, *A. platensis* Brethes, *Lysiphlebus testaceipes* Cress., *Aphelinus maidis* Timberl. and *A. semiflavus* How.

Chemical methods

Chemical treatment of maize in critical phases, using registered insecticides.

Chemical groups:

1. Synthetic pyrethroids (a.i.: lambda-cyhalothrin or deltamethrin);
2. Combined insecticides (a.i.: lambda-cyhalothrin + thiamethoxam);
3. Neonicotinoids (a.i.: thiamethoxam).

These insecticides are registered in Ukraine.

Always follow the label instructions for dosage, application and safety!

Bird cherry-oat aphid (*Rhopalosiphum padi* L.)

General introduction

Host plants

Corn, barley, wheat and oats.

Morphological features

Adults

Adults are 2 mm long, olive-green to black with a red rust patch at the rear and may have wings. Antennae extend to half the body length. Nymphs are similar to adults, but smaller.

Where can they be found?

Populations of *Rhopalosiphum padi* on cereals are usually found on the lower parts of the plant.

In autumn, short day-length induces the appearance of gynoparae on grasses and cereals.

These winged females migrate to bird cherry where the overwintering eggs are laid. Short day-length also induces the somewhat later appearance of winged males on grasses, which migrate to bird cherry where they mate with the oviparae.

Eggs

Eggs are elongated oval, black.

Where can they be found?

The eggs of *Rhopalosiphum padi* are laid in autumn in the narrow gap between the axillary buds and the stem.

Larvae

Larvae have four development stages.

Damage

The feeding of the aphid may stunt plants and lead to yield loss, but it does not cause symptoms of yellowing and leaf curling. Bird cherry-oat aphid is a vector of *barley yellow dwarf virus* (BYDV).

Biology

The life cycle is dioecious. The primary host is bird cherry (*Padus racemosa*). Eggs overwinter on bird cherry buds. In the life cycle, there is an alternation of sexual and asexual generations. The period of pre-imaginal development, depending on conditions, varies from 5 to 21 days. A wingless parthenogenetic female lives from 15 to 19 days at a temperature of 21 °C. At lower temperatures, it can live up to 40 days. In late May and early June, winged individuals appear, and insects migrate from the primary host to the secondary host – cereals. Aphids live on the underside of leaves and in the ears of cereals. From the second half of August, the first immigrants appear.

The aphid produces many generations throughout the growing season. Winged and non-winged forms occur.

Monitoring

Pest monitoring is carried out in the spring on seedlings, and on the overwintering populations – in late October and in early spring. Abundance can be determined by analysis of plant samples. One sample is made up of plants collected along 0.5 m of the sowing line, and the sum of all samples is equal to the number of plants per square metre. On each field, 16 samples are taken and labels are attached to these plant samples.

Field control

Agrotechnical methods

- Appropriate crop rotation;
- Early harvest of grain crops;
- Exclusion of grain losses;
- Application of nitrogen fertilizers;
- Immediate and careful removal of straw from the field; and
- Elimination of volunteer plants from summer to early autumn.

Resistant varieties

In virus-prone areas, resistant plant varieties may be used.

Biological methods

Natural enemies include predators such as ladybeetles (Coleoptera: Coccinellidae), lacewings (Neuroptera: Chrysopidae), damsel bugs (Hemiptera: Nabidae), spiders (Araneae), ground beetles (Coleoptera: Carabidae) and syrphid flies (Diptera).

Chemical methods

Chemical treatment of crops in critical phases of corn.

Chemical group:

1. Synthetic pyrethroids (a.i.: lambda-cyhalothrin or deltamethrin);
2. Combined insecticides (a.i.: lambda-cyhalothrin + thiamethoxam);
3. Neonicotinoids (a.i.: thiamethoxam).

These insecticides are registered in Ukraine.

Always follow the label instructions for dosage, application and safety!

Pests of Soybean

Pests of Seedlings

Pea leaf weevil *(Sitona lineatus* L.*)*

General introduction

Host plants:

It damages annual and perennial crops: soybeans, peas, beans, vetch, rank, lupine, perennial legumes.

Morphological features

Adults

Adults are 3.6 to 5.4 mm long; greyish brown.

© U. Schmidt

Where can they be found?

Adults can be found on the leaves of the host plants.

Eggs

Eggs are 0.5 mm long, yellow-white when first deposited but darken after two to three days.

Where can they be found?

Eggs can be found on the stem, leaves or soil.

Larvae

Larvae are about 0.5 mm long when they first hatch and grow to approximately 5.5 mm. There are five larval instars. Larvae are milky white to yellowish, legless, cylindrical, soft and fleshy with a coppery-brown head capsule. Reddish bristles extend from each segment.


© S. Barkley

Where can they be found?

In the soil.

Pupae

Pupae are 4.5–6 mm long, open, pale yellow (first white and then yellow).

Where can they be found?

In the soil.

Damage

Adult beetles feed on leaf margins and growing points of legume seedlings. Feeding on the leaf margins produces a characteristic scalloped (notched) appearance. Larvae feed on the nitrogen-fixing nodules of legume species resulting in partial or complete inhibition of nitrogen fixation by the plant.

Biology

A single generation is produced per year. Adults overwinter in shelterbelts, field margins, alfalfa or other perennial legumes and become active when temperatures exceed 4.5 °C. Adult emergence can occur from early to mid-May in warm years. Adult weevils begin feeding on any legume foliage they can find immediately after emerging. They then migrate to the primary host crops (those that will support larvae): peas and faba beans. Generally, they move by walking, but are capable of flying at heights of 10 m once temperatures exceed 12.5 °C.

Mating occurs once the primary host is found. Females begin laying eggs within a week of mating. Each female drops one to 24 eggs per day on the soil surface near the host plant seedlings. Oviposition generally lasts about ten days but can extend to three months. Each female can lay from 254 to 1 655 eggs in this period, and densities of eggs can reach 20 000 per square metre. Typically, after about 14 days, eggs hatch and larvae move to nodules, where they chew a tiny hole, enter and feed. All larval instars feed on root nodules that contain Rhizobium leguminosarum.

Larval development typically lasts 30 to 60 days. Mature larvae move into the soil to pupate. Pupation takes about 15 days. New adults start emerging in mid-July and feed on any available legume foliage. Many can stay in place until the crop deteriorates with age and then walk or fly to any green leguminous host plants.

Monitoring

Adult weevils fall off the plants when disturbed or approached and can be difficult to see. Therefore, characteristic scalloping of seedling leaf margins is the best way to detect the presence of the adults. An aggregation pheromone has been isolated from male pea leaf weevils and it is used to monitor their populations.

Field control

Agrotechnical methods

Early sowing of soybeans. Spatial isolation from perennial legumes (up to 1 000–1 500 m). Ploughing the field immediately after picking the soybeans.

Biological methods

The ground beetle Bembidion quadrimaculatum (a generalist predator) is known to consume pea leaf weevil eggs and is being investigated as a potential biological control agent.

Chemical methods

Insecticide treatment in the emergence phase when the number of beetles is 10–15 specimens per square meter or one beetle for 3–5 plants.

Chemical groups:

1. Synthetic pyrethroids (a.i.: lambda-cyhalothrin).

These insecticides are registered in Ukraine.

Always follow the label instructions for dosage, application and safety!

Cotton bollworm *(Helicoverpa armigera* Hb.*)*

General introduction

Host plants

Polyphagous (e.g. soybean, cotton, tomato, maize, legumes, tobacco, sorghum).

Morphological features

Adults

Body length is 12–20 mm, wingspan is 30–40 mm. Wings are variable in colour, but forewings are usually orange-brown in females, and lighter, greenish-grey in males, with a black or dark brown kidney shaped marking near the centre, while hindwings are creamy white with a dark brown or dark grey band on the outer margin. The identification of adult *H. armigera* requires dissection of genitalia.

Where can they be found?

Adults can be found on the plants.

Eggs

Eggs are 0.4–0.6 mm in diameter, white, glistering at first, later greenish, changing to dark brown before hatching, spherical in shape, with a costate surface.

Where can they be found?

Eggs are distributed on various parts of the plant (e.g. on the leaves and reproductive organs).

Larvae

Larvae are up to 35–42 mm long (a fully-grown caterpillar), highly variable in colour (greenish to red-brown), with three dark dorsal stripes, and one light stripe under spiracles on the lateral side.

Where can they be found?

Larvae can be found on the plants, often in the reproductive organs.

Pupae

Pupae are 14–22 mm long, dark brown to red-brown.

Where can they be found?

Pupae are most frequently in the soil.

Damage

Larvae of *Helicoverpa armigera* prefer to feed on reproductive parts of hosts but may also feed on foliage. Feeding damage results in holes bored into reproductive structures and feeding within the plant. Secondary pathogens (fungi, bacteria) may develop due to the wounding of the plant.

Biology

Several hundred eggs can be laid one by one or in small batches of 2–3 by a single female on different parts of the plant. Larvae hatch in three days at 23–25 °C, while egg development may take more than a week during colder periods (spring and autumn). Once hatched, the larva usually eats some or all of the empty eggshell before moving some distance and starting to feed on the plant, usually in a secluded place such as a flower, flower bud, or the underside of a leaf. Larger larvae prefer to feed on immature fruit – hollowing them out – but feeding on leaves also occurs in the absence of

reproductive organs. Larvae often move about between feeding sites on or between adjacent plants. They become full-grown in approximately 2–3 weeks but may develop for more than a month. The time of development is affected by the temperature, precipitation as well as the food source. When fully fed, the larva enters the soil to pupate, at a depth which depends on the hardness of the soil. Pupae are generally formed at a depth of 2-18 cm, but occasionally may be found in litter or at the last feeding site on the plant (e.g. cotton boll, maize ear). Emerging females must feed on flowers before oviposition, and they can migrate over large distances. The moths are active at twilight and night. Depending on the climatic conditions, the pest may have many generations a year. It overwinters as pupae in the soil.

Monitoring

Pest monitoring through light traps or pheromone traps.

Field control

Agrotechnical methods

The removal of susceptible crop residues and weeds and deep ploughing in autumn, intended to destroy the overwintering insects.

Resistant varieties

Partial resistance to the pest was noted in some varieties.

Biological methods

There are about 50 species of entomophagous, which regulate the number of cotton bollworm, for example bugs (Anthocoridae), Chrysopidae or ants (Formicidae) that feed on pest eggs and larvae. Some success has been achieved in the use of microorganisms, in particular *Bacillus thuringiensis*, *Metarhizium anisopliae*, entomophagous *Trichogramma* spp. and *Helicoverpa armigera virus* (HaNPV), which are used as agents to control populations of cotton moth larvae.

Chemical methods

Adults can be controlled by spraying with insecticides:

Chemical groups:

1. Synthetic pyrethroids (a.i.: lambda-cyhalothrin);
2. Organophosphorus insecticides (a.i.: pyrimifos-methyl).

These insecticides are registered in Ukraine.

Always follow the label instructions for dosage, application and safety!

Pests of leaves and stems

Silver Y moth *(Autographa gamma* L.*)*

General introduction

Host plants

This is a polyphagous pest.

Morphological features

Adults

35–40 mm wingspan; grey to greyish brown, with a white "Y" shape on the forewing.

Where can they be found?

Larvae can be found on leaves.

Eggs

Eggs are oval, 0.5–0.6 mm in diameter, watery white.

Where can they be found?

Eggs are most likely to be found on the underside of leaves.

Larvae

24–40 mm in length; body colour varies from green to almost black; often a dark line bordered by two thin and curved white lines runs over the back; a light yellow line runs over the sides; three pairs of abdominal legs are present.

Where can they be found?

Larvae can be found on leaves.

Pupae

Pupae are 17–25 mm in length; green to black in colour.

Where can they be found?

Pupae are most likely to be found on the underside of leaves.

Damage

The pest causes major damage to annual and perennial leguminous cultures, sugar beet, potato, vegetables, industrial cultures (flax, hemp), and various aromatic cultures. Cases of damage caused to corn and sunflower are known. During migrations with outbreaks of mass reproduction, the larvae can damage trees and shrubs (willow, alder, hazelnut, black currant). The economic threshold for this species in field crops is 5–8 larvae/1 m^2.

Biology

A female moth lays eggs individually on the underside of leaves. After an egg hatches, a caterpillar feeds on the host plants, mainly on leaves. Pupation takes place in a silvery cocoon attached to the underside of a leaf. Typically, 2–3 generations develop per year and adults are seen from May through October.

Monitoring

The number of insects on plants per square metre is determined. Pheromone traps can be used.

Field control

Agrotechnical methods

Control measures include: weeding, inter-row cultivations, removal of crop residue from fields, deep autumn ploughing, optimal dates of early sowing.

Biological methods

Natural enemies: entomophagous, such as ladybugs (Coleoptera: Coccinellidae), (Neuroptera: Chrysopidae), bugs (Hemiptera: Nabidae), spiders (Araneae) and beetles (Coleoptera: Carabidae).

Chemical methods

Adults and larvae can be controlled by spraying with insecticides. Spraying is recommended in the evening.

Chemical groups:

1. Synthetic pyrethroids (a.i.: deltamethrin);
2. Organophosphorus insecticides (a.i.: phosalone);
3. Combined insecticides (a.i.: imidacloprid + lambda-cyhalothrin).

These insecticides are registered in Ukraine.

Always follow the label instructions for dosage, application and safety!

Meadow moth *(Margaritia sticticalis* L.*)*

General introduction

Host plants

Polyphagous (soybean, sugar beet, hemp, legumes, sunflower, mustard, cotton, maize, tobacco, melon, watermelon).

Morphological features

Adults

Brownish, mottled; adults show sexual dimorphism: males are smaller in size than females: wingspan of males is 18–20 mm, and that of females is 20–26 mm; antennae of males are serrate while those of the female are filiform.

Where can they be found?

On the leaves of different plants.

Eggs

Eggs are white, 0.8–1 mm in height, 0.4–0.5 mm in diameter.

Where can they be found?

On the underside of the leaves or on dried plant parts on the soil, usually in batches.

Larvae

Larvae are 25–35 mm long (full-grown), greenish or greenish-grey to black, marked by a black stripe down the middle of the back and with a row of dark circles on each side. Head is black with light pattern.

Where can they be found?
Larvae can be found on the leaves.

Pupae
Pupae are yellowish to dark brown, in cocoons 20–70 mm long.

Where can they be found?
Pupae can be found in the soil.

Damage

Caterpillars of a meadow moth skeletonize leaves, leaving a web on them; older caterpillars can eat a leaf completely, leaving only coarse veins and petioles.

Biology

The first adults of the species may appear in May and June. Females need extra food before laying eggs, so that they can fly long distances in search of nectar. Eggs are laid on the underside of the leaves of young plants or on dried plant parts on the soil, either in batches (2-3 or more, sometimes up to 20 eggs) or singly. Development of eggs lasts 2–15 days. Larvae (caterpillars) develop for 10–30 days, depending on the temperature. Young larvae spin webs, remain in the webs, and feed on leaves. Older larvae disperse and creep around to feed, and they can skeletonize plant leaves leaving only the veins.

Adult caterpillar pupates in a cocoon in the soil or on the leaf. The number of generations varies depending on the climatic zone. The overwintering life stage is larva inside a cocoon in the soil.

Monitoring

Presence of the pest and the determination of its numbers can be done visually. The use of traps is suitable for adult fishing.

Field control

Agrotechnical methods

- Deep ploughing in autumn;
- Harrowing in spring;
- Elimination of weeds; and
- Early sowing/planting.

Resistant varieties

Use of soybean resistant or less susceptible to the pest.

Biological methods

There are about 50 species of entomophagous, which regulate the number of meadow moths, for example bugs (Anthocoridae), Chrysopidae or ants (Formicidae) that feed on pest eggs and larvae. Some success has been achieved in the use of microorganisms, in particular *Bacillus thuringiensis*, *Metarhizium anisopliae* or entomophages *Trichogramma* spp., which are used as agents to control the populations of meadow moth larvae.

Chemical methods

Chemical treatments should aim at the control of young larvae when they hatch and wander on the plant, before boring into the stem.

Adults can be controlled by spraying with insecticides.

Chemical groups:

1. Synthetic pyrethroids (a.i.: lambda-cyhalothrin);
2. Neonicotinoids (a.i.: lambda-cyhalothrin + thiamethoxam or thiamethoxam).

These insecticides are registered in Ukraine.

Always follow the label instructions for dosage, application and safety!

Pulse pod borer moth *(Etiella zinckenella* Tr.*)*

General introduction

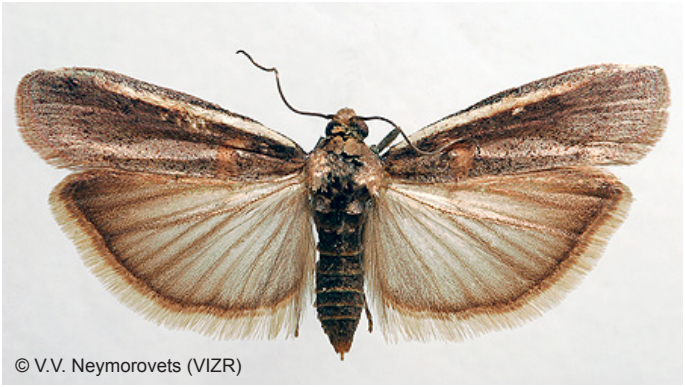
Host plants

The pest develops on more than 80 species of cultivated and wild legumes including soybean, pea, lentil, lupine, vetch, white (silver-chain) and yellow (Siberian pea shrub) acacia, clover, alfalfa, sainfoin, vetchling.-

Morphological features

Adults

Body length 8–11 mm, wingspan 19–27 mm.



Where can they be found?

Adults can be found on leaves

Eggs

Eggs are 0.7 mm in length, milky white.

Where can they be found?

Females lay eggs one by one on ovaries with dried corolla or on green fruit.

Larvae

Colouration of larvae is variable, from dirty greenish-grey. Body length is 15–22 mm.

Where can they be found?

Larvae live inside fruit, eating away seeds.

Pupae

Pupae are brilliant, brown, finely punctured, and up to 7–10 mm long. Cocoon white and usually covered with soil particles.

Where can they be found?

In the soil.

Damage

Damaged seeds lose their commodity value and become unsuitable for sowing. Sowing of grain legumes located near forest shelter belts composed of true or false acacia (serving as reservations for the pest) are especially strongly damaged. The greatest harm is apparent in southern Ukraine.

Biology

Number of generations per year reaches three, though the third generation can be facultative. The pest overwinters as larva. Development of eggs lasts 4–21 days, of larvae 19–40 days, of pupae 12–18 days, depending on temperature. Lifespan of adults is 20 days, average fecundity is about 100–300, maximum 600 eggs.

Monitoring

Monitoring of the pest population can be done using pheromone traps.

Field control

Agrotechnical methods

- sowing of grain legumes at early-optimal periods;
- harvest executed at the proper time;
- 20–25 cm deep winter ploughing; and
- spatial isolation from plantations of true and false acacia.

Biological methods

Entomophagous insects, particularly *Trichogramma*, braconid and ichneumon wasps have a pronounced effect on the decline of the pest population, along with arthropod predators, fungal and bacterial diseases.

Chemical methods

Insecticide treatments soon before larva penetration into beans.

Chemical groups:

1. Synthetic pyrethroids (a.i.: chlorantraniliprole or chlorantraniliprole + lambda-cyhalothrin);
2. Neonicotinoids + pyrethroids (a.i.: imidacloprid + lambda-cyhalothrin).

These insecticides are registered in Ukraine.

Always follow the label instructions for dosage, application and safety!

Spider mite *(Tetranychus urticae* Koch.*)*

General introduction

Host plants

Spider mites infest over 200 species of plants.

Morphological features

Adults

The female is about 0.4 mm in length with an elliptical body that bears 12 pairs of dorsal setae. The male is elliptical with the caudal end tapering and smaller than the female.

Where can they be found?

Adults can be found under the leaves.

Eggs

Eggs are 0.13 mm in diameter, globular and translucent.

Where can they be found?

Eggs can be found under the leaves.

Nymphal stages

There are two nymphal instars, protonymph and deutonymph. Nymphs are pale green with darker markings, and have eight legs.

Where can they be found?

Nymphal stages can be found under the leaves.

Damage

T. urticae, like other spider mites, penetrates plant cells with its mouthparts, preferring the undersides of leaves, and ingests their contents. Each minute, 1–2 dozen cells can be destroyed in this way. The first visible symptoms are small whitish speckles, mainly around the midrib and larger veins. When these spots merge, the empty cells give areas of the leaf a whitish or silvery-transparent appearance.

With ongoing infestation, damage will not be restricted to the spongy mesophyll but include the palisade parenchyma as well, and the leaf tissue may collapse completely. The function of the stomata is affected and transpiration constrained. The leaf will turn yellow, wilt, and finally be shed. Sometimes complete defoliation occurs. Often the whole foliage of attacked plants takes on a yellow or brownish colour. The loss of photosynthetically active surface together with reduced transpiration leads to reduced yield, and the plant may be stunted or in severe cases killed.

Biology

Female *T. urticae* mites lay 10–20 eggs per day, and 80–120 during their lifetime of up to four weeks. The eggs are mostly attached to the silk webbing. The six-legged larvae hatch after 3–15 days. They moult three times within 4–5 days, towards protonymph, then deutonymph and finally the adult. These instars all have eight legs. Before each moult, there is a short quiescent stage. In favourable conditions (optimum are 30–32 °C and a relative humidity below 50 percent), the life cycle can be completed in about 1–2 weeks, including a preoviposition period of 1–2 days. Often a change towards hot and dry weather leads to a very rapid increase in population density. For overwintering, mature females diapause in protected places like cracks in bark or under plant litter. In April/May they emerge and begin with oviposition. As the name "spider" mites suggests, they spin webbing. *T. urticae* produces so much of it that it may completely cover parts of the plant. It protects the mites to some degree against wind, rain and predators. In addition, attached to strands of silk the mites can be dispersed by the wind.

Monitoring

For detection of spider mites, a 10× to 15× magnifying glass is necessary. Examine the undersides of the leaves closely for mites, cast skins and webbing. A more efficient technique is to place a sheet

of white typing paper beneath the leaves and strike the foliage sharply. The mites will fall onto the paper and can be more easily observed and identified than on the green foliage.

Field control

Agrotechnical methods

Control measures include weeding and crop rotation.

Biological methods

Predators are very important in regulating spider mite populations and should be protected whenever possible. Important genera include predatory mites *Amblyseius, Metaseiulus* and *Phytoseiulus*; ladybirds (*Stethorus*); minute pirate bugs (*Orius*); thrips (*Leptothrips*); and lacewing (*Chrysopa*) larvae.

Spider mites are commonly attacked by predator mites: *Phytoseiulus persimilis*, *Mesoseiulus longipes*, *Neoseiulus californicus*, *Galendromus occidentalis* and *Amblyseius fallicus*. Predatory mites can be distinguished from spider mites by their longer legs. The front pair of legs is often extended forward. They are more active and move about at a fast pace. They are often red or orange in colour. *Phytoseiulus persimilis* is the most common predator and preys on all stages of mites. It can consume 20 eggs or five adults daily.

Chemical methods

Chemical groups:

1. Organophosphorus insecticides (a.i.: phosalone);
2. Juvenoids (a.i.: fenpiroximate);
3. Organophosphorus insecticides (a.i.: gamma-cyhalothrin, dimethoate).

These insecticides are registered in Ukraine.

Always follow the label instructions for dosage, application and safety!

Green pea aphid *(Acyrtosiphon pisi* Kalt.*)*

General introduction

Host plants

Oligophagous pest of leguminous cultures.

Morphological features

Adults

Light green ellipsoid body of apterous female is 5 mm in length. The winged female is 4–6 mm long, green in spring, and brown-red in autumn. Wingless females are 4.0–4.5 mm long.

Where can they be found?

The insects prefer the upper part of leaves and stems.

Eggs

Eggs are oval and black.

Where can they be found?

On plant parts near roots on perennial grasses.

Damage

The Green pea aphid feeds by using needle-like mouthparts to extract plant juices. If aphids are present in large numbers, feeding may cause a reduction in plant vigour and growth rates, as well as leaf puckering, reduced beans/seed counts, and ultimately reduced yield. Severity of damage varies widely depending on pressure and other variables present in the field, although yield losses ranging from ten to fifteen percent are not uncommon. It is important to remember that aphid damage is exacerbated by other stressors on the plant (i.e. drought) and stressed plants are, in turn, more favourable hosts for aphids, resulting in increased reproductive rates. Aphid honeydew, produced as a waste product during feeding, promotes the development of grey, sooty mould on leaf surfaces, reducing photosynthetic capacity of plants. The Green pea aphid is a known vector of a number of plant virus diseases. For example, some domestic viruses spread by Green pea aphid include alfalfa mosaic virus, soybean mosaic virus, and bean yellow mosaic virus.

Biology

Embryonic development occurs at the temperature 4.5 °C. The maximum numbers of insects occur at the beginning of June in southern regions, and at the end of June and beginning of July in northern regions of Ukraine. The most favourable conditions for insects are temperatures of 18–22 °C and relative humidity 60–70 percent. The species is polymorphous and cold resistant. Individuals do not perish at -6 °C. In Ukraine, the species produces ten to twenty generations in a year.

Monitoring

Regular monitoring should start at the most vulnerable crop stage. Aphids will generally move into paddocks from roadsides and damage will first appear on crop edges. Infestations can be patchy.

Inspect crops from the 3-leaf stage onwards by direct visual observations of tillers and plant margins.

Field control

Agrotechnical methods

- optimum sowing time;
- use and development of early-ripening varieties;
- spatial isolation of perennial and leguminous crops;
- low mowing of perennial herbs for killing the eggs; and
- weed control.

Biological methods

Most important predators are insects of the families Coccinelidae (*Coccinella septempunctata* L., *C. notata* Host.), Sirphidae (i.a. genera *Syrphus* and *Melanostoma* and others) and Chrysopidae (*Chrysopa carnea* Steph.). Most important parasites include representatives of the family Braconidae (genera *Aphidius* and *Ephedrus)*.

Chemical methods

The following insecticides should be preferred for spraying.

Chemical groups:

1. Synthetic pyrethroids (a.i.: lambda-cyhalothrin or deltamethrin);
2. Combined insecticides: pyrethroid + neonicotinoid (a.i.: lambda-cyhalothrin + thiamethoxam);
3. Neonicotinoid (a.i.: thiamethoxam).

These insecticides are registered in Ukraine.

Always follow the label instructions for dosage, application and safety!

Pests of Winter/Spring Oilseed Rape

Pests of seedlings

Cabbage stem flea beetle *(Psylliodes chrysocephalus* L.*)*

General introduction

Host plants

Adults or larvae of P. chrysocephalus have been recorded on 18 different crop and weed species of the Brassicaceae family.

Morphological features

Adults

Adults are about 3.0–4.0 mm long, variably coloured, but most often a dark metallic blue.

Where can they be found?

Adults feed on stems and leaves of wild or cultivated crucifer plants.

Larvae

The larvae are off-white with three pairs of legs, a black head and a black dorsal plate on the apical segment.

They go through three larval stages. First instar larvae are 1 mm long by 0.3 mm wide, second instar larvae are 3–4 mm long and 0.5 mm wide and third instar larvae are 5–8 mm long and 0.6 mm wide.

Where can they be found?

Larvae can be found in the stems.

Eggs

Eggs are pale orange, around 1.0 mm long and 0.4 mm wide.

Where can they be found?

The female lays her eggs in cracks in the soil near the base of a crucifer plant and the emerging larvae mine the stems and petioles of the plant.

Pupae

Pupae are off-white, about 3–5 mm in length.

Where can they be found?

Pupae can be found in the soil.

Damage

Adults chew holes in leaves. The larvae usually mine the lower petioles, moving from ageing to healthy tissue, but will move to the stem and destroy the growing point. Severe larval attacks can distort the plant and cause the epidermis to peel, leading to death of the plant. As well as causing direct damage, attacks by *P. chrysocephala* are associated with fungal (*Leptosphaeria maculans* and *Phoma lingam*) and bacterial infections. Plants infested with the cabbage stem flea beetle are also more susceptible to frost damage.

Biology

The beetle has one generation per year. Adults emerge from pupae in the spring. About two weeks after emergence, they move to their summer feeding sites to feed on the leaves, stems and pods of the rape plant. After the rape is harvested, the beetles may move to feed on wild crucifers. Beetles emerge from aestivation in late summer and feed on wild plants, before flying to newly emerging winter rape crops. Temperatures higher than 16 °C are required for the flight. Mating first occurs soon after emergence. Oviposition begins after 12–14 days of adult feeding. The female usually lays her pale orange eggs in cracks in the soil near the base of a rape plant. Optimum conditions for egg laying are high humidity and temperatures between 4 °C and 16 °C. Temperatures below 2 °C

inhibit oviposition, and temperatures lower than 3 °C inhibit egg development and larval activity. Maximum fecundity is 800–1000 eggs. There are three larval instars. The neonate larvae will move up to 50 cm to find a host plant. They usually penetrate the upper surface of a petiole of one of the lower leaves, near its point of insertion in the stem. Larvae burrow into the soil and excavate a cell 7–9 cm deep.

Monitoring

No commercial monitoring traps are currently available for this insect. To determine larval infestation levels in oilseed rape, a sample of rape leaf stems from across the field should be dissected and larval numbers noted.

Field control

Agrotechnical methods

- fertilizers used to accelerate the development of seedlings;
- destruction of crop residues in the fields after harvest; and
- ploughing.

Resistant varieties

Sources of resistance to rape pests are the early ripening varieties.

Biological methods

Fungi, bacteria, nematodes, and Hymenoptera may parasitize different life stages of *P. chrysocephala. P. chrysocephala* is attacked by parasitoids of the order Hymenoptera, both at the larval and adult stages, e.g. by braconids (Braconidae) – *Perilitus bicolor* Wesmael., Ichneumonidae – *Pimpla examinator* Fabr. or Pteromalidae – *Trichomalus cristatus* Foer.

Chemical methods

Spraying crops with insecticides to control adult beetles (they should be applied at sunset).

Chemical group:

1. Synthetic pyrethroids (a.i.: lambda-cyhalothrin, cypermethrin, alpha-cypermethrin or deltamethrin).

These insecticides are registered in Ukraine.

Always follow the label instructions for dosage, application and safety!

Rape leaf beetle *(Entomoscelis adonidis* Pall.*)*

General introduction

Host plants

Beetles prefer to feed on turnips and, to a lesser extent, on mustard or horseradish, as well as on weeds from the family Cruciferae (Brassicaceae).

Morphological features

Adults

Body length: 6.0–10.3 mm. Body is convex, nearly parallel-sided, yellow-reddish, with more or less distinct black markings.

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Where can they be found?

Adults feed on flowers and cruciferous leaves.

Larvae

After hatching, larvae are yellowish and covered with light club-like hairs. Mature larva are dark brown dorsally and yellow-reddish ventrally. Body length of a mature larva is 13–14 mm.

Where can they be found?

Larvae can be found on the leaves of the host plants.

Eggs

Eggs are reddish, oviform, about 2–2.5 mm long.

Where can they be found?

Females lay eggs on soil surface.

Pupae

Pupae are 9 mm long, yellow-black.

Where can they be found?

Pupae can be found in soil at a depth of 5–8 cm, in dense cocoons.

Damage

Larvae feed on seedlings of cruciferous weeds and volunteer rape and mustard. They will move into new rape and mustard fields. Larvae can cause economic damage on rape and mustard crops at the seedling stage in May. Cotyledons, first true leaves, petioles and stems may be fed upon sufficiently to cause death of the plants.

Biology

Larvae hatch in April–May. They gnaw round the leaves, leaving the veins. Larvae stop feeding and hide in soil when the temperature falls below 10 ºC. The larval stage includes four instars developing for 10–28 days. Pupation occurs at the end of spring in soil at a depth of 5–15 cm; the depth depends on the soil humidity. At a temperature of 20–22 ºC and soil humidity of 60–80 percent, pupae develop for 8–10 days. Young beetles appear in the beginning of summer, feeding for 15–17 days on leaves and flowers of crucifers. Females lay eggs on the soil surface at a temperature of about 18–24 ºC. Fertility rate is 180–250 eggs.

Monitoring

- Use of yellow traps:
  - in the field of 25–50 hectares: 1–2 traps;
  - from 50 to 100 hectares: 2–3 traps;
  - 100 hectares and more: 4 traps.

Agrotechnical methods

- crop rotation;
- field isolation from cabbage and others cruciferous cultures; and
- weed control.

Resistant varieties

Sources of resistance to rape pests are the early ripening varieties.

Biological methods

Fungi, bacteria or nematodes can parasitize different life stages of *Entomoscelis adonidis* Pall., e.g. entomopathogenic fungi *Metarhizium anisopliae* or *Beauveria bassiana*, or a pathogenic nematode *Steinernema feltiae*.

Chemical methods

When the pest is present on at least ten percent of plants with an average density of 5–6 or more individuals per plant, spraying with insecticides is recommended.

Chemical group:

1. Synthetic pyrethroids (a.i.: lambda-cyhalothrin, esfenvalerate, cypermethrin, alpha-cypermethrin or deltamethrin).

These insecticides are registered in Ukraine.

Always follow the label instructions for dosage, application and safety!

Pests of stems

Pollen beetle *(Meligethes aeneus* F.*)*

General introduction

Host plants

The pest damages rape, turnip, mustard, cabbage and other cruciferous cultures.

Morphological features

Adults

Body 1.9–2.7 mm long, oval, broadly rounded anteriorly and posteriorly, with head relatively broad. Head and body black with distinct metallic greenish, bluish or purplish sheen, legs slightly paler, especially anterior tibiae pitchy to dark yellowish.

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© T. Topchii

Where can they be found?

Adult beetles feed on flowers and leaves of cruciferous plants.

Larvae

The final instar larvae are up to 4.4 mm long, somewhat depressed with milky white bodies and black heads.

Where can they be found?

Larvae can be found on the leaves.

Eggs

Length 0.81 mm, breadth 0.29 mm, cylindrical, rounded at both ends, greyish-white but becoming milky as development occurs.

Where can they be found?

Females lay eggs on the soil surface.

Pupae

Average length 2.35 mm. Creamy-white, oval in outline, depressed in the abdominal area.

Where can they be found?

In the soil.

Damage

Holes in the buds indicate where adults have fed or laid their eggs in the buds. Severe damage to buds can cause the buds to drop.

Biology

Adults emerge in spring after overwintering in woodland and other sheltered uncultivated sites. They fly actively when temperatures exceed 12–15 °C, often feeding on the pollen of any available flowers before locating their breeding hosts (mainly Brassica). Eggs are laid in buds that are at least 3 mm long. The larvae feed on pollen in flowers taking 9–13 days to complete two larval instars. Full-grown larvae then drop to the ground, burying in the soil and forming an earthen cell in which they pupate. The new adults emerge later, and feed on pollen from any available flowers before seeking overwintering sites.

Monitoring

Presence of *M. aeneus* on a crop can most readily be determined by inspecting the flowers or by tapping inflorescences over a tray or sheet. Yellow water traps and sweep netting are often used for monitoring.

Insects in overwintering areas can be accounted for with the help of soil excavations. The size of the accounting pits should be 50 × 50 cm, and about 30 cm deep. The number of pits should be eight at each station. The number of insects per 1 m^2 should be determined.

The threshold of economic damage in the phase of bud formation is an average of one beetle per plant; in the period two weeks before flowering – an average of 2–3 beetles per plant and in the beginning of the flowering phase – 5–6 beetles per plant.

Control in the field

Agrotechnical methods

- crop rotation;
- field isolation from cabbage and other cruciferous cultures; and
- weed control.

Selection of varieties

It is recommended to choose early-flowering and pest-resistant rape varieties.

Biological methods

The number of pests is controlled by different entomophages and pathogens. For example, pest larvae are destroyed by the following insects: (Hymenoptera, Ichneumonidae) – *Aneuclis incidens*); (Hymenoptera, Proctotrupidae) – *Brachyserphus parvulus*; (Hymenoptera, Braconidae) – *Diospilus capito*; (Hymenoptera, Braconidae) – *Leiophron laeviventris*; (Hymenoptera, Ichneumonidae) – *Phradis interstitialis*; (Hymenoptera, Ichneumonidae) – *Tersilochus heterocerus*.

Eggs and larvae are destroyed by (Hymenoptera, Ichneumonidae) – *Tersilochus heterocerus*.

Beetles are destroyed by pathogens: (Fungi, Microsporidiomycota, Anncaliia) – *Anncaliia meligethi;* (Fungi, Hypocreales, Clavicipitaceae) – *Metarhizium anisopliae* or the green muscardine fungus.

Chemical methods

Spraying should be conducted during the budding period, when there is more than one beetle per plant.

Chemical group:

1. Synthetic pyrethroids (a.i.: lambda-cyhalothrin, cypermethrin, alpha-cypermethrin or deltamethrin).

These insecticides are registered in Ukraine.

Always follow the label instructions for dosage, application and safety!

Cabbage seed weevil *(Ceuthorrhynchus assimilis* Payk.*)*

General introduction

Host plants

Crops and weeds of the Brassicaceae family.

Morphological features

Adults

Adults are dull grey, 2.0–3.5 mm long.

Where can they be found?

Adults feed on wild or cultivated cruciferous plants.

Larvae

The larvae are legless, with a creamy white body and a yellow to brown head capsule, and grow to a length of 3–5 mm and a width of 1–2 mm. The body is normally slightly curved ventrally.

Where can they be found?

Larvae can be found in pods.

Eggs

Eggs are creamy-white, smooth, cylindrical with rounded ends, about 0.6 mm long and 0.4 mm wide. They are often covered with a mucus-like substance.

Where can they be found?

Eggs can be found in pods (siliquae), on the leaves or in the stem.

Pupae

Pupae are about 2 mm long.

Where can they be found?

Pupae can be found in the soil.

Damage

Beetles and larvae cause damage. Beetles gnaw through small holes in the stems and veins of leaves, which leads to the death of tissues and organs of plants. Damaged rapeseed plants ripen 10-15 days earlier, the seeds are small, underdeveloped; stems break and seeds fall.

The damage to the pod wall can also allow entry of diseases, for example canker (*Leptosphaeria maculans*), leading to dark-edged spots on the pods.

Biology

There is one generation a year. Adults spend the winter in diapause, in dry soil, litter or under shrubs. In April or May, when the air temperature exceeds 15 °C, they fly to flowers. Beetles and larvae cause damage. Females make a hole in the wall of the pod, and lay eggs in the pod.

Pods of medium length, about 20–40 mm long, are preferred for egg laying. Females lay a total of 25–40 eggs during their lifetime.

Larvae hatch after 6–10 days, but this can last up to 30 days at low temperatures. Larvae occur mainly during June and feed in pods for 14–21 days but can last up to 40 days if the weather is cold. Most infected pods contain only one larva, although sometimes two or even three are found. Each larva consumes about five seeds. After digging into soil to the depth of 10–70 mm, they form a cocoon and pupate. This usually occurs before the crop is harvested. Older adults die during June. New adult individuals appear in 15–19 days and feed on any remaining plant pods or wild hosts during July and August before finding a place for wintering.

Monitoring

Adults can be trapped in yellow water traps, particularly if baited with isothiocyanates or other components with *Brassica* plant odour. To detect larvae, it is necessary to collect developing or mature pods and cut them open. Larvae are found in between the seeds. Damage can also be assessed by collecting mature pods and inspecting them for the exit holes made by emerging adults.

Control in the field

Agrotechnical methods

- crop rotation;
- field isolation from cabbage and others cruciferous cultures; and
- weed control.

Resistant varieties

Sources of resistance to rape pests are the early ripening varieties.

Biological methods

The commonest parasitoid of the adults is *Microctonus melanopus* (Braconidae).

The entomopathogenic nematode *Steinernema feltiae* has been shown to be able to reproduce in the larvae of *C. assimilis*. Carabids have been shown to cause mortality of C. assimilis larvae in the soil.

Chemical methods

When the pest is present on ten percent of plants or more, with a population of 2–3 beetles per plant during the bud formation phase, spraying with insecticides is recommended.

Chemical groups:

1. Neonicotinoids (a.i.: lambda-cyhalothrin + thiamethoxam or thiamethoxam);
2. Organophosphorus insecticides (a.i.: dimethoate).

These insecticides are registered in Ukraine.

Always follow the label instructions for dosage, application and safety!

Cabbage white butterfly *(Pieris rapae* L.*)*

General introduction

Host plants

The primary hosts of *Pieris rapae* are plants in the Brassicaceae family, with some secondary hosts in related plant families (e.g. Capparidaceae, Rosaceae).

Morphological features

Adults

White, diurnally active butterfly with a wingspan of 4–6 cm. The wings are white with a black area near the tip of each forewing and a small black spot on the front edge of the wing. The female has two black spots on each forewing while the male has only one.

Female

Where can they be found?

Adults feed on the nectar of plants.

Larvae

The head and body of the first instar larva are pale yellow with fine transparent hairs arising from small white spots. The mature larva is about 3 cm long, its head and body are velvety green with short hairs. There is a faint yellow mid-dorsal line and numerous black, and occasional white, minute raised spots from which short translucent hairs arise. Segments have one or two yellow lateral spots.

Where can they be found?

Larvae can be found on the leaves of the host plants.

Eggs

Eggs are yellowish, with 12 longitudinal ridges.

Where can they be found?

P. rapae are known to lay eggs singularly on the host plant.

Pupae

The pupa is 18–20 mm long and has a pointed anterior spine.

Where can they be found?

The pupa is attached with a cremaster and girdle to some part of the food plant, or sometimes to a rock, fence or wall some distance away from the host plant.

When attached to the host plant, the colour of the pupa is usually green, but those attached to other objects tend to assume the colour of the background and are often grey or pink.

Damage

Larvae of *Pieris rapae* hatch on the outer leaves and feed on them superficially leaving the upper leaf surface intact. Once they hatch from the eggs, they eat their own eggshells and then move to eat the leaves of the host plant. Heavily-infested plants become ragged and stunted. The presence of masses of wet greenish-brown excrement deep among leaves is indicative of this pest. In large infestations of *P. rapae*, the plant may be reduced to a partial or complete skeleton, where all leaf tissue except the veins has been eaten.

Biology

Adults of *Pieris rapae* live for 5–20 days. Females usually begin laying eggs within a day or so of eclosion and lay 400–1000 eggs during their lifetime. *P. rapae* is usually double or triple brooded, and in most regions, overwinters as a diapason pupa. The females deposit eggs singly on the host plants. After 4–8 days, the eggs hatch and the larvae feed and develop through five instars in 10–14 days. When not feeding, the larvae lie along the ribs on the underside of the leaves. When mature, larvae fasten themselves to the lower leaf surfaces by silk bands. The pupal stage lasts for 7–12 days.

Monitoring

After harvest, pest pupae are considered to be overwintering. In 12 sites in the field, each measuring 50 × 50 cm, the average number of pests per square metre is assessed. The economic threshold of the pest before budding phase is three caterpillars per square metre.

Control in the field

Agrotechnical methods

- crop rotation;
- field isolation from cabbage and others cruciferous cultures; and
- weed control.

Resistant varieties

It is recommended to choose early-flowering and pest-resistant rape varieties.

Biological methods

Bird predators include the house sparrow (*Passer domesticus*), goldfinch (*Carduelis carduelis*) and skylark (*Alauda arvensis*). *P. rapae* caterpillars are commonly parasitized by a variety of insects. The

four main parasitoids are *Cotesia rubecula*, *Cotesia glomerata, Phryxe vulgaris,* and *Epicampocera succinata*. *C. rubecula* lays its eggs in the first and second instar caterpillars. The larvae then grow within the caterpillar and continue to feed on the caterpillar until they are almost fully-grown, and at that point, the caterpillar is killed. It is important to note that only one larva develops per host and the rate of *C. rubecula* is largely independent of *P. rapae* population size. *P. rapae* pupae are frequently parasitized by *Pteromalus puparum.*

Applications of a product based on *Bacillus thuringiensis* (Bt) or entomopathogenic fungi provide about 20 percent efficacious pest control. A naturally occurring granulosis virus may occasionally kill large numbers of the pest.

Chemical methods

Insecticide applications should begin when the population of *P. rapae* reaches a threshold of eight individuals per 100 plants.

Chemical group:

1. Synthetic pyrethroids (a.i.: lambda-cyhalothrin, esfenvalerate, cypermethrin, alpha-cypermethrin or deltamethrin).

These insecticides are registered in Ukraine.

Always follow the label instructions for dosage, application and safety!

Cabbage aphid *(Brevicoryne brassicae* L.*)*

General introduction

Host plants

Plants belonging to the family Brassicaceae (Cruciferae), both cultivated and wild.

Morphological features

Adults

Adult cabbage aphids can take on two forms: winged and wingless.

The body of winged female is ovoid, up to 1.5–2.2 mm in length. The wingless ones are 1.8-2.0 mm long.

Where can they be found?

Colonies of aphids are found on upper and lower leaf surfaces.

Nymphs (larvae)

Larvae are 1–1.2 mm long

Where can they be found?

Larvae can be found on upper and lower leaf surfaces.

Eggs

Eggs are 0.5 mm long, oval, black and shiny.

Where can they be found?

Eggs overwinter in plant debris near the soil surface.

Damage

Cabbage aphids may reduce plant growth by 35 percent, the number of side branches by 43 percent, and the oil content by over ten percent. Aphids may cause 85 percent yield loss and may induce an increase in glucosinolate content in rapeseed. Content of certain amino acids (e.g. methionine) increases in phloem sap due to cabbage aphid feeding. *B. brassicae* transmits about 20 plant viruses.

Biology

Parthenogenetic females live for 30 days; the fecundity of one female reaches 40 larvae. Larval period lasts 7–12 days. Sexual generation appears in August, then the insects lay the overwintering eggs. One female lays up to ten eggs, one by one. Oviposition lasts until the end of October. Spring larvae hatch at the daily average temperature of 7–8 °C or higher. The most favourable conditions for insects are temperatures of 25–26 °C and 60–70 percent humidity. In autumn, the oviposition ceases at the temperatures below 14 °C. The pest has 16 generations in a year.

Monitoring

The number of overwintering eggs should be checked in autumn, counting both the dead and living eggs. In one field, in the budding phase and at the end of bloom phase, 20 samples of five plants each should be taken. The economic threshold is 5–10 percent of infested plants.

Control in the field

Agrotechnical methods

- crop rotation;
- field isolation from cabbage and others cruciferous cultures; and
- weed control.

Resistant varieties

Sources of resistance to rape pests are the early ripening varieties.

Biological methods

The most important predators are: *Adalia bipunctata* L., *Coccinella septempunctata* L., *Sphaerophoria scripta* L., *Scaeva pyrastri* L., *Aphidius cardui* Marsh., *Aph. brassicae* Motsch., *Aph. vulgaris* Motsch., *Pachyneuron aphidis* Bouche, *Asaphes vulgaris* Walk., *Charips recticornis* Kieff. and others.

Chemical methods:

For large-scale (commercial) production, insecticide application should be considered when 2 percent of plants are infested with aphids.

Chemical group:

1. Neonicotinoids (a.i.: lambda-cyhalothrin + thiamethoxam, or thiamethoxam);
2. Organophosphorus insecticides (a.i.: dimethoate).

These insecticides are registered in Ukraine.

Always follow the label instructions for dosage, application and safety!

Pests of Sugar Beet

Soil pests

Common click beetle *(Agriotes sputator* L.*)*

General introduction

Host plants

The larvae of the common click beetle damage sugar beets and many other agricultural plants (corn, sunflower, peanuts and potatoes).

Morphological features

Adults

Body length is 6–9 mm, its width 1.8–2.8 mm.

Where can they be found?

They feed on the leaves of grasses or on pollen and are often seen on the flower-heads of umbelliferous plants.

Eggs

Eggs are white, oval, about 0.5–1.5 mm in length.

Where can they be found?

The eggs develop in soil.

Larvae

Larvae are yellow, about 18 mm in length.

Where can they be found?

The larvae develop in soil.

Pupae

The pupae are milky white.

Where can they be found?

Pupae develop in soil.

Damage

Damage by larvae, often called 'wireworms'. Larvae attack germinating seeds, stem base and young roots of sugar beet. Damage from wireworms can lead to growth reduction of plants, abnormal tillering, and discolouration of leaves. In severe attacks, damage can cause death of sugar beets plants, and lead to total yield loss.

Another factor that leads to an increase in the number of pests is the lack of crop rotation and repeated cultivation of sugar beets in the same field.

Biology

The adult's body is completely covered with thick greyish hairs. Larvae are yellow, up to 18 mm in length and up to 1.5 mm in width, elongated and stiff. Mandibles carry a small tooth in the middle. The pest hibernates as both adult and larva. Beetles are active from late April to mid-June. The period of adult activity lasts 1–2 months. Fertility rate is 100 or more eggs per female. Eggs develop within 12–18 days. Depending on temperature and humidity, larval development lasts from two to four years. Pupation occurs in July and August and pupae develop within 2–3 weeks. The entire generation development cycle lasts from 3 to 5 years.

Monitoring

Monitoring of the presence of wireworms can be done through soil sampling or with bait traps. For the monitoring of adult beetles, pheromone traps can be used. Using a single method to monitor larvae or adults in a field does not necessarily reflect the true amount and distribution of the pest. As wireworms appear unevenly in a field, traps can happen to be put in places with no or many larvae, which can lead to inaccurate results and not always show the actual probability of potential damage in a particular field. Damage is not only related to the number of wireworms but also to climatic and agronomic conditions and to the pest species present in that specific location.

Pheromone traps

Pheromone trapping is a method where female-produced pheromone is used to monitor male click beetles. The method has not been studied extensively but could in the future be a tool for long-term monitoring of click beetles, which is needed due to their long life cycle.

Field control

Wireworms can spend up to five years before pupation and emergence of adult beetles, therefore long-term strategies are needed to control the larvae.

Agrotechnical methods

The following activities may help reduce the number of click beetles in the field:

- ploughing;
- crop rotation;
- trap crops: plants that can divert a pest from a cash crop and can be used in intercropping systems.

Biological methods

Principal biological control agents include the green muscardine fungus (*Metarhizium anisopliae*), *Beauveria bassiana* and bacterium *Bacillus suturalis*. Larvae are parasitized by the nematode *Leptodera dentata*. *Metarhizium anisopliae* enters the larva through any area of the body. Once inside the insect, the fungus produces a lateral extension of hyphae, which eventually proliferate and consume the haemocoel of the insect.

Chemical methods

The key method for chemical control of the pest is seed treatment before sowing.

Insecticides containing active ingredients (a.i.) belonging to the following chemical groups can be recommended:

1. Synthetic pyrethroids (a.i. bifethrin);
2. Neonicotinoids (a.i. imidacloprid or thiamethoxam).

These insecticides are registered in Ukraine.

Always follow the label instructions for dosage, application and safety!

Lined click beetle *(Agriotes lineatus* L.*)*

General introduction

Host plants

The larvae of the lined click beetle damage sugar beets and many other agricultural plants (corn, sunflower, peanuts and potatoes).

Morphological features

Adults

Body length is 7.5–11 mm, light brown to dark brown.

Where can they be found?

They feed on the leaves of grasses and also on pollen and are often seen on the flower-heads of umbelliferous plants.

Eggs

The eggs are white, oval, about 0.5–1.5 mm in length.

Where can they be found?

Eggs develop in soil.

Larvae

Larvae are light yellow, about 27 mm in length.

Where can they be found?

Larvae develop in soil.

Pupae

The colour of the pupae is milky white.

Where can they be found?

Pupae develop in soil.

Damage

Damage is caused by larvae, often called 'wireworms'. Larvae attack germinating seeds, stem bases and young roots of sugar beet. Damage by wireworms can lead to growth reduction of plants, abnormal tillering and discolouration of leaves. In severe attacks, damage can cause sugar beet plants to die, leading to total yield loss.

Another factor that leads to an increase in the number of pests is the lack of crop rotation and repeated cultivation of sugar beets in the same field.

Biology

Imago and larvae overwinter. Beetles are active from late April or early May to late July, with mass flight from the second half of May to June. Beetle activity period is 1–2 months. Fertility rate per female is from 75 to 135, with a maximum of 200 eggs. Eggs are deposited in the upper layers of the soil in small groups in moist places. They develop for 14–30 days, depending on the soil temperature. Larval development takes from two to four years, depending on air temperature and humidity.

Monitoring

Detection of wireworms can be achieved through the testing of soil samples or the use of bait traps. For adult beetles, pheromone traps can be used. Using a single method to monitor larvae or beetles in a field does not necessarily reflect the actual amount and distribution of the pest in soil. Because wireworms appear unevenly in a field, traps may happen to be put in places with none or many larvae, which can lead to inaccurate results and not always show the actual probability of potential damage in that field. Damage is not only related to the number of wireworms but also to climatic and agronomic conditions and depends on the pest species present in the specific location.

Pheromone traps

Pheromone trapping is a method where female-produced pheromone is used to monitor male click beetles. The method has not been studied much but could in the future be a tool for long-term monitoring of click beetles, which is needed due to their long life cycle.

Field control

Wireworms can spend up to five years before pupation and emergence of the adult beetles. Therefore, long-term strategies are needed to control the larvae.

Agrotechnical methods

The following activities may help reduce the number of click beetles in the field:

- ploughing;
- crop rotation;
- trap crops: plants that can divert a pest from a cash crop and can be used in intercropping systems.

Biological methods

Principal biological control agents include the green muscadine fungus (*Metarhizium anisopliae*), *Beauveria bassiana* and bacterium *Bacillus suturalis*. Larvae are parasitized by the nematode *Leptodera dentata*. *Metarhizium anisopliae* enters the larva through any area of the body. Once inside the insect, the fungus produces a lateral extension of hyphae, which eventually proliferate and consume the haemocoel of the insect.

Chemical methods

The key way for chemical control of the pest is seed treatment before sowing.

Insecticides containing active ingredients (a.i.) belonging to the following chemical groups can be recommended:

1. Synthetic pyrethroid (a.i. bifethrin);
2. Neonicotinoids (a.i. imidacloprid or thiamethoxam).

These insecticides are registered in Ukraine.

Always follow the label instructions for dosage, application and safety!

Pests of leaves and stems

Sugar beet weevil *(Bothynoderes punctiventris* Germ.*)*

General introduction

Host plants

The pest is oligophagous. It feeds on plants of the family Chenopodiaceae, and with the development of the sugar industry, weevils have easily adapted to the diet of sugar beet plants.

Morphological features

Adults

Adults' body colour is basically black with many small grey peelings. Body length is 10–16 mm.

Where can they be found?

Adults can be found near sugar beet plants.

Eggs

Eggs are white to light yellow in colour, ovoid in form, 1.2–1.3 mm long and 1–1.1 mm wide.

Where can they be found?

Eggs can be found in pits in the soil.

Larvae

Larvae are cruciform, caterpillar-like and legless. The body is white with a tan or yellow head.

Where can they be found?

Larvae can be found in the soil.

Pupae

Pupae are yellowish white in colour, 10–15 mm long and 5–6 mm wide. The body of the pupa is elongated and egg shaped, with a pronounced head.

Where can they be found?

Pupae develop in soil.

Damage

Damaging infestations of leaf-feeding weevils in sugar beet fields usually occur during the first three weeks in May, although feeding weevils can also be observed as late as in June.

Adult weevils use chewing mouthparts to feed on cotyledons and leaves of young sugar beet plants. Field damage usually appears as circular or oval-shaped patches in affected areas. The weevils generally feed on leaf edges and interveinal areas but usually leave the midrib intact. Significant feeding damage can result in seedling death. Younger plants are especially vulnerable to attack. Weevils are difficult to find on or near damaged plants because they fall to the ground and "play dead" by remaining motionless after being disturbed. Their dark mottled colouring also makes them difficult to detect on the ground. Careful inspection will reveal the insects in plant debris or in the soil immediately surrounding damaged plants.

Biology

Adults appear in spring, when the soil surface (10 cm) is warmed up to 8–10 °C. Massive appearance of weevils occurs during sunny days, when the air temperature reaches 15–25 °C, and the soil surface (10 cm) warms up to 25–35 °C. Individuals that have overwintered in the upper layers of soil emerge first; then, individuals from deeper layers emerge.

The daily activity of the pests starts at around 9–10 in the morning and lasts until evening. During sunny and warm days, the highest activity of the pest can be recorded between 11 a.m. and 2 p.m. With lowering the air temperature to 2 °C, insects become listless and stiff, and they do not move until the temperature rises to 5 °C. Weevils can walk over 10 m in an hour, or up to 500 m in a day. Females lay eggs shortly after mating.

The average female deposits 94–120 eggs in one year, with a maximum of 740–950 eggs. Favourable relative air humidity during oviposition ranges from 55 to 65 percent. Egg development takes 10–15 days at 16–26 °C. Young, just hatched larvae are very sensitive to high levels of soil moisture. The larvae are highly mobile in soil. They move in the direction of sugar beet, as their secretions work as attractants.

Upon the completion of larval development, larvae move away from the roots and create a vertical chamber with smooth interior walls, in which they transform into pupae. After transformation to

the adult form, they remain in the soil until the following spring, and part of the population can remain in diapause for two years.

Monitoring

Long-term forecasts can be made in autumn, based on data on the density of overwintering adult weevils, which is determined by the analysis of soil from the fields, where sugar beets are sown. The fields are examined by digging pits, sized 50 × 50 × 50 cm, in late summer or early autumn. The excavated soil is examined for the presence of weevils. In late winter and early spring, the soil survey is repeated. In addition to a long-term (basic) forecast, a supplementary forecast may be conducted, usually early in the season, where the number of pests before and after summer is determined. Additional inspections of soil and crop residues can be performed during the growing season, on overhead and underground plant parts.

Control in the field

Agrotechnical methods

- the destruction of weeds;
- pre-sowing treatment of seeds with a special shredder;
- choosing the right precursor, observing the rules of rotation; and
- autumn ploughing.

Biological methods

Biological control agents include the green muscardine fungus (*Metarhizium anisopliae*), *Beauveria bassiana* and bacterium *Bacillus suturalis*. The larvae are parasitized by the nematode *Leptodera dentata*. *Metarhizium anisopliae* enters the larva through any area of the body. Once inside the insect, the fungus produces a lateral extension of hyphae, which eventually proliferates and consumes the haemocoel of the insect. Entomophages play an important role in regulating the number of beetles.

Chemical methods

Insecticides for seed treatment before sowing.

Chemical groups:

1. Neonicotinoids (a.i.: imidacloprid);
2. Phenylpyrazoles (a.i.: fipronil).

When the number of beetles is 4–5 individuals/m², in the seedling phase, spraying with organophosphorus insecticides (a.i.: pyrimifos-methyl) is recommended.

These insecticides are registered in Ukraine.

Always follow the label instructions for dosage, application and safety!

Beet leaf miner *(Pegomyia betae* Curtis.*)*

General introduction

Host plants

Beet (Beta vulgaris L.) and other members of the Chenopodiaceae family.

Morphological features

Adults

Adults about 5–7 mm in length with a dark grey body, a silvery head and dark yellow legs.

Where can they be found?

Adults can be found on beet leaves.

Eggs

Eggs are white, elongated and measure around 0.3–1 mm.

Where can they be found?

Eggs can be found on the undersides of the leaves of beet plants.

Larvae

Larvae are 8 mm long, whitish to pale green.

Where can they be found?

Larvae can be found in the leaves of beet plants.

Pupae

Pupae are small and brown, 4–6 mm long.

Where can they be found?

Pupae develop in soil.

Damage

The mining of the leaves of young beet plants by the pest causes large empty spots ("blotches") that may occupy an entire leaf, often containing several maggots. In Europe, the fly is a pest of economic importance.

Biology

The fly overwinters as pupae in the soil and hatches in late April and May. The adult fly then lays eggs on the leaves and the resulting larvae begin their damage. The oblong white eggs, less than 1 mm long, are laid in neat clusters on the underside of the leaves. They are easy to spot if you scout by looking under the leaves. The maggots may migrate from leaf to leaf down a row. They become fully grown in just a few weeks and drop into the soil to pupate.

The entire life cycle is 30–40 days. There are three to four generations per season. Typically mid-late May, late June and mid-August are the peak activity periods.

Monitoring

Young seedlings should be regularly checked for leaf mines. Most mines occur on cotyledons and the first true leaves. Some mines are more visible when seen from the underside of the leaf. If the leaf miner population builds to high levels when seedlings have four to five leaves, a chemical treatment may be necessary. Treat if you find more than an average of one mine per leaf in your overall field sample.

Control in the field

Agrotechnical methods

In early spring, plough a susceptible field deep to expose the overwintering pupae to the environment. Destroy susceptible weeds, as well as the remnants of the old crop.

Biological methods

In various regions, the pest is attacked by the braconid endoparasitoid *Opius nitidulator* (Nees). In Ukraine, some Coccinellidae and *Chrysoperla carnea* prey on *Pegomiya cunicularia*. The entomopathogenic fungus *Beauveria bassiana* is another enemy. Entomopathogenic nematodes kill the pupae in the soil and develop within their bodies, reducing the larval populations in sugar beet leaves by 76–81 percent.

Chemical methods

Chemical group:

1. Neonicotinoids (a.i.: thiacloprid or imidacloprid);
2. Combined insecticides (a.i.: thiacloprid + deltamethrin);
3. Organophosphorus insecticides (a.i.: dimethoate).

These insecticides are registered in Ukraine.

Always follow the label instructions for dosage, application and safety!

Black bean aphid *(Aphis fabae* Scop.*)*

General introduction

Host plants

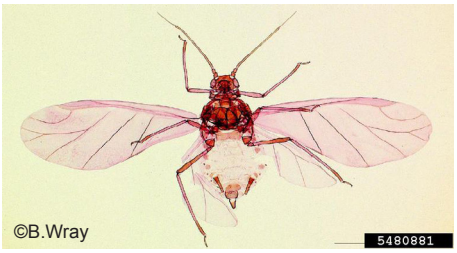
Black bean aphids colonize more than 200 different species of cultivated and wild plants, including sugar beets, beans, potatoes, sunflowers, carrots, tobacco, and tomatoes.

Morphological features

Adults

The wingless parthenogenic females are 1.8–2.5 mm long. Their oval body is black with a green-brown tinge. Winged females are 1.4–2 mm long. Their abdomen is black-green. Amphigonous females are 2.2–2.7 mm long, wingless, blue-black or matte-green.

Wingless females



Winged females

Where can they be found?

Adults can be found on beet plants.

Eggs

Eggs are 0.5–0.6 mm long, oval and yellow-green.

Where can they be found?

Eggs can be found on the branches of trees or shrubs, e.g. Viburnum opulus L.

Larvae

Larvae are similar to adults, but smaller – 1.5–1.7 mm long.

Where can they be found?

Larvae can be found on the leaves and stems of beets.

Damage

As a result of infestation by this aphid, leaves of beet become swollen, roll, and cease developing. The roots grow poorly and the sugar content is reduced. In some other plants, the leaves do not become distorted, but growth is affected and flowers abort due to the action of the toxic saliva injected by the aphid to improve the flow of sap. These aphids are also the vectors of about 30 plant viruses.

Biology

The black bean aphid has both sexual and asexual generations in its life cycle. The primary host plants are woody shrubs, and eggs are laid on these by winged females in the autumn. The adults then die and the eggs overwinter. The aphids that hatch from these eggs in the spring are wingless females known as stem mothers. These are able to reproduce asexually, giving birth to live offspring, nymphs, through parthenogenesis. The lifespan of a parthenogenetic female is about 50 days and during this period, each can produce as many as 30 young. The offspring are also females and able to reproduce without mating, but further generations are usually winged forms. These migrate to their secondary host plants, completely different species that are typically herbaceous plants with soft, young growth.

Further parthenogenesis takes place on these new hosts on the undersides of leaves and on the growing tips. All the offspring are female at this time of year and large populations of aphids develop rapidly

with both winged and wingless forms produced throughout the summer. Winged individuals develop as a response to overcrowding and they disperse to new host plants and other crops.

As autumn approaches, the winged forms migrate back to the primary host plants. Here, both males and sexual females are produced parthogenetically, mating takes place, and these females lay eggs in crevices and under lichens to complete the lifecycle. Each female can lay six to ten black eggs, which can survive temperatures as low as -32° C.

Monitoring

The percentage of beet plants infested by aphids should be determined visually in the third decade of May and in June. Five plants in 20 sites should be inspected on two diagonals of the field. If more than 15 percent of plants are infested, the field should be sprayed with an insecticide.

Control in the field

Agrotechnical methods

- destruction of weeds;
- choosing the right precursor, observing the rules of rotation; and
- autumn ploughing.

Biological methods

Natural predators of black bean aphids include both adults and larvae of ladybirds (Coccinellidae) and lacewings (Chrysopidae), and the larvae of hoverflies (Syrphidae). Certain species of tiny parasitic wasps lay their eggs inside aphids and the developing wasp larvae devour their hosts from inside. Members of the wasp genera *Diaeretiella* and *Lysiphlebus* can serve as a means of combating the aphids.

Chemical methods

Chemical treatment of crops in critical phases of beet growth.

Chemical group:

1. Synthetic pyrethroid (a.i.: lambda-cyhalothrin);
2. Neonicotinoids (a.i.: thiamethoxam);
3. Combined insecticides (a.i.: thiacloprid + deltamethrin).

These insecticides are registered in Ukraine.

Always follow the label instructions for dosage, application and safety!

Mangold flea beetle *(Chaetocnema concinna* Marsh.*)*

General introduction

Host plants

This species is a pest of sugar and fodder beet; also causes damage, to a lesser degree, to buckwheat, spinach and sorrel.

Morphological features

Adults

Adults are 1.5–2.3 mm long. Body is green, upper side with reddish or greenish metallic sheen.

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Where can they be found?

The adults feed on the parenchyma of beet leaves.

Eggs

Eggs are yellow, elongated oval, 0.6–0.7 mm long and 0.2–0.3 mm wide.

Where can they be found?

Eggs can be found in the soil at a depth of 3–5 cm.

Larvae

Larvae are 1.5–2.2 mm long.

Where can they be found?

Larvae can be found on the roots of curlytop knotweed (*Polygonum lapathifolium* L.).

Pupae

Pupae are 1.7–2 mm in length and white.

Where can they be found?

Pupae develop in soil.

Damage

Adults eat small shot holes in the cotyledons and first leaves. If the weather is hot and the beetle population large then seedlings may be destroyed. Larvae in soil eat the roots but cause no discernible damage.

Biology

Beetles appear at the end of March or in April at temperatures of 8–9 °C and eat leaf parenchyma. Propagation begins at 19.5 °C. Oviposition occurs from June until the end of July. Females lay eggs in groups of 2–6 in the soil near host plants at a depth of 3–5 cm. Fertility is about 40 eggs. Development of eggs lasts 11–13 days. Pupation occurs in soil. New generation adults appear at the end of summer and migrate in the middle of September to forest belts and soil sods for hibernation.

Monitoring

Scout Plants. It is important to look for flea beetles on susceptible plants, especially in the spring.

Sticky Traps. Sticky traps are a monitoring tool that provide a guideline of when beetles are present and in what quantity but are ineffective in reducing their populations. Either yellow or white sticky traps can be used. They should be placed around susceptible host plants just after planting but before seedlings emerge. Replace them when the adhesive is covered by insects or no longer sticky. Sticky traps can be used until plants are well established or until harvest. They will also attract some beneficial insects, including pollinators, so consider this negative attribute when planning to use them.

Control in the field

Agrotechnical methods

- sowing sugar beets at the earliest time; and
- using fertilizers to accelerate seedling development and eradication of weeds from fields.

Biological methods

Parasites and predators. Generalist predators such as larvae of lacewing (*Chrysopa* spp.), adult big-eyed bugs (*Geocoris* spp.) and damsel bugs (*Nabis* spp.) feed on adult flea beetles. Additionally, a parasitoid wasp (*Microctonus vittatae*) can kill some species of adult flea beetles. These beneficial insects are attracted to nectar and pollen–producing plants such as anise, chamomile, clover, dill, and marigold.

Nematodes. Entomopathogenic nematodes (*Steinernema* spp. and *Heterorhabditis* spp.) can attack the flea beetle larvae, reducing the subsequent adult populations.

Beneficial microorganisms. White muscadine, a disease that can reduce flea beetle populations, is caused by the fungus *Beauvaria bassiana*. When insects come into contact with the fungal spores, the spores attach to the insect, germinate, and penetrate the insect's body. The fungus releases toxins that liquefy the internal contents of the insect, creating a food source for the fungus and subsequently killing the insect. Since sunlight can dry out and kill spores, applying commercially formulated *B. bassiana* products in the evening and in humid conditions will improve their efficacy.

Chemical methods

Spraying crops with insecticides to control adult beetles (treatments should be applied at sunset).

Chemical groups:

1. Organophosphorus insecticides (a.i.: phosalone);
2. Combined insecticides. (a.i.: thiacloprid + deltamethrin);
3. Synthetic pyrethroids (a.i.: lambda-cyhalothrin);
4. Neonicotinoids (a.i.: thiamethoxam).

These insecticides are registered in Ukraine.

Always follow the label instructions for dosage, application and safety!

Pests of Cereals

Sunn pest *(Eurygaster integriceps* Put.*)*

General introduction

Host plants

Wheat and other cereals.

Morphological features

Adults

Body length 9–12 mm, varying in colouration but usually light brown, wide oval body, with a large scutellum covering the wings.

Where can they be found?

On stems, leaves and ears (during the vegetation period), often in forest litter (in winter).

Eggs

The eggs are about 1 mm in diameter, green, shiny, spherical or barrel-shaped.

Where can they be found?

On the underside of leaves, on stems, weeds, ground lumps, laid in rows next to each other, each row normally containing seven eggs.

Nymphs

Similar to the adult in appearance when fully grown, but with rudiments of wings only. There are five nymphal stages.

Where can they be found?

Nymphs can be found on leaves, stems and ears of cereals.

Damage

Cereal crops infested with *E. integriceps* display yellowing of the leaves and stems, with dead heart and subsequent dieback of whole plants. Adults cause this first stage in crop damage after they exit the overwintering stage.

Biology

The sunn pest has one generation per year. Overwintered adults start flying at an average daily temperature of 13–17 °C in spring. They migrate from their overwintering sites (litter in woods mostly) to cereal fields. Fertilized females lay eggs in a few (generally 2–3) rows, normally containing seven eggs per row, on the underside of leaves, on stems, weeds or sometimes ground lumps. Both the abiotic conditions and the phase of development of the host plant have an effect on the fertility. Oviposition lasts several weeks, and eggs may develop from about a week to a month. Nymphs (the pest has five nymphal stages) cause damage by feeding (piercing and sucking) on different parts of the plant. Feeding may be especially harmful if it occurs on young grains, (injection of saliva reduces baking quality). If the insect cannot complete its development before harvest, then the larvae and young adults continue feeding under windrows, or on fallen ears and grain. Fully developed adults migrate to overwintering sites.

Monitoring

A system for monitoring the population of the sunn pest should include:

- spring counting of the insects in the overwintering sites;
- counting of overwintered insects on crops;
- counting of larvae; and
- autumn counting of bugs in the overwintering sites.

Pest populations should be monitored regularly to determine if it is necessary to apply chemical control. The use of entomological sweep nets is effective for collecting the insects. Plants should be assessed for the presence of symptoms and different developmental stages of the pest. Sites suitable for overwintering (e.g. forest litter) should also be inspected, as this may help predict the risk of infestation during the next season.

Control in the field

Agrotechnical methods

- growing early-ripening varieties and establishing a single regional planting date to minimize damage;
- crop rotation;
- ploughing the field;
- destruction of plant debris; and

Resistant varieties

Sowing varieties which are resistant to this particular pest can help avoid crop damage. Resistant varieties include Pochaevka, Vesnyanka, Sonechko, Ermak, Panna and Zolotokolosa (Ukraine), Rostovchanka 3, Don 95, Stepnaya, Yermak, Garant (Russia), Sardari, Roshan, Tabassi, Omid, Ghods and Karaj 1 (Iran).

Biological methods

A biological control agent, entomopathogenic fungus *Beauveria bassiana* has demonstrated potential in controlling the pest, as it kills the insects when other biological agents do not, i.e. during diapause. Another control agent effective against *E. integriceps* is the microorganism *Bacillus thuringiensis*.

Chemical methods

The use of chemical insecticides is not always necessary and the number of applications should be reduced based on the results of insect scouting.

According to the type of action, insecticides used against the sunn pest are divided into two groups: contact and systemic.

Chemical groups:

1. Neonicotinoids (a.i.: thiamethoxam);
2. Synthetic pyrethroids (a.i.: lambda-cyhalothrin);
3. Combined insecticides (a.i.: lambda-cyhalothrin + thiamethoxam).

These insecticides are registered in Ukraine.

Always follow the label instructions for dosage, application and safety!

Wheat grain beetle *(Anisoplia austriaca* Herbst.*)*

General introduction

Host plants

Wheat and other cereals.

Morphological features

Adults

The beetle body length is 13–16 mm. Body and legs are black with a green sheen. Elytra are yellow-brown or red-brown, deeply striated, with a black square spot near the shield in females.

Where can they be found?

The beetle is most harmful in black earth steppes of Ukraine. Beetles fly from June until July, living openly on ears of grain cereals.

Eggs

Eggs are white, nearly globose, and up to 2 mm in diameter. In July, females lay eggs in soil at a depth of 8–20 cm. Fertility per female reaches 50 eggs laid over 2–3 sittings. Eggs develop over 2–4 weeks (in July and August), depending on soil temperature.

Where can they be found?

The eggs develop in soil.

Larvae

Larvae are white, with yellow-brown head and legs, up to 35 mm long. They develop over 22–23 months and overwinter twice in soil at a depth of 30 to 80 cm. The older larvae (after the second overwintering) pupate in May at a depth of 8–15 cm in soil.

Where can they be found?

Larvae develop in soil.

Pupae

Pupae are yellow-brown, 15–17 mm long. They develop over 10–20 days from May until June.

Where can they be found?

Pupae develop in soil.

Damage

Each beetle eats 7–8 g of grain during its life, but it also knocks out many grains from the ears. In total, each beetle destroys 9–10 ears of grain cereals. Larvae feeding in soil on roots and seedlings of cereals can cause thinning of young crops. The economic threshold for this pest is three beetles per square metre. If the density of the pest population is higher than ten beetles per square metre, and the thickness of sowing is not more than 250 stems per square metre, grain yield losses may reach up to 50 percent. In seasons with favourable conditions, the density of the pest population can reach up to 60–100 beetles per square metre, especially at field borders.

Biology

The beetle has a two-year development cycle. The larvae feed on plant roots and on humus. The larvae pupate in late May. In late June, the adult beetles surface from the soil.

The adult beetles feed on cereals such as rye, wheat or barley, consuming the more immature plants. Female beetles lay their eggs 10–12 days after emergence. Each cluster may contain up to 50 eggs. After three weeks, the larvae hatch and the cycle begins anew.

The beetles prefer daylight and are most active in sunny weather.

Monitoring of the pest population

- systematic observations of adults;
- surveys for the presence of larval stages; and
- systematic analysis of data on the status of the populations of the pest and calculation of the expected number of adults and larvae.

Control in the field

Agrotechnical methods

The most effective way to control the beetle is to cultivate and plough the soil. This is usually done in spring or early summer. This method allows you to get rid of 70 percent of larvae that live in the soil.

Resistant varieties

Sowing varieties which are resistant to the pest can help avoid crop damage. Resistant varieties include Panna, Pochaevka, Vesnyanka, Ermak, Sonechko and Zolotokolosaya.

Biological methods

Use of biological control agents such as the green muscadine fungus (*Metarhizium anisopliae*), *Beauveria bassiana* and bacterium *Bacillus suturalis*.

Larvae are parasitized by the nematode *Leptodera dentata*. *Metarhizium anisopliae* generally enters larvae through any area of the body. Once inside the insect, the fungus produces a lateral extension of hyphae, which eventually proliferate and consume the haemocoel of the insect. Entomophages play an important role in regulating the number of the beetles.

Chemical methods

Insecticides against wheat grain beetle

Chemical groups:

1. Synthetic pyrethroids (a.i.: lambda-cyhalothrin);
2. Neonicotinoids (a.i.: lambda-cyhalothrin + thiamethoxam);
3. Organophosphorus insecticides + pyrethroid (a.i.: chlorpyrifos 500 g/l + cypermethrin 50 g/l).

These insecticides are registered in Ukraine.

Always follow the label instructions for dosage, application and safety!

Corn ground beetle (Cereal ground beetle) *(Zabrus tenebrioides* Goeze*)*

General introduction

Host plants

Wheat and other cereals.

Morphological features

Adults

Adults are 14–16 mm in length, black with a slight metallic sheen. Elytra are convex, with nine strips.

Where can they be found?

Adults can be found on the ground surface or in the soil.

Eggs

Eggs are 2–5 mm, oval, and brilliant white.

Where can they be found?

Eggs can be found in the soil.

Larvae

Larvae are 5–10 mm long when newly hatched and 25–28 mm long when full-grown. They are off-white, with a dark brown head and three thoracic segments; abdominal segments have light brown dorsal spots. The body is flattened.

Where can they be found?

Larvae can be found in the soil, living in burrows close to its host plant.

Pupae

Pupae are 14–17 mm long, yellowish, later light brown, with visible legs and wings.

Where can they be found?

Pupae are located in ground cocoons.

Damage

Typical symptoms of *Zabrus tenebrioides* larval attack on wheat plants are shown in the picture below.

Larvae live in the upper layer of soil, within burrows adjacent to the host plants. At night, they leave the burrows and feed on wheat leaves.

Biology

The beetles start emerging in May–June. They feed on the developing ears of grain. During warm and dry summers, adults bury themselves in the ground, becoming active again usually from the second half of August or the beginning of September, when temperatures decrease and the weather becomes rainy.

They then lay eggs at a depth of 5–15 cm in the soil. One female lays 50-70, up to 270 eggs. Low humidity hinders egg development. Larvae live in the upper layer of the soil (at a depth of approx. 10–20 cm), within burrows adjacent to their host plants. At night, they leave the burrows and feed on the leaves. For diurnal feeding, larvae drag leaves inside their burrows. Leaves of the affected plants are shredded and reduced to a fine, fibrous mat on the soil surface. Feeding activity decreases during cold periods from late autumn, and the larvae overwinter in the soil. They are sensitive to low ground temperatures. Larval activity increases in spring and they continue damaging leaves until pupation, which takes place at the end of April to second half of May. The pupal stage lasts 15–20 days.

Monitoring

Soil excavation in autumn: up to 10 ha – 8 samples; up to 50 ha – 12 samples; up to 100 ha –16 samples. Sample size is 50×50 cm (0.25 m^2), depth up to 50 cm. Count the number of beetles, larvae and eggs. The economic threshold is 2–3 larvae per square metre. In the spring tillering phase, the second soil excavation should be done (to find out the number of larvae).

Control in the field

Agrotechnical methods

Agrotechnical methods are of great importance for the control of the ground beetle. These include:

- use of crop rotation and prevention of repeated sowing of cereal crops in the same field;
- timely grain harvesting; and
- destruction of volunteer plants seedlings.

Biological methods

Tahini-flies and wasp riders from the genus *Proctotrupes* have a large impact on the number of beetles. These insects lay eggs in the body of young beetles and the ground beetle larvae.

Chemical methods

Various chemical insecticides are used to control the cereal beetle.

Chemical group:

1. Organophosphorus insecticides (a.i.: diazolin);
2. Neonictionoids (a.i.: thiamethoxam);
3. Synthetic pyrethroids (a.i.: lambda-cyhalothrin).

Seed treatment**:**

1. Neonicotinoids (a.i.: imidacloprid).

These insecticides are registered in Ukraine.

Always follow the label instructions for dosage, application and safety!

Cereal leaf beetle *(Oulema melanopus* L.*)*

General introduction

Host plants

All cereals, grains and various grasses including: barley, wheat, oats, rye, sorghum, timothy, ryegrass, foxtail grass and bluegrass.

Morphological features

Adults

Cereal leaf beetle adults are small but brightly coloured. They are about 6.5 mm long and 1.5 mm wide with a metallic blue head and forewings. The legs are yellow, and the "neck" and thorax are orange-red.

Where can they be found?

On leaves of wheat and other cereals.

Larvae

The larva is white or yellow, hump-backed, and has a black head and six small legs. It has a defence mechanism in which it smears excrement on its body to mask its vibrant colour and to deter predators.

Where can they be found?

On the leaves of cereal crops.

Eggs

Eggs are cylindrical and round, about 0.9 mm long and 0.4 mm wide. They are bright yellow at first and darken over time, and are partially black, when the larvae emerge.

Where can they be found?

Eggs are often laid along the midvein on the undersides of leaves.

Pupae

Pupae are yellow to yellowish brown. They are rarely seen because they are in the soil, encased in earthen cells.

Damage

Where can they be found?

The pest infects a number of important crops, including wheat, oats and barley.

Biology

Cereal leaf beetles have one generation per year and overwinter as adults. In spring, adults seek out newly-sown fields of small grains to feed and mate. Temperatures above 15–17 °C are ideal for flight and mating. Females deposit up to 300 eggs on the undersides of leaves. Eggs hatch in 4–23 days, depending on spring temperatures. Newly-hatched larvae begin feeding on the upper leaf surface. Larvae feed and grow for about 12–20 days while going through four instars. Larvae drop to the ground and burrow into the soil to pupate. Adults emerge from the pupal cases in about 10–21 days. The total development time from egg to adult is about six weeks, depending on food quality and temperature. Adults will feed on various plants for about 14 days before finding an overwintering shelter. Adults can be found in hollowed-out grass stems or other plant debris, under bark.

Monitoring

In spring (late April and early May), the number of young beetles should be monitored for overwintering. There should be 20 sites per field, with an area of 0.25 m^2 (50 x 50 cm) each, in which the insects are counted. The number of larvae is determined 12–14 days after the appearance of the first eggs.

Control in the field

Agrotechnical methods

- appropriate crop rotation;
- early harvest of grain crops;
- exclusion of grain losses;
- immediate and careful removal of straw from the field; and
- elimination of volunteer plants, from summer to early autumn.

Resistant varieties

Trichomes or pubescence (plant hairs) deter feeding. Leaf pubescence in wheat can deter oviposition and affect hatchability, larval survival and adult feeding on resistant wheat varieties. Trichomes of pubescent wheat varieties contain silica, which imparts indigestibility. Narrow-leaved cereal varieties also resist larval feeding by limiting the space for feeding and larval activity.

Sowing varieties, which are resistant to this particular pest can help avoid crop damage. Resistant wheat varieties include Bogdana, Vesnyanka, Favoritka, Kamma, Caribo and Diplomat.

Biological methods

Natural enemies of the cereal leaf beetle include insect predators, parasitoids, mites and some bird species. Several options exist to control the populations of the adults, which feed on leaves.

The first is *Hyalomyodes triangulifer*, a tachinid fly that parasitizes adults of *O. melanopus.*

Other biological control agents include larval parasites of wasps *Diaparsis carnifer, Lemophagus curtis*, and *Tetrastichus julis*. *D. carnifer* and *L. curtis* both consume the *O. melanopus* larvae, and *T. julis* lays its eggs inside of the body of the larvae. *Anaphes flavipes* is an egg parasitoid that lays its eggs inside the *O. melanopus* eggs, killing them in the process. Effectiveness is around 90 percent. The Coccinellidae ladybird beetles are known to eat the eggs and larvae of *O. melanopus* and are effective in some locations.

Chemical methods

Spraying of wheat fields where the number of beetles observed is within 40–50 per square metre before they lay eggs, with the following insecticides:

Chemical groups:

1. Synthetic pyrethroids (a.i.: lambda-cyhalothrin or deltamethrin);
2. Neonicotinoids (a.i.: acetamiprid).

These insecticides are registered in Ukraine.

Always follow the label instructions for dosage, application and safety!

Barley flea beetle *(Phyllotreta vittula* Redt.*)*

General introduction

Host plants

Wheat and other cereals.

Morphological features

Adults

Body length is 1.5–1.8 mm. Body is slightly convex, elongated and oval, dark green in colour; elytron with wide light yellow band that slightly curves towards the suture near apex. Head and pronotum with metallic green shine.

Where can they be found?

On leaves of, wheat and other cereals.

Larvae

Larvae feed on small roots of cereals. Body length of last instar larva is 3.5 mm; integument covered with sparse hairs; apex of last abdomen segment with spine.

Where can they be found?

Pupation occurs in soil cradles.

Eggs

Females lay eggs under the soil surface. The eggs are pale yellow, oval, 0.52 mm long.

Where can they be found?

Eggs can be found in the soil at a depth of 2–3 cm.

Pupae

Light yellow, 3 mm long.

Where can they be found?

Pupae occur several inches deep in the soil.

Damage

Beetles eat parenchyma on the upper side of the leaves, leaving narrow bands.

Biology

Beetles overwinter under leaves in different places: e.g. forests or beams. In spring, they fly to the field and damage the leaves of wheat. Shoots become inconspicuous, looking sick. Females lay eggs in the ground to a depth of 2–3 cm. Larvae pupate in the ground at a depth of 5–7 cm. New beetles fly in July.

Monitoring:

Scout plants. It is important to look for flea beetles on susceptible plants, especially in the spring.

Sticky traps. Sticky traps are monitoring tools that provide a guideline on when beetles are present and in what quantity, but are ineffective in reducing their populations. Either yellow or white sticky traps can be used. They should be placed around susceptible host plants just after planting but before seedlings emerge. Replace them when the adhesive is covered by insects or no longer sticky. Sticky traps can be used until plants are well established or until harvest. They will also attract some beneficial insects, including pollinators, so consider this negative attribute when planning to use them.

Field control:

Agrotechnical methods

- Crop rotation;
- Early harvest of grain crops;
- Exclusion of grain losses;
- Immediate and careful removal of straw from the field; and
- Elimination of volunteer plants from summer to early autumn.

Resistant varieties

Plant varieties resistant to infestation by the pest may be used.

Biological methods

Parasites and Predators. Generalist predators such as larvae of lacewing (*Chrysopa* spp.), adult big-eyed bugs (*Geocoris* spp.) and damsel bugs (*Nabis* spp.) feed on adult flea beetles. Additionally, a parasitoid wasp *Microctonus vittatae* can kill some species of adult flea beetles. These beneficial

insects are attracted to nectar and pollen-producing plants such as anise, chamomile, clover, dill, and marigold.

Nematodes. Entomopathogenic nematodes (*Steinernema* spp. and *Heterorhabditis* spp.) can attack the flea beetle larvae, reducing the subsequent adult populations.

Soil microorganisms. The entomopathogenic fungus *Beauvaria bassiana* is able to rapidly reduce the insect population. When insects come into contact with the fungal spores, the spores attach to the insect, germinate, and penetrate the insect's body. The fungus releases toxins that kill the insect. Since sunlight can dry out and kill spores, applying commercially formulated *B. bassiana* products in the evening and in humid conditions will improve their efficacy.

Chemical methods

Spraying crops with insecticides to control adult beetles (treatments should be done at sunset).

Chemical group:

1. Synthetic pyrethroids (a.i.: lambda-cyhalothrin); (a.i.: deltamethrin).

These insecticides are registered in Ukraine.

Always follow the label instructions for dosage, application and safety!

Wheat aphid *(Schizaphis graminum* Rond.*)*

General introduction

Host plants

This aphid feeds almost exclusively on a range of grasses in the Poaceae family.

Morphological features

Adults

The body of the female is light green with a longitudinal stripe along the dorsal side. Body length ranges from 2.7 to 2.9 mm and the antenna is twice as long as the body. There are two forms of aphids: winged and wingless females and males. Reproduction in the spring is parthenogenetic, and sexual in the autumn.

Where can they be found?

The aphids feed on both lower and upper sides of leaves and on ears of wheat. Both wingless and winged forms of aphids can be found on the host plants.

Eggs

Eggs are 0.6 mm in size, black and shiny.

Where can they be found?

On the leaves of cereals.

Larvae

Larvae are oval, with light green bodies and a darker green stripe along the back. Larvae and nymphs are similar to adults.

Damage

Feeding by *S. graminum* causes chlorosis and necrotic spots at the feeding sites on susceptible plants.

Biology

Maximum aphid numbers can be observed at the end of June and July. Aphid infestations are very dangerous when the plants are at the stage of stem elongation. During the ripening of summer cereals, the number of aphids rapidly decreases. The most favourable conditions for the insect are temperatures of 20–21 °C, with a relative humidity of 65–70 percent for apterous females, and 25.8 °C and 70 percent humidity for winged females. The appearance of sexual generation depends on the temperature and photoperiod. Aphid populations can be particularly numerous after years with moist and damp summers.

Monitoring

Aphids should be counted in autumn and spring on winter crop seedlings, and the overwintering populations – in late October and early spring. Abundance can be established by analysis of plant samples. One sample is made up of 0.5 m of plants collected along the sowing line, and the sum of all samples is equal to the number of plants per one square metre. In each field, 16 samples are collected. In the spring, the first count is carried out in the phase of exit to the tube of winter wheat. In the beginning of flowering of winter wheat phase, the second count of the number of wheat aphids is carried out, counting them on the ears. Twenty samples are collected from one field, each consisting of five ears.

Control in the field

Agrotechnical methods

- appropriate crop rotation;
- early harvest of grain crops;
- exclusion of grain losses;
- immediate and careful removal of straw from the field; and
- elimination of volunteer plants from summer to early autumn.

Resistant varieties

Host Plant Resistance – resistant varieties include Pochaevka, Sonechko, Panna, Ermak, Zolotokolosa (Ukraine), ELS (K-43578, Norway), SV 01290b (K-46604, Sweden), Izobamba (K-49386, Ecuador) and Asakaza Komugi (K-59945, Japan).

Biological methods

Natural enemies include predators such as ladybirds (Coleoptera: Coccinellidae), lacewings (Neuroptera: Chrysopidae), damsel bugs (Hemiptera: Nabidae), spiders (Araneae), ground beetles (Coleoptera: Carabidae) and syrphid flies (Diptera).

It has been found that the bacteria *Bacillus thuringiensis* Berliner (strains V-6066 and V-5689) are able to suppress the vital activity of the wheat aphid.

Chemical methods

The most recommended chemical treatments against the wheat fly are insecticide sprays in the critical phases of vegetation of winter wheat.

Chemical groups:

1. Synthetic pyrethroids (a.i.: lambda-cyhalothrin);
2. Combined insecticides (a.i.: lambda-cyhalothrin + thiamethoxam);
3. Neonicotinoids (a.i.: thiamethoxam);
4. Synthetic pyrethroids (a.i.: deltamethrin).

These insecticides are registered in Ukraine.

Always follow the label instructions for dosage, application and safety!

Grain aphid *(Sitobion avenae* F.*)*

General introduction

Host plants

This aphid feeds almost exclusively on a range of grasses in the Poaceae family.

Morphological features

Adults

The adult of *Sitobion avenae* is medium-sized and spindle-shaped. It shows colour polymorphism with green and brown forms predominating (immature aphids are green or red.) The antennae are black and somewhat shorter than the body. The legs are yellow but the tips of femora, tarsi and tibiae are dark. The *Sitobion avenae* apterous body length is 1.3–3.3 mm. The two colour forms are especially noticeable in late spring when colonies of bright green or reddish nymphs can be seen on the leaves.

Where can they be found?

Aphids feed on both lower and upper sides of leaves and on the ears of wheat. Both wingless and winged forms of aphids can be found on the host plants.

Eggs

Eggs 0.6 mm in size, black and shiny.

Where can they be found?

Eggs can be found on winter wheat or wild cereals.

Larvae

Larvae and nymphs are similar to adults.

Where can they be found?

Larvae can be found on winter wheat or wild cereals.

Damage

Grain aphids reduce yield by sucking sap from the plants, by excreting honeydew, which becomes covered with sooty moulds, and by transmitting barley yellow dwarf virus.

Biology

The reproduction of *S. avenae* depends on climatic conditions. In milder climates, it is completely anholocyclic, i.e. there are only parthenogenetic females, even during the cool season. However, these cannot withstand low temperatures for a long period, so the monocyclic lineages are frequently found in colder parts of the aphid's range. This species is monoecious. During the warm season, population growth can be very rapid. Each female produces several larvae a day over a period of approximately 3–4 weeks. The larvae pass through four instars over an 8–12 day period and later give birth to new generations. The viviparous morph is usually wingless. When environmental conditions become unfavourable, e.g. as feeding sites become overcrowded and food becomes scarce (because grains become dried and hardened), winged forms may appear that then migrate through the field and can often cover large distances, if carried by the wind.

Monitoring

- sampling of plants on 0.5–1 m^2; and
- use of yellow traps Merike (a variety of entomological equipment used for catching flying insects).

Control in the field

Agrotechnical methods

- Appropriate crop rotation;
- Early harvest of grain crops;
- Exclusion of grain losses;
- Immediate and careful removal of straw from the field; and
- Elimination of volunteer plants from summer to early autumn.

Host plant resistance

Resistant varieties include Pochaevka, Sonechko, Panna, Ermak and Zolotokolosa.

Biological methods

Natural enemies include predators such as ladybirds (Coleoptera: Coccinellidae), lacewings (Neuroptera: Chrysopidae), damsel bugs (Hemiptera: Nabidae), spiders (Araneae), ground beetles (Coleoptera: Carabidae) and syrphid flies (Diptera).

It has been found that the *Bacillus thuringiensis* Berliner (strains V-6066 and V-5689) are able to suppress the vital activity of *Sitobion avenae* F.

Chemical methods

The most recommended chemical treatments against the grain aphid are insecticide sprays in the critical phases of vegetation of winter wheat.

Chemical group:

1. Synthetic pyrethroid (a.i.: lambda-cyhalothrin); (a.i.: deltamethrin);
2. Neonicotinoids (a.i.: lambda-cyhalothrin + thiamethoxam); (a.i.: thiamethoxam).

These insecticides are registered in Ukraine.

Always follow the label instructions for dosage, application and safety!

Bird cherry-oat aphid *(Rhopalosiphum padi* L.*)*

General introduction

Host plants

Barley, wheat

Morphological features

Adults

Adults are 2 mm long, olive-green to black with a red rust patch at the rear and may have wings. Antennae extend to half the body length. Nymphs are similar to adult insects, but smaller.

Where can they be found?

Populations of *Rhopalosiphum padi* on cereals are usually found on the lower parts of the plant.

In autumn, short day-length induces the appearance of gynoparae on grasses and cereals. These winged females migrate to bird cherry where leaves provide the aphids with a rich source of food. There they give birth to apterous oviparae. Short days also induce the somewhat later appearance of winged males on grasses, which migrate to bird cherry where they mate with the oviparae.

Eggs

Eggs are elongated oval and black.

Where can they be found?

The eggs of *Rhopalosiphum padi* are laid in autumn in the narrow gap between the axillary buds and the stem.

Larvae

Larvae have four development stages.

Damage

The feeding of the bird cherry-oat aphids may stunt plants and lead to yield loss. Bird cherry-oat aphid is a vector of barley yellow dwarf virus.

Biology

The life cycle is dioecious. The primary host is bird cherry (*Padus racemosa*). Eggs overwinter on bird cherry buds. In the life cycle, there is an alternation of sexual and asexual generations. The period of pre-imaginal development, depending on conditions, varies from 5 to 21 days. Wingless parthenogenetic females live from 15 to 19 days at a temperature of 21 °C. At a lower temperature, they can live up to 40 days. In late May and early June, winged individuals appear, and insects migrate from the primary to the secondary host – the cereals. From the second half of August, the first immigrants appear. This aphid produces many generations throughout the growing season.

Monitoring

Aphids should be counted in autumn and spring on winter crop seedlings, and the overwintering populations – in late October and early spring. Abundance can be established by analysis of plant samples. One sample is made up of plants collected 0.5 m from the sowing line, and the sum of all samples is equal to the number of plants per 1 m^2. In each field, 16 samples are collected. In spring, the first count is carried out in the phase of exit to the tube of winter wheat. In the phase of the beginning of flowering of winter wheat, the second count of the number of the aphids is carried out, counting them on the ears. Twenty samples are taken from the field, each consisting of five ears.

Control in the field

Agrotechnical methods

- Appropriate crop rotation;
- Early harvest of grain crops;
- Exclusion of grain losses;
- Application of nitrogen fertilizers;
- Immediate and careful removal of straw from the field; and
- Elimination of volunteer plants from summer to early autumn.

Resistant varieties

Tolerant varieties against the pest include: Podolyanka, Chayka and Odessa napívkarlikova. They may be recommended to be used, especially in highly endangered areas.

Biological methods

Natural enemies include predators such as ladybirds (Coleoptera: Coccinellidae), lacewings (Neuroptera: Chrysopidae), damsel bugs (Hemiptera: Nabidae), spiders (Araneae), ground beetles (Coleoptera: Carabidae) and syrphid flies (Diptera). The bacteria *Bacillus thuringiensis* Berliner (strains V-6066 and V-5689) are able to suppress the vital activity of the aphid *Rhopalosiphum padi* L.

Chemical methods

The most recommended chemical treatments against the bird cherry-oat aphid are insecticide sprays in the critical phases of vegetation of winter wheat.

Chemical groups:

1. Synthetic pyrethroids (a.i.: lambda-cyhalothrin or deltamethrin);
2. Neonicotinoids (a.i.: lambda-cyhalothrin + thiamethoxam).

These insecticides are registered in Ukraine.

Always follow the label instructions for dosage, application and safety!

Wheat thrips *(Haplothrips tritici* Kurd.*)*

General introduction

Host plants

Winter wheat, triticale, spring wheat, rye.

Morphological features

Adults

The body is elongated, thin and black-brown to black. The head is 1.1–1.2 times longer than wide. The eyes are dark brown, almost black, large, one third of head length.

Where can they be found?

The adults can be found on the leaves of cereals.

Eggs

Eggs are pale orange, oblong-oval, 0.5–0.6 mm long.

Where can they be found?

Eggs can be found on the ears and the stem of the ear.

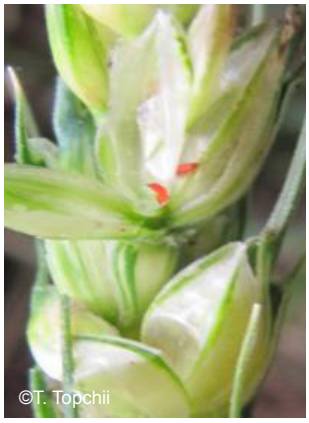
Larvae

Mature larvae are bright red, with two setae at the end of the abdomen. In spring, larvae go through a complicated metamorphosis (pronymph, nymph I, nymph II, adult).

Where can they be found?

Part of the larvae metamorphosis occurs underground.

Pronymphs and nymphs



Where can they be found?

Larval stages can be found in plant debris or in soil.

Damage

Both adults and larvae are dangerous, but the latter are usually more noxious, invoking partial or complete white ear effect, drying of flag leaf, partial ear fertilization, and incomplete grain filling. During the pest outbreaks, the density of larvae can reach 200 and more individuals per ear. The sowing quality of seeds drops notably.

Biology

Adults appear at the beginning of ear formation of winter cereals, usually in May–June. During development of cereals, adult thrips invade winter rye first, then winter wheat. Flying adults migrate with air streams at heights of 1.5–2 m. They frequently feed behind a sheath of the penultimate leaf, sucking sap from the gentlest part of ear husk. Females lay their eggs in small groups containing 4–8 eggs each or, less frequently, one at a time, on the interior sides of ear scales and ear shank. The egg-laying period lasts 25–35 days. First larvae suck sap from ear scales and flower glumes, then from caryopsis. Larval peak density occurs during the milk development stage of seeds. During the stage of early dough development, the larvae start to leave ears. Dry and warm weather during ear emergence and flowering of wheat (the period of egg-laying and the beginning of larval feeding) promotes increased insect survival; prolonged air drought and cool rainy weather are both unfavourable to the insect's development. Hot dry weather at the end of summer may also be unfavourable for the insect's survival due to fast grain ripening and the corresponding shortening of the larvae-feeding period. In spring, the larvae passing through metamorphosis perish because of heat and lack of moisture. When preparing to hibernate, the larvae can penetrate into soil to a depth of 10–20 cm or more (to 90 cm).

Monitoring

- counting the adult insects (numbers per ear);
- counting the second stage larvae when they are red – L_2 (numbers per ear); and
- use of Eclector traps.

Agrotechnical methods

- duly short-timed harvesting;
- early winter ploughing;
- thorough pre-sowing treatment of winter tillage;
- short-timed wheat sowing;
- maintenance of crop rotation; and
- growing early-ripening wheat cultivars.

Resistant varieties

Host Plant Resistance – resistant varieties include Sonechko, Pochivka, Donska napivkarlikova, Vesnyanka and Tarasivska ostista (Ukraine), Rostovchanka 3, Don 95, Stepnaya, Yermak and Garant (Russia), Brompton, Skalmeje, Robigus, Welford and Glasgow (Germany). (Fedorenko, Trybel and Topchii, 2008); (Topchii, 2012).

Biological methods

Only two families of parasitoid Hymenoptera parasitize eggs and larvae of the wheat thrips – the Eulophidae and the *Trichogramma*tidae. Other biocontrol agents of adults and larvae include anthocorid bugs of genus *Orius*, and phytoseiid mites. Biological insecticides such as the fungi *Beauveria bassiana* and *Verticillium lecanii* can kill thrips at all life-cycle stages.

Chemical methods

The most recommended chemical treatments against the wheat thrips are insecticide sprays in the critical phases of vegetation of winter wheat.

Chemical groups:

1. Synthetic pyrethroids (a.i.: lambda-cyhalothrin);
2. Neonicotinoids (a.i.: lambda-cyhalothrin + thiamethoxam).

These insecticides are registered in Ukraine.

Always follow the label instructions for dosage, application and safety!

Hessian fly or barley midge *(Mayetiola destructor* Say.*)*

General introduction

Host plants

Wheat is the primary host.

Morphological features

Adults

Adults are 2–4 mm in length, females are generally larger than males.

Where can they be found?

Adults may be found on cereal or grass plants.

Eggs

Eggs are elliptical, orange, and 0.5 mm long.

Where can they be found?

Eggs may be found on cereals or grass plants.

Larvae

Larvae are pale and cylindrical, growing from 0.5 to 4.0 mm long.

Where can they be found?

Hessian fly larvae (initially white in colour and then turning brown) lodge between leaf sheaths above nodes.

Pupae

Puparia, commonly known as ‘flaxseeds’, are 2–6 mm in length, dark brown, slightly tapered anteriorly.

Where can they be found?

Pupae may be found within leaf sheaths and at the base of plants between stems or tillers.

Damage

A single larva, feeding for three days, is capable of permanently stunting a young plant or tiller; damage is due to feeding and to an excreted salivary toxin. Seedlings attacked at the one-leaf stage may be killed outright. Wheat infested later will be severely stunted, with the first tillers killed and growth delayed. The pest also causes much damage to barley and rye.

Biology

The pest usually raises 2–3 annual generations, sometimes more. Females mate soon after emergence and start to oviposit, laying 250–300 eggs, which are placed end-to-end on host leaves, and often where the stems are covered by leaves. They pupate within a protective structure – the flaxseed.

Monitoring

Observations in the field can reveal infested plants with thickened and darker leaves, as well as stunted. Flaxseeds can be found at the bases of leaves, attached to the stem. Trapping the pest with its female-produced sex pheromone can be used to follow its populations through the year.

Control in the fieldField control

Agrotechnical methods

- removal of volunteer plants; and
- crop rotation.

Resistant varieties

Host Plant Resistance

Resistant varieties include Mironovskaya 808, Mironovskaya 264, Kolektivna and Artemivka (Ukraine), Hope, Merit Minesota 2752 (USA) and Chinook (Canada).

Biological methods

It is known that more than 50 parasitoids that attack the Hessian fly and can kill up to 70–80 percent of the pest. Parasitic insects (Hymenoptera) include *Eupteromalus micropterus, E. fulvipes, E. subapterus, Merisus destructor, Platygaster hiemalis* and *Trichacis tristis.*

Chemical methods

The most recommended chemical treatments against the Hessian fly are seed treatments or insecticide sprays in the critical phases of vegetation of winter wheat.

Seed treatment

1. Neonicotinoids (a.i.: imidacloprid or imidacloprid + clothianidin).

Insecticides

2. Synthetic pyrethroids (a.i.: lambda-cyhalothrin, deltamethrin or imidacloprid + beta-cyfluthrin);
3. Neonicotinoids + pyrethroid (a.i.: thiacloprid + deltamethrin).

These insecticides are registered in Ukraine.

Always follow the label instructions for dosage, application and safety!

Wheat bulb fly *(Leptohylemyia coarctata* Fll.*)*

General introduction

Host plants

Wheat is the primary host.

Morphological features

Adults

Adult flies are similar in appearance to ordinary house flies, although they are slightly smaller, 8–10 mm long.

Where can they be found?

Adult flies may be found on cereals or grass plants.

Eggs

The eggs are white, about 1–1.5 mm long.

Where can they be found?

The pest lays its eggs in soil.

Larvae

Adult larvae are 7–11 mm long, cylindrical. Wheat bulb fly larvae are white and legless, with no distinct head.

Where can they be found?

Larvae can be found in the central shoot of young plants.

Pupae

Pupae are yellow-brown, up to 7 mm long.

Where can they be found?

In the soil

Damage

The feeding on the central shoot causes yellowing and the typical 'dead heart' symptoms. On inspection, larvae can be found feeding in the base of the plant. They can continue to feed on adjoining tillers or move to neighbouring plants.

Biology

The fly lays its eggs in exposed soil. Once hatched, the larvae move through the soil and bore into the base of cereal plants feeding on the central shoot. This causes the characteristic dead-heart symptoms to appear. Although the outer leaves remain green during early stages of attack, plants become dull in appearance and, unless examined carefully, the attack may go unnoticed until dead hearts become visible.

Monitoring

- counting adult insects (flies) by entomological netting;
- counting damaged plants; and
- analysis of collected plant samples.

Field control

Agrotechnical methods

- removal of volunteer plants; and
- crop rotation.

Resistant varieties

Host Plant Resistance resistant varieties include Mironovskaya juvlejna, Mironovskaya ostista, Mironovskaya 33, Mironovskaya 67, Vesta, Snezhana, Voloshkova and Podolyanka.

Biological methods

The number of flies is reduced by entomophages from the family Braconidae: *Coelinidea nigra* Nees., *Protodacnusa trisis* Nees., *Chorebus cyclops* Nixon, *Chasmodon apterus* Nees, *Bembidion quadrimaculatum* L., *B. lampros* Herbst (Carabidae), *Aleochara bilineata* Gyll. (Staphilinidae) and *Gonia capitata* De Geer (Tachinidae).

Chemical methods

The most recommended chemical treatments against the wheat bulb fly are seed treatments or insecticide sprays in the critical phases of winter wheat vegetation.

Seed treatment

Chemical groups:

1. Neonicotinoids (a.i.: imidacloprid).

Insecticides

Chemical group:

2. Synthetic pyrethroids (a.i.: lambda-cyhalothrin, deltamethrin or imidacloprid + beta-cyfluthrin);
3. Neonicotinoids + pyrethroid (a.i.: thiacloprid + deltamethrin).

These insecticides are registered in Ukraine.

Always follow the label instructions for dosage, application and safety!

Wheat fly *(Phorbia securis* Tiensum.*)*

General introduction

Host plants

Wheat is the primary host. Other cereals and many other grasses are secondary hosts.

Morphological features

Adults

The adult fly is 4.0–5.3 mm in length, black and grey.

Where can they be found?

Adult flies may be found on cereals or on grass plants.

Eggs

Eggs are white, 1.25 mm in length.

Where can they be found?

The pest lays its eggs in soil.

Larvae

Larvae are 7.5 mm in length, initially white, yellowish grey at the end of development.

Where can they be found?

Larvae can be found in the central shoot of young plants.

Pupae

Pupae are 5.5 mm in length, red-brown.

Where can they be found?

Pupae overwinter in soil at a depth of 2–3 cm or in stems of winter cereals.

Damage

Central leaf and stem dry up

Biology

The pest has two generations per year. Adults begin to fly in April and continue for 5–6 weeks. Females lay eggs on the lateral stems of winter wheat. The larva lives in the stem, pupates in the ground. At the end of August–September, new flies fly out and lay eggs on seedlings of winter crops; the second generation of the pest develops there. Some larvae in puparia go into diapause until spring of the following year.

Monitoring

- counting of adult flies by entomological netting;
- counting of damaged plants; and
- analysis of collected plant samples.

Field control

Agrotechnical methods

- removal of volunteer plants; and
- crop rotation;

Host plant resistance

Resistant varieties include Myronivska ostista, Myronivska 67, Vesta and Snizhana.

Biological methods

Entomophages from the Carabidae family: *Bembidion quadrimaculatum B. lampros*; (Staphilinidae) *Aleochara bilineata*; (Braconidae) – *Phaenocarpa pulata* reduce the population of the pest.

Chemical methods

The most recommended chemical treatments against the wheat fly are seed treatments or insecticide sprays in the critical phases of winter wheat vegetation.

Seed treatments:

Chemical group:

1. Neonicotinoids: – (a.i.: imidacloprid, imidacloprid + clothianidin or clothianidin + imidacloprid + tebuconazole).

Insecticides:

Chemical group:

2. Synthetic pyrethroid (a.i.: lambda-cyhalothrin); (a.i.: deltamethrin); (a.i.: imidacloprid + beta-cyfluthrin); (a.i.: thiacloprid + deltamethrin).

These insecticides are registered in Ukraine.

Always follow the label instructions for dosage, application and safety!

Frit oat fly *(Oscinella frit* L.*)*

General introduction

Host plants:

Wheat is the primary host. Cereals and many other grasses are secondary hosts.

Morphological features

Adults

The adult is small (about 1.5–2 mm long), shiny and black.

Where can they be found?

Adults can be found on cereal and grass plants.

Eggs

The eggs are white and about 1–1.5 mm long.

Where can they be found?

Eggs can be found on stems and leaves.

Larvae

Adult larvae are 3.5–4.5 mm long.

Where can they be found?

The larvae are usually found inside the damaged shoots.

Pupae

The false cocoon is brown, its length is 2–3 mm.

Where can they be found?

Pupae can be found inside the stem.

Damage

Damage in cereals is most evident as 'dead hearts', where the central leaf of the plant turns yellow, withers and dies, often dropping off completely. Very young plants can be killed. Older plants can produce several tillers in response to the death of the main shoot. This leads to plants with a large number of weak shoots, which produce poor yield.

Biology

Larvae hibernate inside winter shoots and cereal weeds. In spring, the larvae pupate. After 5-12 days, at the end of April or beginning of May, adult insects fly out. Flies live 1–1.5 months, eating nectar of flowers. Females lay eggs 50–60 eggs on young shoots of cereals with 2–3 leaves, usually on coleoptile. After 3–8 days, hatching larvae crawl towards a leaf sheath and penetrate the shoots. After 18–28 days, the larvae pupate in the shoots. After 11–25 days, adults emerge. One to five generations can develop during the year.

Monitoring

Risk assessment can be made by sampling the grass or stubble for frit fly eggs/larvae, before ploughing. Key monitoring takes place after full emergence.

Field control

Agrotechnical methods

- disking or burning wheat remains;
- practising crop rotation.

Host plant resistance

Resistant varieties (varieties with high energy of growth and tillering.

Biological methods

The number of flies is reduced by endoparasites from the family Braconidae, e.g. *Coelinidea nigra* Nees.

Chemical methods

Fighting flies is carried out in the phases from seedling to tillering, during the period of mass flight and laying of adult eggs.

Chemical treatment of crops in critical phases of wheat.

Seed treatment:

1. Neonicotinoids (a.i.: imidacloprid or imidacloprid+clothianidin).

Insecticides:

2. Synthetic pyrethroids (a.i.: lambda-cyhalothrin, deltamethrin or imidacloprid+beta-cyfluthrin);
3. Neonicotinoids+synthetic pyrethroid (a.i.: thiacloprid + deltamethrin).

These insecticides are registered in Ukraine.

Always follow the label instructions for dosage, application and safety!

Lesser frit fly *(Oscinella pusilla* Mg.*)*

General introduction

Host plants:

Poaceae

Morphological features

Adults

The body is black and is 1.5–2 mm long.

Where can they be found?

High harmful activity of *O. pusilla* is reported in forest-steppe and steppe zones.

Eggs

White or cream cylindrical eggs reach 0.7 mm in length.

Where can they be found?

Eggs are laid one at a time or in groups (1–15 eggs) on the coleoptile, the leaf blade, behind the shell of the first leaf or on the ground.

Larvae

Adult larvae are white-yellow, have a cylindrical shape and are 3.5–4.5 mm long.

Where can they be found?

In the stems of winter and wild grasses.

Pupae

The length of the puparia is 1.75–3.0 mm and the width is 0.8–1.3 mm. Their form is cylindrical and they are brown.

Where can they be found?

Pupation occurs at the feeding site.

Damage

Younger larvae penetrate the stem nucleus, crawl to the tillering node, forming a brown channel. Older larvae feed on the tissues of growth points. First generation pests are very harmful, damaging the main shoot.

Biology

The female is much larger than the male. Pupation is observed in spring at an air temperature of 12 °C, lasting 10–14 days. The first generation flies appear in early to mid-May (depending on the zone), and continue until the end of June at a temperature of about 16 °C. The maximum flight is observed at the end of June (in the zone of severe damage) when the plants have 1–3 leaves. Supplementary feeding with pollen and nectar of wild plants is necessary for the insects. Oviposition begins 9–13 days after emergence. Males die after mating. Eggs are laid one at a time or in groups (1–15 eggs) on the coleoptile, the leaf blade, behind the shell of the first sheet or on the ground. Fertility rate reaches 25–30 eggs. Embryonic development lasts 4–10 days. Pests of the first generation are very dangerous, damaging the main shoot or the stems of the main shoots. The larval period lasts 13–20 days. There is only one larva per stalk and before pupation, the larva gnaws through the stem to the epidermis. Second generation flies appear in July. Second generation larvae are less harmful because they only damage the stems of the secondary shoots. Third generation flies appear from late July to September. Eggs are laid in August on discarded grain of spring crops, on young winter crops or on wild grasses. Life expectancy is 22–46 days.

Monitoring

Risk assessment for winter cereals can be made by sampling the grass or stubble for frit fly eggs/larvae before ploughing. Key monitoring takes place after full emergence.

Field control

Agrotechnical methods

Control measures include deep (20–25 cm) early winter ploughing, using ploughs with coulters, packing the ground by rollers before sowing, early sowing, and eradication of weeds.

Resistant varieties

Resistant varieties (varieties with high energy of growth and tillering and rapid development of mechanical tissues) may be used.

Biological methods

Most important predators are *Triaspis obsaerellus* Nees., *Bracon longillus* Wesm., *Ganaspis* sp., *Trichomalus statutus* Forst., *Spalangia fuscipes* Nees., *Halticoptera circulus* Walk., *Ophonus rufipes* Deg., *Broscus cephalotes* L., *Pterostichus cupreus* L., *Pt. punctulatus* Sch. and *Carabus convexus* F.

Chemical methods

Control of the flies is carried out in the phases from seedling to tillering, during the period of mass flight and egg-laying.

Chemical treatment of crops in critical phases of winter wheat.

Seed treatments

Chemical groups:

1. Neonicotinoids (a.i.: imidacloprid or imidacloprid+clothianidin);

Insecticides

2. Synthetic pyrethroids (a.i.: lambda-cyhalothrin); (a.i.: deltamethrin); (a.i.: imidacloprid + beta-cyfluthrin);
3. Neonicotinoids + synthetic pyrethroid (a.i.: thiacloprid + deltamethrin).

These insecticides are registered in Ukraine.

Always follow the label instructions for dosage, application and safety!

Wheat stem sawfly *(Cephus pygmaeus* L.*)*

General introduction

Host plants

Wheat, rye, barley and other species of Poaceae (e.g. oat, millet, timothy).

Morphological features

Adults

The body length is 5–11 mm. The primary colour is black. Third to sixth abdominal segments have yellow transversal bordering.

Where can they be found?

Sawflies can be found on the flowers of different plants or on the host plants.

Eggs

The eggs are white, oval, and 0.8 mm long.

Where can they be found?

Eggs can be found in the stems of the host plants.

Larvae

Larvae reach a length of 10–15 mm. They are yellowish white, with a nut head, S-shaped body without legs, curved, and covered with sparse short hairs.

Where can they be found?

The larvae live and feed in the stems of winter wheat.

Pupae

The pupae are 10–12 mm long, white when first formed, but they soon darken to black spotted with yellow.

Wheat stem sawfly pupae

Where can they be found?

The pupae can be found in stems, closer to the roots of the plant.

Damage

Wheat stem sawfly is one of the most economically important insect pests of winter wheat; it also causes damage to durum wheat, rye, and winter and spring barley. To a lesser degree, it damages oats and millet. It also damages various sown and wild grasses, including brome, couch grass, timothy, and wild oat. Weight and quality of grain decreases because of damage to conducting vascular fibres by the larvae. The under-sawed stems easily break off and as a result, losses of grain increase at harvest. Harmfulness of the wheat stem sawfly varies widely, from 3 to 30 percent, depending on stem infestation.

Stem plugged with frass (larval faeces) and plant material

Biology

Females lay 35–50 eggs, depositing them one by one in cereal stems, more frequently in upper internodes. Egg development lasts 6 to 8 days, larval development lasts 20 to 40 days, depending on weather conditions in the area. Larvae develop inside the stem infested by the egg. Developing larvae crawl down into lower part of stems, gnawing through internodes of culm. Larvae usually complete their development before the grain begins to ripen. Pupal stage lasts 7 to 10 days.

Monitoring

The adult wasps are weak fliers, and therefore the use of entomological sweep nets is recommended for collecting the insects. Stems should be examined for signs of internal feeding and discolouration of plant parts (e.g. darkened areas on the stem) and for signs of stem breakage resulting from the presence of the larva. Stems should be cut open to reveal the egg (difficult to see) or the larva.

Agrotechnical methods

- duly short-timed harvesting;
- early winter ploughing;
- thorough pre-sowing treatment of tillage; and
- crop rotation.

Resistant varieties

Cultivars with solid lower stem segments inhibit the development and movement of the larvae, resulting in their increased mortality. Sustainable winter wheat varieties include Legenda Mironovskaya, Smuglyanka, Don 95, Garant, Vita, Doka, Artek and Colleague.

Biological methods

Entomophagous insects, primarily the specialized parasite *Collyria coxator*, regulate the sawfly numbers, destroying as many as 80 percent of the sawfly larvae.

Chemical methods

The most recommended chemical treatments against the wheat stem sawfly are insecticide sprays in the critical phases of winter wheat vegetation.

1. Neonicotinoids + pyrethroids (a.i.: lambda-cyhalothrin + thiamethoxam);
2. Synthetic pyrethroids (a.i.: deltamethrin or imidacloprid + beta-cyfluthrin);
3. Neonicotinoids + pyrethroids (a.i.: thiacloprid + deltamethrin).

These insecticides are registered in Ukraine.

Always follow the label instructions for dosage, application and safety!

Black grain-stem sawfly *(Trachelus tabidus* F.*)*

General introduction

Host plants

Wheat, rye, barley and other species of Poaceae

Morphological features

Adults

An adult sawfly is 7–10 mm long, black.

Where can they be found?

Adults can be found on the flowers of different plants.

Eggs

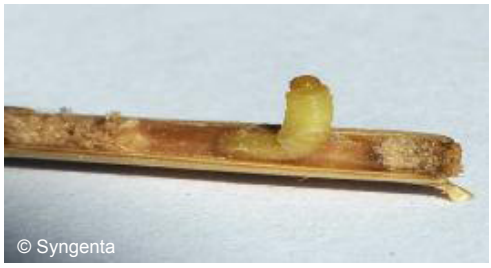
The eggs are white, oval, and 0.9 mm long.

Where can they be found?

Eggs can be found in the stems of the host plants.

Larvae

The larvae reach the length of 10–15 mm. The larvae are yellowish white with a nut head. The S-shaped body does not have legs, it is curved and covered with sparse short hairs.



Where can they be found?

The larvae develop and feed inside cereal stems.

Pupae

Pupae are 10–12 mm long. They are white when first formed but soon darken to black.

Where can they be found?

Pupae can be found in the stem, closer to the roots of the plant.

Damage

Black grain-stem sawfly is one of the most economically important insect pests of winter wheat. Weight of grain decreases, and grain quality decreases because of damage to conducting vascular fibres by larvae. The under-sawed stems easily break off and as a result, losses of grain increase at harvest.

Biology

Body length is 7–10 mm and the primary colour is black. Hind tibia are black inside, legs are a dirty yellow colour. Chest has yellow spots. Larvae are yellowish white with a nut-coloured head, and they reach the length of 10–15 mm. Their body is S-shaped without legs, curved, covered with sparse short hairs at the end of the abdomen and has a process with 14–26 spines. Females lay 35–50 eggs, laying them one by one in the stalks of cereals, often in the upper internodes. Egg development lasts from 6 to 8 days; larvae development lasts from 20 to 40 days, depending on the weather conditions in the area. The larva develops inside the stem infected with the egg. Developing larvae crawl down to the lower part of the stem, gnawing the internodes of the stem. Larvae usually complete their development before the grain begins to ripen. During this period, the damaged stem is easy to distinguish by the shaded area on the stem below the internode. The pupal stage lasts from 7 to 10 days. One generation per year develops.

Monitoring

The adult wasps are weak fliers, and therefore the use of entomological sweep nets is recommended for collecting the insects. Plants should be assessed for the presence of the pest and the severity of symptoms. Stems should be examined for signs of internal feeding and discolouration of plant parts (e.g. darkened areas on the stem) and for signs of stem breakage resulting from the presence of larvae. Stems should be cut open to reveal the egg (difficult to see) or the larva. Infested stems contain frass.

Agrotechnical methods

- duly short-timed harvesting;
- early under-winter ploughing;
- thorough pre-sowing treatment of tillage; and
- crop rotation.

Resistant varieties

Cultivars with solid lower stem segments inhibit the development and movement of the larvae, resulting in their increased mortality.

Sustainable winter wheat varieties include Legenda Mironovskaya, Smuglyanka, Don 95, Garant, Vita, Doka, Artek and Colleague.

Biological methods

Entomophagous insects, primarily the specialized parasite *Collyria coxator*, regulate the sawfly numbers, destroying as many as 80 percent of the sawfly larvae.

Chemical methods

The most recommended chemical treatments against the sawfly are sprays of insecticides in critical phases of winter wheat vegetation.

1. Neonicotinoids + pyrethroids (a.i.: lambda-cyhalothrin + thiamethoxam);
2. Synthetic pyrethroids (a.i.: deltamethrin or imidacloprid + beta-cyfluthrin);
3. Neonicotinoids + pyrethroids (a.i.: thiacloprid + deltamethrin).

These insecticides are registered in Ukraine.

Always follow the label instructions for dosage, application and safety!

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