Guidelines

Integrated Pest Management in Hop Growing

Compiled by the Institute for Crop Science and Plant Breeding
of the Bavarian State Research Center for Agriculture and
the German Hop Growers Association

Deutscher HOPFEN
Verband Deutscher Hopfenpflanzer e.V.

LfL
Pflanzenbau

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The Directive 2009/128/EC of the European Parliament and of the Council of 21 October 2009 establishing a framework for Community action to achieve the sustainable use of pesticides requires member states to adopt national action plans for the sustainable use of plant protection products. These national action plans "are aimed at setting quantitative objectives, targets, measures, timetables and indicators to reduce risks and impacts of pesticide use on human health and the environment and at encouraging the development and introduction of integrated pest management and of alternative approaches or techniques in order to reduce dependency on the use of pesticides". When using plant protection products, the general principles of integrated pest management described in the 8 points of Annex III to the Directive must be observed and have been mandatory since 2014. The provisions of the Directive have been transposed into national law by the Act on the Protection of Cultivated Plants (Plant Protection Act).

Section II of the act regulates the "implementation of plant protection". Here too, §3 (1) states that plant protection may only be carried out in accordance with good professional practice and that the general principles of integrated pest management must be observed. Therefore, the following guidelines are structured in accordance with the 8 principles.

The development of crop or sector-specific guidelines for the use of plant protection products results from an obligation of the member states to implement the Directive on the sustainable use of pesticides (2009/128/EC). The procedure is defined in the national action plan for the sustainable use of plant protection products:

"Crop or sector-specific integrated pest management guidelines shall be developed, further developed and applied on a voluntary basis. Public authorities and/or organizations representing particular professional users may draw up such guidelines and are responsible for ensuring that such guidelines reflect the state of the art in science and technology.
Crop and sector specific guidelines are able not only to support the introduction of integrated pest management in practice and consulting, but are also an important basis for the further development of integrated pest management by indicating where appropriate methods and procedures are not yet available or ready for use."

"The guidelines shall include at least a detailed implementation of the general principles of integrated pest management for the crop or sector concerned. Following the eight general principles, the currently available and practicable (non-chemical and chemical) methods and plant protection practices shall be described."

In the following, the general principles of integrated pest management for hops are specified and summarized as **guidelines for integrated pest management in hop growing**. These are subdivided into **General Guidelines**, which apply to all aspects of plant protection in hop growing, and **Pest-specific Guidelines**, which contain detailed instructions for dealing with the major hop pests. As a dynamic system, the guidelines must be continuously adapted to future developments. This may become necessary due to a changed occurrence of pests, technical developments or new findings from research and practice, for example.

Specifications
Goals
Measures
Schedules

General Guidelines

Preventive Measures

In order to limit the use of chemical plant protection products to the necessary minimum, appropriate measures must be taken to prevent the emergence of critical infestation situations. For this reason, all arable and plant cultivation measures aimed at establishing and maintaining healthy and efficient hop gardens and counteracting infestation by harmful organisms are part of integrated pest management.

Sites

Sites and growing/planting systems (row spacing, plant spacing in the row, trellis height) are to be selected and designed so as to counteract infestation by pests, to allow efficient application procedures for plant protection measures, to avoid drift and erosion, and to ensure that herbicides are applied as far as possible to only one third of the area on the rows.

Before new planting, the suitability of the site must be checked and a soil analysis made. By preference, sites should be chosen with good rootable soil depth, good water conditions and low slope inclination. Soils prone to standing water or compaction should be avoided as far as possible.

Erosion

To reduce soil erosion, a hop garden is best planted on a flat or only slightly sloped surface. The rows should be laid out transversely to the slope on flat and evenly inclined slopes, and in the direction of the slope on more inclined slopes. Erosion protection measures are to be carried out here, especially on large slopes: Interruption of the rows with 3-5m wide grass strips, reduction of soil tillage, additional sowing of a catch crop and permanent greening of the headland.


Standing water

Catch crop between the hop rows

Crop rotation

In order to rehabilitate the soil and reduce the transmission of disease from old hop shoots to new plantings, a minimum of one year's break from cultivation should be observed after grubbing up old hop plantations. If the area is infected with aggressive strains of the soilborne fungus Verticillium nonalfalfae, the cultivation break should be 5 years, during which only monocotyledonous plants are to be grown on the area (cereals, maize, grasses).

Catch crops should be grown between hop rows in order to increase soil fertility, protect against erosion and reduce nitrate migration. Common species for catch crop sowing are winter rape, winter beet, oil radish, mustard, winter rye, triticale and green rye, or seed mixtures. It should be noted that all cruciferous plants are intermediate hosts for the Verticillium wilt and other soilborne diseases and should therefore not be grown in wilt infected hop gardens.

In order to prevent downy mildew and powdery mildew infections, the entire area around the hop gardens should be free of wild hops and/or volunteer hops (poorly cleared hop gardens), because wild hops are potential sources of infection that endanger neighboring hop gardens.

Varieties and planting stock

No varieties designated as susceptible should be used in pest infested areas, provided that marketable, resistant or less susceptible varieties are available. The authorized hop varieties are assessed for their resistance to Verticillium wilt, downy mildew (secondary infections), powdery mildew, botrytis, the common spider mite and aphids. The description of the variety characteristics and the information on the resistance of varieties to diseases and pests in the annually updated consulting brochure "Grünes Heft Hopfen" (Green Book – Hops) should be taken into account.
In order to build up healthy stocks, own plant material (cut, potted or root rhizomes) should only be taken from old plants free of Verticillium and viruses. In the case of purchased planting stock, a plant passport must be issued and delivered by the seller.

Soil tillage

Soil tillage must be carried out in a way that is appropriate to the site and situation, sustains soil fertility, counteracts infestation by weeds and pests, and avoids ecological pollution. The aim of soil tillage is to conserve humus and control weeds in the process. This means doing as little soil tillage as possible and as much as necessary. Soil erosion and soil compaction in the aisles should be avoided as far as possible.

Plant care measures

Hop pruning in spring is used to control pests (downy mildew, powdery mildew, common spider mite), to rejuvenate the rootstock, to control shoots, to mechanically control weeds and, if necessary, to gain rhizomes. The pruning time should be scheduled according to the type and cutting too high or too low should be avoided. If the hops were infected with downy mildew in the previous year, the primary infection can be reduced by a deeper cut of the hop. When training, it should be noted that with more than 2 shoots per hop string, the susceptibility to mildew in some varieties increases due to the denser foliage.

Hop stripping and suckering: A favorable microclimate for diseases and pests is created on the newly sprouting lower shoots of the hop rootstock and the leaves and side shoots close to the ground. Some of the lower shoots are already infected with downy mildew (spikes) and powdery mildew. The lower shoots, lower leaves and side shoots should be removed to reduce the infestation pressure of downy mildew, powdery mildew and common spider mite. Manual, mechanical and thermal processes should have priority over chemical plant protection measures. If there is a need for fertilizer at the same time, a comparable effect can be achieved by the application of liquid nutrient solutions in the lower bine area. This burns leaves, side and lower shoots and dries them out. The nutrients applied must be fully taken into account for the fertilization.

Manual, mechanical and thermal processes should have priority

Hop pruning

Fresh, undecomposed shredded hop bines

Decomposed shredded hop bines

Fertilization and irrigation

Organic and mineral fertilization and, if necessary, irrigation must be adapted to the needs of the plants and designed in such a way that infestation by weeds and pests is not encouraged. It should be noted that excessive N fertilization and dense, leafy bines can promote the occurrence of powdery mildew and Verticillium wilt. Feeding nutrients into the irrigation water as required ensures more efficient nutrient utilization, fertilizer quantities can be saved and harmful effects on the environment in the form of runoff and leaching can be reduced.

Hygiene measures

Fungal diseases often persist on harvest residues such as shredded hop bines. If these are left lying or are returned to the hop garden unhygienized, new infections for next year's hops can be fostered or soilborne diseases such as the Verticillium fungus can be enhanced. The following points should therefore be observed as a matter of precaution:

- No spreading of fresh, undecomposed shredded hop bines in hop gardens.
- The perimeters of the shredded hop bine heap are not sufficiently hygienized, since the necessary temperature of 60°C for the reliable destruction of the pathogens is achieved only at a depth of about 1m. This is why the affected perimeter zones should be spread on other arable land.

No spreading of fresh, undecomposed shredded hop bines in hop gardens!

Note

Promotion and Use of Natural Regulatory Mechanisms

All practicable[1] measures to protect and foster beneficial organisms and natural control mechanisms are to be used. Plant protection measures are to be carried out in such a way that the hop garden ecosystem does not suffer any lasting harm and that the effect of natural enemies to pests is maintained as far as possible. Essential elements of the protection and promotion of beneficial organisms:

- Use of plant protection products that protect beneficial organisms.
- Sowing of catch crops between hop rows.
- Greening of the headland.
- Setting up of perches for birds of prey on open spaces between hop gardens.
- Preservation and promotion of fringe structures (field boundaries, hedges, field shrubs) that encourage beneficial organisms.
- Erection of nesting boxes for songbirds, stone piles, insect hotels, etc.

The more diverse the agricultural areas, the more stable they are. Therefore – as far as possible – it is necessary to create and maintain a balanced, natural environment for the hop plantations and thus a diverse ecosystem for plants and animals. Structural elements and small structures outside the production areas are of particular importance to promote biodiversity and ecological stability. They must be preserved, maintained and, where necessary, created anew.

Measures of regional agri-environmental programs that contribute to integrated pest management and aim at promoting natural control mechanisms and biodiversity should be adopted and implemented by farms, where appropriate.

1 Practicable: economical, effective and proven.

Fostering of beneficial organisms – ladybird

Fringe structures (field boundaries, hedges, field shrubs) that encourage beneficial organisms

Pest Monitoring and Decisions about Control Measures

Hop gardens must be regularly inspected for development and health. Before control measures are applied, the pest infestation must be determined using proven direct and indirect methods on site or predicted with science-based forecast models. The latest warnings of the state hop advisory service must be observed and/or qualified advisers can be called in for plant assessment. Recommendations for the determination of infestation are described in the pest-specific guidelines.

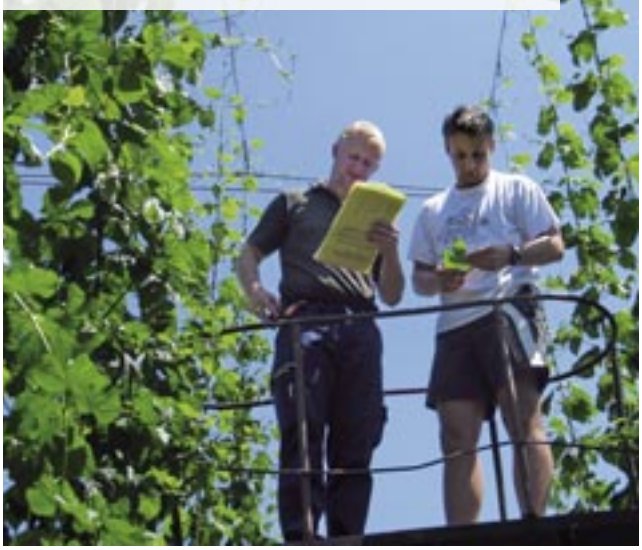
The need for defense or control measures is to be based on the pest infestation applying recognized control thresholds. If determination of infestation and/or the application of control thresholds are not possible or not practicable and other decision aids, e.g. forecast models or warnings of the state hop advisory service are available, these should be used.

If the infestation is in the range around the control threshold, further decision aids (occurrence of other pests, weather forecast, susceptibility of the variety, occurrence of beneficial organisms, information about the resistance behavior of the pests, etc.) and regional experience should be included.

The possibility of treating partial areas should be examined in the event of varying degrees of infestation.

In addition, the hop growing instructions and plant protection recommendations of the official hop advisory service (news faxes, internet instructions) as well as the recommendations in the consulting brochure "Grünes Heft Hopfen" (Green Book – Hops).

On-site advice through the Hop Ring



Preference of Non-chemical and Use of Chemical Plant Protection Products

Non-chemical defense and control methods are to be preferred to the use of chemical plant protection products, provided that practicable and environmentally sound methods are available.

Non-chemical defense and control methods include biological, biotechnical and physical measures (e.g. manual, mechanical and thermal methods).

Non-chemical defense and control methods instead of chemical plant protection products

Their application is usually very specific and can be more complicated, labor-intensive, costly and less efficient than the application of chemical crop protection products. Users are therefore recommended to use relevant advisory services and subsidies (Länder programs) for the implementation of non-chemical defense and control methods (if available).

These include:

- Manual, mechanical and thermal methods for hop stripping and suckering.
- Use of the caustic effect of nutrient solutions for hop stripping and suckering.
- Fencing-in or spreading of repellents to prevent game browsing.
- Biological methods (predatory mites) to control spider mites.
- Mechanical and/or thermal methods for controlling weed grass and weeds.
- Pruning last year's hop shoots.
- Removing infested shoots and bine parts.

Mechanical hop stripping and suckering with a leaf vacuum cleaner

Thermal weed control in the rows

If no practicable, non-chemical defense and control measures are available, the **use of chemical plant protection products** in the case of infestations requiring control is a sustainable measure in the sense of integrated plant protection to protect hops from pests and to avert economic damage.

The **choice of products** must be based on the indication, the respective approval situation, the time of application and the application technology as well as the application regulations (e.g. distance requirements). The selected plant protection products should be as specific as possible to the target organisms and have the least impact on human health, non-target organisms and the environment.

The use of chemical plant protection products is to be limited to the **necessary minimum**. Full use should be made of the possibilities of reduced application volumes depending on the development stage and water application volume, as well as the limitation of the measures to partial areas. Plant protection product savings can also be achieved by using sensor technology in early applications of plant protection products.

Keep it to the necessary minimum!

Sensor technology in hop growing

The application of herbicides and hop stripping and suckering may only be carried out on the row on approx. one third of the total area. If only the perimeter of the hop garden is affected by the spider mite infestation, it is sufficient to treat it.

In order to avoid drift, save plant protection products and ensure successful control, a suitable, functionally reliable plant protection technology tested every three years must be used, which can reduce drift by up to 90%.

With sprayers this is achieved by using TurboDrop nozzles, covering the outer fan outlet opening and two one-sided spraying runs along the edge rows. Furthermore, the danger of drift is reduced by switching off the sprayer in good time before turning, already before the last bine.

Where there is a risk of **resistance** of pests to plant protection products, available resistance avoidance strategies are to be initiated. The instructions and specifications of the official hop advisory service and the manufacturers of plant protection products for the prevention of resistance and for the implementation of resistance avoidance strategies must be observed in order to maintain the effectiveness of the products. Thus, for example, active ingredients should be changed in spraying sequences or during repeated treatments in order to avoid the formation of resistance.

Success Monitoring and Documentation

The **effectiveness** of plant protection measures is to be checked by appropriate methods, infestation checks, for example. Success monitoring is a necessary prerequisite for subsequent control decisions to be taken properly. In case of doubt, technical advisors should be consulted.

The documentation of all plant protection measures carried out must be made promptly and transparently in accordance with the statutory regulations.

The hop and garden-specific records are to include the date of use, the exact name of the plant protection product, the application dose and the name of the user.

Records: Date, product, dose, user

Pest-specific Guidelines

Pests

Hop leaves infested with hop flea beetle.

Hop Aphid

(Phorodon humuli)

Preventive measures	Reason/explanation
Consider the different susceptibility of varieties for new plantings, also taking marketing factors into account.	The hop aphid infests all hop varieties every year. However, a difference of susceptibility between the varieties has been observed. In general, high-alpha varieties such as Hallertauer Magnum and Herkules are infested by preference. The aroma variety Spalter Select has a low attraction for the winged hop aphid (aphis fly).
In order to foster beneficial organism species that act as natural enemies, existing fringe structures along the hop gardens (field boundaries, hedges and field shrubs) are to be preserved and maintained.	Many species of beneficial organisms use fringe structures for hibernation. The natural predators of hop aphids include, among others, ladybirds, green lacewings, flower flies, ichneumon flies, numerous species of spiders and predatory gall midges and true bugs.
Monitoring methods	**Reason/explanation**
The arrival and occurrence of the hop aphid is to be monitored by regular checks and on the basis of information from the official hop advisory service (e.g. Hopfenring / Hop Ring news fax).	From mid to late May, winged aphids (aphis flies) leave their winter hosts (stone fruits) to colonize the young leaves on the shoot tips of the hop plants. The mass propagation takes place on the underside of the leaves. The aphids spread over the entire plant and later also colonize the flowers and cones. Badly infested plants are retarded in their growth and form only a few or stunted cones. The leaves and cones also become sticky and shiny from the excretions of the insects, the so-called "honeydew". Sooty molds that feed off the "honeydew" cause the "blackness" on the infested plants.

Hop Aphid

Threshold values	Reason/explanation
Before flowering: An average of 50 aphids per leaf or 200 aphids on individual leaves.	Depending on the weather, a mass propagation of the aphids on the hops is possible as of the end of May. Warm, humid weather is particularly favorable for this. Heavily infested leaves claw downwards and plant growth is retarded.
From flowering onwards: The hops should be extensively free of aphids.	Badly infested plants produce only few or stunted cones. Diminished yields through to total loss. Stunted and blackened cones lead to loss of quality.
Direct control measures	**Reason/explanation**
Targeted application of insecticides that are as harmless as possible to beneficial organisms, taking into account the control thresholds and advice from the official hop advisory service (e.g. Hopfenring / Hop Ring news fax).	At the time of insecticide application, summer temperatures with warm nights are advantageous. The aphids then feed a lot and reach the lethal dose. Active substances, which have to penetrate into the leaf tissue and spread, should not be applied after prolonged periods of heat and drought if a pronounced wax layer is present. Treatment after preciptation is favorable here when the leaves are "soft" again.
Limiting to the necessary minimum	**Reason/explanation**
In the case of tolerant varieties (e.g. Spalter Select) and/or low occurrence in individual years, direct control of the hop aphid is not necessary in many areas. The targeted application of insecticides should therefore only be carried out after checks have been made and the control thresholds have been reached.	The absence of insecticides encourages proliferation of the natural predators of the hop aphid. In the best case the beneficial organisms can decimate the aphids to such an extent that no economic damage need be feared.
Resistance avoidance strategies	**Reason/explanation**
In case of delayed application, the effect is no longer sufficient and the risk of resistance formation is significantly higher.	If the application is too late, especially in case of dense foliage or if the aphids are already protected by the flowers and cones, even and sufficient moistening is no longer guaranteed, which results in inadequate control. The risk of resistance is increased if the absorption of the active ingredient is low.
Active ingredients should be changed during follow-up treatments.	If the same active ingredient or preparations from the same active ingredient group are used repeatedly, the increased selection pressure leads to faster resistance. The consulting brochure "Grünes Heft Hopfen" (Green Book – Hops) provides information on the active substance group of the different preparations.

Common Spider Mite

(Tetranychus urticae)

Common Spider Mite

Preventive measures	Reason/explanation
Early hop stripping and suckering delays infestation with the common spider mite.	The common spider mite colonizes the hop shoots from the ground. The initial infestation can be greatly reduced by defoliating the lower regions of the hop bines and removing the lower shoots.
In order to foster beneficial organism species that act as natural enemies, existing fringe structures along the hop gardens (field boundaries, hedges and field shrubs) are to be preserved and maintained.	Many species of beneficial organisms use fringe structures for hibernation. Predatory mites, for example, are among the natural enemies of the common spider mite.
Monitoring methods	**Reason/explanation**
Common spider mite infestation is to be monitored by regular checks and with the help of information from the official hop advisory service (e.g. Hopfenring / Hop Ring news fax). To check for incipient infestation, the undersides of the lower leaves of the edge rows or preferred areas of colonization are to be examined with a magnifying glass for spider mites and their eggs.	The occurrence of spider mites is particularly severe in hot, dry years. Infestation begins on the lower leaves of the plant. More or less pronounced yellow spots appear on the leaves depending on the variety. The spider mites and their whitish glassy eggs can usually only be seen with a magnifying glass. In the case of stronger infestation, a fine web on the undersides of the leaves is visible even to the naked eye. In the case of very severe infestation in high and late summer, the sucking action of the animals quickly turns leaves and cones to copper red; hence the damage pattern designation of "copper browning".
From the time of flowering onwards, the leaves and developing cones at the top must also be monitored using a tower.	
Threshold values	**Reason/explanation**
A rough rule of thumb for the **first treatment** is that light infestation (up to 10 spider mites or 30 eggs) on every second monitored leaf already represents a spider mite infestation worth controlling. If there is still slight infestation, especially in the upper regions, 2-3 weeks after the first treatment, **subsequent treatment** is necessary depending on the course of the weather and the time to harvest.	The spider mite infestation develops at different rates depending on the annual weather conditions. Intensive checks are necessary from around mid-June onwards. These checks should not be limited to just the lower third of the hop bines and by mid-July they must include the whole bine, because spider mites very quickly "transmigrate" upwards and the entire plant might be colonized in a very short time. The spider mite population normally grows through to harvest time. If the cones are attacked, considerable losses in yield and quality through to total loss are possible. *Intensive checks are necessary from mid-June onwards.*

Common Spider Mite

Direct control measures	**Reason/explanation**
Targeted application of acaricides that are as harmless as possible to beneficial organisms, taking into account the control thresholds and advice from the official hop advisory service (e.g. Hopfenring / Hop Ring news fax).	It is best to apply acaricides on warm days and nights. The spider mites are more active then and are more likely to come into contact with the active ingredient through feeding or direct contact. For good control success, contact agents must be sufficiently moistened and evenly spread. The amount of water used must be adapted to the plant development and foliage.
Limiting to the necessary minimum	**Reason/explanation**
Common spider mite infestation is different from year to year and from hop garden to hop garden, so that direct control of the spider mite is not necessary in many areas. The targeted application of acaricides should therefore only be carried out after thorough checks have been made at the preferred sites of infestation and the control threshold has been reached.	The absence of acaricides encourages proliferation of the natural enemies of the spider mite, like predatory mites. In the best case the beneficial organisms can decimate the spider mites to such an extent that no economic damage need be feared.
Since the colonization usually takes place from the field edges, it often suffices to treat partial areas or the edges to combat the pest.	Treating partial areas is easier on the environment and spares the natural enemies on the rest of the hops. In the best case, they can keep the remaining spider mite population in check without causing any economic damage.
Resistance avoidance strategies	**Reason/explanation**
For spider mite control, the correct application time and a good application technique are decisive for successful control. Infestations detected too late are difficult to control. Even multiple applications are no longer sufficiently effective and the risk of resistance formation is significantly higher.	If the application is too late, the application conditions are unfavorable or too little water is used, especially in case of dense foliage or if the spider mites are already protected by the flowers and cones, even and sufficient moistening is no longer guaranteed, which results in inadequate control. The risk of resistance is increased if the absorption of the active ingredient is low.
Active ingredients should be changed during follow-up treatments.	If the same active ingredient or preparations from the same active ingredient group are used repeatedly, the increased selection pressure leads to faster resistance. The consulting brochure "Grünes Heft Hopfen" (Green Book – Hops) provides information on the active substance group of the different preparations.

Spider mites can colonize the whole plant in a very short time.

Alfalfa Snout Weevil/Lovage Weevil

(Otiorhynchus ligustici)

The alfalfa snout weevil leaves clearly visible feeding spots on the shoot tips.

Alfalfa Snout Weevil/Lovage Weevil

Preventive measures	Reason/explanation
Report sites of infestation of new plantings.	The flightless beetle has a multi-year development cycle and survives as a larva or beetle in the ground. With severe infestation the hop plants are so greatly weakened by beetle and larvae feeding that the yield is impaired or whole plants are lost.
Monitoring methods	**Reason/explanation**
Check the ground near the junctures for holes of 0.5cm; check the shoot tips after they appear and through to hop stripping and suckering for beetle infestation and feeding spots.	In early spring (April and May) the dark, approx. 1cm large, flightless beetle comes to the surface to feed on the tips of the hop shoots. This is when holes of about 0.5cm can be observed in the ground. On the arable land, very careful observation is needed to recognize the alfalfa snout weevil. Clearly visible, however, are the fresh, light green feeding spots on the shoot tips.
Threshold values	**Reason/explanation**
One beetle per 3 hop plants.	As the flightless beetles like to transmigrate and cover considerable distances, several hop plants can be infested by just one beetle.
Direct control measures	**Reason/explanation**
No plant protection product is currently authorized.	If an authorized plant protection product becomes available again, it is important in the case of contact agents that the weather is warm and sunny at the time of treatment to ensure that the beetles leave the ground and come into contact with the active substance.
Limiting to the necessary minimum	**Reason/explanation**
If a plant protection product is permitted again, contact insecticides should only be applied at warm temperatures after the control threshold has been reached.	Treating at the right time is decisive for successful control. At temperatures of over 20°C at midday and in the early afternoon the beetle is active and most likely to be found.
Application is to be limited to the hop rows.	The space between the hop rows is usually 3.20m. The row treatment involves spraying a belt about 1m wide, so that the plant protection product is applied to only one third of the area.
After training the hops, treatment is no longer useful from a growth height of 2m upwards.	After a certain growth height of the hop plant there is abundant food supply for the beetle. The risks of spray treatment would outweigh the expected benefits.

Beetle and larvae feeding weakens the hop plants.

Hop Flea Beetle

(Psylliodes attenuatus)

The hop flea beetle causes damage similar to that of downy mildew.

Hop Flea Beetle

Preventive measures	
None!	
Monitoring methods	**Reason/explanation**
Hop flea beetle infestation is to be monitored by regular checks in spring during hop sprouting and in summer at the time of cone development, as well as with the aid of information from the official hop advisory service (e.g. Hopfenring / Hop Ring news fax).	The metallic greenish-brownish shiny adult beetles are 2-2.8mm long and half as wide. Flea beetles are easily identified by their large back legs which they use for jumping up to 60cm high or wide. Flea beetles have one generation per year. The adult beetles overwinter in all kinds of suitable hiding places such as in the ground litter, under bark or in the cracks of hop poles. In spring, they become active at temperatures above 5°C, leave their winter habitats and feed on the leaf tissue on the hop shoots. In the case of heavy infestation, the leaves look as if they have been peppered with shotgun pellets or are almost skeletonized. This leaf damage is no longer significant when the hops have attained a height of about 1m. Eggs are laid in the ground in May and June and then the old beetles die off. The larvae and pupae live in the ground for seven to ten weeks before the new generation of beetles hatches in mid-July. Now, in addition to the hop leaves, the flowers, bracts and sprigs are eaten. The cones might now also suffer from damage similar to that of downy mildew as well as the shot-hole feeding.
Threshold values	**Reason/explanation**
In **spring**, it is worth controlling severe infestation with massive shot-hole feeding on the hop shoots. As a rule, infestation can be tolerated by hops with a growth height of 1m and more.	Massive infestation in spring can greatly weaken the hop shoots and growth up to a height of about 1m.
In **summer**, massive infestation with damage done to the cones makes controlling necessary.	A strong presence of the new flea beetle generation as of mid-July damages the hops through feeding on the flowers and cones, and leads to losses in yield and quality.
Direct control measures	**Reason/explanation**
Spring: Targeted application of insecticides that are as harmless as possible to beneficial organisms, taking into account the control thresholds and advice from the official hop advisory service (e.g. Hopfenring / Hop Ring news fax).	Insecticide should be applied on warm days, as it is important for contact agents that warm sunny weather prevails at the time of treatment to ensure that the beetles leave their wintering grounds, feed on the hops and thus come into contact with the active ingredient.
Summer: No plant protection product is currently authorized for controlling the hop flea beetle in the summer.	

Hop Flea Beetle

Limiting to the necessary minimum	Reason/explanation
Contact insecticides should only be applied at warm temperatures after the control threshold has been reached.	Treating at the right time is decisive for successful control. The beetle is active and most likely to be found in warm temperatures at midday and in the early afternoon.
Application is to be limited to the hop rows.	The space between the hop rows is usually 3.20m. The row treatment involves spraying a belt about 1m wide, so that the plant protection product is applied to only one third of the area.
After training the hops, treatment is no longer useful from a growth height of 1m upwards.	After a certain growth height of the hop plant the leaf loss is in no relation to the new growth, so that damage due to inhibition of growth is no longer to be feared.
Hop flea beetle infestation is different from year to year and from hop garden to hop garden, so that direct control of the hop flea beetle is not necessary in many areas. Insecticides should therefore only be applied after thorough checks have been made and the control thresholds have been reached.	The absence of insecticides in spring promotes beneficial organisms in the hop garden and can contribute to the decimation of other pests.

Resistance avoidance strategies	Reason/explanation
Since only one active ingredient (lambda-cyhalothrin) is permitted for controlling the hop flea beetle in spring and no product is available for controlling the summer generation, resistance avoidance strategies are simply not possible!	If the same active ingredient or preparations from the same active ingredient group are used repeatedly, the increased selection pressure leads to faster resistance formation.

Feeding traces of the hop flea beetle

Wireworm

(Agriotes spp)

Preventive measures	Reason/explanation
Avoid the planting of new hops on infested areas or after plowing of acreage that has been set aside.	Wireworms are the larvae of click beetles. The click beetle usually lays its eggs on overgrown soil, preferably grassland or set-aside land. Since the harmful larvae have a development cycle of many years, hops should only be grown on once infested acreage after it has been used as arable land for several years.
Monitoring methods	**Reason/explanation**
To check for infestation, in the spring before the hops shoot, baits such as carrots, potato halves or germinated cereal grains can be placed 5-6cm deep into the soil near the hop crowns and checked for feeding spots. With incipient infestation, information from the official hop advisory service (e.g. Hopfenring / Hop Ring news fax) should also be referred to.	Wireworms infest young roots and shoots that are still below the surface and cause damage through feeding. It is usually the shoot heads that are damaged causing them to die back. In the case of young hops, the shoot tips which have just emerged above the surface very often turn brown, become brittle and die. Wireworms feed mainly in spring and autumn at temperatures of 10-17°C. Young hops that do not yet possess adequate roots are particularly jeopardized; in the case of severe infestation they react with diminished shoots and even rootstock loss.
Threshold values	**Reason/explanation**
–	Control thresholds are not known for hops or have not yet been defined.

Wireworm

Direct control measures	Reason/explanation
Insecticides which are introduced into the soil in the region of the hop crowns by the irrigation method (single-plant treatment). No plant protection products are currently authorized.	If an authorized plant protection product becomes available again, the following should be observed for pest control: Since the wireworms in the soil damage the hop crown and the young shoots before sprouting, the control must be carried out at the beginning of vegetation as soil application in the region of the crown.
Limiting to the necessary minimum	**Reason/explanation**
If a plant protection product is approved again for irrigation treatment, the application should be restricted to the region around the hop crowns.	The space between the hop rows is usually 3.20m. The plant spacing is 1.40-1.70m depending on the hop variety. With the irrigation method, about 200ml of the spray mixture is applied in the region of the hop crown so that the plant protection product is applied to only a small area of the hop garden.
Wireworm infestation is severe only in individual hop gardens, so that direct control of the wireworm is not necessary in most areas. Insecticides should therefore only be applied after thorough checks have been made.	The absence of insecticides in spring promotes beneficial organisms in the hop garden and can contribute to the decimation of other pests. *Pest control at the beginning of vegetation*

Rootstock loss through wireworm

Slugs

Preventive measures	Reason/explanation
Increased tillage between the hop rows.	Repeated thorough tillage between the hop rows ensures that catch crops and associated flora are plowed in and deprives the slugs of their food supply. Intensive tillage also destroys the slugs' habitats and the eggs and adult animals are left to dry out on the surface. Intensive tillage is not recommended on erosion-prone areas, as this causes humus depletion and thus soil erosion is promoted by the lack of vegetation or little mulch material on the soil surface.
Monitoring methods	**Reason/explanation**
To check for infestation, in the spring before the hops shoot, check for feeding spots and/or slime trails. The field emergence of catch crops should also be checked for slug infestation in summer or autumn.	With slug infestation the leaves are covered in slime trails and irregular shot-hole feeding can be observed. Badly affected leaves are skeletonized, i.e. the tissue has been eaten away between the leaf veins.
Threshold values	**Reason/explanation**
Badly infested to skeletonized leaves on the hop shoots and catch crops.	Damage through to total destruction due to feeding can occur in young hops and in the sowing of catch crops.
Direct control measures	**Reason/explanation**
Molluscicides should be applied in the case of severe slug infestation.	An even distribution of the preparation on the infested surface is decisive for a good control success, since the attraction only works in the range of a few centimeters.
Limiting to the necessary minimum	**Reason/explanation**
Slug infestation varies in intensity over the acreage so that it often suffices to treat partial areas or the edges.	Slugs often come in from the field borders. If an incipient infestation is spotted early, treating the field edges usually suffices to control the pest.

Game Browsing

Game browsing damage to young hops: It helps to repel wild animals using hair bags and scent strips or optical and acoustic repellent mechanisms.

Game Browsing

Preventive measures	Reason/explanation
Repel wild animals using bags of hair and scent strips or optical and acoustic repellent mechanisms.	Human hair and game repellents like "Hukinol", which smells intensively of human sweat, have a deterrent effect on wild animals. Similar effects are achieved with repellents like "Wildschwein-Stopp" (wild boar stop) or the liquid fertilizer "Aminosol". Reflective plastic cords and acoustic devices have also had deterrent effects. However, the deterrent effect lasts only for a limited period because after a while the wild animals get used to the smell and the optical and acoustic mechanisms.
Complete fencing of the hop gardens.	Where there is great danger of game browsing it is recommended to completely fence the hop gardens. Optimum is broad-mesh fencing 1.2m to 1.5m high.
Monitoring methods	**Reason/explanation**
Check hop gardens close to woods for game browsing damage in spring and for fraying damage to the hop bines during the summer.	Enormous damage can be done to hops through game browsing particularly in spring. The wild animals, especially roe deer and red deer, graze the young, fresh shoots. Large-scale problems can also be caused by hare, rabbits and wild boar. Fraying damage to high hop bines is caused by roe deer during the summer and this leads to the drying up of individual shoots and trained bines due to damage to and interruption of the plant's water supply system.
Threshold values	
None	
Direct control measures	**Reason/explanation**
Spraying the young hop shoots several times with the animal repellent "Trico".	The plant protection product based on sheep fat repels game animals and may be used up to 3 times per season.
Limiting to the necessary minimum	**Reason/explanation**
Repellents should only be applied alternately and to a limited extent in order to reduce the habituation effect.	Although the deterrent and repellent methods described do not pose a material environmental risk, the effects on other wild animals are not known in detail. Use should therefore be limited to the necessary minimum.
Fences are to be removed after the danger of game browsing has passed.	In order to allow wild animals unhindered access to natural habitats, fences should be dismantled at the end of the risk period. *Limited use only of deterrents!*

Vole runway along the hop row

Field Mice and Voles

Preventive measures	Reason/explanation
Exposure of the mouse runways in the rows through timely abutting in autumn. Deep and intensive tillage between the rows.	Tillage in the rows as well as deep and intensive tillage between the hop rows get rid of the nests of field mice built in the soil. The tillage also destroys the vole runways and removes cover. Intensive tillage is not recommended on erosion-prone areas, as this causes humus depletion and thus soil erosion is promoted by the lack of vegetation or little mulch material on the soil surface.
In order to encourage the natural enemies of the mice, it is recommended to set up perches for birds of prey between the hop gardens in endangered locations.	Birds of prey such as buzzards and barn owls help to reduce the number of mice and voles.
Monitoring methods	**Reason/explanation**
The occurrence and population growth of field mice and voles should be observed in the hop garden, but also on adjacent areas and border structures (embankments, hedges).	Earth mounds as well as numerous holes and runways in the ground indicate an increased population density of field mice and voles.
Threshold values	**Reason/explanation**
Severe infestation and damage to the crowns.	Field mice and voles feed on the roots and subterranean shoots of hop plants. Young hops that do not yet possess adequate roots are particularly jeopardized; in the case of severe infestation they react with diminished shoots and even rootstock loss.
Direct control measures	**Reason/explanation**
Use of rodenticides with the active ingredient zinc phosphide in the event of severe infestation and damage to the hop crown.	The bait should be placed so that it is inaccessible to birds in accordance with the instructions for use, e.g. by using a dosing device to place the bait deep enough into the rodent burrows so that no bait remains on the surface.

Leafroller moth (Cnephasia alticolana)

Caterpillars

taking the examples of the leafroller moth and rosy rustic moth

Rosy rustic moth (Hydraecia micacea)

Caterpillars

Preventive measures	**Reason/explanation**
Removal of quackgrass and tall grasses at the edge of the field and in the hop garden.	The rosy rustic moth lays its eggs during the summer, preferably on quackgrass or high-growing grasses where they overwinter.
Monitoring methods	**Reason/explanation**
In the spring, the shoots must be monitored for symptoms of infestation from the time when the hops are trained.	**Leafroller moth:** The damaging caterpillar is a dirty dark grey-green to black-brown, has 16 legs, is thinly haired with big black warts and fully grown can be up to 1.5 cm long. From May onwards, the caterpillars feed on the leaves and shoot tips of the young hop plants, especially during the warm and dry spring weather, when the heads are gnawed on and bend ("nettle heads").
	Rosy rustic moth: The caterpillar of the Rosy rustic moth occurs more frequently in individual years and can cause economic damage through shoot and rootstock loss. As of end of April, initial infestation can be observed on individual young hop shoots which bend like hooks and start to wilt from the tip. Inside the upper third of the shoot you find the small caterpillars, a few millimeters long. In the further course the caterpillars leave the shoot and migrate to the base of the bine. There they feed from the outside on shoots, roots and rootstock until the end of June, which can lead to die-off in the case of severe infestation. In July, after the pupation, the reddish-brown pupa hatches into a nocturnal butterfly, the rosy rustic moth. It lays its eggs during the summer on high-growing grasses, preferably quackgrass, where they overwinter.
Threshold values	**Reason/explanation**
–	Control thresholds are not known for hops or have not yet been defined.
Direct control measures	**Reason/explanation**
Early, targeted application of insecticide on infested areas.	If the infestation is detected during hop stripping and suckering and training, the insecticide should be applied after the work has been completed.
Limiting to the necessary minimum	**Reason/explanation**
Infestation with caterpillars only occurs more strongly in individual hop gardens and individual years, so that direct control is only necessary in rare cases. Insecticides should therefore only be used after infestation has been detected.	Since insecticides are only used in exceptional cases when infestation is detected in the spring, beneficial organisms are usually promoted in the hop garden and can contribute to the decimation of pests.

Diseases

Downy mildew infection

Primary infection

Downy Mildew

(Pseudoperonospora humuli)

Secondary infection

Downy Mildew

Preventive measures	Reason/explanation
Consider the different susceptibility of varieties for new plantings, also taking marketing factors into account.	Downy mildew is the major hop disease and infests all hop varieties every year. However, a difference of susceptibility between the varieties has been observed. Old landrace varieties and foreign breeds like Northern Brewer and Nugget are generally very susceptible. The Hüll breeds are more tolerant with the exception of the Saphir aroma variety. The classification of the individual varieties with regard to their resistance to downy mildew is given in the consulting brochure "Grünes Heft Hopfen" (Green Book – Hops).
Deep pruning in spring.	If the hops were infested with downy mildew in the previous year, the pathogen, which overwinters at the base of the bine as a mycelium, can be removed by deep pruning of the hops in spring. The hops sprout healthier.
Elimination of wild and volunteer hops in the vicinity of the hop gardens.	Wild and volunteer hops are dangerous sources of downy mildew infection. Since the zoosporangia are spread with the wind, hop gardens in the near vicinity of these infection sources can be infested more intensively. For this reason farmers and landowners in the hop growing regions are obliged by law to train hops up to a height of at least 4m (young hops 1.5m), treat them sufficiently (at least 3 times) with plant protection products or clear them by grubbing up by June 15 at the latest.
Monitoring methods	**Reason/explanation**
Primary infection: The main, lower and side shoots should be checked for symptoms of primary downy mildew infection (spikes) from sprouting to beginning of June (approx. ¾ trellis height). **Secondary infection:** From May (after the hop training) the leaves and later also the hop cones must be checked for symptoms of secondary downy mildew infection and attention paid to the warning service for downy mildew of the official hop advisory service.	This fungal disease occurs every year in varying degrees. All parts of the plant can be infected. Flower and cone infestation can lead to complete loss of yield. A distinction is made between primary and secondary infection. The **primary infection** originates from the rootstock, in which the fungus hibernates as a mycelium and penetrates the young shoots in spring. Diseased shoots are stunted, yellowish-green in color and have downward curled leaves ("spikes"). Top shoots and side shoots are arrested in their development and desiccate. Fungal spores often form as a gray-black coating along the leaf veins on the underside of infested shoots. These are a source of secondary infections. **Secondary infections** come from zoosporangia which are spread by the wind and land on the leaves, flowers and cones. When it rains, zoospores hatch and penetrate into the young plant tissue via leaf openings. At first yellowish spots form on the upper side of the leaves, which later turn brown. At the infested sites, a grey-black fungal spore layer grows on the underside of the leaf, which in turn is the starting point for new zoosporangia formation and secondary infection. Infected flowers harden and die off, which hinders the formation of cones. At the beginning of cone infestation the bracteoles are more strongly discolored than the bracts giving a checked appearance to the cones. In the final stage the whole cone is chocolate brown.

Downy Mildew

Threshold values	Reason/explanation
Primary infection: Control should be carried out at the latest when spikes are to be found on more than 1 % of the bines. However, it has proved successful to preventively treat varieties susceptible to downy mildew, young hops in the first yield year and varieties with sensitive crowns such as Hallertauer Taurus.	According to the warning system for downy mildew, proper control of the primary infection is a prerequisite for control of the secondary infection. Since the fungus is able to grow with the plant and emerge later on main, lower or side shoots in the form of "spikes", hidden primary infestation must be carefully combated in order to reduce the pressure of secondary infection (number of zoosporangia). This also includes the fact that the entire surrounding area is free of wild hops and poorly cleared hop gardens.
Secondary infection: Control of secondary downy mildew is to be carried out after the first symptoms are detected and/or after instructions and calls of the official warning service have been issued. A distinction is made between susceptible and tolerant varieties.	In the hop growing regions of Bavaria and Tettnang, the number of zoosporangia is recorded daily in addition to the weather parameters. If the number of zoosporangia in the 4-day total before flowering rises above 30 (50 for tolerant varieties) and after the start of flowering rises above 10 (20 for tolerant varieties) with simultaneous rain wetting for several hours during the day, a call for spraying is made for the respective variety groups. The warnings are issued by telephone, fax, e-mail or text message (additionally in Bavaria). In the Elbe-Saale growing region, an index value is calculated on the basis of certain weather parameters recorded daily by the hop sites and a warning is issued if a critical threshold is exceeded.
Direct control measures	**Reason/explanation**
Targeted application of fungicides taking into account the control thresholds and advice from the official hop advisory service (e.g. downy mildew warning service).	Experience shows that proper control of the primary infection in susceptible varieties, young hops and on infested sites is the best prerequisite for being able to use the downy mildew warning service for the control of secondary infections.
Limiting to the necessary minimum	**Reason/explanation**
If only parts of the hops or only specific varieties in a hop garden are affected by primary infection, it suffices to treat just those plants.	Primary downy mildew infestation occurs preferentially in wet areas of the hop garden or in susceptible varieties, especially in young hops and young yield sites.
Early and partly preventive control measures against primary infection on suspect acreage can save extensive follow-up treatment.	Early control measures can be carried out with little water and less of the product. These usually take the form of watering or treating of rows in specific parts of the hop garden. A saving of plant protection products and a reduction of environmental risks are possible in comparison to costly spray treatments later on.
With tolerant varieties, the risk of infection and thus the number of recommended warning calls is lower, so that a reduction in plant protection applications is possible here.	On average over the years, about 2-3 downy mildew treatments can be saved with the tolerant varieties.

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Downy Mildew

Resistance avoidance strategies	Reason/explanation
Active ingredients should be changed during follow-up treatments.	If the same active ingredient or preparations from the same active ingredient group are used repeatedly, the increased selection pressure leads to faster resistance. The consulting brochure "Grünes Heft Hopfen" (Green Book – Hops) provides information on the active substance group of the different preparations.

Pay attention to the downy mildew warning service!

Infected hop flower

Mildew pustules beginning to sporulate

Powdery Mildew

(Sphaerotheca macularis)

Powdery Mildew

Preventive measures	Reason/explanation
Consider the different susceptibility of varieties for new plantings, also taking marketing factors into account.	Powdery mildew is a major hop disease that does not occur to the same degree every year and at every location. There are also significant differences in the susceptibility of the varieties. The high alpha varieties like Hallertauer Magnum, Hallertauer Taurus and Nugget are generally very susceptible. The classification of the individual varieties with regard to their resistance to powdery mildew is given in the consulting brochure "Grünes Heft Hopfen" (Green Book – Hops).
Deep pruning in spring.	If the hops were infested with powdery mildew in the previous year, the pathogen, which overwinters at the base of the bine as a mycelium, can be removed by deep pruning of the hops in spring. The hops sprout healthier. Non cultivation promotes powdery mildew and should be refrained from!
Take further hygiene measures such as hilling up and hop stripping and suckering in good time.	Initial sources of infection can be eliminated by covering (hilling up) lower shoots that are growing again with soil, and removing or killing off the lower leaves and side shoots on the bine.
Eliminate wild and volunteer hops in the vicinity of the hop gardens.	Wild and volunteer hops are also dangerous sources of powdery mildew infection. Since the powdery mildew spores are spread with the wind, hop gardens in the near vicinity of these infection sources can be infested more intensively. For this reason farmers and landowners in the hop growing regions are obliged by law to get rid of wild hops at the latest by June 15.
Reduce the number of shoots per training string.	Trials have shown that 2 instead of 3 bines per training string of susceptible varieties (e.g. Hallertauer Magnum, Herkules, Nugget) significantly reduces infection without affecting yield, as dense and leafy plants increase the risk of infection.
Ensure that nitrogen fertilization is adequate and in line with requirements!	High nitrogen levels promote leaf growth and make the tissue softer and thus more susceptible to powdery mildew infections.
Monitoring methods	**Reason/explanation**
Already in spring from the first sprouting onwards, the leaves and later also the hop cones must be checked for symptoms of powdery mildew infection and attention paid to the instructions of the official hop advisory service. As there are currently no reliable forecasting systems, susceptible varieties and hops in infested areas must be regularly treated prophylactically.	This fungal disease does not occur to the same degree every year and at every location. Severe infection can very adversely affect yield and quality. The first symptoms of infection are isolated pustular elevations on the upper and rarely on the underside of the leaf, from which flour-like white spots develop. These powdery mildew pustules can occur on all parts of the plant above ground. Cones can still be infected at any stage of maturity, when they then often show deformations and dry out. Powdery mildew occurs as of the beginning of May especially with warm weather and on dense, leafy plants. Hops in areas prone to orographic precipitation and on the edge of woodlands are also particularly endangered. Once a powdery mildew infection has set in it can survive both rainy and dry periods. In years with long rainy periods, pustules also occur increasingly on the underside of the leaves.

Powdery Mildew

	Particularly serious is the so-called late powdery mildew infection, which only becomes visible at harvest time. Here the supposedly healthy green cones have a yellowish to brown mottled appearance after the drying process. A mycelium can be seen sometimes on the discolored bracts when viewed under a magnifying glass.
Direct control measures	**Reason/explanation**
Fungicides are used prophylactically in accordance with the recommendations of the official hop advisory service; here a differentiated approach can be adopted depending on the variety and infection pressure. When the first symptoms of infection appear, intensive control measures must be carried out at shorter intervals in order to contain the infection.	The chemical plant protection products currently authorized mainly have a preventive effect, which is why the control of powdery mildew can only be successful if it is carried out prophylactically for susceptible varieties and on infected sites or, in the case of the other varieties, at the latest when the first powdery mildew pustules appear. Late fungicide applications from August to shortly before the harvest are also recommended to combat late powdery mildew infection. The waiting times of the products used must be closely observed here.
Limiting to the necessary minimum	**Reason/explanation**
Early and preventive control measures, especially for susceptible varieties and on infected sites, can save extensive follow-up treatments.	Early fungicide applications can be carried out with little water and less of the product. Regular treatments prevent the development of powdery mildew. A saving of plant protection products and a reduction of environmental risks are possible in comparison to costly spray treatments with combinations of active ingredients later on.
With tolerant varieties, the risk of infection and thus the number of recommended treatments is lower, so that a reduction in plant protection applications is possible here.	On average over the years, about 2-3 powdery mildew treatments can be saved with the tolerant varieties.
Resistance avoidance strategies	**Reason/explanation**
Active ingredients should be changed during follow-up treatments.	If the same active ingredient or preparations from the same active ingredient group are used repeatedly, the increased selection pressure leads to faster resistance. The consulting brochure "Grünes Heft Hopfen" (Green Book – Hops) provides information on the active substance group of the different preparations. *Early and preventive treatment of susceptible varieties and infected sites!*

Verticillium Wilt

(Verticillium nonalfalfae)

Preventive measures	**Reason/explanation**
	The Verticillium wilt is a soilborne disease that is spread differently depending on the growing region and location. Whereas in the past the Verticillium fungus could be combated well with preventive measures, more aggressive (lethal) strains have been appearing in the Hallertau for some time now, which can also infect the previously tolerant varieties and cause them to die. Until a routine test is available to classify the hazard of the existing pathogen in practice, the farmers must assess the aggressiveness of the Verticillium infection themselves. Indications for the classification as an aggressive (lethal) form of the Verticillium wilt can be: • Wilt infection of varieties hitherto classed as tolerant PER, SSE, SIR, NBR, HMG. • Wilting and death of the bines happens suddenly. • The crown does not recover and dies off completely. • Follow-up young hops are also infected by Verticillium wilt and die off.
Preventive control measures for **mild strains of Verticillium**: Consider the different susceptibility of varieties for new plantings in so far as a distinction can be made in the field between mild and lethal strains of Verticillium.	The classification of the individual varieties is given in the consulting brochure "Grünes Heft Hopfen" (Green Book – Hops).

Verticillium Wilt

Restrained nitrogen fertilization.	High nitrogen levels promote cell growth and make the tissue softer and thus more susceptible to Verticillium wilt infections. In the case of severe Verticillium infection, the N fertilization should be reduced to zero if necessary. Sudden N replenishment due to high mineral fertilizer application or organic fertilizers with a high ammonium nitrogen content (biogas fermentation residues or pig slurry) should be avoided.
Reduced tillage.	Tillage should aim to avoid root injuries as far as possible. This is achieved by a clean cut, careful use of the circular cultivator, ploughing only once and little grubbing.
Cultivation of neutral catch crops (e.g. cereals).	The wilt fungus infects several hundred different host plants. These include many species like cruciferous plants (rape, mustard, oil radish) and legume crops (clovers, alfalfa, vetch), which are often grown as catch crops in hop gardens. Since cereals are not infected, they should be sown by preference as catch crops on infected areas.
Avoidance of soil compaction and damage to the soil structure.	Compacted and structurally damaged soils have less root penetration and are cooler due to less aeration. Experience has shown that the Verticillium wilt occurs preferentially on these sites. For this reason, special attention should be paid to the load-bearing capacity of the soil when driving on and working the hop gardens.
No spreading of freshly shredded hop bines in hop gardens.	Infectious fungal material can still be detected in the shredded hop bines of infected gardens. Infected shredded hop bines that are not sufficiently hygienized (hot rotting, silage and/or fermentation) and which are returned to the hop acreages contribute to the propagation of the infectious material. That is why fresh shredded hop bines should never be returned to hop gardens. The deposited shredded hop bines may only be returned to hop gardens after the material has been heated for one week at approx. 60 °C in a compost heap. If possible, the layers at the edge should be applied to other arable land.
Do not harvest hops too early.	The longer the hops have time to reach physiological maturity and to transfer reserve substances back into the root system, the more vital and resistant the hop crown will be the next year. Trials have shown that the crowns are then less susceptible to Verticillium wilt the following year. It is therefore recommended to always wait for the optimum harvest time for each variety, to harvest wilt infected hop gardens later and not to harvest young hops at all, but to let them mature.
Observe hygiene measures! No production or transfer of rhizomes from infected hop gardens!	Since the Verticillium fungus can be spread with plant material and thus also via hop rhizomes, care must be taken that no rhizome material is taken from infected hop gardens. Purchased rhizomes or rhizomes from other farms may only be accepted with a plant passport. This guarantees that the original rootstock was checked for Verticillium infection in the previous year. A further hygiene measure is to cut and remove the bine stalks from the garden after the harvest. Since the infectious permanent mycelium of the Verticillium fungus is mainly found at the base of the bine, the removal and burning of the bine stalks contributes to the reduction of the infectious material.

Verticillium Wilt

Additional preventive measures	Reason/explanation
In the case of **aggressive (lethal) strains of Verticillium**:	This measure prevents the reproduction of the fungus and further accumulation of infectious material in the hop garden.
Deep prune and remove infected hop bines from the hop garden and burn them.	This counteracts the further spread of lethal Verticillium strains.
No production or transfer of rhizomes from infected hop gardens.	The aim is to prevent the spread between the hop gardens.
Observance of strict hygiene measures: • Till healthy gardens first, then the infected gardens. • Disinfect tilling equipment. Heavily infected hop gardens which, despite the preventive measures described so far, do not show any signs of recovery, must be completely cleared. In the case of occurrence in isolated outcrops in the hop garden, it is sufficient to clear infected hop bines, which sprout again, with an overlap of one row to the left and right of the infected area and in each case 5m in the longitudinal direction. • No new planting of hops, but greening of the cleared hop gardens or infected sites with wilt-neutral monocotyledonous plants (maize, cereals, grasses). • Quarantine crop rotation or permanent greening in the cleared hop gardens or infected sites must be consistently maintained for 5 years. • Do not allow weeds or dicotyledonous catch crops in the cleared hop gardens or infected nests for at least 5 years.	If the preventive control measures described and applied so far do not lead to an improvement of the Verticillium infection situation, the area has to be cleaned up and quarantined. Quarantine means that the host plant is removed from the Verticillium fungus, so that the infectious permanent mycelium dies over time when it no longer has any possibility of proliferating. According to experiences made in Slovenia, after 5 years without host plants the hop acreages are free of Verticillium and can once again be replanted with hops. Observe hygiene measures!

Verticillium Wilt

Monitoring methods	Reason/explanation
During the summer, the hop gardens must be checked for symptoms of wilting and dead bines.	The soilborne Verticillium fungus is prevalent to varying degrees in the German hop growing regions. In addition, after the turn of the millennium a classification of the pathogens into mild and aggressive (lethal) strains could be proven by molecular genetic examinations and artificial infection tests. In the case of susceptible varieties or severe infection, up to 100% yield loss is possible. Depending on strain and severity of the infection, the crown sprouts again in the next year or dies off. Starting out from the mycelium that persists in the soil (4-5 years), the fungus infects young or injured roots, penetrates the plant's water-conducting tissues and grows from bottom to top in the plant. The mycelium blocks the water-conducting tissues, so that dry and hot weather quickly leads to wilting symptoms. The production of toxins accelerates the aging process and thus the death of the bine. Depending on the location and severity of the infection, individual shoots, entire training strings or the entire crown may be affected. At the beginning of the infection, the leaves sometimes lighten from the underside to the upper side already in June, turn irregularly brown and show symptoms of wilting. The leaves fall off easily when touched. Depending on the progression of the infection, the flowering and cone development are interrupted. Cones that have not died off have a mottled appearance and impair the external quality of the crop. If you cut open the lower part of infected bines, you notice a browning of the water-conducting tissues. In the infected tissue, the fungus forms a kind of permanent mycelium which can be spread via plant residues, unhygienized harvest residues and soil transfer, and can survive in the soil for 4-5 years.
Direct control measures	**Reason/explanation**
The hop wilt pathogen cannot be controlled directly. Preventive control measures are recommended to reduce infection; here a distinction must be made between mild and aggressive (lethal) forms of Verticillium.	In order to reduce infection, the application of the described preventive measures is strongly recommended in the case of a confirmed suspicion of Verticillium infection. In addition, all measures must be taken to prevent the transfer and further spread of the pathogen.

Deep prune and remove infected hop bines from the hop garden and burn them!

Viruses and Viroids

Leaf splitting

Viruses

Mosaic

Band mosaic

Viruses

- **Hop Mosaic Virus (HpMV)**
- **Hop Latent Virus (HpLV)**
- **American Hop Latent Virus (AHpLV)**
- **Apple Mosaic Virus (also Ring and Band Mosaic Virus) (ApMV)**
- **Arabis Mosaic Virus (Necrotic Crinkle Mosaic Virus) (ArMV)**

Preventive measures	**Reason/explanation**
	Viruses are simple pathogen particles consisting solely of proteins and their genetic material. If plants are infected with viruses, the infection lasts for life. Viruses cannot move actively, but are always spread and transmitted passively. Due to the very easy mechanical transfer, e.g. ApMV is transmitted during cultivation measures within a hop garden and also from hop garden to hop garden. Certain viruses are also spread via aphids (HpMV, HpLV, AHpLV) or via nematodes living in the soil (ArMV). One major way of transmitting viruses is via infected hop rhizomes.
Use virus-free planting material.	Plant material from specialized propagation farms (Gärtnerei Eickelmann, Geisenfeld and Landwirtschaftsbetrieb Grosser, Coswig) grown in greenhouses is virus-free and awarded Certificate A. The mother plants used for the production of quality plant stock have either been made virus-free by heat treatment or tested for the most important virus species before propagation. Farmers have the possibility of applying for a Certificate B for new areas planted with Certificate A plants and to obtain healthy rhizome cuttings. The requirements for Certificate B are that 10% of the bines are tested for apple mosaic virus, that a plant check is carried out through the Hop Ring for signs of wilting, viruses and volunteer hop growth and that any detected primary infection of downy mildew is under 1%.
Do not to plant hops on cleared virus-infected sites for at least 1 year.	After hop clearing, rootstock residues always remain in the soil and can sprout again in the next spring. The viruses they harbor are a dangerous source of infection for new plantings. For this reason, it is recommended to use a hop-free year after clearing, in which the regrowth should be intensively combated and root material that has not been removed can rot.
Reduce tillage and mechanical maintenance measures.	Tillage should aim to prevent root damage and thus the transmission of viruses via plant sap. This is achieved by a clean cut, careful use of the circular cultivator, ploughing only once and little grubbing. Mechanical maintenance measures such as manual leaf removal should also be avoided in the case of known virus infections in the hop garden.
Monitoring methods	**Reason/explanation**
During the summer, the hop gardens must be checked for plants with virus symptoms and stunted growth.	Virus diseases are widespread in all hop growing regions. Yield and alpha acid content can be reduced to a greater or lesser extent depending on the type of virus, infection intensity and variety, especially in the case of mixed infections with apple mosaic virus.

Viruses

	When infected with hop mosaic virus, the leaves often have bright mosaic-like patches. When infected with apple mosaic virus, chlorotic rings and bands also appear on the leaves. The leaves harden and curl inwards. In counter light, splits can be seen in the leaves. The type and severity of the virus infection cannot be determined optically from the symptoms. Frequently, the virus-contaminated plants seem to sprout normally in spring, but after a short time they show growth depressions of varying severity. In the process, diseased plants show mostly stunted growth, retarded development and often do not reach the trellis height. Strong fluctuations between day and night temperatures as well as long periods of cool weather lead to more severe development of viruses. In case of subsequent growing weather, the new growth can achieve a normal appearance again.
Direct control measures	**Reason/explanation**
Chemical control is not possible!	
Viruses can only be combated by clearing the hop plants and planting new ones with healthy virus-free plant material. Make sure that all living remains of the infected plants have been removed at the time of the new planting.	Since the virus survives in the remains of the rootstock, care must be taken to clear thoroughly and completely remove the rootstock. Regrowth in the following spring must be combated. To be on the safe side, no hops should be planted in the following year until any root material that has not been removed has rotted. In order to avoid the introduction of viruses with the planting material, only rhizomes with Certificate A or B should be used for new plantings. Purchased or own rhizomes from old hops should be tested to make sure they are virus-free!

Avoid infection!
Recommendation:
After clearing,
put in a hop-free year
and intensively
combat regrowth.

Leaf symptoms

Viroids

Cracked bines (CBCVd)

CBCVd infected (right row)

Viroids

- **Citrus Bark Cracking Viroid (CBCVd)**
- **Hop Stunt Viroid (HpSVd)**
- **Hop Latent Viroid (HpLVd)**

Preventive measures	Reason/explanation
	Viroids are the smallest infectious plant pathogens known. They are composed solely of a short strand of a circular, single-stranded ribonucleic acid (RNA) molecule that is the genetic information. Unlike viruses, they have no protein coating. Viroids cannot move actively, but like viruses are always spread and transmitted passively. Due to the very easy mechanical transfer, viroids are transmitted from one plant to the next during all work and measures in the hop garden where contact with infected plants occurs, and also from hop garden to hop garden. One very significant way of transmitting viroids is via infected hop rhizomes.
Use healthy planting material.	Procuring planting material from specialized propagation farms or from non-infected farms is the best way of avoiding the introduction of the dangerous viroids HpSVd and CBCVd. Do not use planting material of unknown origin. This applies in particular to planting material from abroad (especially from the USA, Japan and Slovenia).
Do not return CBCVd- and HpSVd-infected bine waste to hop gardens.	Since the viroids spread throughout the plant, the waste from CBCVd- and HpSVd-infected hop plants is highly infectious. When the shredded hop bines are returned to the hop gardens, it cannot be ruled out that it will spread over a large area and in the farm. Movement is therefore prohibited, as is recovery for composting or fermentation, unless it can be ruled out that the resulting composts or fermentation substrates will be moved to hop or other host plant areas.
Hop gardens infected with CBCVd must not be planted with hops again for at least 2 years.	After CBCVd-infected hop plants have been cleared, rootstock residues always remain in the soil and can sprout again in the next spring. The viroids they harbor are a dangerous source of infection for new plantings. For this reason, no hop or other host plants may be grown after clearing until all infected plant parts and root remains have been completely destroyed and rotted.
No spreading of organic waste compost or green waste compost containing citrus fruit waste or shrubs.	Citrus viroid is also detectable in certain origins of citrus fruits and is therefore a potential source of infection for transmission to hop plants. Organic waste compost or compost of unknown origin should therefore not be spread in hop gardens.
Observance of strict hygiene measures: Disinfection of machines and equipment.	If individual hop plants or partial areas on the farm are infected by HpSVd or CBCVd, strict hygiene measures must be observed to prevent further transmission both on and off the farm: Infested gardens or delimitable partial areas must always be entered or treated last during all work. The machines and equipment must then be washed and disinfected with a MENNO Florades solution. Work clothes and gloves must then also be changed and washed or disinfected.

Viroids

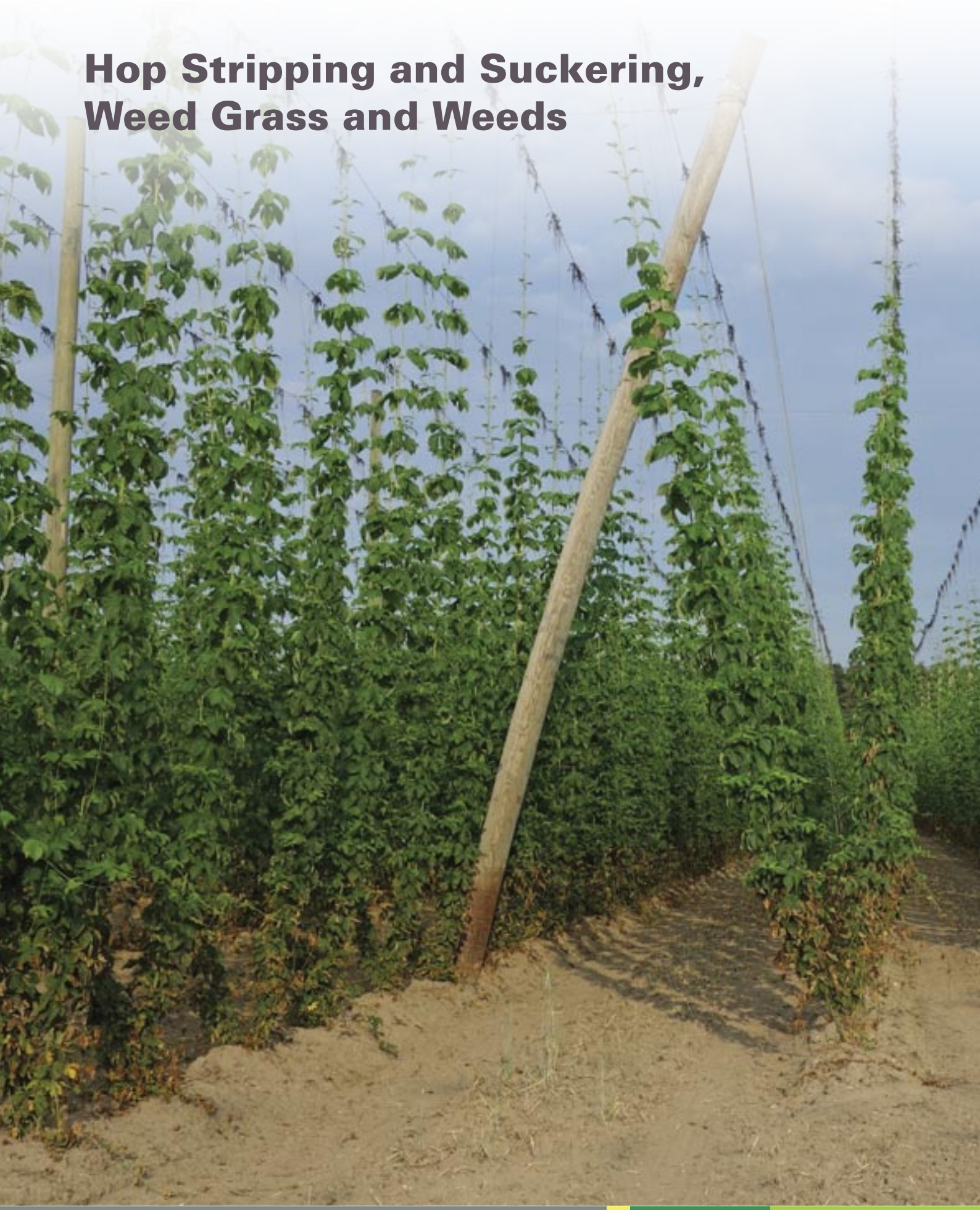
	Mechanical processing and maintenance measures in the infected gardens must be kept to a minimum in order to avoid the transfer of viroids by plant sap from latently infected plants to healthy plants. For all farms it holds that persons working in hop gardens disinfect their hands after contact with citrus fruits or citrus waste and, if necessary, change their working clothes.
Monitoring methods	**Reason/explanation**
During the summer, the hop gardens must be checked for plants with viroid symptoms and stunted growth.	Infections with **Hop Stunt Viroid (HpSVd)** can lead to great loss of yield and quality. HpSVd first appeared in Japan and Korea in the 1940s. In 2004 the viroid was detected in hop gardens in the USA and in China in 2007. No infection of commercial hop gardens in Germany is known. The viroid is very easy to transfer mechanically during cultivation work, such as hop pruning, and spreads via the highly infectious plant sap and thus contaminated equipment. HpSVd-infected hops often show symptoms only 3-5 years after the initial infection. In typical cases, shortened internodes on the main and side shoots and stunted growth are warning signs for HpSVd infection. The lower leaves are mostly curled in, smaller and show yellowing. However, the symptoms vary greatly from variety to variety, also depending on the weather conditions. These symptoms are also typical for an infection with the citrus bark cracking viroid and are significantly enhanced when both viroids occur combined. The **Citrus Bark Cracking Viroid (CBCVd)** known from Slovenia was also detected in the Hallertau in 2019 and leads to even more dramatic reductions in yield and quality than HpSVd. Alongside yellowing of the often downward curling leaves and the stunted growth, another symptom observed in some varieties is cracking of the bine. Symptoms appear only in the 2nd year after infection. A third viroid detected in hops is the **Hop Latent Viroid (HpLVd)**, which can be found in all major hop growing regions worldwide due to its easy transmissibility. Since HpLVd infection in hops has no drastic effects on yield and alpha acid content, this is simply tolerated and can be detected everywhere in hops.
Suspicious plants are to be reported and tested as part of the state monitoring program of the LfL (Bavarian State Research Center for Agriculture). **Observance of strict hygiene measures!**	Since there are currently no reliable remedies for viroid-infected hops, continuous monitoring that is as comprehensive as possible is the best precaution. Since 2008, the Bavarian State Research Center for Agriculture (LfL) has been testing hop plants from breeding gardens, the Eickelmann propagation company and from commercial hop gardens in the Hallertau, Tettnang and the Elbe-Saale region for HpSVd using a molecular technique. Since 2014, testing has also been performed for the citrus viroid. It is strongly recommended that growers of foreign varieties, in particular, have the plants tested at random, even if no symptoms are observed. For a limited number, the test for HpSVd and CBCVd is carried out at no cost to the grower. Registration for the submission of leaf samples for monitoring should be sent to Virologie@ LfL.Bayern.de. To date no HpSVd infections have been detected in any of the hop samples from commercial hop gardens.

Viroids

Direct control measures	Reason/explanation
Chemical control is not possible!	It is not possible to combat viroids with plant protection products and disinfectants. Even exposure to heat up to 150°C cannot render the infectious genetic material of the viroids harmless.
Viroids can only be combated by clearing the hop bines. In addition, no hops or other host plants may be grown on the cleared infected areas for several years.	In order to prevent further spread, all infected plant material must be destroyed. This starts with the immediate clearing and removal of infected plants from the hop garden without other hop plants coming into contact with the infected material. It is advisable to clear a correspondingly wide area around the infected area, as a transmission to and infection of externally healthy neighboring plants cannot be ruled out. After harvesting at the latest, the hop crowns must also be cleared and removed. The infected material must be stored away from hop areas and as soon as possible burned, buried, sent to another officially approved disposal facility or composted on suitable areas. The composted material may only be spread on the farm's own land which is neither used for hop growing nor directly adjacent to a hop garden. Regrowth in the following spring must be treated until no new shoots appear in line with officially recommended PRM. No hops or other host plants may be grown on the cleared infected areas for at least 2 years.

The best precaution is continuous monitoring that is as comprehensive as possible!

Hop Stripping and Suckering, Weed Grass and Weeds



Hop leaves and side shoots on the lower part of the bine (hop stripping and suckering) Weed grass, weeds and lower shoots in the rows

Preventive measures	Reason/explanation
The propagation and spreading of root weeds can be counteracted by intensive tillage. However, on sites with a risk of erosion, this measure should be omitted in order not to promote soil erosion.	Intensive tilling should only be carried out in exceptional cases with the permanent hop crop with its underground storage organs and the wide-spread root system, because the risk of damaging the hop crown and promoting soil erosion is too great and is disproportionate to the expected benefits if carried out incorrectly. If necessary, it makes sense to only treat partial areas. For example, the field bindweed and millet usually spread out from the edge of the field into the gardens, so that more intensive tilling of the edge rows is sufficient. Quackgrass often only occurs on isolated sites in hop gardens.
Monitoring methods	**Reason/explanation**
The correct time for **hop stripping and suckering** should be followed and selected on the basis of growth and weather conditions. The occurrence of **weeds** and the composition of the weed community are to be monitored, particularly in the rows in the summer.	New shoots still continue to sprout from the hop crown. A favorable microclimate for diseases and pests is created on these lower shoots and lower leaves and side shoots. Some of the lower shoots are already infected with downy mildew (spikes) and powdery mildew. An important way of reducing the infestation pressure of downy mildew, powdery mildew and spider mites is to remove the lower shoots, the lower leaves and side shoots. This can save many a spraying operation. In addition, hop stripping and suckering is a necessary measure to facilitate the threading of the harvester during mechanical harvesting and the hanging of the bines into the hop picking machine. The regulation of weeds and weed grasses in the rows reduces water and nutrient competition, prevents infestation of mice and facilitates pruning in the following spring. High-growing grasses such as quack-grass are also preferred sites for the egg deposition of the rosy rustic moth, whose caterpillars in turn damage the hops.

Hop Stripping and Suckering, Weed Grass and Weeds

Threshold values	
-	Control thresholds are not relevant here. Hop stripping and suckering and weed control in the rows are necessary phytosanitary measures and also required for technical reasons in hop growing.
Direct control measures	**Reason/explanation**
Both chemical and non-chemical methods are available for hop stripping and suckering and weed control in the rows.	
For the first hop stripping and suckering, the burning of lower leaves and shoots with **nutrient solutions** has proven successful. The use of nutrient solutions is appropriate if the hop plants have a corresponding nutrient requirement at the time of the hop stripping and suckering. Since the nutrients contained in the spray solutions are absorbed by the leaves and the soil and are effective as fertilizers, they must be counted to 100% in the fertilizer requirement.	The best effect is after precipitation when the wax layer is reduced and the leaves are soft. Sunshine and dry weather conditions after application promote the effect. The treatment can be carried out on trained bines with 2m or more of growth height. The nutrient solutions are usually fertilizer solutions containing nitrogen and/or magnesium chloride, which are reinforced in their effect with trace nutrient salts and wetting agents if required. The recommended nutrient salts and their concentrations can be found in the instructions of the official hop advisory service or in the consulting brochure "Grünes Heft Hopfen" (Green Book – Hops).
The **mechanical removal** of leaves, side and lower shoots can be done either **by hand** or with different tools. A device with **rotating nylon cords** on horizontally guided rollers removes leaves and shoots from the hop bine as it passes laterally. If the rotating roller is set lower, the lower shoots and weeds on the row can also be removed. A so-called **"leaf vacuum cleaner"** passes laterally, sucks in the leaves and side shoots through a grid and then chops them off with a rotating blade.	For manual hop stripping and suckering and the use of mechanical defoliation equipment, the optimum time and setting must be ensured. The disadvantage of all methods is the damage to the bines, especially by the nylon cord device. In this process there is also enormous generation of dust and the risk of stone chipping. In the case of the leaf vacuum cleaner, damage can also occur to the training strings if individual shoots are pulled through the grid and cut off. In the mechanical processes, the lower shoots and weeds in the rows are usually not removed, so that generally a combination with nutrient solutions or a chemical control method becomes necessary.
There is isolated use and testing of **thermal processes** for hop stripping and suckering. The position of the flame nozzles can be adjusted and adapted to the plants according to the application. The heat destroys unwanted leaves in the rows and the lower part of the bine.	The risk with the gas-powered burners is that not only the leaves and side and lower shoots are burned, but also the main shoots are damaged by the heat. This occurs especially with weaker shoots and follow-up crowns. The adjustment of the gas supply, the distance to the target area and the forward speed therefore requires a great deal of experience. In addition, dry weed growth and wooden hop poles can catch fire during dry periods. Appropriate caution is required with this procedure.

Hop Stripping and Suckering, Weed Grass and Weeds

Chemical control is carried out with specially authorized herbicides for hop stripping and suckering and/or weed control.	Chemical treatment agents are safer. Several sharp-edged and low-drift nozzles per side can be precisely adjusted so that, in addition to hop stripping and suckering, lower shoots and weeds on the rows can also be removed. With some preparations, the stage of development of the hop must be taken into account in order to avoid damage to the hop plants. The advantage of soil herbicides lies in the fact that a sustainable dam sealing with weed-free rows is possible until autumn. A sustainable removal of root weeds is also only possible with chemical pesticide residue monitoring (PRM). To use the various preparations, follow the instructions for use as well as the instructions of the official hop advisory service (e.g. in the news fax) or in the consulting brochure "Grünes Heft Hopfen" (Green Book – Hops).
Limiting to the necessary minimum	**Reason/explanation**
Application of the herbicide is to be limited to the hop rows.	The space between the hop rows is usually 3.20m. The row treatment involves spraying a belt about 1m wide, so that the plant protection product is applied to only one third of the area.
Root weeds or grasses occur to varying degrees in the individual hop gardens and usually only on partial areas, so that direct control is necessary in many hop gardens or only on partial areas. The use of special herbicides or weed killers should therefore only take place after precise determination of the composition of the weed community.	By restricting the use of herbicides to certain areas or dispensing with special agents, unnecessary applications can be avoided and plant protection products can be saved.
Early herbicide measures under optimum weather conditions can reduce application rates and save plant protection products.	Young hop leaves and weeds in the cotyledon stage are more receptive and thus more sensitive to herbicides, so that the application rates can be significantly reduced. The effect is also better with application after precipitation or in the morning hours, when the wax layer is washed off or the leaves are still "soft". Sunshine after application is a prerequisite for a good effect with certain preparations.

Hop stripping
and suckering:
manual
thermal
chemical

Annex

General principles of integrated pest management (Article 14, Annex III)

Directive 2009/128/EC of the European Parliament and of the Council

of 21 October, 2009
establishing a framework for Community action to achieve the sustainable use of pesticides

1 The prevention and/or suppression of harmful organisms should be achieved or supported among other options especially by:
- Crop rotation.
- Use of adequate cultivation techniques (e.g. stale seedbed technique, sowing dates and densities, undersowing, conservation tillage, pruning and direct sowing).
- Use, where appropriate, of resistant/tolerant cultivars and standard/certified seed and planting material.
- Use of balanced fertilization, liming and irrigation/drainage practices.
- Preventing the spreading of harmful organisms by hygiene measures (e.g. by regular cleansing of machinery and equipment).
- Protection and enhancement of important beneficial organisms, e.g. by adequate plant protection measures or the utilization of ecological infrastructures inside and outside production sites.

2 Harmful organisms must be monitored by adequate methods and tools, where available. Such adequate tools should include observations in the field as well as scientifically sound warning, forecasting and early diagnosis systems, where feasible, as well as the use of advice from professionally qualified advisors.

3 Based on the results of the monitoring the professional user has to decide whether and when to apply plant protection measures. Robust and scientifically sound threshold values are essential components for decision making. For harmful organisms threshold levels defined for the region, specific areas, crops and particular climatic conditions must be taken into account before treatments, where feasible.

4 Sustainable biological, physical and other non-chemical methods must be preferred to chemical methods if they provide satisfactory pest control.

5 The pesticides applied shall be as specific as possible for the target and shall have the least side effects on human health, non-target organisms and the environment.

6 The professional user should keep the use of pesticides and other forms of intervention to levels that are necessary, e.g. by reduced doses, reduced application frequency or partial applications, considering that the level of risk in vegetation is acceptable and they do not increase the risk for development of resistance in populations of harmful organisms.

7 Where the risk of resistance against a plant protection measure is known and where the level of harmful organisms requires repeated application of pesticides to the crops, available anti-resistance strategies should be applied to maintain the effectiveness of the products. This may include the use of multiple pesticides with different modes of action.

8 Based on the records on the use of pesticides and on the monitoring of harmful organisms the professional user should check the success of the applied plant protection measures.

Further Sources and Links; User Protection

Literature

- **"Grünes Heft" Hopfen (Green Book - Hops)**: This consulting brochure is updated every year and sent to all hop growing farms in Germany in spring.
  Internet: *www.lfl.bayern.de/ipz/hopfen/022297*
- **Fact sheet of the LfL (Bavarian State Research Center for Agriculture): "Hops - Diseases, pests, non-parasitic damage patterns"**
  www.lfl.bayern.de/publikationen/merkblaetter/040620
- **LfL Hop Growing Information:** *www.lfl.bayern.de/ipz/hopfen/021184.*
- **Hop Growing (Hop Ring) – News Fax:** *www.hopfenring.de/download/hr-doku-app/*

Consulting institutions

Bavarian State Research Center for Agriculture, Institute for Crop Science and Plant Breeding 5a (Hop Growing and Production Technology) for special questions
Phone: +49 (0)8442 957-400, E-mail: Hopfenbau.Wolnzach@lfl.bayern.de

Hopfenring (Hop Ring)
Phone: 0800 957 3000 (free hotline), Mail: info@hopfenring.de

Downy mildew warning service

Bavaria:
Bavarian State Research Center for Agriculture, Institute for Crop Science and Plant Breeding 5, Hop Research Center in Hüll
Phone: +49 (0)8442 9257-60 or -61, Internet: *www.lfl.bayern.de/ipz/hopfen/030222*

Baden-Württemberg:
Center for Agricultural Technology Augustenberg, Tettnang Branch Office
Phone: +49 (0)1805 197197-25, Internet: *www.ltz-bw.de/pb/Lde/Startseite/Service/Hopfenbau_Warndienst*

District Administration Office of Lake Constance – Department of Agriculture,
Internet: *www.bodenseekreis.de/de/umwelt-landnutzung/landwirtschaft/fachinformationen/hopfenbau/*

Plant protection products approved for hop growing

www.lfl.bayern.de/mam/cms07/ipz/dateien/hoppfen_pflanzenschutzmittel_april2019.pdf
https://apps2.bvl.bund.de/psm/jsp

User protection information

https://www.bvl.bund.de/DE/04_Pflanzenschutzmittel/04_Anwender/psm_anwender_node.html
www.bvl.bund.de/DE/04_Pflanzenschutzmittel/04_Anwender/03_Schutzausruestung/psm_Schutzausruestung_node.html
www.iva.de/sites/default/files/pdfs/anwenderschutz_handbuch_2014_0.pdf

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