CHIEF INSPECTORATE FOR PLANT HEALTH AND SEED INSPECTION

Draft

METHODOLOGY OF INTEGRATED PRODUCTION OF BLUE HONEYSUCKLE (syn. KAMCHATKA BERRY)

Approved

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

by

the Main Inspector of Plant Health and Seed Inspection

Warsaw, November 2024

INTEGRATED PRODUCTION
OFFICIALLY CONTROLLED

Approved by
~~/signed electronically/~~

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INTRODUCTION

Integrated Plant Production (IP) is a state-of-the-art food quality scheme involving sustainable use of technical and biological advances in plant cultivation, protection, and fertilisation that takes particular note of environmental protection and human health. Application of integrated plant protection principles, which have been mandatory for all professional users of plant protection products since 1 January 2014, is an essential component of the system. These principles particularly prioritise the use of non-chemical methods, which should be supplemented by pesticide use when predicted economic losses caused by agrophages shall be greater than the cost of treatments.

Among other things, application of the IP is a guarantee of production of safe and high-quality food (not exceeding permissible residues of harmful substances), less expenditure on production (application of fertilisers based on the actual demand of plants for nutrients, determined in particular on the basis of soil or plant analysis), and the rational use of plant protection products. Moreover, it helps reduce environmental pollution with chemical plant protection products, enhances biodiversity of agrocenoses and raises awareness among consumers and fruit and vegetable producers.

The certification system in integrated plant production is managed by certification entities authorised and supervised by provincial plant health and seed inspection services. The legal provisions on Integrated Plant Production are regulated by the Plant Protection Products Act of 8 March 2013 (consolidated text: Journal of Laws of 2024, item 630), Regulation of the Minister for Agriculture and Rural Development of 24 June 2013 on documenting activities related to integrated plant production (Journal of Laws of 2023, item 2501) and Regulation of the Minister for Agriculture and Rural Development of 24 June 2013 on the qualifications of persons carrying out checks on compliance with the requirements of integrated plant production and the model certificate certifying the use of integrated plant production (Journal of Laws of 2020, item 810 as amended) and the Regulation of the Minister for Agriculture and Rural Development of 8 May 2013 on training in plant protection products (Journal of Laws of 2022, item 824). The prerequisite for the IP certificate is, among other things, managing production in compliance with this methodology, which has been approved by the Main Inspector of Plant Health and Seed Inspection. Methodology of integrated production of blue honeysuckle (syn. Kamchatka berry) *Lonicera caerulea L. var. kamtschatica Sevast* covers all issues related to cultivation, protection, and fertilisation, from soil preparation and planting of bushes, through agrotechnical treatments and protection against pests, to fruit harvesting and storage. It also discusses the hygiene and health principles that need to be complied with during the harvest and preparation of crops produced in the IP system for sale, and the general rules for issuing certificates in integrated plant production.

This methodology has been developed on the basis of the results of own research done by the Institute of Horticulture – NRI in Skierniewice, and the most recent literature data, in compliance with the guidelines of: Directive 2009/128/EC of the European Parliament and of

the Council, International Organisation for Biological and Integrated Control (IOBC), and the International Society for Horticultural Science.

I. PLANNING, ESTABLISHMENT AND MANAGEMENT OF PLANTATION

Tomasz Golis, M.Sc.

1. Characteristics of the species determining the selection of the site for the plantation

Blue honeysuckle is a relatively easy plant to grow. By providing the right conditions for the site and development of plants, positive economic effects can be expected. Growing kamchacka berry bushes is relatively simple, but requires some knowledge and experience. This is determined by important factors regarding its requirements, varieties, and site for cultivation. These include:

- very high frost resistance - bushes can withstand temperatures down to -40°C in winter, and flowers can withstand spring frosts down to -7°C,
- high resistance to diseases and pests - throughout the more than decade-long research on various varieties of blue honeysuckle, no significant symptoms of diseases or damage from pest feeding that could affect fruiting were observed,
- very early flowering and ripening times (at the end of May/beginning of June) – it is one of the first fruits to ripen in the field, even before early strawberries,
- relatively low soil requirements - the blue honeysuckle does not require the best soil classes and soil acidification, like the blueberry, thus avoiding high costs associated with establishing and running plantations,
- selection of new productive and valuable varieties and genotypes – all Polish varieties and genotypes are characterised by high resistance to diseases, frost resistance, low tendency of ripening fruits to fall off before harvesting, as well as their suitability for mechanical harvesting, which reduces labour costs,
- early entry into the fruiting period – the first fruits on bushes grown from healthy, woody seedlings can be obtained as early as the second year after planting; however, full yielding of plants can be achieved after 5-7 years of growth,
- longevity of bushes on the plantation – with good agricultural practices, 20 years and above.

2. Site selection and soil preparation

Blue honeysuckle is a plant with relatively low soil requirements. Shrubs grow best and bear fruit in sunny places, on sandy-clay soils that are fertile, slightly acidic, fairly moist, but not waterlogged. Blue honeysuckle thrives on sandy soils, clay loams, and slightly acidic peat soils. The site before planting shrubs should be free of weeds, especially perennials, e.g. couch grass, to ensure optimal development conditions for young plants. A very good preceding crop for berry includes root, leguminous, and cereal plants, maintained in good soil condition. If the plantation is established after fallow land that has not been cultivated for several years, the preparation of the field should start 1–2 years earlier. At such sites, the

dangerous pests of the blue honeysuckle include species that damage the roots - grubs and weevils. After fallow land, careful soil cultivation is required, as well as deep ploughing before winter, and several harrowings or discings to limit the number of grubs. On soils that are too wet, drainage will be necessary. On drier and sandy soils, where there may be periodic water shortages, it is worth installing drip irrigation. Organic fertilisation using manure or green fertiliser is highly beneficial before planting. Shrubs respond positively to organic fertilisation, grow better and bear fruit, especially on soils poor in humus.

3. Forecrops and crop rotation

If manure is not used before planting bushes, it is recommended to grow plants for green fertiliser in the spring of the year preceding the establishment of the plantation. The most valuable green fertiliser is obtained from of a mix of legumes: lupin, field pea, vetch, broad beans, with the addition of cereals, phacelia, sunflower and maize. These plants form a large green mass, clearing the soil of weeds. They are a source of humus and improve the soil structure. When plants for green fertiliser reach the flowering phase, they must be cut and incorporated. Blue honeysuckle should not be planted after perennial leguminous plants, because there is a danger of the development of diseases and pests, such as weevil larvae after alfalfa. Per hectare, it is necessary to sow 150 to 200 kg of seeds of legumes and approximately 50 kg of nitrogen in its pure form. A valuable green fertiliser is mustard, which should be sown at 30 kg/ha of seeds. Mustard is sown as early as possible in the spring, adding 100 kg of urea before sowing or strengthening the plants with 100 kg of ammonium nitrate after their emergence. Mustard flowers early, at the end of June or beginning of July. It is cut with a forage shredder or an orchard mower and immediately shallowly incorporated, and then mustard is re-sown with fertilisers, as in spring. The second harvest of mustard green mass is incorporated in autumn (IX/X). In this way, it is possible to incorporate large amounts of organic matter into the soil. Incorporated mustard reduces the occurrence of harmful nematodes and rodents. A good method of counteracting soil fatigue is to activate its biological potential by introducing a large amount of organic matter and enriching it with effective microorganisms. The simplest solution is to apply a large dose of manure, peat, or compost and carry out ploughing (25-30 cm). Manure can be replaced with green fertiliser. In order to reduce the occurrence of certain nematode species in the soil, the cultivation of tagetes is recommended. In spring, 5 to 10 kg/ha of seeds of this annual plant are sown. In autumn, plants should be shredded and ploughed in. To reduce the occurrence of grubs in the soil, buckwheat can be sown, which is shredded and incorporated after flowering.

4. Variety as a factor supporting integrated cultivation

The right choice of blue honeysuckle variety largely determines the effectiveness of integrated cultivation, bush yield and fruit quality, and thus the economic viability of cultivation. The choice of variety is also determined by the size of the plantation and the planned use of the fruit (dessert, processing). On small plantations with dessert varieties, the

berries are harvested by hand. On large commodity plantations, which have been established in recent years, modified currant harvesters are successfully used to harvest fruit. Appropriate varieties must be selected for harvesting with the harvester, which do not tend to drop their fruit before harvesting and ripen fairly evenly. The necessary information about the varieties that can be grown in IP can be found in articles and publications that are the result of many years of research carried out at the Institute of Horticulture - NRI (available in the list of literature). Varieties of the Polish selection of blue honeysuckle are distinguished by a much better and higher yield and better quality of fruit than Russian varieties. The distinguishing feature of Polish varieties is the fairly even ripening of fruits and the lack of tendency to drop fruit, which allows them to remain on the bushes, without major losses in yield. An additional advantage is their adaptation to our conditions. Descriptions of valuable and proven varieties of blue honeysuckle under Polish conditions are provided below.

'Wojtek'. It is one of the first valuable varieties of Polish selection that went into cultivation. The bush has a spherical habit, grows moderately vigorously, reaches a height of 160 cm and a width of up to 140 cm. The fruits are large, elongated, slightly tapered at the ends, uniformly navy blue, with a waxy, light bloom; when ripe, they are sweet and tasty (13 to 15 Bx). The average weight of the fruit reaches 1.2-1.6 grams, with a length of up to 28 mm and a diameter of 11 mm. The fruits typically ripen in the second decade of June, but they can remain on the bush for up to 2 weeks without falling off, gaining in taste. The variety is fertile - on fertile soil, 2.5 to 5 kg of fruit is harvested from a 7-year-old bush. Suitable for mechanical harvesting. The varieties for cross-pollination are 'Zojka' and 'Indigo Gem'.

Genotype No 44 ('Julia'). The bush of the Polish selection grows moderately strong, has a spherical habit, and reaches a height of 170 cm and a width of 140 cm. The fruits are attractive, large, and mace-like, tapering from the peduncle side. The colour of the skin is uniformly navy blue, with a waxy, light coating. Aromatic, sweet and tart berries (13 to 16 Bx). Average weight of the fruit is 1.4-1.7 grams, length up to 30 mm, diameter 11 mm. Fertile variety with a yield of 3 to 5 kg per bush. It ripens, as a rule, in mid-June, but the berries can be kept on the bush for up to 2 weeks to accumulate more sugar. Suitable for mechanical harvesting. The cross-pollination varieties are 'Vostorg' and 'Indigo Gem'.

Genotype No 30 ('Michał'). The bush of Polish selection grows poorly and tends to thicken. Plant height up to 100 cm, leaves dark green, blades relatively wide. Fruits are large, attractive, and oval with a stem up to 5 mm. The rind is navy-blue with a waxy bright bloom. The berries are the largest and sweetest of the described Polish varieties (15 to 17 Bx). They can be eaten as tasty dessert fruits and are suitable for preserves. Average weight of the fruit is 1.9-2.3 grams, length up to 25 mm, diameter 16 mm. Medium-yielding variety with a yield of 2 to 3 kg per bush. The fruits ripen the latest among the assessed Polish varieties in the experiment, generally at the end of June, but the berries can be kept on the bush until mid-July. Valuable dessert variety with excellent taste for manual harvesting. Thanks to the late ripening of berries of this variety, you can extend the harvest of fresh fruits of this species. The varieties for cross-pollination are 'Wojtek' and 'Jolanta'.

‘Aurora’. It is a Canadian variety, derived from the Russian Solovey variety and the Japanese MT46.55 variety. It was made available to manufacturers in 2012. The bush is vigorously growing, with a compact, upright habit and stiff, straight shoots. It reaches a height of 160-180 cm and a width of up to 120 cm. Fruits are elongated, cylindrical, sometimes pear-shaped, sweet (14 to 16 Bx), easy to harvest. They are suitable for consumption as dessert and for processing. As a rule, they mature at the end of June and do not tend to drop fruit. The average weight of the fruit reaches 1.8 g, with a length of up to 30 mm and a diameter of 12 mm. The fruits ripen unevenly, and the harvesting of some of them may extend until mid-July. The variety is fertile - from one fully fruiting bush, 3-5 kg of fruit can be harvested. The cross-pollination varieties are ‘Borealis’ and ‘Indigo Gem’.

‘Indigo Gem’. The variety was bred in Canada. ‘Indigo Gem’ fruits ripen the earliest among the Canadian varieties assessed, usually in the first decade of June. The bush has a spherical habit, grows moderately vigorously, reaches a height of 150 cm and a width of 120 cm. It is medium compact, with stiff shoots. The fruits are oval, medium-sized, slightly tapered at the ends, uniformly navy blue, with a waxy, light coating, ripe, sweet, and very tasty (16 to 18 Bx). Fruits do not tend to drop and are perfectly suitable for direct consumption, as well as for processing. The average weight of the fruit is 1.4 g, the length is up to 22 mm, and the diameter is 13 mm. They ripen evenly, and the harvest can be done at one time. They are suitable for mechanical harvesting. The variety is fertile - from one bush in full fruiting, 2.5 - 4 kg of fruit can be harvested. The cross-pollination varieties are ‘Aurora’ and ‘Honeybee’.

‘Vostorg’. It is a variety bred in Russia. The bush is characterised by an average growth force, is medium-branched, with an upright habit and rigid, straight skeletal shoots. It reaches a height of up to 170 cm and a diameter of up to 150 cm. The fruits are elongated, spindle-shaped, blue-violet with a waxy coating, sweet and tasty (14 to 15 Bx), easy to harvest. The skin is strong, and the berries are firm, which allows them to withstand transport well. As a rule, they ripen evenly in mid-June and do not tend to fall. They are suitable for mechanical harvesting. The average weight of the fruit is 1.6-2 g, with a length of up to 34 mm and a diameter of 11 mm. The variety is medium-yielding; from one fully fruiting bush, 2.5-3.5 kg of fruit can be harvested. Recommended cross-pollination varieties are ‘Docz Velikana’ and ‘Bakczarskij Velikan’.

5. Planting shrubs and care after planting

An essential element of the integrated blue honeysuckle production system is the establishment of plantations from proven, high-quality nursery material, which guarantees its health from the beginning of cultivation. In Poland, blue honeysuckle bushes are produced and sold mainly in containers or rooted in a nursery with bare roots. Only healthy, good quality material with a proven varietal identity should be used for planting. Plants should be purchased from a reliable source, with a plant passport, which should be kept in case of a complaint. Plants should be propagated vegetatively, not from seeds, since shrubs obtained from seeds do not replicate the characteristics of the mother plants and bear poor fruit. Blue honeysuckle is easily propagated by herbaceous cuttings, woody cuttings, or by

layering. For the establishment of the plantation, the best are woody seedlings, 30-50 cm high, with two, and preferably 3-4 shoots with a well-developed root system. Seedlings growing in pots can be planted on the plantation throughout the growing season; however, the optimal planting period is from spring to the beginning of summer. In autumn, only well-wooded seedlings, at least two years old, can be planted, because in the event of mild winters, the seedlings may become de-acclimatised, resulting in significant losses of poorly-wooded plants. It is best to plant at least 2-3 different varieties blooming at a similar time, because cross-pollination of bushes is a guarantee of their good yield. On the plantation, it is recommended to designate the rows in a north-south direction, which ensures uniform illumination of the bushes and better ripening of the fruit. The spacing at which the bushes will be planted depends on the machines and tools that will be used during soil and plant care and on the type of soil on which the plantation will be established. The spacing when planting bushes also depends on the size of the plantation and the method of harvesting the fruit. On small backyard plantations, where manual harvesting is planned, plants can be planted in a spacing of 1.0-1.5 m in a row and 2.5-3.0 m between rows. On larger plantations, where harvesting with a combine harvester is planned, a spacing of 0.7 m in a row and 4.0-4.2 m between the rows is recommended. Seedlings from pots should be planted 4-5 cm deeper than they grew in containers. Especially important is the deeper planting of plants on freshly prepared soil. After planting, the soil around the plants should be well compacted to facilitate faster root growth beyond the volume of the root ball. On small plantations, plants can be planted by hand in pre-prepared furrows. For larger plantings, orchard planters can be used. In the first years after planting, mechanical destruction of weeds is recommended, and from the 2nd to 3rd year, the inter-rows can be sodded and grass mechanically mowed. In rows of plants, crop cover, deacidified peat, or wood chips can be used to reduce weed growth around the plants. For older plants, herbicides can be used in accordance with the recommendations of the plant protection program.

6. Arrangement of the plantation surroundings

It is not recommended to establish a blue honeysuckle plantation near orchards that are intensively protected, due to the risk of drift of the spray liquid during the use of pesticides for tree protection. The fruit of the blue honeysuckle ripen in June, when the orchards are still intensively protected. During this time, there is a high risk of their contamination with residues of chemical plant protection products, which may drift from neighbouring orchards. The proximity of cherry orchards is also not advisable due to the threat from birds (starlings, fieldfares), which willingly eat berries before the cherries begin to ripen. Young plantations, especially those established near forests and wooded areas, should be fenced, for example, with mesh used in forestry, to protect the plants from hares and roe deer, which can damage young shrubs. In order to protect the blue honeysuckle plantation from other crops and in areas exposed to strong winds, a line of intensively growing thuja, e.g. the ‘Brabant’ variety, or spruces forming a high hedge, can be planted from the west and north-west. Such

a natural cover can be established by planting cover plants along the plantation border. Also, do not destroy the natural thickets around the plantation. Trees and shrubs between plantations are a refuge for beneficial insects, which limit the occurrence of many species of pests. The scrub around the plantation also creates a favourable environment for pollinators, mainly bumblebees. Only a diverse environment can ensure biological balance and reduce the need for chemical plant protection. When constructing plantation fences, it is also necessary to provide shelters for small predators such as martens and weasels, which help in controlling the population of field mice and voles. Such predators find shelter in shrubberies and rubble. Thus, such features should be kept when fencing the plantation.

7. Protection against birds

Birds, especially starlings and fieldfares, can cause significant losses on blue honeysuckle plantations locally and in dry summers, particularly when they are situated near cherry orchards. These birds prefer small, fully ripe berries with dark-coloured skin. The most effective methods of protection against birds are covering the bushes with netting or a light shade. The mesh can be unfolded on the support structure, but it can easily be unfolded on the bushes themselves before the fruit ripens. It can also be effective to frighten birds using acoustic deterrent devices, emitting the sounds of birds of prey or the sounds of a frightened starling/ fieldfare. Gas cannons and various types of repellent kites – imitating birds of prey – can also be used.

II. FERTILISATION AND LIMING

Dr Paweł Wójcik, associate professor at the Institute of Horticulture – National Research Institute

The fertilisation strategy for fruit plants is based on their visual evaluation and the results of soil and leaf analysis. Soil analysis is obligatory in integrated fruit production.

1. Soil analysis and its significance in fertilisation strategy

1.1. Soil sampling and chemical analysis

Soil samples should be taken separately from sites with different topographies (upper, middle, and lower part of the elevation). In addition, if the bushes of the blue honeysuckle are to be planted in a location previously occupied by a grubbed-up orchard or plantation, it is advisable to take soil samples separately from the former herbicide strips and from under the turf. On an existing plantation, soil samples are taken only from herbicide strips/mechanical fallow along the plant rows. Where the plants are irrigated with a drip system, samples should be taken from about 20 cm from an emitter.

Soil samples are taken at least one year before planting the bushes, and on the existing plantation at least once every 3-4 years (on light soils once every 3 years, and on heavier soils every 4 years).

Before planting, soil samples are taken from two soil levels (0-20 cm and 21-40 cm), and in the case of an existing plantation, only from the surface layer of the soil (0-20 cm). It is best to collect them with Egner's stick or a drill. In the absence of these tools, a spade can be used. When taking soil samples with a shovel, cut soil patches of comparable depth and width. This is very important because a mixed sample (from a uniform plot) should consist of 20-25 individual samples. After thorough mixing of the individual samples in the bucket, about 1 kg of soil (so-called representative sample) is taken, dried in a shady place, placed in a canvas bag or cardboard box, and then delivered to the agrochemical laboratory. A basic soil analysis involves checking its pH and the content of assimilable phosphorus (P), potassium (K), and magnesium (Mg). It is also justified to assess the organic matter content and the granulometric composition of the soil.

1.2. P, K and Mg Fertilisation

Fertilisation with phosphorus, potassium and magnesium is based on a comparison of the results of soil analysis with the so-called limit numbers of the content of these elements (table 1-3). On the basis of the classification of the element content into a given abundance class (low, medium or high), a decision is made on the desirability of fertilising and the dose of the element.

Table 1. Soil fertilisation with phosphorus (P) before the establishment of the blue honeysuckle plantation and during its cultivation depending on the bioavailability of P in the soil* (Wójcik and Kowalczyk, 2021)

P abundance of the humus layer		
low	optimal	high
P content (mg kg^{-1})		
<40	40-80	>80
Phosphorus fertilisation before plantation establishment [kg P_2O_5 ha^{-1}][a]		
100-150[b]	50-100[b]	0-50[b]
Phosphorus fertilisation on the plantation [g P_2O_5 m^{-2}][c]		
5-10	0	0

* Assimilability of P in soil determined by the Egner-Riehm method.

[a] Phosphorus dose applied onto the fertilised surface.

[b] Apply decreased or increased phosphorus doses by 20 % when its content in the layer below the humus level is > 40 mg P kg^{-1} and < 20 mg P kg^{-1}, respectively.

[c] Use fertilisers containing polyphosphates without mixing with soil.

Table 2. Soil fertilisation with potassium (K) before the establishment of the blue honeysuckle plantation and during its cultivation depending on the bioavailability of K in the soil* and granulometric composition (Wójcik and Kowalczyk, 2021)

Share of soil particles	**Abundance of K in the humus layer**

with a size of < 0.02 mm [%] in the earth part	low	optimal	high
<20	K content (mg kg^{-1})		
	<50	50-80	> 80
	Potassium fertilisation before plantation establishment [kg K_2O ha^{-1}][a]		
	150-200[b]	100-150[b]	-
	Potassium fertilisation on the plantation [g K_2O m^{-2}]		
	6-8	4-6	-
20-35	K content (mg kg^{-1})		
	< 80	80-130	>130
	Potassium fertilisation before plantation establishment [kg K_2O ha^{-1}][a]		
	200-250 [c]	150-200 [c]	-
	Potassium fertilisation on the plantation [g K_2O m^{-2}]		
	8-10	6-8	-
>35	K content (mg kg^{-1})		
	< 130	130-210	> 210
	Potassium fertilisation before plantation establishment [kg K_2O ha^{-1}][a]		
	250-300[d]	200-250[d]	-
	Potassium fertilisation on the plantation [g K_2O m^{-2}]		
	10-12	8-10	-

[*] Assimilation of K in soil determined by the Egner-Riehm method.

[a] Potassium dose applied onto the fertilised surface.

[b] Use potassium doses reduced or increased by 20 % when their content in the layer immediately below the humus level is >50 mg K kg^{-1} d.m. and <30 mg K kg^{-1}d.m.

[c] Use potassium doses reduced or increased by 20 % when their content in the layer immediately below the humus level is >80 mg K kg^{-1} d.m. and <50 mg K kg^{-1}d.m.

[d] Use potassium doses reduced or increased by 20 % when its content in the layer immediately below the humus level is >130 mg K kg^{-1} DW and <80 mg K kg^{-1}DW.

Table 3. Magnesium soil fertilisation (Mg) before and during the establishment of the blue honeysuckle plantation depending on the absorption of Mg in the soil[*] and granulometric composition (Wójcik and Kowalczyk, 2021)

Share of soil particles with a size of <0.02 mm (%) in the earth part	Abundance of Mg in the humus layer		
	low	optimal	high
<20	Mg content (mg kg^{-1})		
	<30	30-50	>50
	Magnesium fertilisation before plantation establishment (kg MgO ha^{-1})[a,b]		
	80-100[c]	60-80[c]	-
	Magnesium fertilisation on plantation [g MgO m^{-2}]		
	6-8	3-6	-
≥20	Mg content (mg kg^{-1})		

	<50	50-70	>70
	Magnesium fertilisation before plantation [kg MgO ha^{-1}][a,b]		
	100-120[d]	80-100[d]	-
	Magnesium fertilisation on the plantation ($g\ MgO\ m^{-2}$)		
	8-10	6-8	-

[*] Assimilability of Mg in soil determined by the Schachtschabel method.

[a] Magnesium dose applied to the fertilised area.

[b] If the pH of the humus layer is below the optimal value for the blue honeysuckle, magnesium lime should be applied at the dose required for liming.

[c] Magnesium doses reduced or increased by 20 % shall be applied when its content in the layer immediately below the humus level is >50 mg of Mg kg^{-1} DM and <35 mg Mg kg^{-1}DM, respectively.

[d] Magnesium doses reduced or increased by 20 % shall be applied when its content in the layer immediately below the humus level is >70 mg of Mg kg^{-1} DM and <50 mg Mg kg^{-1}DM, respectively.

1.3. Fertilisation with nitrogen (N)

Fertilisation needs of the blue honeysuckle in relation to N can be estimated based on the content of organic matter in the soil (table 4). They should be adjusted to the plants' growth vigour and/or the N content in leaves.

Table 4. Indicative nitrogen (N) doses for blue honeysuckle plantations depending on the organic matter content in the soil* (according to Wójcik and Filipczak, 2023)

Age of the plantation	**Organic matter content (%)**		
	0.5–1.5	**1.6–2.5**	**2.6–3.5**
	N dose		
First two years	5–6**	4–5**	-
Subsequent years	40–60***	20–40***	-

* N doses refer to plantings in which mechanical/herbicidal fallow is maintained along rows of bushes

** N doses in g/m^{-2} of fertilised area

*** N doses in kg ha^{-1} of fertilised area

1.4. Liming

Evaluation of liming needs and the calcium dose depend on soil pH and soil texture, as well as the period of liming (tables 5-9).

Table 5. Recommended dose of fertiliser lime before establishing a blue honeysuckle plantation on very light soils (< 10 % of 0.02 mm fraction) depending on the initial pH (according to Jadczyszyn, 2021)

pH_w of soil	**Recommended dose*(CaO t ha^{-1})**

5.0	0.2
4.9	0.5
4.8	0.8
4.7	1.0
4.6	1.3
4.5	1.6
4.4	1.8
4.3	2.0
4.2	2.2
4.1	2.4
4.0	2.8
3.9	3.1
3.8	3.4

Table 6. Recommended doses of lime fertiliser before establishing a blue honeysuckle plantation on light soils (11-20 % of 0.02 mm fraction) depending on the initial pH (according to Jadczyszyn, 2021)

pH_w of soil	**Recommended**	**Dose distribution**	
	Total dose (CaO t ha^{-1})	**Dose I (CaO t ha^{-1})**	**Dose II* (CaO t ha^{-1})**
5.5	0.2	0.2	-
5.4	0.5	0.5	-
5.3	0.9	0.9	-
5.2	1.2	1.2	-
5.1	1.5	1.5	-
5.0	1.8	1.8	-
4.9	2.1	2.1	-
4.8	2.3	2.3	-
4.7	2.6	2.6	-
4.6	2.9	2.9	-
4.5	3.1	3.1	-
4.4	3.4	3.4	-
4.3	4.5	3.5	1.0
4.2	4.7	3.5	1.2
4.1	5.5	3.5	2.0
4.0	5.9	3.5	2.4
3.9	6.3	3.5	2.8
3.8	6.5	3.5	3.0

*Dose II should be administered 2-4 years after Dose I.

Table 7. Recommended doses of fertiliser lime before the establishment of the blue honeysuckle plantation on medium soils (< 21-35 % of 0.02 mm fraction) depending on the initial pH (according to Jadczyszyn, 2021)

pH_w of soil	Recommended	Dose distribution	
	Total dose (CaO t ha^{-1})	Dose I (CaO t ha^{-1})	Dose II* (CaO t ha^{-1})
6.0	0.4	0.4	-
5.9	0.8	0.8	-
5.8	1.2	1.2	-
5.7	1.6	1.6	-
5.6	2.0	2.0	-
5.5	2.4	2.4	-
5.4	2.8	2.8	-
5.3	3.2	3.2	-
5.2	3.6	3.6	-
5.1	3.9	3.9	-
5.0	4.2	4.2	-
4.9	4.4	4.4	-
4.8	4.8	4.8	-
4.7	5.0	5.0	-
4.6	5.4	5.0	0.4
4.5	5.8	5.0	0.8
4.4	6.2	5.0	1.2
4.3	6.4	5.0	1.4
4.2	6.6	5.0	1.6
4.1	7.0	5.0	2.0
4.0	7.4	5.0	2.4
3.9	7.8	5.0	2.8

*Dose II should be administered 2-4 years after Dose I.

Table 8. Recommended fertilising lime doses before establishing a blue honeysuckle plantation on heavy soils (> 35 % of 0.02 mm fraction) depending on the baseline pH (Jadczyszyn, 2021)

pH_w of soil	Recommended	Dose distribution	
	Total dose (CaO t ha^{-1})	Dose I (CaO t ha^{-1})	Dose II* (CaO t ha^{-1})
6.3	0.2	0.2	-
6.2	0.2	0.2	-
6.1	0.5	0.5	-
6.0	0.8	0.8	-
5.9	1.0	1.0	-
5.8	1.5	1.5	-
5.7	2.0	2.0	-
5.6	2.5	2.5	-
5.5	3.0	3.0	-
5.4	3.5	3.5	-
5.3	3.8	3.8	-

5.2	4.1	4.1	-
5.1	4.5	4.5	-
5.0	4.8	4.8	-
4.9	5.1	5.1	-
4.8	5.4	5.4	-
4.7	5.7	5.7	-
4.6	5.8	5.8	-
4.5	6.0	6.0	-
4.4	7.0	6.0	-
4.3	7.5	6.0	1.5
4.2	8.0	6.0	2.0
4.1	9.0	6.0	3.0
4.0	9.8	6.0	3.8
3.9	10.8	6.0	4.8

*Dose II should be administered 2-4 years after Dose I.

Table 9. Single doses of lime used in the blue honeysuckle plantation (according to Wójcik and Kowalczyk, 2021)

Soil pH	**Agronomic category of the soil**		
	light	**medium**	**heavy**
	Dose [kg CaO 100 m^{-2}][a,b]		
<4.5	17	20	30
4.5-5.5	10	15	20
5.6-6.0	5	8	15
6.1-6.5	-	5	10
6.6-7.0	-	-	5

[a] Recommended lime doses on a 3-4 year cycle.

[b] Use lime only on the herbicide/mechanical fallow strips along the rows of plants.

2. Chemical analysis of leaves and its role in the fertilisation strategy

2.1. Leaf sampling and preparation of leaf samples for analysis

Leaves for analysis are taken only from bushes that have entered the period of full fruiting. The 2-3 youngest, fully grown leaves with petioles, derived from annual growths, are taken when about half of the fruits reach harvest maturity.

Considering the high variability of plant nutrition between growing seasons, leafs are best sampled in two consecutive years in 4-year-long cycles.

Collected leaves are placed in paper bags. The leaves should be dried as soon as possible (preferably on the same day) at a temperature of 60-70°C. If it is not possible to dry them on the spot, the leaf sample can be kept for 1-2 days in a refrigerator, and then delivered to an agrochemical laboratory.

2.2. Fertilisation based on leaf analysis

The use of leaf analysis results for fertilising the blue honeysuckle plantation involves comparing the content of the element in the sample with the so-called limit numbers (table 10).

Table 10. Provisional limit values for macronutrient content in blue honeysuckle leaves and recommended doses of elements on the plantation (according to Iheshiulo et al., 2019, modified by Wójcik and Filipczak, 2023)

Element in leaves / recommended doses of element	**Content of element in leaves**			
	deficit	**low**	**optimal**	**high**
N (%)	< 1.70	1.70–2.22	2.23–2.96	> 2.96
N (kg ha^{-1})	60–80	40–60	20–40	0
P (%)	< 0.12	0.12–0.21	0.22–0.28	> 0.28
P_2O_5 (kg ha^{-1})	100	50	0	0
K (%)	< 0.60	0.60–0.83	0.84–1.32	>1.32
K_2O kg ha^{-1})	80-100	60–80	40–60	0
Mg (%)	< 0.08	0.08–0.13	0.14–0.50	> 0.50
MgO (kg ha^{-1})	60	30	0	0

3. Visual method for assessing the nutritional status of plants

In this method, the following aspects are taken into account: growth vigour, leaf appearance, flowering and fruit formation intensity, and fruit quality. The most important symptoms of particular element deficiencies are listed in Table 11.

Table 11. Symptoms of mineral deficiency in blue honeysuckle bushes

Component	**Symptoms**
Nitrogen	The first symptoms of deficiency are visible on older leaves. The leaf blades turn light green and then yellow. The shoots are thin and short.
Phosphorus	Leaf blades turn purple or burgundy. The shoots are thick and short.
Potassium	The first symptoms of deficiency appear on older leaves in the form of chlorosis/necrosis on their edges, which then spreads between the main nerves of the leaf. The necrotised edges of the leaf blade curl up. The leaves hang on the shoots for a long time. The fruit are small.
Magnesium	The first symptoms of deficiency are visible on older leaves. Between the main nerves, chlorotic spots are formed on the leaves, which later turn necrotic. The affected leaves fall during the summer.

Calcium	The symptoms appear on the youngest leaves in the form of chlorotic discolourations. The leaves are wrinkly and the leaf blade edges are frayed.
Boron	Fruit setting is weak. The fruit are small. In case of a severe deficiency, the top leaves are chlorotic, narrow, brittle, and necroses appear on their edges.
Iron	The first symptoms appear on the youngest leaves as interveinal chloroses while the main nerves remain green. In case of a severe deficiency, the shoot tips, or even the whole shoots, die back.
Manganese	The first symptoms of deficiency appear on the leaves in the middle section of shoots in the form of chlorotic spots between the main nerves.
Zinc	The so-called 'rosetting of leaves' takes place. The top leaves are small and narrow, growing close to each other. In cases of a severe deficiency the shoot tips die back.

4. Fertilisation and liming before establishing the plantation

4.1. Organic fertilisation

The use of natural and organic fertilisers/soil improvers before planting shrubs generally improves their growth and yield. The positive effect of natural and organic fertilisers in the first years of plant growth is the result of both the supply of minerals to plants and the improvement of the physical, chemical and biological properties of the soil.

Manure is especially valuable. Its annual dose may not exceed 170 kg N per ha. Manure must not be applied to soil flooded with water, covered with snow or frozen to a depth of 30 cm. The time for the application of manure depends on the period of establishing the plantation and the agronomic category of the soil. On light soil, it should not be used in the autumn. When planning the planting of bushes in the fall, manure is best applied under the preceding crop. For the establishment of plantations in spring on light soil, well-fermented manure can be used about 2 weeks before planting bushes.

So-called green manure, i.e. crops that are supposed to be ploughed into the soil, constitute an alternative to manure. The fertilising value of these plants depend on the amount of biomass produced and its mineral content. Fabaceae plants (legumes and small-seed plants) have a high fertilising value. In order to lower the costs of growing plants intended to be ploughed and to obtain a significant amount of organic mass, it is recommended to sow a mix of Fabaceae and other plants. The most valuable green manures are obtained from mixtures of leguminous and cereal plants. The species of plants included in the mixture should have similar soil requirements. On light and medium soils, the following mixtures may be used: yellow lupin (140 kg/ha) and bird's-foot (25 kg/ha); yellow lupin (120 kg/ha) with field pea (80 kg/ha) and bird's-foot (20 kg/ha), or yellow lupin (120 kg/ha) with field pea (60 kg/ha) and mustard (60 kg/ha) or field pea (150 kg/ha) with sunflower (15 kg/ha). On heavy soils, an example of a suitable mixture is spring vetch (120 kg/ha) with horse bean (50 kg/ha), or field pea (120 kg/ha) with horse bean (50 kg/ha). Depending on the soil and climatic conditions, the mixture composition and the proportions of the components may be different than that given above.

The plants cultivated for green manure should be fed with mineral fertilisers. For legumes (except peas and field bean), the fertilising needs in relation to N are between 10 and 20 kg per hectare. For other plants intended for green manure, the doses of N vary from 50 to 100 kg per hectare. The indicative doses of P and K are 30-50 kg P and 50-100 kg K per ha.

4.2. Mineral fertilisation and liming

Before planting bushes, it may be necessary to use fertilisers/soil conditioners containing phosphorus and potassium. The need to fertilise P and K and their dose is determined by their content in the soil (tables 1, 2).

Phosphorous fertilisers can be used both before and after planting the bushes. It is recommended that potassium-based fertilisers be used immediately before planting. Applying K fertilisers under forecrops is only justified if high doses of K are used in the form of potassium chloride (potassium salt). Phosphorous and potassium-based fertilisers must be mixed with the soil to a depth of approximately 20 cm.

Liming requirements depend on the current pH of the soil and its agronomic category (Tables 5-8). It is preferable to apply lime one year before establishing the plantation. Execution of this procedure too late makes it impossible to increase the soil pH to the required value (for blue honeysuckle pH 5.9-6.5 according to Tremblay et al., 2019). When it is necessary to increase both the soil reaction and the magnesium content, fertiliser lime containing magnesium in the dose resulting from the liming needs should be used.

On light soils, it is recommended to use lime in carbonate form, and on medium and heavy soils in oxide form (caustic lime) or hydroxide form (slaked lime).

5. Fertilisers in the first two years

If fertilisation was done correctly before planting the bushes, then in the first two years of running the plantation, mineral fertilisation is limited to only N. Depending on the content of organic matter in the soil, the recommended N doses for the blue honeysuckle are 4-6 g per m^2 (table 4). These doses apply to plantations in which mechanical fallow is carried out over the entire area or in strips along the bush rows. Where turf is kept on the entire area of a plantation or when a lot of weeds exist around the bushes, the doses of N should be increased by about 50%.

During the first year, nitrogen fertilisers should be applied twice. The first dose of nitrogen, which accounts for approx. 30 % of the required amount, should be applied early in the spring and the remaining part (70 %) at the end of June. In the second year, it is also necessary to split the annual N dose in two. The first dose of N, amounting to about 50–70 % of fertilisation needs, is applied early in spring, and the rest (30–50 %) is applied at the end of June.

In the first year after planting the bushes, nitrogen fertilisers are spread along the rows of plants in strips with a width of 0.5-1.0 m, and in the second year in strips with a width of 1.0-1.5 m.

6. Fertilisation and liming on fruiting plantations

6.1. Nitrogen fertilisation

The fertiliser requirements of the blue honeysuckle in relation to N are not high and can be determined, among others, on the basis of the content of organic matter in the soil (table 4). The N doses given in the table refer to plantations where herbicide/mechanical fallow is maintained along rows of bushes and are indicative; therefore, they should be verified with plant growth force and/or N content in leaves (table 10).

Nitrogen fertilisers are spread in strips along rows of bushes. They can be used once or twice a season. When using N in divided doses, half of the annual dose is applied in early spring, and the second part immediately after flowering.

6.2. Fertilisation with phosphorus, potassium and magnesium

Fertilisation with these elements is based on a comparison of the results of soil analysis with threshold values (tables 1-3). On the basis of the classification of the element into the appropriate soil richness class, the desirability of fertilising the element and the amount of its dose are determined. Failure to fertilise with a given element or the use of excessive doses of it leads to an ionic imbalance in the plant, which reduces not only the yield of plants and the quality of fruits, but also increases the plant's susceptibility to pests and pathogens.

Phosphorus, potassium, and magnesium fertilisers are best spread in early spring or autumn on the surface of herbicide/mechanical fallow along the rows of bushes.

6.3. Micronutrient fertilisation

In the soil and climatic conditions of Poland, symptoms of micronutrient deficiency on blue honeysuckle plantations occur sporadically. The advisability of feeding the blue honeysuckle with micronutrients is determined by the visual evaluation of plants, including leaves (table 11). If there are symptoms of boron (B), iron (Fe), manganese (Mn), or zinc (Zn) deficiency on the blue honeysuckle plantation, fertilising with the given element shall be justified. When micronutrient fertilisers are applied to the soil, the recommended doses on plantations are: 1-3 kg B/ha, 20-30 kg Fe/ha, 10-15 kg Mn/ha and 5-10 kg Zn/ha. In the case of foliar feeding of blue honeysuckle with micronutrients, the fertiliser dose should be in accordance with the instructions for use.

6.4. Fertigation

Fertigation is a fertilisation method consists in feeding plants with components through an irrigation system. In this fertilising method only water-soluble products are used. The doses of substances used for fertigation are several times lower than those recommended in the conventional use of fertilisers. Fertigation of the blue honeysuckle is carried out from the first days of May to mid-August, with a frequency of every 5-7 days. The best production effects are obtained with the combined use of fertigation with traditional fertilisation (however, at reduced doses of the elements).

6.5. Foliar feeding

Foliar feeding should be treated as a complement to soil fertilisation. This type of feeding is applied when a plant is not able to absorb and/or transport a sufficient quantity of an element to its organs/tissues when this particular element is the most needed. It is possible to feed plants with certain nutrients (mainly N) by means of foliar application in order to strengthen their flower buds in the autumn.

6.6. Liming

If at the time of planting bushes, the soil pH was suitable for the blue honeysuckle (5.9-6.5), then liming should be done after another 3-4 years. Doses of lime depend on the agronomic category of the soil and its current pH (table 9). With periodic liming of the plantation, plants are exposed to fluctuations in soil pH, which can weaken their growth and yield. For this reason, it is better to maintain the soil pH at an optimum level throughout the lifetime of the plantation. In order to stabilise the soil acidity, approximately 300 kg of CaO per ha should be used annually (after reaching an optimum soil pH level).

Liming should be carried out early in the spring or late in the autumn. If liming in the spring, the fertilisers are spread when the topsoil has thawed and the plants have not yet formed leaves. Autumn lime application is best done between the end of October and the first half of November.

III. SOIL CARE AND WEED CONTROL

Dr Jerzy Lisek, associate professor at the Institute of Horticulture — National Research Institute

1. A comprehensive approach to soil care and regulation of weeds

Soil care includes activities that keep the soil in a condition suitable for planting shrubs and improving the conditions for their growth. The main goals are improvement of soil structure, fertility, and aeration, improvement of water infiltration into the deeper layers, ensuring that machines can pass, and the removal of weeds. The uncontrolled development of weeds limits the growth and yield of the blue honeysuckle. Weeds compete with shrubs for water, nutrients and light, they have adverse chemical effects (allelopathy), they worsen phytosanitary conditions, which promotes the development of fungal diseases i pests and increase damage shrubs trees through spring frosts. On the other hand, weeds, as an essential element of synanthropic (associated) flora, also perform beneficial functions which are referred to as ecosystem (environmental) services. They are the basis of biological diversity. They create an environment for the development of beneficial organisms. They provide food to bees and other pollinating insects. They reduce soil erosion, salinity, and compaction. They participate in the correct recirculation of elements in the environment. They sequester atmospheric carbon dioxide and ultimately increase the organic matter content of the soil. In winter, weeds retain snow on the plantation which increases the

moisture supply in the soil. Weed control includes a set of activities that keep their number at a sufficiently low level, which allows for good development and yielding of the crops. The greatest threats are caused by the development of weeds in the period March - June. Actions related to the regulation of weeds should be commensurate with the threats and implemented in the form of a pre-planned, coherent programme. When establishing a plantation with integrated production and during its operation, various methods of regulating weeds are used, primarily non-chemical—mechanical treatments (soil cultivation, mowing unnecessary vegetation), maintenance of cover plants, mulching, and physical methods and rarely used (e.g., burning weeds with a propane burner, treatment with hot water, hot steam, a heating plate, or electric current). Methods alternative to the use of herbicides must be used as a first resort. Individual methods of soil care are combined in various ways and used in parallel (turf in between the rows and weeding, mulching or herbicide use in bush rows), rotatively (alternate use of different methods) and as mutually complementary methods (removing perennial weeds in organic mulch). Preventive measures are an important element of protection, including weed control before establishing the plantation, seed release, and in its immediate vicinity, if their seeds are transferred by the wind. The identification of weeds and knowledge of the biology of their development is the basis for effective weed control. Useful information for this purpose is published in the online HortiOchrona Decision Support System (DSS) available on the website of the Institute of Horticulture-NRI (http://hortiochrona.inhort.pl/). For this purpose, after entering the DSS, select the following items: orchard plants (any species)/pests/weeds.

Persistent weeds should not be present en masse in the field reserved for the plantation. If inspection has shown their presence, then in the preparation of the field, they should be carefully controlled, e.g. by a combination of mechanical and chemical methods (spraying with systemic herbicides). If bushes are planted after cereals, soil cultivation is most often carried out in the following sequence: shallow ploughing – deep ploughing – tillage. Runners and rhizomes of perennial weeds that are transported to the surface layer of the soil during tilling should be treated several times with a weed harrow, a cultivator or a cultivation unit. Mechanical control of couch grass after harvesting the preceding crop involves shallow ploughing to a depth of 10 cm, and after the soil has dried, using a spring cultivator or a cultivator and rake. On heavy soils, shallow ploughing is recommended, followed by cross disc harrowing, and after the couch grass has greened, deep ploughing with a skimmer to a depth of 30-35 cm. A frequently practised method of combating couch grass is several destructive cultivations using disc harrows, carried out in late spring and summer.

2. Chemical weed control

Prior to establishing the plantation, foliar systemic herbicides may be used to control persistent perennial weeds, which include, among others, species such as field bindweed, creeping thistle, field horsetail, or couch grass. Herbicides are most often used after the so-called provocative cultivation, such as shallow ploughing or relatively shallow ploughing with a subsoiler. Cultivation is carried out during a period conducive to the vegetation of weeds,

to stimulate them to develop and produce leaf mass, facilitating the uptake of herbicides. The selection of herbicides varies, so at the beginning of each growing season it is necessary to check the status of the herbicides that are used for the scope of registration and IP approval. The method and conditions of spraying with herbicides should be selected in such a manner as to achieve the maximum potential efficacy. The optimal spraying effect is achieved by the correct selection of the type of product and the adjuvant (booster), if recommended, of doses, timing of the treatment taking into account the growth stage of weeds and weather conditions, spray liquid volume, and the spraying technique.

Plant protection products should be used in accordance with the recommendations provided on the label and in such a way as not to endanger human and animal health or the environment

The list of herbicides permitted in Poland is published in the register of plant protection products. Information on the extent of pesticide use on individual crops is included on the labels. The pesticide search engine is a tool to assist in the selection of pesticides. Current information on the use of herbicides can be found on the website of the Ministry of Agriculture and Rural Development at https://www.gov.pl/web/rolnictwo/rejestr-rodkow-ochrony-roslin.

The list of plant protection products recommended for integrated production is developed by the Institute of Horticulture — National Research Institute in Skierniewice and published in the Fruit Plant Protection Programme. A list of plant protection products authorised for use in IP is also available on the website of the Institute of Horticulture at: http://arc.inhort.pl/serwis-ochrony-roslin/ochrona-roslin/ochrona-roslin-rosliny-sadownicze.

In addition, information on plant protection products for integrated production is available on the Pest Alerting Platform at the following address: https://www.agrofagi.com.pl/143,wykaz-srodkow-ochrony-roslin-dla-integrowanej-produkcji.html.

3. Mechanical methods of weed control

Mechanical weed control usually consist in systematic soil cultivation, and is usually carried out in the inter-rows of newly established and young plantations. The surface maintained in this way is called bare or mechanical fallow. Soil cultivation during plant vegetation is carried out at different frequencies (from 10 days to 4 weeks), using rotary cultivators, cultivators, harrows or cultivation units with, for example, cultivator points, open cage rollers and finger weeders. Active rotovators, with knives installed on a rotating shaft, are very effective tools, but they quickly damage the structure of the soil, which leads to a decrease in organic matter content and fertility. It is recommended to use passive tools instead of active tillers, with such working elements as teeth, duckfoot, and cultivator point, often combined with a string roller or disc harrows. Cultivations are carried out after a mass emergence of weeds, abundant rainfall and after the formation of the soil crust. During the

growth season, soil cultivation should be shallow, to a depth of several centimetres. The number of treatments performed in spring and summer should not exceed 4-6 treatments during the season, and the last of them should be performed at the latest in August to limit soil degradation and erosion. On the plantation, after the prior removal of the lodging shoots, it is recommended to use specialized tillers or other types of weeders, e.g., with undercutting knives, placed on side booms that work under the crowns of the bushes. The recommended option is to use weeders that move the soil in the strip along shrub rootstocks, aggregated with a large finger star (finger weeder) which destroys weeds in the shrub line. Mechanical cultivation may form part of a comprehensive soil maintenance technology using the 'sandwich method'. Under this system, an uncultivated strip of herbaceous vegetation 30-50 cm wide is left in the middle of the row of bushes. This strip can be sown with poorly growing grasses or weeded. On both sides of the bush rows, a strip of shallowly cultivated soil with a width of 60-90 cm is left. The cultivation is performed to a depth of 5-10 cm, after the weeds have reached about 10 cm in height, 4–6 times in the April–August period, most often using a cultivator, spring-tine or disc harrow on a lateral boom. Turf is maintained between inter-rows. Mowing unnecessary vegetation is especially important in the second half of the summer to limit the spread of weed seeds. Sub-canopy trimmers are used for work in bush rows, and their cutting elements can be knives, mowing lines or shears. Shallow mechanical cultivation and mowing do not effectively combat deep-rooting and creeping perennial weeds, like couch grass.

4. Ground cover plants

Ground cover plants, usually turf made up of perennial meadow grasses – red fescue (both in tuft and stolon forms), common meadow-grass and perennial ryegrass (English ryegrass), are the optimal way to maintain inter-rows on a plantation. Turf may consist of mixtures of the aforementioned species or mixtures of ecotypes (varieties) within one species, whether or not listed here, suitable for local conditions. Grasses are usually sown in the third year after planting the shrubs and mowed after reaching 15 cm in height, several times a season. The frequency of mowing depends on the composition of the turf, weather conditions and the type of mowers — rotary, drum or flail-type. The last two types allow for a low and thus less frequent mowing. The so-called natural turfing of inter-rows is allowed, especially if grasses develop in it, e.g. annual meadow-grass and weakly growing dicotyledonous weeds, e.g. geraniums, daisies, speedwells, hawkweeds, hawk's-beard, common yarrow. The presence of the dandelion is not desirable, due to its expansion throughout the plantation and the problems it causes. In order to reduce soil erosion, in hilly areas and on very fertile soils, the turf is established in the first year of the cultivation of a plantation.

5. Soil mulching

Synthetic mulches – black polyethylene foil, black crop cover or polypropylene non-woven fabric which are stretched over especially formed low furrows – and mulches of natural origin – textile waste, cereal and rape straw, sawdust, plant chips, wood bark,

manure, lignite, compost, fruit pomace – are used to reduce the number of weeds on plantations. Before using cellulose-rich organic litter (straw, sawdust, bark), the layer of which should be systematically replenished to a thickness of 5-10 cm, additional nitrogen fertilisation should be carried out by increasing the dose of this element. Straw increases the risk of attracting rodents. Organic mulches reduce soil compaction, level out its temperature and humidity and provide nutrients as they decompose. Perennial weeds grow through organic mulches, and the need for their additional control by chemical or mechanical (weeding) means must be taken into account. The lifespan of synthetic mulches is of several years, after which they require troublesome disposal (picking up and processing or combustion in incineration plants).

IV. MANAGING THE PLANTATION

Prof. Waldemar Treder

1. Watering

In our climate, irrigation has a significant impact on vigour, yield and condition of plants. **Water is a non-renewable resource so we should it use it very economically. Take water from an acceptable source in allowed quantities. Legal regulations governing the intake and use of irrigation water are described in the Water Law.**

Every owner of an irrigation system must hold documentation confirming their right to use water resources. During the selection of installations as well as the irrigation process itself, special attention should be paid to water efficiency. Drip irrigation is recommended for fruit plants due to its optimal efficiency. However, there are no restrictions concerning the use of other irrigation systems.

Sprinkling can be recommended on farms that have extensive plantings and efficient sources of surface water. **During sprinkling, water falls on bush leaves, so pay particular attention to correct disease protection.** Sprinkling should take place in the morning, so that leaves can dry as soon as possible. On plantations of blue honeysuckle, permanent sprinklers, portable sprinklers or drum sprinklers can be used. The diameter of the sprinkler nozzle and the spacing of sprinklers are selected depending on the efficiency and pressure of the water supply source. In order to ensure uniform irrigation, the sprinkler spacing should be close to their range radius. The frequency of irrigation depends on the size of the plants and weather conditions, and individual water applications are based on the depth of the root system and the soil's water retaining capacity. The dose of water should be selected so that it does not moisten the soil profile below a depth of 30 cm (Table 12).

Table 12. Approximate maximum irrigation rates (in mm*) for blue honeysuckle plantations grown on different soil types (for soil moistening up to 30 cm)

Clays	Sandy clays	Loamy sands	Slightly loamy sands
36	30	24	18

A sprinkling system can also be used to protect plants against spring frosts. Sprinkling plants during frosts can prevent damage to flowers even when the temperature drops to -5°C at a sprinkling intensity of 3.5 mm/h (3.5 l/m^2/h).

Drip irrigation is recommended for intensive plantings and for farms with limited water resources. On light soils, it is recommended to use drip lines with emitters spaced every 30–40 cm. The recommended length of an irrigation line depends on the emitter type, internal diameter of the tube, emitters' discharge and spacing. Longer irrigation lines than those recommended by the manufacturer in the technical specification should never be used. Some types of drip irrigation lines can be placed underground.

Regardless of the irrigation system, water doses should be adjusted so as to avoid washing out of minerals beyond the range of the root system. The soil should be moistened to the depth of the main mass of the root system (approx. 30 cm). **A prolonged wetness of the root system reduces the amount of air in the soil and creates conditions favourable to the development of soil borne pathogens.** The frequency of irrigation and water volume can be determined based on the measurement of moisture content or soil water potential. Moisture sensors or tensiometers are placed 15-20 cm deep, close to where the water is emitted. In case of drip systems, they are placed from 15 to 20 cm from the dripper along the bush rows. It is also essential to avoid polluting water sources during irrigation. In the case of fertigation or chemigation it is necessary to use a return valve.

Irrigation and fertigation literature, as well as detailed recommendations and information on water requirements of fruit plants are available on the Irrigation Service on the website of the Institute of Horticulture: http://www.nawadnianie.inhort.pl.

2. Pruning of blue honeysuckle bushes

Dr Zbigniew Buler

Blue honeysuckle seedlings, depending on the variety, form shoots that rise upwards, while in others they are more spreading. Seedlings are planted in a row at a distance of 0.7-1 m. Blue honeysuckle bears fruit on annual shoots that grew in the previous year, as well as on 2-year, 3-year, and older growths. The shoots of the berries are limp; therefore, under the influence of leaves and fruits, they tilt gradually to the ground. Annual growths and young shoots are smooth, light grey, some with a beetroot tint, while old shoots are more gnarled, dark, almost black.

After planting the blue honeysuckle plants, it is necessary to cut the horizontal growths lying on the ground and leave the vertical and upward-growing ones. These shoots can be slightly shortened to gain vigour for growth. Blue honeysuckle bushes are inherently low, so in the 2nd and 3rd year after planting, it is advisable to ensure they form a slender, conical shape. For this purpose, in the spring, you should cut thin, deformed, horizontally growing, and hanging growths, and prefer those growing vertically or slightly obliquely. After 3-4 years, the bushes enter the period of full fruiting. Some varieties produce only vertical, rigid growths, so dense that it is difficult to harvest fruit among them. In such varieties, it is

necessary to thin the growths in early spring, leaving 10-12 in the bush. Other varieties grow to a height of 1-1.5 m, and their shoots spread sideways. In this case, the shape of the bush is improved by cutting out old, inclined shoots in the spring and leaving young shoots in their place. 3-5 shoots can be cut in spring and replaced with annual growths. In the case of poor growth and fruiting, the bushes can be rejuvenated by making a thorough cut in spring, for example, cutting ¾ of the old shoots and leaving ¼ of the younger ones.

V. PROTECTION AGAINST DISEASES

1. The most important diseases and their characteristics

Dr Agata Broniarek-Niemiec, Dr Monika Michalecka, Dr Monika Kałużna

1.1. Fungal and bacterial diseases

Powdery mildew (pathogen *Erysiphe ehrenbergii*)

Symptoms of the disease occur most often on the leaves and tops of young shoots, initially in the form of single whitish spots covered with powdery mycelium and conidial stems. Under favourable conditions, i.e. at a temperature above 20°C and periodic wetting of the leaves, the white mycelium coating sometimes extends to entire leaf blades and parts of shoots. Most often, however, the symptoms of the disease are visible only on the leaves in the form of individual spots, usually browning a few days after a white mycelial infestation is observed on them. Strongly infested leaves curl upwards and, over time, also as a result of sunburn, dry up. The disease usually appears only after the fruit is harvested.

The pathogen of the disease overwinters on fallen infested leaves, on which black dotted fruiting bodies (cleistothecia) form, and the ascospores released from them in the spring infect young leaves. The fungus can also overwinter in the infested buds of the apical part of the shoots. Stems growing in spring from such buds are also infested, and conidial spores developing on the mycelium spread with air currents, causing secondary infections.

Gray mould of the blue honeysuckle (pathogen *Botrytis cinerea*)

The fungus overwinters in fallen leaves and fruit and in the affected canes. In the spring, spores are released from the mycelium, which, along with wind and rain, spread across the plantation and infect the developing organs of the blue honeysuckle. Young, green shoots are susceptible, especially in their apical parts, as well as developing inflorescences and ripening fruits. Infested flowers turn brown and dry. Infection of flowers can also be asymptomatic and manifest only during the development of the fruit. Then a grey coating of dusty mycelium appears on the ripening fruit, and the fruit dries or rots. However, the symptoms of grey mould on the fruit may only develop during the post-harvest period, during trade or storage; then, as a result of direct contact between healthy fruit and infested fruit, mass rotting of the fruit may occur. Large, brown, necrotic spots are formed on the leaves and shoots. Another characteristic symptom of the disease is the curvature and browning, followed by the withering of the tips of young, non-woody shoots. The

harmfulness of the disease depends on the size of the inoculum and weather conditions. In years with a lot of rain during flowering and harvesting, grey mould can cause significant yield losses.

Black root rot (pathogen *Neonectria radicicola*)

The fungus mainly infects the root system; sometimes necrosis can occur at the base of the shoot (at the soil level). Characteristic symptoms of the disease are black rot on the roots. Infested roots and rootstock turn black, cracks appear, and bark falls off, revealing dark streaks in the conductive tissues against the background of white, healthy tissue. The plant gradually dies, the leaves curl and fall off, the fruits mummify and remain on the bushes. The fungus causing black root rot can also infect leaves and shoots, forming confluent brown necrosis on them. The pathogen winters on infested plant remains.

Bacterial canker (pathogen *Pseudomonas* spp.)

Bacteria infest all aboveground parts of plants. Symptoms of the disease on the blue honeysuckle have so far been observed only on leaves in the form of small, single, rusty-brown spots, sometimes surrounded by a yellow 'halo'. So far, the prevalence of bacterial canker is low and observed on individual plants.

1.2 Leaf damage caused by the sun

On young leaves of the blue honeysuckle, there may also be damage resulting from sunburn. They are much more often the cause of leaf dieback than infectious diseases. Sunburns usually occur on the underside of young leaves. It happens to them in spring, when after a period of cloudy weather there are days with a lot of sunshine. Young leaves are particularly susceptible to burns; they are very flexible and, under the influence of the wind, bend their underside towards the sun, making them easily damaged by the sun's rays. Leaves affected by powdery mildew also suffer burns, bending upwards and exposing the underside of the leaf blade to sunlight. Young plants are much more likely to be exposed to sunburn, planted in a field with developed leaves, which are extremely delicate and devoid of a waxy layer. However, sunburns generally do not limit the growth and yield of plants in subsequent years.

2. Methods and dates of inspection

The occurrence and severity of diseases of the blue honeysuckle depend to a large extent on the course of weather conditions during the period of infection and the presence of a source of pathogenic fungi inoculum on the plantation. The first observations of the occurrence of symptoms of grey mould should be carried out on shoots even before flowering, especially after the onset of spring frosts. It is necessary to cut out damaged shoots on which dark brown necroses develop, especially in the apical part. Another observation should be made during the flowering period, and then all infested inflorescences should be removed. If the intensity of grey mould on shoots and flowers exceeds 5 %, there is an increased risk of grey mould on harvested and/or stored fruits.

Inspections of the leaves of the blue honeysuckle for the presence of powdery mildew should be carried out during the ripening and harvesting of the fruit.

In the case of expected infections by *N. radicicola*, observing the symptoms of the disease is challenging because they result from damage to the root system and can be mistaken for the drying or dying of the plant in response to stress (such as incorrect irrigation or damage to the root system). Root system paralysis by *N. radicicola* may be asymptomatic until flowering and fruit setting. During this period, plants should be inspected for leaf drying on individual shoots and entire bushes.

3. Types of disease prevention

Blue honeysuckle is a plant that is not very susceptible to diseases; however, in some nurseries and on commercial plantations, there are problems with the health of these plants.

Providing plants with optimal conditions for their development as well as limiting the source of infection are very important in preventing losses caused by diseases. When it comes to ensuring optimal vegetation of plants, it is important to observe proper fertilisation and irrigation as well as proper formation and thinning of bushes. The key elements in preventing the development of infectious diseases are the establishment of plantations from certified material, the selection of a site free from soil pathogens, and ensuring good aeration of the plantation. Weeding and mulching of plantations and the use of drip lines instead of sprinklers are also important. Harvesting of the fruit should be carried out at the appropriate stage of ripeness, which will avoid or reduce the occurrence of grey mould. Removal of shoots infested by pathogens, avoidance of cultivation in places where the disease habitat has developed, and disinfection of tools used to cut shoots limit potential sources of infection on the plantation. Neglecting the cutting of infested shoots promotes the further development of diseases and, as a result, may lead to the loss of entire bushes. The condition for high effectiveness of this procedure is cutting the shoot below the symptoms of the disease, with a reserve of healthy tissue. It is very important to destroy the removed, infested shoots, because on the remains of plants left on the plantation, the fungi will continue to develop and will be a source of infection for the blue honeysuckle bushes. Removing infested shoots, leaves, flowers, and fruits from plantations limits the source of the disease for the following year and reduces the likelihood of new infections.

4. Non-chemical disease protection methods

In limiting the source of infection, the removal of infested shoots, flowers and fruits plays an important role. Before establishing a plantation or immediately after planting, it is recommended to use a preparation containing cells of *Trichoderma asperellum*, which reduces the occurrence of pathogens of the genus *Fusarium* and *Phythium*, as it competes for space in the root zone and nutrients, and can also feed on fungi pathogenic for plants.

In the cultivation of the blue honeysuckle, a biological fungicide containing bacteria obtained from the natural environment, *Bacillus amyloliquefaciens*, is registered. This preparation is intended for preventive use in protection against diseases caused by fungi and

fungal-like organisms. Its fungistatic and fungicidal properties are due to the ability of *B. amyloliquefaciens* to produce substances with antibiotic activity and to compete with pathogens for living space and nutrients on the surface of plants. These bacteria also induce the systemic resistance of the plant on which they live. Alternatively, preparations containing laminarin, which acts systemically, can also be used to stimulate the natural resistance mechanisms of plants, thereby strengthening their resistance to pathogens. After applying the agent, plants produce resistance proteins, phytoalexins, and cell wall lignification occurs.

5. Chemical pathogen control

The list of plant protection products allowed in Poland is published in the register of plant protection products. Information about the scope of pesticide use for particular crops is placed on the product's label. A repository of plant protection products can help to choose a pesticide. The register and labels of plant protection products are available on the website of the Ministry of Agriculture and Rural Development at https://www.gov.pl/web/rolnictwo/ochrona-roslin, and the search engine is available at https://www.gov.pl/web/rolnictwo/wyszukiwarka-srodkow-ochrony-roslin---zastosowanie.

In addition, the list of plant protection products authorised for integrated production is updated annually and published on the website of the Institute of Horticulture - NRI at: http://arc.inhort.pl/serwis-ochrony-roslin/ochrona-roslin/ochrona-roslin-rosliny-sadownicze/rosliny-sadownicze-wykaz-srodkow and on the Pest Alerting Platform at https://www.agrofagi.com.pl/143,wykazsrodkow-ochrony-roslin-dla-integrowanej-produkcji.html.

Plant protection products should be used in accordance with the recommendations given on the label and in a way that does not endanger human health, animals or the environment.

6. Timing and conditions of application of fungicides

The effectiveness of chemical protection should be determined by compliance with the recommended dose of the product and the accuracy of the procedure. When using surface-applied products, it is necessary to take into account the possibility of washing away the product used (rainfall recording) and the rate of tissue growth, e.g. leaves and shoots. When selecting fungicides, it is also worth paying attention to the spectrum of their action and the possibility of performing one procedure against several diseases. Temperature observation during plant protection treatments is particularly important in early spring when colds may occur during which the selected product does not work. The optimal temperature for performing fungicide treatments usually ranges from 12 to 20°C. When it is too low, their effectiveness may decrease significantly, and the means given under such conditions are characterised by a lower rate of chemical reaction and a slower course of physiological processes in the plant cell. Therefore, it is mandatory to conduct and record measurements

of daily precipitation throughout the period of use of plant protection products and to record temperature values immediately before and after each protection procedure. Due to the possibility of selection of resistant forms of certain pathogens, e.g. *Botrytis cinerea*, fungicides from individual chemical groups, especially those with a specific mechanism of action, should not be used more than 2 times a season, in rotation with preparations with a different mechanism of action.

VI. PROTECTION AGAINST PESTS

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1. List of the most common pests and their characteristics

The most important pests of blue honeysuckle in Poland include the cockchafer, hop spider mite, aphids, and the rose tortrix, as well as birds during fruit ripening. Cherry fruit fly can also cause damage locally (table 13).

Cockchafer (*Melolontha melolontha* L.). The body of the cockchafer is cylindrical, 20-25 mm in length, black in colour. The cockchafer's first pair of wings (lids), feelers and legs are brownish-brown. Rows of triangular white spots are visible on the sides of the black abdomen. The eggs are yellowish, the size of a grain of millet, and are laid into the soil in deposits of 25-30 eggs. The larva (called a grub) is initially whitish, then creamy, bent into a horseshoe shape, with a large brown head and three pairs of legs. At the end of development, grubs reach a length of up to 50 mm. Beetles damage the leaves. Complete loss of leaves can occur with a large number of pests. Larvae feed on the roots of plants. Damaged plants are weakened and, with a high incidence of grubs, roots are damaged, shrubs wither and even dry out.

Two-spotted spider mite (*Tetranychus urticae* Koch). The two-spotted spider mite is a small mite. Its body is oval, about 0.5 mm long, with four pairs of legs. The overwintering females are brick-orange, and the summer generation is yellow-green with two darker spots on the sides. Males are of rhomboid shape and slightly smaller than females. Larvae are smaller than adult mites, yellow-green, with 3 pairs of legs. Eggs are spherical, about 0.13 mm in size, yellowish. In early spring, overwintering female spider mites can be observed on the first emerging leaves. All the moving stages of spider mites feed on the lower side of the leaf blade, sucking the juices from the cells. Yellow discolouration appears at the feeding site, visible on both sides of the leaf blade. Severely damaged leaves turn brown over time, dry out and fall prematurely. Feeding of spider mites weakens the growth and fruiting of shrubs. The inhabited shrubs are also less frost-resistant.

Rose tortrix moth (*Archips rosana* L.). The butterfly, a male, has wings spanning 16-19 mm, light brown to purplish brown in colour, with dark markings. The wings of the females are lighter, olive-brown, with a span of 19-24 mm. Flat eggs, oval, size approx. 0.5 mm, laid in depositions, grey disc-shaped, about 5-6 mm in diameter, covered with female secretion.

The caterpillar is yellowish-green with a black head; older ones are green, darker on the dorsal side, with a dark brown head, and grow up to 22 mm. At the end of summer, autumn, and winter, on the bark of the shoots of the blue honeysuckle, one can find deposited eggs of rose tortrix moth. Caterpillars hatch in the last days of April or the first days of May and feed on the leaves, causing them to curl up, which provides protection for them. Caterpillars bite out holes and skeleton leaves; they can also damage fruit buds. They feed until June, after which they pupate at the foraging site on or between the leaves. The butterfly flight takes place in the second half of June and in July. During this time, females lay eggs, about 250 each.

Aphids (Aphididae). They are small bugs. As on other bushes, different species of aphids can inhabit the leaves and young shoots of the blue honeysuckle. By feeding, they suck up plant juices, deprive the plants of nutrients, while excreting large amounts of liquid faeces, called honeydew, which covers the plant. On these secretions, 'sooty' fungi develop. Assimilation is weakened, growth is inhibited, and susceptibility to frost is increased. The species of aphids that can feed on the blue honeysuckle include **peach aphid** (*Myzus* (*Nectarosiphon*) *persicae*) and **black bean aphid** (*Aphis* (*Aphis*) *fabae*).
The peach aphid is about 3 mm in size, with a colour ranging from light to dark green. Winged individuals are pinkish, while unwinged ones are green and green-yellow. Eggs are approximately 0.4 mm in size, black, and shiny. During the season, it develops from 2 to 4 generations.
The black bean aphid is about 2 mm in size and is black and matte. Winged individuals are also black, sometimes brown or dark green, and shiny. Wintering eggs are black, shiny, laid on shoots near the buds. The younger larvae are reddish-graphite in colour and are lighter than the nymphs. The last larval stage (nymph) has rows of white spots on its back. Blue honeysuckle is its secondary host, on which it feeds for several weeks.

Cherry fruit fly (*Rhagoletis cerasi* L.). The adult insect is a fly with a length of 4-5 mm, black and shiny, with a yellow-orange scutellum between the bases of transparent wings covered with black, transverse stripes. Eggs are about 0.7 mm in size. The larva is legless and white in colour, reaching a length of about 4 mm at the end of its development in the fruit. Pupae, known as grubs, overwinter in the top layer of the soil under the bushes. The departure of flies begins around the middle or in late May and lasts until the end of July. The time of departure of adults varies greatly, depending on atmospheric factors, mainly including humidity and soil temperature. About 7-10 days after the flight, fertilised females begin to lay eggs, placing them one by one under the epidermis of colouring, semi-ripe fruits of the blue honeysuckle. The larvae hatch after about 10 days and feed on the fruit, consuming its flesh. After foraging, the mature larvae leave the fruit, fall to the ground, squeeze between the soil clumps, and form pupal cocoons. Some of the larvae do not reach full maturity before harvesting and end up in containers with the fruit. Each season, one generation of the pest develops.

Among the species of **birds** (Aves) that cause losses in the yield of the blue honeysuckle, the starling, fieldfare, and blackbird should be distinguished. Birds feed on different types of food. Until the beginning of the breeding season, they feed almost exclusively on animal food, but then increasingly consume berries, fruits, and seeds.

Table 13. Symptoms of feeding and harmfulness of selected pests of blue honeysuckle

Pest	Symptoms	Harmfulness
Cockchafer	Grubs eat small roots and bite into bigger roots, causing sudden wilting and death of plants, especially on younger plantations. In May and early June, beetles damage the leaves by eating their blades.	Weakening of the growth and yield of plants, dieback of the youngest plants.
Two-spotted spider mite	On the upper side of the blade of the infested leaf, small, later larger, merging yellow spots are formed, which can cover a large part of the leaf. The edges of the infested leaf curl upwards, and the leaf gradually turns brown and dries. With a large pest population on the underside of the leaf, at the feeding sites of spider mites, a delicate web produced by the pest appears.	Premature yellowing and leaf drop. Weakened and starved plants. Lower and poorer quality yield.
Peach aphid	The aphid feeds on the leaves and tops of shoots, sucks plant juices and causes deformations of leaves and shoots.	Inhibited shoot growth, weakened fruiting, leaves and fruits covered with a coating of 'sooty mould'. Loss of commercial value of fruit.
Turnip aphid	It feeds in colonies on the tops of shoots and apical leaves, sucking plant juices, which causes deformation of the affected parts of the plant.	
Rose tortrix moth	Rose tortrix moth caterpillars feed in single leaves curled along the vein or in loosely spun leaf rosettes at the tops of shoots. They can also damage young fruit buds. Similar damage is caused by the caterpillars of other	Inhibition of shoot growth, development of lateral shoots and excessive branching. Smaller yield.

	tortricids.	
Cherry fruit fly	During harvesting, white, legless larvae up to 4 mm long are visible inside the fruit.	Infestation of fruit. Loss of commercial value of fruit.
Birds	They damage, shake off, and eat the fruit.	Reduction of quality and quantity of yield.

2. Inspection periods and risk thresholds

The decision on the need to perform pest control treatments should be made on the basis of an inspection of bushes carried out in order to assess the occurrence and abundance of both individual species of pests and beneficial fauna (table 14). The presence of beneficial predators in cultivation is important because, under favourable conditions, they can effectively reduce the population of pests. Knowledge of the biology of pests facilitates the selection of the appropriate time to observe their occurrence on the plantation. For the blue honeysuckle, no thresholds for economic harmfulness have been developed so far, but the values indicated for other berry bush crops can be used (table 14). **Threat threshold** means such a level of population for which it is recommended to carry out a treatment to avoid a loss in crop value exceeding the total cost of the treatment. However, it should be stressed that the proposed threat thresholds have an indicative value and cannot be applied indiscriminately in every situation. The ability to correctly determine the population size of pests and to individually assess the threat they pose is needed.

Table 14. Times and methods of inspection and danger thresholds

Name of pest	Time of inspection	The method of inspection and the size of the sample for approx. 1 ha	Economic harmfulness threshold
Cockchafer	Before establishing the plantation: May to August	32 holes measuring: 25 x 25 x 30 cm (depth) = 2m² of field area	1 grub/2 m² of field area
Two-spotted spider mite (Tetranychus urcicae)	Prior to flowering	Inspect 3-4 samples of 50 individual leaves at a time	Over 1-2 spider mites/1 leaf
	After peak bloom and then every 10–14 days		
	After harvesting the fruit and then every 2 weeks		Over 2-3 spider mites per leaf
Peach aphid Turnip aphid	When first leaves develop, until flowering	Inspect 4 samples of 50 shoots at a time (200 shoots total)	Over 5 % of infested shoots
	After peak bloom and later every 10–14 days		

	After harvesting the fruit and then every 10-14 days		
Rose tortrix moth	Before flowering and then every 10-14 days	Inspect 4 samples of 50 shoot tips (200 shoots)	Over 10 % of damaged shoot tips
Cherry fruit fly	From the end of May to the first ten days of July	Yellow adhesive traps for trapping adult cherry fruit fly insects, check twice a week	On average, 2 flies caught per 1 trap

3. Non-chemical methods of protecting the blue honeysuckle from pests

Methods of non-chemical protection of the blue honeysuckle against pests are important for maintaining the health of the plantation. Here are the key actions:

1. Before establishing a plantation, it is necessary to cultivate the soil mechanically several times and to grow plants that hinder the development of harmful insects, such as grubs (e.g. buckwheat, mustard).
2. Plantations should be established only from nursery material that is free from pests.
3. Pest-damaged shoots should be cut and burned in the autumn-winter and early spring periods.
4. Favourable conditions should be created for the development and habitation of beneficial species of insects, mites, and other arthropods by maintaining field trees, shrubs, and bird nesting boxes.
5. On plantations, it is recommended to place tall poles with a crossbar for birds of prey to facilitate their hunting of pests.
6. Building houses for mason bees and nesting boxes for bumblebees is also important. Houses for mason bees should contain at least 200 nesting channels made of cut reed tubes and other materials with appropriate parameters. On the other hand, the shelters for bumblebees should be covered, measuring approximately 20 x 15 x 10 cm, with an entrance hole of 2 cm in diameter. Their location should be easily accessible and not overgrown, preferably at the edge of the plantation.

4. Chemical protection

Protection of the blue honeysuckle from pests with chemical agents is recommended; however, it is necessary to follow the guidelines for the use of these preparations, as well as the rotation of agents to prevent the development of resistance. It is also important to monitor the maximum number of sprays with a given preparation and the total number of treatments in the cultivation of the blue honeysuckle. In order to support protection, it is also worth including support measures that create physical barriers limiting the development of pests. For the control of aphids and spider mites, it is recommended to use

preparations with mechanical or physical action, if they are permitted for use on the blue honeysuckle.

Authorised plant protection products in Poland are published in the register of plant protection products, and information on their use can be found on labels (https://www.gov.pl/web/rolnictwo/ochrona-roslin). An additional tool for selecting suitable pesticides is the search engine available on the website of the Ministry of Agriculture and Rural Development at: https://www.gov.pl/web/agriculture/search-engine-for-plant-protection-products---application.

The list of plant protection products recommended for integrated production is developed by the Institute of Horticulture — National Research Institute in Skierniewice and published in the Fruit Plant Protection Programme. Information on this can also be found on the website of the Institute of Horticulture – NRI at: http://arc.inhort.pl/serwis-ochrony-roslin/ochrona-roslin/ochrona-roslin-rosliny-sadownicze/rosliny-sadownicze-wykaz-srodkow.

Information on plant protection products for integrated production is also provided on the Pest Alerting Platform at https://www.agrofagi.com.pl/143,wykaz-srodkow-ochrony-roslin-dla-integrowanejprodukcji.html.

It is important to use plant protection products in accordance with the recommendations on the labels and in order to minimise risks to human health, animal health and the environment.

5. Safety of pollinators and useful entomofauna

5.1. Safety of pollinators

Improper use of plant protection products can negatively affect pollinators, causing their poisoning or destruction. This applies not only to insecticides and acaricides, but also, although to a lesser extent, to fungicides. These agents can act on insects both through contact and ingestion. Under field conditions, the main cause of bee poisoning is usually direct contact with a chemical, but stomach toxicity also occurs when contaminated food (e.g. pollen, nectar, honeydew) is taken in by the bees and transferred to the hive. In such cases, all bee communities, as well as the honey they produce, may suffer. It is important to note that the plant protection products used may have more than one type of toxicity to pollinators.

In order to minimise the negative impact on the population of beneficial insects, it is necessary to observe the following rules:

1. Do not use plant protection products (especially insecticides) during the flowering period of crops, weeds, or other vegetation in the surroundings.
2. Avoid the use of inappropriate mixtures of plant protection products.
3. Avoid the use of plant protection products on plants covered with honeydew, and if necessary, choose safe substances and observe the pre-harvest interval.

4. Always follow the correct application technique of the preparation.
5. Perform plant protection treatments only with products registered for the specific crop and pest.
6. If it is necessary to spray plants during flowering, this should be done before evening, after the end of bee activity, taking into account the pre-harvest interval indicated on the label.
7. Select the timing and dosage of the preparation in accordance with the manufacturer's recommendations.
8. Where possible, use non-chemical methods to control pests, such as biological methods or the introduction of predatory mites.
9. Carefully follow the instructions on the label of the plant protection product.
10. Treatments should be carried out with appropriate precautions to avoid contamination of neighbouring crops with the working liquid.
11. Use plant protection products only when absolutely necessary.

5.2. Protection of useful entomofauna

In order to maintain or increase the number of beneficial organisms in the crop, the following rules must be observed:
• When choosing plant protection products, preference should be given to those that are selective or partially selective for beneficial fauna.
• It is important to increase biodiversity in the growing area by preserving field margins, mid-field shrubs, and other landscape features that provide shelter, breeding, and wintering sites for many beneficial species.

Useful fauna most commonly found on blue honeysuckle plantations:
Coccinellidae: seven-spot ladybird, 14-spotted ladybird beetle, two-spotted ladybird. Main food sources: aphids, spider mites, small butterfly and fly larvae.
Chrysopidae: common green lacewing. Main food sources: aphids, small butterfly caterpillars.
Predatory bugs: common flower-bug, minute pirate bug Main food sources: aphids, thrips, spider mites, eggs and small caterpillars of butterflies, fly larvae.
Predatory flies (mainly Syrphidae, Cecidomyiidae, Tachinidae): marmalade hoverfly, aphid midge. Main food sources: aphids, thrips.
Parasitic insects/parasitoids (Aphidiidae, Ichneumonidae, Trichogrammatidae, Chalcididae): minute polyphagous wasps, aphids. Main food sources: eggs, larvae, pupae, adult insects of harmful butterflies (including leafrollers), aphids.
Predatory beetles (mainly carabidae and staphylinidae): rain beetle, golden ground beetle. Main food sources: larvae and adult insects of many harmful butterflies, hymenoptera, beetles, spider mites.
Earwigs: common earwig. Main food sources: aphids, small insects and their eggs.
Predatory mites (Phytoseiidae): Typhlodromus pyri Main food sources: spider mites, eriophyoidea.

6. Prevention of damage caused by rodents and birds

On blue honeysuckle plantations, rodents, especially field voles, can appear en masse every few to several years. To prevent this, tubular traps can be used. However, birds of prey play an important role in controlling rodent populations. Therefore, on the plantation, it is recommended to place high poles with a crossbar (at least 1 pole per 5 hectares, and in larger areas—several poles), which facilitates predatory birds in observing and hunting prey.

Birds, especially corvids, can cause significant damage, particularly on blue honeysuckle plantations. To scare them away, you can install a special apparatus that generates the sounds of frightened birds.

VII. PROVISIONS AND PRINCIPLES OF GOOD PRACTICE OF HANDLING PLANT PROTECTION PRODUCTS

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Plant protection with chemicals poses specific risks to the operator and the environment. In order to minimise the risks arising from their use, the treatment contractor must have appropriate authorisation to use plant protection products and use them skilfully, with special care, always in accordance with the law and the provisions of the label-instructions for use, and with the use of technically efficient and calibrated equipment for treatments. Personnel and equipment authorisations and the procedures for handling plant protection products, particularly regarding activities performed before and after the treatment, are specified in the provisions of the MARD regulations. They are complemented by the principles of Good Plant Protection Practice.

1. Obligations of the user of plant protection products

According to the regulations, plant protection products may be purchased and used only by persons trained in the use of these products and holding a certificate confirming the completion of the relevant training. The certificate of completion of the training is valid for 5 years, and its renewal can be obtained each time after completing the supplementary training.

Equipment for the application of plant protection products must be technically sound in order not to pose risks to human health, animal health and the environment. Sprayer users are required to have them tested at intervals of no more than 3 years. The first inspection of new equipment is conducted no later than 5 years from the date of its purchase. Until then, the document permitting the use of plant protection products with the sprayer is the purchase invoice. The efficiency of the equipment is confirmed during diagnostic tests carried out in authorised sprayer inspection stations. A positive result of the inspection shall be confirmed by a technical inspection report and a control mark in the form of a sticker affixed to the sprayer tank.

To ensure the correct application of crop protection products, the sprayer must be calibrated. This is a legal obligation for sprayer users, who can and should carry out the calibration themselves. Although the regulations do not specify how often it should be repeated, it is good practice to calibrate the sprayer at least at the beginning and in the middle of the plant protection season. It is also worth documenting the calibration in the form of a record of assumptions and results of subsequent operations. The calibration process is described in one of the following subsections.

Treatments with plant protection products shall be recorded.

In accordance with Article 67(1) of Regulation (EC) No 1107/2009 of the European Parliament and of the Council of 21 October 2009 (OJ EU L 309, 24.11.2009, p. 1), owners of agricultural holdings are obliged to keep records of treatments carried out with chemical plant protection products. Records must contain information such as: the name of the crop grown, the area cultivated on the holding, the size of the area and the date of the treatment, the name of the plant protection product used, the dose of the product, and the reason for using the plant protection product.

2. Safety for the operator and the environment

Any handling of plant protection products poses a risk to the health of the operator. Therefore, personal protective equipment, i.e. protective clothing made of non-absorbent fabric, rubber shoes with trouser legs extended over the uppers, nitrile or neoprene gloves designed for working with chemicals, reaching beyond the wrists and tucked into the sleeves of the overalls, and protective goggles or a face shield with a transparent screen, should be used when conducting them. When measuring plant protection products and preparing a spray liquid, the operator is particularly exposed to direct contact with concentrated preparations. Therefore, during these operations, one should additionally use: a rubber or foil apron covering the torso and legs, goggles tightly protecting the eyes, headgear, and a half-mask with a P2 dust filter for loose preparations or with an A2/A3 absorber for liquid preparations.

The spraying process, even with the use of an efficient and calibrated sprayer, causes the drift of the spray liquid, which in turn creates a risk of contamination of sensitive objects, such as surface water, apiaries, or other non-agricultural areas. In order to prevent this risk, it is necessary to maintain the buffer zones indicated on the labels between the place of application of plant protection products and sensitive facilities. Labels may also indicate the possibility of reducing the buffer zone if drift-reducing equipment is used to a certain extent. The classification of drift reducing techniques (TOZ) is available on the IO-PIB website https://www.inhort.pl/serwis-ochrony-roslin/ in the Plant Protection Technology tab. Where a buffer zone is not indicated on the label of the plant protection product, the general rules on minimum buffer zones shall apply: for public roads, excluding municipal and district roads - 3 m; for apiaries - 20 m; for reservoirs and watercourses and non-agricultural areas - 1 m for field sprayers and 3 m for orchard sprayers.

The most important objective factor influencing the removal of plant protection products is wind. Its excessive strength increases the risk of environmental pollution even despite the use of drift-reducing techniques. Therefore, the maximum wind speed at which plant protection products can be used is legally defined. It is 4 m/s, regardless of the spraying technique used.

The greatest threat to the environment, especially to water, is local pollution caused by leakages or dispersions of concentrated plant protection products during their storage and preparation of the spray liquid, and the lack of safe management of residues from treatments, i.e. remnants of the spray liquid, water after rinsing the spray system, and external washing of sprayers. They may also arise as a result of non-compliance with the rules for handling empty packaging after the products. The provisions concerning the storage of plant protection products, the preparation of the liquid, the washing of the sprayer and the management of liquid residues are laid down in the Regulation of the Minister for Agriculture and Rural Development on the management and storage of plant protection products and plant protection products (Journal of Laws of 2013, item 625). The Regulation imposes a general requirement to act in a way that reduces the risk of contamination of surface water, groundwater and land, which directly translates into the reduction of local pollution.

3. Storage of plant protection products

Specific storage requirements for plant protection products shall ensure that they are kept in their original packaging in such a way as to prevent contact with food, drink or feed and accidental human or animal consumption. The storage place or facility must be capable of being closed to prevent access by third parties, in particular children. If this place is not located on a hardened surface impermeable to liquids (e.g. a floor made of airtight concrete or other durable materials), it must not be closer than 20 m from wells, reservoirs, and watercourses. In addition, it must ensure that plant protection products do not enter open sewage systems. This means that any drains from the grids leading to the sewage system must be closed, unless it is a drainless (closed) system equipped with a sealed tank or device that neutralises the active substances of plant protection products.

The regulation does not require the storage of resources in a specially designated room, which means that small quantities can be stored in cabinets. It is important that the cabinet is made of durable materials and lockable with a key or padlock, and that it prevents substances from escaping outside. For this purpose, one can place a tray at the bottom of the cabinet to collect accidental leaks.

The labelling of plant protection products imposes additional requirements to guarantee their durability and effectiveness. For this purpose, the products should, as a rule, be stored at a temperature of not less than 0°C and not more than 30°C, in dry, cool and properly ventilated places. They should be protected from moisture and direct exposure to heat sources.

Good practice adds to this non-mandatory but practical recommendations, which are aimed at improving and further enhancing the level of safety at work with plant protection

products and enabling effective action in emergency situations. In accordance with the principles of good practice, the place of storage of agents should be appropriately marked and illuminated. Excess stocks of agents should not be accumulated, but rather stored in quantities intended for use within 6-12 months. The shelves on which the agents are placed should be made of a non-absorbent, easy-to-clean material. Wooden shelves can be covered with foil. The agents should be grouped according to their purpose and degree of harmfulness, placing loose preparations (powders and granules) above liquid ones. A separate shelf should be allocated for substandard products intended for disposal. In the storage room, there should also be an accessible, well-lit place for the scales, a measuring jug, and a spatula, intended for measuring preparations to make a spray liquid. It should be borne in mind that all tools in contact with plant protection products must not be used for other purposes. There should also be space for emptied and rinsed product packaging, as well as for a brush, scoop, sawdust container (or other material absorbing spilled liquids), a roll of paper towels, and a container for contaminated waste (e.g., sawdust after collecting spills or a towel after wiping tools). In large storage facilities, it is also advisable to ensure the presence of a fire extinguisher, emergency phone numbers, and health and safety instructions, which should be displayed in a visible location at the entrance to the facility.

In farms that employ workers, it is required to follow Regulation of the Minister for Agriculture and Rural Development of 24 June 2002 on health and safety at work in the use and storage of plant protection products and mineral and organic-mineral fertilisers (Journal of Laws of 2002, No 99, item 896).

4. Preparation of the spray liquid

When preparing the spray liquid, the sprayer operator is exposed to the active substance in the highest concentration, and therefore must use appropriate protective clothing (e.g. coverall cat. III, type 4, 5 or 6), rubber footwear and nitrile gloves, as well as appropriate eye protection (goggles) or full face protection (protective screen) suitable for the degree of toxicity and formulation of the preparation, and respiratory protection (half-mask: filtering P2 or P3, absorbing A2, or filtering-absorbing P2A2). When measuring preparations, extreme care should be taken to avoid spillage, splashing or dispersal, which would result in the risk of serious local contamination. Due to the high level of risk associated with the preparation of a spray liquid, the provisions of the MARD Regulation require this activity to be carried out at a distance of at least 20 m from wells, water intakes, reservoirs, and watercourses. The instructions on the product label require precise determination and measurement of the amount of preparation needed to prepare the liquid. For this purpose, it will be necessary to perform a simple calculation according to the following formula:

$$\text{Quantity of product [l, kg]} = \frac{\text{Product dose [l, kg/ha]} \times \text{Liquid volume in the tank [l]}}{\text{Liquid dose [l/ha]}}$$

The liquid should be prepared immediately before use and used without delay. When considering the mixing of different agents, attention should be paid to the possibility and justification of their combined use, and when preparing the mixture, preparations should be added to the water in the order recommended by the manufacturer. The preparation of the spray liquid should always be carried out with the agitator switched on in order to prevent the suspension from depositing in the nooks and crannies of the tank. If the mixing of liquids results in the formation of abundant foam in the tank, the intensity of mixing should be minimized, for example by reducing the engine speed in the tractor.

The preparation of the spray liquid in the field, each time in a different location, prevents the accumulation of concentrated substances at a single point due to accidental, even minor, but difficult-to-avoid leaks. These minor leaks or scattering of substances onto the biologically active substrate of the field undergo natural biodegradation, minimizing the risk of local contamination. For the safe preparation of liquids in the field, a preparation diluter is used, which is an additional device of the sprayer. Using a diluent, a concentrate of the plant protection product is prepared based on a small amount of water from the tank. This concentrate is then drawn into the main tank by means of ejection and mixed with water. Empty packaging is rinsed using a pressure washer equipped with a diluent. In order to improve and maximize the safety of the entire process, it is advisable that the sprayer be also equipped with a storage compartment for plant protection products, empty packaging, a measuring cup for liquid preparations, and a clean water tank for washing hands. N.B.: the use of a diluent does not eliminate the need for the operator to use personal protective equipment.

If the absence of a diluent on the sprayer prevents the preparation of liquids in the field, or for other reasons this activity must be carried out on the farm, then care should be taken to choose the right place. In addition to the prescribed 20 m from wells, water intakes, reservoirs, and watercourses, good practice recommends that the sprayer be filled on a bunded stand with an impermeable substrate, i.e., one that prevents water from seeping into the ground and spreading outwards, as only in this way is there a guarantee of avoiding contamination of the soil and surface and groundwater. The ideal solution is a station in the form of a concrete slab with the flow of contaminated water into the collection well, from where it is further directed to safe management. In the absence of such solutions on the farm, the soil can be protected against contamination by spreading a film or laminated sheet under the sprayer, from which any spills can be rinsed into the sprayer tank.

When replenishing the water in the sprayer tank, the liquid level indicator should be carefully observed to ensure that under no circumstances does the tank overflow and mass leakage occur, but only the volume of water needed to spray the specified area of the field is taken.

5. Washing the sprayer

Sprayer washing usually involves contamination of the ground with a large amount of polluted water, which can flow into reservoirs or watercourses or seep deep into the soil

profile into groundwater. This risk can be significantly reduced by safely managing the water after rinsing the liquid system and collecting and neutralizing contaminated water after external washing. The provisions of the Regulation of the Ministry of Agriculture and Rural Development and the instructions on the label of the products clearly require that the liquid residues after the treatment be diluted with water and sprayed on the previously treated surface. The same procedure should be applied to subsequent portions of water used for rinsing the tank and liquid system three times. In fact, it is a practical and relatively safe way to handle the remaining liquid and contaminated water. A legal alternative is the neutralisation of liquid residues by biodegradation of active substances in bioremediation stations. Under no circumstances may these residues be discharged onto the ground, into sewage systems or in any other place not intended for the neutralisation of plant protection products or the disposal of chemical waste.

For efficient washing of the liquid system in the field, an additional water tank and a pressurised sprinkler are required to flush the tank. Internal washing of the sprayer is usually carried out in three cycles by successive dilutions of the residues of plant protection products. Half of the additional reservoir water is used for the first dilution, and 25 % for each of the next two. After each dilution, the contaminated water should be sprayed in accordance with the above-mentioned provision of the Regulation. The sequential dilution method shall ensure that, at the end of the operation, the concentration of the active substance in the water remaining in the sprayer system is not more than 2 % of the initial concentration of the spray liquid. Due to the substances flushed from the sprayer during external washing, the provisions of the MARD Regulation specify a minimum distance of 30 m between the washing site and wells, water intakes, reservoirs, and watercourses. This requirement does not apply to washing facilities for plant protection equipment that meet certain technical requirements (a hardened surface made of impermeable concrete, a sealed mud and grease trap, and a sealed sewage tank).

Good practice recommends washing the sprayer in the field using an external washing kit, powered by water from an additional tank. In the field, the rinsed substances end up on a biologically active substrate and undergo biodegradation. Each time, the sprayer should be washed in a different location to avoid the accumulation of substances in the soil. If circumstances prevent washing in the field, the farm should carry out this operation on a bunded impermeable surface with a slope to the separator of solid parts and petroleum products, from where contaminated water can be directed for safe management. Recommendable ways of managing liquid residues are bioremediation, i.e. biological degradation of substances under the influence of soil microorganisms, or dehydration, i.e. evaporation of water under the influence of solar radiation and wind, followed by the disposal of the remaining sludge by entities authorised to eliminate hazardous waste.

6. Packaging

Packages of plant protection products classified as hazardous substances (marked with the pictogram GHS 06: Health hazard – Acute toxicity 1, 2, 3, or GHS 09: Hazard to the environment – Toxicity to the aquatic environment) are hazardous wastes that are subject to

special treatment as defined in the Packaging and Packaging Waste Management Act (consolidated text: Journal of Laws of 2024, item 927) The provisions of the Act impose on the users of these means the obligation to return the packaging to the seller, and on the sellers the obligation to accept this packaging and direct it for safe disposal. The label instructions indicate whether the packaging is to be treated as hazardous waste. If it is hazardous waste, the emptied packaging must be rinsed three times with water, and the rinsate poured into the sprayer tank with the utility liquid. Instead, a packaging scrubber may be used, but in that case, the pressure rinsing shall not take less than 10 seconds. Rinsed packages must be collected in specially marked plastic bags and returned to the seller in this form. The label prohibits the burning of packaging on one's own and its use for other purposes, including as secondary raw materials. Labels of plant protection products not classified as hazardous substances include information on treating packaging as municipal waste. In this case, the incineration of packaging is still prohibited. After rinsing, depending on the type of packaging, they can be placed in a plastic or paper container.

VIII. SELECTION OF TECHNIQUES FOR THE APPLICATION OF PLANT PROTECTION PRODUCTS

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1. Weather conditions

The manner and conditions of the use of plant protection products largely determine the effectiveness of treatments, safety of the operator and the environment. In accordance with the requirements of integrated pest management, plant protection products should be used sparingly, precisely, and with the least possible losses, especially those resulting from the drift of the spray liquid. Therefore, treatments with plant protection products should be carried out under appropriate weather conditions, preferably under optimal and favourable conditions, but never exceeding the limit of acceptable conditions. The characteristics of different categories of weather conditions are shown in Table 15.

Table 15. Characteristics of weather conditions during plant protection treatments

Conditions	OPTIMAL	FAVOURABLE	ACCEPTABLE
Air temperature [°C]	6-15 *	up to 20	up to 25*
Air humidity [%]	60-95	over 50	over 40 **
Wind speed [m/s]	0.5-1.5	up to 2.5	**up to 4.0** ***
Recommended droplet size	SMALL AVERAGE	AVERAGE THICK	THICK VERY THICK

* *when combating pests min 12-15°C*

** *according to good practice*

*** *according to the law (Regulation of MoARD of 31.03.2014 – Journal of Laws 2014, item 516)*

2. Spraying technique

Spraying of spatial crops, such as blue honeysuckle shrubs, is most effectively carried out with the use of an auxiliary air stream. Directed airflow (DA) sprayers, equipped with radial fans, from which air is distributed using 4 to 6 pairs of flexible pneumatic lines, prove to be the most useful. At their end, there are air outlets in the form of diffusers with sprayers. Independently directed diffusers allow the distribution and direction of the air flow to be precisely adjusted to the shape and size of the shrubs to be protected. Due to the possibility of almost any direction and location of diffusers, it is possible to regulate the manner and scope of the air stream to a wide range, and in particular to limit it where necessary, e.g. in the case of small shrubs or early leafless phases of development. This provides the opportunity to significantly reduce the doses of the spray liquid and reduce losses of plant protection products (table 17).

The use of deflector sprayers is also a good option, with low-lying deflectors that direct the airflow sideways and limit its upward flow. The least liquid loss is present in treatments performed with tunnel sprayers. During the leafless period and flowering, they recover about 20-30% of the application liquid, and 10-15% during the full foliage stage. With three times less drift of plant protection products into the environment compared to conventional spraying techniques, tunnel sprayers are the most environmentally-friendly method of crop protection.

Standard orchard sprayers, designed to protect trees, are hardly suitable for the protection of fruit shrub plantations. They have fans positioned too high, which causes uneven distribution of liquids in bushes and significant losses of plant protection products due to drift. This involves the need to use high doses of liquid.

3. Sprayers

In the protection of berry bush plantations, mainly pressurized vortex atomizers are used, which produce a stream of fine droplets in the form of an empty cone and a spraying angle of 80°, which operate most efficiently in the range of 5-15 bar. During windy weather (above 2.5 m/s), small drops are drift easily making it difficult to perform an effective procedure. Therefore, in such conditions, coarse-droplet ejector, whirl, or flat-jet sprayers with a narrow spray angle of 80° or 90° should be used. In the absence of ejector sprayers, the size of the droplets can be increased using whirl sprayers with a higher discharge and the lowest liquid pressure possible.

The discharge of narrow-angle whirl and flat-jet sprayers that meet the ISO standard, depending on the size and pressure of the liquid, is shown in Table 16.

Table 16. Nominal liquid discharge table [L/min] for swirl and flat-jet sprayers with a spray angle of 80° or 90°, meeting the ISO standard, versus liquid pressure [bar]

Rozmiar ISO	L/min															
	bar															
	5	6	7	8	9	10	11	12	13	14	15	16	17	18	18	20
01	0,51	0,55	0,60	0,64	0,68	0,72	0,75	0,78	0,82	0,85	0,88	0,91	0,93	0,96	0,99	1,01
015	0,76	0,83	0,90	0,96	1,02	1,07	1,13	1,18	1,22	1,27	1,31	1,36	1,40	1,44	1,48	1,52
02	1,01	1,11	1,19	1,27	1,35	1,42	1,49	1,56	1,62	1,68	1,74	1,80	1,86	1,91	1,96	2,01
025	1,28	1,40	1,52	1,62	1,71	1,81	1,90	1,98	2,06	2,14	2,22	2,29	2,36	2,43	2,49	2,56
03	1,52	1,64	1,79	1,91	2,03	2,14	2,24	2,34	2,44	2,53	2,62	2,70	2,79	2,87	2,94	3,02
04	2,02	2,21	2,37	2,53	2,68	2,83	2,97	3,10	3,23	3,35	3,47	3,58	3,69	3,80	3,90	4,00
05	2,50	2,74	2,96	3,17	3,36	3,54	3,71	3,88	4,04	4,19	4,34	4,48	4,62	4,75	4,88	5,01

Rozmiar ISO	ISO size
L/min	L/min
bar	bar

4. Efficiency of the fan

In order to penetrate spatial crops such as berry bushes, the air in the rows of plants should be replaced by the air produced by the fan. Excessive speed of the sprayer does not ensure adequate penetration, while too low a speed contributes to losses caused by blowing and drifting of the utility liquid. This means that the efficiency of the fan should be appropriately related to the operating speed and size of the plants, being large enough to ensure even application, but also low enough to minimize liquid losses caused by blowing. The fan efficiency adjustment shall be carried out by changing the transmission ratio or the rotor blade angle or, as a last resort, by changing the motor speed. For the latter, the adjustment range is small, as it involves a simultaneous reduction in the efficiency of the sprayer pump, which increases pressure pulsation and worsens the effect of mixing liquids in the tank.

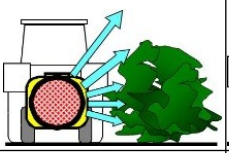
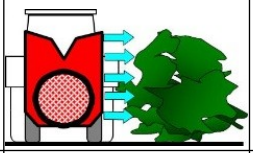
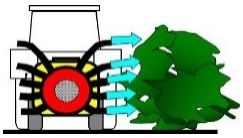
5. Working speed

In the protection of fruit shrub plantations, the spraying speed should not exceed the range of 4.0-8.0 km/h. Treatments during windy conditions and in cases of particularly dense, spatially developed plants (e.g., in the phase of full leaf development) should be carried out using the lower speed range (4.0-5.0 km/h). In early spring and until the flowering period, the working speed can be increased to 8.0 km/h. A working speed that is too low, for a sprayer equipped with a high-performance fan, worsens the conditions for applying droplets and causes liquid losses as a result of its ‘puffing’ through the rows of bushes.

6. Dose of spray liquid

The dose of liquid during spraying must not be too low, as it does not guarantee a sufficiently even distribution of plant protection products in the bushes. Too high a dose causes liquid dripping, which reduces the weight of the active substance of the product and, as a consequence, may lead to a deterioration in the effectiveness of the treatment. The dose range of the spray liquid depends mainly on the type of sprayer and the size of the bushes. Lower doses (even by 30-40 %) are recommended when treatments are performed with precision sprayers, equipped with deflectors or with a directed airflow (DA)) (table 17). This possibility is supported by greater precision in liquid emission, which is directed only at the sprayed plants.

Table 17. Liquid doses applied on blue honeysuckle plantations using different types of sprayers

Sprayer	Standard 	Deflector 	USP 	Tunnel 
Dose of liquid [L/ha]	600÷900*	500÷600**	400÷500	250÷400**
(*) – exclusion of upper sprayers recommended		*(**) – possible recovery of 20 % of the liquid*		

7. Weed control technique

Herbicides are applied using flat-jet sprayers that produce a spray of droplets in the shape of a flat fan. In the standard version, they produce medium droplets, allowing to obtain the required effectiveness of treatments, but are susceptible to drift. Their use should be limited solely to the control of monocot weeds in optimal or favourable weather conditions (table 18) and to herbicide beams equipped with shields. The safest way to combat weeds is with coarse-droplet sprayers, usually of ejector type. If there is a high proportion of monocot weeds, the use of medium-droplet sprayers is also acceptable.

In the group of ejector sprayers, two-jet sprayers deserve special attention, where one jet is tilted forwards and the other backwards, typically creating a +30°/-30° stream arrangement. This solution is used to improve the application of herbicides on weeds, both in the early and late stages of their development.

Foliar herbicides are applied in liquid doses of 150-250 L/ha, and soil-applied herbicides in doses of 250-300 L/ha, always using coarse-drop sprayers.

Before the plantation is established, field sprayers are used to spray overgrown weeds across the entire field area. Flat-jet sprayers with symmetrical sprayers and a wide spray angle (110-120°) should then be used for uniform coverage of the area being sprayed.

In existing plantations, weeds are controlled using herbicide beams usually equipped with 3-4 sprayers, the outermost of which is an asymmetric nozzle, while the others are standard with a spray angle of 110-120°. Weeds occurring in spots can be controlled using a knapsack sprayer with a lance fitted with a shield.

The operating pressure range for standard and ejector compact flat-jet sprayers is 1.5-5 bar, and for ejector sprayers, the so-called long one, 3-8 bar.

Discharge for wide-angle and asymmetrical flat-jet sprayers that meet the ISO standard, depending on the size and pressure of the liquid, is shown in Table 18.

8. Sprayer calibration

Calibration of the sprayer is the responsibility of every professional user of plant protection products. This obligation arises from the Plant Protection Products Act (Journal of Laws of 2015, item 547). Calibration involves determining, selecting, and adjusting the parameters of its operation in a manner that ensures the precise implementation of the intended dose of liquid with the least possible losses. In the course of calibration, the following parameters shall be selected:

- sprayers: type, size, number across the width of sprayer operation
- pressure of liquid
- nozzle discharge,
- working speed
- airflow efficiency

Table 19 shows the procedures for calibrating sprayers for disease and pest control, while Table 20 shows the procedures for calibrating band sprayers for weed control. When calibrating, use the appropriate tables (16 and 18) of sprayer discharge.

Table 18. Table of nominal liquid discharge [L/min] for ISO sprayer sizes 01 to 06 versus liquid pressure [bar] and liquid dose [L/ha] at different operating speeds [km/h]

01		L/ha						
		km/h						
bar	L/min	4,0	5,0	6,0	7,0	8,0	10,0	12,0
1,5	0,28	85	67	57	48	42	34	28
2,0	0,33	98	79	65	56	49	39	33
2,5	0,37	110	89	73	63	55	44	37
3,0	0,40	120	96	80	69	60	48	40
4,0	0,46	139	110	92	79	69	55	46
5,0	0,52	155	125	103	89	77	62	52
6,0	0,57	171	137	114	98	86	68	57
7,0	0,61	183	146	122	105	92	73	61
8,0	0,65	195	156	130	111	98	78	65

03		L/ha						
		km/h						
bar	L/min	4,0	5,0	6,0	7,0	8,0	10,0	12,0
1,5	0,85	255	204	170	145	127	102	85
2,0	0,98	294	235	196	168	147	118	98
2,5	1,10	329	264	219	188	164	131	110
3,0	1,20	360	288	240	206	180	144	120
4,0	1,39	416	334	277	238	208	166	139
5,0	1,55	465	372	310	266	232	186	155
6,0	1,64	492	395	328	281	246	197	164
7,0	1,79	537	430	358	307	269	215	179
8,0	1,91	573	460	383	328	288	230	191

015		L/ha						
		km/h						
bar	L/min	4,0	5,0	6,0	7,0	8,0	10,0	12,0
1,5	0,42	127	101	85	73	64	51	42
2,0	0,49	147	118	98	84	73	59	49
2,5	0,55	164	132	110	94	82	66	55
3,0	0,60	180	144	120	103	90	72	60
4,0	0,69	208	166	139	119	104	83	69
5,0	0,77	232	185	155	133	116	93	77
6,0	0,84	252	199	168	144	126	101	84
7,0	0,90	270	216	180	154	135	108	90
8,0	0,96	288	231	192	165	144	115	96

04		L/ha						
		km/h						
bar	L/min	4,0	5,0	6,0	7,0	8,0	10,0	12,0
1,5	1,13	339	271	226	194	170	136	113
2,0	1,31	392	314	261	224	196	157	131
2,5	1,46	438	350	292	250	219	175	146
3,0	1,60	480	384	320	274	240	192	160
4,0	1,85	554	444	370	317	277	222	185
5,0	2,07	620	497	413	354	310	248	207
6,0	2,21	663	530	442	379	332	265	221
7,0	2,37	711	569	474	406	356	284	237
8,0	2,53	759	608	507	434	381	304	253

02		L/ha						
		km/h						
bar	L/min	4,0	5,0	6,0	7,0	8,0	10,0	12,0
1,5	0,57	170	137	113	97	85	68	57
2,0	0,65	196	156	131	112	98	78	65
2,5	0,73	219	175	146	125	110	88	73
3,0	0,80	240	192	160	137	120	96	80
4,0	0,92	277	221	185	158	139	111	92
5,0	1,03	310	247	207	177	155	124	103
6,0	1,11	333	266	222	190	167	133	111
7,0	1,19	357	286	238	204	179	143	119
8,0	1,27	381	306	254	218	191	152	127

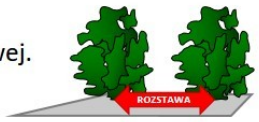
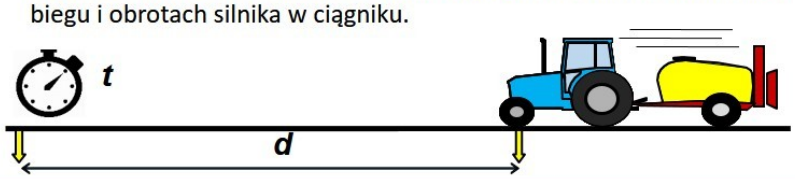
05		L/ha						
		km/h						
bar	L/min	4,0	5,0	6,0	7,0	8,0	10,0	12,0
1,5	1,41	424	338	283	242	212	170	141
2,0	1,63	490	391	327	280	245	196	163
2,5	1,83	548	439	365	313	274	219	183
3,0	2,00	600	480	400	343	300	240	200
4,0	2,31	693	554	462	396	346	277	231
5,0	2,58	775	619	516	443	387	310	258
6,0	2,75	825	660	550	471	413	330	275
7,0	2,96	888	710	592	507	444	355	296
8,0	3,17	951	761	634	543	476	380	317

025		L/ha						
		km/h						
bar	L/min	4,0	5,0	6,0	7,0	8,0	10,0	12,0
1,5	0,70	210	168	140	120	105	84	70
2,0	0,81	244	194	162	139	122	97	81
2,5	0,91	274	218	182	156	137	109	91
3,0	0,99	298	238	198	170	149	119	99
4,0	1,15	346	276	230	197	173	138	115
5,0	1,28	384	307	256	219	192	154	128
6,0	1,40	420	336	280	240	210	168	140
7,0	1,52	456	365	304	261	228	182	152
8,0	1,62	486	389	324	278	243	194	162

06		L/ha						
		km/h						
bar	L/min	4,0	5,0	6,0	7,0	8,0	10,0	12,0
1,5	1,70	509	408	339	291	255	204	170
2,0	1,96	588	470	392	336	294	235	196
2,5	2,19	657	526	438	376	329	263	219
3,0	2,40	720	576	480	411	360	288	240
4,0	2,77	831	665	554	475	416	333	277
5,0	3,10	930	744	620	531	465	372	310
6,0	3,28	984	787	656	562	492	394	328
7,0	3,54	1062	850	708	607	531	425	354
8,0	3,79	1137	910	758	650	569	455	379

L/ha	L/ha
km/h	km/h
L/min	L/min
bar	bar

Table 19. Calibration of sprayer for disease and pest control

KALIBRACJA OPRYSKIWACZA DO KRZEWÓW	PRZYKŁAD
1 Biorąc pod uwagę wielkość krzewów i ich fazę wzrostu określ wymaganą dawkę cieczy użytkowej. Sprawdź rozstawę rzędów krzewów. 	*Dawka cieczy = 500 L/ha* *Rozstawa = 3,0 m*
2 Określi liczbę pracujących rozpylaczy tak, aby, zakres ich działania nie wykraczał poza wielkość krzewów. 	*n = 2 x 6 szt*
3 Obserwując zakres działania rozpylaczy dobierz obroty wentylatora tak, aby do minimum ograniczyć przewiewanie cieczy przez krzewy. 	*Obroty silnika: 1500/min* *Bieg w ciągnika : II* *Przekładnia went.: I*
4 Oblicz prędkość roboczą opryskiwacza na podstawie pomiaru czasu przejazdu na odcinku drogi o znanej długości, na ustalonych jak wyżej biegu i obrotach silnika w ciągniku. 	*d = 100 m* *t = 50 sek*
Prędkość [km/h] = $\frac{\text{Długość odcinka pomiarowego [m]}}{\text{Czas przejazdu [sek]}}$ *x 3,6*	$\frac{100}{50}$ *x 3,6 = 7,2 km/h*

Czas sek/100 m	45	48	**50**	52	54	56	58	60	62	64	66	68	70	72	74	76	78	80	85	90
Prędkość km/h	8,0	7,5	**7,2**	6,9	6,7	6,4	6,2	6,0	5,8	5,6	5,5	5,3	5,1	5,0	4,9	4,7	4,5	4,4	4,2	4,0

Prędkość dla odcinka 100 m można odczytać także z tabeli

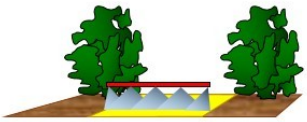
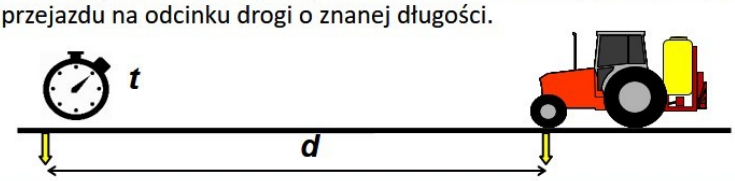
5 Oblicz jednostkowy wydatek rozpylaczy potrzebnych do realizacji wyznaczonej dawki cieczy dla swojej plantacji przy obliczonej jak wyżej prędkości roboczej.	*Dawka cieczy = 500 L/ha* *Rozstaw rzędów = 3,0 m* *Liczba rozpylaczy = 12* *Prędkość = 7,2 km/h*
Wydatek [L/min] = $\frac{\text{Dawka [L/ha] x Rozstawa rzędów [m] x Prędkość [km/h]}}{\text{600 x Liczba rozpylaczy}}$	$\frac{500 \text{ x } 3,0 \text{ x } 7,2}{600 \text{ x } 12}$ *= 1,5 L/min*
6 Z tabeli wydatków nominalnych w katalogu rozpylaczy wybierz rozmiar rozpylaczy i ciśnienie cieczy, dla których wydatek jednostkowy jest najbliższy obliczonemu jak powyżej.	*Rozpylacz ISO:* *02 (żółty) - 10,5 bar*
7 Zamontuj wybrane rozpylacze, uruchom opryskiwacz i ustaw nominalne ciśnienie odczytane w tabeli wydatków. Przy użyciu wyskalowanego naczynia zmierz w ciągu 1 minuty wydatek kilku rozpylaczy na każdej sekcji i w razie niezgodności wyniku z wydatkiem wymaganym skoryguj ciśnienie i powtórz pomiar. 	*Rzeczywiste, skorygowane wartości ciśnienia po pomiarze wydatku rozpylaczy:* ***11,0 bar***
8 Zapisz wszystkie uzyskane wyniki kalibracji w tabeli.	

KALIBRACJA OPRYSKIWACZA DO KRZEWÓW	CALIBRATION OF SPRAYER FOR BUSHES
PRZYKŁAD	EXAMPLE
1. Biorąc pod uwagę wielkość krzewów i ich fazę	1. Taking into account the size of the bushes and

wzrostu określ wymaganą dawkę cieczy użytkowej. Sprawdź rozstawę rzędów krzewów.	**their growth phase, determine the required dosage of the spray liquid.** Check the spacing of the rows of bushes.
Dawka cieczy = 500 L/ha *Rozstawa = 3,0 m*	*Liquid dosage = 500 L/ha* *Spacing = 3.0 m*
2. Określ liczbę pracujących rozpylaczy tak, aby zakres ich działania nie wykraczał poza wielkość krzewów.	**2. Determine the number of working sprayers so that the scope of their operation does not exceed the size of the bushes.**
n = 2 × 6 szt	*n = 2 × 6 pcs*
3. Obserwując zakres działania rozpylaczy dobierz obroty wentylatora tak, aby do minimum ograniczyć przewiewanie cieczy przez krzewy.	**3. Observing the range of action of the sprayers, adjust the fan speed to minimize the drift of liquid through the bushes.**
Obroty silnika: 1500/min *Bieg w ciągniku: II* *Przekładnia went.: I*	*Engine speed: 1500/min* *Tractor gear: II* *Transmission: I*
4. Oblicz prędkość roboczą opryskiwacza na podstawie pomiaru czasu przejazdu na odcinku drogi o znanej długości, na ustalonych jak wyżej biegu i obrotach silnika w ciągniku.	**4. Calculate the operating speed of the sprayer based on the measurement of the travel time over a section of road of known length, at the gear and engine speeds specified above on the tractor.**
d = 100 m *t = 50 sek*	*d = 100 m* *t = 50 s*
Prędkość (km/h) = (Długość odcinka pomiarowego [m] ÷ Czas przejazdu [sek]) × 3,6	Speed (km/h) = (Length of measuring section [m] ÷ Travel time [s]) × 3.6
100 ÷ 50 × 3,6 = 7,2 km/h	100 ÷ 50 × 3,6 = 7,2 km/h
Czas sek/100 m **Prędkość** km/h	**Time** sec/100 m **Speed** km/h
Prędkość dla odcinka 100 m można odczytać także z tabeli	The speed for the 100 m section can also be read from the table
5. Oblicz jednostkowy wydatek rozpylaczy potrzebnych do realizacji wyznaczonej dawki cieczy dla swojej plantacji przy obliczonej jak wyżej prędkości roboczej.	**5. Calculate the unit discharge of sprayers needed to achieve the designated liquid dose for your plantation at the above calculated operating speed.**
Dawka cieczy = 500 L/ha *Rozstawa rzędów = 3,0 m* *Liczba rozpylaczy = 12* *Prędkość = 7,2 km/h*	*Liquid dose = 500 L/ha* *Row spacing = 3.0 m* *Number of sprayers = 12* *Speed = 7.2 km/h*
Wydatek [L/min] = (Dawka [L/ha] × Rozstawa rzędów [m] × Prędkość [km/h]) ÷ (600 × Liczba rozpylaczy)	Discharge [L/min] = (Dose [L/ha] × Row spacing [m] × Speed [km/h]) ÷ (600 × Number of sprayers)
500 × 3,0 × 7,2 ÷ 600 × 12 = 1,5 L/min	500 × 3.0 × 7.2 ÷ 600 × 12 = 1.5 L/min
6. Z tabeli wydatków nominalnych w katalogu rozpylaczy wybierz rozmiar rozpylaczy i ciśnienie cieczy, dla których wydatek jednostkowy jest najbliższy obliczonemu jak powyżej.	**6. From the table of nominal discharges in the sprayer catalogue, select the size of the sprayers and the liquid pressure for which the unit discharge is closest to the one calculated as above.**
Rozpylacz ISO: 02 (żółty) – 10,5 bar	*ISO sprayer: 02 (yellow) – 10.5 bar*
7. Zamontuj wybrane rozpylacze, uruchom opryskiwacz i ustaw nominalne ciśnienie	**7. Install the selected sprayers, start the sprayer, and set the nominal pressure as indicated in**

odczytane w tabeli wydatków. Przy użyciu naczynia pomiarowego zmierz w ciągu 1 minuty wydatek kilku rozpylaczy na każdej sekcji i wyznacz skorygowane ciśnienie i powtórz pomiar.	**the discharge table. Using a measuring vessel, measure within 1 minute the discharge of several sprayers on each section, determine the corrected pressure, and repeat the measurement.**
Rzeczywiste, skorygowane wartości ciśnienia po pomiarze wydatków rozpylaczy: 11,0 bar	*Actual corrected pressure values after measuring sprayer discharge: 11.0 bar*
8. Zapisz wszystkie uzyskane wyniki kalibracji w tabeli.	**8. Record all obtained calibration results in a table.**

Table 20. Calibration of sprayer for weed control

KALIBRACJA OPRYSKIWACZA DO ZWALCZANIA CHWASTÓW	PRZYKŁAD
1 Określi szerokość opryskiwanego pasa herbicydowego 	*Pas herbicydowy = 2 m*
2 Określ wymaganą dawkę cieczy użytkowej w pasie herbicydowym. 	*Dawka cieczy = 200 L/ha*
3 Określ liczbę rozpylaczy przypadających na szerokość pasa herbicydowego 	*Liczba rozpylaczy = 5 szt*
4 Oblicz prędkość roboczą opryskiwacza na podstawie pomiaru czasu przejazdu na odcinku drogi o znanej długości. 	*d = 100 m* *t = 58 sek*
Prędkość [km/h] = Długość odcinka pomiarowego [m] / Czas przejazdu [sek] x 3,6	$\frac{100}{58}$ x 3,6 = **6,2 km/h**

Czas sek/100 m	45	48	**50**	52	54	56	58	60	62	64	66	68	70	72	74	76	78	80	85	90
Prędkość km/h	8,0	7,5	**7,2**	6,9	6,7	6,4	6,2	6,0	5,8	5,6	5,5	5,3	5,1	5,0	4,9	4,7	4,5	4,4	4,2	4,0

Prędkość dla odcinka 100 m można odczytać także z tabeli

5 Oblicz jednostkowy wydatek rozpylaczy potrzebnych do realizacji wyznaczonej dawki cieczy przy obliczonej jak wyżej prędkości roboczej.	*Dawka cieczy = **200 L/ha*** *Rozstaw rzędów = **2,0 m*** *Liczba rozpylaczy = **5*** *Prędkość = **6,2 km/h***
Wydatek [L/min] = Dawka [L/ha] x Szer. pasa herbic. [m] x Prędkość [km/h] / 600 x Liczba rozpylaczy na pas herbicydowy	$\frac{200 \times 2{,}0 \times 6{,}2}{600 \times 5}$ = **0,83 L/min**
6 Z tabeli wydatków nominalnych w katalogu rozpylaczy wybierz rozmiar rozpylaczy i ciśnienie cieczy, dla których wydatek jednostkowy jest najbliższy obliczonemu jak powyżej.	*Rozpylacz ISO:* *02 (żółty) - 3,2 bar*
7 Zamontuj wybrane rozpylacze, uruchom opryskiwacz i ustaw nominalne ciśnienie odczytane w tabeli wydatków. Przy użyciu wyskalowanego naczynia zmierz w ciągu 1 minuty wydatek kilku rozpylaczy i w razie niezgodnośc wyniku z wydatkiem wymaganym skoryguj ciśnienie i powtórz pomiar. 	*Rzeczywiste, skorygowane wartości ciśnienia po pomiarze wydatku rozpylaczy:* **4,0 bar**
8 Zapisz wszystkie uzyskane wyniki kalibracji w tabeli.	

KALIBRACJA OPRYSKIWACZA DO ZWALCZANIA CHWASTÓW	CALIBRATION OF SPRAYER FOR WEED CONTROL
PRZYKŁAD	**EXAMPLE**
1. Określ szerokość opryskiwanego pasa herbicydowego	**1. Determine the width of the sprayed herbicide strip**

Pas herbicydowy = 2 m	*Herbicide strip = 2 m*
2. Określ wymaganą dawkę cieczy użytkowej w pasie herbicydowym.	**2. Determine the required dosage of the spray liquid in the herbicide strip.**
Dawka cieczy = 200 L/ha	*Liquid dosage = 200 L/ha*
3. Określ liczbę rozpylaczy przypadających na szerokość pasa herbicydowego	**3. Determine the number of sprayers per width of the herbicide strip**
Liczba rozpylaczy = 5 szt	*Number of sprayers = 5 units*
4. Oblicz prędkość roboczą opryskiwacza na podstawie pomiaru czasu przejazdu na odcinku drogi o znanej długości.	**4. Calculate the operating speed of the sprayer based on the measurement of the travel time on a section of road of known length.**
d = 100 m *t = 58 sek*	*d = 100 m* *t = 58 sec*
Prędkość (km/h) = (Długość odcinka pomiarowego [m] ÷ Czas przejazdu [sek]) × 3,6	Speed (km/h) = (Length of measuring section [m] ÷ Travel time [s]) × 3.6
100 ÷ 58 × 3,6 = 6,2 km/h	100 ÷ 58 × 3.6 = 6,2 km/h
Czas sek/100 m **Prędkość** km/h	**Time** sec/100 m **Speed** km/h
Prędkość dla odcinka 100 m można odczytPrędkość dla odcinka 100 m można odczytać także z tabeli:	The speed for the 100 m section can also be read from the table:
5. Oblicz jednostkowy wydatek rozpylaczy potrzebnych do realizacji wyznaczonej dawki cieczy przy obliczonej jak wyżej prędkości roboczej.	**5. Calculate the unit discharge of sprayers needed to achieve the designated liquid dose at the above-calculated operating speed.**
Dawka cieczy = 200 L/ha *Szerokość pasa herbicydowego = 2,0 m* *Liczba rozpylaczy = 5* *Prędkość = 6,2 km/h*	*Liquid dose = 200 L/ha* *Width of herbicide strip = 2.0 m* *Number of sprayers = 5* *Speed = 6.2 km/h*
Wydatek [L/min] = (Dawka [L/ha] × Szer. pasa herbic. [m] × Prędkość [km/h]) ÷ (600 × Liczba rozpylaczy na pas herbicydowy)	Discharge [L/min] = (Dosage [L/ha] × Width of herb. strip [m] × Speed [km/h]) ÷ (600 × Number of sprayers per herbicide strip)
200 × 2,0 × 6,2 ÷ 600 × 5 = 0,83 L/min	200 × 2,0 × 6,2 ÷ 600 × 5 = 0.83 L/min
6. Z tabeli wydatków nominalnych w katalogu rozpylaczy wybierz rozmiar rozpylaczy i ciśnienie cieczy, dla których wydatek jednostkowy jest najbliższy obliczonemu jak powyżej.	**6. From the table of nominal discharges in the sprayer catalogue, select the size of the sprayers and the liquid pressure for which the unit discharge is closest to the one calculated as above.**
Rozpylacz ISO: 02 (żółty) – 3,2 bar	*ISO sprayer: 02 (yellow) – 3.2 bar*
7. Zamontuj wybrane rozpylacze, uruchom opryskiwacz i ustaw nominalne ciśnienie odczytane w tabeli wydatków. Przy użyciu wyskalowanego naczynia zmierz w ciągu 1 minuty wydatek kilku rozpylaczy i w razie niezgodności wyników z wartościami nominalnymi skoryguj ciśnienie i powtórz pomiar.	**7. Install the selected sprayers, start the sprayer, and set the nominal pressure as indicated in the discharge table.** Using a calibrated vessel, measure the discharge of several sprayers within 1 minute and, in the event of non-compliance with the nominal values, adjust the pressure and repeat the measurement.
Rzeczywiste, skorygowane wartości ciśnienia po pomiarze wydatku rozpylaczy: 4,0 bar	*Actual corrected pressure values after sprayer discharge measurement: 4.0 bar*
8. Zapisz wszystkie uzyskane wyniki kalibracji w tabeli.	**8. Record all obtained calibration results in a table.**

IX. HYGIENIC AND SANITARY PRINCIPLES

During the harvest and preparation for the sale of agricultural produce as part of an integrated plant production system, the producer shall ensure compliance with the following hygiene and health rules.

1. Personal hygiene of workers

1. Persons involved in the harvest and preparation of produce for sale should:
    a. not be infected with or suffer from food-borne diseases;
    b. maintain personal hygiene, observe hygiene rules, and in particular wash their hands often during work;
    c. wear clean clothing and, where necessary, protective clothing;
    d. injuries and abrasions should be treated with a waterproof dressing.

2. The fruit producer ensures that the workers that participate in the harvesting and preparation of the vegetables for sale:
    a. unlimited access to washbasins and toilets, cleaning products, paper towels or hand dryers, etc.;
    b. training in hygiene.

2. Hygiene requirements for crops prepared for sale

The crop producer should take appropriate measures to ensure:

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

3. Integrated plant production hygiene requirements for packaging, means of transport and places for the preparation of crops for sale

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

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

X. RULES FOR DOCUMENTATION IN INTEGRATED PLANT PRODUCTION

Dr Grzegorz Gorzała

Inherent in the cultivation of plants in the Integrated Plant Production system is the maintenance or possession of various documentation by the agricultural producer. An obligatory item of this documentation is the IP notebook.

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).

Other documents that a producer using integrated plant production must or may have 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;
- mandatory and control lists;
- 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 application 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. When applying for certification for more than one plant species, IP Notebooks must be kept individually for each crop.

The notebook should be completed according to the following scheme (appropriate to the plant species).

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 (...) in the integrated plant production system — all cultivated varieties declared for IP certification to be recorded in the field inventory table.

Field plan with biodiversity-increasing elements — graphically reproduce the plan of the farm and its immediate surroundings with the proportions of the various elements. The farm plan uses the same markings as those used in the list of fields.

General information, sprayers, operators — the year in which production according to the principles of Integrated Plant Production was started is to be recorded. Then, tables must be filled in. The bullet points should be filled in with appropriate entries and the information confirmed by ticking the relevant boxes (□). The 'Sprayers' table should be filled in with the required data and the information confirmed by ticking the relevant boxes (□). 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 devices and persons performing treatments, including those performed by a service provider, are 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 is supplemented by entering information about the purchased material — variety, degree of qualification, quantity, and proof of purchase (invoice, plant passport or official label).

Sowing (...) — in the table, record the quantity of seed used in individual fields. 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 organic material was used, the species or specie composition should be indicated in the 'Fertiliser type' column. The date, type and dose of fertilisation and liming applied and the field should be recorded in the 'Soil mineral fertilisation and liming' table. 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. **Filling the mandatory IP notebook in the integrated plant production system fulfils the requirement to keep the above-mentioned documentation for certified crops.** The rules for documenting plant protection treatments will change on 1 January 2026 as a result of the application of the provisions of Implementing Regulation (EU) 2023/564.

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

Hygiene and sanitation requirements — record whether people in direct contact with food have access to clean toilets and hand-washing facilities, cleaning products, and paper towels or hand dryers. Also the manner of observing the hygiene and health requirements for IP methodologies should be described.

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 relating to cleaning of machines, equipment, and hardware used in production according to the requirements of the integrated production methodology — a page in the notebook containing space for IP manufacturer's for information relating to cleaning of machinery, equipment, and hardware used in manufacturing 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.

XI. LIST OF OBLIGATORY ACTIVITIES AND TREATMENTS IN THE INTEGRATED PRODUCTION SYSTEM OF BLUE HONEYSUCKLE (syn. KAMCHATKA BERRY)

Basic requirements (100% compliance i.e. 12 points)			
No.	**Checkpoints**	**YES/NO**	**Comment**
1.	Carrying out soil analysis to determine its pH, organic matter content and bioavailable phosphorus, potassium and magnesium – on light soils at least once every 3 years, and on heavier soils – at least once every 4 years (see chapter II.1.1).	❑/❑	
2.	The use of agricultural lime, mineral/organic fertilisers or soil-enhancing agents containing nitrogen, phosphorus, potassium and/or magnesium carried out based on the results of soil analysis, leaf analysis and visual assessment of the plant's condition (see chapter II. 1.2-1.4, 2.2, 3).	❑/❑	
3.	The use of mineral fertilisers containing the necessary micronutrients on the basis of a visual assessment of the plants (see chapter II. 3, 6.3).	❑/❑	
4.	Effective reduction of weeds with a height of more than 15 cm or long-term covering of the		

	soil surface in rows of bushes by mechanical, physical, or mulching methods during spring and summer (see chapter III)	❑/❑	
5.	Regular mechanical cultivation (young plantings) of inter-rows or maintaining them under periodically mowed cover vegetation (recommended form of soil care for older plantations) (see chapter III.3–4).	❑/❑	
7.	Recording daily rainfall totals over the entire period of application of plant protection products (see chapter V.6).	❑/❑	
8.	Recording the temperature values immediately before and after carrying out the plant protection procedure (see chapter V.6).	❑/❑	
9.	Regular monitoring of the health status of plants on the plantation (see chapter V and VI).	❑/❑	
10.	Removal of infested plant organs (e.g. branches, whole bushes) in order to reduce or eliminate the source of infection (see chapter V and VI).	❑/❑	
11.	Regular monitoring of pests from early spring in the event of their occurrence on the plantation. The frequency and method of monitoring shall be carried out in accordance with the guidelines described in the methodology for integrated production of blue honeysuckle (syn. Blue honeysuckle) (see chapter VI).	❑/❑	
12.	Creation of appropriate conditions for the presence of birds of prey, i.e. the setting of resting poles (see chapter VI).	❑/❑	

XII. CHECKLIST FOR ORCHARD 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 Crop Protection Products Act?		
3.	Are all required documents (e.g. methodologies, notebooks) present and kept on the farm?	❑/❑	
4.	Is the IP notebook* kept correctly and up to date?	❑/❑	
5.	Does the producer apply fertilisation on the basis of the actual nutrient requirements of the crops, determined in particular on the basis of soil or crop analyses?	❑/❑	
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 expired 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 alerting 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 authorised for IP and use in a given crop or 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 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 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 procedures during the growing season specified on the label of a 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?		

Additional requirements for plant producers (minimum 50% compliance i.e. 6 points)			
No.	**Checkpoints**	**YES/NO**	**Comment**
1.	Were the plant varieties grown selected for Integrated Plant Production?	❑/❑	
2.	Does the applied planting material have a certificate confirming its health status?	❑/❑	
3.	Is each quarter/field marked according to the entry in the IP notebook?	❑/❑	
4.	Are fertiliser application machines maintained in good working order?	❑/❑	
5.	Do fertiliser application machines allow for accurate dose determination?	❑/❑	
6.	Is each fertilisation recorded in the IP notebook taking into account the application form, type, date, amount, place and area?	❑/❑	
7.	Does the producer protect empty PPP packaging against unauthorised access?	❑/❑	
8.	Is the presence of predatory mites, Chrysopidae, ladybirds and other predators in the orchard recorded?	❑/❑	
9.	Does the producer use the available coloured flypaper (boards), traps with pheromones, fragrances, grip bands, useful in a given crop?	❑/❑	
10.	Does the producer have a properly equipped space for collecting waste and rejected crops?	❑/❑	
11.	Are there first-aid kits in the vicinity of workplaces (e.g. storage rooms, utility rooms, cold room)?	❑/❑	
12.	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 non-organic 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.	Is there an irrigation system on the farm that ensures optimal water consumption?	❑/❑	
5.	Is the water used for irrigation tested in a laboratory for microbiological and chemical contamination?	❑/❑	
6.	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?	❑/❑	
7.	Does the producer know how to proceed in the event of spill or scatter of plant protection products?	❑/❑	
8.	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?	❑/❑	
9.	Does the producer improve their knowledge at Integrated Plant Production meetings, courses or conferences?	❑/❑	
10.	Does the producer provide conditions conducive to the survival of the enemies of natural harmful organisms in the surroundings of crops?	❑/❑	
	Total points		

XIII. GENERAL RULES FOR ISSUING CERTIFICATES IN INTEGRATED PLANT PRODUCTION

The intention to apply an integrated plant production system shall be notified annually by the plant producer concerned to the certifying body **within the time limit laid down 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.

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

- completion of IP training;
- compliance with the production methods approved by the Main Inspector of Plant Health and Seed Inspection;
- fertilisation;
- documenting the management of plantations under the IP system;
- 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.

Tests for the maximum permissible residues of plant protection products and the levels of nitrates, nitrites and heavy metals in plants will be carried out on plants or plant products of at least 20 % of plant producers entered in the register of producers carried out by the certifying entity, starting with plant producers for whom there is a suspicion of non-compliance with the requirements of integrated crop production.

The tests are carried out in laboratories properly accredited in keeping with the provisions of the Conformity Assessment System Act of 30 August 2002 or the provisions of Regulation (EC) No 765/2008.

Producers of plant products intended for human consumption should know the values of the maximum permissible pesticide residue level (Regulation (EC) No 396/2005 of the European Parliament and of the Council of 23 February 2005 residue levels of pesticides in or on food and feed of plant and animal origin and on their surface. They should seek to reduce and minimise residues by extending the period between the use of pesticides and harvest.

The currently binding values of maximum permissible residue levels of pesticides in the European Community are published at: https://ec.europa.eu/food/plant/pesticides/eu-pesticides-database/start/screen/mrls.

A certificate issued at the request of the grower attests that integrated plant production principles are followed. An integrated plant production certificate is issued if the grower meets the following requirements:

1) has completed an integrated production plant training and holds a corresponding training certificate, subject to Article 64(4),(5),(7) and (8) of the Act on Plant Protection Products;
2) produces and protects plants in line with the detailed methodology approved by the Main Inspector available on the website administered by the Main Inspectorate for Plant Health and Seed Inspection;
3) uses fertilisation based on the actual plant nutritional needs determined on the basis of, in particular, the analysis of the soil and plants;
4) correctly documents the activities related to integrated plant production;
5) observes hygienic and sanitary rules in the production of plants, in particular those set out in the methodologies;
6) 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.
7) during plant production, observes requirements with respect to plant protection against harmful organisms, in particular, as these specified in the methodologies.

The certificate which confirms the use of integrated plant production is issued for a period necessary for the sale of plants, but no longer than for 12 months.

A plant producer who has received a certificate certifying the use of integrated plant production may use the Integrated Plant Production Mark to label the plants for which this certificate was issued. The sample mark is made available by the Main Inspector on the website managed by the Main Inspectorate of Plant Health and Seed Inspection.

XIV. LITERATURE

Bieniek A., Grygorieva O., Bielska N. 2021. Biological properties of honeysuckle (*Lonicera caerulea L.)*: a review. Agrobiodiversity for Improving Nutrition, Health and Life Quality, 5(2): 287-295. DOI:10.15414/ainhlq.2021.0027

Becker R., Dashbaldan S., Pączkowski C., Golis T., Szakiel A. 2019. Comparison of triterpenoids in leaf cuticular waxes of selected Polish and Russian cultivars and genotypes of edible honeysuckle. Phytochemistry Letters, 30: 238-244.

Berry C., Crowell S., Rusdi-ar M., Cheverie R.M. 2018. Nova Scotia Haskap Berry Best Management Practices. Haskap Growers Association of Nova Scotia. 18 s. https://www.perennia.ca/wp-content/uploads/2018/03/BMP-Haskap-Nova-Scotia-v1.2.pdf.

Burrows R.L., Pfleger F.L. 2002. Arbuscular mycorrhizal fungi respond to increasing plant diversity. Canadian Journal of Botany, 80: 120-130.

Ferris K. 2017. Haskap production and Integrated Pest Management for Yukon Berry Crops. 30 s. https://emrlibrary.gov.yk.ca/agriculture/haskap-production-and-integrated-pest-management-for-yukon-berry-crops.pdf.

Golis T. 2015. Start z jagodą kamczacką. Truskawka, malina, jagody, 8: 38-39.

Golis T. 2007: Jagoda kamczacka cenna roślina do uprawy towarowej. Sad Nowoczesny, 10: 25-27.

Golis T. 2020. Kanadyjskie odmiany jagody kamczackiej. Działkowiec, 6: 30-31.

Golis T. 2021. Jagoda kamczacka ze wschodu. Działkowiec, 6: 32-33.

Golis T. 2021. Uprawa jagody kamczackiej cz. I. Sad Nowoczesny, 7: 40-43.

Golis T. 2021. Uprawa jagody kamczackiej cz. II. Sad Nowoczesny.,9: 56-59.

Golis T. 2022. Jagoda kamczacka czy borówka amerykańska? Działkowiec, 12: 28-29.

Golis T. Peszko D. 2019. Czy uprawa jagody kamczackiej może być opłacalna? Truskawka, malina, jagody, 4: 65-69.

Golis T., Rozpara E., Kruczyńska D. 2017. Polskie odmiany jagody kamczackiej (*Lonicera caerulea* L. var. *kamtschatica* Sevast.) do uprawy towarowej. Oferta wdrożeniowa 2 pages

Golis T., Rozpara E. 2012. Jagoda kamczacka - wartościowy gatunek do uprawy w Polsce. National Conference Science and Practice: 'Intensification of the cultivation of berry bushes through the implementation of the latest research results'. Cultivation of highbush blueberries and little-known berry bushes. 23.3.2012, Skierniewice, 59-62.

Golis T., Rozpara E. 2010. Ocena odmian jagody kamczackiej (*Lonicera coerulea var. edulis*) w doświadczeniach prowadzonych w Instytucie Sadownictwa i Kwiaciarstwa. XLVI National Scientific Horticultural Conference, 29-30.8.2010, Skierniewice: 157-159.

Grewal A.S. 2020. Haskap (*Lonicera caerulea* L.) Response to Plastic Mulch Colours and Fertility Amendments. MSc Thesis. Dalhousie University Halifax, Nova Scotia 114 s. https://dalspace.library.dal.ca/bitstream/handle/10222/80080/Grewal-Arshdeep-MSc-AGRI-November-2020.pdf?sequence=1&isAllowed=y.

Iheshiulo, E.M.A., Abbey L., Hammermeister A.M. 2019. Nutrient sufficiency levels for haskap (*Lonicera caerulea* L.) using the boundary-line approach. Canadian Journal of Plant Science, 99: 268-280.

Jadczyszyn T. 2021. Nowe zalecenia w zakresie wapnowania gleb. Studia i Raporty IUNG-PIB, Zeszyt 65: 99-109.

Lisek J. 1997. Sadowniczy atlas chwastów. Instytut Sadownictwa i Kwiaciarstwa. Skierniewice, p. 129

Mika A. 2004. The importance of biodiversity in natural environment and in fruit plantations. Journal of Fruit and Ornamental Plant Research, 12: 11-21.

Program Ochrony Roślin Sadowniczych. 2024. Praca zbiorowa, Viridia AB, Warszawa, p. 264

Rabcewicz J., Wawrzyńczak P. 2006. Wpływ głębokości roboczej glebogryzarki sadowniczej na efektywność niszczenia chwastów w sadach. Inżynieria Rolnicza, 6: 185-191.

Storkey J., Westbury D.B. 2007. Managing arable weeds for biodiversity. Pest Management Science, 63 (6): 517-523.

Tremblay C, Deslauriers A, Lafond J, Lajeunesse J, Paré MC. 2019. Effects of soil pH and fertilizers on haskap (*Lonicera caerulea* L.) vegetative growth. Agriculture, 9: 56.

Wojdyło A., Nallely-Jauregui P., Carbonell-Barrachina A., Oszmiański J., Golis T. 2013: Variability of Phytochemical Properties and Content of Bioactive Compounds in *Lonicera caerulea* L. *var*. *kamtschatica* Berries. Journal of Agricultural and Food Chemistry. 61: 12072- 2084.

Wójcik P. 2009. Nawozy i nawożenie drzew owocowych. Wydawnictwo Hortpress, Warszawa, 1-252.

Wójcik P., Filipczak J. 2023. Zrównoważone nawożenie i wapnowanie. In: Metodyka Integrowanej Ochrony Jagody Kamczackiej. Collective work edited by M. Kałużna. Instytut Ogrodnictwa-PIB, Skierniewice, 16-21.

Wójcik P., Kowalczyk W. 2021. Nawożenie roślin sadowniczych na podstawie analizy gleby – uaktualnienie liczb granicznych oraz użycie nowych wskaźników glebowych. Instytut Ogrodnictwa-PIB, Skierniewice, 1-20.

Yvoz S., Cordeau S., Ploteau A., Petit S. 2021. A framework to estimate the contribution of weeds to the delivery of ecosystem (dis)services in agricultural landscapes. Ecological Indicators, 132: 108321, https://doi.org/10.1016/j.ecolind.2021.108321.