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Bayerische Landesanstalt für Landwirtschaft

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Gesellschaft für Hopfenforschung e.V.

Annual Report 2007

Special Crop Hops

Bavarian State Research Center for Agriculture

- Institute for Crop Science and Plant Breeding -

and the

Society of Hop Research e.V.

March 2008

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Appreciation

Widespread support is indispensable in order to carry out research on hops on the present scale at the Hop Research Center in Hüll with its other offices in Freising and Wolnzach. Therefore the preface to this year's Annual Report presents an opportunity to express our appreciation:

We should like to thank the representatives of the hop and brewing industries for their moral support. By regularly dropping hints on the significance of hop research at all their encounters with politicians, civil servants and presidents they set extremely important building blocks for continuing research.

The long-term tasks must be supplemented by research projects. While the permanent staff and the running costs are borne by the Bavarian state (approx. 1.4 million euros annually) and the Society for Hop Research (approx. 800,000 euros annually) sponsors for so-called sponsored research have to be found for the temporary projects. This third foothold is financed by the following organisations or firms, to which we should like to express our hearty thanks:

- The Federal Institute for Food & Agriculture on behalf of the Federal Ministry for Food, Agriculture & Consumer Protection (four projects at present)
- The Bavarian State Ministry for Agriculture & Forestry (three projects up until 2007 and extra budgetary resources for the downy mildew forecasting service)
- The Scientific Fund of the German Brewing Industry e.V. (six projects since 1998)
- The Scientific Station for Breweries, Munich (four projects up to 2009)
- The European Hop Research Council (one project at present)
- Simon H. Steiner, Hopfen, GmbH (one project at present)
- The Hops Producer Group HVG (eight projects at present)
- The Anheuser Busch Brewery (in addition to the membership fee three projects up until 2007)

We should also like to thank the hop-growers who make their hop yards available for tests. Without their readiness to cooperate here and make allowance for testing when tending the hops, these important practical field trials would not be possible.

A special word of thanks goes to the scientists and all the staff at the Hop Research Center in Hüll. The results of their targeted research are held in high esteem in the hop and brewing industries. The scientific well-founded projects provide the basis for further procurement of research projects.

We should also like to thank all the other individuals, organisations and firms which through their ideas and constructive criticism help to advance research and are well-disposed to hop research.

Michael Doetsch
Chairman of the Management Board
of the Society of Hop Research

Dr. Peter Doleschel
Head of the Institute for Crop Science
and Plant Breeding

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1 Research projects and main research areas of the Hops Dept.

1.1 Current research projects

Powdery mildew isolates and leaf resistance test in the laboratory as a basis to develop powdery mildew resistant hops

Sponsored by:	Bayerische Landesanstalt für Landwirtschaft, *(Bavarian State Research Center for Agriculture)* Institut für Pflanzenbau und Pflanzenzüchtung (*Institute for Crop Science and Plant Breeding*)
Financed by:	Wissenschaftliche Station für Brauerei in München e.V. *(Scientific Station for Brewing in Munich)*
Project Manager:	ORRin Dr. E. Seigner, LAR A. Lutz, Dr. S. Seefelder
Cooperation:	Dr. F. Felsenstein, EpiLogic GmbH Agrarbiologische Forschung und Beratung, Freising
Assisted by:	LA A. Lutz, LTA J. Kneidl; S. Hasyn (EpiLogic), Dr. S. Seefelder
Duration:	01.05.2006 –30.04.2009

Objective:

The powdery mildew (PM) isolates and the leaf resistance test system, which are used for testing for PM resistance in wild hop germplasm, beyond that will be used in many other research issues concerning powdery mildew. They have become crucial "pillars" for the successful resistance breeding at the Hop Research Center in Hüll.

Results:

At present there is a range of 12 different single conidia isolates of *Podosphaera macularis ssp. humuli* available as inoculation material with characteristic virulence properties. This range of PM pathotypes permits testing on all resistance genes known so far and used in breeding hops.

Therefore in 2007 the PM isolates were used for the following problems or tests:

- providing 4 different PM isolates for resistance testing in the greenhouse. These PM strains cover the virulence spectrum of the PM races prevalent in the Hallertau
- in assessing the resistance properties of 156,000 seedlings from the crosses of the previous year, 103 wild hops, 231 breeding lines and 7 foreign varieties in the greenhouse and in the laboratory leaf test
- for obtaining reliable resistance data in 345 seedlings from 4 mapping populations in order to develop molecular markers for PM resistance genes
- in 10 analyses concerning the gene expression after inoculation with special PM isolates. The aim is to identify molecular markers for genes which are directly involved in the fungus defence
- in judging the virulence situation of the PM populations and in evaluating the effectiveness of known resistances in specific hop growing regions

Breeding of dwarf hops for the growth on low trellis systems

Sponsored by:	Bayerische Landesanstalt für Landwirtschaft, *(Bavarian State Research Center for Agriculture)* Institut für PIflanzenbau und Pflanzenzüchtung *(Institute for Crop Science and Plant Breeding)*
Financed by:	Bundesanstalt für Landwirtschaft und Ernährung (BLE) *(Federal Institute for Food & Agriculture)* HVG Hopfenverwertungsgenossenschaft e.G.
Project Manager:	ORRin Dr. E. Seigner, LAR A. Lutz
Assisted by:	LA A. Lutz, LTA J. Kneidl; A. Bogenrieder ORR Dr. K. Kammhuber, C. Petzina (both IPZ 5d)
Cooperation:	Gesellschaft für Hopfenforschung *(Society of Hop Research)* Hop farms: J. Schrag and M. Mauermeier
Duration:	01.04.2007 – 31.12.2010

Objective:

The aim of this new research project is to breed hops which due to their shorter growth, broad resistance to disease and excellent brewing quality are particularly suited to be economically and successfully grown on low trellis systems. So far this kind of adapted varieties are the missing building block with which it is possible to reduce the production costs considerably on the 3 metre high trellis system. Furthermore this new production system provides considerable environmental benefits because less pesticides and fertilizers are required, especially since chemicals and liquid fertilizers can be sprayed with recycling tunnel sprayers with less spray drift.

Result

Breeding work began in April 2007. Seedlings from earlier crosses with considerably shorter growth or less abundant growth were planted in two low trellis yards and at the same time their growth properties as well as their resistance towards pests and diseases were assessed. These seedlings which mainly derived from the English dwarf variety "Pioneer", show quite good alpha-acids values, but like their mother are very susceptible to the downy mildew. Traditional varieties such as the high-alpha acids variety "Hallertauer Taurus" or the aroma variety "Perle", which were grown on low trellis wirework, demonstrate the weak points of hop varieties which are not suited to this low trellis system: luxuriant growth forming strong heads, in which longer bines grow back downwards over the wires therefore obstructing the formation of flowers and later of cones within the extremely thick bine, which results in a drastic reduction in the yield of 40-60 % compared with high-trellis cultivation. The English dwarf hops available which were grown as reference varieties in the 3-metre yards do indeed produce better yields but are not worthwhile for German production due to their susceptibility to downy mildew and their not fully satisfying brewing value.

15 special crosses were carried out in summer 2007 in order to realise the desired combinations of traits in the new breeding lines. Until the end of the project in 2010 certainly only the first promising breeding lines can be created and until the variety is registered at least another 10 – 15 years will pass before the low trellis system can be introduced. However the initial crucial steps will be made with this research project which contribute to safeguard the hop-growing locations in Germany

Gene transfer in hops to improve fungal resistance

Sponsored by:	Bayerische Landesanstalt für Landwirtschaft (LfL), *(Bavarian State Research Center for Agriculture)* Institut für Pflanzenbau und Pflanzenzüchtung *(Institute for Crop Science and Plant Breeding)*
Financed by:	Erzeugergemeinschaft Hopfen HVG e.G. *(Hop Producer Group*) Bayerisches Staatsministerium für Landwirtschaft und Forsten *(Bavarian State Ministry for Agriculture & Forestry)*
Project Manager:	ORRin Dr. E. Seigner, Dr. H. Miehle (up till 30.06.2007)
Assisted by:	Dr. H. Miehle (until 30.06.2007), S. Marchetti (until 31.07.2007), K. Ehm
Duration:	01.01.2005 – 31.12.2007

Objective:

The aim of the continued research project was to transfer resistance genes into important Hüll hop varieties and therefore develop an improved tolerance towards fungal pathogenes.

Results:

With three different bacterial chitinase (*chi)* constructs, which had been made by Dr. Miehle based on published gene sequences it was possible to transform "Saazer" and "Hallertauer Mittelfrüher" successfully. The first regenerated plants of the variety "Hallertauer Mfr. " from transformations with the *chi-C gene* could already be verified as stable transgenic plants. The most regenerates from the various transformation approaches with the different *chi* constructs (*chi I*, *chi III*, *chi C* and combinations from *chi I/chi III* and *chi I/chi C*) are first expected in spring 2008. First of all the stable insertion and the expression of the new gene still have to be confirmed for these plants. Afterwards it can be tested via the leaf resistance test in the laboratory whether the bacterial *chi* gene can contribute to protection against powdery mildew attacks.

With the status of research attained the LfL is leading in gene transfer in hops: For the first time gene constructs were produced harboring self-isolated hop-own or foreign resistance genes and were successfully inserted into hops. The effect of the hop-own resistance gene could already be confirmed in the laboratory. For the first time it was possible to transform a hop variety outside the "Saaz family" and produce stable transgenic plants of the variety "Hallertauer Mittelfrüher".

Development of molecular selection markers for powdery mildew resistance to provide effective support in breeding quality hops *(Humulus lupulus)* (Wifö-Nr. B 80)

Sponsored by:	Bayerische Landesanstalt für Landwirtschaft, *(Bavarian State Research Center for Agriculture)* Institut für Pflanzenbau und Pflanzenzüchtung *(Institute for Crop Science and Plant Breeding)*
Financed by:	Wissenschaftsförderung der Deutschen Brauwirtschaft e. V. *(Scientific Fund of the German Brewing Industry e.V.)*
Project Manager:	Dr. S. Seefelder
Cooperation:	Dr. F. Felsenstein, EpiLogic GmbH Agrarbiologische Forschung und Beratung Freising
Assisted by:	Dr. S. Seefelder, LTA P. Hager, CL V. Mayer, LAR A. Lutz, LTA J. Kneidl, Dr. E. Seigner
Duration:	01.01.2006- 31.12.2007

Objective:

To work out molecular selection markers to speed up the powdery mildew (PM) resistance breeding. Expression studies to identify genes involved in the resistance reaction of "Wye Target".

Results:

- Successfully establishing a "differential display" approach as the basis for the gene diagnostic marker development for PM resistance.
- Examining a "differential gene expression" following inoculation with PM spores. For this the RNA of "Wye Target" and "Northern Brewer" plants was isolated at various definite times after inoculation and transcription into cDNA. The following screening of the various cDNA probes ("Wye Target" + virulent PM isolate, "Wye Target" + avirulent isolate and "Northern Brewer" + virulent isolate) was carried out with 50 AFLP primer combinations.
- At the two probing times 6 and 24 hours after fungus contact solely "Wye Target" inoculated with an avirulent isolate showed a differential gene expression pattern with specific DNA fragments newly expressed.
- Confirming the allocation of this DNA pattern as a plant’s reaction to a successful fungus defence after cloning and sequencing of the fragments has taken place. Data bank researches of the identified sequences produced homologies to fungal resistance genes of apple, barley, poplar, soya and wine.
- The results gained in this project would be the best prerequisites for subsequent projects for developing the SNP (Single Nucleotide Polymorphism) marker.

Analysis of QTLs for alpha acids, beta acids, cohumulone, xanthohumol and yield

Sponsored by:	Bayerische Landesanstalt für Landwirtschaft, *(Bavarian State Research Center for Agriculture)* Institut für PIflanzenbau und Pflanzenzüchtung *(Institute for Crop Science and Plant Breeding)*
Financed by:	Hopsteiner, Mainburg
Project Manager:	Dr. S. Seefelder
Koordination:	Dr. E. Seigner
Cooperation:	Dr. P. Matthews, S. S Steiner, USA
Assisted by:	Dr. S. Seefelder, LTA P. Hager, CL V. Mayer, LTA J. Kneidl, LAR A. Lutz , Dr. E. Seigner
Duration:	01.05.2002- 31.12.2007

Objective:

The aim of this research project was to identify DNA markers for components relevant to brewing. In addition, efforts were made to describe molecularly the agronomic properties valuable for breeding such as yield and cone shape.

Results:

- The basis for this project is a mapping population from the cross "Spalter Select" x male Hüll breeding line 93/9/47 comprising 139 female plants. Since 2003 each plant has been grown in Germany and in the USA at two different locations and in three replications.
- The chemical data of the hop samples harvested each year were produced using HLPC .
- Starting from 786 AFLPs and 26 microsatellites a male and a female genetic map was constructed.
- Due to the greater data deviations of the American HPLC data on all 4 locations these data could not be included in the statistic evaluation. For this reason only the chemical data collected in the Hop Research Center in Hüll have so far been used for a statistic evaluation.
- To identify relevant genetic markers a linear single marker regression was carried out. For specific characteristics up to 63 % of the phenotypical variance could be explained with single markers. Alpha acids contents up to 29 %, beta acids values up to 31 %, cohumulone up to 63 % and xanthohumol up to 34 %.
- A QTL map is to be compiled with the statistically secured data record.

Development of molecular markers linked to powdery mildew resistance genes in hops to support breeding for resistance

Sponsored by:	Bayerische Landesanstalt für Landwirtschaft, *(Bavarian State Research Center for Agriculture)* Institut für PIflanzenbau und Pflanzenzüchtung *(Institute for Crop Science and Plant Breeding)*
Financed by:	EHRC (European Hop Research Council - Carlsberg Breweries, Heineken, InBev, Hopfenveredlung St. Johann, Hallertauer Hopfenveredelungsgesellschaft /Hopsteiner)
Project Manager:	Dr. S. Seefelder; ORRin Dr. E. Seigner
Assisted by:	R. Seidenberger, Dr. S. Seefelder, LAR A. Lutz, LTA J. Kneidl, Dr. E. Seigner
Cooperation:	Dr. F. Felsenstein, EpiLogic GmbH Agrarbiologische Forschung und Beratung, Freising; Dr. S. Mikolajewski, IPZ 1b
Duration:	01.12.2004 – 30.04.2008

Objective:

The aim is to work out molecular selection markers for the resistance genes of two wild hops which have so far proved to be resistant to all available powdery mildew (PM) races.

Results:

- Based on the preliminary work to examine the differential gene expression following inoculation with PM spores the analyses were continued in 2007.
- Starting from a cDNA-AFLP analysis the search began for specifically expressed gene sequences in plants with and without PM contact. In this respect presumably resistant plants activate special genes after inoculation with PM.
- Meanwhile the first findings are available for cDNA-AFLPs, which due to their expression kinetics and their homology to known resistance genes in other crops may play a role in recognising or defending against the pathogene.
- A final report with detailed results is being worked on.

Completed projects of the Work Group Plant Protection (April 2008)

Development of a simple biotest system for aphid tolerance of hop seedlings within the framework of hop breeding

Project staff: Dr. F. Weihrauch, LAR A. Lutz, A. Baumgartner, M. Felsl

Financed by: Anheuser-Busch Companies, Inc., Gesellschaft für Hopfenforschung e.V., Erzeugergemeinschaft Hopfen HVG e.G.

Central statement: In this test a male breeding line definitely verifies the known aphid resistance. No statistically assured differences can be seen in registered varieties tested. Possible causes: Temperatures during the test too high (Dr. Darby) or single leaf reacts differently from the whole plant.

Literature:
Kindsmüller G. (2005) Diploma thesis 107 pp.
Weihrauch F., Baumgartner A., Felsl M., Lutz A. (2008): Talk at the ISHS International Humulus Symposium in Ghent (enrolled)

Which aphid infestation can be tolerated during cone formation on the hops?

Project staff: Dr. F. Weihrauch, A. Bogenrieder

Financed by: Gesellschaft für Hopfenforschung e.V., (Society of Hop Research) Erzeugergemeinschaft Hopfen HVG e.G. (Producer Group)

Central statement: There is negative influence on yield and alpha-acid in aroma varieties from 10 - 15 and in Hallertauer Magnum from 20 - 25 hop aphids per leaf. Below this the hop aphid attacks only cause optical deterioration in these initial tests for a planned three-year project.

Trial to introduce the predatory mite *Typhlodromus pyri* in a hop yard in the Hallertau for the natural control of two-spotted spider mites *Tetranychus urticae*

Project staff: Dr. F. Weihrauch

Financed by: Anheuser-Busch Companies, Inc.

Central statement: The 12 predatory mites that were set out in average per training during 2007 produced the classic control success. However, this success cannot be expected every year.

Trials to attract aphid and spider mite antagonists

Project staff: Dr. F. Weihrauch

Financed by: Anheuser-Busch Companies, Inc.

Central statement: It was possible to attract a species of lacewing from a distance of over 500 m. Unfortunately this species is only found on conifers and is not endemic on hops. An attractant would have to be found that appeals to *Chrysoperla carnea*.

Literature: Weihrauch F. (2007): Trials to attract lace-wings on the special cultivar hops: status quo. DGaaE-Nachrichten 21 (3): 137

Application of entomopathogene nematodes (EPN) for the biological control of the Lucerne weevil *Otiorhynchus ligustici* in hops

Project staff: Dr. F. Weihrauch, J. Schwarz

Financed by: Erzeugergemeinschaft Hopfen HVG e.G., (Hop Producer Group)
Gesellschaft für Hopfenforschung e.V. (Society of Hop Research)

Central statement: These are orientation trials in order to work out the methods of application. Therefore success in controlling the weevil cannot be expected.

The detailed reports on these projects can be found under Point 6.3.

<u>Current research project of the Work Group Plant Protection</u>

Development of an innovative prognosis model to control the powdery mildew *Podosphaera macularis* in hops *Humulus lupulus*

Project staff: Dipl.-Ing. S. Schlagenhaufer

Financed by: Bundesanstalt für Landwirtschaft und Ernährung (BLE)
Federal Institute for Food & Agriculture
Erzeugergemeinschaft Hopfen HVG e.G. (Hop Producer Group)

Duration: 01.05.2007 - 31.12.2009

Central target: Working out basis data on the biology and epidemiology of the fungus in laboratory and field trials. Checking and adjusting a temporary prognosis model.

First trend: If the hops are 100% free of mildew by mid-June then they are no longer at risk. Sprayings in August when attacks occur have no effect with the products at present available.

Literature: Schlagenhaufer S. (2007) Dissertation
Schlagenhaufer S., et al. (2008): Talk for Innovation Days of the BLE

1.2 Main research areas

1.2.1 Main research area: Breeding

Breeding powery mildew-resistant varieties with brewing quality in the aroma and bitter sectors

Project managers: ORRin Dr. E. Seigner, LAR A. Lutz
Project staff: LAR A. Lutz, LTA J. Kneidl
Cooperation: Dr. F. Felsenstein, EpiLogic GmbH Agrarbiologische Forschung und Beratung, Freising

Objective:

The Hüll breeding work mainly focuses on the development of quality varieties adapted to the needs of the market which can be produced in an environmentally beneficial manner. As a good to very good resistance or tolerance towards the downy mildew and the V*erticil-lium* wilt is already anchored in the Hüll-bred varieties, for some years work has been carried out to improve the resistance to powdery mildew (PM).

Measures:

95 specific crosses with PM resistant crossing parters were carried out in 2007 in the aroma and/or bitter sector.

- Testing for PM resistance in the greenhouse and in the field
  - 156,000 seedlings from the various breeding programmes were screened for their resistance following artificial inoculation with four different PM strains, which are widespread in the Hallertau. Furthermore 7 foreign varieties, 231 breeding lines, 352 seedlings from 4 mapping populations as well as 103 wild hops were included in this greenhouse testing.
  - Subsequently only individuals which were classed as resistant in the greenhouse were examined in the field under natural infection conditions and without the use of fungicides (approx. 4000 seedlings per crop year) for their PM reaction.

- Testing for PM resistance in the laboratory by EpiLogic (detached leaf assay)
  - At the present time 12 different PM isolates with charactistic virulence properties are available for testing in the Petri dishes. With this range of PM isolates, tests can be made on all the hitherto resistances used in breeding all over the world.
  - In the detached leaf assay 7 varieties, 216 breeding lines, 352 seedlings from seedlings from 4 mapping populations and 91 wild hops were brought into contact with two English PM isolates. In this way their reaction could be tested towards PM races which have not yet occurred in Germany.
- Work is only to be continued with hops which show resistance towards powdery mildew in all tests.

1.2.2 Main research areas: Hop growing, production methods

Fertilizing trial for fixing potassium
Project manager: LOR J. Portner
Project staff: LA E. Niedermeier

The fertilizing trial to rectify the fixed potassium level was carried out in 2006 on a suspect area. Compared with the 0 plots the fertilization levels 300 kg K_2O/ha and 600 kg K_2O/ha were tested every three years. The influence of potassium containing chloride or little chloride with or without magnesium will also be investigated. The first test results show a positive yield reaction on potassium fertilization. Statements on the preferred form of potassium fertilizer cannot be made due to the fluctuating results of the trial.

Fertilizing trial to mobilise the nutrients present in the soil with the soil additives Agrovit and Litho KR

Project manager: LOR J. Portner
Project staff: LA E. Niedermeier
Cooperation: Firma MEKO, Ljubljana, Slowenien

With the "soil activators" Agrovit and Litho research will be made over four years in a trial at two locations with two different varieties to find out how far the one inoculation of the soil has an effect on the yield and the alpha-acid formation for the whole duration of the trial compared with the plots worked in the usual way. On an average over the first two years of the trial the yield in the case of the variety Perle declined by a quarter and by almost a half in the case of Hall. Mittelfrüher compared with the practice variant. Due to the poor crop results the trial will no longer be continued.

Standing room and bine-training trial with the variety Herkules

Project manager: LOR J. Portner
Project staff: LA E. Niedermeier

The optimum standing room or distance in the row depends on the habit of the bine and is to be ascertained typical for the variety.
Bine-training trials serve to find the optimum number of bines per wire in the case of newer varieties. With an increasing number of bines per wire the labour time for training and re-training bines increases as well as the pressure of disease due to the dense foliage. As ever the optimum of yield and alpha-acid is still extremely important for the economic success. To clarify the trial issues in 2006 the new high-alpha variety Herkules was planted in the row at a distance of 1.44 m and 1.62 m and 2 or 3 bines were twisted up each wire. The first trial crop 2007 shows the trend that with a closer distance between stands the 2-bine and with a wider distance the 3-bine training has yield advantages. The trial will be continued for another 2 years.

Determining the optimum harvest-time for the varieties Saphir and Herkules

Project staff: LOR J. Portner, LA A. Lutz
Duration: 2004 – 2007 (Saphir)
2006 – 2008 (Herkules)

In order to determine the optimum harvest-time in the Hallertau for the aroma variety Saphir and the high-alpha variety Herkules, 20 trained bines were harvested from a stand at intervals of 3-4 days resepectively and this repeated four times. The harvesting took place on 5 harvesting dates. Evaluation was made regarding yield, alpha-acid content, aroma and external quality (picking, colour and sheen, cone development and defects). The variety Herkules was harvested in the 2nd year. As for the variety Saphir the trial will be finished with the 4th harvest. After 3 years with harvesting beginning fairly late the 2007 trials could be carried out at a "normal" harvest time.

Developing and trying out the sensor technology in early plant protective applications

Project manager: LOR J. Portner
Project staff: LOI S. Fuß
A. Hartmair (graduand)
Cooperation: OAR A. Schenk, IPS Freising
Reith Landtechnik GmbH & Co. KG, Wolnzach
agrotop, Obertraubling
Hans Wanner GmbH, Wangen i. Allgäu
Müller-Elektronik, Salzkotten

Due to the distances between the plants (1.4 - 1.6 m in the row) and the lack of foliage in the spring there are considerable losses in the first plant protective applications if the insecticide is sprayed through the plants when advancing. Within the bounds of a dissertation research was made to find out whether it is possible to save the amount of plant protectives with the aid of sensors which recognise plants or surfaces of leaves consequently making a targeted application.

In another trial issue a solution was sought after to automate by sensor control the manual treatment by watering individual plants. For this a device was developed and tried out which recognises by sensor control the inserted wire and therefore the position of the plant and automatically positions the preselected amount of spraying liquid accurately on each individual plant.

Development of an EDP water household model to control irrigation in hop-growing

Project manager: LOR J. Portner
Project staff: LA J. Münsterer

The amounts of water and watering times required for an optimum hop yield are being deterined in three irrigation trials at the locations Hüll, Ilmendorf and Lurz through various trial variants.

At the same time threshold values i.a. for the soil water content are being tested which calculates the EDP water household model HyMoHOP via meteorological data. Weekly measurements are carried out As a check to determine the soil water content.

Increasing performance and saving energy with trestle kilns through optimum air conduction

Project staff: LA J. Münsterer

After possibilities to save energy by using alternative sources of energy and heat recovery were investigated and shown in 2006, research focused on optimising the air conduction during the 2007 crop. The most important finding is that only by regulating the air speed in the course of drying can the highest possible water discharge and consequently a high drying peformance be attained with simultaneous energy-savings. At the same time the air speed is ascertained and calculated via the oil consumption as well as the difference between the temperature of the incoming air and the heated kiln air.

Testing alternative materials for training wires

Project staff: LAR J. Schätzl

Hops need help in climbing. In the practice a 1.1 – 1.4 mm thick iron wire is used. To avoid the dreaded "hop spikes" alternative materials of natural fibres or biodegradable plastics are offered for sale time and time again. By testing these materials in comparison with traditional training wire information is to be supplied on their suitability for use in the practice.

Increased nitrogen trial with area and belt fertilization

Project manager: LOR J. Portner
Project staff: LA E. Niedermeier

Earlier trials in the Hallertau and Thuringen prove that with belt fertilization up to a third of the amount of nitrogen fertiliser can be saved compared with fertilizing over the whole area without any losses in yield. This can be of advantage for the hop farmer if when using nitrogen fertiliser he reaches the limits of the tolerated balance in the nutrient comparison according to the fertilising regulation.
The planned increased nitrogen trial is to investigate whether the limit of the balance of 60 kg N/ha in the hop farm is sufficient and whether nitrogen can really be saved with belt fertilization.

Fungicide treatment with and without Strobilurine

Project staff: LAR J. Schätzl
LOI S. Fuß

Besides the fungicide effect the plant protectives of the group of Stobilurine are said to have positive effects on the development of yield and hop components. Optically a certain "greening effekt" could be proven. To ensure the results, in a practice stand two peronspora treatments were given with a Strobilurin preparation and a comparative preparation from another group of active ingredients and harvested with regard to yield and alpha-acid content.

Leaf fertilization with Nutri-Phite Magnum

Project staff: LA E. Niedermeier

Nutri-Phite Magnum is a NPK liquid fertilizer for leaf application and should increase the vitality and resistance of the hop plant. The harvesting is made with regard to yield and alpha-acid content.

1.2.3 Main research areas: Hop quality and analytics

Developing a NIR calibration for the alpha-acid content based on HPLC data

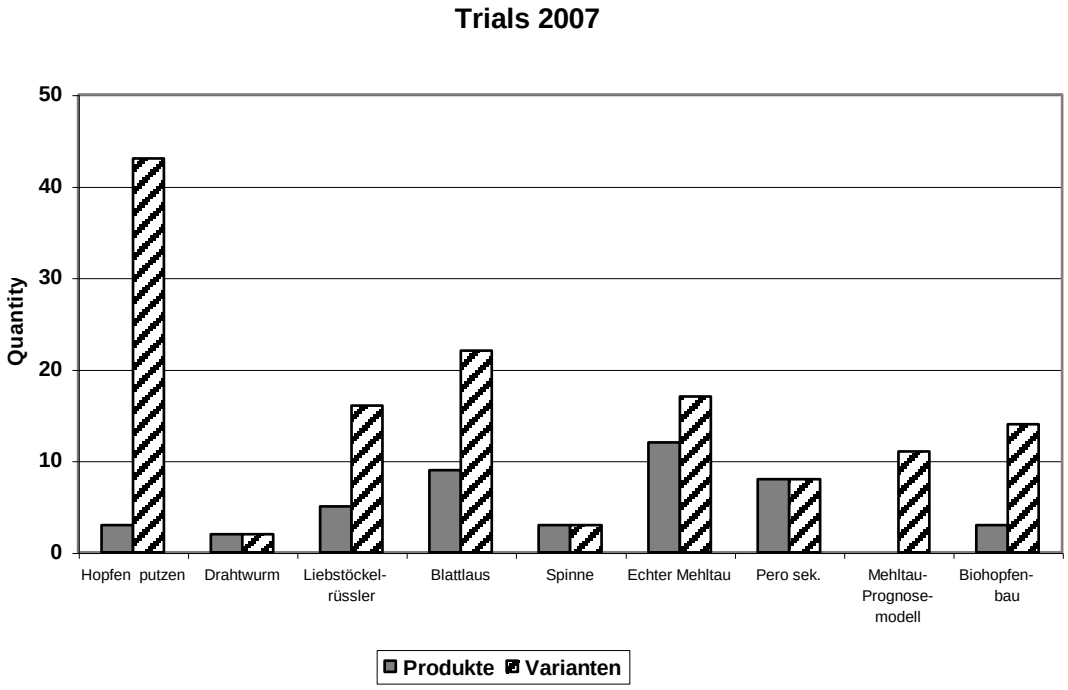
Project manager:	RR Dr. K. Kammhuber
Cooperation:	Dr. M. Biendl, Hallertauer Hopfenveredelungsgesellschaft mbH J. Betzenbichler, Hallertauer Hopfenveredelungsgesellschaft mbH R. Schmidt, NATECO_2 GmbH & Co. KG U. Weiss, Hopfenveredelung HVG Barth, Raiser GmbH & Co KG
Assisted by:	CL E. Neuhof-Buckl, CTA B. Wyschkon, Dipl. Ing. Agr. C. Petzina, RR Dr. K. Kammhuber
Duration:	The project was begun in September 2000, the end is still open

Since the year 2000 a NIR calibration based on HPLC data has been developed by Hüll and the laboratory of the hop-processing firms, in order to replace the rising number of wet-chemical examinations by a cheap fast method. The target is to improve the NIR method so that an acceptable repeatability and reproducibility can be attained for daily practice. Every year the existing calibration is expanded and improved through new data records. In the Work Group for Hop Analytics (AHA) it was decided that this method will then be suitable for practice and can be used as an analytic method for the Hop Supply Contracts, if it is at least equally as accurate as the conductometric titration according to EBC 7.4. The NIR method is already being used as a screening method for the breeding research.

1.2.4 Main research areas: Plant protection in hops

Testing plant protectives for licenses or approval respectively and for the advisory service 2007

Project Manager: Ltd. LD Bernhard Engelhard
Assisted by : J. Schwarz, G. Meyr



In the trials for hop stripping the products Shark and Quickdown were tested on two varieties at the 1st and 2nd hop stripping as well as Reglone at the 2nd hop stripping with various amounts of water and active ingredients.

It could be seen that in the case of Reglone the hitherto licensing with 5.0 l/ha is correct and also the planned time in the case of the two new products can remain so. In all the trials the double product amount produced no losses in yield and quality; i.e. there is good plant suitability although superficial burns occur on the parts of the bine which are sprayed. The amount of water can remain at the amounts of 900 - 1.200 l/ha usual in practice for the 1st hop stripping and 1,500 – 1,800 l/ha for the 2nd hop stripping. Only in the case of Shark is the respective greater amount of water necessary.

2 Weather conditions 2007 – warmest spring since the beginning of meteorological records

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An "unusual winter" with average minimum temperatures above freezing was the start in the new vegetation year. No ground frost means that winter work such as trellis repairs and hanging up wires as well as taking soil probes was not possible. The warm winter also had other negative consequences:

Crown rot – the combination with the wet August 2006 and the drought in March/April 2007 was the cause of unusually high crown rot especially with the varieties HT, PE, TU and young HS.

Vegetation began much too early on 5th March – the spring work began ahead of time and therefore the hop plants began growing prematurely which in the case of HA and HM resulted in their coming into burr too early. As presumably these occurrences will happen more frequently in the future, the hop growers should exercise patience in the spring and if in doubt take a look at the actual date on the calendar. In 2007 the first cutting work began on 21st February (Ash Wednesday).

The first half of March enabled all the spring work to be carried out in very good conditions with spring temperatures.

The hop stripping and training began on 14th April and for the very first time was even finished in the last days of April. Generally the whole vegetation development was about three weeks ahead of time. The hops just about survived the long drought over the whole of April and the beginning of May without any damage. At last it rained on 8th/9th May but this soon turned into a storm on 10th – 12th May and resulted in a hailstorm on 14th May. Heads were broken off and the retraining caused a lot of work.

On the one hand warmth and drought in the spring resulted in the very early migration of hop aphids (from 10th May), on the other hand the primary infection of downy mildew dried in the hop shoots so that for a long time no pressure of disease could build up. Also the stands with crown rot were able to recover. In the months of June (even with only 55 mm rain) there were always sufficient showers at the right time up until August. Special occurrences were the rain showers on 27th – 29th May with 80 – 100 mm rain and the frequent widespread hailstorms.

Altogether a good harvest was predestined due to the weather conditions. In the case of the variety HM the cone formation was very late particularly at the Center of the bine; consequently the formation of alpha-acid was far below expectations.

2.1 Weather data (monthly mean averages or monthly totals) from the year 2007 compared with the 10- and 50-year mean averages

Month		Temperature in 2 m height Average (°C)	Min.∅ (°C)	Max.∅ (°C)	Rel. humidity (%)	Precipi-tation (mm)	Days w. preciptn >0.2 mm	Sun-shine (hrs.)
January	2007	**3.9**	**0.2**	**7.1**	87.8	**90.9**	**20.0**	44.9
∅	10-yr.	-1.4	-4.7	2.2	89.0	41.6	10.5	73.0
	50-yr.	-2.4	-5.1	1.0	85.7	51.7	13.7	44.5
February	2007	**4.0**	**0.2**	**8.9**	90.1	**63.4**	**18.0**	103.4
∅	10-yr.	0.5	-4.1	5.4	84.0	36.7	11.1	97.8
	50-yr.	-1.2	-5.1	2.9	82.8	48.4	12.8	68.7
March	2007	**5.4**	**0.0**	**11.7**	82.5	57.6	15.0	173.4
∅	10-yr.	4.2	-0.7	9.6	80.4	66.2	13.2	142.8
	50-yr.	2.7	-2.3	8.2	78.8	43.5	11.3	134.4
April	2007	11.7	2.9	20.4	66.9	**27.8**	**2.0**	322.4
∅	10-yr.	8.3	2.7	14.3	74.1	55.8	11.9	175.4
	50-yr.	7.4	1.8	13.3	75.9	55.9	12.4	165.0
May	2007	14.8	8.0	21.5	71.9	167.6	13.0	242.4
∅	10-yr.	13.8	7.5	20.2	72.4	77.9	12.2	223.4
	50-yr.	11.9	5.7	17.8	75.1	86.1	14.0	207.4
June	2007	17.9	11.6	24.5	76.0	**55.1**	13.0	241.7
∅	10-yr.	16.9	10.2	23.4	72.6	94.9	14.0	245.5
	50-yr.	15.3	8.9	21.2	75.6	106.1	14.2	220.0
July	2007	17.9	11.9	24.5	77.6	108.6	18.0	234.0
∅	10-yr.	17.8	11.8	24.3	75.9	97.8	15.8	222.9
	50-yr.	16.9	10.6	23.1	76.3	108.4	13.9	240.3
August	2007	16.6	10.8	23.2	83.0	**116.7**	**16.0**	181.7
∅	10-yr.	17.6	11.5	24.5	77.3	83.4	11.7	217.1
	50-yr.	16.0	10.2	22.5	79.4	94.9	13.3	218.4
September	2007	11.9	6.7	18.0	88.1	**117.6**	16.0	127.1
∅	10-yr.	13.6	8.1	20.2	82.0	67.0	11.0	179.1
	50-yr.	12.8	7.4	19.4	81.5	65.9	11.4	174.5
October	2007	7.6	2.9	13.8	91.5	**15.9**	**7.0**	129.7
∅	10-yr.	9.3	5.0	14.4	86.6	73.1	13.1	113.0
	50-yr.	7.5	2.8	13.0	84.8	60.0	10.4	112.9
November	2007	1.8	-1.1	4.8	95.5	95.2	16.0	45.5
∅	10-yr.	3.3	0.0	6.9	91.4	59.4	12.1	65.8
	50-yr.	3.2	-0.2	6.4	87.5	58.8	12.6	42.8
December	2007	0.1	-2.7	3.1	93.6	64.4	14.0	42.2
∅	10-yr.	0.3	-2.7	3.3	91.0	43.6	13.5	61.6
	50-yr.	-0.9	-4.4	1.6	88.1	49.1	13.3	34.3
Year 2007		9.5	4.3	15.1	83.7	980.8	168.0	1888.4
10 – year average		8.7	3.7	14.1	81.4	797.3	150.1	1817.3
50 – year average		7.4	2.5	12.5	81.0	828.8	153.0	1663.0

The 50-year average refers to the years 1927 up until and including 1976, the 10-year average refers to the years 1997 up until and including 2006.

3 Statistic data on hop production

LOR Johann Portner, Dipl. Ing. agr.

3.1 Production data

3.1.1 Structure of the hop production

Table 3.1: Number of hop farms and their hop acreage in Germany

Year	No. of farms	Hop acreage per farm in ha	Year	No. of farms	Hop acreage per farm in ha
1963	13 259	0.68	1991	3 957	5.70
1973	8 591	2.33	1992	3 796	6.05
1974	8 120	2.48	1993	3 616	6.37
1975	7 654	2.64	1994	3 282	6.69
1976	7 063	2.79	1995	3 122	7.01
1977	6 617	2.90	1996	2 950	7.39
1978	5 979	2.94	1997	2 790	7.66
1979	5 772	2.99	1998	2 547	7.73
1980	5 716	3.14	1999	2 324	7.87
1981	5 649	3.40	2000	2 197	8.47
1982	5 580	3.58	2001	2 126	8.95
1983	5 408	3.66	2002	1 943	9.45
1984	5 206	3.77	2003	1 788	9.82
1985	5 044	3.89	2004	1 698	10.29
1986	4 847	4.05	2005	1 611	10.66
1987	4 613	4.18	2006	1 555	11.04
1988	4 488	4.41	2007	1 510	11.72
1989	4 298	4.64			
1990	4 183	5.35			

Table 3.2: Acreage, no. of hop farms and average area under hops per farm in the German production regions

Production area	Hop acreagae				Hop farms				Hop acreage per farm in ha	
	in ha		Increase+ / Decrease - 2007 to 2006				Increase+ / Decrease- 2007 to 2006			
	2006	2007	ha	%	2006	2007	farms	%	2006	2007
Hallertau	14 280	14 754	+ 474	+ 3.3	1 255	1 222	- 33	- 2.6	11.38	12.07
Spalt	388	384	- 4	- 1.0	93	84	- 9	- 9.7	4.17	4.57
Tettnang	1 200	1 220	+ 20	+ 1.7	176	173	- 3	- 1.7	6.82	7.05
Baden, Bitburg and Rhineland-Palatinate	19	19	± 0	± 0	2	2	± 0	± 0	9.50	9.50
Elbe-Saale	1 284	1 321	+ 37	+ 2.9	29	29	± 0	± 0	44.28	45.55
Germany	**17 170**	**17 698**	**+ 528**	**+ 3.1**	**1 555**	**1 510**	**- 45**	**- 2.9**	**11.04**	**11.72**

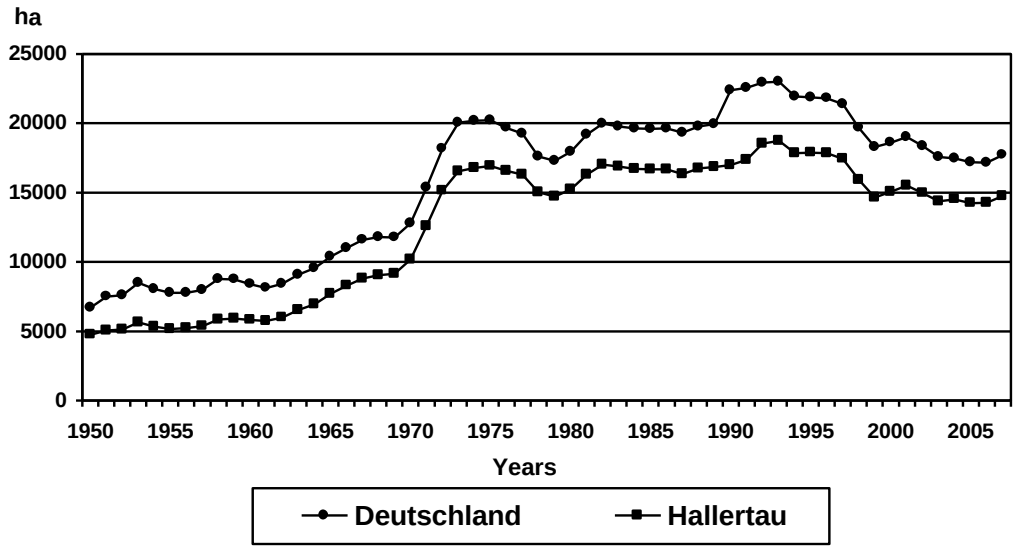


Fig. 3.1: Hop acreage in Germany and in the Hallertau

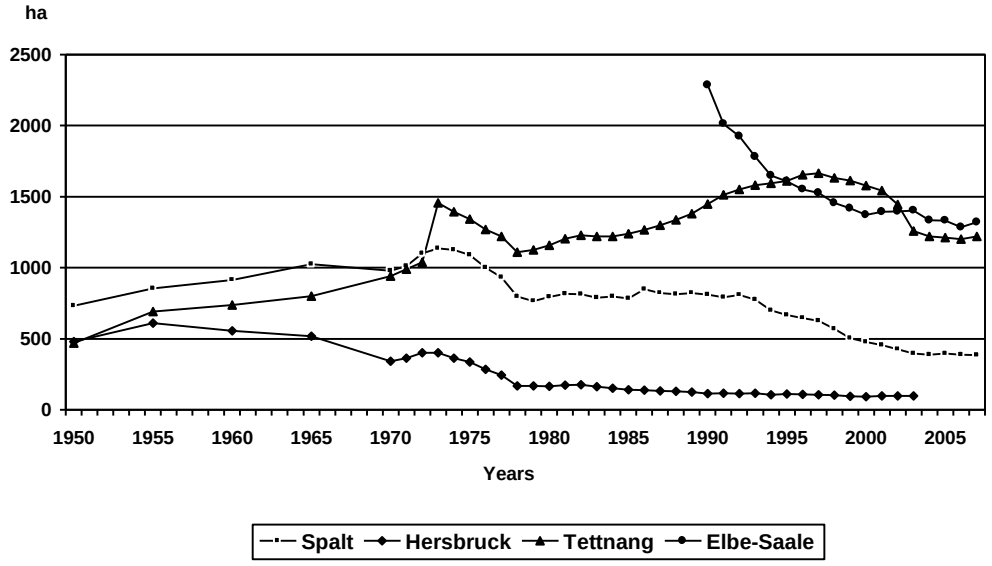


Fig. 3.2: Hop acreage in the regions Spalt, Hersbruck, Tettnang and Elbe-Saale

The Hersbruck hop-growing region has come under the Hallertau since 2004.

3.1.2 Hop varieties

As far as the hop varieties are concerned after years of an increase in the aroma varieties in 2007 there was a slight shift in production towards bitter varieties. The reason for this is the new high-alpha variety Herkules, which with 868 hectares or 5 % of the area under hops is already the third biggest bitter variety and sixth biggest variety in Germany. The proportion of aroma varieties in the year 2007 amounts to 59.1 % compared with 59.9 % in 2006. According to this the bitter varieties have increased by 40.1 % of the area under hops to 40.9 % in the year 2007.

Due to the improved state of the market the hop production in Germany was expanded by 528 hectares. In the case of aroma varieties especially the three biggest varieties Perle (+ 111 ha), Hallertauer Tradition (+ 126 ha) and the old traditional variety Hallertauer Mittelfrüher (+ 76 ha) profited from this. More areas were cleared only relating to the variety Hersbrucker Spät with 124 ha. The new aroma varieties Saphir, Opal and Smaragd were just able to hold their production area or just slightly increase it.

In 2007 the area of the bitter varieties increased by 346 hectares. As all varieties recorded reductions in the areas under hops, the good result can be traced back solely to the expansion in acreage of Herkules with 654 hectares. The exact distribution of the varieties according to production areas can be seen in the tables 3.3 and 3.4.

Fig. 3.3: Distribution of hop varieties in Germany in 2007

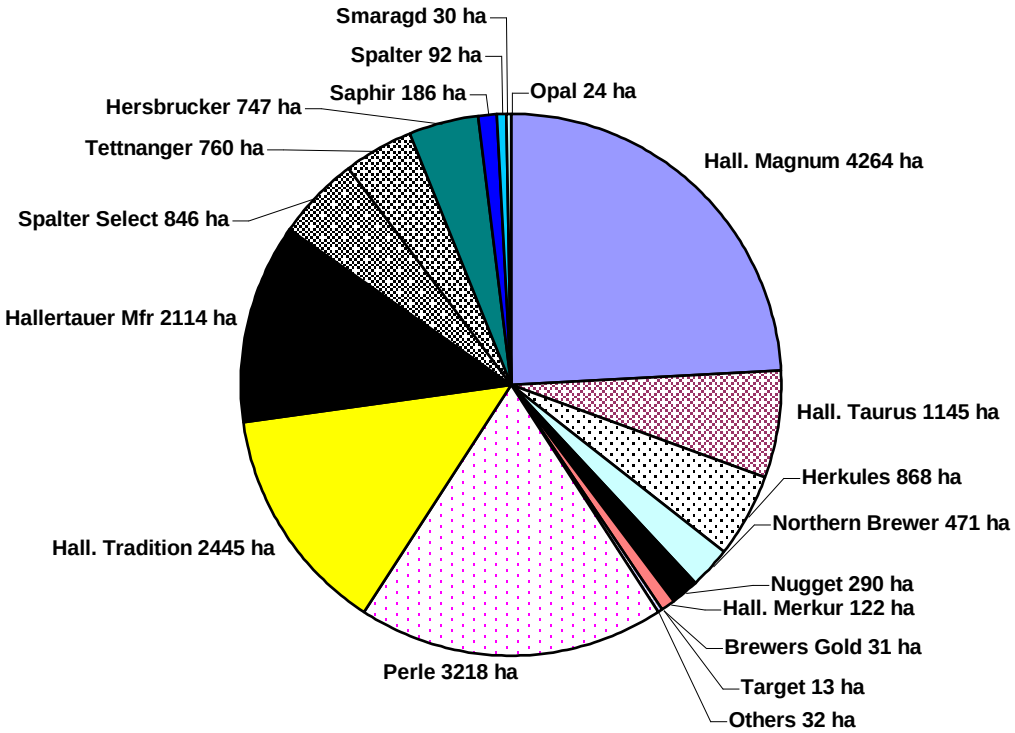


Table 3.3: Hop varieties in the German hop-growing regions in ha in 2007
Aroma varieties

Hop region	Total areage	HA	SP	TE	HE	PE	SE	HT	SR	OL	SD	Aroma varieties	
												ha	%
Hallertau	14.754	1.594	1		741	3.034	733	2.358	186	24	30	8.701	59.0
Spalt	384	109	91		6	25	111	25				367	95.3
Tettnang	1.220	410		760		19		19				1.208	99.0
Baden. Bit-burg and Rhineland-Palatinaate	19	1				8	2	5				16	84.7
Elbe-Saale	1.321					132		38				170	12.9
Germany	17.698	2.114	92	760	747	3.218	846	2.445	186	24	30	10.462	59.1
Distribution in **%**		12.0	0.5	4.3	4.2	18.2	4.8	13.8	1.1	0.1	0.2		

Change in varieties in Germany

2006 ha	17.170	2.037	97	755	871	3.108	855	2.319	191	20	26	10.279	59.9
2007 ha	17.698	2.114	92	760	747	3.218	846	2.445	186	24	30	10.462	59.1
Change in ha	+ 528	+ 76	- 5	+ 5	-124	+ 111	- 9	+ 126	- 5	+ 3	+ 4	+ 182	

Table 3.4: Hop varieties in the German hop-growing regions in ha in 2007

Hop region	NB	BG	NU	TA	HM	TU	MR	HS	Others	Bitter varieties	
										ha	%
Hallertau	334	31	251	9	3.431	1.117	83	775	21	6.052	41.0
Spalt					3		10	5	17	18	4.7
Tettnang					1	4		4	3	12	1.0
Baden. Bit-burg and Rhineland-Palatinate					2	1				3	15.3
Elbe-Saale	137		39	4	827	23	29	84	8	1151	87.1
Germany	471	31	290	13	4.264	1.145	122	868	32	7.236	40.9
Distribution in **%**	2.7	0.2	1.6	0.1	24.1	6.5	0.7	4.9	0.2		

Change in varieties in Germany

2006 ha	550	32	331	20	4.387	1.178	147	214	31	6.890	40.1
2007 ha	471	31	290	13	4.264	1.145	122	868	32	7.236	40.9
Change in ha	- 79	- 1	- 41	- 7	- 123	- 33	- 25	+ 654	+ 1	- 346	

3.2 Crop situation in 2007

The volume of hops harvested in 2007 in Germany amounts to approximately 32,138,870 kg (= 642,777 ztr.) compared with 28,508,250 kg (= 570,165 ztr.) in 2006. The size of the crop is therefore about 3,630,620 kg (= 72,612 zentners) over the previous year's result; this means an increase of around 12.7 %.

The hectare yields and relative figures for Germany are shown in Table 3.5.

Table 3.5: Yields per hectare and relative figures in Germany

	2002	2003	2004	2005	2006	2007 [1)]
Yield ztr./ha or kg/ha	1758 kg (35.2 Ztr.)	1444 kg (28.9 Ztr.)	1900 kg (38.0 Ztr.)	2006 kg (40.1 Ztr.)	1660 kg (33.2 Ztr.)	1816 kg (36.3 Ztr.)
Relative to 100% (many yr ∅ =35 Ztr.)	100.5	82.5	108.6	114.6	94.9	103.7
Acreage in ha	18,352	17,563	17,476	17,179	17 170	17,698
Total crop in ztr. or kg	32,270,970 kg = 645,419 Ztr,	25,356,200 kg = 507,124 Ztr,	33,208,000 kg = 664,160 Ztr,	34,466,770 kg = 689,335 Ztr,	28,508,250 kg = 570,165 Ztr,	32,138,870 kg = 642,777 Ztr,

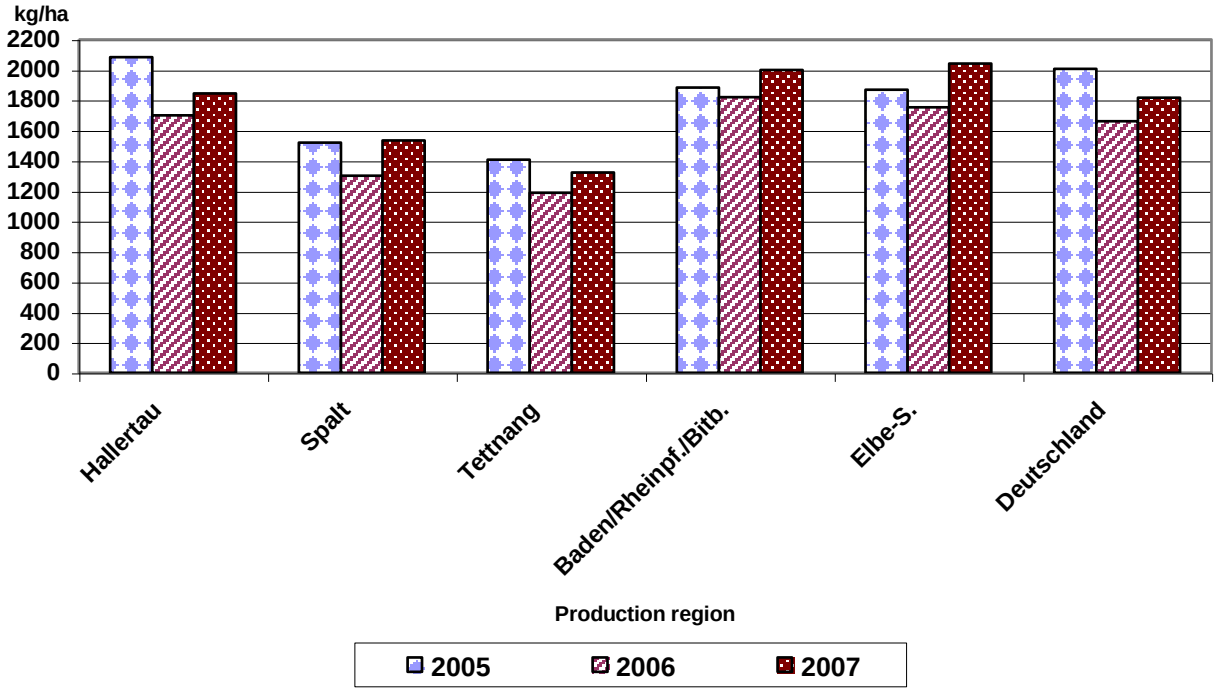


Fig. 3.4: Average yields in the various production regions in kg

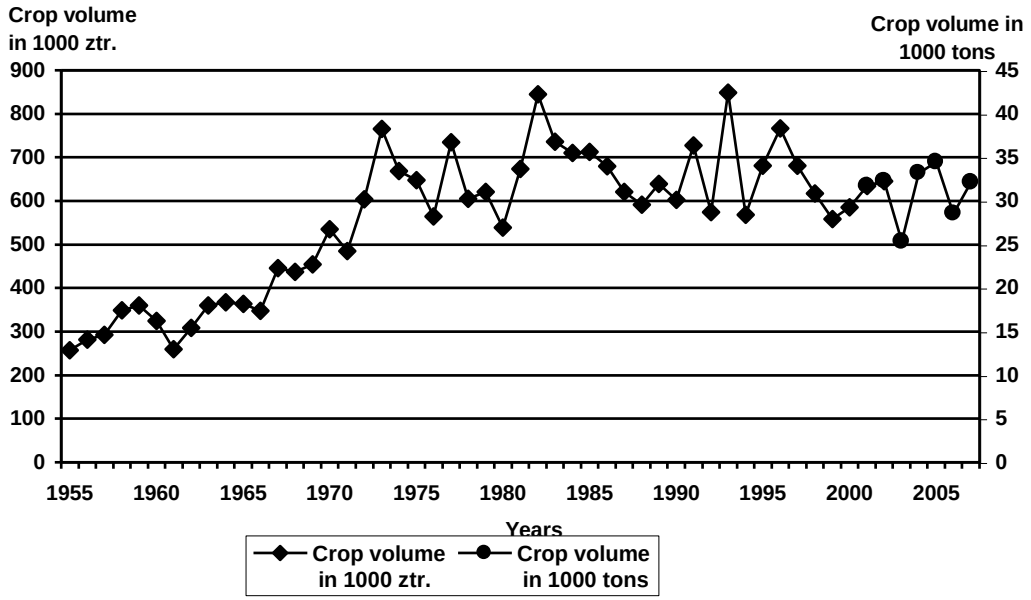


Fig. 3.5: Crop volume in Germany

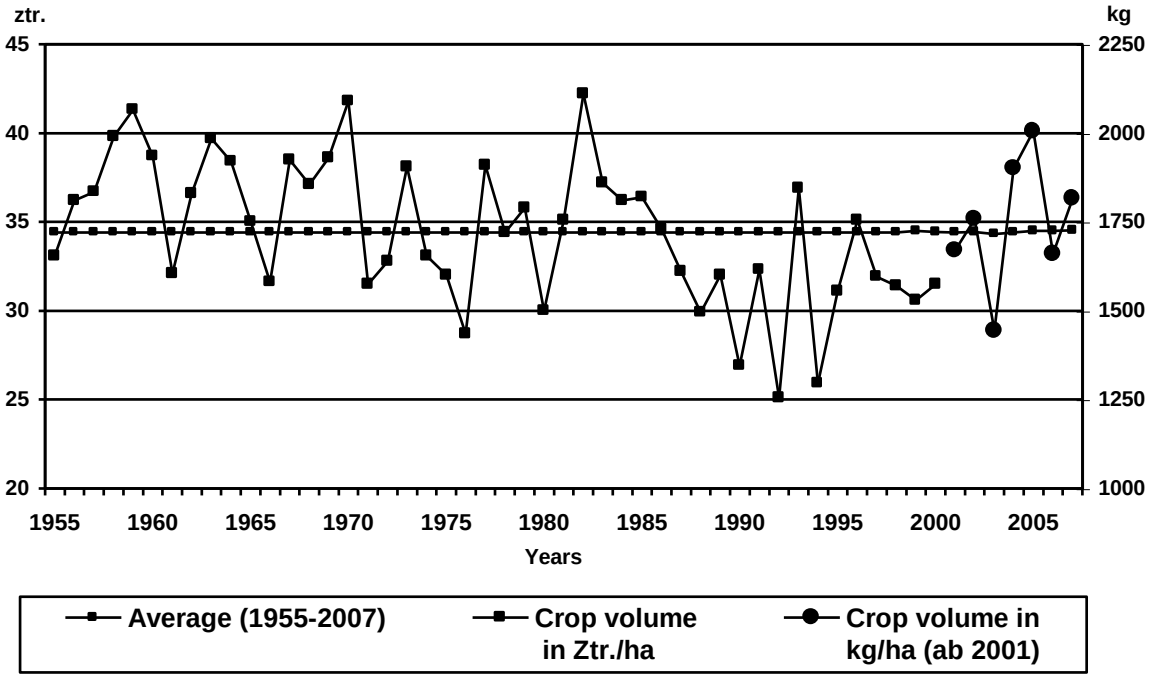


Fig. 3.6: Average crop (ztr. or kg/ha) in Germany

Table 3.6: Yields per hectare in the German production regions

Region	Yields in ztr./ha total acreage (from 2001 in kg/ha)								
	1999	2000	2001	2002	2003	2004	2005	2006	2007 [1)]
Hallertau	31.2	33.6	1724	1825	1462	1946	2084	1701	1844
Spalt	28.2	20.9	1298	1464	1131	1400	1518	1300	1532
Hersbruck	23.5	26.8	1233	1306	983	- *	- *	-*	- *
Tettnang	28.3	16.4	1212	1360	1216	1525	1405	1187	1323
Bad./RhinePa Bitburg	31.4	31.6	1445	1763	1936	1889	1881	1818	1998
Elbe-Saale	27.3	30.0	1594	1576	1555	1895	1867	1754	2043
∅ Yield p. ha Germany	30.6	31.5	1669 kg	1758 kg	1444 kg	1900 kg	2006 kg	1660 kg	1816 kg
Total crop Germany (t or ztr.)	559 096	585 964	31 739 t 634 782	32 271 t 645 419	25 356 t 507 124	33 208 t 664 160	34 467 t 689 335	28 508 t 570 165	32 139 t 642 777
Acreage Germany	18 299	18 598	19 020	18 352	17 563	17 476	17 179	17 170	17 698

* The Hersbruck hop-growing region has come under the Hallertau since 2004.
1) provisional

Table 3.7: Alpha-acid values for the various hop varieties

Region/Variety	1998	1999	2000	2001	2002	2003	2004	2005	2006	**2007**	5-year ∅	10-year. ∅
Hallertau Hallertauer	4.7	4.1	4.9	4.6	4.6	3.1	4.3	4.4	2.4	**3.9**	**3.6**	**4.1**
Hallertau Hersbrucker	3.7	2.1	4.9	3.0	3.2	2.1	3.0	3.5	2.2	**2.6**	**2.7**	**3.0**
Hallertau Hall. Saphir							3.4	4.1	3.2	**4.6**		
Hallertau Opal										**7.4**		
Hallertau Smaragd										**6.1**		
Hallertau Perle	6.7	7.0	8.1	7.0	8.6	3.9	6.4	7.8	6.2	**7.9**	**6.4**	**7.0**
Hallertau Spalter Select	5.5	4.5	6.4	4.8	6.0	3.2	4.9	5.2	4.3	**4.7**	**4.5**	**5.0**
Hallertau Hall. Tradition	5.6	6.0	7.1	6.3	7.2	4.1	6.3	6.3	4.8	**6.0**	**5.5**	**6.0**
Hallertau North. Brewer	9.1	9.0	10.1	9.6	10.1	6.0	9.8	9.8	6.4	**9.1**	**8.2**	**8.9**
Hallertau Hall. Magnum	14.0	13.4	14.4	13.9	14.6	11.7	14.8	13.8	12.8	**12.6**	**13.1**	**13.6**
Hallertau Nugget	11.2	10.0	12.9	11.9	12.4	8.5	10.6	11.3	10.2	**10.7**	**10.3**	**11.0**
Hallertau Hall. Taurus	13.7	15.9	15.6	15.7	16.5	12.3	16.5	16.2	15.1	**16.1**	**15.2**	**15.4**
Hallertau Hall. Merkur							13.5	13.3	10.3	**13.0**		
Hallertau Herkules										**16.1**		
Tettnang Tettnanger	4.0	3.8	4.9	4.4	4.6	2.6	4.7	4.5	2.2	**4.0**	**3.6**	**4.0**
Tettnang Hallertauer	4.3	4.2	4.8	4.5	4.8	3.1	5.0	4.8	2.6	**4.3**	**4.0**	**4.2**
Spalt Spalter	4.4	3.8	4.0	4.4	4.6	3.1	4.4	4.3	2.8	**4.6**	**3.8**	**4.0**
Elbe-Saale Hall. Magnum	12.4	12.2	14.0	13.9	13.9	10.2	14.0	14.4	12.4	**13.3**	**12.9**	**13.1**

Source: Work Group Hop Analysis (AHA)

4 Breeding research on hops

ORRin Dr. Elisabeth Seigner, Dipl. Biol.

4.1 Classic breeding

It is top priority to breed new hop varieties which meet to the requirements and wishes of the hop and brewing industry. A very extensive collection of German and foreign hop varieties, breeding lines and wild hops from all over the world, which are evaluated, maintained and tended at the Hop Research Center, forms the basis for breeding work. Also biotechnological and genome-analytical methods have been applied in a supportive way.

4.1.1 Crosses 2007

Altogether 99 crosses were carried out in 2007. The breeding principle is a stable resistance / tolerance to downy mildew, powdery mildew, crown rot and wilt. The number of crosses for the respective breeding targets is shown in Table 4.1.

Table 4.1: Breeding objectives for the 2007 crosses

Breeding direction combined with resistance / tolerance towards various hop diseases	Further requirements	No. of crosses
Aroma type	none	-
	new powdery mildew resistances from wild hops	35
	suitable for low trellis system	6
	suitable for developing molecular markers	2
High alpha-acids type	none	22
	new PM resistances from wild hops	12
	high xanthohumol content	3
	high beta acids content	2
	suitable for low trellis system	13
	suitable for developing molecular markers	4

4.1.2 Breeding resistant hops especially suitable for the growth on low trellis systems

Objective

It is the target of this research project to breed hops which due to shorter growth, broader resistance to disease and excellent brewing quality are particularly suitable to be grown successfully on low wirework. Up until now there have not been this kind of adapted varieties. They are the still missing building block with which the production costs can be successfully reduced on the 3 meter trellis system. This can be reached by reducing the amount of work, through less costs for the trellis and savings in fertilizers and plant protectives. In this way the competitiveness of German hops on the world market can be considerably improved. Furthermore the environmental benefits of the hop production could be gravely improved with this new system, because less plant protectives and fertilizers are needed and in addition pesticides can be sprayed with recycling tunnel sprays reducing the spray drift.

Results

Seedlings 2008 from the crosses in 2007

In June and July 2007 for the first time specific crosses could be carried out within the framework of the project to develop dwarf hops especially suited for the 3-meter trellis systems. Altogether 14 crosses were carried out: 6 aroma type crosses, 8 bitter type crosses 2 of which are mapping crosses in order to develop molecular markers for dwarf stature. Beyond that in the case of three interesting and well-fertilized dwarf lines which had been openly fertilized, the cones were harvested and the seeds threshed out.

Characterising the crossing parents: Growth, resistance, quality of the hop components

In selecting the crossing parents attention was particularly paid to shorter growth, disease resistance and as far as cone components are concerned on fine aroma quality and/or high bitter acids contents.

All the crossing mothers used showed dwarf growth and – proven by chemical analyses over several years – pleasant aroma or bitter compositions respectively. Furthermore they have broad powdery mildew resistance as tests have shown in the greenhouse over several years under artifical infection conditions. This is also proven in the detached leaf tests carried out by EpiLogic, where even non-endemic PM races are used for testing. Disease resistance in these hops is based on the resistance genes *R1 a*nd *R2*, which originate from English varieties.

All the fathers used in the crosses were classified as PM resistant in the greenhouse. Seven of these male crossing parents are already characterised in their PM resistance to fungal isolates from England and the USA which was made via the leaf resistance test (= detached leaf test) with EpiLogic. So it is certain that in five crosses male crossing partners are used which show a complete PM resistance based on the wild hops WH18 or WH127 respectively. These tests are being carried out for the first time in 2008 for the four other fathers.

Beyond that all the male hops used in the crosses show good growth properties in the breeding yard in Freising.

Dwarf growth has a polygenous inheritance. Therefore in the "growth length" of short to long all the inbetween lengths occur in the descendants. In five crosses dwarf growth can not only be ascertained in the mothers but also in the crossing fathers, therefore it is expected that in these descendants the "yield" of seedlings with dwarf properties increases considerably.

Male crossing partners which showed a very high alpha-acids potential for inheritance in earlier crosses were used in four crosses.

Seedlings 2004 – 2006

Altogether 22 seedlings, which closely approach the target direction now striven for, were harvested in 2007. All seedlings belong to the bitter type. Interesting aroma seedlings could not be selected in 2007. Of the bitter-type seedlings nine were selected with dwarf or semi-dwarf growth type, which are now to be planted out in May 2008 in the 3-meter trellis system on Mr. Mauermeier's farm in Starzhausen. At present they are being tested for virus infection and virus-free material is being propagated for the low-trellis trials.

Seedlings 2007

In 10 crosses from the year 2006 (2x aroma type, 1x dual type [aroma- and simultaneous bitter hop properties], 7x bitter type) seedlings with dwarf or semi-dwarf growth type can be expected. All the crossing parents possess broad PM resistance, which in recent years was proven in the greenhouse as well as in the laboratory via the detached leaf test by Epi-Logic. Altogether more than 15,000 seedlings have been germinated and grown in February 2007 from the seeds of the above mentioned crosses.

Testing for powdery and downy mildew resistance/tolerance

After the seedlings were artificially inoculated in the greenhouse with four of the PM races typical for the Hallertau between 24 – 100% of the seedlings – depending on the crossing parents - could be classified as PM resistant. After all 2,800 mildew resistant seedlings (on average 280 per cross) were transferred from the seed dishes into single pots in March. At the beginning of April testing followed for tolerance towards downy mildew. For this the seedlings were sprayed with a fungus spore suspension and afterwards assessed. There were great differences in the susceptability from average to extremely strong.

Assessments in the vegetation hall

At the beginning of May 2007 668 seedlings were planted out in the vegetation hall. Generally the hop aphid susceptibility was only slight. In the course of the summer natural attacks were observed with a PM strain which can break the resistance gene *R1*. In most of the crosses a part of the seedlings were attacked. Plants which showed considerable weaknesses such as e.g. bad attacks of hop aphid or PM respectively, root rot and/or no suitable type of growth (dwarf or semi-dwarf) were discarded by the autumn. 53 seedlings showed no flowers and so their sex was determined via molecular sex markers.

Planting out the seedlings on the high trellis system in the breeding yard

In the autumn of 2007 altogether 46 male and 280 female seedlings of the ten above named crosses were transplanted from the hall into the field. There was no room for another 209 interesting seedlings in summer 2007 which is why they were planted in the field in Rohrbach. After further selection in the summer (for downy mildew, hop aphid, growth type, etc.) 123 seedlings of these were left over. They were likewise planted for the 3-year seedling test in the breeding yard in Hüll (7 m high wirework). So far these plants did not develop any flowers, their sex is therefore unknown.

Assessing the breeding lines so far available when grown on low trellis systems

In the meantime breeding lines with shorter growth from various breeding programmes are being grown on two low wireworks which were used between 1993 and 2002 in the R&D research projects.

Low trellis system in Starzhausen at the Mauermeier hop farm

Here there are altogether 29 plots with 12 plants per plot. Besides the English dwarf hops and four Hüll high-trellis varieties as reference varieties there are 18 breeding lines with shorter growth being cultivated. The yard is worked under conventional farming with pruning and hilling. Galvanized wire is used as training wire. Harvesting on two dates : D1: 07.09.2007 and D2: 19.09.2007

Table 4.2: Low-trellis Starzhausen – harvest results in 2007

Breeding line/ Variety	Type	Yield[3] in g/wire	α-acids in %	β-acids in %	Cohumulone in %	Aroma 1-30
First Gold[1]	A	375	8.0	4.4	25.8	24
Herald[1]	A	204	12.8	5.1	29.0	19
Pioneer[1]	A	527	11.0	4.6	27.9	20
Perle[2]	A	255	8.2	5.2	26.1	25
Hall. Magnum[2]	B	177	13.8	6.6	28.1	22
Hall. Taurus[2]	B	354	16.0	5.4	23.9	20
Herkules[2]	B	442	16.4	5.8	32.6	20
99/097/702	B	310	5.8	4.3	22.9	24
99/097/706	B	382	5.1	4.9	32.2	21
99/097/725	B	352	13.7	5.9	29.5	21
2000/102/004	B	397	8.1	4.2	24.7	19
2000/102/005	B	469	13.8	5.6	25.9	21
2000/102/008	B	443	11.4	7.2	23.2	20
2000/102/012	B	439	13.1	5.6	29.7	20
2000/102/019	B	578	14.8	5.0	26.9	21
2000/102/032	B	444	15.0	6.3	29.2	21
2000/102/043	B	537	12.7	5.8	26.3	22
2000/102/054	B	505	14.4	5.1	28.9	20
2000/102/074	B	399	12.0	4.4	25.1	19
2000/102/791	B	535	17.8	6.0	26.0	19
2001/040/002	A	282	9.3	4.9	24.3	25
2001/045/702	A	279	5.8	6.0	22.4	26
2003/039/022	B	508	12.5	6.6	30.0	19
2004/098/010	A	344	9.9	4.7	27.5	26
2004/107/736	B	335	5.8	4.3	31.9	19

A= Aroma type; B= Bitter type; [1]= English dwarf hops; [2]= Hüll high-trellis varieties; Aroma evaluation max. 30 points with especially fine aroma; [3]yield and chemical analyses refer to the average values of the two harvest dates. The hop components were analysed by IPZ 5d.

Low trellis yard in Pfaffenhofen at the Schrag hop farm

Here there are five breeding lines at present with shorter growth planted in rows (194 plants/row, 75 cm distance between plants in a row). The yard is being worked in conventional farming with pruning and hilling and galvanized wire is also used as training wire. Harvesting was carried out on 19.09.

Table 4.3: Low-trellis Pfaffenhofen – crop results in 2007

Breeding line	Type	Yield in kg/ha	α-acids in %	β-acids in %	Cohumulone in %	Aroma 1-30
2000/102/005	B	834	15,9	6,5	28,7	23
2000/102/008	B	1419	12,6	6,2	25,5	20
2000/102/019	B	951	15,4	4,8	26,9	23
2000/102/032	B	804	15,5	6,3	31,5	21
2000/102/791	B	1194	17,0	5,8	28,1	17

A= Aroma type; B= Bitter type; Aroma evaluation of max. 30 reachable points with especially fine aroma. The hop components were analysed by IPZ 5d.

A bad downy mildew infection was observed throughout the year in the hop yard which is why the yield was also approximately 10-20 % lower.
The "technically out-of-date" mobile picking machine was used for harvesting which had already been bought for the R&D projects between 1993 and 2002. Using this the hops are only picked inadequately and some of the picked hops fall through the cover onto the ground and are lost. This means that about 15 - 20 % of the harvest is lost.

Assessing the breeding lines so far available in cultivation on low-trellis systems

A large part of the seedlings being grown on 3 meter wirework from earlier crosses with considerably shorter growth or less lush growth originate from crosses with the English dwarf variety "Pioneer". To some extent they show good alpha-acids values, but like their mother are very susceptible to downy mildew. Traditional varieties such as the high-alpha variety "Hallertauer Taurus" or the aroma variety "Perle", which are grown on the low trellis system, show the weaknesses of hop varieties which are not suited to this production system: lush growth with strong head development whereby longer bines grow downwards over the wire thus obstructing the formation of flowers and later on the cones on the inside of the extremely thick bine which results in a drastic reduction of the yield to 40-60 % compared with the high wirework. The English dwarf hops set as reference varieties do produce better yields in the 3 metre hop yards but cannot be considered for production in Germany due to their susceptibility to downy mildew and their unsatisfying brewing value.

The necessity of a special breeding programme in which hops adapted for low trellis systems with broad resistance to diseases and pleasant brewing quality are developed, is emphasized through these results. Within the framework of a programme to promote innovation this research project has been sponsored since April 2007 from funds from the Federal Ministry of Food, Agriculture & Consumer Protection (BMELV) via the Federal Institute for Food & Agriculture (BLE).

4.2 Genome analysis and biotechnology in hops

4.2.1 Developing molecular selection markers for powdery mildew resistance

Objective

Powdery mildew in hops, caused by *Podosphaera macularis*, results in worldwide drastic yield and quality losses. Target of this project of the Scientific Funds of the German Brewing Industry was the development of functional, genetic markers to support the powdery mildew (PM) resistance breeding. This research project focused on the *R2*-PM resistance gene of the English variety "Wye Target". This gene so far confers resistance to the whole spectrum of PM races representative for Germany and therefore promises long-term protection. On the other hand this *R*-gene has already been anchored in the Hüll breeding material since the 1980s.

Method

A gene expression analysis (differential display) was carried out using PM resistant ("Wye Target") and very susceptible ("Northern Brewer") hop plants. The plants were inoculated with special PM races in various experiments and leaf material harvested at set times (0h, 4h, 6h, 24h and 5 days) and blast-frozen in liquid nitrogen. RNA isolation from the leaf samples at various harvest times "fixed" the active gene (switched on genes) of resistant and susceptible individuals. Direct comparison of the expression profiles with one another reveals polymorphic cDNA-AFLP fragments.

Result

In the course of the expression analyses carried out it was possible to identify differentially expressed cDNA fragments, which occurred at specific times (4h-24h) after the contact of the PM resistant variety "Wye Target" with an avirulent PM isolate (Buch 10) (Fig. 4.1). The fact that these fragments do not appear when "Wye Target" is inoculated with a virulent isolate (E 10) and are missing in the highly susceptible variety "Northern Brewer", proves the assumption that these bands really occur as the plant's answer to a successful fungus defence.

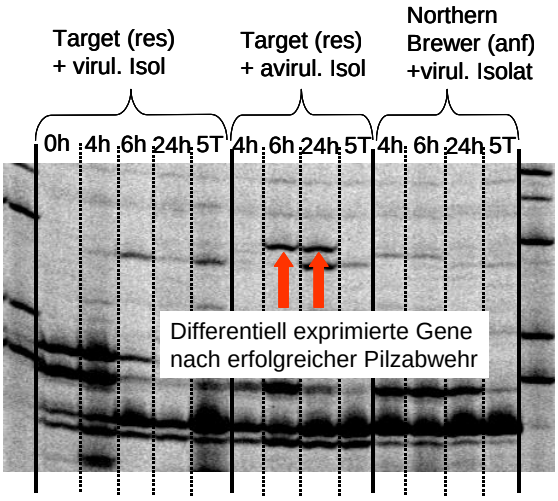


Fig. 4.1: Gene expression pattern following artifical powdery mildew infection

The cloning, sequencing and database investigation of two DNA fragments (175bp and 270bp) of an infected "Wye Target" *in vitro* plant also confirmed this assumption. Homologies (Table 4.4) could be identified to already published resistance genes of apple, barley, poplar, soya and wine. Specific primers are being developed at the present time for these fragments in order to test and validate them with genomic DNA on the breeding material.

Table 4.4: Homology (in %) of the identified hop gene to resistance genes in other crops

	Barley	Apple	Poplar	Wine	Soya	Hops
Barley	100	40	30	31	35	41
Apple		100	37	38	34	39
Poplar			100	81	41	50
Wine				100	40	49
Soya					100	89
Hops						100

4.2.2 Gene transfer in hops to improve the fungal resistance

Objective

The target of the continued research project was to transfer resistance genes into hop varieties in order to improve tolerance towards fungal pathogenes.

Method

Resistance genes were isolated from plant and soil bacteria by means of PCR and cloned in diverse vectors. Several resistance gene constructs could be transferred into the hop plants via agrobacteria. Furthermore tests were carried out to optimise the *in vitro* culture of transgenic and non-transgenic hops.

Results

After successfully working out and establishing an effective transformation protocol for hop it was the aim of the continued research project to isolate presumed resistance genes from hops, tomatoes and from a soil bacterium and insert the various gene constructs into the hop genome using agrobacteria. In this way the resistance to powdery mildew or *Verticillium* should be improved.

After the transformation with a hop-own chitinase *HCH1* and the regeneration on a medium with Kanamycin the stable integration and the expression of the gene could be confirmed for 15 plants of the hop cultivar "Saazer" and for three "Hallertauer Mittelfrüher" plants using PCR (polymerase chain reaction), RT-PCR (reverse transcriptase PCR) and micro-biological tests. In some of these transgenic plants an increased resistance towards powdery mildew could be proven in the laboratory (Miele und Seigner, 2007).

Furthermore "Saazer" and "Hallertauer Mittelfrüher" plants could be successfully transformed with three different bacterial chitinase (*chi*) constructs. The first regenerated plants of the cv. "Hallertauer Mfr." from the transformations with the *chi C-gene* could already be verified as stable transgenic plants. The most regenerates from the various transformation attempts with the various *chi* constructs (*chi I, chi III, chi C* and combinations from *chi I/chi III* and *chi I/chi C*) are only to be expected in spring 2008.

First of all the stable insertion and activity of the new gene has yet to be confirmed for these plants. Afterwards it can be checked via the leaf reistance test (detached leaf assay) in the laboratory whether the bacterial *chi*-gene can contribute to the protection against powdery mildew.

A decisive step forward which was achieved within this project, is the successful regeneration of stable transgenic plants of the cultivar "Hallertauer Mittelfrüher". Consequently for the first time worldwide it was possible to transform a hop cultivar outside the "Saazer family".

Literature

Miehle, H. and Seigner, E. (2007): Production of powdery mildew resistant hops via gene transfer. In: Seigner E (Ed.), Proceedings of the Scientific Commission, International Hop Growers' Convention (IHGC), 24-28 June 2007, Tettnang, 78-81. ISSN: 1814-2192

5 Hop Cultivation, Production Techniques

Johann Portner, Dipl. Ing. agr.

5.1 Nmin-Untersuchung 2007

Nitrogen fertilization according to nach DSN (N_{min}) was introduced into the practice and has become an integral part of the fertilizer planning. 3668 hop yards in Bavaria were tested in 2007 for their N_{min} content and a fertilizer was recommended.
The development of a number of samples for the N_{min} test has been compiled in Table 5.1.
In 2007 the average N_{min}-Gehalt in the Bavarian hop yards was 10 kg more than in the previous year and slightly higher compared with the past 10 years (88 kg). The reason for this was the low yields of the 2006 crop with lesser withdrawals, the dry autumn and winter with lower wash-out losses and the warm winter with higher rates of mineralisation.
As every year again bigger fluctuations were ascertained between the farms and within the farms between the individual hop yards and varieties. Therefore an indivudal investigation is indispesnsable to determine the optimum amount of fertilizer.
Compared with the previous years there were no changes regarding the calculation of the N-fertilizer requirements and the fertilizer recommendations.

Table 5.1: Number, average N_{min}-contents and fertilizer recommended for hop yards according to districts and/or production areas in Bavaria in 2007

Year	No. of samples	N_{min} kg N/ha	Fert.recommended kg N/ha
1983	66	131	
1984	86	151	
1985	281	275	
1986	602	152	
1987	620	93	
1988	1031	95	
1989	2523	119	
1990	3000	102	
1991	2633	121	
1992	3166	141	130
1993	3149	124	146
1994	4532	88	171
1995	4403	148	127
1996	4682	139	123
1997	4624	104	147
1998	4728	148	119
1999	4056	62	167
2000	3954	73	158
2001	4082	59	163
2002	3993	70	169
2003	3809	52	171
2004	4029	127	122
2005	3904	100	139
2006	3619	84	151
2007	3668	94	140

The number of hop yards tested, the average N_{min} value as well as the average nitrogen fertilizer calculated thereof are listed in Table 5.2 for the Bavarian production areas based on the administrative districts. It was ascertained that the district of Eichstätt showed the highest N_{min} values and the district of Landshut as well as the former Hersbruck production regions the lowest N_{min} values. The recommendations for nitrogen fertilizer are consequently reversed.

Tabelle 5.2: Number, average Nmin contents and fertilizer recommended for the hop yards of the districts and production areas in Bavaria 2007

District or production area	**No. of samples**	**N_{min} kg N/ha**	**Fertilizer recommended kg N/ha**
Eichstätt	188	111	129
Pfaffenhofen	1212	100	136
Freising	369	96	139
Kelheim	1510	92	143
Landshut	222	69	157
Hersbruck	41	69	146
Hallertau	**3542**	**95**	**140**
Spalt	126	81	144
Bavaria	**3668**	**94**	**140**

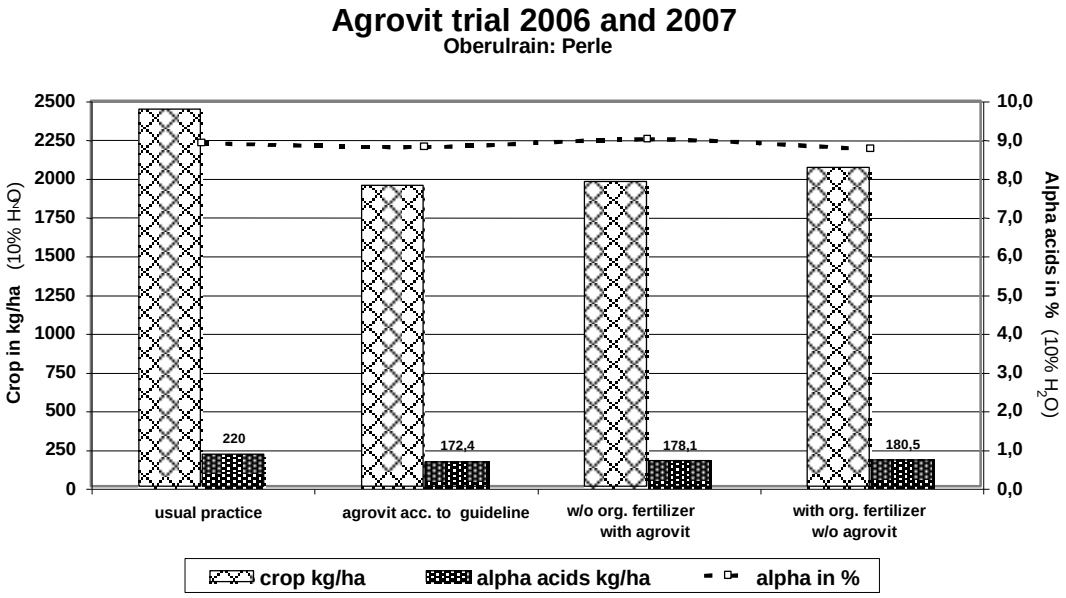
The values are listed according to varieties in Table 5.3.

Table 5.3: Number, average N_{min}-contents and fertilizer recommended relating to various hop varieties in Bavaria 2007

Variety	**No. of samples**	**N_{min} kg N/ha**	**Fertilizer recommended kg N/ha**
Brewers Gold	10	73	161
Herkules	81	84	158
Nugget	64	81	155
Hall. Magnum	791	83	152
Hall. Taurus	343	94	144
Hallertauer Mfr.	506	80	144
Hall. Merkur	18	90	143
Hersbrucker Spät	174	95	141
Perle	682	104	133
Spalter Select	214	103	132
Spalter	36	89	132
Hall. Tradition	610	106	131
Saphir	38	110	126
Northern Brewer	84	114	119
Others	17	78	157
Bavaria	**3668**	**94**	**140**

5.2 Fertilizer trial to mobilise the nutrients present in the soil with the soil activators Agrovit and Litho KR

Using the soil "activators" Agrovit and Litho KR research is to be carried out at two locations over four years with the varieties Perle and Hallertauer Mittelfrüher as to how the inoculation of the soil affects the yield and the formation of alpha-acid compared with the usual practice plots before the trial begins for the total period of the trial.
The trials are finished already with the two year results as the drop in yield was considerable at both locations.



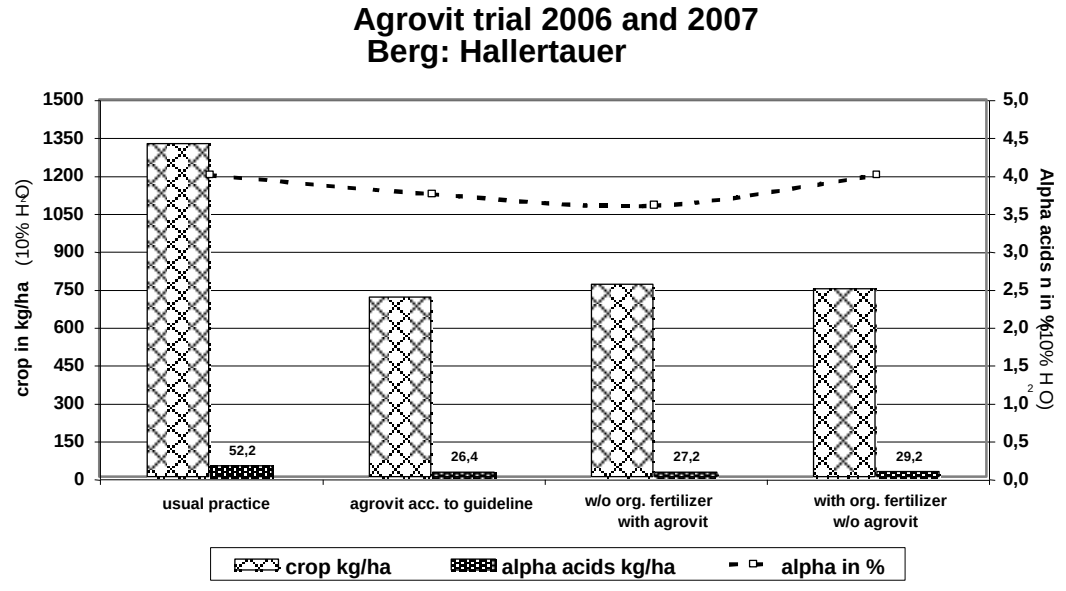


Fig. 5.1 and 5.2: Yields in kg/ha dry hops, alpha-acids in % and in kg/ha

Method

The trials were set each time with four treatment steps because only through this was the effect of the soil inoculation guidelines comprehensible.

Factors:
1 = working as normally in the practice
2 = Agrovit, Litho KR and organic fertilizer according to guidelines of marketing firm
3 = without organic fertilizer, with Agrovit and Litho KR
4 = with organic fertilizer, without Agrovit and Litho KR

According to the guidelines of the marketing firm the inoculation with Agrovit and Litho KR is only successful if these preparations are distributed in connection with organic fertilizers.
Based on a company intern soil examination in autumn 2005 1.5 kg organic fertilizer per hop plant was distributed on a narrow band to the left and right of the hop rows. On this band at the following location:

- Oberulrain, variety Perle: 40 g Agrovit and 40 g Litho KR had to be strewn per hop plant. In spring 2006 supplemented by 40 g monokaliumphosphate and 20 g Agrovit per hop plant in a narrow band on the cut surface of the row.
- Berg, Variety Hallertauer Mfr.: 30 g Agrovit and 40 g Litho KR per hop plant. In spring 2006 supplemented by 50 g monokaliumphoshate and 20 g Agrovit per hop plant as described above.

With this inoculation of the soil no more nutrients of N, P, K and Mg are needed, as according to the marketing firm the activating of mineral nutrients so far not available is stimulated. The costs for the inoculation are about the amount for the usual mineral fertilization based on the tried and tested soil examination methods for four years.
According to the LfL advice as early as the first year of the trial 2006 on nitrogen deficiencies in those plots not worked as normal in the practice, the marketing firm requested an N fertilizer at the end of June until the beginning of July with 26 kg N/ha in the form of ammonium sulphate per trial year.

Results

Compared with the plots fertilized in the usual way the drop in yield of the Agrovit variant according to the guideline is highly significant at both the locations while the alpha-acid contents show no significant deviation.
The variety Perle, soil type sand, showed a decline in yield of 8.8 % in 2006 and of 28.7 % in 2007.
The variety Hallertauer Mfr., soil type coarse clay, reacted in 2006 with a drop in yield of 40.2 % and of 52.2 % in 2007. The factors three and four reacted identically, so that the influence of Agrovit and Litho KR as "soil activators" could not be seen at either locations.
The plants showed a massive lack of nitrogen which resulted in poor formation of laterals and through this a reduction in the nodes for the crop development.

5.3 Determining the optimum harvest time for the variety Saphir

The optimum harvest time is important for a high yield and a good quality. If harvested too early the yield is given away and the hop plant is weakened. If harvested too late the external quality and the aroma etc. suffers. It is particularly the latter properties in the aroma varieties which are extremely important.
In order to determine the optimum harvest time 20 training wires in a practice yard were harvested at intervals of 3-4 days and this repeated four times. With the variety Saphir the harvesting took place at five different dates over a period of 2 weeks. The parameters yield, alpha-acid content, aroma and external quality (picking, colour and sheen, cone development and deficiencies) were evaluated.

The harvest time trial was carried out in the years 2004 - 2007 at the Kreithof location near Rohrbach. Here there is deep sandy soil with a good supply of water. The harvest dates of the various years can be seen in Table 5.4.

Table 5.4: Date of the harvest time trial for Saphir, Kreithof 2004-2007

Date	2004	2005	2006	2007
T 1	23.08.	25.08.	24.08.	23.08.
T 2	26.08.	29.08.	28.08.	27.08.
T 3	30.08.	31.08.	31.08.	30.08.
T 4	2.09.	5.09.	4.09.	3.09.
T 5	6.09.	8.09.	7.09.	6.09.

As ripening was delayed in the first three years of the trial due to weather conditions another trial year was added in order to clarify the optimum picking time.

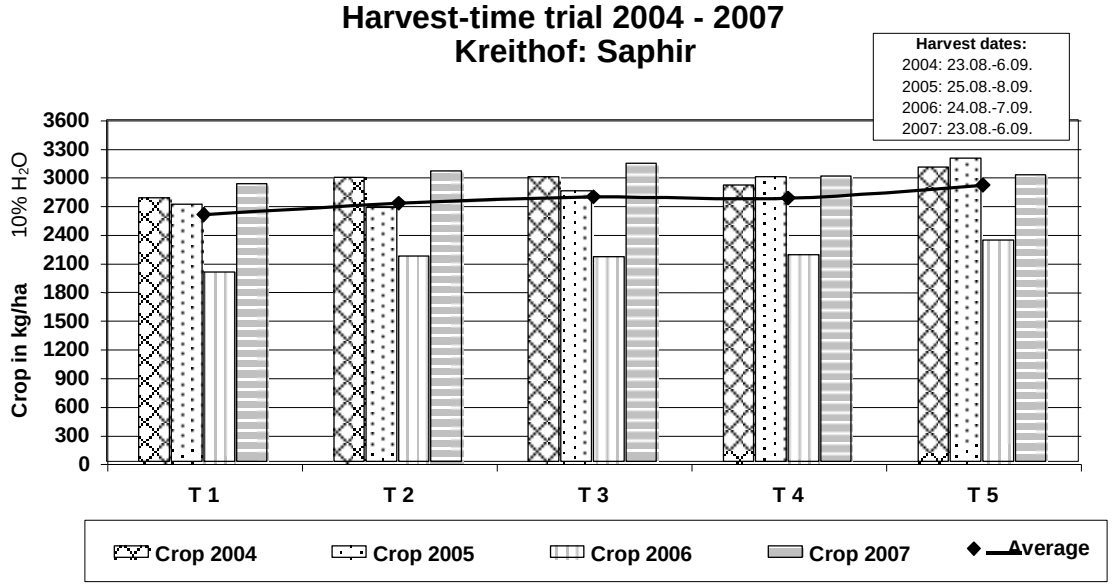


Fig. 5.3: Course of the crop Saphir 2004-2007

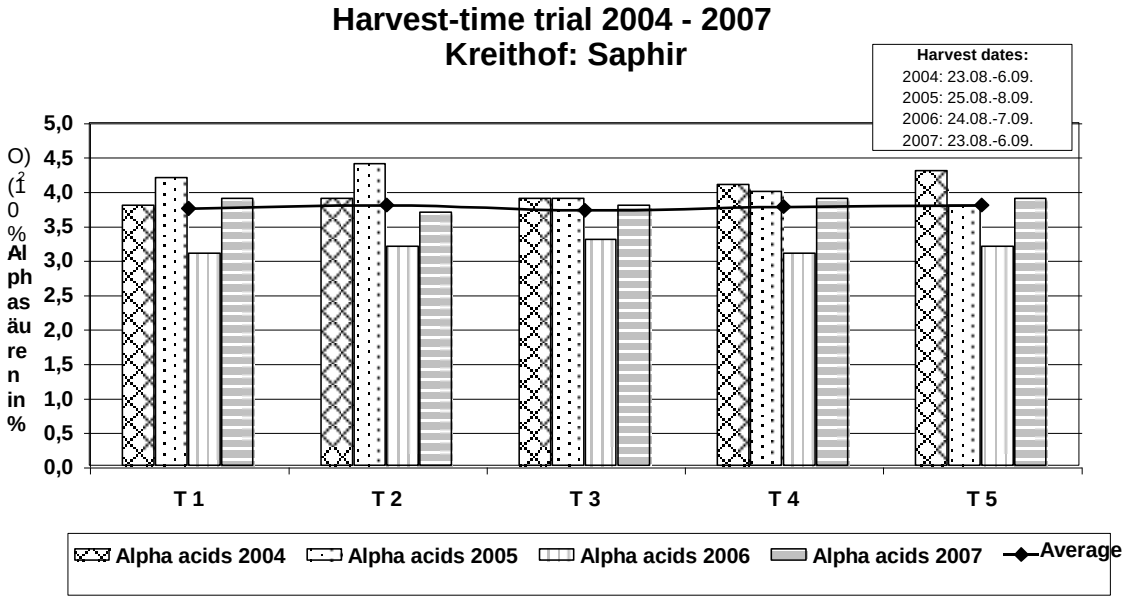


Fig. 5.4: Alpha-acid content Saphir 2004-2007 (HPLC)

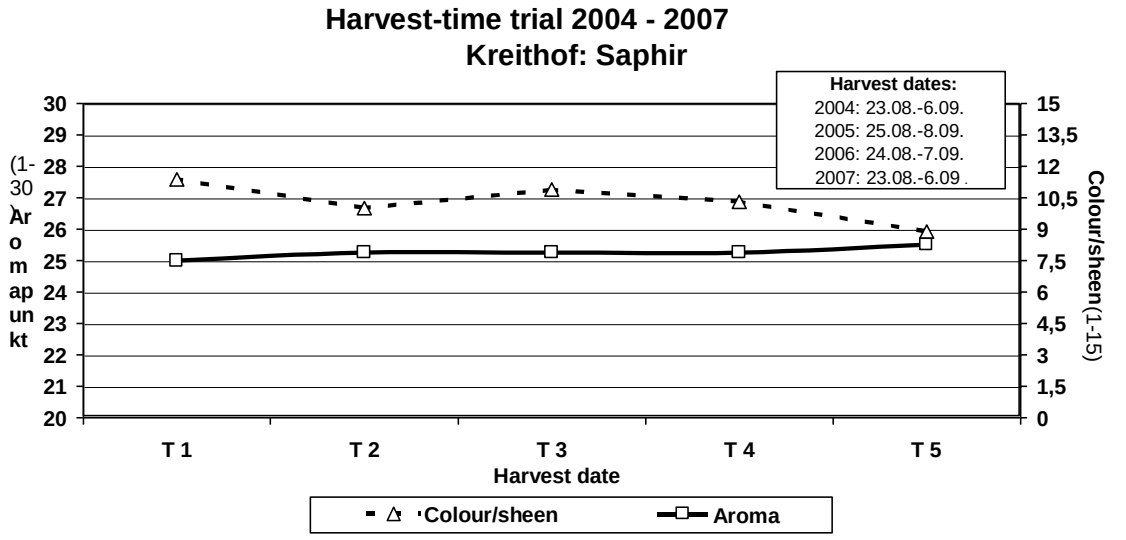


Fig. 5.5: Evaluation of colour/sheen and aroma, Saphir 2004-2007

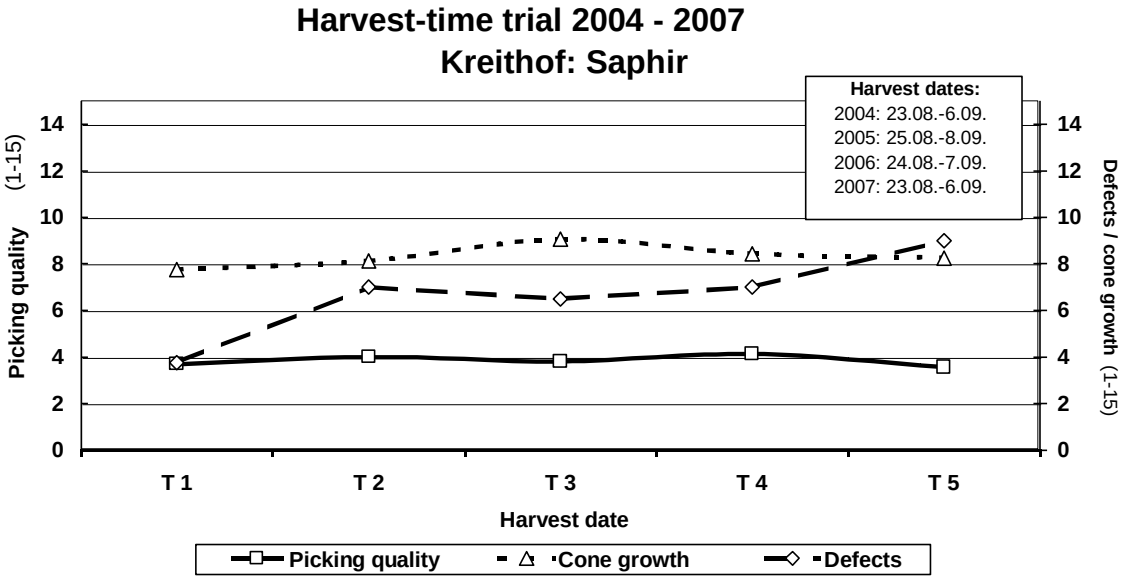


Fig. 5.6: Evaluation picking quality, cone development or deficiencies, Saphir 2004-2007

An increase of approx. 200 kg could be recorded from the first harvest time (T1) up until the third harvest time (T3). This corresponds to a financial advantage of around 900 €/ha when harvesting takes place seven days later. The further increase in yield until T5 is accompanied by a deterioration in the external quality. The statistics show that the first harvest time (T1) deviates in yield significantly downwards from the three middle harvest times (T2-T4), whereas the last harvest time (T5) is significantly higher. Aroma and alpha-acid contents can be judged as very constant over all five harvest times.

As a compromise with regard to the requirements of the market (quality and aroma) as well as those of the hop-grower (optimum yield and maintaining healthy plants) the middle harvest times T3 and T4 should be seen as optimum. In normal years that should be between 30th August and 5th September. With favourable weather conditions and constant good optical quality then the late harvest time T5 is definitely still possible.

5.4 Testing alternative training materials

Objective

Alternatives to the iron training wire are sold time and time again and would be desirable for various reasons:

- avoiding the so-called "hop spikes" when returning bine choppings
- independent from constantly increasing costs for energy and raw commodities re steel
- increasing the lifespan of the barbed wire by degradable remains which do not rust
- easy on all the cutting tools (pruner, ripping device, chopper etc.)
- degradable training materials rot faster and can also be used in biogas plants together with the bine choppings

However, alternative training materials only have a chance for practical use in hop farms if the requirements on tension, resistance to bending and tearing are comparable with the iron training wire throughout the whole vegetation period.

Method

The "hop bio string" from Messrs. Beakert (Belgium) was tested as early as 2006 in a tactile trial in a practice hop yard in Rohrbach with the variety Hall. Magnum on 2 narrow rows with 60 trained hops respectively. This absolutely organic string (variant A) is made of reproductive raw materials and is bio-degradable. The inside of the string is made of a natural fibre and on the outside has a sheath with compostable material.
In 2007 the trial was continued additionally with a further development of the "hop bio string" which has a fine inside wire (variant B). The variante B was developed in order to improve its resistance to breaking.
In 2007 it was again tested with the variety Magnum with altogether 180 trained hops. In both trial years the strings were only hung up at the beginning of April.

Results

Knotting the strings when hanging them up takes the same time as fixing the wire. On the other hand the lighter weight would seem to be an advantage.
It takes slightly more time (approx. 15 %) to insert the string into the plant (variant A and B) because the strings tangle up more easily when it is windy due to their own light weight.
The first problems could be seen from mid-July onwards. At the beginning when the cones were forming the first strings began to stretch which resulted in their tearing away from the barbed wire. The breaking load of at least 45 kp required for hop training material and the minimum reistance to tearing linked with it, which was doubtless present when it was hung up, had decreased too quickly after 3-4 months due to the changeable weather conditions. Even with only moderately heavy bines the dreaded "falling down" of bines occurred, although the trial rows arranged in the middle of the hop yard did not have to withhold any extreme wind conditions.
As the results in the following table show, in its present composition this material made available to us by Messrs. Beakert does not meet the requirements and is not suitable for use in the practice of hop growing.

Table 5.5: Proportion of the ripped off bines using bio string in the trial variants

Year	No. of the trained hops Variant A bio string	No. of the Variant B (improved bio string)	Bines torn off in %
2006	100		58 %
2007	80		89 %
		100	78 %

Among those bines which fell down in % the bines were also counted which broke off several times. In the practice plot with conventional training wire (13 mm) the quota of ripped off bines was below 0.3 % in both years.

5.5 Increased performance and energy savings with trestle kilns through optimum air conduction

The air speed of the drying air affects the drying performance
Setting the right air speed is prerequisite for an optimum drying performance and high energy efficiency. Due to the varying storage density of the hops too high an air speed results in unequal drying and increased energy consumption as the air flowing through has not enough time to absorb the moisture up to saturation. On the other hand too low an air speed extends the drying time and decreases the drying performance. For setting the optimum drying parameters it is absolutely essential that the current air speed is known in m/s during drying besides temperature and kiln depth.

New method to determine the air speed
In trestle kilns the air speed can be set by regulating the volume flow either by changing the diameter of the suction channel or by changing the rotational speed of the fan motor. Due to the constantly changing flow conditions during drying and the altogether low air speeds up to now it has not been possible to measure the actual air speed directly in m/s in the practice. Therefore during the 2007 crop a process was developed which calculates the average air speed per m^2 kiln area by means of a thermodynamic formula. With the help of this formula in which an efficiency of the heat exchanger of the air heater of 90 % was assumed, the warmed air volume can be calculated in m^3/s via the oil consumption and the difference in temperature between sucked-in air and drying air. If you divide this figure by the kiln area in m^2, you get the average air speed in m/s. These connections were put together in a table so that the air speed can be read in m/s depending on the oil consumption and the difference in temperature between drying air and sucked-in air.

Determining the air speed via the oil consumption
Oil flow meters were installed in the delivery pipes of the oil burners in 10 trial farms to measure the oil consumption analog or digital. In addition the temperature of the suction air to be warmed and the drying air was measured. In drying protocols the times when the trays were filled, the tipping times, when the trays were emptied and the measurements during drying were documented. Through this it was possible to ascertain immediately the air speed in m/s for defined drying phases from when the kiln was filled until the tray was emptied with the aid of the table. So that the influence of the air speed on the drying performance could be determined, only the air speed was changed in the trials with uniform temperatures of 65 °C and kiln depths of 35-40 cm.

Maximum drying performance through optimum use of energy
The air speed of the drying air has a great influence on the drying performance and the heating oil consumption. The result of the drying trials was an optimum air speed in the floor in the range of 0.38 m/s having been filled up to 0.30 m/s at the point when it is tipped. In the case of lower air speeds the flow rate of the drying air and consequently the drying performance decreased. It was surprising that the drying performance with air speeds over 0.4 m/s likewise decreased with simultaneously much higher heating oil consumption. Using the table for the first time the hop grower has a tool in his hand with which he can record in a simple manner the average air speed in m/s pro m^2 kiln area and can make corrections. For example if the farmer ascertains that the calculated air speed is too high he can reduce the blower output or next time he can pile the hops up higher. Alternatively when the air speed is too low he can increase the blower power or if that is no longer possible reduce the height of the piled hops.

Consequently a method was also developed with which an automatic drying control is always in a position in the future to set the respective optimum air speed during the whole drying process.

Table 5.6: Determining the air speed in m/s

Air speed in m/s

depending on oil consumption and difference in temperature between drying air and sucked-in air

Temperature difference between Drying air and sucked-in air	*Oil consumption l/h & m² kiln area*																				
in °C	*1,0*	*1,1*	*1,2*	*1,3*	*1,4*	*1,5*	*1,6*	*1,7*	*1,8*	*1,9*	*2,0*	*2,1*	*2,2*	*2,3*	*2,4*	*2,5*	*2,6*	*2,7*	*2,8*	*2,9*	*3,0*
20	0,37	0,40	0,44	0,48	0,51	0,55	0,59	0,62	0,66	0,70	0,73	0,77	0,81	0,84	0,88	0,92	0,95	0,99	1,03	1,06	1,10
22	0,33	0,37	0,40	0,43	0,47	0,50	0,53	0,57	0,60	0,63	0,67	0,70	0,73	0,77	0,80	0,83	0,87	0,90	0,93	0,97	1,00
24	0,31	0,34	0,37	0,40	0,43	0,46	0,49	0,52	0,55	0,58	0,61	0,64	0,67	0,70	0,73	0,76	0,79	0,82	0,85	0,88	0,92
26	0,28	0,31	0,34	0,37	0,39	0,42	0,45	0,48	0,51	0,54	0,56	0,59	0,62	0,65	0,68	0,70	0,73	0,76	0,79	0,82	0,85
28	0,26	0,29	0,31	0,34	0,37	0,39	0,42	0,44	0,47	0,50	0,52	0,55	0,58	0,60	0,63	0,65	0,68	0,71	0,73	0,76	0,78
30	0,24	0,27	0,29	0,32	0,34	0,37	0,39	0,42	0,44	0,46	0,49	0,51	0,54	0,56	0,59	0,61	0,63	0,66	0,68	0,71	0,73
32	0,23	0,25	0,27	0,30	0,32	0,34	0,37	0,39	0,41	0,43	0,46	0,48	0,50	0,53	0,55	0,57	0,60	0,62	0,64	0,66	0,69
34	0,22	0,24	0,26	0,28	0,30	0,32	0,34	0,37	0,39	0,41	0,43	0,45	0,47	0,50	0,52	0,54	0,56	0,58	0,60	0,62	0,65
36	0,20	0,22	0,24	0,26	0,28	0,31	0,33	0,35	0,37	0,39	0,41	0,43	0,45	0,47	0,49	0,51	0,53	0,55	0,57	0,59	0,61
38	0,19	0,21	0,23	0,25	0,27	0,29	0,31	0,33	0,35	0,37	0,39	0,40	0,42	0,44	0,46	0,48	0,50	0,52	0,54	0,56	0,58
40	0,18	0,20	0,22	0,24	0,26	0,27	0,29	0,31	0,33	0,35	0,37	0,38	0,40	0,42	0,44	0,46	0,48	0,49	0,51	0,53	0,55
42	0,17	0,19	0,21	0,23	0,24	0,26	0,28	0,30	0,31	0,33	0,35	0,37	0,38	0,40	0,42	0,44	0,45	0,47	0,49	0,51	0,52
44	0,17	0,18	0,20	0,22	0,23	0,25	0,27	0,28	0,30	0,32	0,33	0,35	0,37	0,38	0,40	0,42	0,43	0,45	0,47	0,48	0,50
46	0,16	0,18	0,19	0,21	0,22	0,24	0,25	0,27	0,29	0,30	0,32	0,33	0,35	0,37	0,38	0,40	0,41	0,43	0,45	0,46	0,48
48	0,15	0,17	0,18	0,20	0,21	0,23	0,24	0,26	0,27	0,29	0,31	0,32	0,34	0,35	0,37	0,38	0,40	0,41	0,43	0,44	0,46
50	0,15	0,16	0,18	0,19	0,21	0,22	0,23	0,25	0,26	0,28	0,29	0,31	0,32	0,34	0,35	0,37	0,38	0,40	0,41	0,42	0,44
52	0,14	0,15	0,17	0,18	0,20	0,21	0,23	0,24	0,25	0,27	0,28	0,30	0,31	0,32	0,34	0,35	0,37	0,38	0,39	0,41	0,42
54	0,14	0,15	0,16	0,18	0,19	0,20	0,22	0,23	0,24	0,26	0,27	0,28	0,30	0,31	0,33	0,34	0,35	0,37	0,38	0,39	0,41
56	0,13	0,14	0,16	0,17	0,18	0,20	0,21	0,22	0,24	0,25	0,26	0,27	0,29	0,30	0,31	0,33	0,34	0,35	0,37	0,38	0,39
58	0,13	0,14	0,15	0,16	0,18	0,19	0,20	0,21	0,23	0,24	0,25	0,27	0,28	0,29	0,30	0,32	0,33	0,34	0,35	0,37	0,38
60	0,12	0,13	0,15	0,16	0,17	0,18	0,20	0,21	0,22	0,23	0,24	0,26	0,27	0,28	0,29	0,31	0,32	0,33	0,34	0,35	0,37

Source: Münsterer Jakob - Arbeitsbereich Hopfen - IPZ 5a Tel. 08442/957-400 Fax. 08442/957-402 Status 2007

5.6 Sensor technology for early plant protective applications

Objective

The hops have large gaps in the stands due to the distance between the plants (1.4 m - 1,6 m) and the lack of foliage in the early development stages and this resulted in enormous spraying losses when there are early plant protective applications. By using sensors which recognise the leaf surfaces and therefore the plant, a specific target application should enable the plant protective losses to be reduced. The objective of the trials was to find out which areas of application come in question for this technique. Furthermore the savings potentials should be researched and how these are assessed from an economic point of view.

Method

A blower sprayer, which was already available in the Hop Research Center in Hüll, from Messrs. Wanner, Model 20/105/Z was used as a carrier for the sensor technology. For this two v-form rods were attached to the frame of the sprayer by the agrar-engineering firm of Wallner in Wolnzach. The sensors were attached to the front rods, the output unit to the back rods. This unit consists of magnetic valves, membrane drip-stop valves and swivel holders with releasing jets each with a turbo-drop jet. The sensor technology and controlling technology was supplied and installed by Messrs. Müller Elektronik in Salzkotten. Opened out the rods reach a height of 3.7 m, which corresponds to approx. half the height of the trellis.

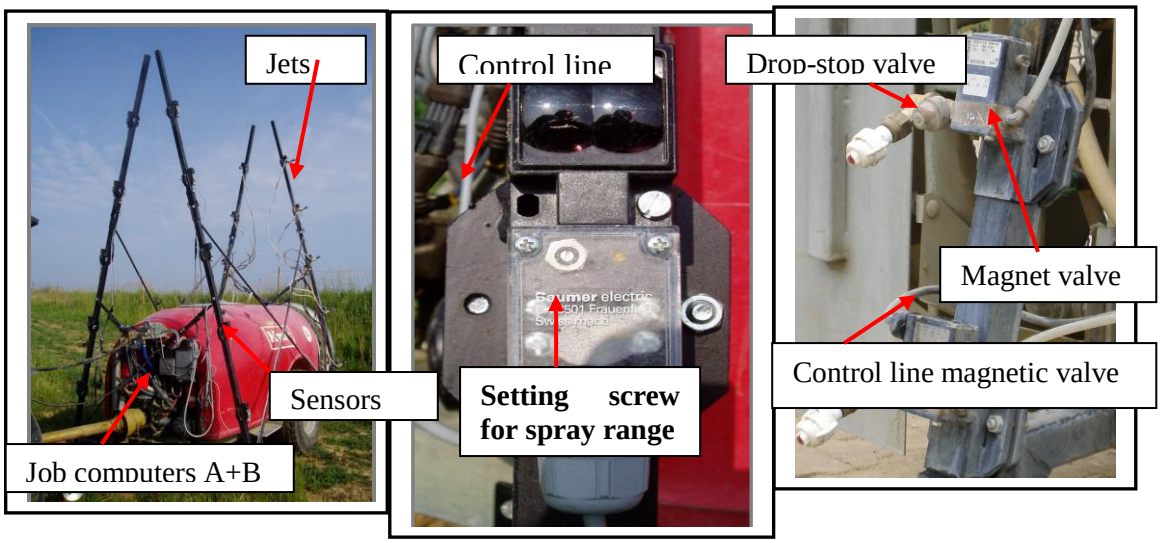


Fig. 5.7: Survey on sensor technology

Table 5.7: Survey of the parts of the trial

Area of application	Controlling	Time	Target
up to 1 m height of hops	downy mildew, alfalfa weevil, flea beetle	April, May	spray savings
up to halfway up trellis	mildew, downy mildew, hop aphid, common spider mite	May, June	spray savings
weed control	weeds on rows and hop stripping and suckering	August	spray savings
wetting trial	-	May	wetting test
highly concentrated spray to wet bines w. effectiveness trial	hop aphid	June	reducing spray drifting away, effect

Parts of the trial and/or areas of use are described in the Table. The focus is on the amount of average savings in the first 3 areas (up to 1 m height of hops, up to halfway up the trellis and weed control).
The rate of savings as a percentage arises from the relation of the spraying process with traditional technique and the reduced consumption of spray mixture by the sensor technique.

$$\text{Rate of savings (\%)} = \frac{(\text{consumption sprayer} - \text{consumption sensor technique}) \times 100}{\text{consumption power sprayer}}$$

In the wetting trial the adsorption of the spraying mixture should be compared between sensor technique and traditional wetting with the power sprayer. To do this water sensitive paper was not only attached to the upper side (BOS) of the leaves but also to the underside (BUS) of the leaves and the wetting was evaluated as a percentage due to the colour change in the scanalyser.
The testing of a new application technique as a substitute for the painting method is to be investigated with the highly concentrated spray to wet the bines.
To obtain representative results, all variants were repeated three times. In the choice of the hop stands homogenity was decisive.

Results

Treating up to 1 m height of hops
At this time of application the so-called band spraying will be carried out against the primary infection of downy mildew and/or control of the alfalfa weevil and/or flea beetle. The spraying costs for these treatments amount to approx. 60 €/ha.
With the sensor spray it was sufficient if two jets were activated on both sides respectively. Due to this arrangement it was possible to spray a band of approx. 1 m height.
By using the sensor technique 39% of spray mixture was saved on an average.

Treatment up to halfway up trellis
Application up to only halfway up the trellis is possible by limiting the height of the sensor technique. In addition to this work can still be carried out at this point in time without support from the power blower.
According to experience the following frequencies in treatment occur during this period. Each time it must be reckoned with a treatment against secondary infections of downy mildew and powdery mildew and with 0.25 treatments against hop aphid and common spider mite as these pests do not have to be controlled so early in each vegetation year.
For this the spray costs come to approx. 205 €/ha.

In treatment with the sensor technique an average savings rate of 43% could be achieved in this area of application.

Weed control
For controlling weeds in the practice likewise band sprayings with 2 jets per side are carried out, from which spray costs of approx. 29 €/ha arise.
Only a slight savings rate of 15 % could be recorded as at this point the spaces between the individual hops and consequently the switching off intervals are very short and the lower jet permanently sprays to wet the row.

Wetting trial
In this trial it should be tested whether the wetting of the sensor spray can be compared with the method normally used in the practice with regard to coverage.

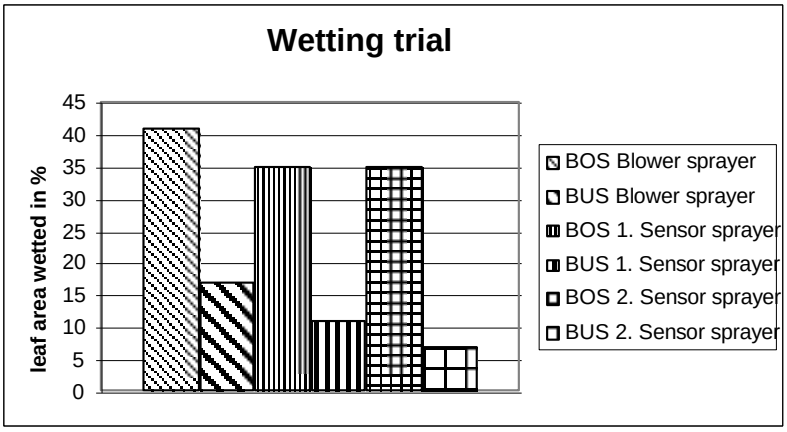


Fig. 5.8: Wetting trial

In both courses of the trial the wetting with the sensor technique was not only on the BOS (upper side of leaf) but also on the BUS (under side of leaf) poorer than with the power blower normally used in the practice. Whether this has effects on the effectiveness of plant protectives must still be tested in exact effectiveness trials.

Highly concentrated spray for wetting the bines
In a hop aphid trial for the official insecticide test the sensor technique was tested to spray the defoliated base of the bine as an alternative to the painting process. For the spray Teppeki (Flonicamid) was used. The systemic Teppeki was painted in the comparative plot. The hand evaluations were carried out according to good experimental practice. In this effectiveness trial the focus was not on saving spray but to develop a new user-friendly application process. In all parts of the trial for the sensor technique no adequate effect could be achieved towards the hop aphid.
It can be assumed that with this application technique too little spray reaches the base of the bine. In contrast good control was successfully achieved with the conventional painting method. The evaluation of the trial showed that the sensor technique is not suitable for this area of application.

Economic consideration
Here the acquisition costs for the sensor technology and the variable and fixed costs resulting from them as well as the costs of the extra expense for labour and towing hours are set

against the savings potential in plant protectives. The basis is a hop area of 25 ha. With 4 treatments this means an application area of 100 ha per year.

Machinery costs			
Acquisition costs	11,416.- €		
Useful life	10 years		
Application area	100 ha / year		
		Savings potential in plant protectives:	
Amortization	1.141 €	Treatment up to 1 m	550 €
Interest due	342 €	Treatment up to halfway up trellis	2.250 €
+ Repair costs	1.255 €	+weed control	125 €
Machinery costs / year	2.738 €	Savings/ year	2,925 €

	Savings	2,925 € / year
-	Machinery costs	2,738 € / year
-	Additional costs (towing, labour)	3,100 € / year
	Pecuniary disadvantage	**2,913 € / year**

The costs for saving plant protectives over a 25 hectare farm or 100 hectare application area per year just cover the annual machinery costs of the sensor technique. However it should be observed that exact effectiveness trials are still outstanding which will prove whether the poorer wetting with the sensor spray also results in a poorer effect compared with the power sprayer. If this is the case then an additional economic disadvantage can be expected. However first and foremost there are greater problems with the additional costs for the towing vehicle, spraying device and labour as each aisle has to be driven through with the sensor technique. These costs are even over and above the savings in plant protectives. From the economical point of view it is clear that the additional labour requirement and the present high costs for the sensor technology cannot balance out the advantages of the savings in spray mixture.

5.7 Sensor controlled individual plant treatment with watering method

Objective

When the hop shoots begin to grow in the development stage 07 - 19 soil pests such as the alfalfa weevil (otiorrhynchus ligustici), the flea beetle (phyllotreta and psylliodes), the grey caterpillar (cnephasia alticolana) as well as the wire worm (agriotes lineatus l.) damage the hop plants and shoots so badly that it can result in the plant dying off. At the same time as early as this the control of the downy mildew primary infection (pseudoperonospora humuli) is carried out on approx. 50 % of the areas.

The plant protectives needed for this are applied in the form of a single plant treatment. This application method is called "watering". It is carried out by two workers on a towing vehicle where the spray mixture is applied with manually activated spraying lances or watering sticks on the hop plant. In order to protect the user and facilitate the work a technique should be developed which enables the hop plant to be recognised with the aid of

sensor technology and which distributes the plant protective absolutely accurately. Efforts are being made for a combination of methods with another work sequence, hop spinning.

Method

To locate the hop plant an optical sensor is mounted on the side appliance, which when passing by can recognise the hidden training wire and therefore the position of the hop plant. The circular cultivator and the jet unit developed by Messrs. "Agrotop" for individual plant treatment is likewise attached onto the side appliance. The work routines of "circulating" and watering treatment can be combined in this way. The "circulating" is done with traditional technology which can be controlled manually via the joystick. Through the sensor technique in the first trial the watering is to be automated. Optimising the work speed and setting the amount to be distributed was determined by practical applications.

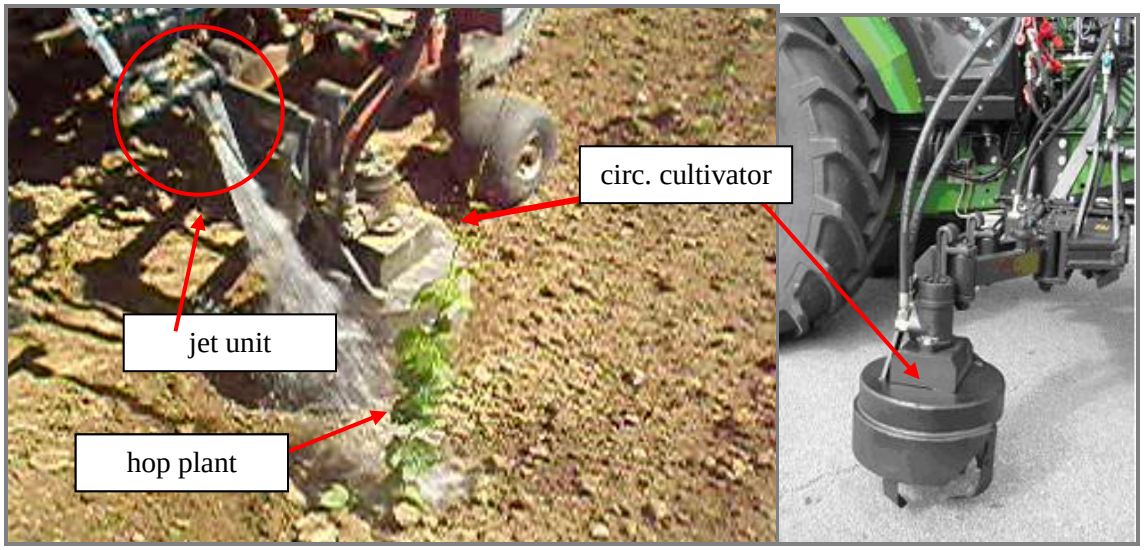


Fig. 5.9: Hop circulating and sensor-controlled individual plant treatment in one work sequence

Results

The sensors could recognise the training wire without any problem, if the intensity of the infra red light or the range was set correctly. During the preparations for the trial the sensors were also tested for their accurate functioning with a working speed of 4-4,5 km/h and no problems were found. However, due to the reaction ability of the driver the working speed combined with the circulating is limited to max. 3.5 km/h. The jet output can be varied by changing the pressure from 2.5 up to 5 bar between 280 and 800 l/ha. Through the automatisation one worker could be saved in the watering treatment. Another labour time-saving can be achieved by combining the plant protective treatment with the circulating.

Risks for the user by contamination with the plant protective could be considerably reduced as with the new method the individual plant treatment is carried out from the closed cabin of the towing vehicle.

According to the manufacturer the acquisition costs for the sensor technique and jet unit which form the basis for economic considerations, run into approx. 4,400 €. The variable and fixed machinery costs arising through this amount to 1,060 € per year with a service life of 10 years and 25 hectares of application area. Compared with this there are potential savings in the labour and towing hours required by combining the work steps of circulating and individual plant treatment. The savings add up to 1,145 € per year with the previously

mentioned application extent of 25 hectares. If you subtract the annual repair costs of 441 € from the annual savings this yields a cash flow of 703 €. By using the technique this cash flow is the annually achieved surplus which is needed to pay off the acquisition costs. Taking an interest rate of 6 % the technique is repaid in the 9th year of use. Economical application of the new technique is definitely possible.

Table 5.8: Amortisation period taking into consideration the interest due (6 %)

Year	0	1	2	3	4	5	6	7	8	9	10
Cash Flow I	-4,417	703	703	703	703	703	703	703	703	703	703
Discount factor	1.000	0.943	0.890	0.840	0.792	0.747	0.705	0.665	0.627	0.592	0.558
Discounted cash flow	-4,417	663	626	590	557	526	496	468	441	416	393
Accumulated discounted cash flow	-4,417	-3,754	-3,128	-2,538	-1,981	-1,455	-959	-492	-50	366	759

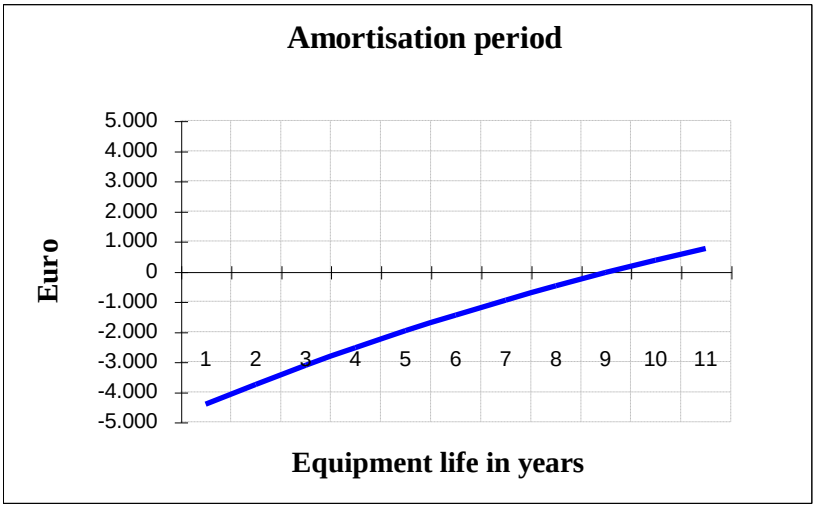


Fig. 5.10: Chart of the amortisation period

5.8 Advisory and training activities

Besides the applied research in the area of production techniques for cultivating hops the Hop Work Group, Production Techniques (IPZ 5a) evaluates the test results for the practice making them directly available to the hop farmers through special consultations, training, instruction, seminars, talks, print media as well as via the internet. The organisation and implementation of the peronospora warning service and updating the warning instructions are also among their tasks just as much as providing specialist support for the producers' rings and the training of multiplicators for the Advisory Service on the spot. The training and advisory activities during the past year are summarized as follows:

5.8.1 Training the Hop Ring consultants

15 so-called Ring consultants carried out hop stand evaluations for 351 hop growers in 2007 at the request of the Hallertau Hop Ring and gave plant protective recommendations. The Ring consultants were invited to Hüll by the Hop Advisory Service of the Bavarian State Research Center for Agriculture (LfL) to eight meetings in mid-May at intervals of 14 days for an exchange of experience and for training. In preparation for the meeting the Ring consultants were committed to enter the observations and experiences from their farm visits and telephone contacts in a report sheet and send them to the Hop Ring. The LfL carried out the evaluation relating to attacks by pests and diseases, the impressions on plant development, nutrient supply and growth problems as well as effects of the fungicides, insecticides or acaricides.
All the observations made on the spot as well as the numerous telephone enquiries reaching the Hop Advisory Service daily from the various hop producing areas gave a total impression of the respective prevailing situation. Advisory strategies and recommendations were derived from this - taking into consideration the latest trial results - and directly passed onto the Ring consultants at the training courses. During this regular exchange of experience at the request of the Ring consultants even special subjects and problems such as evaluation of the Hop Card Index, crown rot, downy mildew warning service, lack of trace elements, virus elimination, control thresholds or special instructions in the case of hail storms. The theoretical training was supplemented by practical demonstrations and inspections in the breeding yard or on practice plots.
After the season ended there was a final discussion which focused on the future Ring consulting activity within the bounds of the joint Advisory Service of the Hop Ring and the Bavarian State Research Center for Agriculture (LfL). An evaluation sheet rounded off the Ring consulting programme. In it the Ring consultants showed their overall satisfaction with the past year and rated the subject matter and methods of the training courses as good.

5.8.2 Information in written form

The "Green Pamphlet" Hops 2007 – Cultivation, Varieties, Fertilization, Plant Protection, Harvest – was brought up-to-date in collaboration with the Plant Protection Work Group in agreement with the advisory authorities of the German states of Baden-Wurttemberg, Thuringia, Saxony and Saxony-Anhalt and distributed with a circulation of 2960 copies by the LfL to the ÄfL and research facilities and distributed by the producer rings to the hop growers

- LfL-Information Brochure "Data collection –management planning in growing hops" (sent by the HVG Producer Group to all hop growers!).

- up-to-date hop-growing tips and warning service advice was sent to the hop-growers via the Hop Ring fax (2007: 57 faxes à 943 participants) in 36 faxes.
- in the same way up-to-date information was made available at weekly intervals for the weather fax.
- within the framework of the DSN soil test 3668 results were checked for plausibility and released for despatch to the hop-growers
- advisory notes and specialist articles were published for the hop-growers in 4 Hop Ring ER-circulars and in 8 monthly issues of the Hopfen Rundschau.
- with the HSK (Hop Card Index) recording and evaluation programme on 680 cards hop index evaluations were carried out for 180 hop-growers and returned to the farmers in written form.

5.8.3 Internet and Intranet

Warnings and advisory notes, specialist articles and talks were made available via the internet for the hop-growers.

5.8.4 Telephone advice and announcement services

- The peronospora warning service was compiled during the period 10.05.–24.08.2007 by the Work Group Hop Cultivation, Production Techniques in Wolnzach in collaboration with the Work Group Plant Protection in Hüll and updated 72 times so that it could be called up via the answerphone (Tel. 08442/9257-60 and 61) and/or via the internet.
- Tips on hop cultivation with up-to-date notes on pests and diseases as well as fertilizer and soil-working measures can be heard via the answerphone in Wolnzach (Tel. 08442/957-401).
- As for special questions on hop cultivation, the consultants of the Work Group Hop Cultivation, Production Techniques provided advice in approx. 3,200 cases per telephone or by consultations in individual discussions or on the spot.

5.8.5 Talks, tours, training facilities and meetings

- 8 training courses for the Hop Ring consultants
- 9 hop cultivation meetings in collaboration with the ÄLF
- 57 specialist talks
- 13 trial tours for the hop-growers and the hop industry
- 4 seminars on Drying and Conditioning
- 16 lessons at the Pfaffenhofen Agricultural College for the students in the Hops Faculty
- 1 school day for the summer semester of the Pfaffenhofen Agricultural College
- 1 symposium for trying out the sensor technology in plant protection
- 1 symposium on the subject Nutrient Content and Absorption in Hops
- Practical training for BiLa participants in Hüll
- Revision for examinations by apprentices in agriculture with the focus on hops

6 Plant protection in hop cultivation

Bernhard Engelhard, Dipl. Ing. agr.

6.1 Pests and diseases in hops

Hop aphid migration

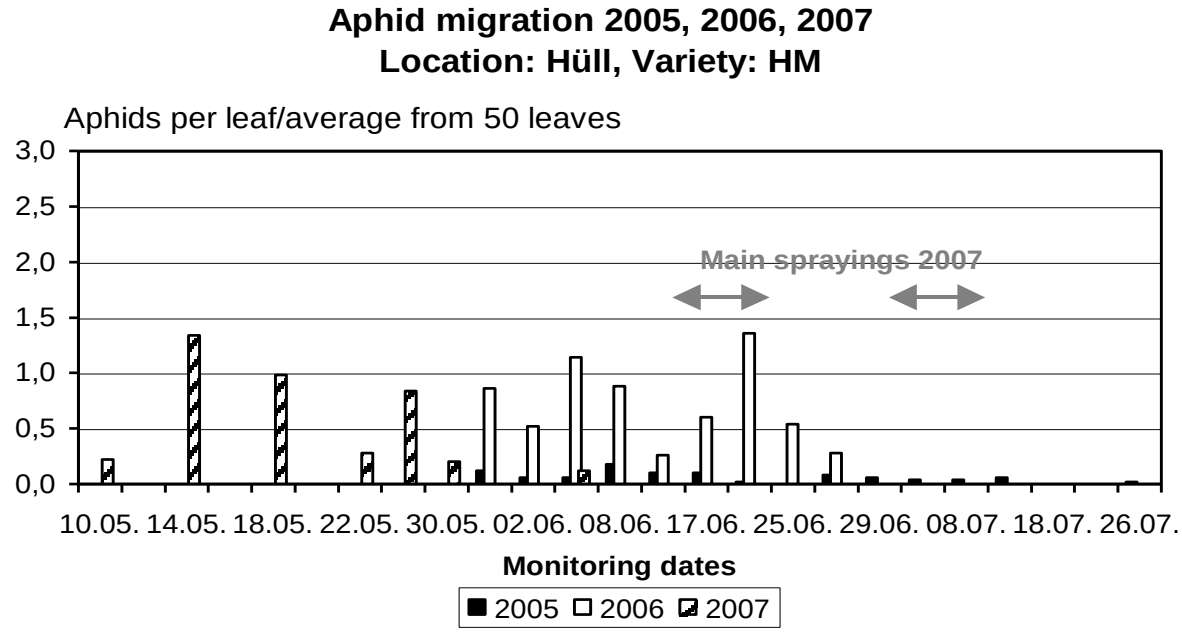


Fig. 6.1: Hop aphid migration

Start and finish as well as the intensity of the aphid migration decide considerably on the population development and consequently on the time for the first treatment. 2007 saw the earliest migration as well as the earliest end of the migration since records began.

6.2 Using quassia to control aphids in organic hop production

Objective

The most important pest in hop cultivation is the hop aphid *Phorodon humuli*. Quassia extracts were used worldwide as early as the beginning of the 20th century to control it. Almost a hundred years later quassia or its active ingredient quassin was rediscovered as an option for controlling aphids in organic hop production, as at this time the registered pyrethrines were no longer having a satisfactory effect. In recent years the German organic hop growers used quassia mixture which they made themselves on the farm. To do this wood chips were boiled in water, which in compliance with the 'Bioland' guidelines must solely come from the South American bitter ash tree *Quassia amara*. This method is only an interim solution according to § 6a of the Plant Protection Law as the active ingredient in the mixture can only be surmised.

In order to make a product with a standardised quassin content generally available in the EU quassin must first be listed on Annex I of the EU Directive 91/414/EEC of the Council. In order to generate the necessary data for this further effectiveness tests were carried out in 2007. In this respect for the first time quassin was also tested in a conventionally grown high-alpha variety, as the results so far solely came from organically grown aroma varieties.

Methods

The trials were carried out at three locations with different varieties (Haushausen: Hallertauer Tradition; Eichelberg: Perle; Schweinbach: Hallertauer Magnum). At the same time two different application techniques and three different amounts of the active ingredient were tested. On the one hand 12 g and 18 g quassin/ha were distributed with a power blower normally used in the practice, by which two treatments were made in the case of the spray variants, on the other hand 18 g and 24 g quassin/ha were applied in the painting method. At the same time bines defoliated by hand were painted with approx. 3 ml suspension solution on a length of about 30 cm with a paint brush. Painting was carried out at the end of May at full growth (¾ of way up the trellis), so that the active ingredient was transported systemically with the circulation of the sap upwards. This application was only carried out once. All variants were prepared three times. A variant not treated with insecticide served as a check. The attacks were monitored weekly by hand during 13 or 14 weeks from May to August on 50 leaves each time this was repeated. The trial harvest was carried out with ten training wires per variant, with four replications and at the same time the yield and the content of alpha acid was ascertained. In addition to this the cones were checked for aphid infestation.

Results

At all three locations the 24 g/ha painted variant definitely showed the best control success followed by the 18 g/ha painted variant. The two spray applications were less effective despite two applications. There was a reduction of only 70% in the amount of attacks compared with the untreated variant, which is insufficient in the case of greater attacks. As an example for all three locations Fig. 1 shows the effects of the differing attacks on the yield and the alpha-acid in Haushausen, an organically farmed yard.

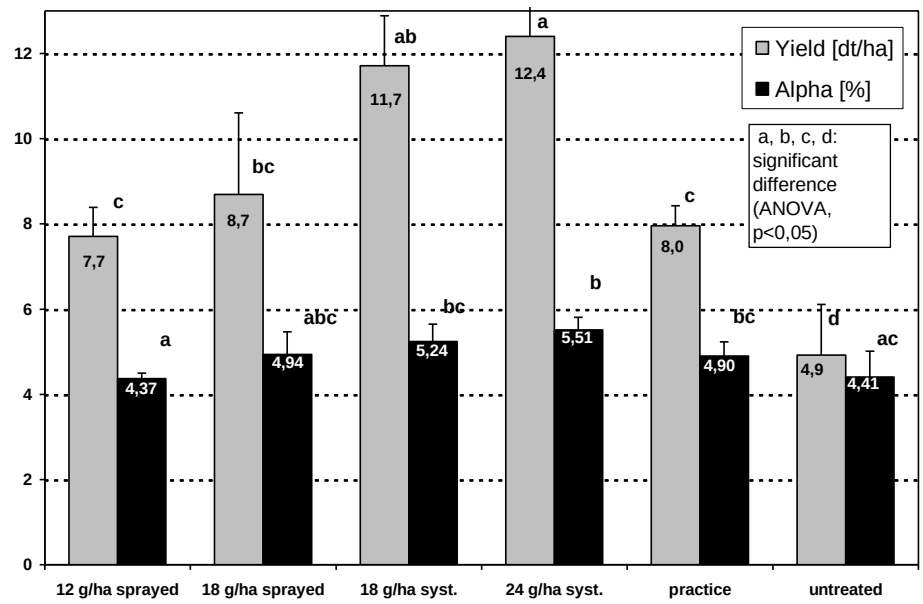


Fig. 6.2: Yield and alpha in varying trial variants for controlling aphids with quassia 2007: Results of the trial crop, hop yard "Leitnacker", cv. HT, Haushausen, 29.08.2007.

With regard to effectiveness the painted application is definitely preferable as it is not dependent on the weather. In addition when painted as a broad-spectrum insecticide quassin is no problem with non-targeted organisms or else with protecting beneficial insects. With regard to the costs of the treatment the greater amount of 24 g/ha cannot be reduced to 18 g/ha as here no adequate effectiveness can be guaranteed with certainty. To summarize, at present only the 24 g/ha painted variant can be recommended for successful control of the hop aphid in organic hop production.

Project Manager: B. Engelhard

Assisted by: J. Schwarz, Dr. F. Weihrauch

Duration: 2007

6.3 Joint research project from five single projects on the subject of "organic plant protection"

Within the processing time from 01.04.2005 - 30.04.2008 this complex of five single projects was sponsored by Anheuser-Busch Companies, Inc., the HVG Hop Producer Group and the Society of Hop Research.

6.3.1 Development of a test system for testing the aphid resistance on hop seedlings within the bounds of hop breeding

6.3.1.1 Objective

A standardised, scientifically sure testing method is necessary for the reliable verification of descendants from a crossing in hops for varying susceptibility towards the hop aphid *Phorodon humuli*. This kind of (laboratory) method has so far not yet been described in the literature and as far as the Hop Research Center knows nor has it yet been used in any hop breeding station.

At the time being there are already definite differences in the susceptibility to hop aphid in the present spectrum of varieties and in the other hop production regions in Europe. While the variety Hallertauer Magnum (HM) has to be rated as the most susceptible variety the variety Spalter Select (SE) has considerably less colonies of aphids [1]. In the examinations for resistance to hop aphids in various hop varieties in 1998 and 1999 it was found that as soon as the winged aphids migrate they fly onto HM ten times more than onto SE. There must be genetically fixed substances in hops which enable the aphids to select the optimum host [2]. After colonisation the reproductive rate with the same starting colony on HM was nine times higher than on SE.

In the English breeding material there are genotypes of japanese origin which are totally resistant to the hop aphid [3], such as the new variety Boadicea. In the Hüll collection of wild hops (approx. 300 genotypes) there are likewise individual genotypes with probably good resistance prerequisites. Therefore there are genetic resources available which have to be taken into consideration in planning crossings and which in the medium term provide relief in the use of insecticides.

In order to be able to breed specifically for aphid resistance, as in the case of powdery mildew and downy mildew it is necessary to find genetically fixed resistances in the individual plants if possible still in the juvenile stage of the seedlings and test these plants further according to the other criteria. Possible bases for this kind of standard method are to be worked out in this project.

6.3.1.2 Work plan and methods

Since the end of the 1980s tests for aphid resistance to insecticides have been carried out in Hüll by means of a laboratory method. This laboratory test has been further developed [4] within the bounds of a dissertation completely for this resistance test, which first of all served as a basis for further research.

The test method so far exerted looks like this: From various hop genotypes which were grown in the greenhouse, leaves from the 3rd and 4th leaf tier were taken off, cut up and fixed between two plastic plates. The leaf is exposed in a gap on the underside. A plastic ring is welded on to it so there is a firm leaf surface from which the aphids put onto it cannot escape. The ring is covered with gauze so there is an "aphid cage".

With a paint brush an adult aphid capable of reproducing from the "Hüller Population" was put in the ring on the surface of the leaf and the cage was closed with gauze.

When aphid larvae have been set down the mother aphid is removed with the larvae except for one young aphid. This larva which is still in the cage with a definite birth date is now further observed as the new "primary aphid". The following points were recorded:

- general behaviour
- the days on which the young aphids were set down
- number of young aphids set down
- young dead young aphids
- lifespan of the primary aphid.

All the young aphids set down were again removed from the cages in order to determine only the lifespan and the reproduction ability of each individual respectively. Without removing the larvae which were set down the number of the insects per cage would quickly be unclear and would "explode". In addition with only one insect continually living in the cage the hop leaves could only hold out as the basic food for the lifespan of the insects without wilting too much. The following six genotypes were selected as hop material whose differences regarding the aphid susceptibility are be researched:

- Boadicea (abb.: **BO**), allegedly aphid resistant variety from the U.K.
- Spalter Select (**SE**), current variety with the highest aphid tolerance
- Wild hops type 49, origin Jena (**WH**), good resistance prerequisites
- Male clone "3-W-42-30-38" (**38**), good resistance prerequisites
- Hallertauer Magnum (**HM**), current variety with most aphid susceptibility
- Herkules (HS), current variety with probably greater aphid susceptibility.

One primary aphid was set on each of these six genotypes and this repeated 12 times per test and their development and descendants were observed throughout their whole lifespan. The altogether 72 aphid cages were opened three times a week (Monday, Wednesday, Friday), the set larvae counted, reported and removed with a fine brush. The same trial was carried out altogether eight times. The rack with the 72 aphid cages were kept in a temperature chamber at 25°C and 60-70 % rel. air humidity.

Running time and duration of the series of experiments:

1st Series 2006: 05.05.-14.06., 15 counting days

2nd Series 2006: 19.05.-14.06., 10 counting days

3rd Series 2006: 22.06.-11.08., 21 counting days

4th Series 2006: 07.07.-18.08., 17 counting days

1st Series 2007: 28.03.-27.05., 25 counting days

2nd Series 2007: 19.04.-13.06., 21 counting days

3rd Series 2007: 18.05.-11.07., 21 counting days

4th Series 2007: 20.06.-28.08., 25 counting days

6.3.1.3 Results

Altogether more than 11,000 data records could be obtained in the eight series. The evaluation so far presents a very heterogeneous picture which not only relates to the data streams within a hop variety but also the differences between the varieties (Table 6.3.1-6.3.4). Up to now it was only definitely clear that the male clone 38 showed by far the greatest aphid tolerance of all the genotypes examined with on an average 14.9 living larvae per aphid over all eight series. Here the highest values were reached in the case of HM with 66.2 larvae on an average, although the mean average values of the other varieties were only slightly below this (HS: 59.7; SE: 59.6; BO: 57.6; Table 6.3.1).

In the lifespan of the individual primary aphids there were definitely the highest values with HM with an average of 39.8 days throughout all the series. The aphids on "38" had the significantly shortest lifespan with an average of 24.4 days. On the other genotypes there were comparable values between 31.7 and 34.3 days lifespan (Table 6.3.3). The record holder was a primary aphid which survived altogether 69 days on HM. What was noticeable in the long lifespan on HM was generally that the reproductive phase of the aphids lasted just about as long as on the other varieties, but the insects still continued living much longer after the last produced larvae in a phase of senescence.

Conclusion: The data so far obtained does not yet permit any concrete statements to be made on the prospects of success of the biotest and further test series are indispensable.

Table 6.3.1: Aphid biotest 2006/2007: Total of living descendants, mean average ± S.E.

Series / cv.	BO	SE	WH	38	HM	HS
1/2006 03.05.-14.06.	73.4 ± 15.0	59.6 ± 32.2	64.0 ± 17.6	24.7 ± 12.5	85.4 ± 10.1	80.6 ± 11.0
2/2006 17.05.-14.06.	59.5 ± 21.0	60.5 ± 10.3	51.1 ± 20.1	18.4 ± 9.8	62.2 ± 23.6	66.1 ± 10.3
3/2006 21.06.-11.08.	18.2 ± 8.9	53.5 ± 22.0	57.7 ± 19.2	6.8 ± 4.7	44.5 ± 12.5	48.4 ± 10.5
4/2006 06.07.-18.08.	56.6 ± 15.2	47.4 ± 34.6	0.5 ± 1.6	28.1 ± 22.0	78.7 ± 6.9	63.8 ± 16.7
1/2007 27.03.-27.05.	76.1 ± 14.8	72.2 ± 22.7	68.7 ± 16.5	21.6 ± 10.9	91.0 ± 16.6	70.5 ± 22.6
2/2007 18.04.-13.06.	52.6 ± 14.6	54.4 ± 22.3	58.8 ± 11.5	3.2 ± 1.8	59.7 ± 10.5	46.0 ± 23.9
3/2007 16.05.-11.07.	75.8 ± 10.9	78.3 ± 9.7	60.8 ± 7.1	8.9 ± 4.9	60.2 ± 11.3	63.5 ± 14.1
4/2007 19.06.-28.08.	48.8 ± 30.4	50.5 ± 7.4	32.3 ± 18.6	7.8 ± 5.4	47.5 ± 15.6	38.9 ± 9.3
MW	57.6	59.6	49.2	14.9	66.2	59.7

Table 6.3.2: Aphid biotest 2006/2007: Total of the living descendants, rank (1 =few, 6 =many)

Series / cv.	BO	SE	WH	38	HM	HS
1/2006 03.05.-14.06.	4	2	3	1	6	5
2/2006 17.05.-14.06.	3	4	2	1	5	6
3/2006 21.06.-11.08.	2	5	6	1	3	4
4/2006 06.07.-18.08.	4	3	1	2	6	5
1/2007 27.03.-27.05.	5	4	2	1	6	3
2/2007 18.04.-13.06.	3	4	5	1	6	2
3/2007 16.05.-11.07.	5	6	3	1	2	4
4/2007 19.06.-28.08.	5	6	2	1	4	3
Rank total	31	34	24	9	38	32
MW	3.88 ± 1.13	4.25 ± 1.39	3.00 ± 1.69	1.13 ± 0.35	4.75 ± 1.58	4.00 ± 1.31

Table 6.3.3: Aphid biotest 2006/2007: Lifespan of the primary aphid [d], mean average ± S.E.

Series / cv.	BO	SE	WH	38	HM	HS
1/2006 03.05.-14.06.	36.2 ± 5.8	33.4 ± 7.0	37.5 ± 5.2	29.8 ± 4.5	37.3 ± 4.9	34.5 ± 7.1
2/2006 17.05.-14.06.	25.8 ± 0.6	25.4 ± 1.0	24.8 ± 3.8	22.8 ± 3.8	26.0 ± 0.0	23.3 ± 3.2
3/2006 21.06.-11.08.	34.8 ± 10.8	33.4 ± 8.4	40.2 ± 4.3	24.4 ± 4.4	42.1 ± 6.2	32.8 ± 4.5
4/2006 06.07.-18.08.	25.7 ± 3.7	30.4 ± 11.8	7.1 ± 6.6	23.5 ± 12.6	40.5 ± 2.8	23.4 ± 4.8
1/2007 27.03.-27.05.	40.1 ± 8.0	39.9 ± 10.3	39.4 ± 4.1	29.5 ± 4.1	40.8 ± 6.0	32.5 ± 7.4
2/2007 18.04.-13.06.	34.6 ± 9.0	31.8 ± 8.8	37.2 ± 6.1	17.1 ± 5.0	41.4 ± 9.8	31.6 ± 6.6
3/2007 16.05.-11.07.	38.5 ± 3.8	39.8 ± 6.0	39.5 ± 6.8	24.2 ± 5.4	47.7 ± 6.0	40.0 ± 14.1
4/2007 19.06.-28.08.	38.4 ± 13.8	35.6 ± 4.4	35.0 ± 8.1	23.7 ± 9.2	43.1 ± 5.7	35.4 ± 7.6
MW	34.3	33.7	32.6	24.4	39.8	31.7

Table 6.3.4: Aphid biotest 2006/2007: Lifespan of the primary aphid, Rank (1 = short, 6 = long)

Series / cv.	BO	SE	WH	38	HM	HS
1/2006 03.05.-14.06.	4	2	6	1	5	3
2/2006 17.05.-14.06.	5	4	3	1	6	2
3/2006 21.06.-11.08.	4	3	5	1	6	2
4/2006 06.07.-18.08.	4	5	1	3	6	2
1/2007 27.03.-27.05.	5	4	3	1	6	2
2/2007 18.04.-13.06.	4	3	5	1	6	2
3/2007 16.05.-11.07.	2	4	3	1	6	5
4/2007 19.06.-28.08.	5	4	2	1	6	3
Rangsumme	33	29	28	10	47	21
MW	4.13 ± 0.99	3.63 ± 0,92	3.50 ± 1.69	1.25 ± 0.71	5.88 ± 0.35	2.63 ± 1.06

6.3.2 Which aphid infestation can be tolerated during cone formation on the hops?

6.3.2.1 Objective

The migration of the winged aphids from the winter host to the hop plants generally begins mid-May in the German production regions and as a rule lasts until the end of June, sometimes even until mid-July or the end of July. The population of the wingless aphids develops according to the intensity of migration and the weather conditions. The current admissable control threshold is reached when on an average 50 aphids per leaf or 200 aphids are found on individual leaves. However according to current findings, at the latest when the hops come into burr, when the cones are forming, control must be carried out even if the control threshold has not yet been reached. When the cones are developing existing aphids colonize the bracteoles and can no longer be reached by contact and part-systemic insecticides once the cones are closed. There is further multiplication in the cone and consequently damage quickly occurs. Therefore for decades the Advisory Service has been demanding: "At the time when the cones are forming the hops must be free of aphids. If any isolated aphids are found then another control measure is necessary!"

The objective of the project was to begin with checking this indeed very restrictive advice. It should be investigated whether and if yes under what conditions (variety, time, choice of insecticide) a certain number of aphids per leaf can be tolerated without the cones being negatively affected qualitively and quantitatively at the time of the harvest. Up to now there have been no trial results over several years nor any publications in this respect.

Also the trials so far for the official insecticide tests do not provide any answers to this question.

6.3.2.2 Work plan and methods

In the years 2005 and 2006 altogether 14 conventionally worked practice yards (four varieties: HM, HT, PE, SE) were selected in each of five farms, in each of which one trial plot was set out which remained unsprayed during each treatment with insecticide. Also other plant protective measures which could have an influence on the population development of the aphids were only carried out after agreement. So in no case was the acaricide Abamectin used which has a strong aphid side effect. The size of the untreated plots was approx. 170 or nearly 400 m^2 respectively.

The population development of the aphids in these plots was monitored at weekly intervals from the end of June until the harvest. Besides leaf monitoring at each date random checks were also made over the aphid attacks on the cones. In addition to this a trial harvest was carried out in 2005 in eight yards and in 2006 in nine yards when the yield and alpha-content of the trial plot were compared with insecticide-treated, for the most part aphid-free plants from the direct neighbourhood of the plot.

6.3.2.3 Results

In principle it can be established over all varieties that the attacks of aphid were very low in 2005 as in 2006. In 2005 only two HM plots showed total damage through aphids at the time of harvesting. Regarding established yields and alpha-contents significant losses of 10 and 40% respectively were recorded in the case of two other yards (1 HM, 1 HT) (Fig. 6.3.1). The other ten untreated plots showed either optically no aphid damage or else no significant crop and quality differences in the trial harvests whatsoever. On the other hand the cone monitorings showed that despite this in two other of these plots which at first glance looked as though they were only slighted affected, the cones showed considerable aphid attacks: one HM plot had cone attacks of 92 % and one PE plot 30 %. To sum up in the extremely weak aphid year 2005 in eight of 14 trial yards without insecticide treatment there were no aphid attacks or they were hardly worth mentioning.

No aphid colonies worth mentioning developed on the leaves in 2006 with HM in three of four cases. However, aphid attacks were continually found on HM from about the end of July up until the harvest which developed into total damage in Buch due to hops which were no longer marketable (Table 6.3.5). The trial harvest in the three other yards only in Kirchdorf produced a significant loss in yield of about 20 %, whereas in all the other cases no differences could be established in yield and alpha (Fig. 6.3.2).

The monitorings in the variety PE all began at the end of July with average aphid counts of 50 - 60 insects per leaf which however decreased to very small numbers in all three cases by the end of August (Table 6.3.5). As far as PE was concerned there were no damages whatsoever by aphid attacks.

In the case of HT it was similar as in PE, from an attack definitely worthy of treatment assessed at the end of July between 20 and 100 insects per leaf to a continual decrease in the density of aphids up until the harvest. Light cone attacks were not only found in Buch but also in Holzhof. In both the trial harvests no differences whatsoever could be established regarding yield and alpha. However when monitoring the cones at the HT yard in Buch with untreated hops there were cone attacks of 25.1 % compared with 15.7 % when treated with insecticide which would possibly have resulted in cuts in the Independent Quality Appraisal (Table 6.3.7). In the case of SE no attacks of aphid worth mentioning were found in all three yards and the cones remained absolutely free of aphids. Accordingly both the trial harvests showed no differences whatsoever in yield and quality.

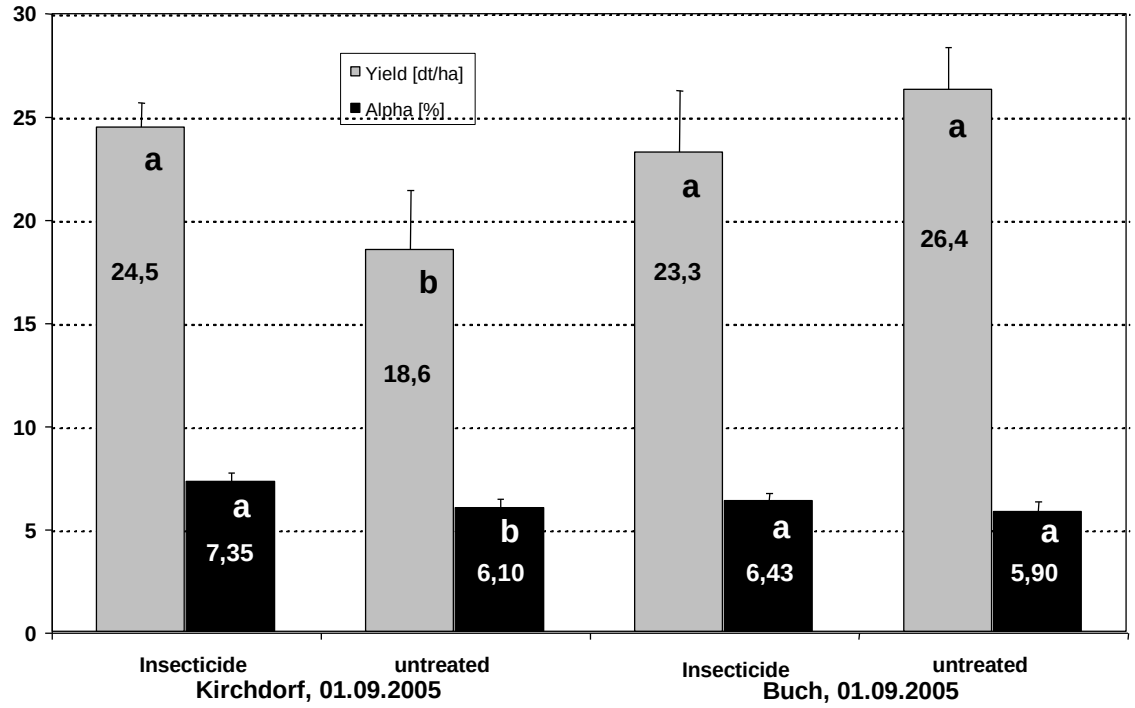


Fig. 6.3.1: Trial harvests 2005, cv. Hallertauer Tradition

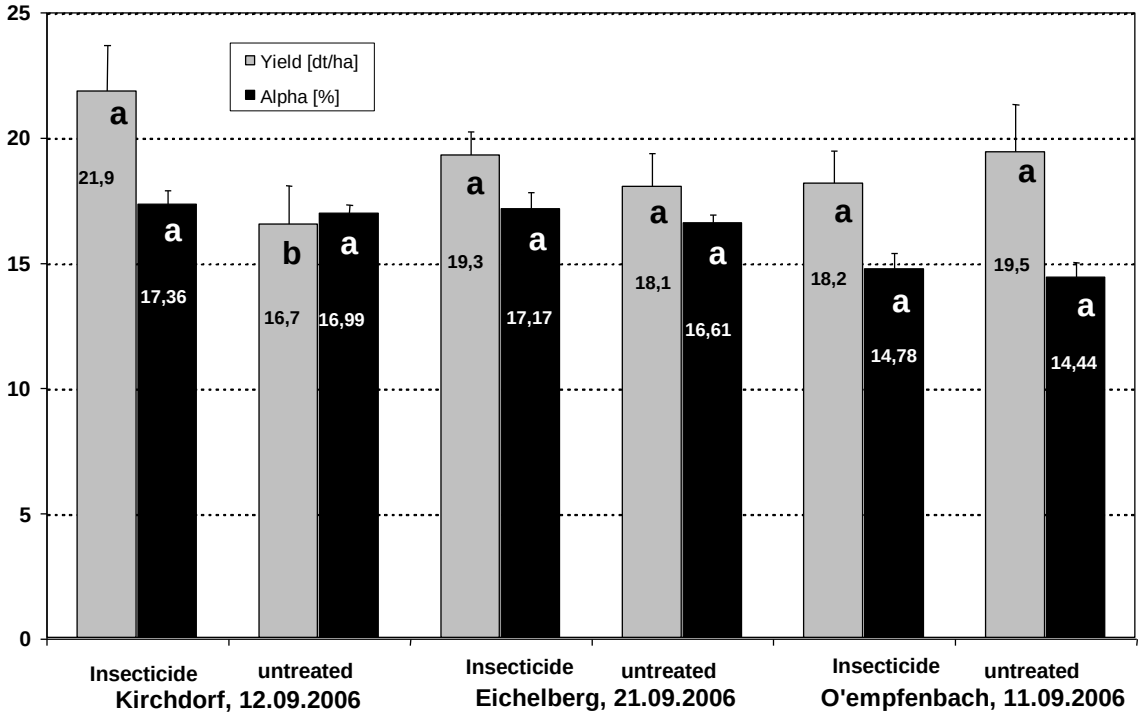


Fig. 6.3.2: Trial harvests 2006, cv. Hallertauer Magnum

Table 6.3.5: Aphid monitorings 2006 in insecticide-free plots at various trial yards, varieties Hallertauer Magnum (HM) and Perle (PE).

All figures are mean averages per leaf from 50 counted hop leaves respectively (25 at top, 13 midway, 12 at bottom). * = parallel to monitoring cone attacks established by *p. humuli.* CW = calender week. Locations: BCH = Buch, EBG = Eichelberg,
HHF = Holzhof, KDF = Kirchdorf, OEB = Oberempfenbach.

Variety	**HM**				**PE**		
CW	BCH	EBG	KDF	OEB	EBG	HHF	OEB
26	27.0	30.7	21.2	33.1	54.3	46.4	61.0
27	24.9	15.0	66.7	48.2	71.0	51.6	201.7
28	42.0	17.7	114.2	21.3	21.4	115.4	73.0
29	99.7	12.1	64.6	13.3	3.1*	16.6	41.0
30	94.5*	15.1*	68.9	4.3*	3.4*	0.3	10.0*
31	407.9*	24.8*	20.3*	3.6*	1.2*	1.3	4.5*
32	248.1*	20.5*	23.3*	11.4*	2.1*	3.6*	3.2*
33	238.1*	6.8*	21.7*	9.6*	0.8	1.0	2.7*
34	488.0*	6.7*	27.4*	29.9*	0.1	0.9	3.7
35	171.8*	1.4*	17.3*	13.0*	0.1	0.6*	1.1*

Table 6.3.6: Aphid monitorings 2006 in insecticide-free plots at various trial yards, varieties Hallertauer Tradition (HT) and Spalter Select (SE).

Variety	**HT**				**SE**		
CW	BCH	EBG	HHF	KDF	BCH	HHF	KDF
26	102.1	29.9	46.2	17.5	9.0	2.9	18.9
27	98.4	20.0	74.2	36.9	4.4	0.9	32.1
28	111.0	17.3	63.2	41.3	1.0	1.9	27.8
29	334.9	1.8	8.1	2.3	1.9	0.8	6.2
30	101.9*****	1.7	5.1*****	2.2*****	0.7	0.2	1.1
31	55.5*****	1.7	10.7*****	0.7	0.2	0.7	0.3
32	21.9*****	1.3	9.3*****	0.3	0.9	0.2	0.1
33	4.1*****	0.7	2.8	0.5	0.7	0.0	0.3
34	3.8*****	0.9	2.3*****	2.6	0.7	0.2	0.0
35	2.6*****	0.4	3.6*****	0.6	0.5	0.3	0.1

Table 6.3.7: Results of the cone monitorings from the trial harvests 2006 in various yards

Locations: BUC = Buch, EBG = Eichelberg, HHF = Holzhof, KDF = Kirchdorf, OEB = Oberempfenbach.

Location/treatmt.	var.	date crop	bad cones in %	weighed average*	weight [g] ***)	volume [ml]
OEB insecticide	HM	11.09	35,2	1,58	125,8	3425
OEB untreated	HM	11.09	62,5	2,27	127,2	3150
KDF insecticide	HM	12.09	28,1	1,40	117,3	2550
KDF untreated	HM	12.09	85,8	2,81	114,7	2375
EBG insecticide	HM	21.09	45,9	1,68	104,8	2350
EBG untreated	HM	21.09	82,8	2,70	111,5	2450
HHF insecticide	HT	29.08	0,65	1,00	46,1	1600
HHF untreated	HT	29.08	8,35	1,09	44,8	1450
BUC insecticide	HT	02.09	15,6	1,18	63,3	2350
BUC untreated	HT	02.09	25,0	1,28	59,1	2200
HHF insecticide	PE	30.08	1,30	1,01	35,5	1100
HHF untreated	PE	30.08	4,15	1,04	39,5	1250
OEB insecticide	PE	04.09	2,05	1,02	49,3	1525
OEB untreated	PE	04.09	12,5	1,15	49,2	1425
BUC insecticide	SE	10.09	4,10	1,04	48,0	1900
BUC untreated	SE	10.09	4,30	1,04	43,7	1675
KDF insecticide	SE	11.09	0,15	1,00	35,9	1500
KDF untreated	SE	11.09	1,40	1,01	37,9	1450

*) unhealthy cones : cones total x 100
**) (healthy cones + low attacks x 2 + average attacks x 3 + strong attacks x 4) :
***) 500 cones, mean average of 4

6.3.2.4 Discussion and conclusion

At the final count in 2006 the picture was the same as in the corresponding investigations during the previous year: In the comparable weak aphid year 2005 with 14 untreated plots there were two (HM) total losses and in two others there were significant yield or alpha losses. In 2006 one HM plot was a total loss and another suffered considerable losses in yield. In the other twelve yards there were no yield or quality losses which could be traced back to aphids. The cone monitorings of the trial harvests in the case of aroma varieties only showed cones attacked in one case which would have resulted in cuts in the Independent Quality Appraisal, so that in 2006 eleven of 14 trial yards could have done without an insecticide treatment without any problems. The enormous differences in variety as far as aphid susceptibility is concerned was confirmed anew, which between HM and SE amount to about the factor 10 [1]. Then among the aroma varieties particularly SE was absolutely not at risk without insecticide application.

The results from 2005 and 2006 encourage us to check even more exactly the necessity of using insecticides (several times) to control aphids in the future; this particularly applies to aroma varieties, first and foremost SE. But also in the case of high-alpha varieties the question must be asked whether - particularly with the new alpha contracts - the aphid control must actually be continued at the current level as the number of tolerable aphids on the plants is considerably higher than the farmers at present assume. Actual yield and alpha losses are only to be expected when there are several hundred insects per leaf at the time of harvesting so that here without a "Quality Appraisal" through optical hand monitoring there is still a lot of room until real damage occurs. Naturally a hop farmer can never quite do without insecticides but further, more extensive investigations on the actual applications necessary are urgently recommended taking into considseration the differences in variety.

6.3.3. Trial to introduce the predatory mite *Typhlodromus pyri* in a hop yard in the Hallertau for the natural control of two-spotted spider mites *Tetranychus urticae*

6.3.3.1 Objective

The predator spider mite *Typhlodromus pyri* is known to be a very effective beneficial insect to control the common spider mite. If it is possible for the beneficial predator to overwinter in the hop yard the common spider mite population can be kept below the control threshold and the use of acaricides reduced.

The beneficial insect is firmly established in viniculture and significantly contributes to saving acaricides. *T. pyri* has been used for ten years in trials at the Hop Research Center [5]. For this purpose leaves were brought from vinyards which were colonized with the beneficial insect or else the insects were bought from a commercial breeder and distributed in hop plots. The effective reduction of the common spider mite was proven several times in these trials. Objective of the trial work is to check whether a permanent establishment of predator mites is possible in normally worked hop yards through "inoculation", in order to be able to do without the expensive annual purchase of beneficial insects. However, in hop production the problem is that the whole green mass is transported from the field with the hop harvest before physiological maturity and therefore all the beneficial insects are also removed from the hop yard.

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6.3.3.2 Work plan and methods

For the first time in spring 2004 proof was found that predator mites released in 2003 had successfully overwintered in a hop yard (cv. HT) in Buch near Aiglsbach [6]. No acaricide treatment was carried out between 1st July 2004 and the end of July 2006 without there being spider mite damage in any form whatever in 2005. Without further beneficial insects being brought there, it was regularly proven that predator mites were in this hop stand even in 2005 and 2006, when however the very low level of spider mites made no useful trials possible. During monitoring on 4th July 2006 it was discovered that a dense predator population existed on the stinging nettle tendrils which extended over the total length of the yard of over 200 m on the south side.

There was a considerable increase in the numbers of spider mites early in 2007 and again a big exact trial was prepared on 1.2 hectares. At the same time plots were prepared with and without predator mites (per 470 m^2, 250 trained hops) and this repeated four times and predator mites were released in the first ones in two waves (01.06., 13.06.). In comparison with earlier trials this time a mixture of two kinds of bean leaves were distributed on each plant, i.e. *Amblyseius californicus* and *Phytoseiulus persimilis* in the ratio 1:2. Altogether 24 predator mites on an average were put out on each plant. Besides the weekly monitoring for spider and predator mites up until the harvest, a trial harvest took place on 29.08.

6.3.3.3 Results

Altogether 3888 predator mites were registered during the monitoring in 2007 which were divided between 55 % *P. persimilis*, 30 % *A. californicus* and 15 % predator eggs. The height at which the beneficial insects were distributed over the bines was almost the same compared with the results of the previous year with 34 % in the lower area (1-2 m above ground level), 39 % in the medium area (3-5 m) and 27 % in the upper area (6-7 m). During the first eight weeks of monitoring the predator mites for the most part stayed in the plots they were released in and were only registered in a density worth mentioning from the end of July even in the untreated plots (Fig. 6.3.3). This "territoriality" of the beneficial insects resulted in a definite control effect towards *T. urticae*. On seven of twelve monitoring days, among them the decisive last four, the abundance of spider mites was significantly higher in the control plot than in the plots where the predators were released. On the last monitoring day, a week before harvesting, the difference was with 316 spider mites on an average per leaf in the control plot compared with 26 in the plots where the predators were released (Fig. 6.3.3).

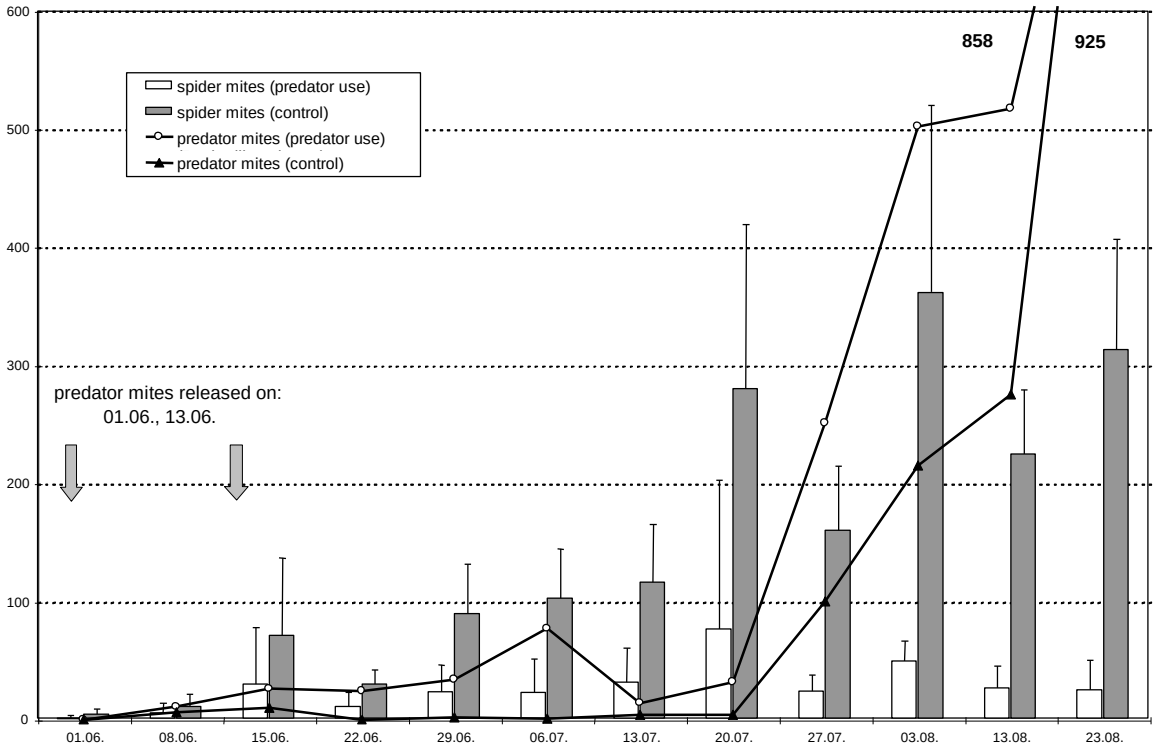

Fig. 6.3.3: Development of the spider mite and the predator mite population (spider mites: mean averages per leaf, n = 30; predator mites: total of 120 monitored leaves respectively per part of trial) in plots with and without use of predator mites (control) in 2007. Location Buch, variety HT.

The yields established in the trial harvest were at 19.6 dt/ha in the untreated control, at 23.8 dt/ha in den predator mite plots and at 26.0 dt/ha in the remaining yard which was worked as usual in the practice with two acaricide treatments. Between the yields of the control and the predator mites plots due to the relatively high variances in an ANOVA only very nearly could significant differences be found (P=0.08), but also the yields of the predator mites plots were statistically equal to those which had been worked as usual in the practice (P=0.19). On the other hand there was a highly significant difference (P=0.0038) between the control and the practice plots. As for the content of alpha acids all the harvested variants were between 6.09 und 6.25 % and there were no significant differences whatsoever.

6.3.3.4 Discussion and conclusion

The outstanding control success of spider mites by predator mites which could also be attained in 2007 even in a year with above-average widespread aphid attacks, is by far the best result which proved successful in over a decade of comparable trials in Hüll. Crucial for the plain results it seems was a very early spider mite attack in the trial yard, which - serving as a basis for food - could keep the released beneficial insects mainly in the plots where they were released – in previous years the insects spread out relatively quickly over the entire trial area including the control plot so that differences in spider mite attacks soon became blurred.

A really good choice was also the combination of *P. persimilis* and *A. californicus* used for the first time, which is obviously particularly well suited for the control of spider mites out in the open. Therefore this combination should definitely be tested in comparable trials in coming years hopefully in order to be able to reproduce the results of 2007. In any case the conclusion of the trial is the opinion which has already been held for a long time in Hüll that predator mites are those beneficial insects which can most of all be successfully introduced into the practice.

6.3.3 Investigations to lure aphid and spider mite antagonists

6.3.3.5 Objective

The beneficial insects which occur naturally in the hop yards are a decisive factor[7] in the control of the hop aphid *Phorodon humuli* as well as the common spider mite *Tetranychus urticae*. In biological pest control the use of this potential is fundamentally preferable than the expensive and labour-intensive use of bought beneficial insects. However one problem here is the fact that beneficial insects only appear on the hops under natural circumstances when aphids or spider mites have already reached a certain population level, which is generally no longer completely eliminated by the antagonists and results in damage to the plant.

The objective of the project was to search for baits (volatile substances such as volatile hop components or pheromons) which could serve as attractants for various species of beneficial insects on the hops in order to have antagonists for the main pests before their mass reproduction. At the same time the most important object of the investigations should be the lace-wing species *Chrysoperla carnea* which regularly appears in great density in the hop yards and whose larvae serve as effective predators for aphids as well as spider mites.

6.3.3.6 Work plan and methods

According to first experience and results obtained in 2004 it made sense to begin the investigations only in mid-July as earlier in the year the density of imaginal lace-wings in the hops is only very low. As from the 17th July 2005 and the 13th July 2006 one set of insect traps was exposed in five or four hop yards respectively which to some extent were located a considerable distance apart (locations: Hüll, Buch, Eichelberg, Oberempfenbach). The traps consisted of delta-formed huts made of cardboard with a floor space of 9x17 cm, which were equiped with exchangeable sticky bottoms. Under the "roof" of the traps one rubber septum respectively was fixed with a cardboard strip, onto each of which the volatile test substance had been put drop by drop or otherwise a PVC strip impregnated with the substance was fixed . Each set of traps consisted of five traps: the attractants to be tested nepetalactol, nepetalacton, phenylacetaldehyde, 2-phenylethanol as well as an untreated control. In 2006 another set of traps was exposed next to four locations in hop yards in the clearing of a pine forest (at the "Schattenhalle" in Hüll). At each one the traps were hung up for eight weeks until mid-September and were emptied in weekly intervals by changing the sticky bottoms.

In all cases the baits were renewed after four weeks. Later the species of the lace-wings caught was ascertained, the sex determined and then counted.

6.3.3.7 Results

During the eight weeks altogether 520 lace-wing individuals were caught in 2005 and 1475 in 2006 consisting almost only of males of the species *Peyerimhoffina gracilis*. Additionally in 2005 eleven males of *Chrysopa pallens* as well as one female each of *Chrysopidia ciliata* and *Cunctochrysa albolineata* were caught. Besides *P. gracilis* in 2006 only three males of *C. pallens* were caught. *P. gracilis* was only successfully caught in traps which had nepetalactol or nepetalacton as a bait, those of *C. pallens* were solely in nepetalactol traps (Table 6.3.8). The phenology of the *P. gracilis* (Fig. 6.3.4) caught in 2005 shows a peak at the beginning of August with a second, smaller maximum at the beginning of September, which probably means a second generation. In 2006 a clear maximum could be seen between 13th July and 2nd August which however was mainly caused by the bad weather which set in in August (Fig. 6.3.5).

When selecting the trial yards in 2006 efforts were specifically made to test the effectiveness of the attractants over the greatest possible distances. As normally *P. gracilis* solely lives on conifers, yards were chosen which were as far away as possible from the next conifers: Eichelberg –200 m as the crow flies, Oberempfenbach 250 m, Buch (HT) 150 m and Buch (SE) as much as 550 m.

Table 6.3.8: Total of lacewing individuals caught in each of the five kairomon traps in the Hallertau in 2005 and 2006. The figures signify males, females. Baits: PAA = phenylacetaldehyde, 2PE = 2-phenylethanol, N-ol = nepetalactol, N-on = nepetalacton, Ctrl = untreated control.

2005	**total**	**Active ingredient**				
		PAA	2PE	N-ol	N-on	Ctrl
C. ciliata	0.1		0.1			
C. pallens	11.0			11.0		
P. gracilis	507.0			305.0	202.0	
C. albolineata	0.1		0.1			

2006	**total**	**Active ingredient**				
		PAA	2PE	N-ol	N-on	Ctrl
C. pallens	3.0			3.0		
P. gracilis	1472.0			956.0	516.0	

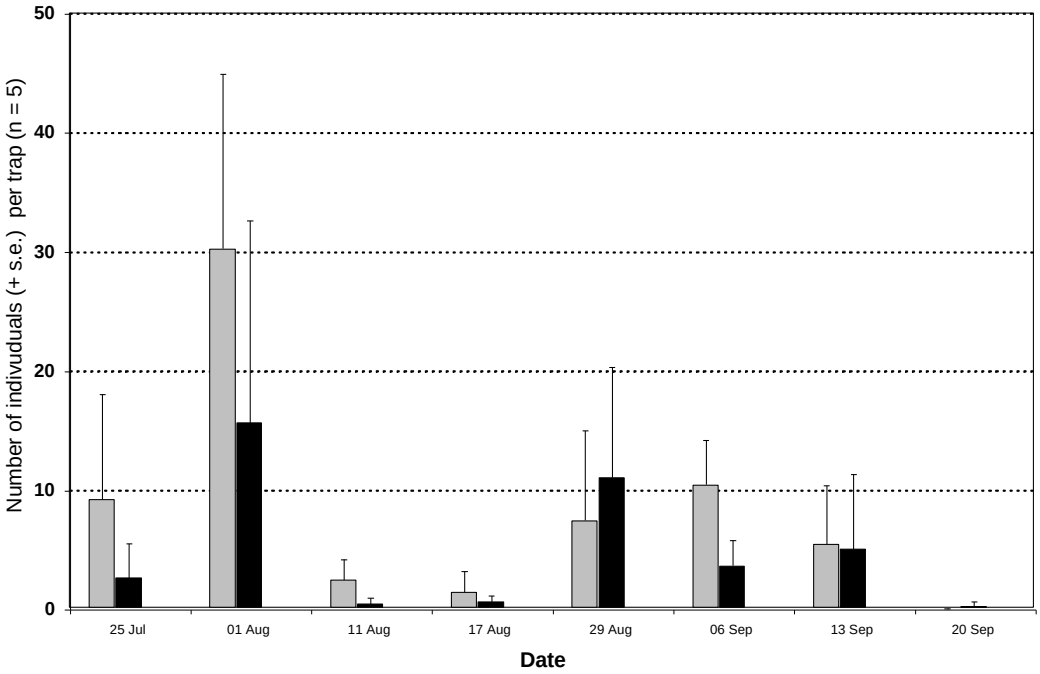

Fig. 6.3.4: Peyerimhoffina gracilis males caught in kairomon traps in hop yards in the Hallertau in 2005 (n = 507). Grey columns: nepetalactol (n=305),black columns: nepetalacton (n=202).

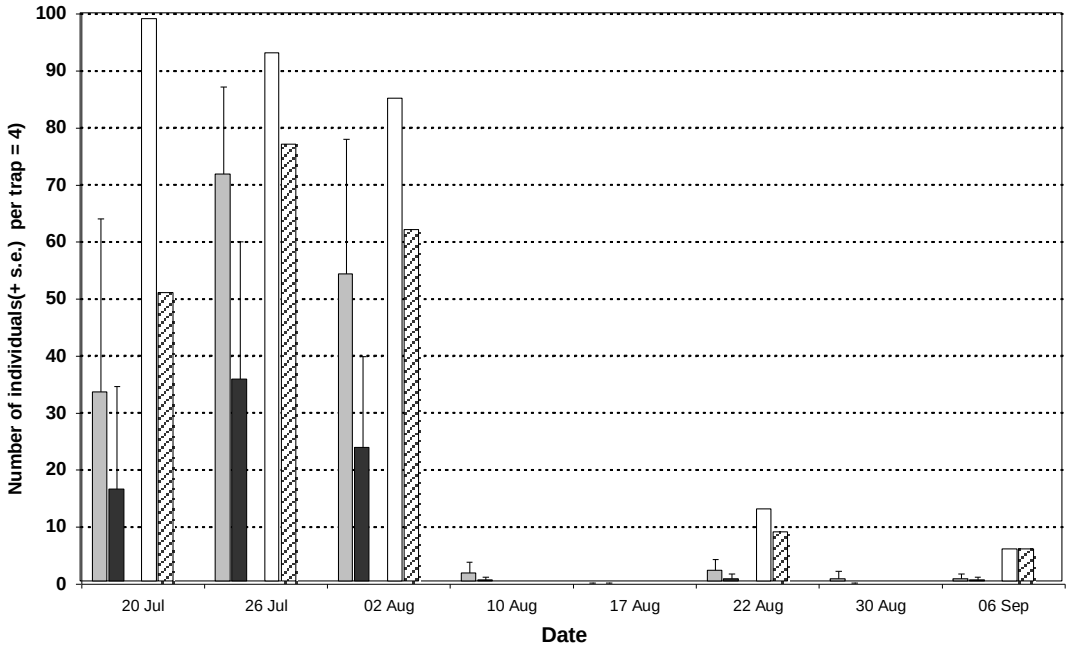

Fig. 6.3.5: Peyerimhoffina gracilis males caught in kairomon traps in hop yards in the Hallertau in 2006 (n = 1472). Grey columns: nepetalactol (n=660), black columns: nepetalacton (n=311). In comparison results of the traps from a clearing in the woods: white columns: nepetalactol (n=296), hatched columns: nepetalacton (n=205).

6.3.3.8 Discussion and conclusion

The attraction of *Peyerimhoffina gracilis* males through nepetalacton and/or nepetalactol was definitely confirmed as in 2004. Especially those caught from a yard in Buch, which was located at a distance of 550 m away from the next pine trees – with altogether 419 individuals here the most lacewings were caught – prove the extremely widespread effect of a suitable kairomon on a specific species. Also the luring effect of nepetalactol on *Chrysopa pallens* males can be said to be quite clear. On the other hand the trials with phenylacetaldehyd and/or 2-phenylethanol ran unexpectedly in endeavouring to lure *Chrysoperla carnea*, the actual objective of the research. Although both substances are described in current literature as very good attractants for this species [8] [9], not one of them was caught.

If a suitable attractant is found for a lacewing species and it is used, it is possible to lure the lacewings over considerable distances. For *Chrysoperla carnea* still nothing is known about a suitable substance so that more investigations are needed in the following years.

6.3.4 Use of entomopathogene nematodes (EPN) for the biological control of the alfalfa weevil *Otiorhynchus ligustici* in hops

6.3.3.9 Objective

Every year the alfalfa weevil *Otiorhynchus ligustici* causes economic losses on approx a third of the German area under hops. The Hallertau and Elbe-Saale production regions are particularly affected. The availability of registered insecticides for this indication is becoming more and more difficult. In addition the chemical control is only directed at beetles and not against the likewise damaging larvae. Regulating this in a biological way by distributing and possibly establishing insect pathogenic nematodes would be an ecologically friendly, sustainable alternative. In this project the bases for the methods using entomopathogenic nematoden (EPN) and corresponding success controls are to be tested. The long-term objective should be the permanent colonization of EPN in the soil and the sustained reduction of the pest linked with it.

6.3.3.10 Work plan and methods

With the aid of the very labour-consuming catch plant method – i.e. putting red clover between the hop stands to serve as food and plants where the beetles can lay their eggs – two species of nematodes are to be researched as a pilot study on the differences in their effectiveness. As *Heterorhabditis bacteriophora* and *Steinernema feltiae* have already been tested in 2005, the trials in 2006 were carried out with *H. bacteriophora* and *Steinernema carpocapsae.*

For this purpose in late summer 2005 red clover was sown in sandy earth in altogether 360 small plastic pots (10x10x12 cm) and left outside in the open during the winter. The red clover sown had developed dense, well-rooted sods by spring 2006. The beetles were checked on 20. and 26.04.2006 in some hop yards well known from previous years in Oberulrain, Mühlhausen and Untermantelkirchen. The pregrown red clover sods

were planted out in the two hop yards: on 27.04.2006 in Oberulrain and on 05.05.2006 in Untermantelkirchen. In these yards four (Untermantelkirchen) or six (Oberulrain) narrow rows were set out in those areas which during the controls had shown the most beetle attacks, altogether twelve plots each with 15 hop plants. The plots were randomized as four repeats respectively divided over three parts of the trials: (1) use of *Heterorhabditis bacteriophora*, (2) use of *Steinernema carpocapsae* and (3) untreated control. Finally the 180 red clover sods were planted per hop yard in the rows between the hop plants; the clover took well as in both cases rain fell after the planting action. Afterwards the clover as well as the hop plants were monitored four times (Oberulrain) or three times (Untermantelkirchen) for alfalfa weevils and signs of their feeding (Table 6.3.9).

The beneficial insects were actually spread out on 25.07 in Untermantelkirchen and on 23.08.06 in Oberulrain. At the same time both the nematode species were distributed with a quantity of 1 Mio. infection larvae respectively in 1 l water per hop plant and 0.5 million in 0.5 l water per red clover in the respective plots. For the distribution the two 100 l tanks of the single bine treatment apparatus mounted on a towing vehicle and equipped with stirring apparatus were used, which were filled with good 90 l water in each case. Shortly before being distributed the EPNs – which had been packed in the factory as a small bunch in mineral clay and refrigerated – were first dissolved in water in a plastic beaker and this suspension was then filled into one of the tanks with the stirring apparatus activated. From there the desired EPN suspension now available in the required concentration was pumped via a pump device driven by the towing vehicle into a plastic tub at the back of the tractor (on the platform of the individual bine apparatus) from where slowly progressing two workers poured the suspension in the respective amount directly onto the hop plant or onto the clover respectively. This process proved to be very easy to carry out, simple and fast. It had to be observed that if possible the EPN must not come into contact with direct sunshine, as it is badly affected by UV rays. Therefore the first distribution was made when the sky was overcast, the best possible time being shortly before a rain shower, while the second distribution was carried out during the 2006 high-summer hot spell only in the evening about eight o'clock.

Each time about four weeks after the EPN was distributed – on 25.07. in Untermantelkirchen and on 23.08.2006 in Oberulrain – the entire 180 clover sods were dug out in each trial yard, each with their surrounding soil and put into a big plastic tub and the roots were carefully examined for signs of feeding as well as for the presence of alfalfa larvae.

6.3.3.11 Results

The colonization of the clover sods which were buried in the spring was very fast, i.e. as early as a week after they were planting it could clearly be seen that they had been accepted by the beetles as a fodder plant and consequently probably also as substrate where they could lay their eggs. However, in Oberulrain the density of beetles monitored was regarded as too low for the trial and was considerably below the density of the previous year. In Untermantelkirchen the beetle densities were considerably higher in 2006 and relatively equal in all the plots (Table 6.3.9).

Table 6.3.9: Monitoring the clover sods as catch plants for O. ligustici *in spring 2006 before the treatment. Locations: Oberulrain and Untermantelkirchen. The figures signify feeding spots on clover leaves / beetle per plot. All figures are mean averages from 4 repeats with 15 clover sods.*

Treatment/Date	**4th May**	**11th May**	**18th May**	**8th June**
Oberulrain				
H. bacteriophora	3.75 / 0.75	1.50 / 1.00	12.00 / 0.75	9.00 / 0.50
S. carpocapsae	2.75 / 0.25	1.75 / 0.75	11.00 / 1.00	10.00 / 0.50
untreated	4.75 / 0.75	1.00 / 0.25	10.50 / 0.25	5.50 / 0.00
Untermantelkirchen				
H. bacteriophora		6.50 / 2.25	15.00 / 1.00	14.25 / 2.00
S. carpocapsae		3.00 / 4.75	15.00 / 2.00	14.50 / 1.25
untreated		4.25 / 3.50	15.00 / 1.50	14.50 / 3.75

The monitorings of the clover sods which had been dug up about four weeks after treatment showed varying results: At the end of July in Untermantelkirchen only very few feeding spots were ascertained on the roots and no beetle larvae were found whatsoever. On the other hand four weeks later in Oberulrain considerably more feeding spots were determined and ten beetle larvae sized 5 - 7 mm were discovered on altogether 180 clover sods at the F-2 stage.

6.3.3.12 Discussion und conclusion

Generally the numbers of the beetle larvae ascertained with the catch plant method in the two years were much too low to be able to make a statement. The monitoring at the end of August in Untermantelkirchen shows that the larvae at least from the F-2 stage can be found without any problem. The fact that in July in Oberulrain not one single larva could be found, can be explained in two ways: Either the EPN worked here so well that no larvae were present any more – although no single larva was found even in the untreated plots– or the larvae were still too small at this point to be discovered during monitoring.

Anyway in addition to this the beetle density was very low at this location in 2006 so that the latter explanation seems more probable. But also in Untermantelkirchen no differences whatsoever could be seen between treated and untreated plots. All things considered this highly labour-intensive method was not suited to answer the question which nematode species is the right one for the actual trials.

The effectiveness tests with the aid of the very labour-intensive catch plant method produced no differences whatsoever between the nematode species.

Taking these results into consideration as well as the higher effectivity of s. carpocapsae [10] ascertained in 1993 and the fact that the steinernema species indigenous to the hop yards of the Hallertau show a considerably higher persistance than h. bacteriophora in the soil [11], the proposal has been made to work in future with *Steinernema carpocapsae*.

Alternatively the new mixture *Heterorhabditis bacteriophora* and *Steinernema feltiae* sold by the producers of the nematodes (1:1) would also be conceivable as due to the various optimum temperatures of the two species it apparently covers soil temperatures of 8° - 25°C.

6.3.5 Literature

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7 Hop quality and analytics

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7.1 Introduction

The Work Group IPZ 5d carries out all the analytic research in the Hops Section IPZ 5 which is needed to support questions on trials put by other work groups. Hops have three groups of components relevant for brewing: the bitter compounds, the essential oils and the polyphenols. Of the bitter compounds the alpha-acids are regarded as the primary economic quality characteristic of hops as they are a criterion for the bitter potential and through their antimicrobial effect take care of the biological stability of the beer. The essential oils are responsible for the smell and the aroma. Their soothing effect can be used in medicine. The polyphenols are antioxidative and can capture free radicals. Xanthohumol in particular aroused great public interest in recent years due to its remarkable anticarcinogenic properties. The substance 8-prenylnaringenin, traces of which only occur in hops, is regarded as one of the strongest phyto-oestrogens and consequently gives the hops a slightly oestrogenic effect. It is important that also other alternative uses can be found for the hops outside the brewery on account of its manifold components, e.g. in the food industry, as a constituent for cosmetics and medicines, in functional foods and food additives.

7.2 Optimising the hop components as the breeding objective

7.2.1 Demands by the brewing industry

Up to now the selection of hop varieties relating to the hop components has mainly been directed towards the demands of the brewing industry. Bitter varieties with the highest possible and most stable alpha-acid contents should be bred without special standards. On the other hand bitter hops with very good aroma and low cohumulone contents such as Hallertauer Magnum and Hallertauer Taurus are desired. The cohumulone proportion is losing in weight as a quality parameter.

As far as the aroma varieties are concerned an excellent aroma, which equals the old traditional varieties Hersbrucker Spät, Hallertauer Mittelfrüher or also Tettnanger is still top priority. The substance linalool has crystallized as a leading substance for the aroma quality. However, in the alpha-acid content and in the alpha-acid stability per crop year the newer aroma varieties should surpass the old traditional varieties. In this respect the Hüllbred varieties Saphir, Smaragd and Opal can be regarded as real headway.

7.2.2 Alternative applications

The beta-acids do not play a great part in brewing beer as for the most part they are lost. However they prove to be antimicrobial towards gram positive, pathogenic bateria. This can be used to insert the beta-acids as natural biocides everywhere where bacteria have to be kept under control. In the sugar and ethanol industry formalin is already to a certain extent being replaced by beta-acids. Further uses relating to the antimicrobial activity are: Hygienising biogenic waste (sewage sludge, compost), removing mould fungus, improving smell and hygiene of fertilizer, control of allergenes. For this area of use it is conceivable that there will certainly be a greater need for hops. One breeding line is available in Hüll which can only produce beta acids due to a natural mutation which occurred coincidentally.

The other possibility for alternative applications is the area of health and wellness. Hops could be used for food additives, functional foods or medicines. As mentioned in the Introduction especially xanthohumol is a substance with great abilities. Of all the commercially grown varieties the Hüll variety Hallertauer Taurus has the greatest xanthohumol content at 1 %. However, one breeding line with 1.7 % xanthohumol is available already. The increase of the xanthohumol content is a defined breeding target. Other prenylated flavonoids such as 8-prenylnaringenin are only found in traces in the hops but have very strong physiological effects. The substance quercetin has a very strong anti-oxidative potential and occurs in hops to the amount of up to 0.2 %. This substance is regarded as very positive for health and is also found in greater amounts in apples. The other polyphenols such as the catechins and proanthocyanidins are negatively correlated with the alpha-acid contents. As a rule aroma hops have a higher polyphenol content than bitter hops. So far no selections have been made to increase the total polyphenol content. Hüll can however react if certain components are required.

7.3 Development of analysis methods for the hop polyphenols

As the focus is more and more on the hop polyphenols it is also important to develop analysis methods for this group of substances. Hops can contain up to 8 % polyphenols. More than 80 % of the hop polyphenols are made up of high molecular compounds such as the catechin tannins and the tannins. Approx. 20 % consist of monomer substances such as the xanthohumol, the phenolic carbonic acids as well as the flavonoids and their glycosides (Table 7.1).

Table 7.1: The composistion of the hop polyphenols and their concentrations in hops.

Substances and substance groups	**Concentrations**
Phenolic carbonic acids	
1) Benzoic acid derivates	< 0.01 %
2) Cinnamon acid derivates	0.01 – 0.03 %
Flavonoids	
3) Quercetin glycosides	0.05 – 0.23 %
4) Kämpferol glycosides	0.02 – 0.24 %
5) Catechins and epicatechins	0.03 – 0.11 %
6) Proanthocyanidins	0.06 – 0.11 %
7) Xanthohumol	0.20 – 1.00 %
Higher molecular substances	
8) Catechin tannins and tannins	2.00 – 7.00 %

At the moment there have not been any official analysis methods for the hop polyphenols to date therefore quantitative analysis methods should be developed for the total polyphenols, total flavanoids and for individual components and be standardised within the Work Group for Hop Analytics (AHA).

Methods have already been worked out for the total phenol content and tested in ring trials. First of all a hot-water extract is made from hops. After adding an iron (III) reagence the polyphenols form brown complexes which can be measured spectral photometrically. According to the intensity of the colouring respectively the concentration is ascertained. For the quantitative recording of the flavanoids a p-dimethylamino cinnamic aldehyde solution is added to the hot-water extract. The flavonoids react with violet compounds which can be quantified spectral photometrically. Xanthohumol is analysed together with the bitter compounds. A HPLC method is being developed for the analytics of individual low molecular polyphenols. Later on it is to be changed to UHPLC. Quercetin and Kämpferol solely occur in hops combined glycosidically. After hydrolytical separation of the sugar a quantitative analysis with HPLC is possible. The Fig. 7.1 shows a typical HPLC-chromatogram.

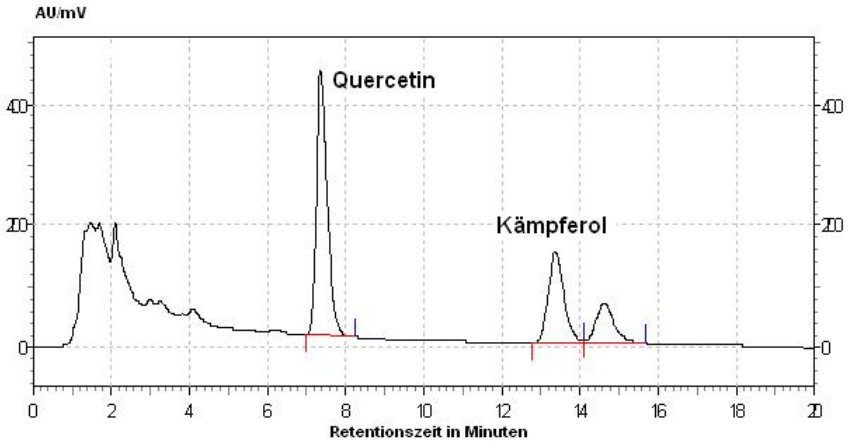


Fig. 7.1: HPLC chromatogram of quercetin and kämpferol in hops

The methods for the total polyphenol and total flavanoid content have already been tested within the AHA in ring trials. In particular for the total polyphenol content the dispersion is still relatively high. The variation coefficient is around 10 %. These methods still need some improvements and refinement. Ring trials are planned soon for the HPLC methods. However the work carried out so far already shows a very concrete picture on the polyphenol composition of hops (Table 7.1).

In order to develop alternative uses for hops the research on hop components is of tremendous importance. Especially the polyphenols possess a great potential for applications in the food and health sector. However the analysis methods used so far must still be improved and standardised.

7.4 World hop range (2006 crop)

This research programme is carried out every year. The objective is to determine the quality and variety specific hop components of the domestic and foreign hop varieties available when grown under the locational conditions in Hüll. The Table 7.2 shows the results of the 2006 crop year. It can serve as an aid to classify unknown hop varieties to a specific variety type.

Table 7.2: World hop range 2006

Variety	Myr-cene	2-M.-iso-butyrate	Sub. 14b	Sub. 15	Lina-lool	Aroma-dendrene	Unde-canon	Humu-lene	Farne-sene	γ-Muu-rolene	ß-Seli-nene	α-Seli-nene	Cadi-nene	Seli-nadien	Gera-niol	Alpha-acids	Beta-acids	ß/a	Cohu-mulone	Colu-pulone
Admiral	3702	554	3	23	31	0	9	277	7	8	5	3	17	0	0	13.0	5.9	0.45	29.2	57.6
Agnus	2652	104	2	6	8	2	3	143	0	7	6	5	15	0	0	11.3	7.8	0.69	32.5	53.2
Ahil	3119	224	28	3	10	4	6	191	46	7	7	5	15	0	0	8.8	4.4	0.50	31.3	57.2
Alliance	992	151	0	1	16	0	6	303	6	9	6	4	19	0	0	4.3	2.6	0.60	28.4	56.0
Alpharoma	1608	176	14	7	8	0	7	284	20	10	7	5	19	0	0	8.1	3.3	0.41	26.6	54.8
Apolon	3091	84	25	5	15	4	3	210	35	9	8	5	16	0	0	4.5	3.9	0.87	34.0	54.1
Aquila	4218	47	0	93	22	40	14	15	0	12	66	73	10	90	0	4.9	3.3	0.67	47.0	69.2
Aromat	3747	17	4	5	43	0	27	357	16	11	0	4	19	0	0	3.3	3.9	1.18	29.6	48.3
Atlas	2991	989	26	7	21	8	2	208	36	10	11	7	17	0	0	4.8	3.0	0.63	27.1	54.5
Aurora	4161	161	5	30	32	0	26	281	21	8	3	2	16	0	0	8.7	4.3	0.49	25.0	51.1
Backa	763	224	4	8	10	0	9	299	12	10	6	2	19	0	0	6.5	4.5	0.69	33.7	56.9
Belgian Spalter	2355	262	4	12	22	14	13	175	0	10	27	28	15	38	0	5.1	3.3	0.65	26.5	49.2
Blisk	2287	261	24	5	19	0	4	216	36	9	7	5	16	0	0	7.1	4.2	0.59	28.4	53.5
Boadicea	1074	75	1	8	3	2	2	112	8	7	6	5	15	0	0	5.2	4.5	0.87	23.2	44.2
Bobek	8247	278	17	97	57	0	15	262	29	8	6	3	15	0	0	6.4	6.3	0.98	30.5	49.1
Bor	2423	122	3	36	8	0	6	302	0	8	4	2	16	0	0	8.8	4.9	0.56	28.3	51.2
Braustern	2146	109	2	36	7	0	4	244	0	7	4	3	14	0	0	5.2	4.7	0.90	31.7	51.2
Brewers Gold	1602	252	9	8	10	0	3	177	0	8	7	6	16	0	0	6.3	3.7	0.59	38.5	59.3
Brewers Stand	8492	1190	43	45	52	47	21	83	0	102	94	83	171	90	0	4.3	4.5	1.05	30.1	46.1
Buket	1701	99	4	33	13	0	11	283	19	9	4	3	17	0	0	9.8	5.5	0.56	27.0	51.7
Bullion	1613	158	13	12	10	0	2	169	0	8	7	5	16	0	0	4.9	4.4	0.90	36.4	54.8
Cascade	3470	300	31	10	21	0	10	273	16	11	21	16	22	0	0	4.8	4.9	1.02	26.8	46.1
Chang bei 1	1597	31	5	2	40	0	13	250	13	11	23	22	20	22	0	4.0	5.3	1.33	24.9	43.4
Chang bei 2	1455	3	6	3	41	0	14	249	12	9	20	19	18	21	0	3.8	5.4	1.42	23.0	42.1
College Cluster	611	139	12	5	5	0	4	136	0	5	6	5	9	0	0	6.1	2.7	0.44	27.0	54.0
Columbus	2153	156	11	6	11	0	2	150	0	22	13	10	43	13	0	11.0	5.4	0.49	30.6	56.8
Comet	2083	61	8	23	11	0	3	10	0	2	35	39	5	11	0	8.8	4.9	0.56	30.7	51.1

Table 7.2 continued

Variety	Myr-cene	2-M.-iso-butyrate	Sub. 14b	Sub. 15	Lina-lool	Aroma-dendrene	Unde-canon	Humu-lene	Farne-sene	γ-Muu-rolene	ß-Seli-nene	α-Seli-nene	Cadi-nen	Seli-nadien	Gera-niol	Alpha-acids	Beta-acids	ß/a	Cohu-mulone	Colu-pulone
Crystal	957	25	7	9	21	47	15	193	0	14	47	47	18	69	0	3.6	6.9	1.92	24.1	40.9
Density	2327	288	14	7	46	0	16	291	0	11	8	2	20	0	0	3.8	2.5	0.66	35.4	64.2
Diva	2919	71	6	21	26	0	16	311	7	11	140	143	26	0	0	5.1	6.3	1.24	25.4	48.7
Dunav	2549	177	4	53	8	0	5	198	10	8	4	2	16	0	0	6.0	6.5	1.08	29.3	46.7
Early Choice	4861	183	0	47	7	0	7	244	0	6	51	57	12	0	0	2.2	1.6	0.73	22.8	50.9
Eastern Gold	1422	2	1	2	9	0	5	188	11	20	10	8	41	11	0	13.8	5.5	0.40	27.1	50.1
Eastwell Golding	1476	133	1	7	13	0	6	288	0	8	5	4	16	0	0	4.2	3.7	0.88	28.8	49.9
Emerald	1192	53	7	10	5	0	7	306	0	7	5	4	16	0	0	7.2	5.5	0.76	27.1	47.7
Eroica	2202	414	49	64	4	14	6	176	0	8	9	7	15	0	0	6.4	4.9	0.77	34.2	56.4
Estera	1580	152	0	4	19	0	6	285	11	9	4	2	16	0	0	2.9	2.7	0.93	32.5	54.1
First Gold	3702	577	4	12	23	5	11	274	6	9	126	155	24	0	0	8.6	4.7	0.55	27.2	52.8
Fuggle	1899	154	1	7	16	0	8	272	11	9	4	2	16	0	0	3.8	3.1	0.82	31.1	52.4
Galena	3584	572	51	102	6	9	5	184	0	9	7	5	16	0	0	7.6	5.5	0.72	33.7	55.5
Ging Dao Do Hua	3355	895	3	3	26	0	8	249	0	23	60	62	48	0	0	5.8	5.3	0.91	39.3	57.5
Glacier	2716	32	7	5	36	0	8	287	0	8	5	3	16	0	0	7.4	9.4	1.27	28.3	43.4
Golden Star	3812	1035	3	3	28	0	7	257	0	24	58	60	50	0	0	5.9	5.3	0.90	39.6	58.1
Granit	999	52	6	9	4	0	14	201	0	6	8	6	13	0	0	6.6	5.2	0.79	27.2	47.0
Hallertauer Gold	1387	71	28	5	16	0	7	332	0	8	4	2	16	0	0	6.4	5.9	0.92	23.0	44.0
Hall. Magnum	5446	161	40	21	7	3	4	294	0	6	3	2	12	0	0	11.4	8.0	0.70	29.5	49.9
Hall. Merkur	2616	158	17	5	16	3	5	289	0	9	5	3	17	0	0	13.3	8.1	0.61	22.0	43.0
Hallertauer Mfr.	771	75	1	0	21	0	6	331	0	10	4	2	18	0	0	3.4	4.4	1.29	21.5	42.0
Hall.Taurus	10838	282	29	28	46	0	10	286	0	8	63	80	20	0	0	15.0	5.7	0.38	25.4	48.5
Hall. Tradition	980	112	12	0	20	0	10	324	0	9	5	2	18	0	0	6.7	4.8	0.72	28.6	50.3
Herald	5010	469	5	84	11	7	21	219	0	7	38	41	17	0	0	12.0	4.5	0.38	30.2	63.4
Herkules	7424	337	61	132	12	0	7	270	0	7	4	2	15	0	0	15.3	6.1	0.40	36.5	54.5
Hersbrucker Pure	2184	110	6	14	29	23	18	213	0	12	32	34	19	53	0	4.9	3.0	0.61	27.7	53.3
Hersbrucker Spät	1143	27	8	0	29	57	12	172	0	16	54	54	20	72	0	2.1	6.9	3.29	26.9	39.7

Table 7.2 continued

Variety	Myr-cene	2-M.-iso-butyrate	Sub. 14b	Sub. 15	Lina-lool	Aroma-dendrene	Unde-canon	Humu-lene	Farne-sene	γ-Muu-rolene	ß-Seli-nene	α-Seli-nene	Cadi-nene	Seli-nadie-	Gera-niol	Alpha-acids	Beta-acids	ß/a	Cohu-mulone	Colu-pulone
Horizon	5107	214	11	34	32	6	6	172	12	5	8	6	10	0	0	9.4	6.2	0.66	26.5	48.3
Hüller Anfang	750	80	7	0	16	0	5	325	0	10	4	3	16	0	0	2.8	4.0	1.43	20.0	44.3
Hüller Aroma	912	83	2	0	20	0	6	325	0	9	5	3	19	0	0	3.2	4.0	1.25	21.0	44.5
Hüller Bitter	1195	151	38	0	23	21	8	172	0	56	59	53	91	72	0	5.4	5.2	0.96	29.9	47.4
Hüller Fortschritt	1253	72	8	0	25	0	7	318	0	9	4	2	15	0	0	3.1	4.3	1.39	24.5	45.4
Hüller Start	962	49	1	2	11	0	8	328	0	11	5	3	18	0	0	2.4	3.3	1.38	16.6	44.2
Japan C 730	1302	12	14	27	17	0	12	151	29	7	9	6	11	0	0	3.6	2.9	0.81	32.0	55.5
Japan C 827	816	14	11	3	6	0	6	301	13	7	6	4	16	18	0	6.6	3.2	0.48	28.0	55.1
Japan C 845	900	13	5	10	3	0	3	282	19	8	4	3	17	0	0	11.4	5.4	0.47	23.1	46.4
Japan C 966	4966	27	41	9	18	10	4	258	155	9	40	41	17	0	0	4.7	2.5	0.53	32.0	48.0
Kirin 1	2327	838	4	4	23	0	8	256	0	23	46	47	45	0	0	5.7	5.5	0.96	41.7	56.5
Kirin 2	3119	1030	3	3	25	0	7	253	0	25	57	57	49	0	0	5.3	5.2	0.98	40.1	56.3
Kitamidori	873	14	5	11	3	0	3	286	17	9	4	3	17	0	0	10.7	5.3	0.50	22.6	44.4
Kumir	3000	100	4	13	18	0	7	286	8	8	4	3	16	0	0	9.9	5.7	0.58	27.2	48.4
Late Cluster	10625	1110	30	50	54	49	26	60	21	101	96	81	169	77	0	4.1	4.0	0.98	30.0	49.0
Liberty	803	45	1	6	15	2	9	294	0	11	9	7	20	5	0	4.8	3.7	0.77	23.2	48.5
Lubelski	3594	10	5	0	37	0	20	309	29	9	0	0	16	0	0	3.4	4.3	1.26	25.8	44.9
Malling	2371	126	0	7	18	0	5	276	16	8	3	2	13	0	0	2.2	2.2	1.00	34.1	54.1
Marynka	2481	239	3	27	7	6	6	155	56	8	9	7	14	0	0	7.2	4.7	0.65	23.9	46.4
Mt. Hood	198	18	12	0	4	0	5	317	0	13	6	4	21	0	0	4.7	6.1	1.30	26.6	43.1
Neoplanta	1499	75	2	23	4	0	6	237	18	8	4	3	16	0	0	7.6	4.1	0.54	32.7	58.6
Northern Brewer	3216	121	2	52	6	0	5	248	0	8	4	3	15	0	0	8.6	6.1	0.71	31.1	50.9
Nugget	1507	88	3	9	12	2	3	168	0	5	7	6	9	0	0	12.3	5.2	0.42	30.6	54.2
NZ Hallertauer	3695	190	4	25	28	4	12	181	11	10	27	27	16	33	0	5.1	7.4	1.45	33.8	46.6
Olympic	1508	97	3	10	11	3	4	155	0	4	8	8	9	0	0	11.5	4.6	0.40	29.1	55.3
Omega	3131	541	25	16	18	0	8	287	0	8	58	65	20	0	0	7.6	3.9	0.51	25.4	53.3
Opal	1907	33	21	23	23	2	7	259	0	7	4	2	17	21	0	5.4	5.5	1.02	12.2	30.3

Table 7.2 continued

Variety	Myr-cene	2-M.-iso-butyrate	Sub. 14b	Sub. 15	Lina-lool	Aroma-dendrene	Unde-canon	Humu-lene	Farne-sene	γ-Muu-rolene	ß-Seli-nene	α-Seli-nene	Cadi-nene	Seli-nadien	Gera-niol	Alpha-acids	Beta-acids	ß/a	Cohu-mulone	Colu-pulone
Orion	745	115	7	5	13	0	5	258	0	9	4	2	18	0	0	6.9	5.3	0.77	30.2	51.0
OT 48	1682	161	5	4	38	0	14	298	0	10	9	5	19	0	0	4.1	3.8	0.93	31.8	52.9
Pacific Gem.	4663	460	15	22	20	0	14	262	0	8	4	2	16	0	0	11.1	5.8	0.52	30.8	54.7
PCU 280	1862	81	1	15	4	0	4	282	0	8	5	4	15	0	0	8.0	4.4	0.55	29.5	52.9
Perle	1006	52	2	21	3	0	3	280	0	7	4	3	16	0	0	7.6	5.0	0.66	28.4	51.8
Phoenix	2876	269	2	17	7	0	7	260	8	8	56	70	18	0	0	9.7	4.3	0.44	27.6	52.5
Pilgrim	5132	478	5	65	11	5	17	286	0	8	82	100	19	0	0	7.5	3.1	0.41	28.7	61.0
Pilot	5870	592	27	70	67	18	49	114	0	14	503	609	45	0	0	8.9	5.2	0.58	27.1	54.1
Pioneer	3153	446	3	128	8	5	23	256	0	8	35	39	18	0	0	11.2	4.7	0.42	30.0	62.9
Premiant	2384	101	5	11	19	0	7	289	3	8	4	3	16	0	0	9.5	5.7	0.60	28.5	50.4
Pride of Kent	1041	20	1	2	15	0	7	316	0	9	5	3	16	0	0	5.7	3.3	0.58	25.9	50.2
Pride of Ringwood	1416	38	3	1	6	0	12	12	0	6	75	80	16	0	0	10.2	5.6	0.55	31.9	57.1
Progress	12189	1307	43	60	56	59	22	50	0	97	95	83	169	91	0	4.4	4.3	0.98	31.3	48.1
Saazer	1892	4	3	6	29	0	18	324	24	11	7	4	20	0	0	2.6	3.1	1.19	26.9	44.0
Saphir	3120	106	13	26	36	12	34	222	0	10	26	23	17	36	0	2.2	4.7	2.14	9.2	40.0
Serebrianker	1667	84	0	4	24	0	4	169	0	11	41	40	19	0	0	1.9	4.4	2.32	43.4	46.9
Sirem	4091	7	0	5	45	0	22	322	31	10	0	3	18	0	0	3.9	3.9	1.00	33.1	49.9
Sladek	2587	105	4	14	16	0	6	290	6	7	4	3	17	0	0	8.3	5.2	0.63	27.0	48.6
Smaragd	1163	10	20	6	21	0	7	297	0	8	5	3	19	29	0	7.8	5.8	0.74	24.6	46.1
Spalter	1626	0	2	6	31	0	17	324	23	10	6	2	17	0	0	2.2	4.3	1.95	27.7	41.9
Spalter Select	3157	144	36	0	84	19	18	225	20	12	37	34	18	53	0	4.2	4.9	1.17	27.1	47.6
Sterling	1270	65	3	10	10	3	3	169	0	5	8	7	12	0	0	12.8	4.8	0.38	27.2	52.4
Sticklebract	5280	451	23	11	9	0	11	173	35	6	48	54	16	0	0	9.6	4.8	0.50	31.8	59.5
Strisselspalter	883	28	7	6	24	32	9	202	0	13	40	40	17	52	0	2.7	8.8	3.26	27.8	39.5
Südafrika	729	18	2	1	3	0	8	267	0	11	76	79	24	0	0	6.2	5.0	0.81	29.5	50.0
Super Alpha	3198	248	21	13	24	0	9	251	0	9	6	4	19	0	0	8.4	5.1	0.61	29.4	51.7
Talisman	3478	195	2	53	8	0	5	237	0	7	4	3	14	0	0	6.5	5.4	0.83	30.9	49.2

Table 7.2 continued

Variety	Myr-cen	2-M.-iso-butyrate	Sub. 14b	Sub. 15	Lina-lool	Aroma-dendrene	Unde-canon	Humu-lene	Farne-sene	γ-Muu-rolene	ß-Seli-nene	α-Seli-nene	Cadi-nene	Seli-nadien	Gera-niol	Alpha-acids	Beta-acids	ß/a	Cohu-mulone	Colu-pulone
Tettnanger	1583	0	4	5	28	0	15	334	18	10	5	2	17	0	0	2.4	4.5	1.88	29.8	43.2
Toyomidori	2637	213	16	72	11	0	14	211	0	21	15	10	39	11	0	12.7	5.5	0.43	29.5	59.7
Ultra	282	41	3	1	16	0	5	331	2	12	6	4	22	0	0	3.5	5.0	1.43	24.3	43.8
Urozani	5237	0	0	0	87	0	18	241	58	11	30	29	18	27	0	2.8	3.8	1.36	29.5	47.4
USDA 21055	5315	475	3	183	8	0	4	122	64	6	18	20	15	0	0	8.7	4.5	0.52	35.5	63.6
Vojvodina	3635	250	3	34	11	0	7	250	5	8	5	2	15	0	0	6.0	3.6	0.60	29.0	55.2
WFG	2543	15	5	5	33	0	19	313	20	10	7	3	17	0	0	3.8	4.4	1.16	22.3	42.5
Willamette	1076	121	0	4	12	0	5	274	12	9	5	3	16	0	0	3.7	3.6	0.97	27.8	48.9
Wye Challenger	4432	523	6	43	29	0	10	284	6	9	57	62	19	0	0	6.0	5.0	0.83	26.3	49.3
Wye Northdown	2578	91	2	15	11	0	4	258	0	7	4	3	13	0	0	6.9	6.0	0.87	29.6	48.7
Wye Target	3404	322	6	18	27	3	11	175	0	16	11	9	32	8	0	10.0	4.8	0.48	29.8	59.0
Wye Viking	9798	293	8	81	24	0	17	222	89	7	32	33	15	0	0	7.8	4.3	0.55	26.9	49.2
Yeoman	2646	235	12	15	7	0	5	244	0	7	44	49	17	0	0	11.5	5.5	0.48	27.7	52.2
Zatecki	2412	145	0	12	21	0	5	274	12	9	5	3	15	0	0	2.6	3.0	1.15	31.6	49.7
Zenith	1843	75	3	13	15	2	6	277	0	8	80	99	20	0	0	7.8	4.0	0.51	27.7	51.4
Zeus	1876	115	7	8	8	0	2	153	0	20	11	9	40	12	0	9.7	5.4	0.56	29.2	54.4
Zitic	1612	6	2	11	5	0	7	305	7	6	4	2	13	0	0	5.2	6.1	1.17	27.5	45.0
Zlatan	3723	13	0	5	41	0	23	319	29	10	0	0	16	0	0	3.4	3.9	1.15	31.4	48.5

Essential oils = relativevalues, ß-caryophyllene = 100, alpha and beta acids in % as is. Analoga in % der α or ß acids

7.5 Ring analyses on the 2007 crop

Since the year 2000 there has been a supplementary agreement in the hop supply contracts, where the alpha-acid contents are taken into consideration. The price agreed in the contract applies if the alpha-acid content is in a neutral range. If this neutral range is exceeded or not reached, there is a surcharge or a price reduction. In the duty book of the Work Group for Hop Analytics it is precisely laid down how the samples should be treated (dividing samples, storage), which laboratories are to carry out the further examinations and which tolerance ranges are permitted for the results of the analyses. The Work Group IPZ 5d was given the task again in 2007 to organise and evaluate Hop Ring analyses in order to ensure the quality of the alpha-acid analyses.

In Year 2007 the following laboratories participated in the Hop Ring test:

- Hallertauer Hopfenveredelungsgesellschaft (HHV), Werk Au/Hallertau
- NATECO$_2$ GmbH & Co. KG, Wolnzach
- Hopfenveredlung St. Johann GmbH & Co. KG, St. Johann
- Hallertauer Hopfenveredelungsgesellschaft (HHV), Werk Mainburg
- Hallertauer Hopfenverwertungsgenossenschaft (HVG), Mainburg
- Agrolab GmbH, Oberhummel
- Thüringer Landesanstalt für Landwirtschaft (TLL)
- Bayerische Landesanstalt für Landwirtschaft, Arbeitsbereich Hopfen, Hüll

The ring test was started on 4th September 2007 and ended on 16th November 2007, as during this time the majority of hop lots had been examined in the laboratories. The sample material was kindly made available by Mr. Hörmannsperger (Hopfenring Hallertau). Each sample was only ever taken from one bale in order to ensure maximum homogeneity. Each Monday the samples in Hüll were ground with a hammer mill, divided with a sample divider, vacuum-packed and brought to every single laboratory. On the following weekdays one sample was always analysed per day. The results of the analyses were sent back to Hüll a week later and evaluated there. Altogether 42 samples were analysed in 2007.

The evaluations were passed on to the individual laboratories as quickly as possible. As an example of an evaluation Fig. 7.2 shows the Ring test with the smallest dispersion.

Nr. 1: HHA (04.09.2007)

Lab	cw		average	s	cvr
1	3,71	3,68	3,70	0,021	0,6
2	3,64	3,63	3,64	0,007	0,2
3	3,76	3,71	3,74	0,035	0,9
4	3,72	3,70	3,71	0,014	0,4
5	3,75	3,70	3,73	0,035	0,9
6	3,67	3,71	3,69	0,028	0,8
7	3,67	3,80	3,74	0,092	2,5
8	3,76	3,76	3,76	0,000	0,0

mean	3,71
sr	0,039
vkr	1,06
sR	0,047
vkR	1,28
sL	0,026
r	0,11
R	0,13
Min	3,64
Max	3,76

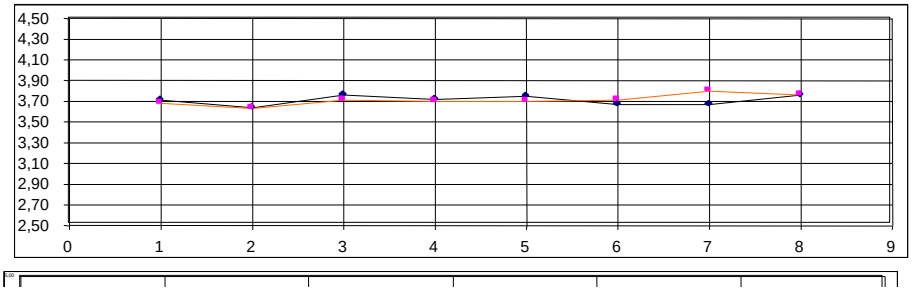


Fig. 7.2: Ring analysis with the smallest dispersion

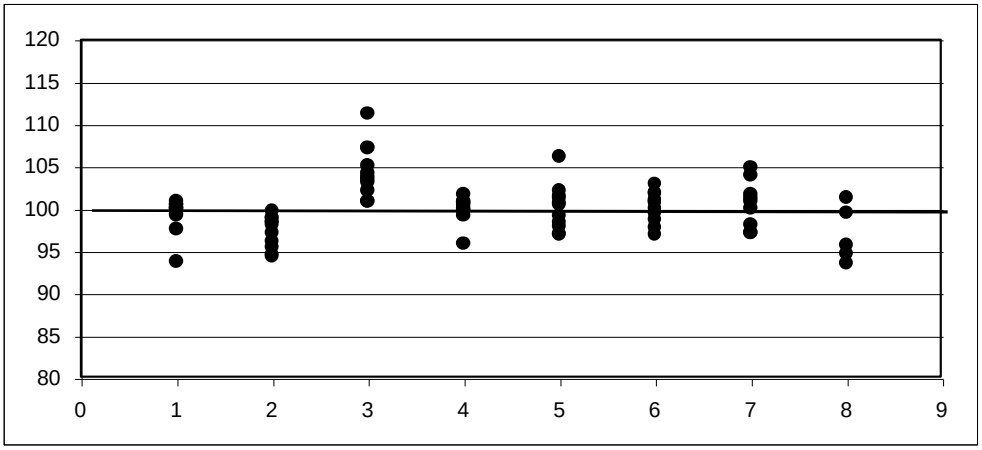
As a runaway test between the laboratories the Grubbs Test was calculated according to DIN ISO 5725. 1 runaway was found in 2007. Table 7.3 shows the tolerance limits (d critical, Schmidt, R., NATECO2, Wolnzach) from the methods collected by the European Brewery Convention (EBC 7.4, conductrometric titration) and their exceedings in the years 2000 bis 2007.

Table 7.3: Tolerance limits of the method EBC 7.4 and their exceedings in the years 2000 - 2007

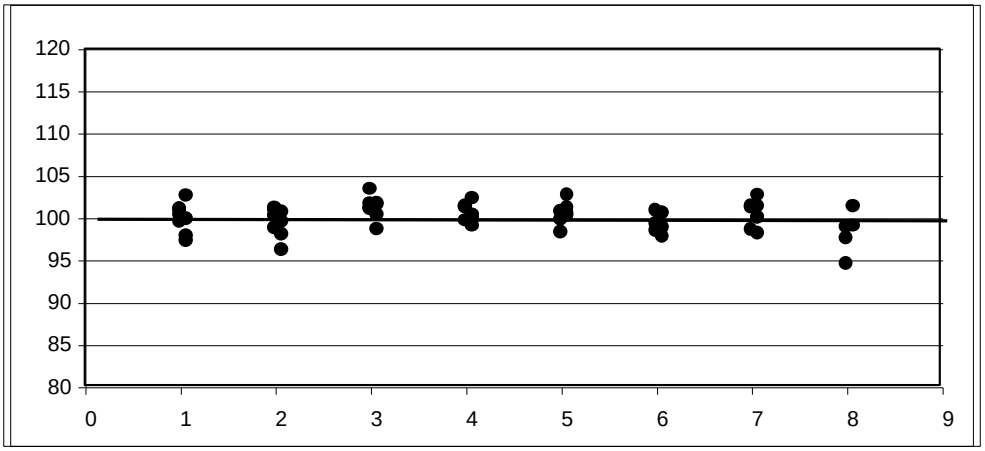
	Up to 6.2 % α-acids	6.3 % - 9.4 % α-acids	9.5 % - 11.3 % α-acids	from 11.4 % α-acids
d critical	+/-0.3	+/-0.4	+/-0.5	+/-0.6
Range	0.6	0.8	1.0	1.2
Exceedings in 2000	0	3	0	3
Exceedings in 2001	2	1	0	2
Exceedings in 2002	4	4	2	4
Exceedings in 2003	1	1	1	0
Exceedings in 2004	0	0	0	4
Exceedings in 2005	1	0	1	3
Exceedings in 2006	2	0	1	0
Exceedings in 2007	1	0	0	0

There was altogether one exceeding of the permitted tolerance limits in 2007. In Fig. 7.3 all the analysis results are listed in Fig. 7.3 for each laboratory as relative deviations from the mean average (= 100 %) differentiated according to alpha-acid contents < 5 %, > = 5 % and < 10 %, > = 10 %.

Probes with α-acid contents < 5 %



Probes with α-acid contents >= 5 % und < 10 %



Probes with α-acid contents >= 10 %

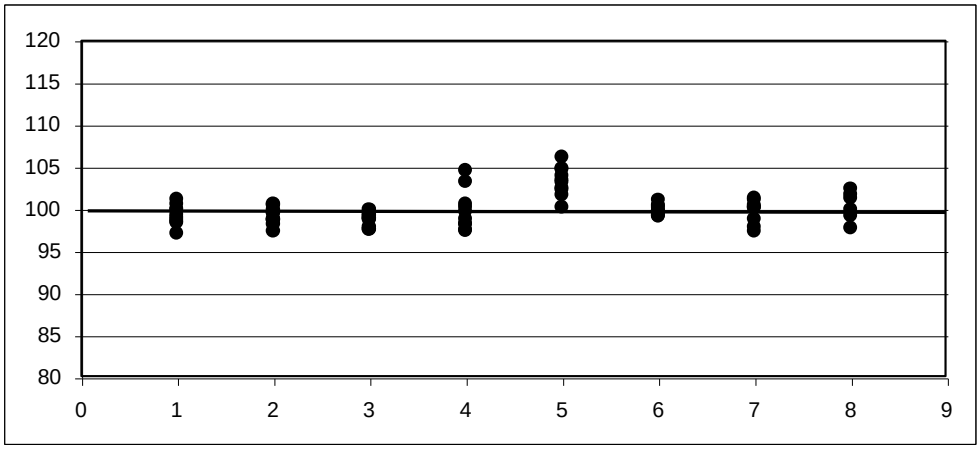


Fig. 7.3: Analysis results of the laboratories relative to the mean average

7.6 Development of a NIRS (near infrared reflection spectroscopy)-calibration for alpha-acid contents based on HPLC (high-resolution liquid chromatography)

There are two different measuring methods for determining the alpha-acid contents in hops. On the one hand the conductrometric titration according to EBC 7.4 and EBC 7.5, on the other hand the HPLC method according to EBC 7.7. Both methods require a relativly high labour input and need toxic chemicals, which are expensive to dispose of. However the alpha-acid contents are gaining increasing importance even in the payment for hops, therefore in recent years the number of analyses carried out rose considerably. It would be a great relief for the laboratories to have a cheap fast method available. This is the reason why the development of NIRS methods was begun. The objective is to maintain acceptable accuracy for the practice.

The following four laboratories, which also work together in the Work Group for Hop Analytics (AHA), are participating in the development of the NIRS analytics in the Hallertau:

Hallertauer Hopfenveredelungsgesellschaft (HHV), Werk Au/Hallertau

NATECO$_2$ GmbH & Co. KG, Wolnzach

Hopfenveredlung St. Johann GmbH & Co. KG, St. Johann

Bavarian State Research Center for Agriculture, Work Group IPZ5d, Hüll

When constructing the calibration it is important that the different varieties, locational influences, harvesting times and annual crop effects of a production region are taken into consideration. Therefore a great many probes have to be incorporated into the calibration. From the laboratories of the processing works in the mid-nineties a beginning was made to build up a calibration based on the conductometer values according to EBC 7.4. The laboratory in Hüll only joined in the year 2000. At the present time there are 5700 data records in this calibration. By adding new data records no further improvement could be reached. Therefore it was decided within the AHA not to continue working on this calibration but instead of this develop a calibration based on HPLC values according to EBC 7.7. HPLC values are much more specific than the conductormeter values which not only capture the alpha acids but also other organic acids. Work has been done on this calibaration since the year 2000. Ring tests are carried out every year in order to enlarge the calibration and check it.

Table 7.4 shows the evaluation of the Ring test in 2007. Mean averages, r, R and d critical of the reference method measurement are put together compared with the NIRS.

Table 7.4: Mean averages, r, R, d critical of the HPLC method compared with the NIRS(HPLC) method in 2007

Variety	HPLC				HPLC (NIRS)			
	α-acids	r	R	d	α-acids	r	R	d
HHA	3.49	0.14	0.18	0.15	3.23	0.28	0.89	0.64
HHE	3.13	0.18	0.22	0.18	2.66	0.28	0.96	0.69
HHM	11.91	0.17	0.47	0.34	11.28	0.42	1.45	1.05
HHS	14.61	0.29	0.73	0.54	14.03	0.32	1.17	0.84
HHT	5.54	0.13	0.19	0.15	5.11	0.29	1.01	0.73
HMR	11.85	0.17	0.44	0.32	11.40	0.28	1.12	0.80
HNB	8.29	0.32	0.41	0.33	8.10	0.42	0.95	0.70
HNU	10.10	0.45	0.66	0.52	9.54	0.58	0.88	0.69
HPE	7.20	0.24	0.28	0.23	7.01	0.34	1.07	0.78
HSD	6.47	0.32	0.35	0.29	6.09	0.23	0.57	0.42
HSE	4.37	0.13	0.23	0.18	4.05	0.19	0.80	0.57
HSR	4.13	0.20	0.23	0.19	3.99	0.23	0.64	0.47
HTU	15.13	0.29	0.54	0.41	15.04	0.43	0.99	0.73

In 2007 the NIRS values were always somewhat lower than the HPLC values. The repeatability (r) and particularly the reproducibility (R) are considerably greater with the NIRS method than with the wet-chemical HPLC method. This also results in a greater d critical which indicates how far measuring values can differ without being significantly different.

NIRS methods are not as precise as the wet-chemical refence methods. Within the AHA it was decided to continue the development of the NIRS calibration based on HPLC until a maximum accuracy is reached. Up until the present time it cannot be decided whether this method is eligible for hop supply contracts. The NIRS method is by all means suitable as a screening method for the hop breeding.

7.7 Research on plant protective residues in hops of the 2007 crop

The annual inspections for residues of plant protectives in hops give a very good overview on the actual situation regarding the use of plant protectives.

It can also ascertained in 2007 that hops are free of harmful residues from plant protectives.

Due to the high costs for the total analysis (approx. € 1,250.-- per sample) the extent of the analyses also had to be restricted this year to six samples. However, in addition very many analyses will be carried out with the same analysis spectrum commissioned by the hop-trading firms. The variety Hallertauer Mittelfrüher will be checked thoroughly for the active substances examined in this study.

Although considerably fewer active substances are used in the practice, altogether 95 different plant protective active ingredients were analysed in this study. In addition to the active ingredients permitted at present examinations and checks will be made for previously licensed substances and others from other cultures (e.g. wine). Consequently it is assured that all the possible active ingredients are covered.

In 2007 newly licensed or approved substances are Flonicamid (aphid), Spirodiclofen (common spider mite), Carfentrazone-ethyl (hop stripping), Haloxyfop-R-methyl (unwanted grasses) und MCPA (weeds).

7.7.1 Selecting samples and analysis results

Distributed over the 2007 weighing and certifying season altogether 110 hop samples of all the important varieties in the Hallertau production region were delivered by the Hopfenring Hallertau e.V. to the Hops Dept., of the Bavarian State Research Center for Agriculture (LfL) in Hüll. The samples were only marked with the designation of variety and the bale number. Therefore the names of the hop farms are not known to the LfL.

From these samples at the LfL **two** hop samples were selected respectively for the hop varieties named in the Table and a mixed sample was made for each variety. The extensive residue analyses of a mixed sample from two single samples are justified as the lots delivered to the purchasers (breweries) are generally put together from more than two single lots.

The variety selection represents varieties which are very susceptible to pests and diseases (e.g. Hallertauer Magnum -HM-, Hersbrucker Spät -HE-), less susceptible varieties (e.g. Hallertauer Tradition -HT-), late maturing varieties (e.g. Hallertauer Taurus -TU-, Herkules -HS-) and varieties with wide areas under hops (e.g. Hallertauer Magnum -HM-). For the first time the new varieties Saphir (SR) and Herkules (HS) were included in the research.

The analyses were carried out at the Bioanalytik Weihenstephan (formerly the Agricultural Research Facility HVA) of the Technical University (TUM) in Freising-Weihenstephan. Table 7.5 shows the results.

Table 7.5: Research on residues of plant protectives – 2007 crop (licensed or else approved in 2007)

Active ingredients according to pest/disease	Max. amount permitted in ppm	Milligram per kilogram = ppm					
		R 1/07	R 2/07	R 3/07	R 4/07	R 5/07	R 6/07
		HE	SR	HT	TU	HM	HS
Fungicides with main effect against							
1. Downy mildew							
Azoxystrobin	**20.00**	**n.n.**	**1.10**	**1.10**	**n.n.**	**0.36**	**0.10**
Captafol	0.10	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Captan	0.05	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Cymoxanil	2.00	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Dimethomorph	**50.00**	**1.60**	**<0.05**	**0.07**	**0.18**	**0.38**	**n.n.**
Dithiocarbamate	25.00	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Fentin-acetate	0.10	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Folpet	**150.00**	**0.27**	**1.40**	**37.80**	**<0.2**	**18.80**	**17.70**
Fosethyl	**100.00**	**n.n.**	**n.n.**	**n.n.**	**n.n.**	**n.n.**	**n.n.**
Cupric compounds	**1000.00**	**954.00**	**495.00**	**159.00**	**152.00**	**112.00**	**127.00**
Metalaxyl	**10.00**	**n.n.**	**n.n.**	**n.n.**	**n.n.**	**n.n.**	**n.n.**
Tolylfluanide	30.00	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
2. Powdery mildew							
Boscalide	-	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Chlorthalonil	50.00	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Fenarimol	5.00	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Fenpropymorph	*0.05	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Flusilazol	*0.01	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Kresoxim-methyl	0.10	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Myclobutanil	**2.00**	**1.10**	**<0.1**	**0.35**	**0.14**	**<0.10**	**0.12**
Nitrothal-isopropyl	*0.05	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Penconazol	0.50	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Propiconazol	0.10	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Pyraclostrobin	10.00	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Quinoxyfen	**0.50**	**0.13**	**0.17**	**0.12**	**0.14**	**n.n.**	**n.n.**
Spiroxamine	0.10	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Tebuconazol	30.00	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Triadimefon	10.00	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Triadimenol	**10.00**	**n.n.**	**n.n.**	**n.n.**	**n.n.**	**n.n.**	**n.n.**
Triforin	30.00	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Trifloxystrobin	**30.00**	**n.n.**	**2.90**	**7.30**	**9.00**	**6.10**	**16.30**
3. Botrytis							
Dichlofluanid	150.00	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Procymidon	0.10	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Vinclozolin	40.00	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.

Table 7.5 continued

Active ingredients according to pests/disease	Max. amount permitted in ppm	Milligram per kilogram = ppm					
		R 1/07	R 2/07	R 3/07	R 4/07	R 5/07	R 6/07
		HE	SR	HT	TU	HM	HS
Insecticide with main effect against							
1. Aphids							
Acetamiprid	0.10	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Acrinathrin	-	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Alphacypermethrin	30.00	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Bifenthrin	10.00	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Bioresmethrin	0.20	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
3-Hydroxy-Carbofuran	0.05	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Clothianidin	-	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Cyfluthrin	20.00	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Cypermethrin	30.00	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Deltamethrin	5.00	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Diazinon	0.05	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Dibrom	-	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Dichlorvos	0.02	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Dicrotophos	*0.01	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Dioxacarb	*0.01	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Endosulfan	0.10	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Ethiofencarb	*0.05	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Fenvalerat	0.05	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Flonicamid	**2.00**	**n.n.**	**n.n.**	**n.n.**	**n.n.**	**n.n.**	**n.n.**
Flucythrinate	0.10	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Imidacloprid	**2.00**	**<0.10**	**<0.10**	**0.20**	**n.n.**	**n.n.**	**n.n.**
Mevinphos	0.02	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Omethoat	-	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Parathion-methyl	0.05	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Permethrin	0.10	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Pirimicarb	*0.05	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Propoxur	0.10	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Pymetrozin	**15.00**	**n.n.**	**n.n.**	**n.n.**	**n.n.**	**n.n.**	**n.n.**
Thiometon	-	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
2. Alfalfa weevil							
Acephat	0.05	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Carbofuran	0.05	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Carbosulfan	1.00	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Chlorpyrifos-ethyl	-	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Fipronil	-	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Lambda-Cyhalothrin	**10.00**	**n.n.**	**n.n.**	**n.n.**	**n.n.**	**n.n.**	**n.n.**
Methamidophos	**0.02**	**n.n.**	**n.n.**	**n.n.**	**n.n.**	**n.n.**	**n.n.**
Methidathion	0.10	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Spinosad	-	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.

Table 7.5 continued

Active ingredient according to pest/disease	Max. amount permitted in ppm	Milligram per kilogram = ppm					
		R 1/07 HE	R 2/07 SR	R 3/07 HT	R 4/07 TU	R 5/07 HM	R 6/07 HS
Acaricide against common spider mite							
Abamectin	**0.05**	**n.n.**	**n.n.**	**n.n.**	**n.n.**	**n.n.**	**n.n.**
Amitraz	0.10	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Azocyclotin/Cyhexatin	0.10	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Brompropylat	0.10	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Clofentezin	0.05	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Dicofol	50.00	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Etoxazol	-	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Fenbutatinoxid	0.10	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Fenpropathrin	*0.02	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Fenpyroximate	**10.00**	**n.n.**	**n.n.**	**n.n.**	**n.n.**	**n.n.**	**n.n.**
Fluvalinate	-	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Hexythiazox	**3.00**	**n.n.**	**n.n.**	**n.n.**	**n.n.**	**n.n.**	**n.n.**
Malathion	*0.05	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Propargit	30.00	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Pyridaben	-	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Spirodiclofen	**30.00**	**n.n.**	**n.n.**	**n.n.**	**n.n.**	**n.n.**	**n.n.**
Herbicides							
Carfentrazone-ethyl	**0.02**	**n.n.**	**n.n.**	**n.n.**	**n.n.**	**n.n.**	**n.n.**
Cinidon-ethyl	**0.10**	**n.n.**	**n.n.**	**n.n.**	**n.n.**	**n.n.**	**n.n.**
Fluazifop-butyl	**0.10**	**n.n.**	**n.n.**	**n.n.**	**n.n.**	**n.n.**	**n.n.**
Haloxyfop-R-methyl	**0.02**	**n.n.**	**n.n.**	**n.n.**	**n.n.**	**n.n.**	**n.n.**
MCPA	***0.10**	**n.n.**	**n.n.**	**n.n.**	**n.n.**	**n.n.**	**n.n.**
Metribuzin	0.10	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Monolinuron	0.10	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Trifluralin	*0.10	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.

* = generally assigned to "other plant-based food"

n.n. = not detected

Bold type = active ingredients licensed or else approved in 2007

HE = Hersbrucker Spät
SR = Saphir
HT = Hallertauer Tradition
TU = Hallertauer Taurus
HM = Hallertauer Magnum
HS = Herkules

7.7.2 Assessing the results

As in previous years only few active substances were detected. In all cases the values are considerably below the legally permitted maximum amounts in compliance with the current regulation for maximum amounts of residues in the respective valid version (Table 7.6). This also applies for the stipulations on maximum quantities in compliance with the US and Japan standards. No unauthorised hop plant protectives were ascertained whatsoever.

Table 7.6: Residue situation in hops of the 2007 crop (compiled from Table 7.5)

Active ingredient (brand name)	Frequency = 6	ppm min.-max.	ppm max. amount	ppm US tolerance	ppm Japan tolerance
Azoxystrobin (Ortiva)	4	0.1 - 1.1	20.0	20.0	20.0
Dimetomorph (Forum)	5	<0.05 - 1.6	50.0	60.0	60.0
Folpet (Folpan WDG)	6	<0.2 - 37.8	150.0	120.0	120.0
Imidacloprid	3	<0.1 - 0.2	2.0	6.0	10.0
Cupric compounds	6	112.0 - 954.0	1.000.0	ex.	ex.
Myclobutanil (Systhane 20 EW)	6	<0.1 - 1.1	2.0	10.0	2.0
Quinoxyfen (Fortress 250)	4	0.12 - 0.17	0.5	3.0	3.0
Trifloxystrobin (Flint)	5	2.9 - 16.3	30.0	11.0	20.0

ex = exempt

7.7.3 Resumé

This year the long-term programme for determining residues of plant protectives in hops also confirms that hops are free from harmful residues. The maximum amounts have been fully adhered to not only for the German market but also for export. Consequently it can be ruled out that plant protectives have a negative effect on the beer.

7.8 Checking that the variety is authentic

It is the duty of the Work Group IPZ 5d as official assistants for the food controlling authorities to check that the variety is authentic.

Variety inspections for the food controlling authorities
(district administrator's office) 22
Complaints thereof 0

8 Publications and specialist information

8.1 Overview on public relations work

	No.		No.
Practice information and scientific publications	41	Guided tours	65
LfL publications	4	Exhibitions	4
Press releases	2	Education and further training	16
Contributions in radio and television	7	Diploma theses	2
Conferences, specialist meetings and seminars,	2	Dissertations	1
Talks	87	Participation in work groups	18
Foreign guests	138	Honours awarded	2

8.2 Publications

8.2.1 Practice information and scientific contributions

Engelhard, B., Schwarz, J., Weihrauch, F. (2007): Standard ranges of the application of pesticides in hops – a proposal for the EPPO guidelines. Proceedings of the Scientific Commission of the International Hop Growers´ Convention, Tettnang, Germany, 24-28 June 2007: 110-113.

Engelhard, B., Weihrauch, F. (2007): Bekämpfung von Blattläusen und Peronospora im ökologischen Hopfenbau. In: Wiesinger, K. (Hrsg.): Angewandte Forschung und Beratung für den ökologischen Landbau in Bavaria. Öko-Landbau-Tag 2007 am 7. März 2007 in Freising-Weihenstephan. Publication series der Bayerischen Landesanstalt für Landwirtschaft 3/2007: 85-97.

Engelhard, B., Bogenrieder, A., Eckert, M., Weihrauch, F. (2007): Entwicklung von Pflanzenschutzstrategien ökologischen Hopfenbau als Alternativen zur Anwendung kupfer- und schwefelhaltiger Pflanzenschutzmittel. Publication series der Bayerischen Landesanstalt für Landwirtschaft 9/2007: 1-49.

Engelhard, B. (2007): Untersuchungen auf Pflanzenschutzmittelrückstände. Hopfenrundschau 1, 22-24.

Kammhuber, K., Kneidl, J., Lutz, A., Petzina, C. (2007): Bonitierung und Results für die Deutsche Hopfenausstellung 2006. Hopfenrundschau 1, 12-15.

Lutz, A. und Seigner, E. (2007): Erste Erfahrungen im Anbau von Herkules. Hopfenrundschau 58 (4), 91-93.

Lutz, A., Kneidl, J. und Kindsmüller, G. (2007): Produktion und Pflege von leistungsfähigem Fechsermaterial. Hopfenrundschau 58 (4), 93-95.

Miehle, H. and Seigner, E. (2007): Production of powdery mildew resistant hops via gene transfer. Proceeding of the Scientific Commission, International Hop Growers`Convention. Tettnang, Germany, 78-81.

Niedermeier, E. (2007): Pflanzenstandsbericht. Hopfen Rundschau 58 (5), 124.

8.2.1 continued – Practice information and scientific contributions

Niedermeier, E. (2007): Pflanzenstandsbericht. Hopfen Rundschau 58 (6), 144.

Niedermeier, E. (2007): Pflanzenstandsbericht. Hopfen Rundschau 58 (7), 170.

Niedermeier, E. (2007): Pflanzenstandsbericht. Hopfen Rundschau 58 (8), 209-210.

Niedermeier, E. (2007): Pflanzenstandsbericht. Hopfen Rundschau 58 (9), 247.

Portner, J. (2007): Aktuelle Hopfenbauhinweise. Hopfenbau-Ringfax Nr. 5; 6; 7; 8; 11; 12; 14; 16; 17; 18; 20; 21; 22; 23; 24; 25; 27; 28; 30; 33; 34, 35; 36; 37; 39; 40; 41; 43; 45; 47; 50; 52; 53; 54; 56; 57.

Portner, J. (2007): Richtige Durchführung der Stickstoffbodenuntersuchung. Hopfen Rundschau 58 (2), 41.

Portner, J. (2007): Überprüfung der Pflanzenschutzgeräte im Hopfenbau. Hopfen Rundschau 58 (3), 56.

Portner, J. (2007): Gezielte Stickstoffdüngung des Hopfens nach DSN (Nmin). Hopfen Rundschau 58 (3), 60.

Portner, J. (2007): Erste Nmin-Results in Hopfen und anderen Ackerkulturen: Empfehlungen zur Stickstoffdüngung 2007. Hopfen Rundschau 58 (3), 62.

Portner, J. (2007): Düngebedarfsermittlung für P, K, Kalk und Magnesium. Hopfen Rundschau 58 (3), 72.

Portner, J., Brummer, A. (2007): N_{min}-Untersuchung 2007. Hopfen Rundschau 58 (5), 117.

Portner, J. (2007): Erlaubt ist nur die Ausbringung von zugelassenen Pflanzenschutzmitteln auf Nutzflächen. Hopfen Rundschau 58 (5), 125.

Portner, J. (2007): EU Erntebericht 2006 – Übermittlung von Angaben im Hopfensektor VO (EG) Nr. 1557/2006. Hopfen Rundschau 58 (5), 128.

Portner, J. (2007): Peronosporabekämpfung – Planen Sie Ihren Mitteleinsatz. Hopfen Rundschau 58 (6), 148.

Portner, J. (2007): Kostenfreie Rücknahme von Pflanzenschutzverpackungen PAMIRA 2007. Hopfen Rundschau 58 (7), 174.

Portner, J. (2007): Rebenhäcksel bald möglichst ausbringen! Hopfen Rundschau 58 (8), 206.

Portner, J. (2007): Fachkritik zur Moosburger Hopfenschau 2007. Hopfen Rundschau 58 (10), 274-277.

Portner, J. (2007): Einflussgrößen und produktionstechnische Maßnahmen zur Verbesserung der Hopfenqualität für die Brauerei. Hopfen Rundschau 58 (11), 302-307.

Portner, J. (2007): Datensammlung – Betriebsplanung Hopfenbau nach 7 Jahren aktualisiert. Hopfen Rundschau 58 (12), 344-345.

Portner, J. (2007): Hinweise für Hopfenpflanzer zu Aktuelles im Pflanzenschutz und zu Themen der Hopfenberatung. Hopfenring/Erzeugerring-Information v. 24.05.2007, 1-2.

Portner, J. (2007): Hinweise für Hopfenpflanzer zu Aktuelles im Pflanzenschutz. Hopfenring/Erzeugerring-Information v. 26.07.2007, 1.

Portner, J. (2007): Hinweise für Hopfenpflanzer zu Schlagkarteiauswertung, Fortbildungsveranstaltungen und KuLaP-Förderung. Hopfenring/Erzeugerring-Information v. 09.11.2007, 1-2.

Schätzl, J., Kindsmüller, G., Maurmeir, K. (2007): Vergleich verschiedener Methoden der pH-Schnellbestimmung auf Genauigkeit und Praktikabilität in der Beratung. Hopfen Rundschau 58 (6), 142-144.

Seigner, E. und Lutz, A. (2007): Wildhopfen erschließen neue Ressourcen für die Mehltauresistenzzüchtung. Hopfenrundschau 58 (5), 120-122.

Seidenberger, S. Mikolajewski, A. Lutz, E. Seigner, S. Seefelder (2007): Development of molecular markers linked to powdery mildew resistance genes in hops (*Humulus lupulus* L.) to support breeding for resistance. Proceedings EBC Congress, Venedig, 7.-10.05.2007.

8.2.1 continued – Practice information and scientific contributions

Seidenberger, S. Mikolajewski, A. Lutz, E. Seigner, S. Seefelder, W.E. Weber (2007): cDNA-AFLP markers for powdery mildew resistance in hops (*Humulus lupulus* L). Proceeding of the Scientific Commission, International Hop Growers`Convention. Tettnang, Germany, 67-70.

Weihrauch, F. (2007): Management of lacewings in the special crop of hops: state of the art. In: Freier, B., Ehlers, R.-U. (eds), Report on the 25th Annual Meeting of the Working Group Beneficial Arthropods and Entomopathogenic Nematodes: 95. Journal of Plant Diseases and Protection 114: 89-95.

Weihrauch, F. (2007): Management of lacewings in the special crop of hops: state of the art. In: Freier, B., Ehlers, R.-U. (eds), Report on the 25th Annual Meeting of the Working Group Beneficial Arthropods and Entomopathogenic Nematodes: 47. DGaaE-Nachrichten 21(1): 33-47.

Weihrauch, F. (2007): Bibliographie des Arbeitskreises „Neuropteren“, Version 1.0. DGaaE-Nachrichten 21(3): 136.

Weihrauch, F. (2007): Versuche zur Anlockung von Florfliegen in der Sonderkultur Hopfen: Stand der Dinge. DGaaE-Nachrichten 21(3): 137.

Weihrauch, F., Eckert, M., Engelhard, B. (2007): An ancient compound rediscovered: perspectives of aphid control in organic hop growing by the use of quassia products. Proceedings of the Scientific Commission of the International Hop Growers´ Convention, Tettnang, Germany, 24-28 June 2007: 105-108.

Weihrauch, F., Schwarz, J., Engelhard, B. (2007): Einsatz von Quassia zur Bekämpfung der Hopfenblattlaus *Phorodon humuli* in der Sonderkultur Hopfen. In: Kühne, S., Ganzelmeier, H., Friedrich, B., Pflanzenschutz im ökologischen Landbau - Probleme und Lösungsansätze. 12. Fachgespräch am 27. September 2007. Berichte aus der Biologischen Bundesanstalt für Land- und Forstwirtschaft 141: 53-60.

8.2.2 LfL publications

Name	Work group	LfL publications	Title
Engelhard, B., Weihrauch, F.	IPZ 5b	Lfl publication series 03/2007	Organic Agriculture Day 2007
Engelhard, B., Bogenrieder, A., Eckert, M., Weihrauch, F.	IPZ 5 b	LfL publication series 09/2007	Development of plant protective strategies in ecological plant hop production as alternatives to the application of protectives containing copper and sulphur
Fuß, S., Schätzl, J, Portner, J.	IPZ 5a	LfL information	Data collection –Business Planning in Hop Production
Portner, J.	IPZ 5a	"Green Leaflet"	Hops 2007

8.2.3 Press releases

Author(s), Work group	Title
Engelhard, B., IPZ 5	Order of the Hop awarded to Dr. Elisabeth Seigner
Engelhard, B., IPZ 5	Informative meeting for hop-growers, who are members of the Society of Hop Research.

8.2.4 Contributions in radio and television

Name /Work Group	Broad-cast on	Subject	Title of pro-gramme	Station
Engelhard, B.	28.03.07	Current research targets	TV News	IN-TV
Engelhard, B., IPZ 5	26.07.07	Objectives of hop research	Report on hops	DW-Radio
Engelhard, B., IPZ 5	04.08.07	Hops in Germany	Weekend Journal	D-Radio
Engelhard, B., IPZ 5	22.08.07	Assessing hops	Daily News	INTV
Engelhard, B., IPZ 5	22.08.07	Assessing hops	News	Bavaria 1/2 Radio
Engelhard, B., IPZ 5	28.08.07	New hop varieties	Regional studio Pfaf-fenhofen	INTV
Herz, M., IPZ 2b, Schweizer, G., IPZ 1b, Lutz, A., IPZ 5c und Seigner, E., IPZ 5c	24.04.07	Nature plus high-tech, modern plant breeding without gene technology	IQ-Science & Research	Bavaria 2 Radio

8.3 Meetings, lectures, guided tours, exhibitions

8.3.1 Conferences, symposiums and seminars

	Date/Place	Subject	Participants
Engelhard, B. , Seigner, E.	24.-29.06.07	Congress of the Scientific Commis-sion of the International Hop-Growers Convention	58 hop scientists and ex-perts from the hop and brewing industry
Weihrauch, F.; IPZ 5b	20.-21.11.07 Freising	26th Workshop of the Circle of "Useful arthropods" of the DgaaE and the DPG	Scientists and breeders of beneficial insects

8.3.2 Talks

(WG =Work Group)

WG	Name	Subject/Title	Organiser/ No. of partici-pants	Date /Place
IPZ 5	Engelhard, B., Seigner, E.	Research activities at the Hop Research Center Hüll and future perspectives	GfH (Society of Hop Research), Advisory Board Session	27.03.07, Munich
IPZ 5a	Fuß, S	Evaluation of Hop Card Index	LfL and HR/ 20 participants	14.02.2007 Koppenwall
IPZ 5a	Fuß, S	Sensor technology	LfL and company representatives	10.05.2007 Hüll
IPZ 5a	Fuß, S	Business planning in hop production	HR (ISO farms) 80 participants	05.12.2007 Aiglsbach
IPZ 5a	Fuß, S	Sensor technology	LfL and company representatives	11.12.2007 Wolnzach

WG	Name	Subject/Title	Organiser/ No. of participants	Date /Place
IPZ 5a	Fuß, S	Investment plannung	LfL and ALF LA, 18 participants	17.12.2007 Wolnzach
IPZ 5a	Münsterer, J.	Alternative sources of energy in drying hops	ALF Abensberg/130 hop-growers	30.01.2007 Elsendorf
IPZ 5a	Münsterer, J.	Alternative sources of energy in drying hops	Hop group of regulars Oberlauterbach	31.01.2007 Oberlauterbach
IPZ 5a	Münsterer, J.	Hop card index evaluation	LfL, HR, IGN / 80 hop-growers	07.02.2007 Niederlauterbach
IPZ 5a	Münsterer, J.	Hop card index evaluation	LfL, HR, IGN / 18 hop-growers	08.02.2007 Hiendorf
IPZ 5a	Münsterer, J.	Chances and economic efficiency of alternaive sources of energy	Members meeting ER Jura / 75	09.02.2007 Tettenwang
IPZ 5a	Münsterer, J.	Irrigation in hops	Advisory Board HPV / 35	13.02.2007 Wolnzach
IPZ 5a	Münsterer, J.	Irrigation in hops	HR (ISO farms) /40	22.02.2007 Elsendorf
IPZ 5a	Münsterer, J.	Reasons for high proportion of bracteoles in the variety HA	IHT / 90	12.03.2007 Mainburg
IPZ 5a	Münsterer, J	New findings in hop drying and conditioning	BayWa Tettnang/ 70	19.03.2007 Tettnang
IPZ 5a	Münsterer, J	Saving energy when drying hops	Society of Hop Research TWA/ 35	26.03.2007 Wolnzach
IPZ 5a	Münsterer, J	New findings in hop drying and conditioning	Austrian hop-growers' / 60	26.03.2007 Neudorf/ Haslach
IPZ 5a	Münsterer, J	Evaluation of hop card index and current recommendations	LfL + HR, Ring gr. Eschelbach /18	17.04.2007 Eschelbach
IPZ 5a	Münsterer, J	Pests and diseases – up-to-date control strategies	LfL + HR/ 18 Ring consultants	15.05.2007 Hüll
IPZ 5a	Münsterer, J	Alternative sources of energy and optimum air speeds in drying hops	HR (ISO farms) 80 participants	05.12.2007 Aiglsbach
IPZ 5a	Niedermeier, E.	Evaluation of hop card index	Ring group Mitterstetten	12.02.07 Mitterstetten
IPZ 5a	Niedermeier, E.	New recommendations on fertilizing with lime	Hop-grower meetings LfL, IPZ 5 / ALF	22.02.-02.03.07, 9 places
IPZ 5a	Niedermeier, E.	Plant protection in hops 2007	Hop-growers Wolnzach	16.04.07 Wolnzach

WG	Name	Subject/Title	Organiser/ No. of participants	Date /Place
IPZ 5a	Niedermeier, E.	Plant protection in hops 2007	Niederlauter Hop Syndicate	24.05.07 Niederlauterbach
IPZ 5a	Niedermeier, E.	Plant protection in hops 2007	Ring group Forchheim	19.06.07 Birkhof
IPZ 5a	Portner, J.	Costs in hop production	IGN Niederlauterbach/ 35 hop-growers	10.01.2007, Niederlauterbach
IPZ 5a	Portner, J.	Peronospora warning service – How reliable is it?	BayWa/ 20 employees	12.02.2007, Mainburg
IPZ 5a	Portner, J.	Peronospora warning service – How reliable is it?	Beiselen GmbH/ 15 participants from agric. trading firms	15.02.2007, Mainburg
IPZ 5a	Portner, J.	Peronospora warning service – How reliable is it?	Hop cultivation meetings LfL, IPZ 5/ALF	22.02.-02.03.07, 9 places
IPZ 5a	Portner, J.	Peronospora warning service – How reliable is it?	LfL + ALF LA/ 40 hop-growers	02.03.2007, Oberhatzkofen
IPZ 5a	Portner, J.	Agrarian markets in upheaval – Possible effects on the Hallertau hop location	HR Hallertau / 120 guests and hop-growers	06.03.2007, Aiglsbach
IPZ 5a	Portner, J.	Process engineering in hop-growing	FH Weihenstephan / 8 students	11.05.2007, Weihensteph.
IPZ 5a	Portner, J.	Controlling wild hops 2007	Hop-growers Assn. Hallertau / MR w. troupe (25 pers.)	14.05.2007, Hüll
IPZ 5a	Portner, J.	Latest news on plant protection	Hop Ring + LfL/ 25 hop-growers	20.06.2007, Koppenwall
IPZ 5a	Portner, J.	Controlling wild hops, campaign 2007	Hop-growers Assn. +LfL/20particpants	12.07.2007, Wolnzach
IPZ 5a	Portner, J.	Latest news on plant protective situation	ALF Roth/ 30 participants	13.07.2007, Spalt
IPZ 5a	Portner, J.	Report on the conference of the Scientific Commission of the IHGC in Tettnng and in the Hallertau	Congress des IHGC/ 120 participants	02.08.2007, Yakima (USA)
IPZ 5a	Portner, J.	Determinants and productive-technical measures to improve the quality of hops for the brewery	Congress des IHGC/ 80 participants	03.08.2007, Yakima (USA)
IPZ 5a	Portner, J.	Current situation and harvest-time	Hop Ring/ 55 participants	16.08.2007, Lurz
IPZ 5a	Portner, J.	Current situation and harvest-time	Hop Ring/ 125 participants	16.08.2007, Aiglsbach
IPZ 5a	Portner, J.	Weather conditions, growth development and special events in the hop year 2007	IGN/ 130 participants	23.08.2007, Niederlauterbach

WG	Name	Subject/Title	Organiser/ No. of participants	Date /Place
IPZ 5a	Portner, J.	Expert criticism on hops 2007	Moosburg town / 130 guests	20.09.2007, Moosburg
IPZ 5a	Portner, J.	Hop Advisory Service – Effects of the agricultural law	GfH-LfL/ 11 participants	28.11.2007, Hüll
IPZ 5a	Portner, J.	Crown rot – Causes and chances for controlling it	HVG+Hopgrowers Assn. Elbe-Saale/ 40 participants	29.11.2007, Höfgen/Grimma
IPZ 5a	Schätzl, J.	Results of trial for controlling wild hops	HVH, MR/ 25 TN	14.05.2007 Hüll
IPZ 5a	Schätzl, J	Latest news on fertilization and controlling crown rot	LfL + HR/ 17 Ring consultants	15.05.2007 Hüll
IPZ 5a	Schätzl, J.	Latest news on plant protection 2007	LfL + HR/ 16 Ring consultants	30.05.2007 Hüll
IPZ 5a	Schätzl, J.	Controlling pests and diseases 2007	LfL + HR/ 17 Ring consultants	12.06.2007 Hüll
IPZ 5a	Schätzl, J.	Latest news on plant protection 2007	LfL + HR/ 32 hop-grower	19.06.2007 Hirnkirchen
IPZ 5a	Schätzl, J.	Pests and diseases – latest control strategies	LfL + HR/ 18 Ring consultants	26.06.2007 Hüll
IPZ 5a	Schätzl, J.	Warning service, pests and diseases latest control strategies	LfL + HR/ 16 Ring consultants	10.07.2007 Hüll
IPZ 5a	Schätzl, J.	Up-to-date plant protection, measures for controlling wilt	LfL + HR/ 19 Ring consultants	24.07.2007 Hüll
IPZ 5a	Schätzl, J.	Up-to-date plant protection, final treatments	LfL+. HR/ 15 Ring consultants	07.08.2007 Hüll
IPZ 5a	Schätzl, J	Glance back on the hop season 2007	HR + LfL/ 13 Ring consultants	10.12.2007 Wolnzach
IPZ 5b	Engelhard, B. Weihrauch, F.	Results of three-year tests on controlling downy mildew in organic hop-growing	Bioland Winter Conference	07.02.2007 Plankstetten
IPZ 5b	Engelhard, B.	Plant protection in hops 2007	Baywa Table Talk	12.02.2007 Mainburg
IPZ 5b	Engelhard, B.	Plant protection in hops 2007	Rural trading firms	15.02.2007 Mainburg
IPZ 5b	Engelhard, B.	Plant protection in hops 2007	Hop cultivation meetings LfL, IPZ 5/ALF	22.02.-02.03.07, 9 places
IPZ 5b	Engelhard, B. Weihrauch, F.	Controlling aphids and downy mildew in organic hop-growing	LfL Organic Farming Day 2007	07.03.2007 Freising
IPZ 5b	Engelhard, B.	Sustainably safeguarding plant protectives in hops	IGN	24.05.07, Niederlauterbach
IPZ 5b	Engelhard, B.	Standard ranges of the application of pesticides in hops – a proposal for the EPPO guidelines	Congress of the Scien. Commission Tettnang, 58 Pers.	27.06.07, Tettnang

WG	Name	Subject/Title	Organiser/ No. of participants	Date /Place
IPZ 5b	Engelhard, B.	Is the availability of licensed plant protectives in hops sustainably safeguarded?	IGN – 20 years	23.08.07, Niederlauterbach
IPZ 5b	Engelhard, B.	Plant protective licensing for the integrated plant protection in German hop production	VdH/Parlamentary Evening	06.11.07 Berlin
IPZ 5b	Weihrauch, F.	Controlling aphids in organic hop farms	GfH - TWA	26.03.07 Freising
IPZ 5b	Weihrauch, F.	Trials to attract lacewings in the special crop hops: Status quo	9th Workshop of German-speaking neuropterologists	28.04.07 Rödelsee - Schloß Schwanberg
IPZ 5b	Weihrauch, F.	The bibliography of the Working Group „Neuropteren“ , Version 1.0	9th Workshop of German-speaking neuropterologists	29.04.07 Rödelsee - Schloß Schwanberg
IPZ 5b	Weihrauch, F.	An ancient compound rediscovered: perspectives for aphid control in organic hop growing by using quassia products	Congress of the Scien. Commission Tettnang, 58 pers.	27.06.07, Tettnang
IPZ 5b	Weihrauch, F.	Using quassia to control the hop aphid Phorodon humuli in the special crop hops: status quo	12th Expert Discussion "Plant protection in organic farming"	27.09.07 BBA Braunschweig
IPZ 5b	Weihrauch, F.	Controlling spider mites by predator mites in the special crop hops	26th AGM of the Work Circle "Beneficial arthropodes" of the DPG and DGaaE	20.11.07 Freising
IPZ 5c	Lutz, A.	First experience in growing Herkules	Hop cultivation meetings LfL IPZ 5/ALF	22.02.-02.03.07, 9 places
IPZ 5c	Lutz, A.	Patent applications for hop breeding – an internet investigation	Tech. –Scientific Committee of GfH	26.03.07, Wolnzach
IPZ 5c	Lutz, A.	Hop quality – cone monitoring	Old Weihenstephaner Brewers' Assn. a. 40 pers.	07.11.07, Freising
IPZ 5c	Seefelder, S.	Up-to-date results from the hop genome analysis	Tech. –Scientific Committee of GfH	26.03.07, Wolnzach
IPZ 5c	Seefelder, S.	Development of molecular selection markers for mildew resistence for stüteffective support for breeding quality hops	Agrarian committee of the Federation of German Brewers	28.08.07 Hüll
IPZ 5c	Seidenberger, R.	Development of molecular markers linked to powdery mildew resistance genes in hops to support breeding for resistance	EHRC (European Hop Research Council)	19.01.07, Freising
IPZ 5c	Seidenberger, R.	cDNA-AFLP markers for powdery mildew resistance in hops	Congress of the Scien. Commission	26.06.07, Tettnang

WG	Name	Subject/Title	Organiser/ No. of partici-pants	Date /Place
			Tettnang, 58 pers.	
IPZ 5c	Seidenberger, R.	Development of molecular markers linked to powdery mildew resistance genes in hops to support breeding for resistance – current results	EHRC (European Hop Research Council)	27.09.07, Hüll
IPZ 5c	Seigner, E.	Perspectives for the future in genome analysis in hop	EHRC (European Hop Research Council)	19.01.07, Freising
IPZ 5c	Seigner, E.	Mildew isolates and leaf resistance test as the basis for the mildew resistance breed-ing in hops	Scientific Station for Brewing in Munich, 50 pers.	20.03.07, München
IPZ 5c	Seigner, E.	Production of powdery mildew resistant hops via gene transfer	Congress of the Scien. Commission Tettnang, 58 pers	26.06.07, Tettnang
IPZ 5c	Seigner, E.	Utilisation of genetic resources in breed-ing programmes at the Hop Research Center Hüll	Genetic Plant Re-sources	19.09.07, Zatec, Tschechien
IPZ 5c	Seigner, E.	Research objectives up until 2020 at the Hop Research Center Hüll	GfH (Society of Hop Research), Advisory Board meeting	27.09.07, Hüll
IPZ 5c	Seigner, E.	Improving fungal resistance in hops via gene transfer	Supervisory Board Meeting of HVG Hop Cooperative	15.10.07, Wolnzach
IPZ 5c	Seigner, E.	Breeding improvement in hops as a me-dicinal plant – crossing in breeding to adapt the hop components	Symposium "Hops – a special sub-stance", Hallertau TourismAssn. 80 Pers.	09.11.07 Wolnzach
IPZ 5d	Kammhuber, K.	The significance of the hop components for brewing beer and for health	LfL Colloquium	30.01.07 Freising
IPZ 5d	Kammhuber, K.	Differentiating between the world hop range according to alpha-acids and poly-phenoles and their influence on the qual-ity of the beer	Techn. – Scientific. Study Group of the GfH	26.03.07 Wolnzach
IPZ 5d	Kammhuber, K.	Survey on the hop components, their significance and analytics	Hop Tour (Ministers Seehofer and Miller)	28.08.07, Hüll

8.3.3 Guided Tours

(WG = Work Groups; NP = No. of participants)

WG	Name	Date	Subject/Title	Visiting institution	NP
IPZ 5	Engelhard, B. Kammhuber, K.	29.03.07	From organic hops to gene transfer	Teachers' Academy in Dillingen	17
IPZ 5	Engelhard, B.	17.04.07	Hop research	Team assistents IPZ 5	12
IPZ 5	Engelhard, B. Weihrauch, F.	19.04.07	Bavarian hop research	Master Brewers' College in Ulm	15
IPZ 5	Engelhard B.,	08.05.07	Hop research	Prof. Keller, VSE AG	3
IPZ 5	Engelhard B., Seigner E., Lutz A., Kammhuber K.	14.05.07	Up-to-date hop research	Anheuser-Busch	2
IPZ 5	Engelhard B.,	30.05.07	Hop research	Kindinger (old)-hop farmers	40
IPZ 5	Engelhard B., Kammhuber K.,	31.05.07	Hop research, hop cultivation	Tech. College for Agrarian Science, Bingen	38
IPZ 5	Seigner, E.	12.06.07	Hop research at Hüll	Russian delegation, HVG	3
IPZ 5	Engelhard B., Kammhuber K.,	19.06.07	Hop research	LfL, AFR	20
IPZ 5	Kammhuber, K.	28.06.07	Chemical analysis in hops at Hüll	Participants at the Congress of the Scientific Commission	26
IPZ 5	Seigner, E., Lutz, A.., Kammhuber, K., Weihrauch, F.	05.07.07	Hop research in Hüll	AQU	5
IPZ 5	Engelhard B., Weihrauch F.	10.07.07 /11.07.07	Plant protection near water	UBA	12
IPZ 5	Engelhard B.,	20.07.07	Hop research	STMLF, Abt. L	14
IPZ 5	Engelhard, B., Kammhuber, K. Lutz, A., Seigner, E.	27.07.07	Hop research at Hüll	GfH –Advisory Board	16
IPZ 5	Engelhard B.	17.08.07	Hop inspection	Hop-growers and guests from seal-district HEB	45
IPZ 5	Engelhard B., Seigner E., Portner J., Lutz A.,	28.08.07	Hop tour	District of Pfaffenhofen	ca. 200
IPZ 5	Engelhard B.,	31.08.07	Hop Research	VHS Hop Weeks	55

WG	Name	Date	Subject/Title	Visiting institution	NP
IPZ 5	Engelhard B., Portner J., Münste-rer J.,	04.09.07	Hop farms in the Hallertau	Colleagues from Zatec	8
IPZ 5	Engelhard B., Kammhuber K., Lutz A.	05.09.07	Hop varieties – Hop re-search	HVG + Swedish brewers	4
IPZ 5	Engelhard B., Seigner E., Kammhuber K., Lutz A.	27.09.07	Hop research	HVG Advisory Board (brewers)	12
IPZ 5	Engelhard B. Seigner E.	18.10.07	Quality hops for excellent beer	Boston-Brewery USA (Filming)	10
IPZ 5	Engelhard B. Lutz A. Kammhuber K.	19.11.07	Hop research	BMELV, BayStMLF, HVG	5
IPZ 5	Engelhard B, Weihrauch F. Kammhuber K.	23.11.07	Hop research	Rotarians Morbach	15
IPZ 5	Engelhard, B. Lutz, A Kammhuber K.	11.12.07	Hop research Hüll	Zhujiang Brewery, China	6
IPZ 5	Seigner, E., Kammhuber, K.	11.07 07	Hop Research Center	Ms. Bauer, Head of AFL Abendberg	1
IPZ 5	Engelhard, B., Seigner, E., Kammhuber, K.	17.07 07	Hop Research Center Hüll	Students of the WZW, Chair for Brewing Technology I, PD Dr. Krottenthaler	13
IPZ 5a	Niedermeier, E.	15.06.07	Protecting ground water with N-fertilizer in hop-growing	Hop-growers in the drinking-water protection area Zwv.Au	11
IPZ 5a	Niedermeier, E.	19.06.07	Up-to-date plant protection and checking hop stands	Ring group Jura	36
IPZ 5a	Schätzl, J.	28.06.07	Up-to-date plant protection and checking hop stands	Ring group Mainburg	68
IPZ 5a	Niedermeier, E.	11.07.07	Trial inspection and up-to-date plant protection	Hop Syndicate Niederlauterbach (IGN)	32
IPZ 5a	Schätzl, J.	27.07.07	Up-to-date plant protection and checking hop stands	Ring group Eberstetten	24
IPZ 5a	Niedermeier, E.	02.08.07	Field inspection	Representatives of Geisenfeld council	42
IPZ 5a	Niedermeier, E.	07.08.07	Field inspection	Wolnzach hop-growers	17
IPZ 5a	Portner, J.	07.08.07	Tour of trial plots	VLF Landshut	20
IPZ 5a	Portner, J.	07.08.07	Tour of trial plots	Ring of young hop-growers	110
IPZ 5a	Schätzl, J.	08.08.07	Field inspection and u-to-date plant protection	Hop-growers, district of Freising	78
IPZ 5a	Portner, J.	10.08.07	Tour of trial plots	VLF Kelheim	60

WG	Name	Date	Subject/Title	Visiting institution	NP
IPZ 5a	Portner, J. Niedermeier, E.	23.08.07	Excursion to the hop stands	Hop Syndicate Niederlauterbach (IGN)	100
IPZ 5a	Portner, J.	04.09.07	Farm tours	Czech Hop Research Institute	8
IPZ 5b	Engelhard, B. Weihrauch, F., Lutz A.	02.05.07	Plant protection in hops	Carl-Orff Grammar School Unterschleißheim	36
IPZ 5b	Engelhard, B., Weihrauch, F.	28.06.07	Plant Protection in hops at the Hop Research Center Hüll	Participants at the Congress of the Scientific Commission	26
IPZ 5b	Weihrauch, F. Schwarz, J. Meyr, G.	05.07.07	Plant protection in hops	Belchim	15
IPZ 5b	Weihrauch, F.	11.07.07	Field inspection	IG Niederlauterbach	35
IPZ 5b	Engelhard B., Weihrauch F.,	27.07.07	Plant protection in organic hop-growing	IAB, Organic H. Wiesinger	1
IPZ 5b	Engelhard B., Weihrauch F., Schwarz J., Münsterer J.,	31.07.07	Plant protection in organic hop-growing, irrigation	AG Organic hop farmers	20
IPZ 5b	Engelhard B.,	30.08.07	Plant protection trials	Bayer AgrarScience	12
IPZ 5c	Miehle, Helga	23.01.07	Gene transfer in hops	Regional Assn. of Young Farmers	18
IPZ 5c	Lutz, A., Seigner, E.	6.02.07	Hop breeding programme at the Hop Research Center Hüll	Boston Beer Company, Barth	5
IPZ 5c	Seigner, E.	07.03.07	Hop breeding and gene transfer	Agricultural College	35
IPZ 5c	Seigner, E.	29.03.07	Genome analysis in hops	Carlsberg Breweries, Hopsteiner	2
IPZ 5c	Engelhard B., Seigner E., Lutz A.,	29.05.07	Hop breeding	Jens Eicken –Jakobsen Brewery, DK	2
IPZ 5c	Lutz, A..	13.06.07	Hop breeding in Hüll	Dr. A. Haunold, USA and escort	2
IPZ 5c	Lutz, A,	28.06.07	Hop Breeding at the Hop Research Center Hüll	Participants at the Congress of the Scien. Commission	26
IPZ 5c	Seigner, E.	28.06.07	Biotechnology and gene transfer in hops in Freising	Participants at the Congress of the Scien. Commission	26
IPZ 5c	Lutz, A.	05.07.07	Breeding research in Hüll	Belchim Crop Protection	10
IPZ 5c	Kneidl, J.	09.07.07	Breeding research in Hüll	Anheuser-Busch	4
IPZ 5c	Lutz, A.	10.07.07	Varieties bred in Hüll and research work at the Hop Research Center in Hüll	Bauer tea company	1
IPZ 5c	Lutz, A.	11.07.07	Hop breeding in Hüll	11th grade, Traunstein Grammar School	50

WG	Name	Date	Subject/Title	Visiting institution	NP
IPZ 5c	Seigner, E.	08.08.07	Hop Research at the LfL	Quilmes, Argentinia	1
IPZ 5c	Lutz, A.	14.08.07	Varieties and lines bred at the Hop Research Center in Hüll	Hop-growers of the Society of Hop Research	40
IPZ 5c	Lutz, A.	21.08.07	Hop-growing in low-trellis yards	Sapporo Breweries, Japan	1
IPZ 5c	Lutz, A., Seigner, E.	21.08.07	Hop breeding at Hüll	SAB-Miller, South Africa	1
IPZ 5c	Seigner, E.	22.08.07	Genetic engineering in hops	US Delegation, BMELV, StMLF	6
IPZ 5c IPZ 5d	Lutz, A.., Kammhuber, K.	17.01.07	Varieties bred and their properties in beer	S. Loch-Ahring,Veltins and hop-growers	2
IPZ 5d	Kammhuber, K.	06.02.07	Chemical analysis of hops	Boston Beer Company, Barth	5

8.3.4 Exhibitions and posters

(WG =Work Group)

Event, Place	Ausstellungsobjekte/ -projekte bzw. Posterthemen	Organiser	Termin	WG
St. George's Day,	Hop yard/hop breeding, hop varieties	INCity	21.04.2007	IPZ 5
EBC-Congress, Venice	Development of molecular markers linked to powdery mildew resistance genes in hops to support breeding for resistance	EBC (European Brewery Convention)	06-10.05.07	IPZ 5c
Congress of the Scientific Commission of the Breweries	Wild hops – new sources for resistance to powdery mildew	Scientific Commission (WK) of the International Hop Growers' Convention (IHGC)	24.-28.06.07	IPZ 5c, IPZ 5d
	Genome analysis – an important tool to support classical hop breeding			
	The biosynthesis of the bitter acids in hops			
Utilisation of Plant Genetic Resources, Zatec, Czech Republic	Wild hop collection: A valuable germplasm resource for improving resistance to powdery mildew	Hop Research Institute Zatec	19.-20.09.07	IPZ 5c

8.4 Training and further education

Name, Work Group	Title	Participants
Portner, J., IPZ 5a	Drying and conditioning of hops	Students in the 3rd semester at the Agricultural College in Pfaffenhofen
Portner, J., IPZ 5a	Peronospora (downy mildew)	Students in the 1st semester at the Agricultural College in Pfaffenhofen
Portner, J., IPZ 5a	Low trellis system; PS-Application technique in hop-growing	Students in the 3rd semester at the Agricultural College in Pfaffenhofen
Portner, J., IPZ 5a	Botrytis and powdery mildew	Students in the 1st semester at the Agricultural College in Pfaffenhofen
Portner, J., IPZ 5a	Hop wilt	Students in the 1st semester at the Agricultural College in Pfaffenhofen
Portner, J., IPZ 5a	Lesser pests and hop aphids	Students in the 1st semester at the Agricultural College in Pfaffenhofen
Portner, J., IPZ 5a	Common spider mite Good expert practice in plant protection	Students in the 1st semester at the Agricultural College in Pfaffenhofen
Portner, J., IPZ 5a	Escorting and evaluating work projects in hop-growing within the framework of the Master Brewer examination	7 candidates for the Master Brewer diploma
Portner, J., IPZ 5a	Hop varieties	Students in the 1st semester at the Agricultural College in Pfaffenhofen
Schätzl, J., IPZ 5a	Peronospora warning service, pests and diseases and current spray options	BILA participants, trainees on the job
Schätzl, J., IPZ 5a	Pests and diseases, up-to-date plant protection, warning service	Students in the 2nd semester at the Agricultural College in Pfaffenhofen
Schätzl, J., IPZ 5a	Hop-growing subject for examinees from the districts of PAF and FS	Trainees (emphasis on hop-growing)
Miehle, H., IPZ 5c	In-vitro culture and gene technology in hops	Vanessa Bockhorni, University of Technology, Sydney
Seefelder, S. IPZ 5c	Methods in the genome analysis	Practical training Daniela Prestele
Seefelder, S. IPZ 5c	Methods in the genome analysis	Practical training Martina Fuchs
Seefelder, S. IPZ 5c	Methods in the genome analysis	Training for laboratory chemist, Stefanie Nadler

8.5 Diploma theses

AG	Name	Subject/Title Diploma thesis	Period	Partner at the LfL, cooperation
IPZ 5a	Weingart, Florian	Developing the structure of the Hallertauer hop farms and the effects on hop marketing	Nov. 06 – June 07	J. Portner, FH Weihenstephan Prof. Dr. Gerschau
IPZ 5a	Eichinger, Bernhard	"Training hops" – Status of the technique and alternative methods	April 07 – October 07	J. Portner, FH Weihenstephan Prof. Dr. Bauer

8.6 Participation in work groups

Name	Memberships
Engelhard, B.	• Scientific Commission in the International Hop-Growers Convention (Chairman) • Member of the German Phytomedical Society
Kammhuber, K.	• Analysis Committee of the European Brewery Convention (Hops Sub-Committee) • Work Group for Hop Analytics (AHA)
Portner, J.	Expert Advisor Equipment Acceptance Process for the evaluation of plant protection equipment and expert for application technology at the BBA
Seefelder, S.	• Society of Hop Research e. V. • Society for Plant Breeding e. V. • LfL-KG public relations (from Sept. 2007 onwards)
Seigner, E.	• Secretary: Scientific Commission of the International Hop Growers' Convention Editorial Board of the "Hop Bulletin", Institute for Hop Research & Brewing, Zalec, Slovenia • Society for Plant Breeding e. V. • LfL-KG PR work (until Sept.. 2007)
Weihrauch, F.	• Working Group of the Bavarian Entomologists e.V. • German Society for Orthopterology e. V. • Society of German-speaking Odonatologists e. V. (Member of the Executive) • Society for Tropical Ecology e. V. • Munich Entomologic Society e.V. • Society for the Protection of Dragonflies in Baden-Wurttemberg e.V • Worldwide Dragonfly Association • Red List Work groups for the Grasshoppers and Dragonflies pf Bavaria of the Bavarian State Office for Environmental Protection • Editor of the magazine "Libellula"

8.7 Honours and awards

8.7.1 Awards

Jutta Kneidl, IPZ 5c, anniversary of 25 years' service, 01.09.07

Herfried Hesse, IPZ 5b, anniversary of 40 years' service, 01.05.07

8.7.2 Honours award

Dr. Elisabeth Seigner, awarded the Hop Order of the International Hop Growers' Convention, 27.06.2007

9 Current research projects financed by third party funds

(WG = Work Group)

WG Projektleiter	Project	Duration	Sponsored by	Cooperation
IPZ 5b B. Engelhard	Development of an innovative prognosis model to control powdery mildew (*podosphaera macularis*) in hops	2007-2009	BLE (Federal Institute for Food & Agriculture); Erzeugergemeinschaft Hopfen HGV (producer group)	Christian-Albrecht-Universität, Kiel; Hopfenring Hallertau; Society of Hop Research (GfH); 8 hop farms;
IPZ 5b/IPZ 5c B. Engelhard	Development of a test system to test the aphid resistance on hop seedlings within the bounds of hop breeding	2005-2008	Erzeugergemeinschaft HVG(producer group) Anheuser-Busch GfH (Society of Hop Research)	
IPZ 5b B. Engelhard	Trial to establish the predator mite *typhlodromus pyri* in a hop yard in the Hallertau for the natural control of the common spider mite Spinnmilbe	2005-2007	Anheuser-Busch	Obster Farm, Buch
IPZ 5b B. Engelhard	Research on luring antagonists for hop aphid and spider mite antagonists	2005-2007	Anheuser-Busch	Swedish University of Agricult. Sciences, Alnarp, Schweden; Rothamstead Research, UK, Obster Farm, Buch
IPZ 5b B. Engelhard	Use of entomopathogenic nematodes (EPN) for the biological control of the alfalfa weevil *otiorhynchus ligustici* in hops	2005-2007	Erzeugergemeinschaft Hopfen HVG, (producer group) GfH (Society of Hop Research)	2 hop farms
IPZ 5c Dr. Seefelder Dr. Seigner	Development of molecular selection markers for ntwicklung molekularer mildew resistance for effective support in breeding quality hops	2006-2007	Scientific Fund of the German Brewing Industry e.V.	EpiLogic

WG Projektleiter	Project	Duration	Sponsored by	Cooperation
IPZ 5c Dr. Seigner A. Lutz	Breeding resistant hops especially suitable for production in low-trellis yards	2007-2010	BLE (Federal Institute for Food & Agriculture); GfH (Society of Hop Research)	Betriebe J. Schrag und M. Mauermeier; GfH
IPZ 5c Dr. Seigner A. Lutz S. Seefelder	Mildew isolates and leaf resistance test in the laboratory as a basis for breeding mildew resistance in hops	2006-2009	Scientific Station for Brewing in Munich e.V.	EpiLogic
IPZ 5c Dr. Seefelder Dr. Seigner	Analysis of QTLs for α-and ß-acids, cohumulone, xanthohumol and yield	2002-2007	Hopsteiner	IPZ 5d
IPZ 5c Dr. Seefelder Dr. Seigner	Development of molecular markers linked to powdery mildew resistance genes in hops	2004-2008	Europ. Hop Research Council (EHRC)	EpiLogic
IPZ 5c Dr. Seigner, Dr. Miehle	Gene transfer in economically relevant hop varieties to improve fungal resistance	2005-2007	StMLF, Erzeugergemeinschaft HVG (Producer Group)	EpiLogic

10 Personnel IPZ 5 – Hops Department-

The following staff were employed at the Bavarian State Research Center for Agriculture (Lfl) – Institute for Crop Science and Plant Breeding – at Hüll / Wolnzach in 2007:

WG = Work Group

IPZ 5

Coordinator: Engelhard Bernhard

Dandl Maximilian
Felsl Maria (from 01.02.2007)
Graßl Christine (from 18.06.2007 until 19.10.2007)
Hertwig Alexandra (from 01.02.2007)
Hock Elfriede
Krenauer Birgit (from 01.02.2007)
Maier Margret
Mauermeier Michael
Pflügl Ursula
Presl Irmgard
Suchostawski Christa
Waldinger Josef
Weiher Johann

IPZ 5a

WG Hop Cultivation, Production Techniques

Portner Johann

Heilmeier Rosa
Münsterer Jakob
Niedermeier Erich
Schätzl Johann
Fuß Stefan

IPZ 5b

WG Plant Protection in hop-growing

Engelhard Bernhard

Ehrenstraßer Olga
Hesse Herfried
Meyr Georg
Schlagenhaufer Stefan (from 01.05.2007)
Schwarz Johannes
Dr. Weihrauch Florian

IPZ 5c

WG Breeding Research - Hops

Dr. Seigner Elisabeth

Bogenrieder Anton (from10.04.2007)
Ehm Katharina
Hager Petra
Kneidl Jutta
Lutz Anton
Marchetti Sabine (until 31.07.2007)
Mayer Veronika
Dr. Miehle Helga (until 30.06.2007)
Petosic Sabrina (from 01.07.2007)
Seidenberger Rebecca (from 15.01.2007)
Dr. Seefelder Stefan

IPZ 5d

WG Hop Quality and Analytics

Dr. Kammhuber Klaus

Neuhof-Buckl Evi
Petzina Cornelia
Weihrauch Silvia
Wyschkon Birgit