



MAIN INSPECTORATE FOR PLANT HEALTH
AND SEED INSPECTION

Methodology for the integrated production of oats (*Avena sativa*)¹⁾

(first edition)

Approved

pursuant to Article 57(2)(2) of the Act of 8 March 2013 on plant protection products
(consolidated text: Journal of Laws [Dziennik Ustaw] 2024, item 630)

by

the Main Inspector for Plant Health and Seed Inspection

Warsaw, September 2025

¹⁾ This Methodology for the integrated production of oats (*Avena sativa*) was notified to the European Commission on 6 February 2025 under No 2024/0125/PL, pursuant to § 4 of the Cabinet Regulation of 23 December 2002 concerning the manner in which the national notification system of standards and legal acts functions (Journal of Laws, item 2039, and of 2004, item 597), which implements the provisions of Directive (EU) 2015/1535 of the European Parliament and of the Council of 9 September 2015 laying down a procedure for the provision of information in the field of technical regulations and of rules on Information Society services (codification) (OJ EU L 241, 17.9.2015, p. 1)



Approved by
Andrzej Chodkowski

/signed electronically/

Methodology developed as part of task 1.5.
'Development of Integrated Plant Production Methodologies'
financed by the Ministry of Agriculture and Rural Development

PLANT PROTECTION INSTITUTE — STATE RESEARCH INSTITUTE
ul. Władysława Węgorka 20, 60-318 Poznań
email: upowszechnianie@iorpib.poznan.pl, www.ior.poznan.pl

Collective paper edited by:

Dr Jakub Danielewicz, Prof. Przemysław Strażyński and Prof. Marek Mrówczyński

Reviewed by:

Prof. Krzysztof Jankowski⁵

Authors:

Dr Jakub Danielewicz¹
Prof. Marek Korbas¹
Dr Joanna Horoszkiewicz¹
Dr Ewa Jajor¹
Dr Joanna Zamojska¹
Dr Monika Jaskulska¹
Daria Dworżańska, MSc¹
Rafał Nowaczyk, MSc¹
Prof. Marek Mrówczyński¹

Prof. Przemysław Strażyński¹
Dr Przemysław Kardasz¹
Prof. Roman Kierzek¹, Associate Professor at PPI – SRI
Prof. Kinga Matysiak¹, Associate Professor at PPI – SRI
Prof. Anna Sułek²
Dr Grzegorz Gorzała³
Karolina Madajska, MSc⁴
Andrzej Najewski, MSc⁴

¹Plant Protection Institute — State Research Institute, Poznań

²Institute of Soil Science and Plant Cultivation — State Research Institute, Puławy

³Main Inspectorate of Plant Health and Seed Protection, Warsaw

⁴Main Research Centre for Cultivars of Agricultural Plants, Słupia Wielka

⁵University of Warmia and Mazury in Olsztyn

ISBN 978-83-974552-4-5

Table of contents

1. Introduction.....	6
2. Legal regulations applicable to integrated production (IP) and rules for its certification.....	6
2.1. Integrated pest management as the basis for integrated production (IP).....	6
2.2. Integrated plant production in legislation.....	8
2.3. Certification rules.....	8
3. Climate and soil requirements and site selection.....	9
3.1. Site.....	9
3.2. Soil.....	9
3.3. Precursor crop.....	10
4. Selection of oat varieties in integrated production.....	10
5. Pre-sowing tillage and sowing.....	11
5.1. Soil cultivation.....	11
5.2. Sowing.....	12
6. Sustainable oat fertilisation system.....	14
7. Integrated protection against harmful organisms.....	17
7.1. Weed infestation control.....	19
7.1.1. The most important weed species.....	19
7.1.2. Agronomic methods of weed management.....	21
7.1.3. Chemical methods of weed control.....	23
7.2. Reduction of disease vectors.....	25
7.2.1 The most important diseases.....	25
7.2.2 Agronomic methods of disease vector control.....	28
7.2.3. Chemical methods of disease vector control.....	29
7.3. Reduction of losses caused by pests.....	30
7.3.1. Most important pests.....	30
7.3.2. Agronomic methods of pest control.....	32
7.3.3. Methods of monitoring pests in oats crops.....	34
7.3.4. Chemical methods of pest control.....	36
7.4. Biological methods and protection of beneficial entomofauna in integrated oat production.....	36
8. Appropriate selection of techniques of application of plant protection products....	36
9. Hygiene and health rules.....	42
10. Preparation for harvesting, harvest, and post-harvest procedure.....	49

11. Developmental stages of oats based on the BBCH scale.....	50
12. Rules for keeping records as part of integrated production.....	50
13. List of mandatory activities and treatments in integrated oats production.....	55
14. Checklists for agricultural crops.....	59
15. Additional reading.....	60

1. PREFACE

Integrated plant production (IP) is a management system that takes into account a sustainable use of technology and biological progress in the cultivation, protection and fertilisation of plants while ensuring the safety of the natural environment. The essence of integrated plant production is therefore obtaining crops satisfactory for both producers and consumers, in a way that does not interfere with the protection of the environment and human health. Its strategy is more complex than that of production using conventional methods. As much as possible, natural biological mechanisms supported by the rational use of plant protection products are used in the integrated plant production process. In modern agricultural production technology, the use of fertilisers and plant protection products is necessary and extremely beneficial, but at times it may also threaten the environment. In integrated plant production, however, special attention is paid to the reduction of the role of plant protection products used to limit pests to a level that does not threaten crops, fertilisers and other necessary resources needed for plant growth and development to create an environmentally safe system while ensuring high-quality crops free from residues of substances known to be harmful (heavy metals, nitrates, plant protection products).

2. LEGAL PROVISIONS APPLICABLE IN INTEGRATED PRODUCTION (IP) AND RULES FOR ITS CERTIFICATION

2.1. Integrated plant protection as the backbone of integrated production (IP)

Integrated plant protection consists of protecting crops against harmful organisms using all available methods, in particular the non-chemical ones, in a way that minimises risks to human health, animals and the environment.

Integrated protection consolidates and systematises practical knowledge about organisms harmful to plants (especially about their biology and harmfulness), in order to determine optimal deadlines for taking action to combat these organisms while taking into account naturally occurring beneficial organisms, i.e. predators and parasites of the organisms harmful to plants. It also reduces the use of chemical plant protection products (PPP) to a necessary minimum, thus reducing environmental pressure and protecting the biodiversity of the agricultural environment.

Professional users who apply plant protection products are obliged to take into account the requirements of integrated plant protection. An agricultural producer should use all available measures and methods of protection against pests before applying chemical plant protection methods with a view to reducing the use of pesticides. They involve the use of crop rotation, appropriate varieties, compliance with optimal timing, the use of appropriate agronomics, proper fertilisation and the prevention of the spread of harmful organisms. One of the requirements is also to protect beneficial organisms and create favourable conditions for their occurrence, in particular pollinators and natural enemies of harmful organisms. The use of chemical plant protection should be preceded by monitoring activities and supported by appropriate scientific instruments and counselling.

Under the current law, only plant protection products authorised for marketing and use on the basis of authorisations (or parallel trade permits) issued by the Minister for Agriculture and Rural Development may be used for chemical protection of plants.

The list of plant protection products authorised in Poland is published in the register of plant protection products. Information about the scope of pesticide use for particular crops is placed on the product's label. The Ministry of Agriculture and Rural Development makes the register and the labels available at: <https://www.gov.pl/web/rolnictwo/ochrona-roslin>.

Information on plant protection products authorised for integrated production is published in the Online Pest Warning System at: <https://www.agrofagi.com.pl/143,wykaz-srodkow-ochrony-roslin-dla-integrowanej-produkcji>.

It is the responsibility of each user to read and follow the label before the application of a plant protection product.

Plant protection products may be applied in open areas using:

- ground equipment at a distance of at least 20 m from apiaries;
- field sprayers at a distance of at least 3 m from the edge of the roadway of public roads, excluding public roads falling within the category of municipal and district roads;
- field sprayers at a distance of at least 1 m from reservoirs and watercourses and non-agricultural areas other than those intended to be treated with plant protection products.

When using plant protection products, their labels should be read in detail, as they may contain additional conditions limiting their applicability.

In accordance with the legislation in force, any use of a plant protection product must be registered. Professional users are obliged to maintain and store for three years documentation containing the name of the plant protection product, the time of use and the dose applied, the area or surface area or unit of weight of the grain and crop or the facilities on which the plant protection product has been applied. Legislation also requires the method of fulfilling the requirements of integrated plant protection to be indicated in the documentation by providing at least the reason for treatment with a plant protection product. Filling out the IP Notebook, mandatory under the integrated plant production scheme, fulfils the requirement to keep the above-mentioned documentation for certified crops.

For treatment with plant protection products, equipment intended for that purpose must be used which, when used for its intended purpose, does not present a risk to human health, animal health or the environment, is in good technical condition and is calibrated to ensure the correct application of plant protection products. The holders of equipment for the use of plant protection products are obliged to carry out periodic tests confirming its good technical condition. The first inspection of a new sprayer must be conducted no later than five years from the date of its purchase. Tractor and self-propelled field sprayers should be tested

at intervals of no more than three years. Manual and backpack sprayers whose tank capacity does not exceed 30 litres are excluded from the testing obligation.

2.2. Integrated plant production in legislation

Under this integrated plant production certification scheme, all legal requirements for plant protection products must be respected, with particular regard to the principles of integrated plant protection.

2.3. Certification rules

The basic requirement for the possibility of growing crops in the system of integrated plant production and obtaining an IP certificate is to submit a notification to the entity certifying integrated plant production.

The list of entities is available on the website of the State Plant Health and Seed Inspection Service [PIORiN] at <https://www.gov.pl/web/piorin/podmioty-certyfikujace-ip>. The interested plant producer notifies its intention to use integrated plant production to the certification body on an annual basis. The integrated plant production scheme is open to all producers. Notification of the intention to participate in the scheme may be submitted on paper by post, electronically, or in person.

Integrated production training is generally available, and those who have acquired the appropriate knowledge through education (confirmed by post-primary school or higher education credentials) are exempt from the obligation to complete basic training.

Following the notification, the agricultural producer is obliged to cultivate crops according to the method of integrated plant production for the notified plant and to document their actions in the IP Notebook in detail.

The certification body inspects plant producers who follow the principles of integrated plant production. Supervisory actions cover in particular:

- confirmation of completion of IP training;
- compliance with the production methods approved by the Main Inspector of Plant Health and Seed Protection;
- fertilisation;
- documentation;
- following hygiene and health principles;

- sampling and controlling the highest permissible plant protection product residue content and the level of nitrates, nitrites and heavy metals in plants and plant products.

A certificate issued at the request of the grower attests that integrated plant production principles are followed. In order to obtain the certificate, the producer must:

- have completed integrated plant production training and hold a certificate of completion of this training (or other qualifications);
- grow and protect plants in line with the detailed methodology approved by the Main Inspector and made available on the website administered by the Main Inspectorate of Plant Health and Seed Inspection;
- use fertilisation based on the actual plant nutritional needs determined on the basis of, in particular, the analysis of the soil and plants;
- correctly document the activities related to integrated plant production;

- follow plant production hygiene and health rules, in particular those referred to in the methodology;
- ensure that no maximum permissible residues of plant protection products or levels of nitrates, nitrites, and heavy metals have been exceeded in plant and plant product samples collected for testing;
- adhere to the requirements concerning plant protection against harmful organisms, particularly those specified in the methodologies, during plant production.

Integrated plant production certificates are issued for the period necessary for the plant product to be disposed of, but for no longer than 12 months.

Growers who have been granted a certificate attesting that they follow integrated plant production principles may use the Integrated Plant Production mark to distinguish the plants for which the certificate has been issued. The model mark is made available by the Main Inspector on the website administered by the Main Inspectorate of Plant Health and Seed Inspection.

More information on registration in the integrated plant production scheme and the rules for issuing IP certificates is available on the website of the State Plant Health and Seed Inspection Service at <https://www.gov.pl/web/piorin/zasady-ip>.

3. CLIMATE AND SOIL REQUIREMENTS AND SITE SELECTION

3.1. Site

Oats are a species of cereal with specific properties, having many advantages but also disadvantages. Compared to other cereals, the advantages include: its lower soil requirements (thanks to a better developed root system), tolerance to low soil pH, greater resistance to diseases of the stem base and leaves, lower precursor crop requirements, and the fact that it is itself a fairly good precursor crop for other cereals. The disadvantages of oats are: low drought resistance, high sensitivity to sowing delay, and poor feed value of grains of hulled varieties for non-ruminants and birds. Recently introduced into practice hull-less varieties of oats do not have the latter property.

Hulled oat grain is an excellent feed for horses and a good feed for ruminants (cattle, sheep, goats) and geese (in the final stage of their fattening). It also has a high nutritional value as food for humans. Among breakfast cereals, oatmeal is distinguished by the highest quality, thanks to its high content of dietary fibre. A distinctive feature of oats, distinguishing it from other spring cereals, is its high demand for water, especially in the period from the stem elongation stage to the heading stage. The thermal requirements for oats are low. The seed begins to germinate at a temperature of 2–3 °C. Spring frosts are harmless to oats, and the low temperature after the emergence of plants is beneficial for high yields. For this reason, the early date of sowing is of great importance.

3.2. Soil

The roots of oats have a very high capacity to absorb nutrients found in the soil in a

form that is difficult for plants to access. In this respect, oats surpass other cereals, even rye. Thanks to this property, oats should be grown on the soils of rye complexes, from very good to poor, and on the soils of a strong and poor grain-fodder complex. The highest yields of oats are obtained on better soils, classified as wheat complexes. These soils yield high yields of other, more valuable cereal species (wheat, barley), which is why its cultivation is considered justified here only on farms with a large (more than 50 %) share of wheat and barley in the sowing structure, due to its phytosanitary properties. Oats should not be cultivated on so-called dry soils, classified as a very poor rye complex. However, it is more tolerant than other spring cereals in terms of soil acidity (pH).

3.3. Precursor crop

Oats have low precursor crop requirements and at the same time leave a good stand for other cereal plants.

Oats have lower soil requirements than wheat and barley. The most suitable soils for the cultivation of this cereal species are moist, clayey, undried peatlands. It is recommended to avoid soils with disrupted water ratio. Compared to other cereal species, oats tolerate cultivation on acidic soils much better.

Oats, as the only cereal plant, are not affected by diseases of the stalk base. Not only is it not attacked by them, but it does not participate in the host chain of fungi, i.e., it does not transfer them to follow-on plants. Oat roots secrete substances that inhibit the development of fungal pathogens, and in the rhizosphere of oats, fungi develop that do not cause diseases in wheat, barley, and rye. In particular, these factors, combined with the high competitiveness of oats against weeds, and consequently the reduction of weed infestation in the follow-on crop, make oats a valuable plant in rotation.

The best precursor crops for oats are: root crops, legumes, winter oilseed rape. In practice, oats are sown in poorer conditions, usually after cereals. Decreases in its yield due to sowing after cereals are smaller than in the case of other cereals, especially on better soils. Oats should not be grown in succession, after barley, or too frequently in rotation (ideally every 3–4 years), due to the potential for harmful nematodes to proliferate in the soil, including cereal cyst nematodes, which can lead to significant yield reductions.

4. SELECTION OF OAT VARIETIES IN INTEGRATED PRODUCTION

Two species of oats are cultivated: common oats (*A. sativa*) and naked oats (*A. nuda*). They occur in both spring and winter forms. In addition, varieties of rough oats (*A. strigosa*) are also subject to registration.

Oats have small soil and heat requirements. It is worth mentioning here the high tolerance for low soil pH, which allows cultivation on acidic and neutral soils, rich in essential nutrients, but its water requirements are higher compared to other cereals. A well-developed root system allows for the utilisation of nutrients from hard-to-reach compounds.

One of the important factors determining the yield obtained is the optimal sowing date. The plants then make the best use of the winter water reserves accumulated in the soil, which results in good rooting, greater resistance to lodging, and a greater number of spikelets

in the panicle. The amount of sowing per unit area is also important.

Appropriate selection of varieties and the use of certified seed may determine the success of cultivation, as well as allow for a reduction in production inputs. Research conducted under the Post-Registration Variety Testing enables the assessment of the yield and economic value of available varieties. The conditions for conducting experiments are similar to the requirements of integrated agriculture, and the results obtained for individual varieties can definitely be valuable information for farmers who wish to use this system.

The variety used must be entered in the National Register or the Community Catalogue of Varieties or the register of another Member State, or the register of an associated country (provided that the choice of the variety is justified in accordance with the IP). The basic principle is to use seed of at least the certified category.

Detailed rules for the selection of varieties in integrated plant production are published on a dedicated Research Centre for Cultivar Testing [COBORU] website.

Detailed information on the selection of varieties recommended for IP by the COBORU can be found in the list at: coboru.gov.pl/pdo/ipr.

5. PRE-SOWING TILLAGE AND SOWING

5.1. Soil cultivation

The cultivation of soil for oats should be very meticulous. Its methods depend mainly on the date of harvesting the precursor crop and on the type of cultivation tools held by the farmer.

Autumn tillage

The task of the first cultivation procedure preparing the field for sowing oats is to manage crop residues, reduce water losses, and mechanically destroy weeds. The type of crop and the cultivation tools that will be used to achieve this goal largely depend on the precursor crop. Therefore, the field can be prepared by performing a shallow ploughing or another type of cultivation. Shallow ploughing is carried out with a stubble plough. Disc harrows or various types of stubble cultivators are used to prepare the field with other cultivation treatments. When cultivating post-harvest crops, it should be remembered to do it as shallowly as possible. However, it must be remembered that crop residues on the soil surface must be well mixed with the soil. Therefore, the depth of post-harvest cultivation varies significantly depending on the precursor crop, and strictly speaking, on the amount of post-harvest residue remaining in the field after its harvest. It is assumed that the depth of post-harvest cultivation should be 5–12 cm. In some cases, the working depth of cultivation tools can be reduced to 3 cm. Depending on the precursor crop, post-harvest cultivation is carried out once or is extended with further agronomic treatments. The aim of expanding post-harvest cultivation is the systematic destruction of weeds. Mechanical weed control can be carried out by harrowing, which usually takes place after ploughing, or by re-using a disc harrow or stubble cultivator. Alternative to post-harvest tillage is stubble cropping. This solution can be applied when the

precursor crop harvest has been carried out early and when the soil is adequately moistened. Thanks to this, post-harvest plants will have an appropriate period of time and good conditions for growth and development. The most commonly used catch crops are: white mustard, oil radish, rapeseed, blue phacelia, etc. Sowing catch crops plays a very important role, as densely growing plants suppress the growth of volunteer cereals and weeds. The role of catch crops is not limited to reducing weeds; they also positively affect soil structure and improve its biological life. Catch crops enrich the soil with organic matter and counteract erosion. It is important to include several plants belonging to different families.

The next autumn treatment that prepares the field for sowing oats is pre-winter ploughing. In most cases, it should be made to a depth of 20–25 cm. The soil should be left in a rough furrow until spring. Thanks to this, the soil is loosened up and its porosity increases, which promotes greater water accumulation and a better impact of frost on the formation of a granular soil structure.

Spring Cultivation

The first spring treatment preparing the field for sowing oats is harrowing or dragging. The type of tools used depends on the type of soil on which the oats will be grown. On light soils, the use of harrows is sufficient, while on heavy, compact soils, the use of drags is recommended. The first spring treatment should be carried out in early spring, as soon as it is possible to enter the field. The signal to start the work is the whitening furrows. Another treatment that prepares the field for sowing oats is pre-sowing cultivation. This treatment should be carried out after sowing multi-nutrient mineral fertilisers, provided that they were not applied in autumn. A cultivation aggregate should be used for this purpose. The use of the aggregate is economically justified, as the use of several cultivation tools in one pass significantly reduces the costs associated with cultivation. In addition, the negative impact of the tractor on the soil will be significantly reduced. When cultivating the soil for sowing oats, it is necessary to ensure that it is properly moistened. Soil that is too moist should not be cultivated. Cultivation treatments on clumped soils most often need to be performed twice or require the use of an active aggregate. On light soils, spring cultivation should be reduced to a minimum due to the high risk of excessive drying. In the case of cultivation with a cultivator (without an aggregate), it is recommended to equip the tractor with track eradicators or twin wheels to reduce soil compaction.

5.2. Sowing

Oats are among the earliest crops to be sown, and any delay in sowing results in a significant reduction in yield. The optimal time for sowing oats is considered to be when the soil has dried sufficiently in spring. This situation applies to both hulled and naked oats. Optimal, early sowing of oats has a beneficial effect on rooting and tillering of plants. Thanks to this, the crop will be dense, and the plants will form more spikelets in the panicle. Grain from early sowing has lower protein content and higher starch content. The share of chaff in this case is usually smaller, although this is not always the case. When growing oats, one should not be concerned about early sowing, as oat grain germinates at a temperature of 2–3 °C, so there is no thermal barrier limiting early sowing. In addition, it should be remembered that in conditions of very early sowing, oats can use up winter water reserves in the soil and are less

affected by pests and diseases. This has a positive effect on plantations. Postponing the date of sowing oats always results in a decrease in yield. Differences in yield reduction are mainly due to the delay in sowing, but also to the weather conditions prevailing in a given growing season and the type of soil. An estimated sowing delay of 10–14 days results in a yield reduction of 15–22 %. The main reason for the reduction in yield is a decrease in the number of panicles in the crop. When cultivating oats on light soils, special attention should be paid to the sowing date, as any delays at such sites strongly affect the reduction of yield. This is especially evident in the dry years.

Sowing parameters

The yield of oats is closely related to the number of panicles per unit area, which in turn is related to the amount of sowing. This dependence is due to the low productive bushiness of oats. This is confirmed by studies by the Institute of Soil Science and Plant Cultivation – National Research Institute, which found that a large number of lateral shoots are entirely unproductive or their yield is below 50 % compared to the main shoot. This situation causes the strong propagation of oats to adversely affect the yield obtained from a given unit of area. Therefore, dense sowing of oats is recommended, ensuring a compact stand and yielding from the main shoots, which are the most productive. Of course, the plant density per unit area must not be too high, as this may lead to intra-species competition, which would negatively affect not only the yield size but also its quality parameters. Depending on the soil category, the recommendations for plant density per unit area vary (Table 1).

Table 1. Optimal sowing density of sprouted caryopsis seeds per m² depending on the soil category

Soil category	Recommended plant density of live caryopsis [pcs/m ²]
Rye: very good	500–550
Cereal and fodder: strong	
Cereal: mountains	
Rye: good	
Oat and potato: mountains	560–620
Rye: poor	
Cereal and fodder: poor	600–650
Oat and fodder: mountains	

An important element of sowing is the definition of the sowing rate. For the correct determination of this parameter, the following information is necessary: plant density per m², weight of one thousand grains [g] and germination capacity [%]. After obtaining this information, it should be entered in the formula on the basis of which the seeding standard will be correctly determined.

$$\text{Sowing rate (kg/ha)} = \frac{\text{Plant density per m}^2 \times \text{Weight of a thousand grains [g]}}{\text{Germination capacity [%]}}$$

Oats are sown in rows, every 12–15 cm, to a depth of 2–4 cm. On heavier, well-moistened soils, oats should be sown shallower, while on lighter, drier soils — deeper.

Cultivation of winter oats

Winter oats are increasingly cultivated due to their lower sensitivity to drought, which can occur in early summer. This has a positive effect on obtaining a higher yield. A major advantage of winter oats is their low chaff content and higher feed energy compared to spring oats. An important feature of winter oats is the possibility of early harvesting, which is important when the weather conditions during the harvest season are unfavourable. Winter oats are classified as cereals that are sensitive to large temperature drops, which is the main reason for their freezing out. Therefore, currently available varieties should be grown in warmer regions. When growing winter oats, it is necessary to avoid compacted soils with compacted subsoil. A good precursor crop for winter oats is winter oilseed rape, field beans, edible and fodder peas, white, narrow-leaved, and yellow lupins. The worst precursor crop for winter oats is winter barley. Winter oats must not be grown in monoculture. The lack of rotation will pose a significant threat to the cultivation of winter oats from loose silky-bent, which is related to the insufficient effectiveness of its control by non-chemical methods and the inability to use chemical methods. The interval in the cultivation of oats on the same field should be at least 3 years.

The soil before sowing winter oats can be prepared using the classic plough-based tillage system and in various no-till systems. Regardless of the technology used, the cultivation of the soil must be carried out in a timely and careful manner. Winter oats in integrated production should not be cultivated using the direct sowing system.

Winter oats should be sown early during the sowing period of winter barley. This timing is due to the slow growth rate of winter oats and the need for them to reach the full tillering stage before winter dormancy. The recommended sowing period for winter oats is from 15 September to 10 October. Delayed sowing hinders achieving the full tillering stage and increases the risk of freezing out.

The optimal seeding rate for winter oats is 320–400 germinated caryopses/m². Analysing the weight of sown grains, it should be noted that winter oats are sown less than spring oats by weight, because their MTG is smaller compared to spring oats. In the case of delayed sowing and sowing in colder areas where there is a higher risk of freezing out, the maximum recommended planting density per m² shall be used. Winter oats should be sown in rows every 12–15 cm to a depth of 3–4 cm.

In integrated production, fertilisation is determined on the basis of a nutrient balance analysis before each crop, and soil testing is conducted at least every four years (and documented).

6. SUSTAINABLE OAT FERTILISATION SYSTEM

When harvesting oats, large quantities of macro- and micronutrients are removed from the field. The amount of removed nutrients largely depends on whether the straw remains in the field or is also harvested and removed. Leaving straw in the field means that the nutrients it

contains will be available to plants grown in the next growing season. Therefore, when arranging the fertilisation plan for crops grown after oats, account should be taken of the way straw is handled. With individual plant parts of oats, different contents of macro- and micronutrients are removed (Tables 2 and 3). Knowledge of the content of individual macro- and micronutrients in grain and straw is very important. Thanks to it, it is possible to determine the demand of oats for individual nutrients, as well as to take into account their losses resulting from the harvesting of these plant parts. Oat straw contains significantly more potassium, lime, and manganese compared to grain. The grain, on the other hand, contains more nitrogen, phosphorus, magnesium, copper, molybdenum and zinc.

Table 2. Percentage content of macronutrients in dry matter of grain and straw

Plant part	Nitrogen [N]	Phosphorus (P ₂ O ₅)	Potassium (K ₂ O)	Calcium (CaO)	Magnesium (MgO)
Grain	1.81	0.85	0.60	0.14	0.22
Straw	0.63	0.32	2.31	0.56	0.19

Table 3. Micronutrient content in dry matter of grain and straw [mg/kg dry matter]

Plant part	Copper (Cu)	Manganese (Mn)	Molybdenum (Mo)	Zinc (Zn)
Grain	5.0	60	0.44	44
Straw	4.0	100	0.32	36

Knowing the content of individual macro- and micronutrients in grain and straw, and taking into account its other needs resulting from individual life processes, the demand of oats for the production of an appropriate amount of grain and straw was determined. For the production of 100 kg of grain together with straw, oats must absorb the appropriate amounts of macronutrients (Table 4).

Table 4. Quantity of macronutrients required to produce 100 kg of grain with straw [kg]

Nitrogen [N]	Phosphorus (P ₂ O ₅)	Potassium (K ₂ O)	Calcium (CaO)	Magnesium (MgO)
2.4	1.3	3.6	0.7	0.4

Nitrogen

In the cultivation of oats, nitrogen can be applied to the soil or during the growing season, when the crop is in the tillering stage. The date of application of nitrogen depends mainly on the fertilisation technology and weather conditions. It should be remembered that in conditions of drought, the utilisation of applied nitrogen significantly decreases. The dose of nitrogen used depends on the expected yield and precursor crop. After good, non-cereal precursor crops with a yield of 3.5 tonnes, the sufficient dose of nitrogen is 30–40 kg N/ha. In this case, nitrogen should be applied in a single dose before sowing or when the oats are in the tillering stage. When cultivating oats after inferior precursor crops, the nitrogen dose should be increased to 60 kg N/ha, using it entirely before sowing. The dosage is different when growing oats on poor, permeable soils. At such sites, due to the risk of leaching, nitrogen should be

applied in two doses, regardless of their size. In the cultivation of oats on poor soils, a pre-sowing application of nitrogen at a dose of 40 kg N/ha and a top dressing in the second node stage of 20 kg N/ha is recommended. In farms where oats are grown on better sites and higher yields are obtained, the nitrogen dose must be slightly increased. When determining it, it is also necessary to take into account the expected yield as well as the site on which the plantation will be established. With an expected yield of 4.0 tonnes, the nitrogen dose should be 75–85 kg N/ha in cereal sites and 50–60 kg N/ha in sites following better precursor crops. Doses higher than 60–80 kg N/ha should not be used in the cultivation of oats, as the marginal efficiency of higher doses is low, usually less than 2 kg of grain per 1 kg of nitrogen. In addition, when using nitrogen fertilisers, it should be borne in mind that the division of nitrogen doses lower than 60 kg N/ha is completely unjustified. In this case, it is recommended to apply nitrogen before sowing, as its application at this time positively affects the development of the main shoot panicles, particularly the number of ears in the panicle.

Phosphorus

The dose of phosphorus depends on the richness of the soil. When cultivating oats on soils with an average abundance of assimilable phosphorus, the dose of fertiliser should be equal to the removal of this nutrient with the crop. Along with 3.5 tonnes of oat grain, 45 kg of P_2O_5 is removed from the field. When oats are grown on phosphorus-poor soils, the dose of fertilisers containing this nutrient should be increased by 20–60 kg P_2O_5 /ha. Thanks to this, not only will oats have adequate amounts of available phosphorus, but the balance of this nutrient in the soil will also be improved. Therefore, on soils poor in phosphorus, the dose of this nutrient should be 60–80 kg P_2O_5 /ha. Using manure regularly, the phosphorus dose can be reduced by 10–20 kg P_2O_5 /ha. All individual forms of phosphate fertilisers available on the market are suitable for the cultivation of oats. Multi-nutrient fertilisers can also be successfully used, making sure that they contain the right amount of phosphorus. Phosphate fertilisers can be applied before pre-winter ploughing as they do not leach.

Potassium

The dose of potassium used in the cultivation of oats varies depending on the richness of the soil. On sites with an average abundance of assimilable forms of this nutrient, the dose of potassium should be equal to its removal in the crop. With the yield of 3.5 tonnes of grain, 126 kg of K_2O is removed from the field. When cultivating oats on soils with low potassium content, fertiliser doses should be increased to improve soil fertility. In this case, the dose of potassium should be increased by 30–50 kg K_2O /ha. The potassium dose ensuring proper conditions for oat growth and development and improving soil fertility should be 130–160 kg K_2O /ha. If the field is systematically fertilised with manure, then the dose of potassium can be reduced by approx. 40 kg K_2O /ha. Potassium fertilisation on medium and heavy soils can be done in the autumn. It should not be done on light soils, as potassium leaches away. Therefore, on poor sites, potassium should be applied in early spring before preparing the site for sowing.

Magnesium

Magnesium is a nutrient that plays a very important role in the cultivation of oats on lighter and acidic soils, where it is a factor that significantly stabilises yield. Its use increases the concentration of magnesium, nitrogen, and phosphorus not only in grain but also in straw.

Lime

Oats are a cereal that tolerates a broad pH spectrum. It does not inhibit growth at pH_{KCl} from 5 to 7. Despite their high tolerance to low pH levels, highly acidic soils should be limed. The best time for the application of lime is its spreading before the precursor crops. If it is not possible to apply lime before the precursor crop, it should be spread after the harvest of the precursor crop. The use of lime on soils with a low pH is very important, as it is needed by plants for proper growth and development, and also has a positive effect on the availability of other macronutrients in the soil.

Micronutrients

Oats are very sensitive to a shortage of microelements. It reacts most strongly to copper and manganese deficiencies. Also to zinc and molybdenum deficiencies, but to a lesser extent. Copper deficiencies are best supplemented foliarly by applying a solution of copper sulphate or another micronutrient fertiliser. Manganese can also be supplied to oat plants in the form of micronutrient foliar fertiliser.

7. INTEGRATED PROTECTION AGAINST HARMFUL ORGANISMS

Integrated production (IP) of oats should be carried out using integrated pest management and using technical and biological progress in cultivation and fertilisation with particular regard to human and animal health and environmental protection.

Integrated plant protection includes all available actions and methods of plant protection (against weeds, pathogens, pests) with preference given to the use of non-chemical measures and methods that reduce the harmfulness of those organisms, in particular:

- the use of crop rotation, the appropriate date for sowing and plant density;
- the use of appropriate agronomic techniques, including the use of mechanical plant protection;
- the adoption of appropriate measures and methods for the protection of plants against harmful organisms should be preceded by the monitoring of their presence and take into account current knowledge on the protection of plants against them;
- the use of seed of at least the certified category, which has been produced and evaluated in accordance with the seed regulations;

- the use of resistant and tolerant varieties (where possible);
- the application of fertilisation and liming where appropriate;
- the use of hygiene measures (cleaning, disinfection) to prevent the occurrence and spread of harmful organisms;
- the protection of beneficial organisms and creating favourable conditions for their occurrence, in particular for pollinators and natural enemies of harmful organisms.

In the framework of integrated plant protection, when carrying out a chemical plant protection treatment, account should be taken of:

- the appropriate selection of plant protection products in such a way as to minimise the negative impact of plant protection treatments on non-target organisms, in particular pollinators and natural enemies of harmful organisms;
- limiting the number of treatments and the quantity of plant protection products used to the necessary minimum;
- preventing the formation of resistance of harmful organisms to plant protection products by their appropriate selection and alternating use.

Plant protection products authorised for use in European Union countries are subject to periodic review in accordance with the latest studies and principles set out by the European Union. Strict requirements in terms of their quality, toxicology and effects on arable crops and the environment are monitored so that they do not pose a risk to the user, the consumer and the environment.

Plant protection products are to be applied in accordance with the recommendations given on the label and in a manner that prevents hazards to human or animal health or to the environment.

The list of plant protection products authorised in Poland is published in the register of plant protection products. Information about the scope of pesticide use for particular crops is placed on the product's label. The current edition of the oat protection programme and a search engine for plant protection products serve as an auxiliary tool in the selection of pesticides. Current information on plant protection products use is available on the Ministry of Agriculture and Rural Development website at: <https://www.gov.pl/web/rolnictwo/ochrona-roslin>.

The list of plant protection products authorised for IP is available on the Online Pest Signalling Platform at: <https://www.agrofagi.com.pl/143,wykaz-srodkow-ochrony-roslin-dla-integrowanej-produkcji.html>.

For protection against harmful organisms (weeds, pathogens, pests), only products registered and authorised for marketing and use may be used which are clearly indicated on the labels attached to the packaging to be recommended for use in oats cultivation.

It should be borne in mind that the products included in the protection programme do not present a risk when properly applied in accordance with the approved labelling of the plant protection product. Adherence to application recommendations, such as the appropriate selection of the product, dose, the date of use, the appropriate stages of development of the crop and pests, the appropriate thermal and humidity conditions and the technical conditions for the procedure have a decisive impact on the safety of treatments with plant protection

products.

7.1. Weed infestation control

The cultivation of oats is threatened by many species of weeds, both mono- and dicotyledonous (Table 5). Weeds compete with oats for water, nutrients, light, and space for growth and development. The harmfulness of weeds is not limited only to competitiveness; their negative impact on oats is definitely greater. Many of their species are biological bridges favouring the occurrence of diseases and pests. Pests inhabiting weeds threaten not only the cultivation of oats but also neighbouring crops. In addition, weeds found in oats significantly hinder harvesting, and their aerial parts and seeds contaminate the yield. This unfavourable situation makes it necessary to immediately clean the grain after harvesting, which increases production costs and thus negatively affects the overall crop production on the farm.

7.1.1. The most important weed species

Most common dicotyledonous weeds are present in oat crops, depending on the location of the field, in addition to the typically thermophilic weeds. Among monocotyledons, it is exposed to competition mainly with couch grass, millet weeds (barnyard grass, blue and green foxtail, less often finger-grass) and the most difficult to eliminate wild oats (Table 5).

How to distinguish between common oats and wild oats?

Literature most often focuses on the morphology of the oat species: the coleoptile is dirty white, 15–25 mm long. Characteristic features include the first leaf, which is long (7–9 cm) and narrow (0.4–0.5 cm), with a vertical habit; its edges at the base are gently hairy. The second and subsequent ones are larger and less hairy. Many nerves are visible on them, but only three are clear. The ligule is membranous, strongly elongated. No ears, leaves curl to the left.

The leaf sheath of common oats is smooth, while the leaf sheath of the lower leaves of wild oats is hairy. This is one of the features that allows distinguishing the two species in the younger developmental stages. Mature individuals of wild oats have three flower spikelets and differ from common oats, which have two flower spikelets. In addition, adult plants of wild oats are characterized by very dispersed panicles (definitely more so than common oats). The height of both species is given within different, often overlapping limits. The height of wild oat stalks usually varies from 60 to 130 cm, while common oat stalks oscillate around 1 m. If both species occur at the same site (under the same conditions), wild oats are always taller than common oats.

Oats as a genus are characterized by very high variability, including intra-species variability. Many ecotypes and genotypes, and over a dozen botanical varieties are known: short oats, naked oats, rough oats, sterile oats, one-sided oats, and cultivated common oats. In addition, there are many wild forms. This variability and the tendency to interbreed, especially between wild oats and common oats, may make it difficult to recognise certain characteristics.

Table 5. Characteristics of the most dangerous mono- and dicotyledonous weeds occurring in the cultivation of oats

Weeds	Characteristics
Small-flowered crane's-bill (<i>Geranium pusillum</i>)	spring species, preferring moist, humus-rich soils, rich in nutrients, especially lime and nitrogen; weed dangerous when occurring en masse; during the growing season, in favourable conditions, it can produce several generations
Cornflower (<i>Centaurea cyanus</i>)	annual species, found on all types of soil, but prefers light, sandy and sandy loam; under favourable conditions it grows up to 1 m in height
Marsh woundwort (<i>Stachys palustris</i>)	a perennial species, common, prefers heavy, clayey soils with shallow groundwater levels; reaches a height of 20–60 cm; the main source of spreading is fragmentation during mechanical field work.
Field bugloss (<i>Anchusa arvensis</i>)	a spring species that grows in clusters and is highly competitive with the crop; prefers light soils with an acidic pH
Field pansy (<i>Viola arvensis</i>)	annual species, common; dangerous due to the abundance of occurrence during the emergence of the cultivated plant
Field mustard (<i>Sinapis arvensis</i>)	annual species, prefers fertile soils, particularly rich in lime; the harmfulness of this species is not merely due to its competitiveness; it is also a host plant for many diseases and pests, such as the pathogens of clubroot
Chickweed (<i>Stellaria media</i>)	spring species, common; prefers humus-rich, moist soils, abundant in nutrients, especially nitrogen; creates a strong turf, significantly interfering with the emergence and development of the crop
White goosefoot (<i>Chenopodium album</i>)	annual species, common; prefers loose soils, rich in nutrients, especially nitrogen and potassium; strongly competitive in relation to oats
Red chickweed (<i>Anagallis arvensis</i>)	an annual species, spring or wintering, is commonly found throughout the lowlands and in the lower mountain ranges; prefers fertile, humus-rich, and limestone soils
Sea mayweed (<i>Matricaria maritima</i> subsp. <i>inodora</i>)	annual species; occurs on different types of soils, but prefers humus-rich and moist soils; in the cultivation of oats, it can grow above the crop
Creeping thistle (<i>Cirsium arvense</i>)	perennial species, occurs on different types of soil, prefers soils with regulated water-air relations, rich in nutrients; difficult to control, often occurs in clusters
Field bindweed (<i>Convolvulus arvensis</i>)	perennial species, commonly found on all types of soils; light-loving plant, resistant to drought; its harmfulness is not merely due to its competition, but also consists of shading and choking crops, and significantly hinders harvesting.
Common hemp-nettle (<i>Galeopsis tetrahit</i>)	annual species; prefers clay soils and lighter humus with a high groundwater level
Persian speedwell (<i>Veronika persica</i>)	annual species, spring and also wintering; common, prefers clay soils, slightly moist and rich in nutrients, especially nitrogen
Catchweed (<i>Galium aparine</i>)	annual species; prefers moist, fertile soils, rich in nutrients, especially nitrogen; with a high intensity of occurrence, it causes lodging of cereals
Treacle-mustard (<i>Erysimum cheiranthoides</i>)	annual spring species, also wintering; prefers moist soils – both loamy and sandy

Wild buckwheat (<i>Fallopia convolvulus</i>)	annual species, spring; occurs on different types of soils, prefers sandy, light, and medium-heavy soils; copes well during drought; its harmfulness is not merely due to competition, but also consists of shading and choking crops, and significantly hinders harvesting
Wild radish (<i>Raphanus raphanistrum</i>)	annual species; prefers sandy, loamy, and slightly acidic soils; the harmfulness of this weed is mainly due to competition; it also hosts many diseases and pests, including clubroot, which makes it a threat to follow-on crops
Shepherd's purse (<i>Capsella bursa-pastoris</i>)	annual species; occurs on different types of soils; prefers fertile, humus-rich, loose, and airy soils; is a host of many diseases and pests, including clubroot
Field pennycress (<i>Thlaspi arvense</i>)	annual species, common; prefers loamy, medium, and heavy soils, rich in nutrients and calcium; is a host of many diseases and pests, including clubroot
Four-seeded vetch (<i>Vicia tetrasperma</i>)	an annual species, springing up across the lowlands and lower mountain areas; prefers lighter soils that are rich in nutrients and moist
Common wild oat (<i>Avena fatua</i>)	annual spring species; occurs on different types of soils, but prefers moist, limestone, and clay soils; competes heavily for water, because it consumes twice as much water during the growing season as common oats or wheat
Couch grass (<i>Agropyron repens</i>)	perennial, monocotyledonous; occurs on all types of soils; highly competitive, rapidly spreading through runners

7.1.2. Agronomic methods of weed management

Weeds are an inseparable part of farmland. The primary source of weeds is their diaspores (seeds, rhizomes, runners, tubers, bulbs) occurring in the top layer of the soil. They are usually called 'soil seed bank', which constitutes the so-called 'potential weed infestation' (of soil). On the other hand, weed seedlings occurring in a crop are defined as: a current weed infestation.

An uncontrolled weed development usually results in the occurrence of undesirable vegetation in an amount or mass significantly limiting yield.

In integrated production, various methods of weed control should be implemented, taking into account preventive measures and direct methods of weed destruction. The main cause of weed infestation is the 'soil seed bank', which is why efforts should be made to reduce its abundance through various treatments, in all possible phases.

The strategy to reduce the size of the 'soil seed bank' of weeds should be initiated during the post-harvest tillage operations. These treatments should in particular target species of perennial weeds reproduced by underground stolons or rhizomes, such as: dandelions, thistles, field bindweed, sorrel. Subsequent cultivation treatments that stimulate weed diaspores to germinate, and then combat their seedlings, significantly reduce the number of active seeds in the top layer of the soil.

An important factor limiting weed growth is the uniform emergence of the crop at optimal planting density. Therefore, it is necessary to sow healthy, good-quality seed respecting the recommended agronomic deadlines and sowing density. Optimal planting density reduces the risk of secondary weed growth.

In integrated production, treatments should be applied to limit both potential and current weed infestation. The most important activities include:

- appropriate selection of the site, taking into account crop rotation;
- weed control in the post-harvest cultivation of precursor crops based on mechanical or chemical treatments;
- the use of crop treatments as appropriate and in a way that does not lead to soil pulverisation and drying;
- the use of seed of at least the certified category; adequate seed quality ensures rapid, even emergence and planned plant density when sowing is carried out under optimal conditions (sowing date, sowing depth, soil temperature and moisture, etc.);
- application of sustainable fertilisation;
- application of hygiene measures consisting of regular cleaning of machinery and equipment to prevent the spread of weeds.

Non-chemical methods of weed control

Mechanical weed control should start immediately after harvesting of the precursor crop. During this period, post-harvest cultivation is carried out, the purpose of which is to manage post-harvest residues, reduce water losses, stimulate weed seeds to germinate, and destroy emerging plants. The cultivation schedule and the tools used to break the stubble and manage crop residues depend to a large extent on the farm's machine park, as well as the weeds present in the field. A sub-tillage plough, a disc harrow or a stubble cultivator may be used for post-harvest cultivation. Until recently, ploughing was the primary treatment for post-harvest cultivation; currently it is used to a lesser extent. The lower popularity of ploughing is due to its low efficiency and the need to carry out harrowing, which significantly increases costs. Therefore, it has been increasingly replaced by tools characterised by greater efficiency, which makes them less labour- and energy-intensive. These tools include a disc harrow and various types of stubble cultivators.

These tools should not be used when the field contains couch grass and other perennial weeds such as creeping thistle, field bindweed, or common mugwort. This is due to the fact that these tools are equipped with cutting elements. Their use causes fragmentation of the vegetative propagation organs, which significantly increases their spread in the field and, consequently, pressure and competitiveness for oats. When mechanically combating weeds in post-harvest cultivation, it should be remembered to carry out the cultivation carefully and in a timely manner. Treatments in post-harvest cultivation should be repeated after successive weed emergences. This significantly reduces the number of weeds endangering the crop. The next element is the performance of winter ploughing. In the spring, after drying of the skids, as soon as one can enter the field, a levelling plate or harrow should be used. Cultivation with these tools accelerates the heating of the soil, reduces evaporation, and also creates favourable

conditions for the germination of weeds. During subsequent treatments, weeds are mechanically controlled. For this purpose, it is necessary to carry out one or two harrowings. Oats are grown in narrow row spacing, which makes mechanical weed control after their emergence very limited. The mechanical fight against weeds should be carried out by harrowing crops, using light tooth harrows or weeders. It should be remembered that the weeder harrow will definitely perform this task better. The working depth of harrows used to control weeds in oats should be 1.5–2 cm. Harrowing of oats should be carried out from the 3–4 leaf stage until the end of the tillering stage. Harrowing oats is not permitted from emergence until the three-leaf stage, as oats are very sensitive to mechanical damage during this period.

Methods for determining weed abundance and damage thresholds

Currently, no harm thresholds have been developed for monocot and dicot weeds found in the cultivation of common oats.

Decision support systems

Decisions can only be supported by the Plant Protection Institute — State Research Institute in Poznań or other scientific and research units dealing with plant protection issues. Expert opinions in support of decisions must be drawn up on the basis of the results of research carried out in scientific and research units.

7.1.3. Chemical methods of weed control

The basic condition for effective control of weeds in oats cultivation is the correct recognition of weeds, both mono- and dicotyledon ones. Another very important factor for the effective control of weeds is the selection of the herbicide, or more precisely, the active substance. The current state of weed infestation should be strictly followed when selecting the active substance. When selecting an active substance, attention should also be paid to the mechanism of action of the substance and, where possible, choose one with a different mechanism of action than the one used in the previous growing season. This is very important because the use of active substances with different mechanisms of action is a fundamental element in combating weed resistance to herbicides. The fight against weeds in the cultivation of oats is carried out post-emergence. When using herbicides, it is absolutely necessary to follow the indications placed by the manufacturer on the label. When applying foliar herbicides, care should be taken in order to apply to dry plants and when the wind speed is less than 4 m/s. The optimal temperature for the use of herbicides in the cultivation of oats is 10–20 °C. Herbicides from the group of growth regulators should be applied at a minimum temperature of 8 °C, as they work better and faster at higher temperatures. The situation is similar for other active substances belonging to different chemical groups. Sulfonylurea herbicides perform well at slightly lower temperatures, below 8° C. It is recommended that weeding of oats be carried out with medium-droplet treatments with a usable liquid amount of 200–300 litres/ha.

The list of plant protection products authorised for IP is available on the Online Pest Signalling Platform at: https://www2.agrofa.gov.pl/143,wYkaz-srodkow2_ochrony-roslin-dla-integrowanej-produkcii.html.

Plant protection products listed in the 'List of Herbicides Recommended for Integrated Production (IP) of Agricultural Plants' have been selected from the 'Register of Plant Protection Products' (<https://www.gov.pl/web/rolnictwo/rejestr-rodkow-ochrony-roslin>) on the basis of their harmfulness to humans and warm-blooded animals, in accordance with labels, permits, and decisions of the Ministry of Agriculture and Rural Development and the European Commission.

Information about the scope of pesticide use for particular crops is placed on the product's label. The repository of plant protection products can be a helpful tool in the selection of pesticides. Current information on plant protection products use is available on the Ministry of Agriculture and Rural Development website at: <https://www.gov.pl/web/rolnictwo/ochrona-roslin> at <https://www.gov.pl/web/rolnictwo/wyszukiwarka-srodkow-ochrony-roslin—zastosowanie>.

Crop rotation after herbicide application

Herbicides vary in duration of action and biodegradation in soil, which should be taken into account when planning subsequent crops. Each herbicide label contains a section: 'CROP ROTATION', which provides information on the possible cultivation of successive crops. Most herbicides do not pose a risk to follow-on crops, but some herbicides persist longer in the soil and may cause symptoms of phytotoxicity or stunting on following crops.

Weed resistance to herbicides and methods of limiting it

The occurrence of herbicide-resistant weed biotypes is becoming a serious problem, which is why proper monitoring is crucial in terms of preventing weed resistance to herbicides.

One of the factors contributing to the development of weed resistance to herbicides is improper weed control based only on a widespread use of herbicides, without taking into account other methods, in particular the agronomic ones.

The risk of weed resistance to herbicides increases when herbicides with the same mechanism of action are used cyclically. In order to counteract the risk of weed resistance to herbicides, it is necessary, among other things, to use herbicides with a different mechanism of action or at least from different chemical groups alternately. For this purpose, classification according to the mechanism of action of the active substance based on the HRAC classification (*Herbicide Resistance Action Committee*) should be used when selecting the herbicide for the procedure. Individual mechanisms of action of the active substances of herbicides according to this classification are currently assigned numerical codes (formerly, letter codes were commonly used, which can still be found on the labels of plant protection products).

Oat height regulation

In the integrated production of oats, the use of growth regulators – retardants – is allowed. These preparations are used to prevent lodging, which reduces yield, hinders the ripening of plants, significantly complicates harvesting, and also increases the infestation of

plants by diseases and the proportion of sprouted grain. These negative effects of lodging adversely affect the profitability of oat production. In the cultivation of oats, one treatment is performed. Most often, the treatment is performed at the beginning of the stem elongation stage. It is permitted to use retardants in other developmental stages, as indicated by the manufacturer of the product on the labels. Growth regulators should not be used at temperatures below 10° C and above 25° C. The treatment should not be performed before the expected frost or shortly after its disappearance. The application of growth regulators before expected rainfall should be avoided. The minimum period between the application of growth regulators and rainfall is 3–4 hours. Growth regulators should be applied to dry plants, in winds below 4 m/s.

7.2. REDUCTION OF DISEASE VECTORS

7.2.1. The most important diseases

Oats may be infested by pathogenic fungi (Table 6.), like other cereal species; they may be present on leaves, stems, and panicles, which may lead to lower and inferior grain yields (Kolenda and Mroczkowski 2013, Korbass et al. 2018). The most important diseases occurring on oat plants caused by fungi include: crown rust of oats, oat leaf helminthosporiosis, powdery mildew of cereals and grass, stem rust (and fusarium blight of oats (Harder and Haber 1992, Langaro et al. 2001, Kiecana et al. 2005, Korbass et al. 2015, Menzies et al. 2019).

In integrated protection, priority is given to non-chemical control methods, most often agrotechnical and breeding methods of controlling disease agents.

If the use of non-chemical control methods did not result in the population of harmful organism concerned falling below the threshold of economic harmfulness, then a chemical method should be applied.

Table 6. The economic significance of selected oat disease agents

Disease	Pathogen(s)	Importance
Fusarium panicle rot	<i>Fusarium graminearum</i> Schwabe (teleomorph: <i>Gibberella zeae</i> (Schwein.) Petch), <i>Fusarium</i> spp.	+
Loose smut of oats	<i>Ustilago avenae</i> (Pers.) Rostr.	+
Covered smut of oats	<i>Ustilago segetum</i> (Bull.: Pers.) Roussel syn. <i>Ustilago kollerii</i> Wille, syn. <i>Ustilago levis</i>	+
Helminthosporiosis of leaves	<i>Drechslera avenacea</i> (M.A. Curtis ex Cooke) Shoemaker = <i>Helminthosporium avenaceum</i> M.A. Curtis ex Cooke <i>D. avenae</i> (Eidam) Scharif = <i>H. avenae</i> Eidam (teleomorph: <i>Pyrenophora avenae</i> Ito & Kuribayashi)	++
Powdery mildew of cereals and grass	<i>Blumeria graminis</i> DC. f. sp. <i>avenae</i> Em. Marchal, <i>B. graminis</i> DC., (anamorfa: <i>Oidium monilioides</i> (Nees) Link)	++

Rust of oat (crown rust, crown blight)	<i>Puccinia coronata</i> Corda	++
Stem rust of cereals and grasses	<i>Puccinia graminis</i> Pers. f. sp. <i>avenae</i> Ericks	++
Spread of cereals	<i>Claviceps purpurea</i> (Fr.) Tul	+
Seedling blight	<i>Bipolaris sorokiniana</i> (Sacc.) Shoemaker, <i>Drechslera avenae</i> (Eidam) Scharif, <i>Fusarium</i> spp. (Wm. G. Sm.) Sacc., <i>Pythium</i> spp., <i>Rhizoctonia solani</i> Kuhn	++

+ — small; ++ — medium

In integrated production, information on the sources of primary and secondary infections, i.e. the places where the pathogen resides and the way in which diseases are transmitted during the vegetation of oats, may be useful. Fungi require specific conditions for their development, i.e. appropriate humidity and temperature. Table 7 presents the conditions conducive to the occurrence of individual oat diseases and the sources of their infection.

Table 7. The most important sources of oats infections and favourable conditions for the development of the pathogens

Disease	Sources of infection	Favourable conditions for development	
		Temperature [°C]	Soil and air humidity
Fusarium panicle rot	seed, crop residues, airborne spores	high temperature	high air humidity
Loose smut of oats	seed	16–19	low soil humidity
Covered smut of oats	seed	15–20	moderate
Helmintosporiosis of leaves	seed, crop residues	cool	high
Powdery mildew of cereals and grass	seed, soil	more than 15	dry
Rust of oat (crown rust, crown blight)	crop residues, self-sown seeds,	20–22	moderate humidity
Stem rust of cereals and grasses	crop residues, self-sown seeds,	15–24	humid
Spread of cereals	spores (sclerotia)	20–25	high humidity
Seedling blight	seed, soil	cool	humid spring

Taking action to reduce the occurrence of harmful organisms should be preceded by monitoring the occurrence of these organisms and taking into account current knowledge in the field of plant protection against pests, including, if justified, taking into account, inter alia, indications resulting from scientific studies enabling the determination of optimal dates for the performance of chemical plant protection treatments, in particular on the basis of meteorological data and knowledge of the biology of harmful organisms. Therefore, in addition to knowing the sources of infection and the conditions conducive to a given disease, it is helpful to know the diagnostic features when determining the disease on the oat plantation (Table 8). The data in Figure 1, which shows the developmental stages of oats in which the disease can occur and the dates on which it can be controlled, may also be helpful.

Table 8. Diagnostic features of oat diseases

Disease	Diagnostic features	Possible confusing symptoms
Loose smut of oats	In infested plants, all floral parts, even before heading, are transformed into a black dusty mass of spores (teliospores). Initially, some of the caryopses are covered with a white-grey casing. After its destruction, the spores are dispersed by the wind, leaving the panicles destroyed. Infested plants are often shorter and can be difficult to find on plantations.	Covered smut of oats
Covered smut of oats	It is less common loose smut of oats. In the spikelets of the panicles, instead of caryopses, black, hard compact clusters with the shape of caryopsis are formed, constituting a mass of spores of the pathogen, sheltered by surviving lemma and chaff. The spreading of spores in the field during flowering is hindered. It is only during threshing that there is a mass release of spores (teliospores), which get on the lemma and infest the grain.	Loose smut of oats
Seedling blight	It is caused, among others, by a number of species of fungi such as: <i>Pythium</i> , <i>Bipolaris</i> and the following species of the genus <i>Fusarium</i> : <i>F. graminearum</i> , <i>F. culmorum</i> , <i>F. avenaceum</i> and <i>Microdochium nivale</i> (<i>F. nivale</i>). In emerging oat plants, these fungi can cause pre-emergence plant death (pre-emergence gangrene). Spots with no plants are visible on the plantation. In the case of post-emergence gangrene, infested plants emerge; however, they are weakened, and the chlorotic leaves are spirally twisted.	-
Rust of oat (crown rust, crown blight)	Symptoms occur on leaves, leaf sheaths and stems. Infested organs have uredinia in the form of round orange-yellow pustules. Infected blades may be limp and lodge. As the plants age, black telia (winter spores) form around the uredinia, which can resemble a crown (hence the former name of the disease).	Stem rust of cereals and grasses
Stem rust of cereals and grasses	It primarily affects the blades and leaf sheaths. Initially, spore clusters develop under the epidermis, which over time breaks and clearly stands out from the surface of the blade. On the blades, rusty-brown clusters of urediniospores are visible. Then, in the place of urediniospores, black glossy teliospores form.	Rust of oat (crown rust, crown blight)
Powdery mildew of cereals and grass	On the leaves and leaf sheaths, there is a white coating composed of mycelium, stalks, and conidial spores of the fungus. Later on, symptoms of the disease may occur on the stems and panicles. Over time, the white coating turns grey and dark fruiting bodies - cleistothecia - become visible on it. As a result of severe infestation, the leaves can die prematurely.	-

Helminthosporiosis of leaves	It occurs from the earliest stages of development. On young seedlings, it causes brown-red spots. Infested seedlings may have a deformed shape. On older leaves, red-brown spots are initially visible, which later take the form of elongated spots surrounded by a red or brown border. The spots often merge and form large necrotic areas, causing parts of the leaf blades to die off.	-
Fusarium panicle rot	Panicles affected by the pathogens are partially white, and in the event of severe infestation, the entire panicle is discoloured. Orange spore clusters, known as sporodochia, are sometimes visible on caryopsis. Fungi of the genus <i>Fusarium</i> can cause major problems in the cultivation of oats, as they can produce secondary metabolites – mycotoxins. Toxins produced by <i>Fusarium</i> fungi include, among others, deoxynivalenole, nivalenole, T-2 toxin, HT-2 toxin, diacetoxyscirpenol and zearalenone.	-
Spread of cereals	On the tops, honeydew droplets of yellow colour and sticky consistency are visible. Soon after, in the individual spikelets of the panicle, instead of grain, ergot spores develop in the shape of cones, with a purple-red colour. Sclerotia are hard but easily broken; they also contain alkaloids harmful to mammals, such as ergometrine, ergotamine, ergotone, and others.	-

7.2.2. Agronomic methods of disease vectors control

The agrotechnical method involves limiting the presence of pathogens primarily through the correct and timely performance of all activities related to soil preparation and oat cultivation.

Basic agrotechnical treatments used in the cultivation of oats can significantly reduce the use of chemical agents, contributing to the protection of the environment and reducing inputs.

From an agronomic point of view, the factors limiting and, in some cases, eliminating the presence of pests in oats may include:

- correct crop rotation,
- timely and careful cultivation of the land,
- appropriate mineral fertilisation,
- optimal timing and depth of sowing and plant density,
- sowing in mixtures with cereals,
- mechanical maintenance,
- timely harvest.

All the above treatments affect proper emergence and harmonious development of plants.

Proper agro-technology allows for a significant reduction of the risk from the pathogens.

Sowing oats too early causes the plants to tiller vigorously, and in such overly dense fields, the development of powdery mildew, rust, or helminthosporiosis is facilitated.

The higher humidity on the plantation, associated with dense sowing, promotes the development of leaf and panicle pathogens. The optimal plant density does not allow for the mass development of pathogens.

Oats are a good precursor for other cereals, which is why they play a phytosanitary role in crop rotations strongly focused on cereals or in monoculture crops, as the complex of basal stem diseases and diseases transmitted by soil and crop residues occurs sporadically in their cultivation.

The oat rhizosphere is richly populated by a collection of fungi that are not pathogenic to wheat, barley or rye. In addition, the roots of oat plants have the ability to secrete specific substances (avenacin), which have fungistatic properties on soil pathogens (e.g. *Gaeumannomyces graminis* — causing gangrene of the base of the stalk). Its advantage is also good competition against weeds, but the disadvantage is the possibility of excessive water intake and drying of the soil under winter crops.

7.2.3. Chemical methods of disease vectors control

Chemical protection of oats is possible both during emergence and the early stages of plant development (seed treatments) and in the form of fungicides applied to the leaves in the form of spraying treatments. Only certified seed with good plant health shall be used, treated as far as possible with products limiting oat loose smut, oat smut, and seedling blight. Ensuring optimal conditions for emergence and development, especially in the initial stage of growth, makes plants less susceptible to infestation by pathogenic fungi.

Plant protection products should be used in accordance with the current list of products recommended for growing oats within the integrated production system (IP). The messages provided in the Online Pest Warning System (www.agrofagi.com.pl) may be helpful. Use instructions on the label should be read before application.

The list of plant protection products authorised in Poland is published in the register of plant protection products. Information about the scope of pesticide use for particular crops is placed on the product's label. The plant protection product search engine is a helpful tool in the selection of pesticides (<https://www.gov.pl/web/rolnictwo/wyszukiwarka-srodkow-ochrony-roslin-zastosowanie>). Current information on plant protection products use is available on the Ministry of Agriculture and Rural Development website at: <https://www.gov.pl/web/rolnictwo/ochrona-roslin>.

The list of plant protection products authorised for IP is available on the Online Pest Signalling Platform at: <https://www.agrofagi.com.pl/143,wykaz-srodkow-ochrony-roslin-dla-integrowanej-produkcji.html>.

7.3. REDUCING LOSSES CAUSED BY PESTS

7.3.1. The most important species of pests

The most important pests that occur on cereal plantations are aphids, cereal leaf beetles and gall midges. We've been able to observe, locally and sometimes in huge numbers, the occurrences of some other pests, such as Bishop's Mitre, tortoise bug, ground beetle, cereal chafer, leaf miner, oscinella frit, delia platura, and soil pests, mainly turnip moths, grubs and wireworms. Cereals may also be damaged by slugs, rodents, thrips, wheat stem fly, saddle gall midge, nematodes, birds and game animals, as well as tortrix caterpillars (Table 9) (Mrówczyński et al. 2017, Tratwal et al. 2017; Hołubowicz-Kliza et al. 2018, Grzebisz et al. 2021). Pests can cause damage to both above- and underground parts of plants (Tables 10, 11).

Systematic monitoring of the field from emergence to the beginning of maturity, at least once a week, for the occurrence of pests (aphids, cereal leaf beetles, and gall midges) (direct inspection of the plants, yellow pots, etc.) is an extremely important element of integrated production of oats.

Table 9. Current and projected importance of oat pests

Pest	Current	Forecast
Wireworms	+(+)	+++
Bishop's Mitre	++	+++
Bibionidae (march flies)	+	++
Ground beetle	++(+)	+++
Leaf miners	+(+)	++
Aphids	++(+)	+++
Cereal chafer	+	++
Chlorops ringens	+	++
Grubs	++	+++
Frit fly	++	+++
Gall midges	++	+++
Cutworms	++	+++
Leafhopper	+(+)	++
Cereal leaf beetle	++(+)	+++
Root flies	+(+)	++
Thrips	+(+)	++

Leafroller moths	+	++
Wheat stem-sawfly	+	++
Tortoise bug	++	+++
Rodents	(+)	+
Snails	+	++
Game and birds	+	+(+)

+ pest of minor importance, ++ important pest, +++ very important pest, () pest of local importance

Table 10. Damage to the underground parts of oat plants caused by pests

Pest	Damage description
Wireworms	Damage to the root system — bitten off lateral roots and traces of gnawing of the main root.
Rodents	Damage to the root system — biting plants while digging burrows underneath them. Leaf and stem damage is also observed — especially in the early stages of cereal development.
Bibionidae (march flies)	Damage to the root system — bitten off lateral roots and traces of gnawing of the main root.
Ground beetle	Damage to germinating plants (larvae), to a lesser extent to kernels (imago).
Nematodes	Stunted plants, growing very slowly, with leaves bending and wilting. Distortions and globules — nematode cysts — can be observed on the roots.
Grubs	Damage to the root system — bitten lateral roots and the main root.
Cutworms	Plants are bitten near the root neck, causing them to be severed from the roots. Some of these are pulled into holes previously made by the caterpillars in the soil. The caterpillars at the youngest and oldest growth stages can feed on aboveground plant parts.
Turnip maggot Wheat-bulb fly	Damage to germinating grains, roots and tissues of young plants.

Table 11. Damage to the above-ground parts of oat plants caused by pests

Pest	Damage description
Bishop's Mitre	Foraging on leaves and stems — yellowing and drying of leaves. Foraging on kernels — bleaching of ears, reduction of kernels in the ear, underdevelopment of kernels, and deterioration of kernel quality.
Leaf miners	Eating out the parenchyma between the upper and lower leaf skin, usually along the veins — reducing the assimilative surface (usually flag and sub-flag leaves).
Aphids	Direct damage (sap sucking) — loss of turgor, twisting and wilting of leaves. Indirect damage (transmission of viruses, mainly BYDV) — leaf discoloration, tillering, dwarfism, absence or low number of spikelets. In addition, secondary infestations by the disease pathogens.
Cereal chafer	Damage to flowers and forming grains leading to the bleaching of parts of the ear (imago), and damage to the root system (larvae).
Chlorops ringens	Damage to young seedlings and growth cones leads to stunted growth,

	shoot distortion, excessive tillering, yellowing of leaves, shortened ears or dying of entire plants.
Frit fly	Damage to the base of the shoot can result in whole plants dying or excessive tillering with few (or no) spikelets (characteristic yellowing heart leaf).
Gall midges	Weakening and shortening of the stem, abnormal development of ears and grains, reduced quality and germination of grains.
Leafhoppers	Due to sap sucking — weakening of growth, wilting and drying of plant parts. Like aphids, leafhoppers can act as vectors of viruses (including WDV).
Cereal leaf beetle	Eating the tissue along the leaf veins — reduction in assimilative surface area and photosynthesis, secondary infestation by disease pathogens.
Snails	After emergence, the seedlings are either entirely eaten or nibbled until completely cut off by slugs, just above the soil surface.
Thrips	Leaf deformation, failure of ears to emerge from the leaf sheaths, bleaching of the tops of the ears, deformation of the grains and deterioration in grain quality.
Game and birds	Eating of seeds or germinating plants during their emergence (birds) and gnawing of plants at later stages of development (game).
Leafroller moths	The greatest losses occur when caterpillars fodder on the ears; they usually destroy 3–4 kernels.
Wheat stem-sawfly	Larvae foraging causes underdevelopment of the ears or inadequate grain filling. Plants damaged at the base of the stem are easily broken.
Tortoise bug	Foraging on leaves and stems — yellowing and drying of leaves. Foraging on kernels — bleaching of ears, reduction of kernels in the ear, underdevelopment of kernels, and deterioration of kernel quality.

7.3.2. Agronomic methods of pest control

One of the basic principles of integrated pest management for oats is preventive measures, based primarily on agronomic (Table 12). Appropriate use of agricultural technology and the replenishment of any mineral nutrients shall improve the condition of plants in the early growth stages, when they are particularly vulnerable to attack from particular agrophage species. In addition, faster growth shall help to smother weeds which often provide a food base for some pests. Proper pre-sowing and post-sowing cultivation reduce the threat from pests, especially soil pests and those who overwinter in the soil. It is very important to implement crop rotation correctly. Many pests overwinter in the top layer of the soil or leftover plant residues. In the case of monocultures, pests after wintering have facilitated access to the food base. For this reason, spatial isolation is recommended, including from host plants of multivorous pests. Spatial isolation also helps make certain pests fly over longer distances. Appropriate measures to reduce the potential damage caused by individual pest species can also be taken at the seed sowing stage. The faster the initial vegetation stage of the plants, the more possibilities there are to anticipate the period of the greatest threat from the pests that are particularly dangerous to the emerging crops. The plant density is also important. Sowing too densely makes it easier for pests to spread, while sowing too sparsely favours weeds on which, for example, aphids thrive. The timing of the harvest is also very important — harvesting

too late creates the risk of greater losses, especially in terms of yield quality. After the harvest, it is important to carry out a series of post-harvest cultivations aimed at thoroughly disintegrating plant residues (overwintering sites for certain pests), and reducing weed seeds, including perennial weeds. Post-harvest tillage should be completed by deep autumn ploughing, which serves a phytosanitary role. A thick layer of soil covers the wintering forms of pests, weed seeds and fungal spores. It also brings to the surface pests that are found deeper, exposing them to adverse weather conditions. At the same time, soil pests are mechanically destroyed (Mrówczyński et al. 2017, Tratwal et al. 2017).

Integrated plant protection consists in using all available methods that minimise the use of chemical plant protection products. Such a system of protection makes it possible to regulate pest numbers to a level below the economic harmfulness threshold, i.e. not endangering the crop, unlike all other methods that prevent the mass occurrence of pests by completely destroying them. The development of pro-ecological principles of plant protection against pests is particularly important, as any attempt to solve phytosanitary problems based only on a chemical method has become unreasonable and less effective. Pro-ecological principles and methods to protect most crops from pests (including pests) include, among other things, agronomic methods which are part of properly managed crop protection.

Table 12. Agronomic methods and ways to protect oats from pests

Pest	Methods and measures of protection
Wireworms	proper crop rotation, ploughing, discing, deep autumn ploughing, early sowing and increased sowing rate, weed control, spatial isolation from other cereals, root crops and brassicas
Bibionidae (march flies)	spatial isolation from other cereal plants, early seed sowing, increasing the standard of seed sowing
Bishop's Mitre	cultivation measures, spatial isolation from meadows and pastures, weed control
Ground beetle	spatial isolation from other cereal plants, increasing the standard of seed sowing, early seed sowing
Leaf miners	spatial isolation from other cereals, meadows and wasteland
Aphids	spatial isolation from other cereal plants, early seed sowing, balanced fertilisation, spraying of plants with selective insecticides, especially the edges of plantations
Cereal chafer	tillage operations, mainly deep pre-winter ploughing, spatial isolation from meadows and pastures
Nematodes	tillage operations, correct crop rotation, 5-year break in cultivation, spatial isolation from other cereal crops
Chlorops ringens	spatial isolation from other cereal crops, late sowing of winter cereals, increasing the standard of seed sowing
Grubs	ploughing, discing, harrowing, weed control, increasing the sowing rate of seeds
Frit fly	spatial isolation from meadows, pastures, grass seed plantations, control of weeds and cereal volunteers, delayed sowing of winter crops, accelerated sowing of spring crops
Gall midges	tillering operations, spatial isolation from other cereal crops, balanced

	fertilisation
Cutworms	spatial isolation from other cereals and crucifers and brassica vegetables, early sowing of grain, weed control, increasing the sowing rate of grain, increasing the fertilisation rate
Leafhopper	tillering operations, spatial isolation from other cereal crops, sowing of early varieties, increasing the fertilisation rate
Cereal leaf beetle	tillering operations, spatial isolation from other cereal plants, balanced fertilisation, spraying of plants, especially at the edge of the field
Gastropods	ploughing, discing, careful tillage, liming, destruction of weeds, spatial isolation from other cereals and crucifers and brassicas, early and deeper seed sowing, increasing the seed sowing rate
Root flies	spatial isolation from other cereal plants, early seed sowing, increasing the standard of seed sowing
Thrips	tillage, spatial isolation from other cereal plants, balanced fertilisation, plant spraying
Leafroller moths	tillering operations, spatial isolation from other cereal plants, increasing nitrogen fertilisation
Tortoise bug	cultivation measures, spatial isolation from meadows and pastures, weed control

The main idea of integrated pest management is to use all available pest control methods while minimising the use of insecticides. It is a programme to manage pests in such a way as to keep their population below the threshold of economic damage. In integrated cereal protection, non-chemical methods are used first, and only when the crop is threatened beyond the damage threshold is insecticide protection applied. Prevention is very important, i.e. preventive action with all available non-chemical methods that reduce the number and development of pests.

7.3.3. Methods of monitoring pests in oats crops

Monitoring for the presence of pests in a plantation is a very important part of integrated plant protection. Continuous observation facilitates the assessment of the current situation in the field and, if necessary, allows for a quick response. Therefore, it is necessary to systematically monitor the occurrence of pests from the time of emergence to maturation, at least once a week, using appropriate methods. The basic element underpinning a properly set date for pest control is the monitoring of pest flights and number. Monitoring is carried out primarily on the basis of visual inspection or, in the case of soil pests, soil sieving. Other methods are also useful, such as sweep-netting or sticky boards. The basic method of plantation inspection is visual inspection (tour). Depending on the shape of the field, it should include the edge of the plantation and two diagonals. Depending on the pest species, the average number of pests per 1 m² or 100 randomly selected plants should be checked. Such observations should be carried out in several places on the plantation. Sweep-netting is a useful method. This is an easy and quick way to make an initial assessment of the species composition

and number of insects on a plantation. This method of monitoring, when performed correctly, provides preliminary information not only about pests, but also about other insects, including the useful ones inhabiting the plantation, in a relatively short time. However, it should be remembered that this method is not precise and in the event of a detected threat, more detailed inspection of the plantation should be carried out. For the purpose of initial inspection, 25 strokes should be performed with a sweep net from the edge of the plantation, moving inwards. Sweep-netting should always be carried out in the place most vulnerable to pest infestation, for example from last year's location of the crop concerned. Observations on the occurrence of soil pests consist of sieving the soil at several sites from holes measuring 25 × 25 cm and 30 cm deep. It is crucial for proper pest risk assessment to know the basics of the morphology and biology of a given pest species, e.g. the time of their potential occurrence on the crop. Monitoring should be carried out both in order to determine the time of infestation and number of harmful insects on the plantation, as well as after the procedure to check the effectiveness of the control. In case of unsatisfactory effectiveness, the occurrence of resistance or prolonged infestations of harmful insects, such actions offer the possibility of a quick reaction and, if necessary, repeating the treatment. Due to many factors determining the occurrence of pests, monitoring should be carried out on each plantation. The correct carrying out of the inspections requires knowledge of pest morphology and biology. Regardless of the monitoring method used, the results of observations should be recorded (Tratwal et al. 2017).

Constant monitoring is necessary to determine the optimal treatment timing due to the continuous impact of many environmental factors, and only direct observations allow for the actual threat from pests to be assessed. Threats can vary depending on climatic conditions, terrain, plant growth stage, natural enemies or even fertilisation level.

Integrated plant protection programmes require considerable knowledge and experience from the farmer, ranging from pest identification to elements of development and habitation to ways of pest reduction and elimination. Information on pest biology, data from previous years on the occurrence of a pest in a given area combined with knowledge of loss reduction measures can help in deciding on a treatment. The benefits of knowledge of modern methods of plant protection go beyond economic. The lack of chemical pest control also translates into a healthier environment.

One of the tools facilitating the implementation of the principles of integrated plant protection is systems supporting the adoption of decisions in plant protection. These systems are helpful in determining the optimal deadlines for performing plant protection treatments (in correlation with the plant growth phase, pest biology and weather conditions), and thus make it possible to achieve high efficiency of these treatments while limiting the use of chemical plant protection products to a necessary minimum.

The Online Pest Signalling Platform managed by the Institute of Plant Protection — State Research Institute and partner institutions contains, among other things, the results of monitoring of individual stages of pest growth in selected locations for the needs of short-term forecasting. If the threshold of economic harmfulness is exceeded in individual cases, the system indicates the need to perform treatments. In addition, the system offers instructions that facilitate proper control of plantations and making decisions about the optimal treatment dates. For each pest species, basic information is provided on its morphology, biology and methods of field observation, as well as the value of the thresholds for economic harmfulness.

Thresholds of economic harmfulness are the fundamental basis for rational protection. In the case of oats, detailed economic threshold levels have been established for certain pest species. The principles and deadlines for their observation and the harmfulness thresholds are set out in Table 13.

Table 13. Observation dates and economic damage thresholds for oat pests

Pest	Observation date	Damage threshold
Wireworms	before sowing	10–20 larvae per 1 m ²
Ground beetle	autumn – from emergence to vegetation break	1–2 larvae or 4 freshly damaged plants per 1 m ²
	spring – beginning of the growing season	3–5 larvae or 8–10 freshly damaged plants per 1 m ²
Aphids	earring or immediately after earing	5 aphids per 1 ear
Cereal chafer	flowering and grain development	3–5 beetles per 1 m ² or 5 grubs per 1 m ²
Wheat yellow blossom midge	earring	5–10 insects per 1 ear
Wheat midge	earring	8 larvae per 1 ear
Saddle gall midge	flag leaf fall	15 eggs per 1 stem
Cutworms	before sowing	6–8 caterpillars per 1 m ²
Cereal leaf beetle	flag leaf fall	1–1.5 larvae per blade
Root flies	in the spring	10 damaged plants per 30 tested or 80 larvae per 1 m ²
Thrips	stem elongation for full flowering	10 larvae per blade, 5–10 adult insects or larvae per 1 ear
Tortoise bug	Spring growth and tillering	2–3 adults per 1 m ²
	grain development, late milk stage	2 larvae per 1 m ²

7.3.4. Chemical methods of pest control

Plant protection products should be used in accordance with the current list of plant protection products recommended for oat in integrated production (IP). The messages provided in the Online Pest Warning System (www.agrofagi.com.pl) may be helpful. Use instructions on the label should be read before application. The list of plant protection products authorised in Poland is published in the register of plant protection products. Information about the scope of pesticide use for particular crops is placed on the product's label. The plant protection product search engine is a helpful tool in the selection of pesticides (<https://www.gov.pl/web/rolnictwo/wyszukiwarka-srodkow-ochrony-roslin-zastosowanie>). Current information on plant protection products use is available on the Ministry of Agriculture and Rural Development website at: <https://www.gov.pl/web/rolnictwo/ochrona-roslin>.

The list of plant protection products authorised for IP is available on the Online Pest Signalling Platform at: <https://www.agrofagi.com.pl/143.wykaz-srodkow-ochrony-roslin-dla-integrowanej-produkcji.html>.

8. BIOLOGICAL METHODS AND PROTECTION OF PLANT ENTOMOFAUNA IN THE INTEGRATED PRODUCTION OF OATS

Biological methods consist of the use of natural biological agents such as: viruses, micro-organisms (bacteria, fungi) and macro-organisms (nematodes, parasitic and predatory insects and mites) to reduce the population of pests, pathogens and weeds in plant crops in the field and under covers. Biological agents, similarly to chemical agents, combat pest populations, but their mechanism of action varies.

In biological pest control, three main methods are distinguished:

1. introduction, i.e. the permanent establishment in new areas of natural enemies imported from other regions or continents — the classical method;
2. the use of naturally occurring and specially introduced into agricultural and forest areas landscape elements enabling and enhancing the development of populations of beneficial organisms that naturally occur in these environments — the conservation method;
3. periodic colonisation, i.e. the periodic introduction of natural enemies of a given pest, on crops that do not occur or occur in small quantities — the augmentative method.

In field crops, the use of biopreparations containing parasitic micro-organisms is uncommon. First of all, the interest of producers in these measures is low, as they require more knowledge and precision in their application. Registered micro-organisms are effective provided that they are used in accordance with the product label. Their effectiveness is influenced by weather conditions in the field, which often change. These include: temperature, humidity and insolation. However, it must be remembered that when introduced into the environment these factors persist for a long period.

Reducing pest populations in oats with bioinsecticides.

Currently registered biocides can be found using the search engine for plant protection products (<https://www.gov.pl/web/rolnictwo/wyszukiwarka-srodkow-ochrony-roslin-zastosowanie>).

When using micro-organisms to control oat pests, one should bear the following in mind.

- They are sensitive to high temperatures and strong sunlight.
- The bacteria are best used when the first caterpillars/larvae of the pest appear, as the younger stages of the pest are more sensitive to insecticidal bacteria.
- Insecticidal fungi in their first stage of action require temperatures of around 25° C and high humidity to germinate and enter the insect.
- The pest's caterpillars die 24–72 hours after consuming the bacteria. During this time, they can still feed and look healthy.
- Micro-organisms are applied using self-propelled or tractor-mounted sprayers. Such procedures should be performed in the evening or early in the morning.

- Chemical fungicides must not be used after the application of biological agents containing micro-organisms (this is particularly relevant for products containing fungi in the composition of the product).
- They are living organisms and have a short shelf life at room temperature, but can be stored in the refrigerator for up to 6 months.
- The labels of biological products must be carefully read before use to avoid potential errors in their application.
- Attention must be paid to the information on the pH of the working liquid and its miscibility with chemical products (usually this information can be found on the labels; in case of doubt, contact the representative of the company placing the product on the market).
- When using biological products based on living organisms, it is very important to monitor crops in order to select the appropriate date for the application of the solution.

Mechanism of action of parasitic fungi and conditions of use

The infectious stage of the insecticidal fungus, which is the active substance of the bioinsecticide, consists of spores or hyphae of the fungus, which do not have to be ingested by the pest; it is sufficient for them to reach the surface of the host's body. They germinate and penetrate its interior. The insect dies from paralysis caused by the overgrowth of its body by the developing fungal hyphae. All stages of pest development are vulnerable. The pest dies within 3 to 7 days from infection.

Insecticidal fungi, such as *Beauveria bassiana*, are sensitive to low and very high temperatures. The optimal temperature for spore germination is 25° C. High humidity is required for the penetration of spores into the body of the pest. Micro-organisms are applied using self-propelled or tractor-mounted sprayers. The use of an insecticidal fungus in the form of a registered biopreparation means that the biological agent introduced into the environment can also act on other pests not listed on the label of the product for a long period of time. Fungus *B. bassiana* is a known biological agent commonly found in soil and may, for example, reduce the different stages of development of pests wintering in soil.

Symptoms of infestation by insecticidal fungi: the body of an infested insect often changes colour. One of the typical symptoms is mummification; the body hardens, and, under humid conditions, a mycelium of different colours is formed on its surface, depending on the species of the fungus.

The biological preparation containing parasitic fungi should be stored in cool conditions at 2–6 °C.

Mechanism of action of insecticidal bacteria

The death of an insect occurs after consuming spores and toxic crystals (Cry protein) of the bacteria, resulting from damage to the epithelial cells of its intestine, caused by endotoxin activity. The digestive tract becomes paralysed and the insect stops feeding. The most sensitive are the younger larval stages of

insects.

The body of the infested insect darkens and becomes almost black due to necrotic changes.

It is important to remember that:

In the environment, biological factors, i.e. elements of the living environment, have a direct impact.

Also gastropods may prove problematic in oats cultivation. They can be controlled with available biological preparations having macroorganisms – nematodes – as their active ingredient. Macro-organisms are not subject to registration in Poland. Larvae of an insecticide nematode, *Phasmarhabditis hermaphrodita*, penetrate the gastropods' body through the respiratory canal, infecting it with bacteria and making it stop foraging after 3–5 days. The application of the agent to a moist substrate increases its effectiveness. The preparation is retained in the soil for about 6 weeks. When using nematode preparations, it is necessary to know that the sprayer should have nozzles greater than 0.5 mm, and the pressure of 300 psi should not be exceeded. The preparation contains living organisms — larvae of nematodes, so their use must be carried out especially carefully and according to the label of the product.

Conservation biological protection

Biological protection is not only about the use of registered microbiological biopreparations. It is also supported by nature and the use of **the conservation biological method**. It involves the modification of the agricultural landscape by humans in order to create appropriate conditions for the action of beneficial organisms occurring in the environment (Sosnowska 2018, 2022). The number of beneficial organisms can be increased, among others, by sowing melliferous plants in the vicinity of crops, flower strips or leaving natural furrows. Midfield woodlots and bushes play a big role. These sites serve as habitats for those organisms that significantly reduce populations of various pests. Hence the need to ensure an increase in the number of beneficial organisms near the crop through field scrub and flower strips. The rational use of selective chemical plant protection products is very important, allowing to reduce their negative effects on beneficial organisms. The decision on the need to perform chemical treatment in the field should be made on the basis of the real pest threat to the crops.

A large role in nature is played by beneficial macroorganisms, i.e. parasitic and predatory insects, mites, and insecticidal nematodes (they are not subject to registration in Poland). Under natural conditions, the importance of beneficial ground beetles is growing in integrated plant protection. They occur in large numbers in all agricultural environments, including oat crops. They are found on the top layer of soil and litter. Due to their large size, high motility and great voraciousness, they are among the most effective beneficial insects, significantly reducing the number of plant pests; among other things, they feed on eggs, pupae

and larvae/caterpillars of many species of butterflies, beetles and Hymenoptera. The herbivorous corn ground beetle (*Zabrus tenebrioides*) is an exception in the family of ground beetles, considered to be a pest.

A small parasitic hymenopteran can be found under natural conditions: *Trichogramma* spp.; it is approximately 1 mm in size. It is, among other things, a parasite of maize borer eggs. A *Trichogramma* female can lay up to 300 eggs, so the scale of pest egg parasitisation can be large. Biopreparations containing aggregates are available for use mainly against the European corn borer. However, the *Trichogramma* is a parasite of the eggs of many other species of pests.

Aphids are another problem in oat cultivation. In natural conditions, aphid populations are reduced by many species of predatory insects, such as ladybirds (Coccinellidae). One larva, throughout its development (approx. 30 days), can eliminate from 100 to 200 aphids. A beetle eats 30–250 aphids a day. Given that aphid flights usually occur earlier than those of ladybirds and other beneficial insects, it is necessary to decide whether chemical treatment with a plant protection product is needed. If necessary, it should be performed as early as possible, before the flight of natural enemies, or restricted to the edge strips of the plantation, or even for a spot treatment by choosing a selective insecticide. Net-winged insects (Neuroptera) also feed on aphids. Green lacewing larvae eat up to 400 aphids. However, despite enormous aphidicidal effectiveness, the high motility of these insects significantly hinders the ability to control their populations, both natural and artificially introduced into crops. Aphids are also preyed upon by species of soldier beetles (Cantharidae), gall midges (Cecidomiidae), earwigs (Dermaptera), as well as predatory insects such as specialized aphid wasps (Aphidiidae) (Tomalak 2008).

Under favourable conditions (high humidity and temperatures above 20 °C), insecticide Entomophthoraceae fungi ('insect destroyers') play a major role. These fungi can cause epizootic diseases, i.e. mass extinction of aphid colonies. The development of insecticide fungi is promoted by water habitats, strongly humidified habitats, forests, woodlots, rushes and meadows. Forests are more than twice as rich in insecticidal fungi as agro-ecosystems (Tkaczuk et al. 2016). Insecticides can reduce populations of pests wintering in the soil, such as cutworms and weevils. Insecticidal fungi species develop in the soil, such as: *Beauveria bassiana*, *Metarhizium anisopliae* and *Cordyceps fumosorosea*. The effectiveness of these mushrooms is best at high humidity and a temperature of 25 °C. Insecticide fungi also grow on the surface of the plant. Parasitised insects, such as aphids, can often be found on leaves. Insecticidal bacteria and viruses can also play an important role.

In the environment, not only beneficial insects and micro-organisms play a role in reducing pest populations. Are other animals, such as amphibians, birds or mammals, play a similar role, too (Wiech 1997). The grey toad plays a useful role in agroecosystems. This large amphibian feeds on a variety of foods, predominantly snails and insects, often harmful ones. One of the insectivorous mammals is the

mole. It is a useful animal that feeds on white grubs and other insects found in the soil. The largest representative of insectivorous mammals is the hedgehog, which hunts at night, and its food consists of insects, gastropods, and other animals. Birds play a useful role in the environment. They feed on various plant pests. Therefore, in integrated oat production, it is required to create appropriate conditions for the presence of birds of prey, which involves the setting up of resting poles.

Unfortunately, it is not possible to ensure the protection of oats with the exclusive use of biological agents. The oats protection strategy should include a series of actions based on different methods, mainly non-chemical, and the efforts to minimise the use of chemical plant protection products. Although we do not currently have a large assortment of biological plant protection products for field crops, the current strategies of the European Union, as well as the reduction of chemical plant protection products, will contribute to increasing the range of these products in the coming years.

Most of the biological agents available do not guarantee better effectiveness compared to chemical agents. This depends on many factors: both biotic and abiotic ones. Farmers must be trained in the availability, mode of use, and the advantages and disadvantages of biological plant protection products. The use of these measures requires a high level of knowledge, because when used incorrectly, they often produce no desired effect. The greatest advantage of biological agents is their safety for the environment. They enrich the biodiversity of the agricultural landscape, are safe for the consumer and beneficial organisms, do not require a withdrawal period, and once introduced into the environment, they may persist for a long time and under natural and optimal conditions for their development, they can reduce pest populations without reintroduction. Other benefits of using them include: the absence of residues, their non-toxicity to entomophages, their often observed specificity to certain groups of organisms (e.g., only aphids are affected), the reduction in the use of chemical plant protection products, and the protection of environmental biodiversity. Drawbacks to the use of biopreparations also exist, such as their sensitivity to environmental conditions (temperature, humidity), short lifespan in the preparation, the need for precise execution of treatments, and a slow mechanism of action.

Plant protection products, including biological agents, should be used in crops for which they are recommended and the information contained in the labelling of the product must be observed. The basis for their application is the monitoring of harmful species.

Predatory birds living near plantations are effective in controlling small mammals (rodents, hares). To allow them to watch their surroundings, resting poles of at least 3 m in height should be placed along the plantation (at least 1 unit per 5 ha).

Detailed information on registered plant protection products for oat protection can be found at:

- search engine for all registered plant protection products (including biological ones) <https://www.gov.pl/web/rolnictwo/wyszukiwarka-srodkow-ochrony-roslin-zastosowanie>;

- list of plant protection products for integrated production in agricultural crops: <https://www.agrofagi.com.pl/143,wykaz-srodkow-ochrony-roslin-dla-integrowanej-produkcji>.

Protection of bees and other pollinators

Legal protection of these organisms during chemical treatments is also an important element of modern plant protection. Integrated pest management includes 'the protection of beneficial organisms and the creation of conditions conducive to their occurrence, in particular pollinators and natural enemies of harmful organisms' (Pruszyński 2007, 2008).

Bearing in mind the obligation to carry out crop protection in accordance with the principles of integrated pest management, chemical plant protection treatments should take into account the selection of plant protection products in such a way as to minimise their negative impact on non-target organisms, in particular pollinators and natural enemies of harmful organisms.

A more efficient use of beneficial species may be achieved through a number of actions, including:

- rational use of chemical plant protection products and basing the decision on their use on the real risk to oat cultivation from pests, assessed on an ongoing basis. One should consider abandoning treatments if pests do not occur in large numbers and are accompanied by the occurrence of beneficial species. In this group of activities, the limitation of the treatment area to the edges or patches should be considered if the pest does not occur on the whole plantation. The use of tested mixtures of plant protection products and liquid fertilisers should be recommended as it reduces the number of entries into the field and mechanical damage to plants;
- protection of beneficial species by avoiding the use of insecticides with a broad spectrum of action and replacing them with selective agents;
- choosing the treatment time to prevent high mortality among beneficial insects;
- based on the studies, reducing doses and adding adjuvants;
- having a constant awareness that by protecting the natural enemies of oat pests, other beneficial species present in the field are also protected;
- leaving dead furrows and mid-field shelters as a habitat for many species of beneficial insects;
- reading carefully the content of the label accompanying each plant

protection product and observing the information contained therein.

Other insects are also very efficient pollinators. In order to ensure the development of pollinators living in the wild in agrocenoses, and thus increase pollination efficiency, it is necessary to place mason bee houses or bumblebee mounds (scattered bags of peat) or other facilities for pollinators within the crop—at least 1 per 5 ha.

9. PROPER SELECTION OF PLANT PROTECTION TECHNIQUES

Storage of plant protection products

Plant protection products should be stored:

- a) in original packaging, sealed and clearly labelled, and in a manner preventing these products from coming into contact with food, drink or feed;
- b) in a manner ensuring that they:
 - are not consumed by or earmarked for animal feeding,
 - are inaccessible to children,
 - there is no risk of:
 - contamination of surface and groundwater within the meaning of the water law,
 - soil contamination due to leakage or seepage of plant protection products into the soil profile,
 - penetration into sewage systems, excluding separate drain-free sewage systems equipped with a leak-proof sewage tank or equipment for their neutralisation.

The labels of plant protection products approved by the Minister for Agriculture and Rural Development contain information on the principles of safe storage.

Plant protection products in accordance with the principles of good practice should be stored in separate rooms (except residential and livestock buildings). These rooms should be clearly marked (e.g.: 'Plant Protection Products') and secured against unauthorised access, i.e. locked.

If poisoning is suspected in connection with contact with a plant protection product, medical advice should be sought immediately and the doctor informed of the method of exposure to the specific chemical in question.

Requirements for professional users

Persons or sprayer operators handling plant protection products must be suitably qualified, as attested to by a certificate of completion of training in the use of plant protection products or advisory on plant protection products and integrated plant production, or another document attesting to their qualifications to carry out plant protection treatments.

The sprayer operator must be equipped with appropriate protective clothing, as prescribed on the label and in the safety data sheet of the plant protection product. The basic protective clothing gear includes: a suit, suitable shoes, rubber gloves resistant to plant protection products, glasses and mask to protect the eyes, respiratory system and covering the mouth. Proper work organisation and available technical measures should be used at each stage of the handling of plant protection products, in accordance with the principles of **Good Plant Protection Practice**.

Apparatus and equipment for protective treatments

The sprayer or other equipment used for crop protection must be in good technical condition, ensure reliable operation and guarantee the safe use of plant protection products, liquid fertilisers or other agrochemicals. The sprayer must have undergone a technical inspection (with up-to-date certification) and be properly calibrated. The good technical condition of the equipment must be confirmed by the protocol of the test carried out and by the control mark issued by the units authorised to do so (sprayer inspection stations). Testing of new equipment must be carried out no later than five years after its acquisition and subsequent tests must be carried out at intervals of no more than three years.

Equipment used for plant protection treatments must be safe for humans and the environment. In addition, it should guarantee the full effectiveness of protective treatments by ensuring proper action to allow accurate dosing and even distribution of plant protection products on the treated area of the field.

Before performing the procedure, it is necessary to check the technical condition of the sprayer, in particular the condition of: filters, pumps, lubrication and lubrication points, nozzles, field beam, measuring and control devices, fluid system and agitator. It is also advisable to carry out a preventive rinsing of the sprayer in order to remove mechanical impurities and possible residues after previously performed treatments.

Calibration (adjustment) of the sprayer

Periodic adjustment of the sprayer makes it possible to choose the optimal parameters of the treatment. In accordance with good plant protection practice in the adjustment (calibration) process of the sprayer, the type and dimension of the sprayers and the working pressure should be determined, which ensure the application of the assumed dose of liquid per hectare for the specified operating speed of the sprayer.

The adjustment of the sprayer's operating parameters should be performed when changing the type of chemical agent (especially from herbicide to fungicide or insecticide), the dose of the spray liquid, as well as the setting of operating parameters (working pressure, field beam height). The adjustment of the sprayer is carried out each time when replacing important equipment and components of the sprayer (sprayers, pressure gauge, control device, repair of

essential elements of the liquid system), as well as when changing the tractor or tyres of the drive wheels. The discharge of the liquid from the nozzles at the specified operating pressure should be checked regularly. When adjusting the sprayer, attention should be paid to the flow capacity of the nozzles and the uniformity (type and size) of the nozzles mounted on the field beam.

An example procedure for calibration of the sprayer is contained in the Code of Good Practice for Plant Protection or other thematic studies in this area.

Choice of plant protection product and dosage

In line with the requirements of integrated plant protection, selective measures with low risk to pollinators and beneficial organisms should be chosen.

Treatments with plant protection products should be planned in a way that ensures acceptable efficacy with the minimum quantity of plant protection product necessary, taking into account local conditions.

The dose of the plant protection product should be selected according to the manufacturer's recommendation on the basis of the label, also taking into account the development phase of the plants, their condition and climatic and soil conditions: wind, temperature and humidity of soil and air, type of soil, as well as the content of organic matter in the soil.

The decision to use a plant protection product at a dose lower than recommended on the label must be taken with great care, based on knowledge, experience, observations and professional advice. The use of reduced doses may lead to the development of resistance to active substances of plant protection products in target organisms.

When using plant protection products, also in split doses, it is necessary to comply with the requirements specified on the product label, i.e.:

- **time intervals between individual treatments;**
- **maximum number of uses per season;**
- **the maximum dose of the plant protection product.**

Selection of spray liquid volume

In integrated crop protection systems, the volume of spray (l/ha) should be selected based on available catalogues, training materials and handbooks or other thematic studies. Factors such as the type of crop being sprayed, the development stage of the crop, the density of the crop, the possibility of using different spraying techniques (type of treatment apparatus, type and kind of spray equipment), as well as the recommendations contained on the label of the specific plant protection product, should be taken into account in the selection of spray volume.

Surface agents require very good coverage of sprayed plants and generally require the use of more spray fluid than systemic agents. In foliar feeding

treatments and when combining the use of several chemicals, it is recommended to use increased volumes of spray liquid. With suitable treatment equipment (e.g. sprayers with auxiliary air stream [(AAS)], the dose can be possibly reduced to 50–100 l/ha which should guarantee sufficient coverage of the treated plants.

Selection of sprayers

Sprayers have a direct impact on the quality of spraying and thus on the safety and effectiveness of plant protection products. Catalogues and general recommendations concerning their use for the protection of agricultural crops are useful in the selection of suitable sprays for individual plant protection treatments.

The selection of the atomiser for specific protective treatments should be preceded by getting to know its technical characteristics, and above all information about the type, size of the spray slot, and intensity of the liquid discharge.

Preparation of spray liquid

The intended volume of the liquid should be prepared immediately before the procedure to avoid undesirable physicochemical reactions. The sprayer agitator must be switched on at all times to protect the mixture from precipitation at the bottom of the tank. Before pouring the product into the tank, it is necessary to read the indications on the label as to the method of preparation of the spray liquid and the possibility of mixing the product with other preparations, adjuvants or fertilisers.

The measurement of plant protection products quantity and preparation of the spray liquid should be carried out in a way that reduces the risk of contamination of surface water, groundwater and soil, and at a distance of no less than 20 m from wells, water intakes, reservoirs and watercourses.

Sprayer filling:

- the sprayer must be filled on an impermeable and hardened surface (e.g. concrete slab), in a place where it is possible to prevent the spreading of spilled or leaked plant protection products;
- the measured quantity of crop protection product should be poured into the partially filled tank with the agitator switched on or in accordance with the instructions for use of the sprayer;
- empty plant protection product packaging must be rinsed three times, the contents poured into the spray tank, and the packaging preferably returned to the dealer;
- if possible, it is best to fill the sprayer on a special stand with a biologically active substrate;
- when filling the sprayer on a permeable surface, a thick foil for the collection of spilled or scattered preparations should be laid down where

the plant protection products are measured and introduced into the sprayer tank;

- spilled or scattered plant protection product and contaminated material must be safely managed using absorbent material (e.g. sawdust);
- contaminated absorbent material must be collected and submitted to a bioremediation site for plant protection products or placed in a sealed, labelled container;
- the container with the contaminated material should be stored in plant protection product storage until safely disposed of.

Combined use of agrochemicals

In treatments with the use of several agrochemicals, the order of adding ingredients during the preparation of the spray liquid should be observed. A weighed portion of fertiliser (e.g. urea, magnesium sulphate) is poured into the sprayer tank half filled with water with the stirrer on. Further components are added to this solution. It is recommended that they be pre-diluted before pouring into the sprayer tank. Start with an adjuvant that improves compatibility of the components of the mixture, if used. Then plant protection products are added (in the correct order, according to the formulation), followed by water to the desired volume of the sprayer tank.

In multi-component mixtures using two or more plant protection products, the order in which they are added to the liquid must be followed — according to the physical properties of the formulations. First, add preparations that form a suspension in water, then add agents that form emulsions, and finally, solutions. After adding all the components, fill the tank up with water to the required volume.

Do not use water at a low temperature (taken directly from a deep well) for the treatment. Very hard and contaminated water should not be used. Protective treatments may begin when the spray liquid is properly prepared.

Treatment conditions

Plant protection products should be used in such a way that they do not pose a risk to human health, animal health and the environment, including preventing the spread of plant protection products to areas and facilities not intended for treatment

Treatments with plant protection products should be performed in low wind and rain-free weather and moderate temperature and insolation. Spraying during adverse weather (stronger wind, high temperature and low air humidity) can cause damage to other plants as a result of the spray liquid drifting to areas not intended to be covered by the treatment, and may cause unintended poisoning of many beneficial species of entomofauna.

Table 14 shows recommendations for optimum and limiting weather conditions during spray applications. The recommended air temperatures during

treatments are conditioned by the type and mechanism of action of the plant protection product applied and such details are included in the label texts. For most preparations, optimal effectiveness is achieved at a temperature of 12–20 °C.

Plant protection products can be applied in the open if the wind speed does not exceed 4 m/s. A slight wind, with a speed of 1 to 2 m/s, is also beneficial due to turbulence and better movement of the sprayed liquid among the sprayed plants. In weather conditions close to the upper (wind temperature and speed) or lower (air humidity) limit values, spray nozzles limiting drift (e.g. low drift or ejector) and lower recommended operating pressures should be used for spraying operations.

Table 14. Borderline and optimal meteorological conditions for plant protection treatments

Parameter	Limit values (extreme)	Optimal (most advantageous) values
Temperatures	1–25 °C during the procedure	12–20 °C during the procedure
	up to 25 °C the day after the procedure	20 °C the day after the procedure
	no less than 1 °C the following night	no less than 1 °C the following night
Air humidity	40–95%	75–95%
Rainfall	less than 0.1 mm during treatment	no rainfall
	less than 2.0 mm within 3–6 hours of the treatment	
Wind speed	0.0–4.0 m/s	0.5–1.5 m/s

Plant protection products should be used in open areas by means of tractor sprayers and self-propelled field or fruit sprayers, if the place of application of these products is remote:

- at least 20 m from the apiaries,
 - at least 3 m from the edge of the roadway with the exception of public roads classified in the category of municipal and district roads;
- and
- in the case of tractor and self-propelled orchard sprayers, at least 3 m from reservoirs and watercourses and land not used for agriculture, other than for treatment with plant protection products,
 - in the case of tractor and self-propelled field sprayers at a distance of at least 1 m from reservoirs and watercourses and land not used for agriculture, other than those treated with plant protection products.

It is important to bear in mind the obligation to comply with the labelling of plant protection products in the first place. On many labels, distances (buffer zones) from specific sites and facilities for the use of plant protection products are greater than those indicated above.

The spraying procedure is performed at a constant movement speed and working pressure, set during sprayer adjustment. Successive runs over the field should be made very precisely to avoid strips being left unsprayed and so that no overlapping of the sprayed liquid occurs on already sprayed areas.

Post-treatment procedure

At the end of each treatment cycle, removal of the spray liquid from the sprayer should be carried out by spraying the spray liquid in the field or plantation where the treatment was carried out or on the producer's own unused agricultural area, away from drinking water intakes, and sewer wells. The sprayer should be washed thoroughly in the place intended for this purpose.

Residual liquid must not be poured onto the soil or into the sewage system, or poured in any other place that prevents collection or poses a risk of soil and water contamination.

Washing and rinsing the tank and liquid sprayer system should be carried out at a safe distance - no less than 30 m - from wells, water intakes and reservoirs and watercourses.

Procedure for rinsing the tank and liquid system

- Use the least necessary amount of water for rinsing (2-10 % of the volume of the tank or an amount that dilutes liquid remaining in the tank up to 10 times); it is recommended to rinse the liquid system with a small portion of water three times.
- Turn on the pump and rinse all the elements of the liquid system used during the procedure.
- Spray the rinsings on previously sprayed surface or, if it is not possible, use the residues according to the recommendations on the management of liquid residues.
- The residual liquid drained from the sprayer shall be disposed of using technical equipment that ensures biodegradation of the active substances contained in plant protection products. Until neutralisation or disposal, liquid residues may be stored in a sealed, labelled and secured container earmarked for that purpose.

External sprayer washing

After the end of the working day, all the apparatus, as well as components in contact with chemical agents, must be washed from the outside with water.

External washing of the sprayer should be carried out at a location that allows the washings to be directed into a closed collection system for contaminated residues or into a neutralisation/bioremediation system (e.g. Biobed, Phytobac, Vertibac station); if this is not possible, the sprayer should preferably be washed in the field.

Wash the sprayer with a small amount of water, preferably using a high-

pressure lance instead of a brush to shorten the time and increase the efficiency of external washing.

Use recommended, biodegradable means to increase washing efficiency.

Recording of treatments

Professional users of plant protection products are required to maintain and keep records of their plant protection products for three years. The documentation should contain information on:

- the names of the plant protection product,
- the date of application,
- the dose used,
- the area and crops on which the protective treatment was carried out,
- reasons for the treatment with a plant protection product.

The law also requires the method of fulfilling the requirements of integrated plant protection to be indicated in the documentation by providing at least the reason for the treatment with a plant protection product. **Filling the mandatory IP Notebook in the system of integrated plant production fulfils the requirement to keep the above-mentioned documentation for certified crops.**

10. HEALTH AND HYGIENE RULES

Personal hygiene of workers

Persons working in the harvesting and preparation of crops for sale should:

- a) not be infected with or suffer from food-borne diseases;
- b) maintain personal hygiene, observe hygiene rules, and in particular wash their hands frequently during work;
- c) wear clean clothes and, where necessary, protective clothing;
- d) cover wounds and skin abrasions with a waterproof dressing.

The producer shall ensure that persons involved in harvesting crops and preparing them for sale:

- a) have unlimited access to washbasins and toilets, cleaning products, paper towels or hand dryers, etc.;
- b) have undergone hygiene training.

Requirements on hygiene relating to agricultural produce prepared for sale

The crop producer shall take measures to ensure the following, as appropriate:

- a) clean or consumption-class water is used to wash the crops as necessary;
- b) during and after harvesting, the crops are protected against physical, chemical, and biological pollution.

Integrated plant production hygiene requirements for packaging, means of

transport and places for the preparation of crops for sale

Under integrated plant production, the producer takes the necessary actions to ensure that:

- a) cleanliness of rooms (and equipment), means of transport and packages is maintained;
- b) farm and domestic animals are not allowed into rooms, vehicles, and packages;
- c) harmful organisms (pests and organisms hazardous to humans), that may cause contamination or threat to human health, e.g. mycotoxins, are eliminated;
- d) hazardous waste and substances are not stored together with crops prepared for sale.

11. PREPARATION FOR HARVESTING, HARVEST, AND POST-HARVEST PROCEDURE

Due to the high water requirements, it is very important to harvest oats at the right time – before heavy rainfall. The oat grain is ready for harvest when its moisture content is approx. 16 %. Any delays in harvesting are inadvisable, as there may be significant losses in the size and quality of the crop. This is associated with a high risk of lodging, which is favoured by intense rainfall, usually accompanied by strong gusty winds. An important element of oat harvesting is the proper setting of the harvester. When preparing the harvester, it must be remembered to use a larger sieve opening and a lower fan speed. After setting these elements, the amount of losses should be checked. If they are large, the fan speed should be reduced and upper sieve partially closed. However, it should be remembered that the upper sieve should not be closed more than the lower sieve, as this will cause very large losses.

Harvesting of winter oats should be done in the same way as spring oats, paying special attention to the setting of the fan and sieves. With the right settings, crop losses will be significantly reduced. The grain to be harvested should have a moisture content of approx. 16 %.

12. DEVELOPMENTAL STAGES OF OATS BASED ON THE BBCH SCALE

The BBCH scale is becoming more and more frequently used to determine the precise crop growth stages. It is appreciated by advisers and plant producers, primarily for its universality, because for all crops the same division of phenological phases has been used, and complex descriptions were replaced by suitable number codes. The standard description of the development phases

according to the BBCH has the same code, regardless of the language and country in which the scale is used. The two-digit code precisely determines the current growth stage of the plant. The first digit always determines the principal growth stage, and the second enables an even more precise determination of the growth stage and development of the crop. An arithmetically higher code indicates a later growth stage.

In oats, there are 9 main developmental stages: Stage 0 – Germination, Stage 1 – Leaf development, Stage 2 – Tillering, Stage 3 – Stem elongation, shoot growth in length, Stage 4 – Thickening of the sheath of the flag leaf, Stage 5 – Heading/ear emergence, Stage 6 – Flowering, Stage 7 – Grain development, Stage 8 – Ripening, Stage 9 – Senescence.

The duration of individual development stages largely depends on the variety of oats and agrotechnical and weather conditions. Weather conditions are important for both the germination of seeds and the uniform emergence of plants, as well as the further development of oat plants. In general, however, for oats it is assumed that the period from sowing to emergence is 7–10 days (stage 0). The entire growing period of oats is approximately 120–150 days (Matysiak and Strażyński 2018).

CODE DESCRIPTION

Principal growth stage 0: Germination

- 00** Dry seed (caryopsis)
- 01** Beginning of seed imbibition, soft kernel of a typical size
- 03** Seed imbibition complete, swollen kernel
- 05** Radicle has emerged from caryopsis
- 06** Radicle elongated, root hairs and/or side roots visible
- 07** Leaf shed (coleoptile) emerged from the kernel
- 09** Coleoptile penetrates soil surface
(soil cracking)

Principal growth stage 1: Leaf development^{2, 3}

- 10** The first leaf emerges from the leaf sheath (Coleoptile) (pinning)
- 11** 1st leaf unfolded
- 12** 2nd leaf unfolded
- 13** 3rd leaf unfolded
- 1** . Stages continue until...
- 19** 9 or more leaves have unfolded

Principal growth stage 2: Tillering⁴

- 20** No tillers

² A leaf is considered to be fully developed when its ligule is visible.

³ Tillering or elongation of the stem may occur earlier than in phase 13; in such a case, the description continues in phase 21.

⁴ If the shoot elongation starts before the end of the tillering, then the description continues in phase 30.

- 21 Beginning of the tillering stage: 1st tiller visible
- 22 2 tillers detectable
- 23 3 tillers detectable
- 24 Stages continue until...
- 29 End of the tillering stage. Maximum no. of tillers detectable
- 30

Principal growth stage 3: Stem elongation

- 30 Beginning of stem elongation: pseudostem and tillers erect, first internode begins to elongate, top of inflorescence at least 1 cm above tillering node
- 31 Node 1 at least 1 cm above tillering node
- 32 Node 2 at least 2 cm above node 1
- 33 Node 3 at least 2 cm above node 2
- 34 Stages continue until...
- 37 Flag leaf just visible, still rolled, ear begins to swell
- 39 Flag leaf stage: flag leaf fully unrolled, ligule just visible
- 40

Principal growth stage 4: Booting

- 41 Beginning of leaf sheath swelling, early boot stage: flag leaf sheath extending
- 43 Mid boot stage: flag leaf sheath just visibly swollen
- 45 Late boot stage: flag leaf sheath swollen
- 47 Flag leaf sheath opening
- 49 First awns visible

Principal growth stage 5: Earing

- 51 The beginning of earing: tip of inflorescence emerges from the sheath, first spikelet just visible
- 52 20 % of the inflorescence emerged (ear, panicle)
- 53 30 % of the inflorescence emerged
- 54 40 % of the inflorescence emerged
- 55 50% of the inflorescence is exposed, full heading stage
- 56 60 % of the inflorescence emerged
- 57 70 % of the inflorescence emerged
- 58 80 % of the inflorescence emerged
- 59 End of heading: inflorescence fully emerged

Principal growth stage 6: Flowering

- 61 Beginning of the flowering stage: first anthers visible
- 65 Full flowering: 50% of anthers mature
- 69 End of flowering: all the spikelets have completed flowering but some dehydrated anthers may remain

Principal growth stage 7: Kernel development

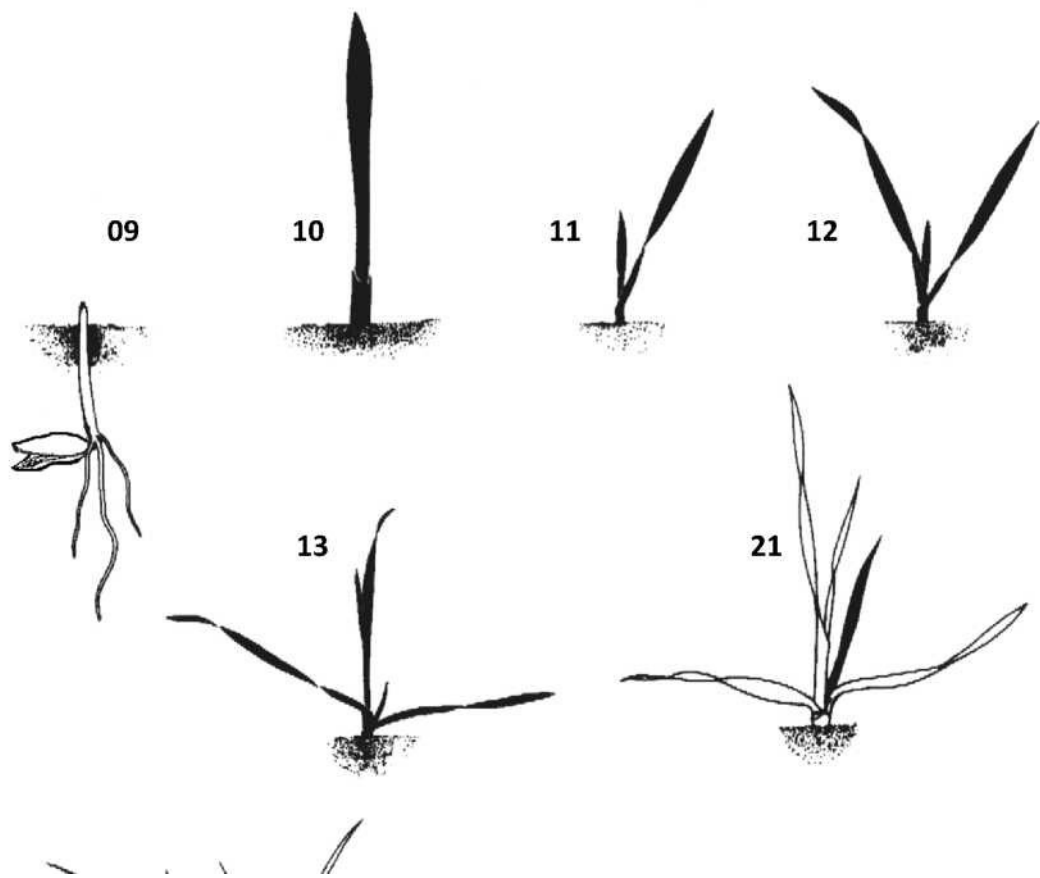
- 71 Water maturity: the first watery grains have reached half their typical size
- 73 Beginning of milk maturity
- 75 Medium milk: grain content milky, grains reached final size, still green
- 76 Late milk

Principal growth stage 8: Ripening

- 83 Beginning of waxy maturity of the kernels
- 85 Soft waxy maturity, grains easily smeared between the fingers
- 87 Hard waxy maturity, grains easily broken with a fingernail
- 89 Full maturity, hard grains, difficult to split with a fingernail

Principal growth stage 9: Senescence

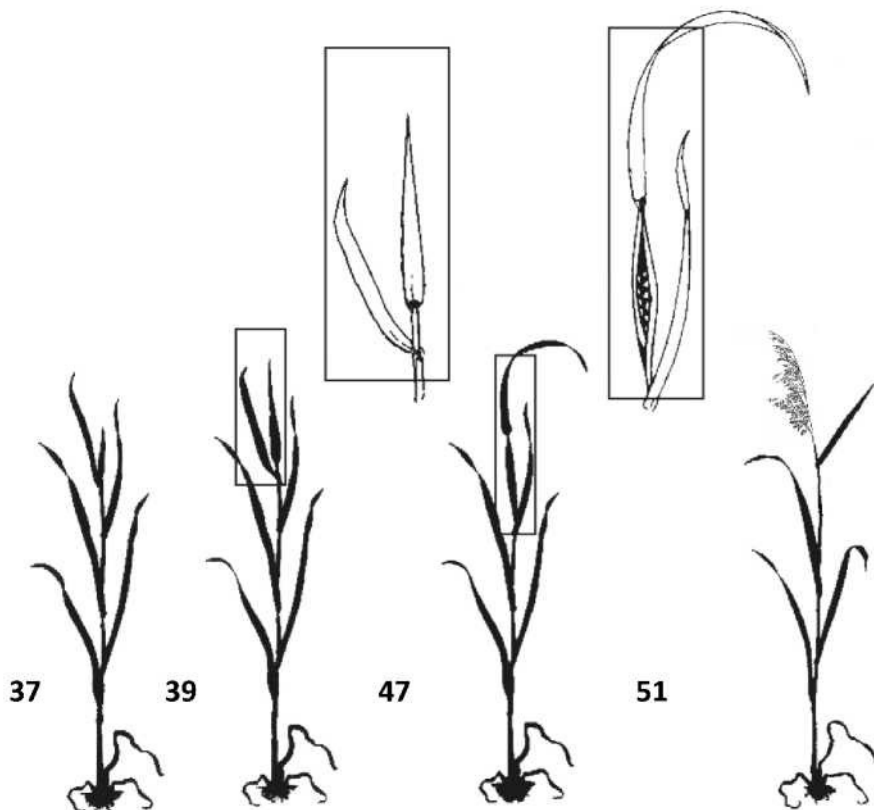
- 92 Over-ripe: very hard grains, cannot be dented by a fingernail
- 93 Grains loose in the ear, may fall off
- 97 Plant dead and collapsing
- 99 Harvested product, resting period



30

31

32



59

65

7

13. RULES FOR KEEPING RECORDS IN INTEGRATED PRODUCTION

The cultivation of plants under the integrated plant production system is inextricably linked to the keeping or possession of various types of documentation by the agricultural producer. The IP Notebook is one of the most important of these documents. The record-keeping rules will change on 1 January 2026 as a result of the application of Implementing Regulation (EU) 2023/564.

Other documents that a integrated plant producer must possess or may have to deal with during the certification process include:

- the methodology of integrated plant production;
- the notification of accession to integrated plant production;
- the certificate of the registration number;
- programme or conditions for certification of integrated plant production;
- the price list for the certification of integrated plant production;
- the contract between the agricultural producer and the certification body;
- rules for dealing with appeals and complaints;

- information on the GDPR;
- lists of plant protection products for IP;
- inspection reports;
- checklists;
- results of tests carried out to determine the presence of residues of plant protection products and levels of nitrates, nitrites and heavy metals in agricultural crops;
- soil and leaf test results;
- certificates of completion of training;
- reports or proof of purchase attesting to the technical functioning of the equipment for applying plant protection products;
- purchase invoices for, among other things, plant protection products and fertilisers;
- application for a certificate;
- IP certification.

The certification process begins with the producer completing and submitting to the certification body, within the statutory deadline, an application for participation in integrated plant production. A model application may be obtained from the certification body or downloaded from its website.

The application form should be completed with information such as:

- the name, address and place of residence or the name, address and registered office of the plant producer;
- the PESEL [personal identification] number, if one has been assigned to them.

The application must also include the date and signature of the applicant. The declaration shall be accompanied by information on the species and varieties of plants to be grown under the IP system and the location and area of their cultivation. A copy of the certificate of completion of training in integrated plant production or a copy of the certificate or copies of other documents attesting to the qualification must also be attached to the application.

During cultivation, the agricultural producer is obliged to keep records of activities related to integrated plant production in the IP Notebook on an ongoing basis. The type of notebook is chosen according to the species of crop that has been reported to the certification body. When applying for certification for more than one plant species, IP Notebooks must be kept individually for each crop.

The Notebook should be filled in according to the following outline.

Cover — the plant species and the year of cultivation as well as the number in the plant producers' register should be stated on the cover. Then, one's own information must be added.

Inventory of fields/plots/greenhouses/tunnels used in integrated production — all cultivated varieties submitted for IP certification must be recorded in the table containing the list of fields.

Field plan with biodiversity-increasing elements - graphically reproduce the plan of the farm and its immediate surroundings with the proportions of the given elements. Use the same markings on the farm plan as in the field list.

General information, sprayers, operators - record the year in which production according to the principles of Integrated Plant Production was started. Then, the tables must be filled in. The bullet points should be filled in with appropriate entries and the information confirmed by ticking the relevant boxes (). The 'Sprayers' table should be filled in with the required data and the information confirmed by ticking the relevant boxes (). All sprayer operators carrying out plant protection treatments must be listed in the 'Sprayer operator(s)' table. It is absolutely necessary to confirm that the training in the use of plant protection products is up to date and enter the date of its completion (or gaining other qualifications). List all devices and persons performing treatments, including those performed by a service provider, in the 'Sprayers' and 'Sprayer operator(s)' tables.

Purchased plant protection products — the purchased plant protection products (trade name and quantity) intended to protect the crop for which the Notebook is kept must be recorded in the table.

Monitoring tools, e.g. colour stickers, pheromone traps — in this table the used colour sticky boards, pheromone traps, etc. must be recorded with an indication of the pests which these tools were intended to monitor.

Crop rotation - fill in the crop rotation table with the name of the crop and the code of the field on which it was cultivated. Crop rotations must be reported for the period (number of years) specified in the methodology.

Seed material (...) — the table is to be filled in by entering information about the purchased material: species, variety, degree of qualification, quantity, and proof of purchase (invoice, official label or marketing operator label).

Sowing/Planting — the table should be filled in with the recorded quantity of seed material used in each field. The dates of the activities carried out should also be recorded. Confirm information on soil testing/assessment for existing pests that exclude the field from IP cultivation by ticking the relevant boxes ().

Soil/substrate and plant analysis and fertilisation/fertigation — soil analysis is a fundamental activity to determine the fertilising needs of plants. A producer growing crops under the IP scheme must perform such analyses and record them in the notebook. Enter the field code, the type or scope of testing and the number and date of the report in the 'Soil and plant analysis' table. Record all organic fertilisers applied in the 'Organic fertilisation (...)' table. If green manures are used, the species or composition of the mixture is indicated in the 'Type of fertiliser' column. In the next table, 'Mineral soil fertilisation and liming,' record the date, type

and dose of fertilisation and liming used and the place of its application. The table 'Observations of physiological disorders and foliar fertilisation' is a record of observations of plant nutritional deficiencies and constitutes a register of fertilisers used. The IP grower must regularly inspect the crops for the occurrence of physiological diseases and record this fact each time. Foliar fertilisation should be correlated with the observation of physiological disorders.

Control observations and record of plant protection treatments — the plant protection tables are the key element of the IP Notebook. The first table 'Observations of weather conditions and plant health' is a detailed record of observations, in which we record the data indicated in the heading. The need for chemical treatment should also be indicated in this table. The next two tables are registers of plant protection treatments (agronomic, biological and chemical ones) and are closely correlated with the observation table. When carrying out this type of procedure, it is mandatory to record the name of the plant protection product or the biological or agrotechnical method applied, as well as the date and place of treatment. The table 'Other chemical treatments applied (...)' is a record of all treatments authorised for use on the crop that are not listed in the previous tables, e.g. the use of desiccants.

Harvest — in this table, record the volume of crop taken from each field.

Hygiene and health requirements — record whether people in direct contact with food have access to clean toilets and hand-washing facilities, cleaning products, and paper towels or hand dryers. It should also be described how hygiene and sanitary requirements are observed in relation to IP methodologies.

Other mandatory requirements for the protection of plants against pests according to the requirements of the integrated production methodology — a page in the Notebook containing space for IP producer's comments concerning the requirements for pest management set out in the integrated plant production methodologies.

Information on the cleaning of machinery, devices and equipment used in production, according to the requirements of the integrated production methodology — notebook page with the IP producer's space for information relating to the cleaning of machinery, devices and equipment used in the production, which is required in the integrated production methodology.

The Notebook also contains space for comments and own notes, and a list of appendices.

It is possible for an agricultural producer to obtain an IP certificate by submitting an application to a certification body. Relevant applications forms are available from the certification bodies. Along with the completed application for a certificate attesting to the application of integrated plant production, the plant producer provides the certifying body with a declaration that the cultivation has been carried out in accordance with the requirements of integrated plant production, and information on the species and varieties of

plants grown in line with the requirements of integrated plant production, the area of their cultivation and the yield size.

14. LIST OF MANDATORY ACTIVITIES AND PROCEDURES IN INTEGRATED PRODUCTION (IP) OF OATS

Mandatory requirements (100 % compliance, i.e. 14 points)			
Item	Control points	YES/NO	Comment
1.	Implementing appropriate crop rotation — indicated in the methodology (see Chapter 3.3.)	<input type="checkbox"/> /□	
2.	Selection of varieties recommended by the coboru (see Chapter 4)	<input type="checkbox"/> /□	
3.	Use of at least certified seed material, treated in accordance with the ESTA standard or an equivalent standard - certified seeds (Chapter 5.2).*	<input type="checkbox"/> /□	
4.	Analysing soil pH and the content of the main nutrients (NPK and Mg) according to the cycles indicated in the methodology confirmed by documents (see Chapter 6).	<input type="checkbox"/> /□	
5.	Application of macro- and micronutrient of fertilisation at the appropriate times and doses, depending on the type and pH of the soil, following a nutrient balance carried out according to the indications in the methodology (Chapter 6.)	<input type="checkbox"/> /□	
6.	Use of agronomic methods as the first step in weed control and, in the case of a chemical control necessity, the correct application of herbicide at the right dose, taking into account the level of susceptibility of the weeds determined for individual weeds or their groupings (Chapter 7.1).	<input type="checkbox"/> /□	
7.	It is mandatory to systematically monitor the field in the stage of tillering/stem elongation, flag leaf, heading in order to assess the occurrence of diseases (powdery mildew and of cereals and grass, leaf septorioses, brown rust, brown leaf spots, yellow rust) with particular emphasis on fusarium ear blight after heading (see Chapter 7.2).	<input type="checkbox"/> /□	
8.	Systematic monitoring of the field from emergence to propagation 1 × per week for the presence of aphids - virus vectors, and from the beginning of the pollination phase to maturation, observation for the presence of violin and foot-and-mouth disease 1 × per two weeks (direct plant vetting, yellow vessels, etc.) (see Chapter 7.3.)	<input type="checkbox"/> /□	
9.	When pest and disease threshold values are exceeded, use of plant protection products (using the Pest Signalling Platform or other decision support systems) (see Chapters 7.2.3	<input type="checkbox"/> /□	

	and 7.3.2.)		
10.	Use of plant protection products only from the list of those approved for use in integrated triticale production (see Chapter 7.)	<input type="checkbox"/>	
11.	Alternating use of active substances of plant protection products from different chemical groups to prevent resistance of agrophages (weeds, pests and pathogens) (see Chapter 7.)	<input type="checkbox"/>	
12.	Creating the right conditions for the presence of birds of prey, i.e. setting up resting poles at a frequency of at least 1 for every 5 ha of plantation (see Chapter 8.)	<input type="checkbox"/>	
13.	Setting up 'houses' for mason bees or bumblebee mounds, or other facilities for pollinating insects in the number of at least 1 per 5 ha (see Chapter 8.)	<input type="checkbox"/>	
14.	Harvest at the right time (correct grain moisture) (see Chapter 11.)	<input type="checkbox"/>	

* Certified seed treated other than in accordance with the ESTA or equivalent standard may be used for sowing in 2026.

Note:

The fulfilment of all the requirements in the list of mandatory actions and treatments under the integrated production scheme must be documented in the integrated plant production Notebook.

15. CHECKLIST FOR AGRICULTURAL CROPS

Basic requirements (100% compliance, i.e. 28 points)			
Item	Control points	YES/NO	Comment
1.	Does the producer produce and protect the crops according to detailed methodologies approved by the Main Inspector?	<input type="checkbox"/>	
2.	Does the manufacturer have an up-to-date IP training confirmed by a certificate?	<input type="checkbox"/>	
3.	Does the producer only apply the plant protection products listed as IP-recommended products?	<input type="checkbox"/>	
4.	Are all required documents (e.g. methodologies, notebooks) present and kept on the farm?	<input type="checkbox"/>	
5.	Is the IP Notebook kept correctly and up to date?	<input type="checkbox"/>	
6.	Does the producer systematically conduct control observations of the crops and record them in the Notebook?	<input type="checkbox"/>	
7.	Does the producer handle empty plant protection product containers and expired products in line with the provisions in force?	<input type="checkbox"/>	

8.	Is chemical protection of crops replaced by alternative methods wherever justified?	<input type="checkbox"/> /	
9.	Is chemical plant protection carried out based on risk thresholds and the signalling of harmful organisms (wherever possible)?	<input type="checkbox"/> /	
10.	Are plant protection product treatments carried out only by persons holding an up-to-date, as of the date of such treatments, certificate attesting to the completion of training in the scope of the application of plant protection products, counselling on plant protection products or integrated plant production, or any other document confirming the permission to apply plant protection products?	<input type="checkbox"/> /	
11.	Are the applied plant protection products authorised for use in a given plant crop?	<input type="checkbox"/> /	
12.	Is each use of plant protection products recorded in the IP Notebook taking into account the reason, date and place of use, the area of the crops, the dosage and the amount of the spray liquid applied per unit area?	<input type="checkbox"/> /	
13.	Were plant protection treatments carried out under appropriate conditions (optimal temperature, wind below 4 m/s)?	<input type="checkbox"/> /	
14.	Is the rotation of the active substances of plant protection products used in treatments observed if possible?	<input type="checkbox"/> /	
15.	Does the producer limit the number of treatments and the amount of crop protection products used to an indispensable minimum?	<input type="checkbox"/> /	
16.	Does the producer have measuring devices to precisely determine the quantity of the measured out plant protection agent?	<input type="checkbox"/> /	
17.	Are the conditions for safe use of the products respected, as set out on the labels?	<input type="checkbox"/> /	
18.	Does the producer follow the indications place on the label with regard to environmental precautions, that is, for instance, preserving protection zones and keeping a safe distance from non-agricultural land?	<input type="checkbox"/> /	
19.	Are prevention and withdrawal periods observed?	<input type="checkbox"/> /	
20.	Are the doses and maximum number of treatments per growing season specified on the label of the plant protection product respected?	<input type="checkbox"/> /	
21.	Are the sprayers listed in the IP Notebook in working order and have current technical inspections?	<input type="checkbox"/> /	
22.	Does the producer carry out systematic calibration of the sprayer(s)?	<input type="checkbox"/> /	

23.	Does the producer have a separate space for filling and cleaning the sprayers?	<input type="checkbox"/> /	
24.	Does the handling of residues of the operating liquid comply with the indications on plant protection product labels?	<input type="checkbox"/> /	
25.	Are plant protection products stored in an appropriately marked closed room in such a way as to prevent contamination of the environment?	<input type="checkbox"/> /	
26.	Are all plant protection products stored exclusively in their original packaging?	<input type="checkbox"/> /	
27.	Does the IP producer comply with hygiene and sanitary rules during plant production, in particular those specified in the methodologies?	<input type="checkbox"/> /	
28.	Are appropriate conditions for the development and protection of beneficial organisms ensured?	<input type="checkbox"/> /	
Total points			

Additional requirements for field agricultural crops (minimum compliance 50 %, i.e. 8 points)			
No.	Control points	YES/NO	Comment
1.	Have the plant varieties grown been selected with respect to integrated plant production?	<input type="checkbox"/> /	
2.	Is each box marked according to the entry in the IP Notebook?	<input type="checkbox"/> /	
3.	Did the producer perform all the necessary agronomic procedures in accordance with the IP methodologies?	<input type="checkbox"/> /	
4.	Is the recommended catch crop used in cultivation?	<input type="checkbox"/> /	
5.	Are actions taken on the holding to reduce soil erosion?	<input type="checkbox"/> /	
6.	Are sprayers specified in the IP Notebook used for the treatment?	<input type="checkbox"/> /	
7.	Are fertiliser application machines maintained in good working order?	<input type="checkbox"/> /	
8.	Do fertiliser application machines allow for accurate dose determination?	<input type="checkbox"/> /	
9.	Is each fertilisation applied recorded in terms of its form, type, date of application, quantity, location and surface?	<input type="checkbox"/> /	
10.	Are fertilisers stored in a separate and specially designated room in a manner that ensures protection of the environment against contamination?	<input type="checkbox"/> /	
11.	Does the producer protect empty plant protection product packagings against unauthorised access?	<input type="checkbox"/> /	
12.	Does the producer have a properly equipped space for	<input type="checkbox"/> /	

	collecting waste and rejected crops?		
13.	Are there first-aid kits near the workplace?	<input type="checkbox"/> /	
14.	Are hazardous areas on the holding, e.g. plant protection product storage rooms, clearly marked?	<input type="checkbox"/> /	
15.	Does the producer use consultancy services?	<input type="checkbox"/> /	
Total points			

Recommendations (min. implementation 20 %, i.e. 2 points)			
No.	Control points	YES/NO	Comment
1.	Have soil maps been drawn up for the holding?	<input type="checkbox"/> /	
2.	Are non-organic fertilisers stored in a clean and dry room?	<input type="checkbox"/> /	
3.	Has a chemical analysis of organic fertilisers for nutrient content been carried out?	<input type="checkbox"/> /	
4.	Does the lighting in the room where the plant protection products are stored make it possible to read the information on the packaging of the plant protection products?	<input type="checkbox"/> /	
5.	Does the producer know how to proceed in the event of plant protection products spilling or scattering and do they have the tools to counteract such a threat?	<input type="checkbox"/> /	
6.	Does the producer restrict access to the keys and warehouse in which plant protection products are stored only to persons who have the authority to use them?	<input type="checkbox"/> /	
7.	Does the producer store on the holding only plant protection products allowed for use with the plant species they cultivate?	<input type="checkbox"/> /	
8.	Does the producer deepen their knowledge through Integrated Plant Production meetings, courses or conferences?	<input type="checkbox"/> /	
Total points			

16. FURTHER READING

- Adamczewski K., Dobrzański A. 2012. Przyszłość herbologii w zmieniającym się rolnictwie. Prog. Plant Prot./Post. Ochr. Roślin 52(4):
- Dobrzański A., Adamczewski K. 2009. Wpływ walki z chwastami na bioróżnorodność agrofitycenozy. Prog. Plant Prot./Post. Ochr. Roślin 49(3):
- Journal of Laws of 2013, item 505; Regulation of the Minister for Agriculture and Rural Development of 18 April 2013 on the labelling of certain foodstuffs.
- Journal of Laws of 2014, item 516; Regulation of the Minister for Agriculture and Rural

- Development of 31 March 2014 on the conditions of use of plant protection products. Journal of Laws of 2023, item 2501. Announcement of the Minister for Agriculture and Rural Development of 7 November 2023 on the publication of the consolidated text of the Regulation of the Minister for Agriculture and Rural Development on documenting activities related to integrated plant production.
- Grzebisz W., Kordan B., Sawińska Z., Sobiech Ł., Kardasz P., Klejdysz T., Nijak K., Strażyński P., Wieremczuk A., Trzmiel K., Antkowiak D., Brachaczek A., Grzanka M., Najewski A., Strzeleńska J., Świtek S., Zawieja A., Zimnoch U. 2021. Cereals. Identyfikacja agrofagów i niedoborów pokarmowych oraz innych czynników. Second edition supplemented. Agro Wydawnictwo Sp. z o.o., Suchy Las, 364 pp.
- Hołubowicz-Kliza G., Mrówczyński M., Strażyński P. 2018. Szkodniki i owady pożyteczne w integrowanej ochronie roślin rolniczych. Instytut Uprawy, Nawożenia i Gleboznawstwa – Państwowy Instytut Badawczy, Puławy, Instytut Ochrony Roślin – Państwowy Instytut Badawczy, Poznań, 502 pp.
- Hołubowicz-Kliza G., Mrówczyński M., Strażyński P. 2018. Szkodniki i organizmy pożyteczne w integrowanej ochronie roślin rolniczych. IUNG-PIB Puławy, IOR-PIB Poznań, 502 pages.
- Korbas M., Czubiński T., Horoszkiewicz-Janka J., Jajor E., Danielewicz J. 2015. Atlas chorób roślin rolniczych dla praktyków. PWR Sp. z o.o., pp. 368
- Korbas M., Jajor E., Horoszkiewicz-Janka J., Danielewicz J. 2016. Atlas chorób roślin rolniczych. Hortpress Sp. z o.o., 212 pp.
- Kryczyński S., Weber Z. (ed.) 2011. Choroby roślin uprawnych. T. 2 PWRiL, Poznań 464 pp.
- Matysiak K., Strażyński P. 2018. Fazy wzrostu i rozwoju wybranych gatunków roślin uprawnych i chwastów według skali BBCH. Institute for Plant Protection — State Research Institute, Poznań, 184 pp.
- Mrówczyński M., Czubiński T., Klejdysz T., Kubasik W., Pruszyński G., Strażyński P., Wachowiak H. 2017. Atlas szkodników roślin rolniczych dla praktyków. PWR, 368 pp.
- Pruszyński G. 2007. Ochrona entomofauny pożytecznej w integrowanych technologiach produkcji roślinnej. Prog. Plant Prot./Post. Ochr. Roślin 47(1): 103-107.
- Pruszyński G. 2008. Zagrożenie zapylaczy w zabiegach ochrony roślin. Progress in Plant Protection/Postępy w Ochronie Roślin 48(3): 798-803.
- Sosnowska D. 2018. Konserwacyjna metoda biologiczna wsparciem integrowanej ochrony roślin i rolnictwa ekologicznego. Progress in Plant Protection/Postępy w Ochronie Roślin 58(4): 288-293.
- Sosnowska D. 2022. Konserwacyjna metoda biologiczna. Nowoczesna Uprawa nr 4: 76–78.
- Tkaczuk C., Majchrowska-Safaryan A., Harasimiuk M. 2016. Występowanie oraz potencjał infekcyjny grzybów entomopatogenicznych w glebach z pól uprawnych, łąk i siedlisk leśnych. Progress in Plant Protection / Postępy w Ochronie Roślin 56(1): 5–11.
- Tomalak M. 2008. [in:] Organizmy pożyteczne w środowisku rolniczym (edited by M. Tomalak, D. Sosnowska). ISBN 978-83-89867-32-2, 95 pp.
- Tratwal A., Bereś P., Korbas M., Danielewicz J., Jajor E., Horoszkiewicz-Janka J., Jakubowska M., Roik K., Baran M., Jajor E., Kubasik W., Klejdysz T., Węgorzek P., Zamojska J., Dworżańska D., Barłóg P. 2017. Poradnik sygnalizatora ochrony zbóż. (A. Tratwal, W.

- Kubasik, M. Mrówczyński, red.). IOR-PIB, Poznań, 247 pp.
- Wiech K. 1997. Pożyteczne owady i inne zwierzęta (M. Kurek, red.). Wydawnictwo Medix Plus, pp. 116
- Woźnica Z. 2012. Herbologia. Podstawy biologii, ekologii i zwalczania chwastów. PWRiL, Poznań, 300 pp.