CHIEF INSPECTORATE OF PLANT HEALTH AND SEED INSPECTION

PIORIN

Integrated Production Methodology of oats

(*Avena sativa*)

(first edition)

DRAFT

Approved
pursuant to Article 57(2)(2) of the Act on Plant Protection Products of 8 March 2013
(consolidated text: Journal of Laws of 2024, item 630)

by

the Main Inspector of Plant Health and Seed Inspection

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INTEGRATED PRODUCTION
OFFICIALLY CONTROLLED

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1. INTRODUCTION

Integrated Plant Production (IP) is a management system that takes into account the use of technology and biological progress in a sustainable manner 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 complicated 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 pest population 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 REGULATIONS IN FORCE IN INTEGRATED PRODUCTION (IP) AND RULES FOR ITS CERTIFICATION

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

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

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 organisms harmful to plants. It also reduces the use of chemical plant protection products to a necessary minimum, thus reducing environmental pressure and protecting the biodiversity of the agricultural environment.

Professional users who use plant protection products are obliged to take into account the requirements of integrated plant protection set out in the Regulation of the Minister for Agriculture and Rural Development of 18 April 2013 on requirements for integrated plant protection (Journal of Laws of 2013, item 505). According to the aforementioned Regulation, an agricultural producer should use all available measures and methods of protection against pests before applying chemical plant protection to reduce the use of pesticides. The provisions of this Regulation put a strong emphasis on, inter alia, the use of crop rotation, suitable varieties, compliance with optimal deadlines, the use of appropriate agrotechnology, proper fertilisation, and prevention of the spread of harmful organisms.

One of the requirements is also the protection of beneficial organisms and the creation of favourable conditions for their occurrence, in particular pollinating insects 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 advice.

According to the current legal provisions, only plant protection products authorised 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 relevant register. Information on the scope of application of pesticides in individual crops is included on the labels. The Ministry of Agriculture and Rural Development provides a register and labels at: https://www.gov.pl/web/rolnictwo/ochrona-roslin.

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

Before the application of a plant protection product, it is the responsibility of each user to read and follow the label.

In accordance with the Regulation of the Minister for Agriculture and Rural Development of 31 March 2014 on conditions of use of plant protection products (Journal of Laws of 2014, item 516) pesticides may be applied in the open area using:

- ground equipment at a distance of at least 20 m from the 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 treated with plant protection products.

When using plant protection products, the label of the products should be read in detail, as it may contain additional conditions limiting its applicability.

In accordance with the legislation in force, any use of a plant protection product must be registered. The professional user is obliged to maintain and store for 3 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 cultivation or the facilities on which the plant protection product has been applied. 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 notepad in the system of integrated plant production fulfils the requirement to keep the above-mentioned documentation for certified crops.

For treatment with plant protection products, equipment intended for that purpose shall be used which, when used for its intended purpose, does not pose a risk to human health, animal health or the environment and is technically efficient and calibrated to ensure the correct use of plant protection products. Owners of equipment for the use of plant protection products are obliged to carry out periodic tests confirming technical fitness. The first inspection of new equipment is conducted no later than after 5 years from the date of its purchase. Tractor and self-propelled field sprayers shall be inspected at intervals of no more than 3 years. Manual and backpack sprayers whose tank capacity does not exceed 30 litres are excluded from the test obligation.

2.2. Integrated plant production in legislation

In the IPM certification scheme, all legal requirements for plant protection products must be respected, with particular regard to the principles of IPM.

2.3. Principles of certification

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 intention to apply integrated plant production shall be notified by the plant producer every year to the certifying authority **within the period set out in Article 55(2) of the Plant Protection Products Act of 8 March, 2013**. The integrated plant production system is open to all producers. Notification of the intention to participate in the system is possible in paper form by post, in electronic form, and directly.

Training in integrated plant production is widely available, and individuals who have acquired the relevant knowledge in course of their education (as confirmed by a secondary school or a university) are exempted from the obligation to complete the basic training.

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After the notification, the agricultural producer is obliged to grow according to the method of integrated plant production for the notified plant and to document the activities in the IP notebook in detail. Model notebooks are included in the Regulation of the Minister for Agriculture and Rural Development of 24 June 2013 on documenting activities related to integrated plant production.

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

- completion of IP training;
- production in accordance with the methodologies approved by the Main Inspector of Plant Health and Seed Inspection;
- fertilisation;
- documentation;

- following hygiene and health principles;
- collection of samples and control of highest tolerable plant protection product residues as well as of nitrate, nitrite and heavy metal levels in plants and plant products.

The maximum permitted plant protection product residue content and nitrate, nitrite and heavy metal levels in plants are tested in the plants or plant products of no less than 20 % of the growers listed in the grower register held by the certification body, starting with any growers suspected of not following integrated plant production principles. The tests shall be carried out in laboratories accredited in the relevant area.

A certificate issued at the request of the grower attests that integrated plant production principles are followed. The producer shall be certified if it has complied with the following requirements:

- has completed an integrated production plant training and holds a corresponding training certificate, subject to Article 64(4),(5),(7) and (8) of the Plant Protection Products Act;
- conducts production and protection of plants according to detailed methodologies approved by the Main Inspector and made available on the website managed by the Main Inspectorate of Plant Health and Seed Inspection;
- uses fertilisation based on the actual demand of plants for nutrients, determined in particular on the basis of soil or plant analyses;
- documents the correct conduct of activities related to integrated plant production;
- complies with hygiene and sanitary rules with respect to the production of plants, in particular those specified in the methodologies;
- in plant and plant product samples collected for testing, no maximum permissible residues of plant protection products and levels of nitrates, nitrites and heavy metals have been exceeded;
- plant protection requirements relating to harmful organisms, in particular those specified in the methodologies, have been met.

Integrated pest management certificates are issued for the period necessary for the plant product to be disposed of, but no longer, however, 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. A sample mark is provided by the Main Inspector on the website of the Main Inspectorate of Plant Health and Seed Inspection.

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 of oats are small. 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 to soil 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 defective water relations. Unlike 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 grown in Poland: 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; however, no variety of this species has been registered so far.

Oats have low 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 (PRVT) 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 want to use this system.

The variety used should be entered in the National Register or the Common Catalogue of Varieties (provided that the choice of the variety is justified in accordance with the IP). The basic principle is the use of seed of at least the certified category.

Detailed rules for the selection of varieties in integrated plant production are published on the dedicated COBORU website.

Detailed information on the selection of varieties recommended for IP by 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 team 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 agrotechnical 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 relaxed and its porosity increased, 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 most 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 classified among the plants for the earliest sowing, and any delay in sowing results in a significant reduction in yield. The optimal time for sowing oats, regardless of the region of the country in which it will be grown, is considered to be when the soil has appropriately dried in the spring. This situation concerns 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 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.

The optimal calendar date for sowing oats in most regions of the country falls in the second half of March. Only in the north-eastern and sub-mountain regions can it be delayed until 10 April.

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 complex, the recommendations for plant density per unit area vary (table 1).

Table 1. Optimum plant density of sprouted caryopsis per m^2 depending on the soil complex

Soil complex	Recommended plant density of live caryopsis (pcs./m^2)
Rye very good	500-550
Rye-fodder strong	
Cereal-mountain	
Rye good	
Oat-potato mountain	560-620
Rye poor	
Rye-fodder poor	600-650
Oat-fodder mountain	

An important element of sowing is determining the sowing rate. For the correct determination of this parameter, the following information is necessary: plant density per m^2, weight of one thousand grains [g] and germination capacity [%]. After obtaining this information, it should be substituted into the formula on the basis of which the seeding standard will be correctly determined.

Sowing rate kg/ha = $\frac{\text{Plant density per } m^2 \times \text{Weight of one thousand grains [g]}}{}$

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 grown in Poland. This is due to the lower sensitivity of winter oats to drought occurring more frequently at the beginning of summer. This situation 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 of Poland, which include the south-western region. 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/m^2. 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 m^2 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 established on the basis of a nutrient balance before each crop, and soil testing is carried out at least every 4 years (and supported by documents).

6. SUSTAINABLE FERTILISATION SYSTEM FOR OATS

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 acquisition 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 of macronutrients in the dry matter of grain and straw

Plant part	Nitrogen [N]	Phosphorus [P_2O_5]	Potassium [K_2O]	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 the 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_2O_5]	Potassium [K_2O]	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 a yield of 4.0 tonnes, the nitrogen dose should be 75-85 kg N/ha in cereal stands and 50-60 kg N/ha in stands 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 distribution 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 tons 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. Phosphorous fertilisers can be applied before winter ploughing, as they are not leachable.

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 tons 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 is leached 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 stabilizes 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 the high tolerance to low pH levels, very 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 the most sensitive to micronutrient deficiencies among all cereals grown in Poland. 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 PEST PROTECTION

Integrated production (IP) of oats should be carried out using integrated pest protection and utilising technical and biological innovations in cultivation and fertilisation, with particular regard to the protection of human and animal health, as well as the environment.

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

- the use of crop rotation, the appropriate date for sowing and plant density;
- the use of appropriate agrotechnology, including the use of mechanical plant protection;
- the adoption of appropriate measures and methods for the protection of plants against pests, which should be preceded by the monitoring of their presence, with consideration of current pest control know-how;
- 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 use of fertilisation and liming, where appropriate;
- the use of hygiene measures (cleaning, disinfection) to prevent the occurrence and spread of pests;
- 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 a necessary minimum;
- preventing the formation of resistance of harmful organisms to plant protection products by appropriate selection and their 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 shall be used in accordance with the current oats protection programme, with the recommendations given on the label and in such a way as to avoid endangering human or animal health or the environment.

The list of plant protection products approved for sale and use in Poland is published in the register of authorised plant protection products. Information on the scope of application of pesticides in individual crops is included on the labels. The plant protection product search engine is a helpful tool when selecting 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 Warning System at https://www.agrofagi.com.pl/143,wykaz-srodkow-ochrony-roslin-dla-integrowanej-produkcji.html.

For protection against pests (weeds, diseases), only products registered and authorised for marketing and use in Poland may be used which are clearly indicated on the labels attached to the packaging as 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 treatment have a decisive impact on the safety of treatments with plant protection products.

In order to perform laboratory diagnostics (usually in the case of determining the perpetrators of diseases), tests are carried out in laboratories accredited to the appropriate extent in accordance with the provisions of the Conformity Assessment System Act of 30 August 2002 or the provisions of Regulation No 765/2008.

7.1. Weed infestation control

The cultivation of oats is threatened by many species of weeds, both monoc and dicot (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

In sowing oats, depending on the location, most common dicot weeds are present, except for typically thermophilic ones. Among monocots, 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 common oats from 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 turn 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 limits, often 'overlapping' each other. 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 intraspecific variability. Many ecotypes and genotypes and several botanical varieties are known. In Poland, there are also 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 monocot and dicot weeds occurring in the cultivation of oats

Weeds	Characteristics
Small-flowered crane's-bill (*Geranium pusillum*)	spring species, preferring moist, humus-rich soils, rich in nutrients, especially lime and nitrogen; weed dangerous during mass occurrence; during the growing season, in favourable conditions, it can produce several generations
Cornflower (*Centaurea cyanus*)	annual species, occurs on all soil types, but prefers light, sandy, and sandy-loam soils; under favourable conditions, grows up to 1 m in height.
Marsh woundwort (*Stachys palustris*)	a perennial species, common throughout the country, 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 (*Anchusa arvensis*)	a spring species that grows in clusters and is highly competitive with the crop; prefers light soils with an acidic pH
Field pansy (*Viola arvensis*)	annual species, commonly found throughout the country; dangerous due to the abundance of occurrence during the emergence of the cultivated plant
Field mustard	annual species, prefers fertile soils, particularly rich in lime; the

(*Sinapis arvensis*)	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 (*Stellaria media*)	spring species, commonly found throughout the country; prefers humus-rich, moist soils, abundant in nutrients, especially nitrogen; creates a strong turf, significantly interfering with the emergence and development of the crop
Goosefoot (*Chenopodium album*)	annual species, commonly found throughout the country; prefers loose soils, rich in nutrients, especially nitrogen and potassium; strongly competitive in relation to oats
Red chickweed (*Anagallis arvensis*)	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 (*Matricaria maritima* subsp. *inodora*)	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 (*Cirsium arvense*)	perennial species, occurs on different types of soil, prefers soils with regulated water-air relations, rich in nutrients; difficult to combat, often occurs in so-called outbreaks
Field bindweed (*Convolvulus arvensis*)	perennial species, commonly found throughout the country, 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 (*Galeopsis tetrahit*)	annual species; prefers clay soils and lighter humus with a high groundwater level
Persian speedwell (*Veronika persica*)	annual species, spring and also wintering; commonly occurs throughout the country, prefers clay soils, slightly moist and rich in nutrients, especially nitrogen
Catchweed (*Galium aparine*)	annual species; prefers moist, fertile soils, rich in nutrients, especially nitrogen; with a high intensity of occurrence, it causes lodging of cereals
Treacle-mustard (*Erysimum cheiranthoides*)	annual spring species, also wintering; prefers moist soils – both loamy and sandy
Wild buckwheat (*Fallopia convolvulus*)	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 (*Raphanus raphanistrum*)	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	annual species; occurs on different types of soils; prefers fertile, humus-

(*Capsella bursa-pastoris*)	rich, loose, and airy soils; is a host of many diseases and pests, including clubroot
Field pennycress (*Thlaspi arvense*)	annual species, commonly found throughout the country; prefers loamy, medium, and heavy soils, rich in nutrients and calcium; is a host of many diseases and pests, including clubroot
Four seeded vetch (*Vicia tetrasperma*)	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 (*Avena fatua*)	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 (*Agropyron repens*)	perennial monocot species; occurs on all types of soils. highly competitive, rapidly spreading by means of runners

7.1.2. Agrotechnological methods of weed management

Weeds are an inseparable part of farmland. The primary source of weeds is their diasporas (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, seedlings of weeds occurring in a crop are defined as: ‘current weed infestation’.

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 stages.

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 runners or rhizomes, such as: dandelions, thistles, field bindweed, sorrel. Subsequent cultivation treatments that stimulate the germination of weed diaspores, followed by the control of 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 plant density. Therefore, it is necessary to sow healthy, good-quality seed at the recommended agrotechnical dates and sowing density. Optimal plant 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;

- use of crop treatments as appropriate and in a way that does not lead to soil pulverisation and drying;
- use of seed of at least the certified category; adequate quality of seed ensures a fast, even emergence and planned plant density, provided that sowing is carried out under optimal conditions (sowing date, sowing depth, soil temperature and moisture, etc.).
- application of sustainable fertilization;
- application of hygiene measures consisting in regular cleaning of machinery and equipment to prevent the spread of weeds;

Non-chemical methods for regulating weed

The mechanical fight against weeds should be started immediately after the harvest 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 scheme and tools used for breaking stubble and managing crop residues largely depend on the farm's machinery, as well as the weeds present in a given field. Ploughs, disc harrows or stubble cultivators may be used for post-harvest tillage. Until recently, shallow ploughing was the basic treatment in post-harvest cultivation; now it is used to a lesser extent. The lower popularity of shallow ploughing is due to its low efficiency and the need to carry out harrowing, which significantly increases costs. Therefore, it is increasingly being replaced by more efficient tools, making 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 is followed by fragmentation of vegetative propagation organs, which significantly increases their spread in the field, and consequently pressure and competitiveness in relation to oats. When mechanically combating weeds in post-harvest crops, it is important to carry out the cultivation carefully and on time. Treatments in post-harvest cultivation should be repeated after successive weed emergences. As a result, the amount of weeds threatening the crop is significantly reduced. The next element is the execution of winter ploughing. In the spring, after the furrow-slices have dried, as soon as the field can be entered, a harrow or drag can be used. Cultivation with these tools accelerates the warming 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 harmfulness thresholds

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

Decision support systems

Decisions may be supported only by the Plant Protection Institute – National Research Institute in Poznań or other scientific and research units dealing with plant protection issues. Expert opinions supporting decisions must be developed on the basis of the results of research conducted in scientific and research units.

7.1.3. Chemical methods of weed infestation control

The basic condition for effective weed control in the cultivation of oats is the correct identification of weeds, both monocot and dicot. Another very important factor responsible for the effective control of weeds is the selection of the herbicide, or more precisely, the active substance. When selecting the active substance, it is absolutely necessary to be guided by the current state of weed infestation. 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 using foliar herbicides, it is important to apply them 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 Warning System at https://www.agrofagi.com.pl/143,wykaz-srodkow-ochrony-roslin-dla-integrowanej-produkcji.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) based on 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 on the scope of application of pesticides in individual crops is included on the labels. The plant protection product search engine is a helpful tool when selecting 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 and https://www.gov.pl/web/agriculture/search-plant-protection-products---application.

Crop rotation after herbicide use

Herbicides vary in duration of action and biodegradation in soil, which should be taken into account when planning follow-on crops. Each herbicide label contains a section titled 'CROP ROTATION', which provides information on the possible cultivation of follow-on 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 follow-on crops.

Weed resistance to herbicides and methods of limiting it

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

A factor contributing to the development of weed resistance to herbicides is, inter alia, improper weed control based on a widespread use of herbicides, without taking into account other methods, in particular agrotechnical 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 alternately with a different mechanism of action or at least from different chemical groups. 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 treatment. The 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 in 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. PATHOGEN CONTROL

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, Korbas et al. 2018). The most important diseases occurring on oat plants caused by fungi include: crown rust of oats (*Puccinia coronata* f. sp. *avenae* P. Syd & Syd), oat leaf helminthosporiosis [*Pyrenophora avenae* Ito and Kurib (anamorph *Drechslera avenae*)], powdery mildew of cereals and grass (*Blumeria graminis* DC. f. sp. *avenae* Em. Marchal), stem rust (*Puccinia graminis* f. sp. *avenae*) and fusarium blight of oats (*Fusarium* spp.) (Harder and Haber 1992, Langaro et al. 2001, Kiecana et al. 2005, Korbas et al. 2015, Menzies et al. 2019).

In integrated protection, priority is given to non-chemical control methods, most often agrotechnical and breeding methods to control the pathogens.

In the case of most cereals grown in Poland, if there is a risk that their use has not caused the presence of the pest concerned to fall below the threshold of economic harm, then the chemical method should be used.

Table 6. Economic significance of selected oat pathogens in Poland

Disease	Pathogen(s)	Significance
Fusarium blight of panicle	*Fusarium graminearum* Schwabe (teleomorph: *Gibberella zeae* (Schwein.) Petch), *Fusarium* spp.	+
Oat smut	*Ustilago avenae* (Pers.) Rostr.	+
Dense oat smut	*Ustilago segetum* (Bull.: Pers.) Roussel syn. *Ustilago kolleri* Wille, syn. *Ustilago levis*	+
Leaf helminthosporiosis	*Drechslera avenacea* (M.A. Curtis ex Cooke) Shoemaker = *Helminthosporium avenaceum* M.A. Curtis ex Cooke *D. avenae* (Eidam) Scharif = *H. avenae* Eidam	++

	(teleomorph: *Pyrenophora avenae* Ito & Kuribayashi)	
Powdery mildew of cereals and grass	*Blumeria graminis* DC. f. sp. *avenae* Em. Marchal, *B. graminis* DC., (anamorph: *Oidium monilioides* (Nees) Link)	++
Rust of oat (crown, stem)	*Puccinia coronata* Corda	++
Stem rust of cereals and grasses	*Puccinia graminis* Pers. f. sp. *avenae* Ericks	++
Ergot of cereals	*Claviceps purpurea* (Fr.) Tul	+
Seedling blight	*Bipolaris sorokiniana* (Sacc.) Shoemaker, *Drechslera avenae* (Eidam) Scharif, *Fusarium* spp. (Wm. G. Sm.) Sacc., *Pythium* spp., *Rhizoctonia solani* Kühn	++

+ 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 main sources of oat disease infections and favourable conditions for the development of their pathogens

Disease	Sources of infection	Favourable conditions for development	
		temperature [°C]	soil and air humidity
Fusarium blight of panicle	seed, crop residues, airborne spores	high temperature	high humidity
Oat smut	seed	16–19	low soil moisture
Dense oat smut	seed	15–20	moderate
Leaf helminthosporiosis	seed, crop residues	chilly	high
Powdery mildew of cereals and grass	seed, soil	above 15	dry
Rust of oat (crown, leaf)	crop residues, self-sown seeds,	20–22	moderate humidity
Stem rust of cereals and grasses	crop residues, self-sown seeds,	15–24	humid
Ergot of cereals	sclerotia	20–25	high humidity
Seedling blight	seed, soil	chilly	wet 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	Possibility of confusing symptoms
Oat smut	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.	dense oat smut
Dense oat smut	It is less common than oat smut. 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.	oat smut
Seedling blight	It is caused, among others, by a number of species of fungi such as: *Pythium*, *Bipolaris* and the following species of the genus *Fusarium*: *F. graminearum*, *F. culmorum*, *F. aveanceum* and *Microdochium nivale* (*F. nivale*). 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, leaf)	Symptoms occur on leaves, leaf sheaths, panicles, and stems. Infested organs have uredinia in the form of round orange-yellow pustules. Infected blades may be	stem rust of cereals and grasses

	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	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, leaf)
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 damage, the leaves may die prematurely.	–
Leaf helminthosporiosis	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 necroses, causing parts of the leaf blades to die off.	–
Fusarium blight of panicle	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 *Fusarium* can cause major problems in the cultivation of oats, as they can produce secondary metabolites – mycotoxins. Toxins produced by fungi of the genus *Fusarium* include deoxynivalenole, nivalenole, T-2 toxin, HT-2 toxin, diacetoxyscirpenole, and zearalenone.	–
Ergot 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, ergotine, and others.	–

7.2.2. Agrotechnical methods of reducing diseases

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 agrotechnical point of view, the factors limiting and in some cases eliminating the presence of pests in the cultivation of oats may include:

– correct 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-mentioned 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 take-all disease). 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 reducing pathogens

The possibility of chemical protection of oats exists both during the period of emergence and the initial stages of plant development (seed treatments) and in the form of fungicides applied foliarly through 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 soybean in integrated production (IP). Messages provided on the Online Pest Alerting System can be helpful (www.agrofagi.com.pl). Use instructions on the label should be read before application.

The list of plant protection products authorised in Poland is published in the relevant register. Information on the scope of application of pesticides in individual crops is included on the labels. The plant protection product search engine is a helpful tool when selecting 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 Warning System 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

In Poland, the most important pests that occur on cereal plantations are aphids, cereal leaf beetles and gall midges. We’ve been able to observe for some years, 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 can also be damaged by snails and slugs, rodents, thrips, cephus pygmeus, chlorops ringens, nematodes, birds and game, and caterpillars of leafroller moths (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 and 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, gall midges, etc.) is an extremely important element of integrated production of oats.

Table 9. Current and forecast significance of oat pests in Poland

Pest	Current	Forecast
Wireworms	+(+)	+++
Bishop's Mitre	++	+++
Marchflies	+	++
Ground beetle	++(+)	+++
Leaf miners	+(+)	++
Aphids	++(+)	+++
Cereal chafer	+	++
Chlorops ringens	+	++
Grubs	++	+++
Frit fly	++	+++
Gall midges	++	+++
Cutworms	++	+++
Leafhopper	+(+)	++
Cereal leaf beetle	++(+)	+++
Maggots	+(+)	++
Thrips	+(+)	++
Leafroller moths	+	++
Cephus pygmeus	+	++
Tortoise bug	++	+++
Rodents	(+)	+
Snails and slugs	+	++
Game and birds	+	+(+)

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

Table 10. Damage to 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.
Marchflies	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.

Turnip moths	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.
Bean-seed fly Wheat-bulb fly	Damage to germinating grains, roots and tissues of young plants.

Table 11. Damage to 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 discolouration, 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 be vectors of viruses (e.g. WDV).
Cereal leaf beetle	Eating the tissue along the leaf veins — reduction in assimilative surface area and photosynthesis, secondary infestation by disease pathogens.
Snails and slugs	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.
Cephus pygmeus	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. Agrotechnological methods of pest control

One of the basic principles of integrated pest management for rye is preventive measures, based primarily on agrotechnics (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 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 set 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 stages of pests, weed seeds and fungal spores. It also brings to the surface pests that are found deeper, exposing them to adverse weather conditions. This also mechanically destroys soil pests (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 agrophages 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 agrophages (including pests) include, among other things, agrotechnical methods which are part of properly managed crop protection.

Table 12. Agrotechnical methods and methods of protecting 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
Snails and slugs	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
Maggots	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 harm 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.

7.3.2. Methods of monitoring pests in the cultivation of oats

Monitoring for the presence of pests in a plantation is a very important part of integrated plant protection. Continuous observation makes it easier to assess the current situation in the field and, if necessary, to react quickly. 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 m^2 or 100 randomly selected plants should be checked. Such observations should be carried out in several places on the plantation. A useful method is sweep-netting. This is an easy and quick way to make an initial assessment of the species composition and number of insects on a plantation. Correctly applied, this method of monitoring makes it possible in a relatively short time to obtain preliminary information not only about pests, but also about other insects, including beneficial ones located on the plantation. 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 made with a sweep net from the edge of the plantation, moving inside it. 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 involve sifting soil from several locations from dug holes measuring 25 × 25 cm and a depth of 30 cm. The essence of proper pest risk assessment is understanding the basics of the morphology and biology of a given pest species, such as the timing of 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 treatment gives the possibility of a quick reaction and, if possible, a repeat treatment. Due to many factors determining the occurrence of pests, monitoring should be carried out on each plantation. Proper inspection requires knowledge of pest morphology 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 operation of many environmental factors, and only direct observations enable assessment of the actual threat from pests. 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 measures to reduce losses can help in deciding on a treatment. The benefits of knowledge of modern methods of plant protection are not only 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 are 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 Warning System operated by the Institute of Plant Protection – National Research Institute and partner institutions features, among others, 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, specific pest thresholds are developed for certain pest species. The principles and deadlines for their observation and the harmfulness thresholds are set out in Table 13.

Table 13. Observation periods and thresholds of economic harmfulness to pests of oats

Pest	Observation date	Threat threshold
Wireworms	before sowing	10-20 larvae per 1 m^2
Ground beetle	autumn — emergence until vegetation cessation	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	heading or immediately after heading	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	heading	5-10 insects per 1 ear
Wheat midge	heading	8 larvae per 1 ear
Saddle gall midge	throwing away a flag leaf	15 eggs per 1 stem
Cutworms	before sowing	6-8 caterpillars per 1 m^2
Cereal leaf beetle	throwing away a flag leaf	1-1.5 larvae per stem
Maggots	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

7.3.3. Chemical methods of pest control

Plant protection products should be used in accordance with the current list of plant protection products recommended for oats in integrated production (IP). Messages provided on the Online Pest Warning System (www.agrofagi.com.pl) can 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 relevant register. Information on the scope of application of pesticides in individual crops is included on the labels. The plant protection product search engine is a helpful tool when selecting 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 Warning System at https://www.agrofagi.com.pl/143,wykaz-srodkow-ochrony-roslin-dla-integrowanej-produkcji.html.

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

Biological methods consist of the use of natural biological agents such as: viruses, microorganisms (bacteria, fungi) and macroorganisms (nematodes, parasitic and predatory insects and mites) to reduce the population of pests, disease perpetrators and weeds in plant crops in the field and under covers. Biological agents, like chemical agents, target 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 microorganisms is not common. 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 of time.

Reduction of pest population in the cultivation of oats with the use of bioinsecticides.

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

When using microorganisms to control oat pests, it should be remembered that:

- 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, at the first stage of action, require a temperature of approximately 25°C and high humidity to germinate and penetrate the insect,
- the pest's caterpillars die 24–72 hours after consuming fungal spores. During this time, they can feed and look healthy,
- micro-organisms are applied using self-propelled or tractor-mounted sprayers. Such treatments 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.
- one should carefully read the labels of biological products before using them to avoid potential errors in their application,

- it is required to pay attention to the information on the pH of the working liquid and its compatibility 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 timing 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 need to be ingested by the pest, but merely need to reach the surface of the host's body. They sprout 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 time from infection to the death of the pest is from 3 to 7 days.

Insecticidal fungi, such as *Beauveria bassiana*, are sensitive to low and very high temperatures. The optimal temperature for spore germination is 25^{0}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 wintering pests in soil.

Symptoms of infection by entomopathogenic fungi: the body of an infected insect often changes colour. One of the typical symptoms is mummification; the body is hard, and on its surface in humid conditions, a mycelium of different colours is formed, depending on the species of fungus.

The biological preparation containing parasitic fungi should be stored in cool conditions at a temperature of 2°-6°C.

Mechanism of action of insecticidal bacteria

The death of an insect occurs after ingesting spores and toxic crystals (Cry protein) of bacteria, resulting from damage to the epithelial cells of its intestine caused by endotoxin activity. The digestive tract is 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 should be remembered that:

In the environment, biological factors, i.e. elements of the living environment, directly or indirectly affect the life of organisms. An example is the antagonistic action of bacteria of the genus *Bacillus* and *Pseudomonas* on the insecticidal fungus *B. bassiana*. These species should not be combined with each other. Similar interactions can occur in the environment between species, so getting acquainted with the product label is the first step to avoid potential errors.

Snails can also be a problem in oat crops. They can be controlled with available biological preparations having macroorganisms – nematodes – as their active ingredient. Macroorganisms are not subject to registration in Poland. Larvae of the insecticide nematode – *Phasmarhabditis hermaphrodita* penetrate the snails' 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.

Reducing pathogens in oat cultivation

There are no currently registered plant protection products containing bacteria of the genus *Bacillus* spp.

Conservation biological protection

Biosecurity is not only about the use of registered microbial 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. A very important element is the rational use of selective chemical plant protection products, 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 threat of pests to cultivation.

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 beetlesis growing in integrated plant protection. They are abundant 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 others, 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 wasp can be found under natural conditions – (*Trichogramma* spp.), approximately 1 mm large. It is a parasite of the European corn borer eggs. A Trichogramma female can lay up to 300 eggs, so the scale of pest egg parasitisation can be large. In Poland, biopreparations containing Trichogramma are available for use mainly against the European corn borer. However, the trichogramma parasitises in the eggs of many other species of pests.

Another problem in the cultivation of oats is aphids. 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 useful insects, it is necessary to decide whether chemical treatment with a plant protection product is needed. If necessary, it should be done 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 eat aphids. Green lacewing larvae eat up to 400 aphids. However, despite enormous aphidicidal effectiveness, the high motor activity 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 fungi belonging to insect destroyers (Entomophthoraceae) 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 agroecosystems (Tkaczuk et al. 2016). Insecticides can reduce populations of wintering pests in soil conditions, such as cutworms and sitona weevils. In the soil, insecticidal fungi species develop, such as: *Beauveria bassiana*, *Metarhizium anisopliae* and *Cordyceps fumosorosea*. The effectiveness of these fungi is optimal at high humidity and a temperature of 25°C. Insecticidal fungi also develop on the surface of the plant. One can often find parasitised insects on the leaves, such as aphids. Insecticides and viruses can also play an important role.

In the environment, not only beneficial insects and microorganisms play a role in reducing populations of harmful pests. There are also other animals, such as amphibians, birds or mammals (Wiech 1997). The grey toad plays a useful role in agrocenoses. 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 grubs and other insects found in the soil. The largest representative of insectivorous mammals is the hedgehog, which hunts at night, and its food is insects, snails, and other animals. Birds play a useful role in the environment. Therefore, in the integrated production of oats, it is required to create appropriate conditions for the presence of birds of prey, which involves the setting up of resting poles. Birds destroy various pests.

Unfortunately, it is not possible to ensure the protection of oats with the exclusive use of biological agents. The oats conservation strategy should include a complex of actions based on different methods, mainly non-chemical, with the aim of minimising 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 spectrum 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, including biotic and abiotic. Agricultural producers must be trained on the availability, application, and the advantages and disadvantages of biological plant protection products. The use of these products requires a high level of knowledge, because when incorrectly used, they often have no desirable 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. Biopreparations also have disadvantages, such as sensitivity to environmental conditions (temperature, humidity), high cost in production and application, 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 where they are recommended for use and the information contained in the labelling of the product should be observed. The basis for their use is the monitoring of pest species.

Predatory birds living near plantations are effective in controlling small mammals (rodents, hares). To allow observation, resting poles with a minimum height of 3 m should be placed along the plantation, at least 1 per 5 ha.

Detailed information on registered plant protection products for the protection of oats can be found at:

- Search engine for all plant protection products (including biological) registered in Poland https://www.gov.pl/web/rolnictwo/wyszukiwarka-srodkow-ochrony-roslin---zastosowanie;
- Methodologies of integrated pest protection for agricultural crops on the IOR-PIB website https://www.agrofagi.com.pl/94,rosliny-rolnicze.

A list of plant protection products for integrated production in agricultural crops can be found at: 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 plant protection 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 minimize their negative impact on non-target organisms, in particular pollinators and natural enemies of harmful organisms.

A more efficient use of beneficial species can be achieved through a number of measures, 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 appear in large numbers and are accompanied by the occurrence of beneficial species. Consideration should be given to limiting the treatment area to edges or patches if the pest is not present on the entire plantation. The use of tested mixtures of plant protection products and liquid fertilisers should be recommended, which reduces the number of entries into the field and reduces mechanical damage to plants;
- protection of beneficial species by avoiding the use of insecticides with a broad spectrum of activity and replacing them with selective agents;
- choosing the treatment time to prevent high mortality among beneficial insects;
- based on the results of studies, dose reduction and adjuvant addition;
- keeping in mind that protecting natural enemies of rye pests also protects other beneficial species present in the field;
- leaving balks, 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 hectares.

9. PROPER SELECTION OF PLANT PROTECTION TECHNIQUES

Storage of plant protection products

Plant protection products should be stored:

a) in their original packaging, tightly sealed and clearly labelled and in such a way that they do not come into contact with food, drink or feed;

b) in a manner ensuring that they:

- are not consumed or intended for animal feeding,
- are inaccessible to children,
- there is no risk of:
  - contamination of surface water and groundwater within the meaning of the Water Law,
  - ground contamination due to leakage or seepage of plant protection products deep into the soil profile,
  - penetration into sewerage 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 spaces 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 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 acquired rights to carry out plant protection treatments.

The sprayer operator must be equipped with appropriate protective clothing, as prescribed by the label and the safety data sheet of the plant protection product. The basic equipment of protective clothing 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 working organisation and available technical measures should be used at each stage of the treatment 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 technically efficient, ensure reliable operation and guarantee the safe use of plant protection products, liquid fertilisers or other agrochemicals. The sprayer must have an up-to-date condition test (certification) and shall be properly calibrated. The technical efficiency of the equipment is 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 shall be carried out no later than five years after its acquisition and subsequent tests shall be carried out at intervals of no more than three years.

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

Before performing the treatment, 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, liquid system and agitator. It is also advisable to carry out a preventive rinse of the sprayer to remove mechanical debris and any residues of previous treatments from the system.

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 in 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 pest management, selective measures

with low risk to pollinators and beneficial organisms should be chosen.

Treatments with plant protection products should be planned to ensure acceptable efficacy with the minimum necessary amount of plant protection product applied, 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, while also taking into account the development stage of 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 the plant protection product at a dose lower than that 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 treatments,**
- **the maximum number of times the product can be used during the season,**
- **the maximum dose of the plant protection product.**

Spray volume selection

In integrated crop protection systems, the volume of spray liquid (l/ha) should be selected based on available catalogues, training materials and handbooks or other subject-matter literature. 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.

Contact-action agents require very good coverage of the plants being sprayed and generally require higher volumes of spray 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 appropriate treatment equipment (e.g. AAS sprayers), the liquid dose can be reduced to 50-100 l/ha, which should guarantee a sufficient quality of treatment coverage on 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 for their use in the protection of agricultural crops are useful in selecting the right nozzles for particular 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 the spray liquid

The planned volume of the spray liquid should be made up immediately before treatment to avoid undesirable physico-chemical reactions. The agitator of the sprayer must be speedwelled on at all times to prevent the mixture from precipitating 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 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 should be filled on impermeable and hardened ground (e.g. concrete slab) in a place that prevents spillage of spilled or spread plant protection products,
- the measured quantities of plant protection products should be poured into a tank partially filled with water with the stirrer on or in accordance with the instructions for operation of the sprayer,
- 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 permeable ground, a thick plastic foil for collecting spilled or spread 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 containing the contaminated material should be stored in plant protection product storage until safely managed.

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) and supplemented with water to the desired volume of the sprayer tank.

In large-component mixtures with the use of two or more plant protection products, the order of their addition to the liquid should be followed – according to the physical characteristics 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, replenish the tank with water to the required volume.

Do not use low temperature water (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 carried out in light wind and rain-free weather and moderate temperature and sunshine. 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 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 data 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. Limit and optimal meteorological conditions for plant protection treatments

Parameter	Limit values (extreme)	Optimum values (most favourable)
Temperature	1-25 °C during treatment	12-20 °C during treatment
	up to 25 °C the day after treatment	20 °C on the day after
	not less than 1 °C the following night	not less than 1 °C the following
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 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 first with the labelling of plant protection products. On many labels, distances (buffer zones) greater than those indicated above are provided from specific sites and facilities after which plant protection products should be used.

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

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

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

Procedure for rinsing the tank and liquid system

- for rinsing, it is required to use the least necessary amount of water (2-10 % of the volume of the tank or the amount up to 10 times dilution remaining in the liquid tank) — it is recommended to rinse the liquid system with a small portion of water 3 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 to use the residue, 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 for that purpose.

External sprayer washing

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

External sprayer washing should be carried out in a place that allows rinsing into a closed collection system for contaminated residues or to a neutralisation/bioremediation system (e.g. biobed, Phytobac, Vertibac); if this is not possible, it is best to wash the sprayer 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.

Registration of treatments

Professional users of plant protection products are required to maintain and keep records of their plant protection products for at least 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 has been 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 notepad in the system of integrated plant production fulfils the requirement to keep the above-mentioned documentation for certified crops.**

10. HYGIENE AND HEALTH PRINCIPLES

Personal hygiene of employees

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

a) be free of food-borne infections or diseases;
b) maintain personal cleanliness, obey the rules of hygiene, and in particular often wash hands during work;
c) wear clean clothes and, where necessary, protective clothing;
d) injuries and abrasions should be treated 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 been trained in hygiene.

Hygiene requirements for crops prepared for sale

The plant producer shall take appropriate measures to ensure that:

a) only clean water or consumption-grade water (as required) is used to wash agricultural produce;

b) crops are protected during and after harvesting against physical, chemical and biological pollution.

Hygiene requirements in the integrated system of crop production for packaging and means of transport and places for preparing crops for sale

A producer in an Integrated Crop Production system shall take appropriate measures to ensure that:

a) the rooms (including equipment), means of transport and packaging are kept clean;
b) farmed and domestic animals have no access to the rooms, vehicles and packaging;
c) harmful organisms (pests and organisms dangerous to humans), which may lead to contamination or pose a 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. DEVELOPMENT 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 digital 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 growth stage in which the plant is located. 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 caryopsis

01 Beginning of seed imbibition, soft caryopsis of a typical size

03 Seed imbibition complete, swollen caryopsis

05 Radicle has emerged from caryopsis
06 Radicle elongated, root hairs and/or side roots visible
07 Leaf sheath (coleoptile) emerged from the caryopsis
09 Emergence: coleoptile penetrates soil surface(cracking stage)

Principal growth stage 1: Leaf development[1,2]

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 till ...
19 9 or more leaves unfolded

Principal growth stage 2: Tillering[3]

20 No tillers
21 Beginning of the tillering stage: 1st tiller visible
22 2 tillers visible
23 3 tillers visible
2. Stages continue till ...
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
3. Stages continue till ...
37 Flag leaf just visible, still rolled, ear begins to swell
39 Flag leaf stage: flag leaf fully developed, visible ligule of the last leaf
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 Visible first awns

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1 A leaf may be described as unfolded when its ligule is visible or the tip of the next leaf is visible
2 Tillering or elongation of the stem may occur earlier than in Stage 13, then the description continues in Stage 21
3 If the shoot elongation starts before the end of tillering, then the description continues in Stage 30.

Main development stage 5: HEADING

51 The beginning of heading: 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 emerged, 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: Development of fruit

71 Water maturity: the first watery caryopsis 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 caryopses

85 Soft waxy maturity, caryopses easily smeared between the fingers

87 Hard waxy maturity, caryopses easily broken with a fingernail

89 Full maturity, hard grains, difficult to split with a fingernail

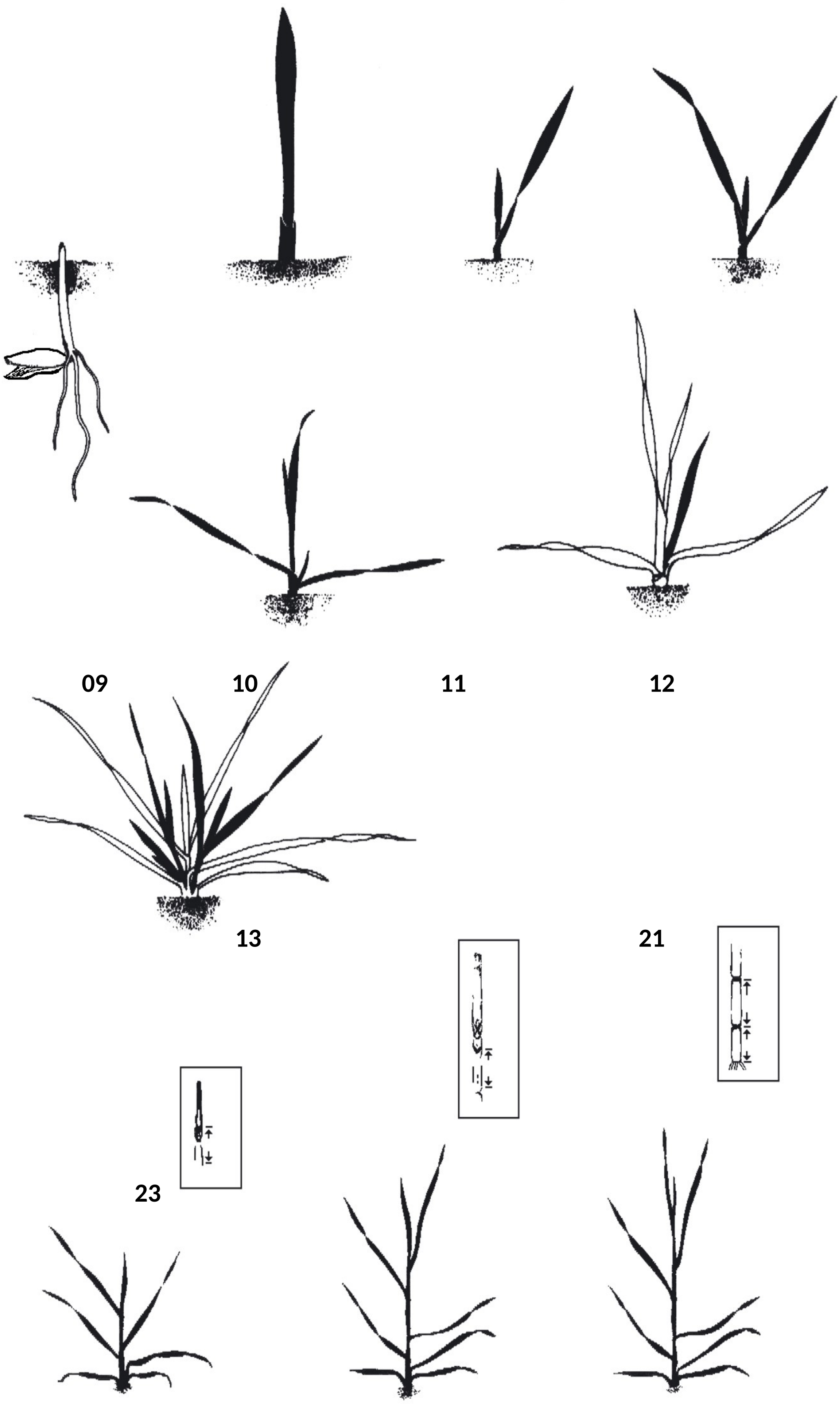
Principal growth stage 9: Senescence

92 Over-ripe: very hard caryopses, cannot be dented by a fingernail

93 Caryopses loose in the ear, may fall off

97 Plant dead and collapsing

99 Harvested product, resting period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13. RULES FOR KEEPING RECORDS IN INTEGRATED PRODUCTION

The cultivation of plants under the integrated plant production (IP) 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. Model notebooks are included in the Annex to Regulation of the Minister for Agriculture and Rural Development of 24 June 2013 on documenting activities related to integrated plant production (consolidated text: Journal of Laws of 2023, item 2501). 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 producer using integrated plant production must possess or may encounter 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 GDPR;
- lists of plant protection products for IP;
- inspection reports;
- checklists;

- test results on 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 others, plant protection products and fertilisers;
- application for a certificate;
- IP certification.

The certification process begins with the completion and submission, within the statutory deadline, of the application for integrated plant production by the producer to the certification body. 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 proving 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 declared 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, own information must be added.

Inventory of fields/plots/greenhouses/tunnels in the integrated production system: in the table with the list of fields, all cultivated varieties submitted for IP certification must be recorded.

Field plan with biodiversity-increasing elements – graphically reproduce the plan of the farm and its immediate surroundings with the proportions of the various elements. On the farm plan, use the markings used as in the list of fields.

General information, sprayers, operators – the year in which the production started should be entered according to the principles of integrated plant production. Then move on to completing the table. Fill in the bulleted places with appropriate entries and confirm the information by ticking the boxes prepared for this purpose ( ). The 'Sprayers' table should be filled in with the required data and the information confirmed by ticking the relevant boxes (□). . Note all sprayers operators carrying out plant protection treatments in the 'Sprayer operator(s)' table. It is absolutely necessary to indicate that the training in the use of plant protection products is up to date, including the date of completion (or other qualification). In the 'Sprayers' and 'Sprayer operator(s)' tables, all equipment and persons performing treatments, including those performed by a service provider, should be listed.

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

Monitoring tools, e.g. colour sticky boards, pheromone traps — in the table, record the used colour sticky boards, pheromone traps, etc. and indicate pests which these tools were intended to monitor.

Crop rotation — the crop rotation table should be filled in with 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 (...): – the table should be completed by entering information about the purchased seed – species, variety, category, degree of qualification, quantity, and proof of purchase (invoice, official label, or marketing label).

Sowing/Planting – the table should record the quantity of seed used in each field. The dates of the activities carried out should also be recorded. Information on soil testing/assessment for existing pests that exclude the field from IP cultivation should be confirmed by ticking the relevant boxes (□).

Soil/substrate and plant analysis and fertilisation/fertigation — soil analysis is a fundamental activity to determine the fertiliser needs of plants. The IP producer must carry out such analyses and record them in the notebook. The field code, the type or scope of testing and the number and date of the report should be entered in the 'Soil and plant analysis' table. All organic fertilisers applied should be recorded 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, 'Soil mineral fertilisation and liming', the date, type and dose of fertilisation and liming applied and where it was applied should be noted. The ‘Observations of physiological disorders and foliar fertilisation’ table should be used to record observations regarding plant nutritional deficiencies and fertilisers applied. 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 observations of physiological disorders carried out.

Control observations and record of plant protection treatments — the plant protection tables are the basic 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. In this table, the need for chemical treatment is also indicated. The next two tables are registers of plant protection treatments (agrotechnical, biological and chemical) 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. 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 sanitation requirements — it should be recorded 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 comment concerning requirements for plant protection against pests 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 has a space for comments and own notes and a list of appendices.

It is possible for an agricultural producer to obtain an IP certificate by applying to a certification body. Forms for the relevant applications are available from the certification bodies. Along with the completed application for a certificate certifying the use of integrated plant production, the plant producer shall provide the certifying operator with a statement that the crop was carried out in accordance with the requirements of integrated plant production and information on the species and varieties of plants grown using 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)			
No.	**Checkpoints**	**YES/NO**	**Comment**
1.	Implementing appropriate crop rotation — indicated in the methodology (**see chapter 3.3.**)	☐/☐	
2.	Selection of varieties recommended by COBORU (**see chapter 4**)	☐/☐	
3.	Use of certified and treated seed in accordance with the ESTA standard or an equivalent standard in the relevant standard (**chapter 5.2.**)	☐/☐	
4.	Analysis of 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.**)	☐/☐	
5.	Application of macro- and micronutrient 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 (**see chapter 6.**)	☐/☐	
6.	The use of agro-technical methods as the first step in weed control and, in the case of required chemical control, 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 (**see chapter 7.1.**)	☐/☐	
7.	Monitoring of the field during the tillering/stem elongation stage, the flag leaf stage, and heading in order to assess the occurrence of diseases (powdery mildew of cereals and grass, septoria leaf spot - symptoms on the leaves, brown rust, brown leaf spot, yellow rust) and after heading, with particular emphasis on fusarium blight of ear (**see chapter 7.2.**)	☐/☐	
8.	Systematic monitoring of the field from emergence to tillering once a week for the presence of aphids – virus vectors, and from the beginning of the heading stage to maturation, observation for the presence of cereal leaf beetles and midges once every two weeks (direct plant inspection, yellow traps,	☐/☐	

	etc.) (**see chapter 7.3.)**		
9.	Once the pest and disease threshold is exceeded, the use of plant protection products (using the Pest Alerting Platform or other decision support systems) (**see chapter 7.2.3. and 7.3.2.**)	?/?	
10.	Using only plant protection products from the list of products authorised for use in the integrated production of triticale (**see chapter 7.**)	?/?	
11.	Alternate use of active substances of plant protection products from different chemical groups to prevent the resistance of pests (weeds, pests and pathogens) (**see chapter 7.**)	?/?	
12.	Creating suitable conditions for the presence of birds of prey, i.e. setting up resting poles in the amount of at least 1 per 5 ha, and in the case of larger plantations – several units (**see chapter 8.**).	?/?	
13.	Placing of 'houses' for mason bees or mounds for bumblebees or other insect pollinators at a frequency of at least 1 pc for every 5 ha (**see chapter 8.**).	?/?	
14.	Harvest at the right time (correct grain moisture) (**see chapter 11.**)	?/?	

Note:

The fulfilment of all the requirements in the list of mandatory operations and treatments under the integrated production scheme must be documented in the Integrated Crop Production Notebook.

15. CHECKLIST FOR AGRICULTURAL CROPS

Basic requirements (100 % compliance, i.e. 28 points)			
No.	Checkpoints	YES/NO	Comment
1.	Does the producer produce and protect the crops according to detailed methodologies approved by the Main Inspector?	?/?	
2.	Does the producer have up-to-date IP training confirmed by a certificate, subject to Articles 64(4), (5), (7) and (8) of the Plant Protection Products Act?	?/?	
3.	Does the producer apply plant protection products only from the list of IP-recommended products?	?/?	
4.	Are all required documents (e.g. methodologies, notebooks) present and kept on the farm?	?/?	
5.	Is the IP notebook kept correctly and up to date?	?/?	

Basic requirements (100 % compliance, i.e. 28 points)			
6.	Does the producer systematically conduct control observations of the crops and record them in the notebook?	□/□	
7.	Does the producer deal with empty packaging of crop protection products and products that are out of date in accordance with the applicable legal regulations?	□/□	
8.	Is chemical protection of crops replaced by alternative methods wherever justified?	□/□	
9.	Is chemical plant protection carried out based on risk thresholds and the signalling of harmful organisms (wherever possible)?	□/□	
10.	Are procedures using plant protection products carried out only by persons having an up-to-date, as of the date of such procedures, certificate on the completion of training in the scope of the application of plant protection products or advisory on plant protection products, or integrated plant production, or any other document confirming the right to apply plant protection products?	□/□	
11.	Are the applied plant protection products approved for use in the plant?	□/□	
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 per unit of area?	□/□	
13.	Were the plant protection treatments carried out under appropriate conditions (optimal temperature, wind below 4 m/s)?	□/□	
14.	Is the rotation of the active substances of the crop protection products used for the treatments respected, if possible?	□/□	
15.	Does the producer limit the number of treatments and the amount of crop protection products used to a necessary minimum?	□/□	
16.	Does the producer have measuring devices to precisely determine the quantity of the measured plant protection agent?	□/□	
17.	Are the conditions for safe use of the agents respected, as set out on the labels?	□/□	
18.	Does the producer comply with the provisions of the label concerning the observance of precautions related	□/□	

Basic requirements (100 % compliance, i.e. 28 points)			
	to environmental protection, i.e. e.g. the observance of protective zones and safe distance from areas not used for agricultural purposes?		
19.	Are prevention and withdrawal periods observed?	□/□	
20.	Are the doses and maximum number of treatments per growing season specified on the label of the plant protection product not exceeded?	□/□	
21.	Are the sprayers referred to in the IP Notebook in good technical condition and are their technical inspection certificates up to date?	□/□	
22.	Does the producer carry out systematic calibration of the sprayer(s)?	□/□	
23.	Does the producer have a separate space for filling and cleaning the sprayers?	□/□	
24.	Does the handling of residues of the spray liquid comply with the indications on plant protection product labels?	□/□	
25.	Are crop protection products stored in a marked closed room in such a way as to prevent contamination of the environment?	□/□	
26.	Are all plant protection products stored only in their original packaging?	□/□	
27.	Does the IP producer observe hygienic and sanitary principles, especially those specified in the methodologies?	□/□	
28.	Are appropriate conditions for the development and protection of beneficial organisms ensured?	□/□	
	Total points		

Additional requirements for field vegetable crops (minimum compliance 50 %, i.e. 8 points)			
No.	**Checkpoints**	**YES/NO**	**Comment**
1.	Were the plant varieties grown selected for Integrated Plant Production?	□/□	
2.	Is each box marked according to the entry in the IP notebook?	□/□	
3.	Did the producer perform all the necessary agrotechnical procedures in accordance with IP methodologies?	□/□	
4.	Is the recommended catch crop used in cultivation?	□/□	

5.	Are steps taken on the holding to reduce soil erosion?	?/?	
6.	Have the procedures been conducted using spraying devices specified in the IP notebook?	?/?	
7.	Are fertiliser application machines maintained in good working order?	?/?	
8.	Do fertiliser application machines allow for accurate dose determination?	?/?	
9.	Is each fertiliser applied recorded with regard to its form, type, date of application, quantity, location and surface?	?/?	
10.	Are fertilisers stored in a separate and specially designated room in a manner that ensures protection of the environment against contamination?	?/?	
11.	Does the producer protect empty PPP packaging against unauthorised access?	?/?	
12.	Does the producer have a dedicated place to collect organic and post-vegetable-sorting residues?	?/?	
13.	Are there first-aid kits near the workplace?	?/?	
14.	Are hazardous areas on the farm, e.g. plant protection product storage rooms, clearly marked?	?/?	
15.	Does the producer use consultancy services?	?/?	
	Total points		

Recommendations (min. implementation 20 %, i.e. 2 points)			
No.	**Checkpoints**	**YES/NO**	**Comment**
1.	Are soil maps drawn up for the farm?	?/?	
2.	Are inorganic fertilisers stored in a clean and dry room?	?/?	
3.	Has a chemical analysis of organic fertilisers been carried out in terms of nutrient content?	?/?	
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?	?/?	
5.	Does the producer know how to proceed in the event of spill or scatter of plant protection products and do they have tools to counteract such a threat?	?/?	
6.	Does the producer restrict access to the keys and the warehouse in which the plant protection products are stored, to persons who do not have the authority to use them?	?/?	
7.	Does the producer store on the farm only plant	?/?	

	protection products allowed for use with the plant species they cultivate?		
8.	Does the producer improve their knowledge at Integrated Plant Production meetings, courses or conferences?	☐/☐	
	Total points		

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