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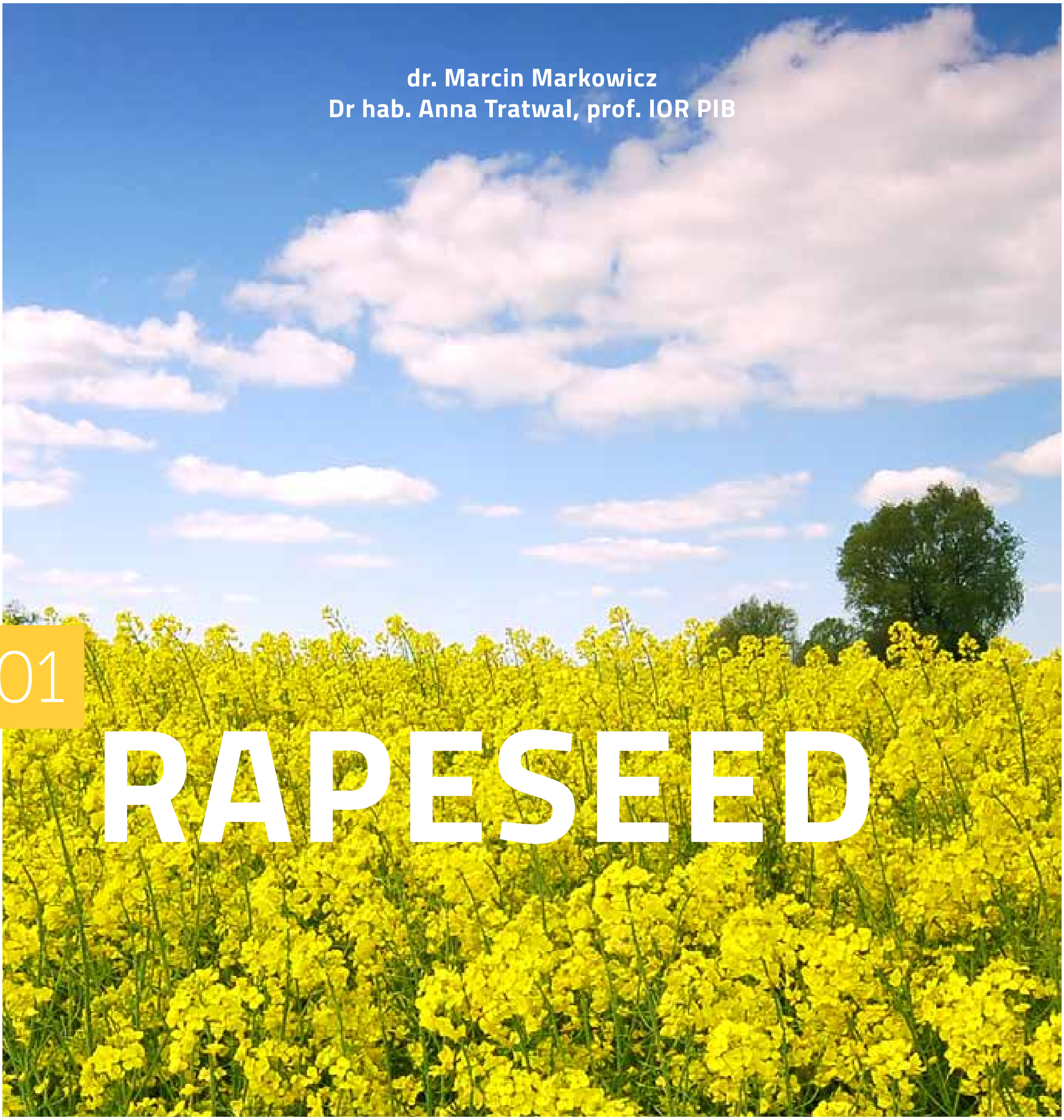
01

RAPESEED



CEE REGENERATIVE AGRICULTURE GUIDEBOOK

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REGENERATIVE AGRICULTURE REVOLUTION

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CEE REGENERATIVE
AGRICULTURE
GUIDEBOOK
RAPESEED

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RAPESEED

CEE REGENERATIVE AGRICULTURE GUIDEBOOK

Poznań 2023

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ECONOMIC IMPORTANCE

The most popular oilseed plant in Europe is rapeseed. Top three producers are France, Germany and Poland in terms of its production.

1.1

Winter rape is a highly useful plant, offering high yields of seeds, but requiring from producers knowledge and diligence in its cultivation. The increase in demand for rape seeds on global markets results from higher importance of rape as a plant for consumption (oil), fodder (fat-free seed residue), straw and because of its environment-friendliness resulting from the organic mass of its harvest residues, and phytomass in the form of catch crops (Kotecki et al. 2020). The oil produced from the seeds of cultivated rapeseed varieties is classified into food oils referred to as functional food, i.e. producing beneficial effects on human health. Rapeseed oil's ratio of omega-6 (linoleic acid) to omega-3 (linolenic acid), of 2:1 is ideal from the nutritional point of view. The quality of the oil is largely determined by the quality of the seeds used as raw material for oil production. High quality of that raw material is ensured primarily by proper cultivation of rape, its protection, harvest and seed storage.

The significant role of rapeseed in agricultural ecosystems is also not to be disregarded. Its importance results from the beneficial effect on the soil environment for monoculture cultivation of cereals. Rapeseed is an attractive forecrop for cereals owing to rapid decomposition of harvest residues (narrow C:N ratio), but also to its biofumigation effect. The importance of rapeseed for landscape is also worth noting.

Its importance results from the beneficial effect on the soil environment for monoculture cultivation of cereals.

SOIL AND CLIMATE REQUIREMENTS

1.2

Rapeseed is known for high soil requirements which, next to the cold weather risk, is the main reason for its uneven geographical distribution in central Europe.

It adapts well to various soil conditions, but reliably high seed yields come from the best soils, in grade I-III, with proper structure and pH. In term of soil types, the most useful ones for the cultivation of winter oilseed rape are brown soil and typical podzolic soil, chernozems, black soil, alluvial soil and well-developed rendzinas.

Satisfactory conditions for the cultivation of rapeseed are provided by the annual rainfall of 500-600 mm. Rapeseed manages water reasonably, which translates into good seed yields also where the annual rainfall is below 450 mm. Good use of water by rapeseed is attributed to its robust and deep root system, a waxy coating on the leaves and relatively quick growth in spring. The distribution of rainfall is more important for successful rapeseed farming than its overall quantity. In the rosette formation period, rapeseed has low water requirements. For the proper course of the germination and emergence stage, 10-20 mm of precipitation is needed. No rainfall during germination and seed emergence, as well as soil overdrying during the latter phase, cause uneven and poor emergence, which, if the number of seeds sown was small, can significantly reduce the yield. Rapeseed is not very sensitive even if water shortage continues for weeks in the rosette formation period, because the quickly growing root allows water to be drawn from deeper layers. The sensitivity of winter rape to drought clearly increases during the spring and summer vegetation. According to Dzieżyc (1993), the optimum precipitation is 70-105 mm during the autumn vegetation period, 150-240 mm during the winter dormancy period and 170-180 mm during the spring-summer vegetation period. Thermal requirements of rapeseed vary depending on the stage of development. The optimum air temperature for the emergence of winter rape is 16-18°C. Rapeseed sown at the optimum time emerges after 4-8 days. Only if winter rape is sown at the best moment in terms of agricultural science, is it possible to achieve full coverage of thermal needs in autumn and proper formation of the leaf rosette, which is a prerequisite for the proper course of the hardening process. Properly hardened rapeseed plants go through the period of winter dormancy without major losses when temperatures are down to -15°C and there is no snow cover. If the snow layer is 5-10 cm, rapeseed plants withstand temperatures down to -20°C. Their resistance to low temperatures increases until mid-January, and then slowly decreases. The sensitivity of plants increases when the winter period of frost is interrupted by warmer spots. When that happens plants de-harden and easily freeze after frost bites return. In addition to typical freezing, winter rape plants can be severely damaged in winter or early spring as a result of cold wind burning, smothering, soaking and uprooting (Muśnicki 2003). Of vital importance for proper preparation of the rapeseed plant for wintering are agrotechnical treatments, careful selection of varieties and keeping the right dates for sowing in a given region.

Rapeseed is not very sensitive even if water shortage continues for weeks in the rosette formation period.

Only if winter rape is sown at the best moment in terms of agricultural science, allows proper formation of the leaf rosette.

BIOLOGICAL PROPERTIES

1.3

Brassica napus **(L.) – rapeseed is a natural amphidiploid and a product of spontaneous crossing between primary species:** ***Brassica*** **oleracea (L.) – cabbage and** ***Brassica campestris*** **(L.) – agrimony.**

There is a winter and spring form within this subspecies (Szempliński 2012). Rapeseed produces a strong tap root, spindle-shaped, with a high rooting depth (120-200 cm), but not very flexible, which means that the movements of the soil during its freezing and thawing can severely damage the root. Above the germinal root there is a root neck, which turns into a hypocotyledon and then into a supracotyledon. The true leaves develop from an apical bud located between the cotyledons. The inflorescence is an elongated, loose bunch consisting of 20-50 flowers. Flowering starts from the bottom and progresses upwards. Flowers are open-pollinated and insect-pollinated, and fields of currently cultivated rapeseed varieties bloom 20-30 days on average. The fruit is a multi-seeded (25-50 seeds), long (5-10 cm), smooth or knobby pod. The seeds are small, spherical red-brown, brown -black or black with a shimmering bluish tint, and a narrow and short mark. The average weight of 100 seeds is 4-6 g.

The true leaves develop from an apical bud located between the cotyledons.

PLACE IN CROP ROTATION

1.4

By increasing the diversification crops, a more diverse environment is created, biodiversity is increased and the presence of crop pests and diseases is reduced.

Winter rape is a very good plant for crop rotation as it leaves harvest residues that increase humus level in the soil.

The share of rapeseed should not exceed 25% in the crop structure. In order to set up the correct crop rotation on farms with a high share of cereals, legumes should also be grown to maintain soil fertility. Simplification of crop rotation leads to a decrease in productivity and soil fertility. As regards crop rotation, winter oilseed rape should not be in close proximity to beetroot, as it is a host plant for beet cyst nematodes. Under no circumstances should this species be grown in succession, even in a short monoculture. Rapeseed reacts very negatively to crop rotation with a high saturation of Brassica plants. Harvest residues are the source of more intense infestation by dry rot, black spot, grey mould, verticillium wilt and cylindrosporium wilt. A very big threat, resulting in significant yield loss, is clubroot, especially on heavy and wet soils. If it occurs, an effective reduction can be achieved only by a long-term break in the cultivation of rapeseed or cultivation of varieties with high resistance to clubroot. A large share of rapeseed in crop rotation and a short rotation also result in widespread presence of volunteers, which leads to excessive plant density and separation in the summer-autumn vegetation period. Under such conditions, rapeseed, competing for light, excessively lengthens the stem, which increases the risk of the plantation freezing. A large share and frequent rotation of rapeseed in the crop rotation setup increases the one-sided use of nutrients and leads to the so-called "soil fatigue". In regenerative production, appropriate proximity

A very big threat, resulting in significant yield loss, is clubroot, especially on heavy and wet soils.

of plants should be used, which prevents the movement of pests (rapeseed honey beetles, moth caterpillars, white beetles, Ceutorhynchus, aphids, flea beetles and other), as well as pathogens present on rapeseed, mustard or vegetables from the Brassicaceae. A natural or intentional isolation zone should be maintained between them.

The best forecrop for winter rape are annual legumes harvested for seeds or perennial legumes (clover, alfalfa and their mixtures with grasses). However, it should be remembered that the disadvantages of these sites in dry years are deep drying of the soil and frequent weed infestation with perennial weeds. Rape is most sown located after cereal forecrops. According to Budzyński [2010], the cultivation of rape after cereals may reduce the yield by approx. 15-25%. This difference cannot be fully compensated by the intensification of production technology.

Rapeseed is one of the best forecrops for cereals - in European practice mainly for winter wheat. The forecrop attractiveness of rapeseed results from the large weight of harvest residues, but also from their quick decomposition (due to the narrow C:N ratio) by soil microorganisms. The beneficial effect of rapeseed crop residues can be estimated at an additional 0.8-1.5 t·ha-1 of wheat grain. It should be emphasized that the growth of wheat grain grown after rape is accompanied by a decrease in expenses on production technology, mainly on fungicidal protection (Kijewski 2013).

Rapeseed is one of the best forecrops for cereals - in European practice mainly for winter wheat.

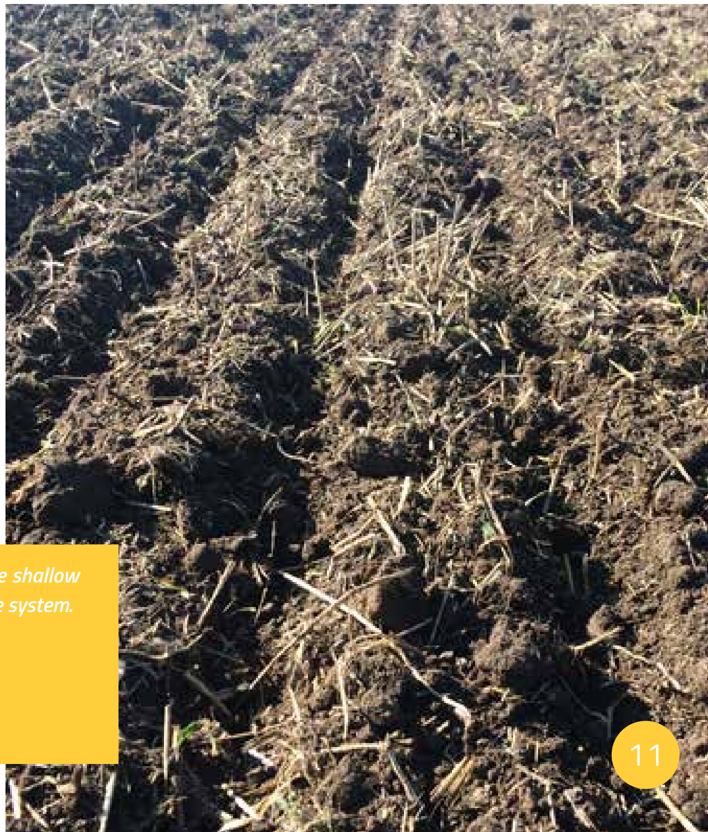
SOIL CULTIVATION

1.5

Tillage for winter rape should ensure good levelling and even loosening of the soil as well as obtaining a lumpy structure.

Irregularities in soil cultivation can result in uneven emergence of the plants, as well as delay their initial development. Soil cultivation for rapeseed should start with forecrop harvesting, during which it is necessary to mow as low as possible, with thorough crumbling and even spreading of straw. Then, regardless of the subsequent method of tillage or sowing, shallow post-harvest tillage should be performed as soon as possible, with soil loosened to a depth of approx. 6-8 cm. A grubber or disc harrow can be used for this procedure. The purpose of this treatment is to mix harvest residues and accelerate their decomposition, inhibit evaporation of water from the soil, collect rainwater and stimulate weed seeds to germinate. After the emergence of weeds and volunteers of the forecrop, shallow tillage should be carried out again to destroy them. It should be remembered that each tillage procedure involves soil drying to the tillage depth, which is why post-harvest treatments should be as shallow as possible.

Deep tillage with shallow seasoning treatments should be used for pre-sowing tillage for winter rape. Particular attention should be paid to the working depth of the tillage tools, as it has a greater impact on the development of the root system, and ultimately on the seed yield. Oilseed rape does not tolerate shallow tillage regardless of the tillage system. Shallow tillage increases soil density and decreases its porosity. This is manifested, inter alia, in hindered gas exchange between the soil and the ground-level atmosphere layer, which results in CO2 increase. The effect is shallow rooting of rapeseed as well as reduction, and in extreme cases inhibition of growth and development of the root system.



Oilseed rape does not tolerate shallow tillage regardless of the tillage system.

Winter rapeseed in regenerative practice should be cultivated in the no-ploughing system, which involves loosening of the soil, without turning it over, or using the strip-till technology, where the main purpose is to loosen only those strips of soil, in which seeds and fertilizer are placed in a single pass. The undisputed advantages of this tillage and sowing method include less dependence on weather conditions, deep loosening of soil strips, so creating ideal conditions for the development of the root system, as well as preservation of moisture in the soil and quick plant emergence. As the forecrop stubble remains between the tilled strips, it provides winter protection against bad weather (burning) and prevents snow from being blown away, which insulates and protects the plants against low temperatures (Sokólski 2017).

If ploughing stops, all soil processes, in particular biological, change dramatically. Soil microorganisms suffer a "shock", followed by adaptation to new conditions. Organic matter transformation flows change, the level of humus in the soil begins to increase, which ultimately improves its structure and increases its water capacity. However, these processes are slow, spread over years. Reduce tillage, performed continuously, without ploughing every few years, has the best effect on soil. Ploughing as a procedure hides many errors and shortcomings from being seen. Cultivation without ploughing, especially of such demanding plants as rapeseed, is not easy, requires diligence and timely performance of treatments, not only strictly related to cultivation, but also to fertilization and plant protection.

Winter rapeseed in regenerative practice should be cultivated in the no-till system, which involves loosening of the soil, without turning it over, or using the strip-till technology.

SOWING

1.6

The right sowing date is a decisive factor for the growth and development of winter rape leaf rosette. It is worth noting that the habit of the rosettes is correlated with the wintering of rapeseed plants.

Proper rapeseed plant formation requires about 80 days of vegetation with a temperature above 5° C in autumn. Rapeseed should be sowed when appropriate for a given region of the country. A deviation of 4-5 days from the recommended date of sowing is allowed, but delayed sowing produces a weak leaf rosette, poor development of the taproot, and in spring a smaller number of plant branches. Too early sowing date is also unfavourable, because the autumn development of the plants increases the risk of their freezing.

Sowing density results from the variety type (hybrid, population), agricultural climate conditions for germination, seed emergence, thermal conditions prevailing during the winter dormancy of plants and the level and distribution of precipitation during the spring-summer vegetation period. Where there is higher risk of winter rape freezing, the reduction of sowing density causes a decrease in seed yield, especially when the sowing date is delayed. In regions where winters are milder, sowing density has a weak effect on rapeseed yield, which indicates its possible reduction. Rape seeds should be sown evenly, precisely (in rows or points) from 30 to 50 plants per 1 m2. Field architecture, i.e. the spatial arrangement of all elements that make up the field, is of key importance in rapeseed cultivation technology. The easiest way to model a field is by row spacing. The even distribution of plants has a positive effect on the diameter of the stems, their lower lodging, stronger branching, better airiness of the canopy and lower binding of a larger number of siliques. The most favourable field architecture and yield structure is ensured by a row spacing of 15-30 cm, while a narrower row spacing causes phytosanitary conditions in the rapeseed canopy to degrade. Rape seeds should be placed at a uniform depth of about 1.5 cm. Their deeper placement delays emergence, makes it uneven, and the stratification of plants deepens in the autumn vegetation period.

The most favourable field architecture and yield structure is ensured by a row spacing of 15-30 cm.

FERTILIZATION

LIMING

1.7

Winter rape shows low tolerance to acidic soil.

Where pH is below 5.8, it grows poorly in autumn, in spring poorly uses the nutrients brought to the soil with fertilizers, shows clear symptoms of inhibition and uneven growth in the budding period, does not branch productively and yields poorly. In order to keep the right pH range (6,5-7,2) for rapeseed, pH of the soil should be constantly monitored. The optimum time to test for pH is the forecrop harvest, because setting the date for liming is the overriding objective in the effective soil pH management for rapeseed farming. In the case of crop rotation, it is best to lime under the forecrop, with the dose and form of lime depending on the current pH and agricultural grade of the soil. If it is necessary to conduct liming before sowing rape, the best form of calcium fertilizer are oxide-carbonate mixtures in a dose 1/3 less than calculated. Oxide lime applied directly before rapeseed sowing may disturb the emergence and autumn growth and development, whereas carbonate lime, due to its too slow action, may not fully meet the nutritional needs of rapeseed. Calcium sulphate is a suitable fertilizer if there are very short breaks between forecrop harvesting and rapeseed sowing. Both components of this fertilizer, i.e. sulphur and calcium, play an important role as rapeseed nutrients, and control the activity of toxic aluminium. The effect of calcium as regards the latter results from its function in the plant. Calcium initiates the activity of growth bud cells, both for the root, and the stem and leaves. In acidic soil, its Al^{3+} competes with calcium (Ca^{2+}), which inhibits growth or even causes the root to die. Equally important is the role of the sulphate residue, which, by binding Al^{3+} into poorly soluble forms, reduces its concentration in the soil. The purpose of using this fertilizer group is to promote migration of calcium into the soil profile, and ensure its presence in the plant's rooting zone at the time of intensive growth. In the case of calcium sulphates, there are no problems with salinity and plant burns.

In order to keep the right pH range for rapeseed, pH of the soil should be constantly monitored.

ORGANIC FERTILIZATION

1.8

One way to enrich the soil with organic matter to leave the straw of the forecrop on the field and treat it as fertilizer.

When harvesting cereals, it is very important to break it up well and leave the shortest possible stubbles, which will facilitate even spreading of straw on the field and its correct and even shallow mixing with the soil to a depth of up to 8 cm. When leaving cereal straw on the field, it is necessary to provide the right amount of nitrogen, which will allow for its faster mineralization (narrowing of the C:N ratio).

Rapeseed responds very well to fertilization with manure, but it is not necessary for this species. The beneficial effect of manure fertilization can be easily compensated for with mineral fertilization. However, it should be remembered that manure is not only a donor of nutrients, but above all it increases the content of humus in the soil, diversifying its sorption, buffer, filtration and retention properties. Manure improves soil structure, microbial life and enzymatic activity. Taking into account the relatively slow transfer of nutrients contained in manure into forms that are assimilable by plants, NPK mineral fertilization for winter rape should be reduced by 25, 30 and 50%, respectively, relatively to the calculated values. Manure can be incorporated into the soil for stubble and covered with shallow and then deep tillage with cultivators used in reduce till systems.

Slurry is also a very good fertilizer for winter rape. It can be used before sowing in a dose that takes into account the chemical composition and fertilizer equivalents. In the case of properly stored slurry, its phosphorus and potassium may be available to rapeseed at the level of their availability from mineral fertilizers (fertilizer equivalent = 1). The fertilizer equivalent of nitrogen is approx. 0.7 (pre-sowing slurry mixed with soil) (Budzyński 2010). It should be emphasized that slurry quickly and strongly modifies the physical, biological and chemical properties of the soil, and therefore environmental effects of its application must be strictly monitored.

Manure improves soil structure, microbial life and enzymatic activity.

MINERAL FERTILIZATION WITH PHOSPHORUS AND POTASSIUM

1.9

Phosphorus promotes harmonious growth and development of the plants, the height and quality of seed yield, regulates the mass ratio of generative and vegetative organs, makes plants resistant to freezing, lodging and some diseases, and prevents the negative effects of overfertilization with nitrogen.

Phosphorus is necessary for the proper growth of roots, the production of the right number of shoots, leaves and flowers, and to limit the subsequent reduction of the pods.

Potassium is taken up as K+. Plants selectively and efficiently absorb potassium, which, if there is shortage, easily moves from older to younger leaves. Young leaves and shoot tips are particularly rich in this ingredient. In mature plants, it accumulates mainly in the vegetative organs. This element regulates water management by plants and is involved in the transformation of assimilates and their transfer in the plant.

The reaction of rapeseed to the level of those soil ingredients is very strong. At their low levels, the plant is not able to absorb sufficient amounts of phosphorus and potassium, even if applied as fertilizers. Conversely, soil containing large amounts of assimilable forms of both ingredients is able to meet the nutritional needs of plants for many years with little intervention from the farmer. The doses of phosphorus and potassium should be determined on the basis of the nutritional needs of plants, and match yield and soil fertility indicators.

MINERAL FERTILIZATION WITH NITROGEN

1.10

Autumn nitrogen fertilization of winter rape should be considered in the context of its effect on the pre-dormant habit of rosettes.

Increased autumn nitrogen fertilization causes a significant increase in the dry matter of rosettes before winter, although its absolute value may slightly decrease, as nitrogen increases tissue hydration and lowers sugar content, which may interfere with the plant hardening process. Nitrogen accelerates the elongation of leaves and stems, which has a particularly adverse effect on the location of the growth cone (swaying), and significantly worsens winter hardiness. On the other hand, the lack or poor availability of nitrogen in autumn means that rosettes of winter rape do not achieve the desired shape, which results in poor hardening, high susceptibility to frost, poor vigour in spring, less binding of pods on the plant, and lower yield.

During the 70-80 days of autumn vegetation, rapeseed absorbs, depending on the degree of leaf rosette development and density, from 30 to even 110 kg N ha^{-1}. This amount is taken from a shallow soil layer of about 30 cm, where the root system of winter rape develops. Nitrogen used during the spring growing season performs the main yield-forming function, as the increase in the dry matter yield of plants in spring is over ten times higher than in autumn. To produce 1 tonne of seeds, together with the corresponding yield of stems, leaves and roots, rapeseed absorbs approx. 58 kg of N. Spring nitrogen doses for winter rapeseed of 100-120 kg ha^{-1} should be applied once. It is the cheapest and least energy-intensive method, and at the same time it is as yield-producing as divided doses. In dry years, it can give even better results, due to better use of nitrogen applied in later phases.

Strip-till method produces very good results. It enables simultaneous spreading of fertilizers and sowing of seeds. Fertilizers can be applied at selected depths. Localized fertilization using this is particularly justified, because fertilizers remain on the soil surface after spreading, leading to nutrient losses. With the strip-till technology, a significantly higher dose of conventional fertilizers can be applied due to their deeper placement.

Winter rape should also be fertilized with sulphur, because it consumes about 15 kg of sulphur to produce 1 tonne of biomass. The role of sulphur is related to its presence in the molecule of some amino acids and glutathione, crucial for maintaining the protein chain conformation. The autumn dose of sulphur should only be at a level that supports the proper development of rosettes, i.e. about 10-15 kg ha^{-1}. The yield-forming efficiency of the spring dose of sulphur depends on its abundance in the soil. In spring, the dose of sulphur should be in the region of 10-15 kg S per 1 tonne of the projected yield.

FOLIAR FEEDING OF RAPESEED WITH MICRONUTRIENTS

1.11

High nutritional needs of rapeseed mean that the fertilization strategy for this plant should not be based only on soil treatment with fertilizers.

Equally important as soil fertilization is foliar feeding, as it improves nutritional status both directly and indirectly. Rapeseed fields most often require fertilization with boron. Rapeseed has the highest boron uptake among all oilseeds. Boron fertilization may intensify the transfer of photosynthetic products from the pericarp to rape seeds, positively influencing seed quality, yield and its useful value. On sites with an average boron content, it is best to apply it in autumn and spring in the quantity of 400g ha^{-1}. In the case of foliar fertilization, it is recommended to apply such ingredients as: manganese, copper, zinc, iron and molybdenum in addition to boron.

PESTS CONTROL

1.12

The adverse impact of weed infestation, diseases and damage by pests on plant development is well-known.

Rapeseed protection, and especially its protection in the regenerative system, involves the simultaneous use of all available and effective methods of pest control, to reduce the presence of pests to the point that they do not pose a threat anymore. Non-chemical methods of pest control should be used in the first place, whereas chemical protection should be used where strictly advisable and in the minimum number of treatments. That is clearly spelled out in the recommendations and requirements for integrated protection, effective in the EU since 2014.

WEED CONTROL

1.13

The degree of weed infestation of the winter rapeseed field depends on the forecrop, the field culture and the tillage method.

The correct sequencing of plants protects the canopy of winter rape against winter weeds and volunteer cereals, and increases the competitiveness of the main crop by having a beneficial effect on its growth and development. Cultivation of rapeseed after non-cereal crops promotes the diversity of weed species. On the other hand, in the case of growing rapeseed after cereals, the weed community becomes less diverse in terms of species, with single species, difficult to eliminate, gaining advantage in terms of numbers (chamomile, clinging weed, grain broom, field poppy and cornflower), which under favourable conditions may be subject to strong compensation. Autumn is the best time to control weeds in rapeseed. In spring, where necessary, it is recommended to perform only corrective treatments as soon as possible after vegetation restarts. Spring weeding is usually more risky, often less effective and definitely less protective for the yield. Reducing weed infestation should be planned throughout the crop rotation. Sulfonylurea herbicides, mainly those with a longer-lasting effect, should be avoided in crop rotations saturated with oilseed rape, especially on heavier and clayey soils. When planning the cultivation technology for winter rape, even before sowing seeds, it is advisable to

carefully select the date and method of herbicide application, taking into account the history of the field, the sowing date, method and technique, and plant density. Herbicides in rapeseed cultivation are most often applied immediately after sowing (soil effect), in foliar application or sequentially. Weeding rape takes place by sequential herbicide treatments with soil and foliar action. The corrective treatment allows for a precise selection of the product against a weed or a group of weeds that remained on the field after the basic (pre-emergence) treatment.

Benefits of sequential weeding:

- ***application of herbicides in doses lower than recommended (higher selectivity and reduced growth inhibition effect),***
- ***possible correction of technical problems with pre-emergence application,***
- ***option to combine weed control products with other products, for example, reducing the population of pests or the intensity of pathogens, or regulating the habit of rosettes before winter.***

The correct sequencing of plants protects the canopy of winter rape against winter weeds and volunteer cereals.

DISEASES CONTROL

1.14

Winter oilseed rape diseases play an important role.

Rapeseed plants are exposed to many diseases, such as blight of seedlings and downy mildew, from the moment they sprout. Later, when the rosette is formed, black spots and stem canker are a big threat. In addition, cylindrosporium, powdery mildew and verticilosis occur on rapeseed, although less frequently. They can be effectively controlled with many recommended, effective fungicides.

The non-chemical methods to control fungal diseases in winter oilseed rape include:

AGROTECHNICAL METHODS:

- ***spatial isolation of crops,***
- ***appropriate rotation taking into account a break in the cultivation of cruciferous plants lasting at least 3-4 years,***
- ***proper cultivation of the soil after the forecrop,***
- ***balanced and timely mineral fertilization,***
- ***timely sowing of healthy and qualified seeds, in the appropriate density per unit area.***

BREEDING METHODS:

- ***selection of varieties tolerant and resistant to some pathogens.***

As regards the control of fungal diseases, it is important to bring together different plant protection methods: agrotechnical, breeding and chemical. Reasonable crop rotation and appropriate selection of the location are the basis for non-chemical pest control on rapeseed plantations. A few years' break in the cultivation of rapeseed and other species of the Brassicaceae family allows to effectively reduce the intensity of the primary pests of rapeseed plants. Soils with a regulated pH limit the occurrence of clubroot. On the other hand, structural soils and those rich in fertilizing ingredients promote quick, even emergence. Uneven and prolonged emergence can be the reason weaker development of plants and their greater susceptibility to diseases. The decision on chemical treatment should be taken only when the agrotechnical and breeding methods prove insufficient, and the limits of economic harm are exceeded.

INSECT PESTS CONTROL

1.15

The effects of damage and the sensitivity of oilseed rape to pests vary at different stages of development.

The biggest threat to winter rapeseed plantations are: ground snails, ground fleas (Phyllotreta ssp), flea beetle (*Psylliodes chrysocephala* L.), stem weevil (*Ceutorhynchus pleurostigma* Marsh.), turnip sawfly (*Athalia rosae* L.), diamondback moth (*Plutella xylostela* L.), cabbage fly *(Delia brassicae* Hoff.), Noctuinae, cabbage aphid (*Brevicoryne brassicae* L), rape stem weevil (*Ceutorhnchus napi* Gyll), cabbage stem weevil (*Ceutorhynchus quadriden* Panz.), common pollen beetle (*Meligethes aeneus* F.), turnip gall weevil (*Ceutorhynchus assimilis* Payk.) and brassica pod midge (*Dasyneura brassicae* Winn.).

A large role in controlling many pest species is played by non-chemical methods, such as:

AGROTECHNICAL METHOD:

- ***spatial isolation from other brassica crops,***
- ***application of appropriate agricultural technology, in particular cultivation treatments that should be carried out carefully and on time,***
- ***use of optimal rotation,***
- ***balanced mineral and foliar fertilization adapted to current needs.***

BREEDING METHOD:

- ***a selection of rapeseed varieties that resume spring vegetation late, adapted to regions with a high risk of the rape stem weevil and cabbage stem weevil. On the other hand, the selection of early rapeseed varieties (vegetation and flowering) is intended to control the common pollen beetle. Late-blooming varieties are recommended if mass appearance of silique pests is expected in the region, such as turnip gall weevil and brassica pod midge.***

BIOLOGICAL METHODS:

- ***the protection of beneficial organisms, including predators and parasites of rape pests, is carried out by protecting biodiversity in the agricultural landscape. An effective role is played by small mid-field ecological zones, consisting mainly of melliferous plants, e.g. borage, lupins, buckwheat, phacelia and others.***

Pests can reduce the yield of winter rape seeds (reaching from 10 to 50% and even 80%). In order to properly protect the plants against pests, it is necessary to constantly monitor the plantation, especially during the period of germination and the development of rosettes, as well as perform intervention insecticidal treatments. The basis for the decision to perform plant protection treatments against pests is monitoring the pest intensity and exceeding the economic harm limits for pests (Table 1).

Insecticides must be used in such a way as to ensure the safety of beneficial insects. Good practices include the use of edge treatments (only on the edges of fields), as this is where the first individuals arrive, which allows reducing the amount of used plant protection products. Spray application should only be performed in the evening, even at stages distant from rapeseed flowering, because bees and other beneficial species may be present in its canopy (on blooming weeds).

Table 1. Limits of economic threat by winter oilseed rape pests

Pest	Observation dateH	arm threshold
Rape stem weevil	early March - late March (BBCH 20–29)	10 beetles in a yellow pot in the next 3 days or 2-4 beetles on 25 plants
Cabbage stem weevil	late March/early April (BBCH 25–39)	20 beetles in a yellow pot in 3 days or 6 beetles on 25 plants
Turnip gall weevil	September - October (BBCH 12–19)	2-3 beetles in a yellow pot in 3 days
Stem weevil	late April/early May (BBCH 60–69)	4 beetles on 25 plants
Turnip sawfly	spring rape: June, July (BBCH 60–69), winter rape: September, October (BBCH 11–19)	1 caterpillar on 1 plant
Cabbage aphid	from the beginning of silique development (BBCH 71–79)	2 colonies per 1m2 on the edge of the field
Flee beetle	September, October (BBCH 12–19)	3 beetles per 1 running meter of row
Ground fleas	after emergence (BBCH 10–15)	1 beetle per 1 meter of row
Brassica pod midge	from the beginning of petal fall (BBCH 65–69)	1 adult insect per 4 plants
Noctuinae	plant emergence (BBCH 9–16)	6-8 caterpillars per 1 m2
Common pollen beetle	compact inflorescence (BBCH 50–52)	1 beetle on a plant
	loose inflorescence (BBCH 53–59)	3–5 beetles per plant
Snails	immediately after sowing and during emergence (BBCH 8–11)	2-3 snails on average per trap, 5% of plants destroyed
	in the 1–4 leaf stage and later (BBCH 11–15)	4 or more snails on average per trap, 10% of plants severely or very severely destroyed
Cabbage fly	September - November (BBCH 15–19)	1 fly in a yellow dish in 3 days
Diamondback moth	September - October (BBCH 12–19)	1 caterpillar on 1 plant

***Methodology of integrated winter and spring rape production**

HARVEST

1.16

Rapeseed remains on the field the longest. In order to harvest the seeds without loss, there are also many requirements to be met during the operation.

Seed collection is a difficult production procedure. That is due to highly varied mechanical properties of silique in the final period of plant maturation. The lability of these features is the result of rapid dehydration of the ripening silique tissues. Rapid dehydration increases the natural tendency of siliques to crack and shed seeds. These losses can range from a few dozen kilograms of seeds per 1 ha to 150-300 kg, or even 300-400 kg. Currently, the dominant harvest of rape is a one-stage harvest, which should start after the plants have reached full maturity (approx. 10-15 days after technical maturity). The optimum harvesting period in the one-step method is only 4-5 days. Mowing the canopy at an earlier date results in a greater amount of unthreshed crops, and thus an increase in seed losses. In addition, seeds obtained from immature plants are a by-product susceptible to self-heating and moulding, and demonstrate inferior process parameters (Tys et al. 2003). The limit moisture content of the seeds that allows a single-stage harvest is 17%. This moisture content ensures low chlorophyll content, good chemical stability of the fat, high mechanical strength of the seed coat and limited susceptibility of the seeds to rapid self-heating. Seeds with a moisture content of 17% can be safely stored on a heap for 1 day, pending drying to the process moisture content of 7%, enabling long-term storage of seeds without deteriorating their useful value.

Currently, the dominant harvest of rape is a one-stage harvest, which should start after the plants have reached full maturity (approx. 10-15 days after technical maturity).

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