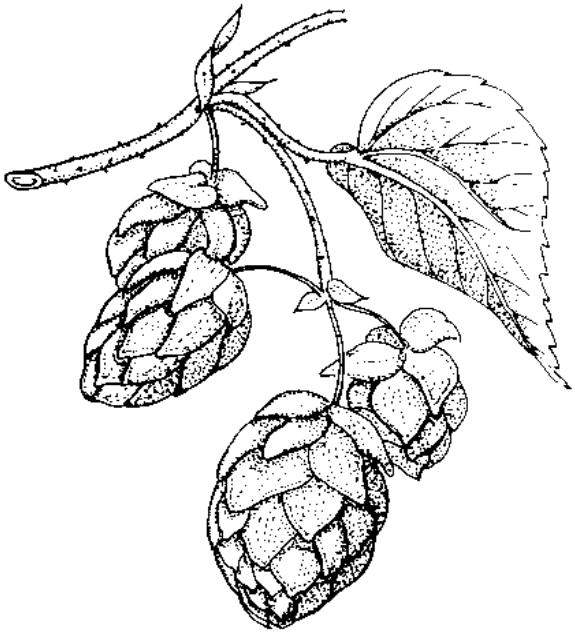
Bayerische Landesanstalt für Landwirtschaft

Gesellschaft für Hopfenforschung

Annual Report 2006
Special Crops - Hops



Bavarian State Research Center for Agriculture

- Institute for Crop Science and Plant Breeding -

and the

Society of Hop Research

March 2007

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Instead of the preface a letter to the Society for Hop Research from Minister of State Josef Miller:

To the
Society of Hop Research e.V.
Hüll 5 1/3
85283 Wolnzach

Munich, 17 Nov.2006

Dear Mr. Doetsch, Chairman
Dear Dr. Schmucker, Manager

On the 80th anniversary of the Society for Hop Research I should like to take this opportunity to express my hearty thanks for the Society's outstanding work for the benefit of the hop and brewing industry. These achievements were presented in a striking way during the Hop Tour in August this year.

With its extremely successful work all around hops the Hop Research Center in Hüll has set worldwide acknowledged standards. Thus in only a few years the bitter variety "Hallertauer Magnum" bred at the Hüll Institute with at present around 5000 hectares advanced to become the most important hop variety in the world. But also the spectrum of the Hüll aroma varieties is equally held in high esteem by corporate groups as well as by small breweries for brewing various types of beer. Altogether almost 30 % of the world hop production today originates from the varieties bred in Hüll. The development shows that this proportion will continue to increase in the future. The responsible use of plant protectives based on the latest scientific findings is an important prerequisite for producing the high quality hops which are in demand worldwide and which are exported to more than 150 countries all over the world.
Here too the basis is created with innovative research at the Hop Research Center in Hüll.
The key for this successful work is found in the link between the Free State of Bavaria and the Society for Hop Research which has been laid down in a cooperation contract since 1975. This is a prime example for an exemplary, very successful Public Private Partnership.
Within the framework of this cooperation the Free State of Bavaria has an annual commitment to provide funds amounting to approx. 1.4 million euros for costs of materials and staff engaged in hop research in Hüll.
I am certain that also in the future the necessary funds will be made available by the Free State of Bavaria; at the same time I presume that the Society for Hop Research will also maintain its hitherto high contribution to financing the current research work.

It is my wish that this successful cooperation is continued to the benefit of the hop and brewing industry and will continue to exist for a long time.

Yours sincerely,

Josef Miller

Contents

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

1.1 Current research projects

Wild hops – new genetic resources in breeding for powdery mildew resistance

Sponsored by: Bayerische Landesanstalt for Landwirtschaft,
(Bavarian State Research Center for Agriculture)
Institut for Pflanzenbau and Pflanzenzüchtung
(Institute for Crop Science and Plant Breeding)

Financed by: Wissenschaftliche Station für Brauerei in München.V.
(Scientific Station for Brewing in Munich)

Project Manager: ORRin Dr. E. Seigner, LA A. Lutz

Cooperation: Dr. F. Felsenstein, EpiLogic GmbH Agrarbiologische Forschung and Beratung, Freising

Working on project: LA A. Lutz, LTA J. Kneidl; S. Hasyn (EpiLogic)

Duration: 01.03.2003 –30.04.2006

Target:

The target for this project was to identify new hitherto unknown resistances in the wild hop gene pool. These new, still fully effective powdery mildew (PM) resistance genes are to be used for crossing and widening the genetic basis in the Hüll breeding material.

Results:

- More than 15,000 wild hops have been tested in the greenhouse and in the laboratory for their PM resistance. For the test in the greenhouse PM races were used which represent the virulence spectrum of the PM populations (with the virulence genes *v3, v4, v6, Vb)* predominant in the Hallertau. In the laboratory the reaction of the wild hops to two English isolates of the *v1-, v2-* and *v5-* virulence type was examined.
- Up until 2006 it was possible to select 54 wild hops which have proved to be resistant to all PM races (*v1, v2, v3, v4, v5, v6, vB*) used so far for testing in the greenhouse and in the laboratory.
- Some wild hops have already been used as crossing partners in order to anchor the new resistances in the Hüll breeding material.
- Molecular selection markers will be worked out for the resistance gene of two wild hops in order to screen for PM resistance in a more reliable and rapid way .

Publication:

Seigner, E., Lutz, A. and F.G. Felsenstein. (2006): Wild hops – New genetic resources for resistance to hop powdery mildew (*Podosphaera macularis ssp. humuli*). Monatsschrift für Brauwissenschaft, July/August 2006 (59), 122-129.

Powdery mildew isolates and leaf resistance test in the laboratory as basis for breeding PM resistance in hops

Sponsored by: Bayerische Landesanstalt for Landwirtschaft,
(Bavarian State Research Center for Agriculture)
Institut for Pflanzenbau and Pflanzenzüchtung
(Institute for Crop Science and Plant Breeding)

Financed by: Wissenschaftliche Station for Brauerei in München e.V.
(Scientific Station for Brewing in Munich)

Project Manager: ORRin Dr. E. Seigner, LA A. Lutz, Dr. S. Seefelder

Cooperation: Dr. F. Felsenstein, EpiLogic GmbH Agrarbiologische Forschung and Beratung, Freising

Working on project: LA A. Lutz, LTA J. Kneidl; S. Hasyn (EpiLogic), Dr. S. Seefelder

Duration: 01.05.2006 –30.04.2009

Target:

The PM isolates and the detached leaf system, which are used to test for PM in wild hops are also used in many other issues concerning the powdery mildew. They have become decisive "pillars" for successful resistance breeding at the Hop Research Center in Hüll.

Results:

At present there is a range of 12 different monosporic isolates of *Podosphaera macularis ssp. humuli* available as inoculation material with characterized virulence properties. This range of PM pathotypes allows testing on all resistance genes known up to now and used in breeding hops.

Thus in 2006 the PM isolates were used for the following problems or tests:

- Providing 4 different PM isolates for resistance testing in the greenhouse, which cover the virulence spectrum of the races prevalent in the Hallertau
- In judging the resistance properties of 107 wild hops, 182 breeding lines and 4 foreign varieties in the greenhouse and in the laboratory using the detached leaf assay
- For the reliable resistance assessment of 670 seedlings from 5 mapping populations in order to develop molecular markers for PM resistance
- In 45 analyses for the gene expression after inoculation with special PM isolates with 2 different resistances. 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 hop resistances in specific hop growing regions
- For reliable testing of 11 transgene hops

Working out an effective method of producing fungus-resistant hops via gene transfer

Sponsored by: Bayerische Landesanstalt for Landwirtschaft,
(Bavarian State Research Center for Agriculture)
Institut for Pflanzenbau and Pflanzenzüchtung
(Institute for Crop Science and Plant Breeding)

Financed by: Erzeugergemeinschaft Hopfen HVG e.G. *(Hop Producer Group)*
Bayerisches Staatsministerium for Landwirtschaft and Forsten
(Bavarian State Ministry for Agriculture & Forestry)

Project Manager: ORRin Dr. E. Seigner, Dr. H. Miehle

Working on project: Dr. H. Miehle, S. Marchetti, P. Hartberger until 05.07.06,
K. Ehm from 01.08.06 onwards

Duration: 01.01.2005 – 31.12.2007

Target:

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

Results:

- PCR protocols for four bacterial chitinase genes were further optimised: two of the bacterial chitinases have already been cloned and transfered into two hop varieties. At the same time an improved regeneration ability could be established especially in the case of the variety "Hallertauer Mittelfrüher". Infection tests are to follow on here during the coming months. The other two chitinases are still in the cloning process.
- The sequences of the two V*erticillium* resistance genes do not correspond repeatedly with the published sequences despite changed DNA material several times. Therefore this work was not continued.

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

Sponsored by:	Bayerische Landesanstalt for Landwirtschaft, *(Bavarian State Research Center for Agriculture)* Institut for Pflanzenbau and Pflanzenzüchtung *(Institute for Crop Science and Plant Breeding)*
Financed by:	Wissenschaftsförderung der Deutschen Brauwirtschaft e. V.
Project Manager:	Dr. S. Seefelder
Cooperation:	Dr. F. Felsenstein, EpiLogic, Agrarbiol.Forschung & Beratung,Freising
Working on project:	Dr. S. Seefelder, LTA P. Hager (geb. Bauer), CL V. Mayer, LA A. Lutz, LTA J. Kneidl, Dr. E. Seigner
Duration:	01.01.2006- 31.12.2007

Target:

Working out molecular selection markers to speed up the PM resistance breeding. Expression studies to identify genes involved in the resistance reaction of ´Wye Target`.

Results:

- Carrying out a "bulk segregant analysis" with the mapping populations 84/8/24 (R2) x 98/44/49, ´Buket` x 98/27/731 (R2) and ´Wye Target` (R2) x WH18/097/003. Using an AFLP enzyme system Pst-MseI in addition to the well established EcoRI-MseI-System. Besides being able to identify resistance markers in hitherto undetected gene regions a new enzyme system also offers the chance in the planned mapping to minimise the undesirable "clustering" of many markers in a very close gene region. So far 12 DNA resistance markers have been identified with 15 Pst-Mse-AFLP primer combinations. With one primer combination the PM resistance could be confirmed and at the same time it was possible to detect the sex of the seedlings. Mapping to test the quality of the markers is to be carried out in the near future.
- Successful verification of resistance markers by means of male and female breeding lines. The suitability of these PM resistance markers in practice was confirmed.
- Testing a "differentiated gene expression" after inoculation with PM spores. For this the cDNA of ´Wye Target` plants was screened after infection with a virulent isolate against cDNA of ´Wye Target` following inoculation with an avirulent isolate with altogether 50 AFLP-primer combinations. At the present time changes are being evaluated in the expression pattern of plants before and after contact (induced resistance reaction) with the PM fungus and differences between the "still effective" and "overcome" ´Wye Target` resistance.

Publications:

Seefelder, S. (2006): Gene diagnostic methods to improve the powdery mildew resistance in hops –An example for applied research at the Bavarian Institute for Agriculture. Brauwelt No. 17, 483.

Seefelder, S., Lutz, A. and Seigner, E. (2006): Development of molecular markers for powdery mildew resistance to support breeding for high quality hops. Monatsschrift for Brauwissenschaft, May/June 2006 (59), 100-104.

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

Sponsored by:	Bayerische Landesanstalt for Landwirtschaft, *(Bavarian State Research Center for Agriculture)* Institut for Pflanzenbau and 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
Working on project:	Dr. S. Seefelder, LTA P. Hager (née Bauer), CL V. Mayer, LTA J. Kneidl, LA A. Lutz , Dr. E. Seigner
Duration:	01.05.2002- 31.12.2007

Target:

The target of this research project is to identify DNA markers for components relevant to brewing. Apart from that efforts are being made to describe in molecular terms the agronomic properties valuable for breeding such as e.g. yield and cone form.

Results:

- The basis for this project is a mapping population from the crossing ´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 three replications.
- In the trial year 2006 each individual has been harvested and at least two hop samples obtained from each plant for the chemical analyses.
- In addition to this, important phenotypical data was gained from 1,112 hop samples.
- Starting from 786 AFLPs and 26 microsatellites a male and a female genetic map has been constructed.
- The chemical data for the crop samples 2004 and 2005 were obtained by HLPC.
- At present all data are being evaluated before beginning with the QTL calculation.
- The chemical data for the 2006 crop samples will be available shortly.

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

Sponsored by:	Bayerische Landesanstalt for Landwirtschaft, *(Bavarian State Research Center for Agriculture)* Institut for Pflanzenbau and 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
Working on project:	R. Seidenberger (née Schürmer), Dr. S. Seefelder, LA A. Lutz, LTA J. Kneidl, Dr. E. Seigner
Cooperation:	Dr. F. Felsenstein, EpiLogic GmbH Agrarbiologische Forschung and Beratung, Freising Dr. S. Mikolajewski, IPZ 1b
Duration:	01.12.2004 – 30.04.2008

Target:

The target 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 resistance data for 5 different mapping populations it is assumed that in each case a single major gene is involved in the PM resistance of the two wild hops WH 18 and Jap-C845.

- Starting from a "bulk segregant analysis" two AFLP markers closely linked with the resistance could be identified for the resistance of the Japanese wild hop (Jap-C845) and for the resistance of the wild hop WH 18.

- For the analysis of the cDNA-AFLPs expressed in the resistance reaction frist of all a protocol was worked out for the effective, careful extraction of RNA from hop tissue.

- Research is at present being carried out for the "differential genetic expression" following inoculation with PM spores. Starting with a cDNA-AFLP analysis a search will be made for differentially expressed genetic sequences between plants with and without PMcontact. At the same time it is assumed that after being inoculated with PM resistant plants activate special genes for defense.

- The first findings on cDNA-AFLPs are available at the end of 2006, which possibly play a part in recognising and/or defending the pathogene due to their expression cinetic and their homology to known resistance genes in other crops.

Research on the influence of weather conditions on the epidemiology of the powdery mildew (*Podosphaera macularis humuli* Burr).

Sponsored by:	Bayerische Landesanstalt for Landwirtschaft, *(Bavarian State Research Center for Agriculture)* Institut for Pflanzenbau and Pflanzenzüchtung *(Institute for Crop Science and Plant Breeding)*
Financed by:	Own funds
Project Manager:	Ltd. LD B. Engelhard
Working on project:	B. Engelhard, Dr. K. Kammhuber, R. Eicheldinger
Duration:	2003 – 2006
Targete:	Development of a forecasting model for the specific control of the powdery mildew

Methods:

Daily from the beginning of May until the end of August the weather data were retrieved on an hourly basis from seven agrometeorological stations in the Hallertau and evaluated according to the provisional forecasting model.

The following trials were set out and evaluated.

– 2 plot trials for the Official Pesticide Test

– 1 large plot trial

– 8 strip trials

There were also untreated (0) plots at each of these 11 locations. 39 hop yards (from Merkur to Magnum) were treated in compliance with the spray warning on 31 farms.

Results:

- At the 11 locations with untreated plots powdery mildew (PM) was only determined at the Reitersberg location. This means that in 2006 PM only occurred at a few locations in the Hallertau and the forecasting model could not be tested under real infection conditions.
- The model was inasfar confirmed as according to the "5 model" only one spray warning was given on 4th August.
- Infections at locations such as in Reitersberg are a collection of a few PM spores and a lot of leaves on the laterals in the 1st – 3rd leaf rows. Through mechanical means the hops are encouraged to form many leaves and the spores find optimum infection conditions on the side of the host. It will not be possible to record these conditions with forecasting models even in the future.
- Two sprayings at the Reitersberg location with the product Prosper (Spiroxamine) brought a very good trial result.
- In the 4th year it was shown that the so-called "4er model" set off too many warnings and testing should not be continued.
- The requirements for the ongoing forecasting model will not be changed at the moment.

Literature: Schlagenhaufer, S.: Research on the infection biology of powdery mildew (*Podosphaera macularis*) in hop cultivation. Diplomarbeit, TU Freising, 106 S.

Development of control strategies in organic hop production as alternatives to using plant protectives containing copper and sulphur

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:	German Programme for Ecological Agriculture at the Federal Institute for Food & Agriculture (BLE)
Project Manager:	Ltd. LD B. Engelhard
Cooperation:	Bioland e.V.
Working on project:	M. Eckert, A. Bogenrieder, Dr. F. Weihrauch
Duration:	01.04.2004 – 30.11.2006
Objective:	Controlling pests and diseases in organic hop production without synthetic plant protectives, and substituting or reducing products containing copper and sulphur.

Powdery mildew *Podosphaera macularis* s*sp. humuli*

In the three years of the trial no powdery mildew occurred in the untreated plots. Therefore it was impossible to test the effectiveness of the products.

Consequence: The variants should be tested again within the bounds of the Official Pesticide Test 2007.

Downy mildew *Pseudoperonospora humuli*

The tests were carried out on the highly susceptible cultivar Hallertauer Mittelfrüher. In none of the years of the trial did four variants with no copper content produce satisfactory results. In the variants with reduced amounts of copper in the form of cu-hydroxide the concentration was set too low. With savings of 50% the effect was no longer sufficient.

Consequence: The downy mildew cannot be effectively controlled in organic hop production with products containing no copper or with a reduced copper content. The amount used with pesticides containing cu-hydroxide is to be adjusted.

Hop aphid *Phorodon humuli*

As far as **sprayings** are concerned, **quassia** (homebrew at the farm) always produced the best results. The effect was even improved by adding soft soap (trial 2005/2006). NeemAzal T/S did show an effect on aphids but the effect was insufficient for more or less satisfactory results. There were no basic differences between sprayed and painted variants. Also the effect of Spruzit Neu observed over the whole duration of the trial remained very unsatisfactory. Among the **painted variants** it was clear that positive results could be expected with TRF-002 in the first year of the trial but this was a matter of the quantities of active substances used. Under the prerequisites of the organic hop production the commercial product TRF-002 actually produced very good results with 24 g/ha quassine. **Consequence:** Efforts should be made to obtain a registration for the finished product in compliance with the law on plant protectives.

Literature: The detailed report will be published in 2007 in the series "LfL-Schriftenreihe".

Development of a test system to test the hop aphid resistance in hop seedlings within the bounds of hop breeding

Sponsored by:	LfL, Institut für Pflanzenbau und Pflanzenzüchtung *(Institute for Crop Science and Plant Breeding)*
Financed by:	Anheuser-Busch Companies, Inc.
	Erzeugergemeinschaft Hopfen HVG e.G.
	Gesellschaft für Hopfenforschung e.V.
Project Manager:	Ltd.LD B. Engelhard
Working on project:	Dr. F. Weihrauch, A. Baumgartner, M. Felsl, M. Fischer
Duration:	01.04.2005 – 30.04.2008

Objective:

A standardized scientifically supported testing method is needed for definitely checking the descendants from a crossing in hops for differing susceptibility to the hop aphid *Phorodon humuli*. So far an according (laboratory) method has not yet been described in the literature, and according to inquiries by the Hop Research Center is not in use in any hop breeding station.

To be able to breed in the direction of aphid resistance as in the case of powdery mildew and peronospora it is necessary to find genetically set resistances in the individual plants, if possible during the seedlings' childhood, and to test these plants further according to the other criteria. In this project the bases for such a standard method are to be worked out.

Results:

The following genotypes were selected as hop material, the differences of which are to be examined regarding their susceptibility to the hop aphid :

- Boadicea (abbreviated: BO), alleged aphid resistant cultivar from the UK
- Spalter Select (SE), current cultivar with highest aphid tolerance
- Wild hops type 49, origin in Jena (WH), good resistance prerequisites
- Male clone "3-W-42-30-38" (38), good resistance prerequisites
- Hallertauer Magnum (HM), current cultivar with highest aphid susceptibility
- Herkules (HS), current cultivar with probable high aphid susceptibility.

An aphid was set on each of these six genotypes and this was repeated 12 times per trial and their development and descendants were observed during their whole lifetime. The record holder in the aphid life-span was an aphid which survived 51 days on HM. The altogether 72 aphid cages were opened three times a week (Monday, Wednesday, Friday), the larvae counted, protocolled and removed with a fine brush. The same trial was carried out altogether four times in 2006 so that all in all more than 4,300 records could be obtained on aphid reproduction on which systematic and statistical evaluation work is still being continued.

Which hop aphid *Phorodon humuli* infestation can be tolerated on the hop during the time of cone formation?

Sponsored by:	LfL, Institut für Pflanzenbau und Pflanzenzüchtung *(Institute for Crop Science and Plant Breeding)*
Financed by:	Erzeugergemeinschaft Hopfen HVG e.G.
	Gesellschaft für Hopfenforschung e.V.
Project Manager:	Ltd.LD B. Engelhard
Working on project:	Dr. F. Weihrauch, A. Bogenrieder, M. Felsl, M. Fischer,
	A. Neuhauser
Duration:	01.04.2005 – 30.04.2008

Targets:

For years the Advisory Service has been demanding: "The hops must be free of aphids at the point when the cones are forming. If individual aphids are found then a further control measure is necessary!"

Target of the project is to check this statement: Can - and if so, under what prerequisites (e.g. cultivar, time) – a certain number of aphids be tolerated on the leaves, without the cones being affected negatively in quality and quantity at the time when they are harvested? So far there have not been any trial results over several years on this subject matter nor any publications.

Results:

As the preliminary trial to a more extensively planned study, as in the previous year in four cultivars (HM, HT, PE, SE) plots (each approx. 380 m^2) were set out in 14 practice yards. These plots laid out as spraying windows without insecticide treatment served to control the unchecked aphid development in the respective yard and were monitored each week. In addition, an experimental harvest was carried out in two hop yards of each cultivar. At the final count in 2006 it looked just the same as in the respective investigation the previous year: In the comparable low aphid year 2005 of 14 untreated plots, two (cv. HM) were total loss and there were significant yield or alpha losses in two more. In the year 2006 there was a total loss in a HM plot and another suffered heavy losses in yield. In the other twelve hop yards there were no yield or quality losses that could be traced back to aphids. The cone monitoring of the trial harvests in the aroma varieties only produced a cone attack in one case which would have resulted in deductions in the Independent Quality Appraisal so that in 2006 treatment with insecticides could have been omitted without any trouble in eleven of 14 trial hop yards (79 %).

Again the enormous varietal differences in the aphid susceptibility were confirmed, which amounted to about the factor 10 between HM and SE. Among the aroma cultivars, above all SE was definitely not jeopardized in both years without the use of insecticide.

Trial to establish the predatory mite *Typhlodromus pyri* in a hop yard in the Hallertau to control the common spider mite *Tetranychus urticae* naturally

Sponsored by:	LfL, Institut für Pflanzenbau und Pflanzenzüchtung *(Institute for Crop Science and Plant Breeding)*
Financed by:	Anheuser-Busch Companies, Inc.
Project Manager:	Ltd.LD B. Engelhard
Working on project:	Dr. F. Weihrauch, A. Bogenrieder, M. Felsl, M. Fischer, A. Neuhauser
Duration:	01.04.2005 – 30.04.2008

Targets:
The predatory mite *Typhlodromus pyri* is known to be a very effective beneficial for the control of two-spotted spider mites. If it is possible for the predator to overwinter in the hop yard, the spider mite population can possibly be kept below the control threshold, and the use of acaricides will be reduced. Target of the trial work is to check whether a permanent establishment of predatory mites is possible in conventionally managed hop yards by inoculation, in order to be able to do without the expensive annual purchase of predators. However, in hop production the problem is that the entire biomass is transported from the field with the hop harvest prior to physiological maturity and therefore all the beneficial insects are also removed from the hop yard.

Results:

For the first time in spring 2004 evidence was found that predatory mites had successfully overwintered in a hop yard (cv. HT) in Buch, near Aiglsbach. For the time being the last acaricide treatment was sprayed there on 1st July 2004. Without a further introduction of beneficials, in 2005 predatory mites had been found regularly in this yard, which in 2005 was left completely without any acaracide application without any spider mite damage occurring. Throughout the spring of 2006 no attacks were ascertained even at the southern "spider mite hot spot" of the yard. Only on 20th June were the first small traces of attack discovered in the hops where once again the spider mites were eliminated in almost all cases by predatory mites. During monitoring on 4th July it was also discovered that a dense population of predatory mites existed on stinging nettle tendrils which trailed over the total length of more than 200 m on the south side. Obviously the beneficial mites had retreated to an adjacent strip of stinging nettle during the winters 2004/2005 and 2005/2006 and used them – possibly as well as hiding places in the uppermost layers of soil or ground cover in the yard – as a winter refuge. In any case it was striking that at this south side of the yard from where according to the farmer the spider mite infection spread out every year on this "hundred percent" spider mite hop yard, in 2005 and 2006 predatory mites always appeared straightaway in practically all the spider mite nests found. The discovery that the stinging nettle strips were an important if not even crucial refuge for the beneficial mites, is an important finding for future management plans and trials for using predator mites. The efficiency of such refuges must be checked in more research over several years.

Investigations to attract aphid and spider mite antagonists

Sponsored by:	LfL, Institut für Pflanzenbau und Pflanzenzüchtung *(Institute for Crop Science and Plant Breeding)*
Financed by:	Anheuser-Busch Companies, Inc.
Project Manager:	Ltd.LD B. Engelhard
Working on project:	Dr. F. Weihrauch, M. Felsl, M. Fischer
Duration:	01.04.2005 – 30.04.2008

Targets:
The target of the project is to find lures (volatile substances such as volatile plant components or pheromons) which can serve as attractants on the hops for various kinds of beneficial insects. By laying their eggs early then they are there in the hops as antagonists for the two main pests. At the same time the most important object of the research is the lacewing *Chrysoperla carnea* which regularly appears very densely in hop yards and whose larvae are effective as predators for aphids as well as for spider mites.

Results:

From the 13th July onwards one set of insect traps was exposed in each of four hop yards that were located clearly apart from one another, plus one in a forest clearing. Each set of traps was equipped with the lures nepetalactol, nepetalactone, phenylacetaldehyde, 2-phenylethanol and an untreated control. The traps were exposed for eight weeks until 6th September and were emptied at weekly intervals. Altogether 1475 lacewing individuals were caught during the eight weeks, which almost solely comprised males of the species *Peyerimhoffina gracilis*; only three insects were males of the species *Chrysopa pallens*. The individuals caught were solely in traps which were baited with nepetalactol or nepetalactone, the other lures did not produce one single catch. As far as the attraction of *Peyerimhoffina gracilis* males by nepetalactone and/or nepetalactol is concerned, the positive results of the two previous years were obviously confirmed. On the other hand unexpected was the result of the trials with phenylacetaldehyde and/or 2-phenylethanol to attract *Chrysoperla carnea*, the actual target of the investigations. Although in the current literature both substances are described as very good attractants for this species, not a single individual was caught..

Using entomopathogenic nematodes (EPN) for the biological control of the alfalfa weevil *Otiorhynchus ligustici* in hops

Sponsored by:	LfL, Institut für Pflanzenbau und Pflanzenzüchtung *(Institute for Crop Science and Plant Breeding)*
Financed by:	Erzeugergemeinschaft Hopfen HVG e.G.
	Gesellschaft for Hopfenforschung e.V.
Project Manager:	Ltd.LD B. Engelhard
Working on project:	Dr. F. Weihrauch, A. Bogenrieder, M. Felsl, M. Fischer,
	A. Neuhauser
Duration:	01.04.2005 – 30.04.2008

Targets:
The alfalfa weevil *Otiorhynchus ligustici* annually causes financial losses on approx. a third of the German hop acreage. A biological regulation by distributing and possibly establishing insect-pathogenic nematodes would be an environmentally friendly, sustainable alternative. In this project the target is to test entomopathogenic nematodes (EPN) to establish them permanently in the soil of hop yards and hence attain sustainable reduction of the pest.

Results:

With the help of the very labour-intensive catch-plant method – i.e. planting red clover between the hop plants as alternative feeding plants and oviposition sites for the beetles– as a preliminary investigation in 2006 two nematode species were examined for differences in their effectiveneness, in order to carry out the actual trial the following year with the most suitable species. The colonization of the clover sods in spring occurred very rapidly, i.e. as early as a week after planting it could be clearly seen that they had been accepted by the weevils as feeding plant and therefore probably also as substrate for oviposition. However, in Oberulrain the monitored density of weevils was regarded as too low for the trial and was way below that of the preliminary trial the year before. In Untermantelkirchen the weevil densities in 2006 were considerably higher and relatively equal over all the plots. The monitorings of the clover sods which were dug out about four weeks after treatment showed varying results: At the end of July in Untermantelkirchen only few few traces of damage could be recorded at the roots and no weevil larvae were found at all. On the other hand in Oberulrain considerably more traces of damage were found four weeks later, and on 180 clover sods there were altogether at least ten weevil larvae discovered at the F-2 stage sized from 5 to 7 mm.

Consequence of the two-year investigations: The nematodes *Heterorhabditis bacteriophora*, *Steinernema carpocapsae* and *S. feltiae* were checked in 2005 (*H. bacteriophora* vs. *S. feltiae*) and 2006 (*H. bacteriophora* vs. *S. carpocapsae*) for possible differences in their effectiveness. These efficacy tests produced no differences whatsoever between the nematode species. Taking these results into consideration as well as the higher effectiveness of *S. carpocapsae* recorded in 1993 and the fact that the indigenous *Steinernema* species in the hop yards of the Hallertau show a considerably higher persistence than *H. bacteriophora* in the soil, it is proposed that work should be carried on with the nematode species *Steinernema carpocapsae* during the further course of the project.

1.2 Main research areas

1.2.1 Main research area: breeding

Breeding powdery mildew-resistant quality varieties in the aroma and bitter sectors

Managed by: ORRin Dr. E. Seigner, LA A. Lutz

Working on project: LA A. Lutz, LTA J. Kneidl

Cooperation: Dr. F. Felsenstein, EpiLogic GmbH Agrarbiologische Forschung und Beratung, Freising

Target:

The Hüll breeding work is mainly focused on the development of market and environmentally suitable quality varieties. As a good to very good resistance or tolerance towards downy mildew and V*erticillium* wilt is anchored in the Hüll-bred varieties, for some years they have been working to improve the resistance to powdery mildew (PM).

Measures:

- 84 specific crosses were carried out in 2006 with PM resistant breeding lines in the aroma and/or bitter sectors.
- Testing for PM resistance in the greenhouse and in the field
  - Seedlings from various breeding programmes were screened for their resistance following artificial inoculation with four different PM isolates which are widespread in the Hallertau. Furthermore 4 foreign varieties, 182 breeding lines as well as 107 wild hops were included in this greenhouse testing.
  - Only individuals which were classed as resistant, were examined in the field after the resistance test in the greenhouse under natural infection conditions and without the use of fungicides (approx. 400 seedlings per crop year) for their PM resistance.
- Testing for PM resistance in the laboratory (leaf resistance test = detached leaf assay)
  - At the present time 12 different PM isolates with characterized virulence properties are available for testing in the Petri dish. With this range of fungal isolates, tests can be made on all the hitherto resistances used worldwide in breeding.
  - In the leaf resistance test 4 varieties, 182 breeding lines and 97 wild hops were brought into contact with two English PM isolates. In this way the resistance ability 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

Working on project: LA E. Niedermeier

In 2006 the fertilizing trial for fixing the potassium level was carried out on a suspect area. Compared with the 0 plots the fertilizing steps 300 kg K_2O/ha and 600 kg K_2O/ha were tested every three years. The influence of potassium low in choride and with chloride content with and without magnesium will also be investigated. The first trial harvest in 2006 shows a slight increase in yield in the plots most fertilized.

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

Project Manager: LOR J. Portner

Working on project: LA E. Niedermeier

Cooperation: Firma MEKO, Ljubljana, Slowenia

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. With the soil activator the first trial harvest in 2006 produced a loss in yield of 9% with the variety Perle and of 40% with the variety Hallertau Mittelfrüher.

Bine-training trials with the varieties Saphir and Herkules (additional standing room trial)

Project Manager: LOR J. Portner

Working on project: LA E. Niedermeier

With an increasing number of bines per training wire the labour time for training and retraining bines as well as the pressure of disease increases due to the dense foliage. As ever the optimum of yield and alpha-acid is extremely important for the economic success. The bine-training trials serve to find the optimum number of bines in the case of newer varieties. 2006 was the third trial year for the variety Saphir. In 2006 the trial with Herkules was started with new planting. As a further trial issue the distance between the plants was varied in the row in order to clarify the standing room required for this high-yielding newly bred variety in the years 2007-2009.

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

Working on project: LOR J. Portner, LA A. Lutz

Duration: 2004 – 2008 (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 each time at intervals of 3-4 days and this was repeated four times. The harvesting took place on 5 harvesting dates. The yield, alpha-acid content, aroma and external quality (picking, colour and sheen, state of cone and defects) were evaluated. The variety Herkules was harvested in the 1st year. As in the past 3 years the harvest began relatively late, the harvest-time trial with the variety Saphir will probably be continued for another year in order to gain data at a "normal" harvest start.

Comparison of various methods for rapidly determing the ph on their accuracy and practibility in the Advisory Service

Project Manager: LOR J. Portner

Working on project: LAR J. Schätzl

Cooperation: K. Mauermeier (Hopfenring Hallertau)
G. Kindsmüller (Hopfenring Hallertau)

Growth problems often occur in hop production, which can be traced back to an excess or lack of traces of nutrients. In order to restrict the possible causes, it is often necessary to determine the approximate pH-value of the soil on the spot in the Advisory Service or in supervising the hop yard. For this the industry has various aids on sale which vary in accuracy and practicability. In an exact trial the various aids were tested for their practicability. The Hellige pH meter was tested as well as the Stelzner soil tester and the reflectometer in comparison with measuring in the laboratory.
The old tried and tested Hellige test produced the most accurate results; it is simple to use and relatively fast.

Trying out the sensory method in early plant protective applications

Project Manager:	LOR J. Portner OAR A. Schenk (IPS)
Working on project:	LOR J. Portner, S. Fuß
Cooperation:	Hans Wanner GmbH, Wangen i. Allgäu Müller Elektronik, Salzkotten
Duration:	2006 – 2008

Due to the distances between the plants (1.4-1.6 m in a row) and the lack of foliage in the spring considerable losses occur in the first plant protective applications, if the insecticide is sprayed through the plants when advancing. Due to the use of sensors which recognise the poles, plants or leaves and therefore enable specifically targeted application, there was a considerable reduction in the pesticide losses. In a 3-year trial suitable sensors for recognising plants should be tried out and a functioning control and switch to switch off the jets are to be developed. The first trials in this respect were very promising.

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

Project Manager:	LOR J. Portner
Working on project:	LA J. Münsterer
Cooperation:	Dr. Th. Rötzer, Munich Erzeugergemeinschaft HVG StMLF

The amounts of water and watering times required for an optimum hop yield are being determined in two irrigation trials at the locations Hüll and Ilmendorf by various trial variants. At the same time the EDP water household model HYMOHOP, which calculates the water household of the hops daily via meteorological data, is calibrated by measuring the soil water content weekly and tested for its use in everyday practice.

Possibilities to save energy in drying hops

Working on project:	LA J. Münsterer
Duration:	2006 - 2008

During the 2006 harvest numerous trials and measurings were carried out in 10 different hop farms to work out the principles and correlations over the chances of saving energy in drying hops,. In the first year research was focused on the use of alternative sources of energy and the heat recovery. At the same time it must be determined how many litres of heating oil per drying hour can be saved by the various alternative sources of energy. An economic consideration will round off the research.

1.2.3 Main research area: hop quality and analytics

Developing a NIR calibration 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

Working on project: CL E. Neuhof-Buckl, CTA B. Wyschkon, Dipl. Ing. Agr.
C. Petzina, RR Dr. K. Kammhuber

Duration: The project was begun in September 2000, it is open-ended

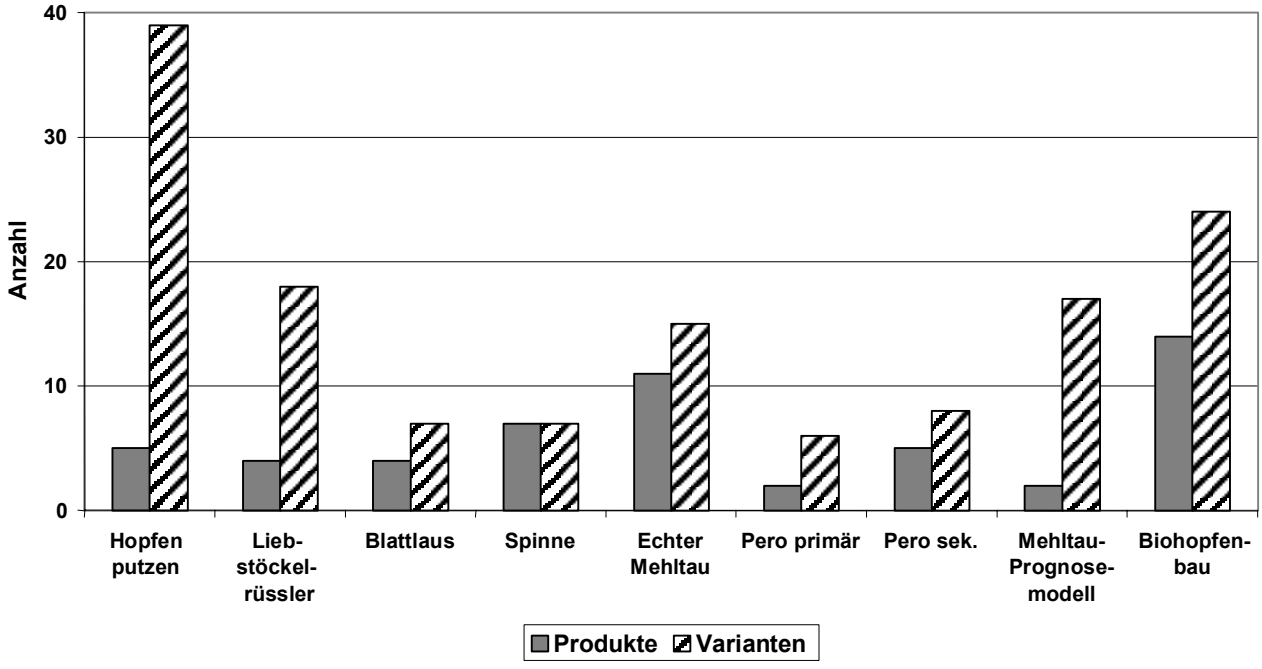
Since the year 2000 a NIR calibration based on HPLC data has been developed by Hüll and the laboratory of the hop-processing firms, in order to replace the rising number of wet-chemical examinations with a cheap fast method. The target is to improve the NIR method so that an acceptable repeatability and reproducability can be attained for daily practice. Every year the existing calibration is being 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 area: plant protection in hops

Testing plant protectives for licences or permission and advisory service 2006

Project Manager: Ltd. LD Bernhard Engelhard

Working on project: LOI R. Eicheldinger, G. Meyr



2 Weather conditions 2006 – the extremes are becoming more frequent

Bernhard Engelhard, Dipl. Ing. agr.

First it was too cold, then at the beginning of March there were new records in snowfall; new records in mean temperatures in July since the meteorological records have been kept and finally the warmest and driest autumn for over 100 years. It is true that hops can take a lot but so many extremes were a bit too much for a very good harvest.

The mean temperatures in the months January - March were not only below the 10-year average but also below the 50-year average. First of all, the ground was not frozen due to snow covering the ground for a long time. Then in February the ground frost reached a depth of 60 cms. Therefore the soil probes could be drawn and the wires hung up under good conditions.

The hop yards were free of snow (except for the northern slopes) very late as from 20th March onwards. It was difficult to work the soil due to continual precipitation. In isolated cases it was possible to begin with the cutting the hop crowns on sandy soil during the afternoons towards the end of March. This work as well as work with the circular cultivator could be best carried out during the last days in April.

Stripping the bines and training them began on 1st May. Warm days and considerable dampness in the soil promoted growth, so that some farms with fewer foreign workers found it difficult to get the main shoots on the wires at the right time. Afterwards the nights were colder again and with less rain the growth stopped until 10th June.

The best possible time to do the first chemical hop stripping was from 9th – 14th June; with the growth beginning again the leaves were sensitive and could be etched off with little active substance.

July was marked by extremely high temperatuares from 3rd. – 27th. In some regions there were thundery showers in the night from 22nd auf 23rd July which were now able to save the somewhat poorly hop plants just in time. In areas without these storms there were crop losses of up to 40% compared with 2005. The last week of drought must have also been the cause for the below average alpha contents in the early ripening varieties.

Also the following thundery or rain showers were very unequally distributed over the Hallertau.

On 11th August unusually large hailstones were recorded in the Hallertau (the breeding yards in Hüll and Rohrbach were just spared).

Another extreme weather condition was the storm on 19th August in the Jura seal district, which took the toll of more than 60 hectares of hop trellis.

Effects of the weather conditions on the individual pests are described under Point 6.1.

Weather data (monthly mean averages or monthly totals) from the year 2006 compared with the 10- and 50-year mean averages

Month		Temperature in 2 m height			Relat.	Precipi-	Days w.	Sun-
		Average (°C)	Min.∅ (°C)	Max.∅ (°C)	humidty (%)	tation (mm)	preciptn >0.2 mm	shine (hrs.)
January	2006	-3.7	-7.1	-0.1	89.6	27.7	5.0	80.7
∅	10-j.	-1.3	-4.6	2.2	88.9	39.1	10.2	68.5
	50-j.	-2.4	-5.1	1.0	85.7	51.7	13.7	44.5
February	2006	-1.8	-6.0	2.7	88.3	49.0	9.0	56.5
∅	10-j.	0.4	-4.1	5.3	83.7	34.4	11.0	102.1
	50-j.	-1.2	-5.1	2.9	82.8	48.4	12.8	68.7
March	2006	1.4	-3.9	6.3	86.1	113.5	19.0	110.5
∅	10-j.	4.1	-0.6	9.5	79.9	56.6	12.4	144.8
	50-j.	2.7	-2.3	8.2	78.8	43.5	11.3	134.4
April	2006	8.4	3.2	14.0	83.4	105.4	20.0	149.6
∅	10-j.	8.3	2.6	14.3	73.3	46.6	10.6	176.5
	50-j.	7.4	1.8	13.3	75.9	55.9	12.4	165.0
May	2006	13.3	7.5	19.3	74.6	111.7	17.0	204.9
∅	10-j.	13.7	7.4	20.0	72.9	77.0	12.0	219.3
	50-j.	11.9	5.7	17.8	75.1	86.1	14.0	207.4
June	2006	17.2	10.2	24.0	74.3	119.8	11.0	267.6
∅	10-j.	16.9	10.2	23.3	72.3	88.5	13.6	244.2
	50-j.	15.3	8.9	21.2	75.6	106.1	14.2	220.0
July	2006	21.3	13.8	29.3	69.9	54.1	6.0	330.9
∅	10-j.	17.2	11.5	23.5	76.6	108.2	16.7	213.0
	50-j.	16.9	10.6	23.1	76.3	108.4	13.9	240.3
August	2006	14.7	10.3	20.3	86.2	166.5	22.0	137.5
∅	10-j.	17.8	11.6	24.7	77.0	79.2	11.0	221.2
	50-j.	16.0	10.2	22.5	79.4	94.9	13.3	218.4
September	2006	15.9	9.9	22.9	82.9	18.4	5.0	201.4
∅	10-j.	13.0	7.7	19.4	82.2	69.5	11.6	169.5
	50-j.	12.8	7.4	19.4	81.5	65.9	11.4	174.5
October	2006	11.1	5.7	18.3	87.2	33.3	8.0	154.8
∅	10-j.	9.0	4.9	13.9	86.7	72.8	13.4	108.0
	50-j.	7.5	2.8	13.0	84.8	60.0	10.4	112.9
November	2006	5.4	1.2	9.9	91.9	36.6	15.0	81.4
∅	10-j.	3.1	0.0	6.6	91.1	61.2	12.1	65.3
	50-j.	3.2	-0.2	6.4	87.5	58.8	12.6	42.8
December	2006	1.7	-1.3	6.0	95.5	40.6	13.0	89.1
∅	10-j.	-0.3	-3.2	2.6	90.6	41.8	13.0	59.3
	50-j.	-0.9	-4.4	1.6	88.1	49.1	13.3	34.3
Year 2006		8.7	3.6	14.4	84.2	876.6	150.0	1864.9
10 – year average		8.5	3.6	13.8	81.3	774.9	147.6	1791.6
50 – year average		7.4	2.5	12.5	81.0	828.8	153.0	1663.0

The 50-year mean average refers to the years 1927 up until and including 1976. the 10-year average refers to the years 1996 up until and including 2005.

3 Statistical data on hop production

Portner Johann. Dipl. Ing. agr.

3.1 Production data

3.1.1 Structure of 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	1 554	11.05
1988	4 488	4.41			
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 acreage				Hop farms				Hop acreage per farm in ha	
	in ha		Increase + / Decrease - 2005 to 2006				Increase + / Decrease - 2005 to 2006			
	2005	2006	ha	%	2005	2006	farms	%	2005	2006
Hallertau	14 221	14 280	+ 59	+ 0.4	1 297	1 251	- 46	- 3.5	10.96	11.41
Spalt	395	388	- 7	- 1.7	95	93	- 2	- 2.1	4.16	4.17
Tettnang	1 212	1 200	- 12	- 1.0	186	179	- 7	- 3.7	6.52	6.70
Baden, Bitburg u. Rheinpfalz	20	19	- 1	- 4.2	3	2	- 1	- 33	6.67	9.50
Elbe-Saale	1 332	1 284	- 48	- 3.6	30	29	- 1	- 3.3	44.40	44.28
Germany	17 179	17 170	- 9	± 0	1 611	1 554	- 57	- 3,5	10,66	11,05

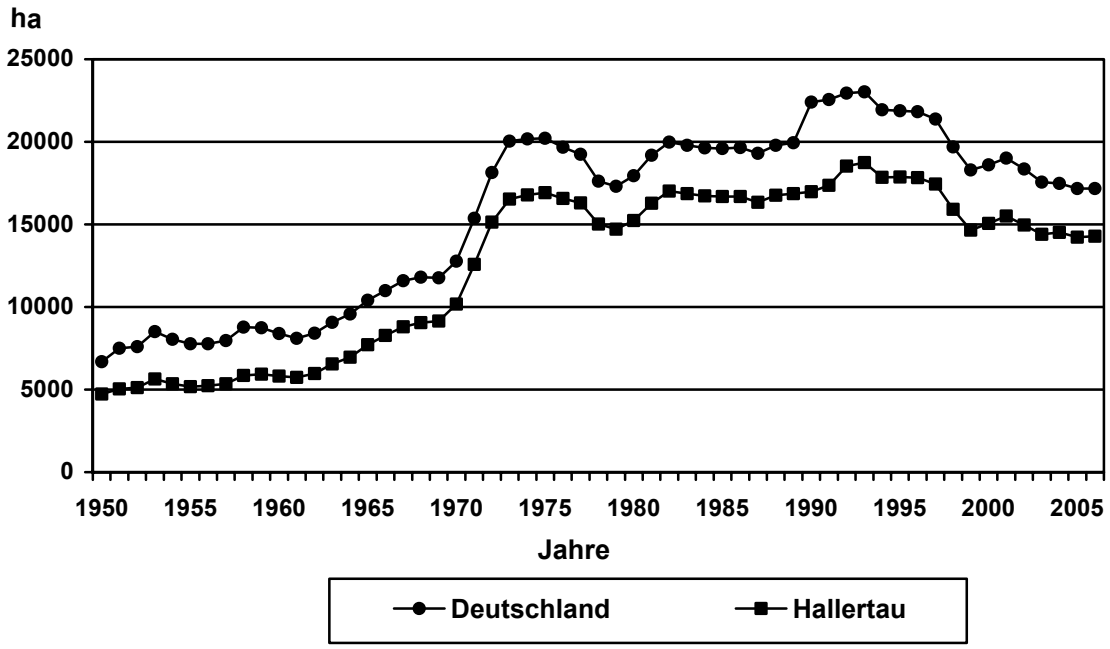


Fig. 3.1: Hop acreage in Germany and in the Hallertau

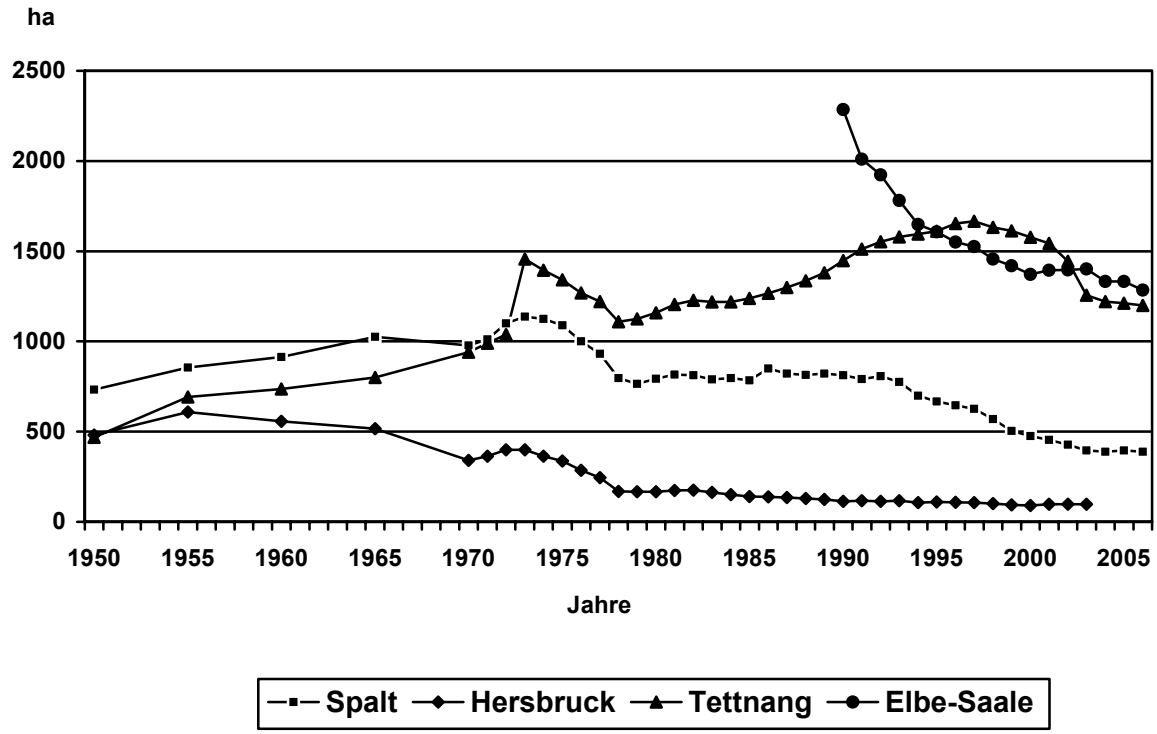


Fig. 3.2: Hop acreage in the regions Spalt, Hersbruck, Tettnang and Elbe-Saale

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, in 2006 again there was a shift in favour of the aroma varieties. The proportion of aroma varieties in 2006 was now 59.9 % compared with 59.1 % in 2005. The bitter varieties make up a proportion of 40.1 % of the acreage compared with 40.9 % in 2005.

The increase in acreage for the aroma varieties can probably be traced back to the expansion of Perle (+ 158 ha), Hall. Tradition (+ 135 ha) and Hallertauer Mfr. (+ 17 ha). The acreage of Spalter Select for the most part remained unchanged with + 6 ha. Of the new aroma varieties only a few hectares of Saphir, Opal and Smaragd were newly planted. Solely the aroma variety Hersbrucker Spät with 180 ha recorded a decrease in acreage.

As far as the bitter varieties are concerned the acreage of all varieties was reduced (except for the new variety Herkules + 188 ha).

The exact distribution of the varieties according to production areas can be seen in Table 3.3.

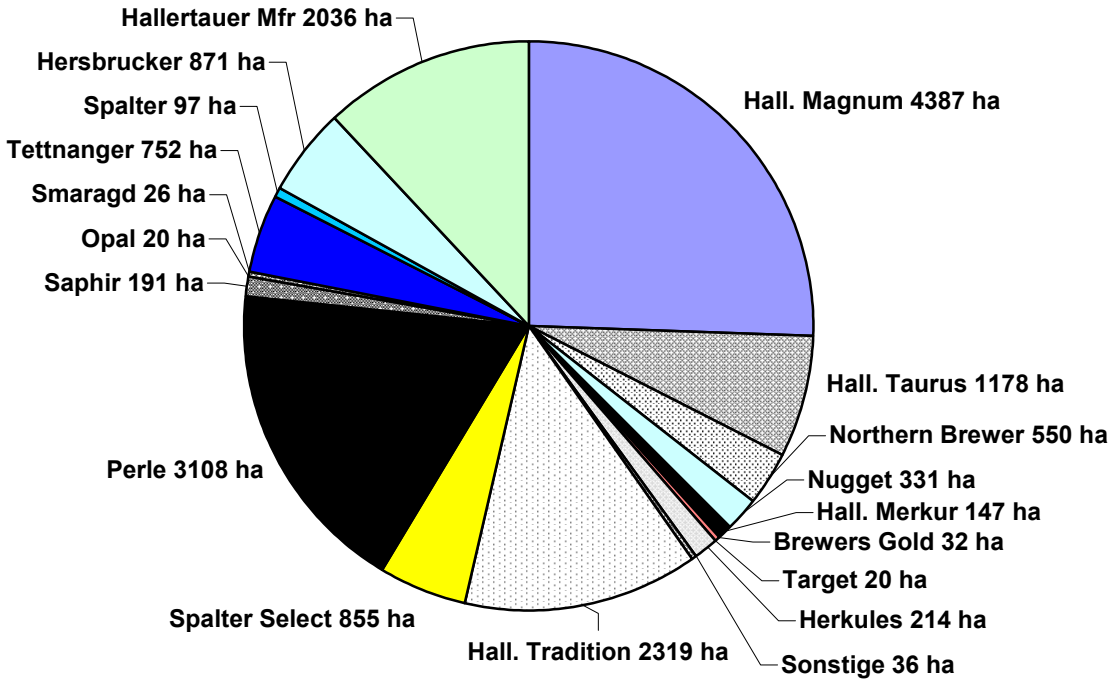


Fig. 3.3: Distribution of hop varieties in Germany 2006

Table 3.3: Aroma varieties in the German hop-growing regions in ha in 2006

Hop region	Total acreage	HA	SP	TE	HE	PE	SE	HT	SR	OL	SD	Aroma varieties	
												ha	%
Hallertau	14.280	1.516	8	1	865	2.931	740	2.235	191	20	26	8.534	59.8
Spalt	388	114	89		6	25	114	26				374	96.4
Tettnang	1.200	404		751		21	0	19				1.195	99.6
Baden. Bitburg u. Rheinpfalz	19	1				7	2	4				14	73.4
Elbe-Saale	1.284					128		38				166	12.9
Germany	17.170	2.036	97	752	871	3.112	855	2.322	191	20	26	10.282	59.9
Distribution **in %**		11.9	0.6	4.4	5.1	18.2	5.0	13.6	1.1	0.1	0.2		

Change in varieties in Germany

2005 ha	17.179	2.018	99	765	1.050	2.954	849	2.186	188	19	19	10.147	59.1
2006 ha	17.170	2.036	97	752	871	3.112	855	2.322	191	20	26	10.282	59.9
Change in ha	- 9	17	- 2	- 13	- 180	158	6	135	3	2	7	135	

Table 3.4: Bitter varieties in the German hop-growing regions in ha in 2006

Hop region	NB	BG	NU	TA	HM	TU	MR	HS	Sonst.	Bitter varieties	
										ha	%
Hallertau	395	32	288	16	3.549	1.146	100	201	19	5.745	40.2
Spalt					3		10	1		14	3.6
Tettnang					1	4				5	0.4
Baden. Bitburg u. Rheinpfalz					3	2				5	26.6
Elbe-Saale	155		43	4	831	26	37	13	8	1118	87.1
In Germany	550	32	331	20	4.387	1.178	147	214	27	6.887	40.1
Distribution **in %**	3.2	0.2	1.9	0.1	25.6	6.9	0.9	1.3	0.2		

Change in varieties in Germany

2005 ha	612	38	380	27	4.526	1.216	165	26	43	7.032	40.9
2006 ha	550	32	331	20	4.387	1.178	147	214	27	6.887	40.1
Change **in ha**	- 62	- 6	- 49	- 7	- 139	- 39	- 17	188	- 15	- 145	

3.2 Crop situation in 2006

The volume of hops harvested in Germany in 2006 amounts to approximately 28 474 000 kg (= 569 480 ztr.) compared with 34 466 770 kg (= 689 335 ztr.) in 2005. The size of the crop is around 6 million kg (or 120 000 zentners) below the previous year's result; this means a reduction of around 17.4 %.

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

	2001	2002	2003	2004	2005	2006[1)]
Yield ztr./ha or. kg/ha	1669 kg (33.4 ztr.)	1758 kg (35.2 ztr.)	1444 kg (28.9 ztr.)	1900 kg (38.0 ztr.)	2006 kg (40.1 ztr.)	1658 kg (33.2 ztr.)
Relative to 100%(long-term ∅ =35 Ztr.)	95.4	100.5	82.5	108.6	114.6	94.7
Acreage in ha	19.020	18.352	17.563	17.476	17.179	17 170
Total crop in ztr. or kg	31.739.100 kg = 634.782 ztr.	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.	28.474.000 kg = 569.480 ztr.

[1)] provisional

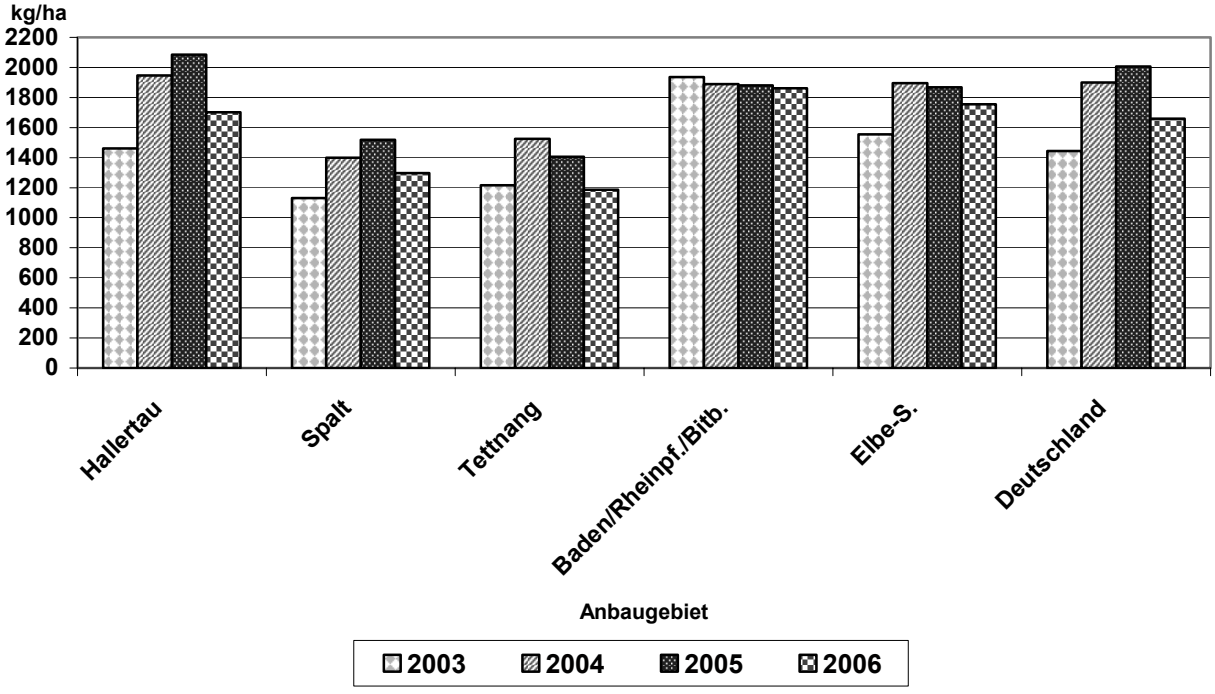


Fig. 3.4: Average yields in the various production regions in kg/ha

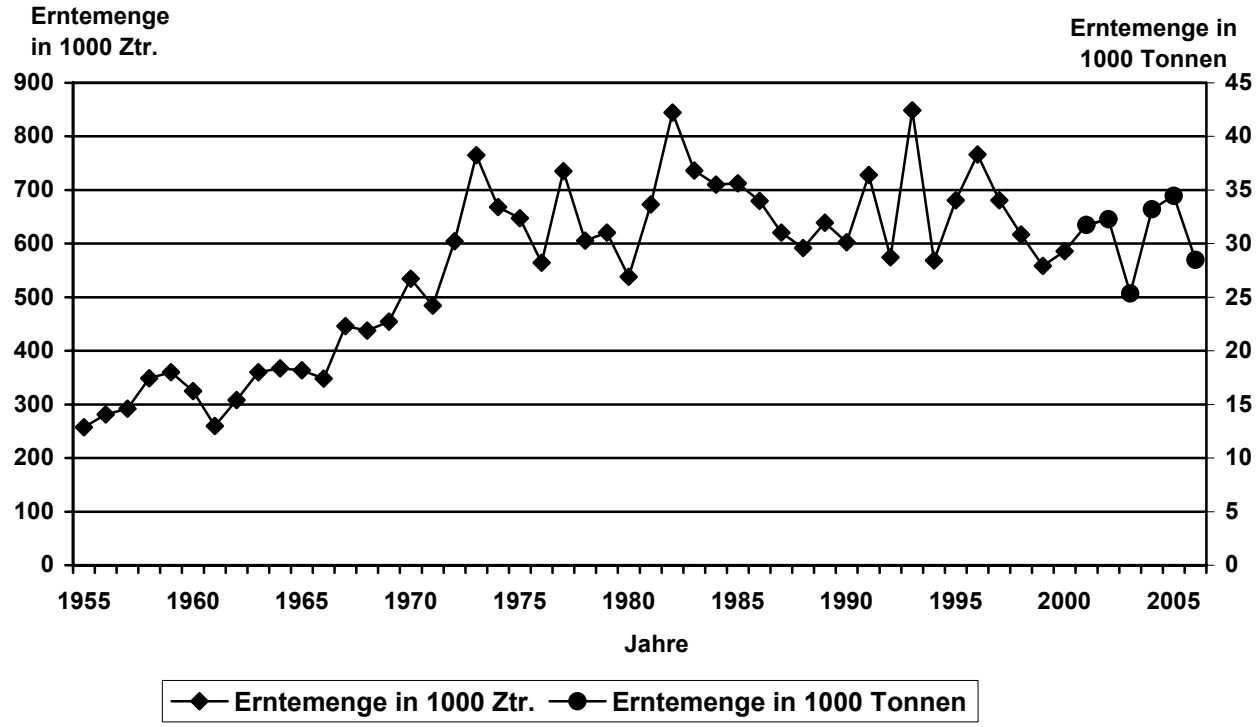


Fig. 3.5: Crop volume in Germany

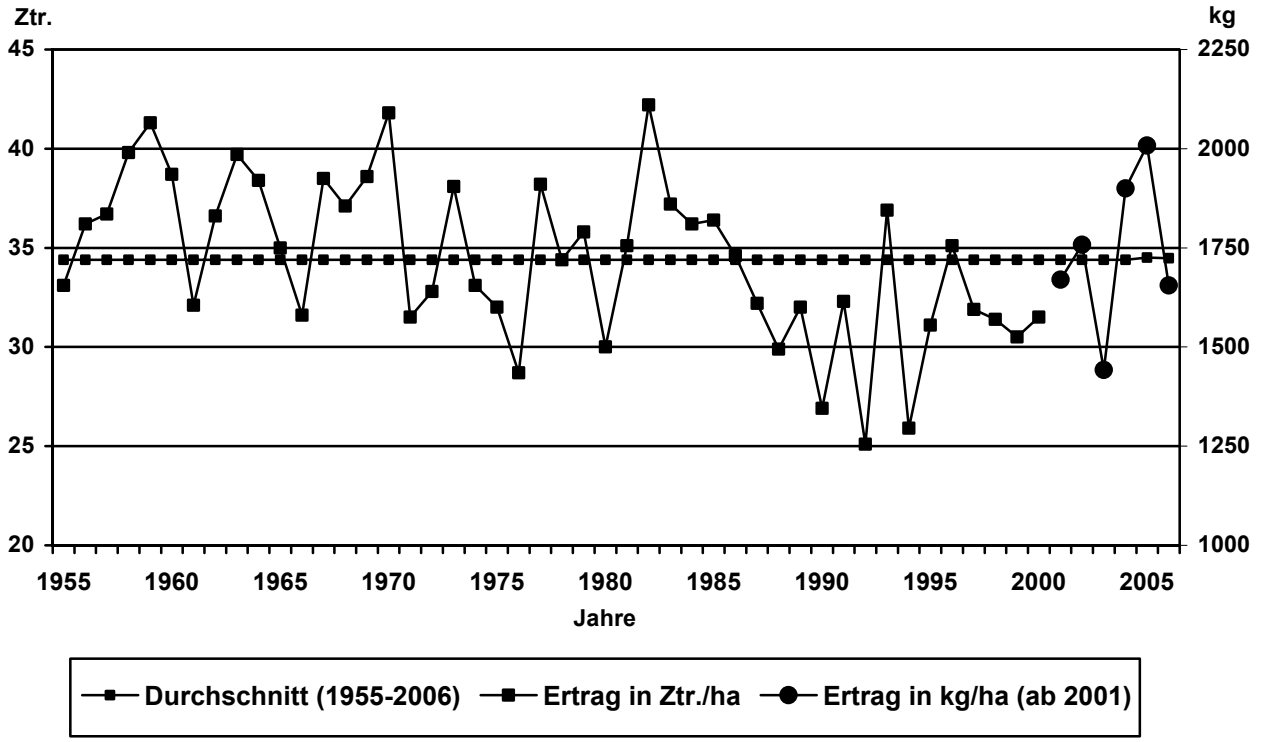


Fig. 3.6: Average yield (ztr. or kg/ha) in Germany

Table 3.6: Yields per hectare in the German production regions

Region	Yields in ztr./ha total acreage (from 2001 in kg/ha)								
	1998	1999	2000	2001	2002	2003	2004	2005	2006[1)]
Hallertau	32.5	31.2	33.6	1724	1825	1462	1946	2084	1701
Spalt	22.1	28.2	20.9	1298	1464	1131	1400	1518	1298
Hersbruck	28.8	23.5	26.8	1233	1306	983	- *	- *	-*
Tettnang	26.8	28.3	16.4	1212	1360	1216	1525	1405	1187
Bad./Rheinpf. Bitburg	30.1	31.4	31.6	1445	1763	1936	1889	1881	1862
Elbe-Saale	27.5	27.3	30.0	1594	1576	1555	1895	1867	1754
∅ yield p. ha Germany	31.4	30.6	31.5	1669 kg	1758 kg	1444 kg	1900 kg	2006 kg	1658
Total crop Germany (t or ztr.)	618 390	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	28 474 t 569 480
Acreage Germany	19 683	18 299	18 598	19 020	18 352	17 563	17 476	17 179	17 170

* 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	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	5-year ∅	10-year ∅
Hallertau Hallertauer	5.4	4.7	4.1	4.9	4.6	4.6	3.1	4.3	4.4	2.4	**3.8**	**4.3**
Hallertau Hersbrucker	4.7	3.7	2.1	4.9	3.0	3.2	2.1	3.0	3.5	2.2	**2.8**	**3.2**
Hallertau Hall. Saphir								3.4	4.1	3.2		
Hallertau Perle	9.3	6.7	7.0	8.1	7.0	8.6	3.9	6.4	7.8	6.2	**6.6**	**7.1**
Hallertau Spalter Select	6.8	5.5	4.5	6.4	4.8	6.0	3.2	4.9	5.2	4.3	**4.7**	**5.2**
Hallertau Hall. Tradition	7.0	5.6	6.0	7.1	6.3	7.2	4.1	6.3	6.3	4.8	**5.7**	**6.1**
Hallertau North. Brewer	10.8	9.1	9.0	10.1	9.6	10.1	6.0	9.8	9.8	6.4	**8.4**	**9.1**
Hallertau Hall. Magnum	16.9	14.0	13.4	14.4	13.9	14.6	11.7	14.8	13.8	12.8	**13.5**	**14.0**
Hallertau Nugget	13.6	11.2	10.0	12.9	11.9	12.4	8.5	10.6	11.3	10.2	**10.6**	**11.3**
Hallertau Hall. Taurus	16.6	13.7	15.9	15.6	15.7	16.5	12.3	16.5	16.2	15.1	**15.3**	**15.4**
Hallertau Hall. Merkur								13.5	13.3	10.3		
Tettnang Tettnanger	5.4	4.0	3.8	4.9	4.4	4.6	2.6	4.7	4.5	2.2	**3.7**	**4.1**
Tettnang Hallertauer	5.5	4.3	4.2	4.8	4.5	4.8	3.1	5.0	4.8	2.6	**4.1**	**4.4**
Spalt Spalter	5.6	4.4	3.8	4.0	4.4	4.6	3.1	4.4	4.3	2.8	**3.8**	**4.1**
Elbe-Saale Hall. Magnum	15.4	12.4	12.2	14.0	13.9	13.9	10.2	14.0	14.4	12.4	**13.0**	**13.3**

Source: Work Group Hop Analysis (AHA)

4. Hop Breeding Research

ORRin Dr. Elisabeth Seigner, Dipl. Biol.

4.1 Classic breeding

It is top priority to breed new hop varieties which meet 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. For some years biotechnological and genome analytical methods have also been applied in a supportive way.

4.1.1 Crosses 2006

Altogether 84 crosses were carried out in 2006. The breeding principle is a stable reistance / tolerance towards downy mildew (DM), powdery mildew (PM) , crown rot and wilt. The number of crosses for the breeding targets is shown in Table 4.1.

Table 4.1: Breeding targets of the crosses 2006

Breeding direction combined with resistance / tolerance towards various hop diseases	Further requirements	No. of crosses
Aroma type	none	-
	New PM resistances from wild hops	30
	Resistance to hop aphid	2
	Suitable for low trellis	2
	Suitable for developing molecular markers	2
High alpha-acid type	none	25
	New PM resistances from wild hops	3
	High xanthohumol content	5
	High beta-acids content	5
	Suitable for low-trellis	8
	Suitable for developing molecular markers	2

4.1.2 Breeding for powdery mildew resistance

In the past three years powdery mildew (*Podosphaera macularis ssp. humuli*) has not been a big problem, nevertheless the risk remains that under suitable weather conditions massive powdery mildew (PM) attacks on susceptible varieties result in drastic yield and quality losses. Therefore efforts continue in breeding to close the resistance gaps step by step with regard to powdery mildew in the aroma and high-alpha varieties. The various approaches from the fields of classic breeding, genome analysis and biotechnology are shown in the following. They all follow the aim to be able to provide quality varieties with a broad level of resistance for the hop and brewing industry in the future.

4.1.2.1 Wild hops open up new resources for the PM resistance breeding

Fig. 4.1: Testing for PM resistance in the greenhouse and with the leaf test in the laboratory using PM spores carrying various virulences

Target

Extensive research on the virulence spectrum of PM populations from Germany, France, England and the USA (Seigner et al., 2002; sponsored by the Scientific Fund of the German Brewing Industry) have shown that all resistance genes which are at present known worldwide, are already broken by PM races with complementary virulence genes. It is therefore essential to look for new resistance sources which were assumed to be found in wild hops.

Method

Starting with a very extensive wild hop range (150 origins) which due to its broad geographic origin (Europe, North America, Asia, Australia) is regarded as an important new genetic resource (within the bounds of a project sponsored by the Scientific Fund of the German Brewing Industry in Munich) over 15,000 wild hops were examined in the greenhouse, laboratory and to some extent in the field for their resistance to powdery mildew.

Results

PM testing in the greenhouse

A start was made with the wild hop material in 2001 with the resistance screening in the greenhouse. Since then more than 15,000 wild hops have been tested. Highly susceptible hops with high infection of PM - so-called infector plants, were put inbetween the dishes with the young hop seedlings (Fig. 4.1) as source of infection. From 2003 onwards the infection conditions were optimized in this greenhouse screening. Thus PM races, which reflected the virulence spectrum in the Hallertau (*v3-, v4-, v6-, vB*-virulence type) were made available by our cooperation partner EpiLogic for inoculation of the infector plants in February of each year. Due to the PM pathotypes used for resistance testing, all wild hops with complementary resistance genes (*R3, R4, R6* and *RB*) or without R-genes were infected with the PM pustles. Whereas wild hops with other kinds of resistances remained free of PM infection.

Two to three weeks after the seedlings had been exposed to the bad infection, selection was made for the first time. Seedlings without fungal spots or with only slightly light areas on the leaves were classed as resistant and only these were further observed under the bad PM infection in the greenhouse as pot plants until the close of the PM screening season at the end of May and examined every 4 weeks for pustules. Up until the end of the vegetation period 2006, 75 wild hops in the greenhouse were judged as resistant, when no infestation or only slightly lighter areas had been determined on their leaves as this can be classed as defence reactions against fungus.

The high infection which had been attained with the PM races in the greenhouse and the repetition of the resistance tests over 2-3 years guarantee that the data collected in this way can be classed as very reliable for the fungal resistance.

PM testing in the laboratory

Wild hops classed as resistant in the greenhouse were further tested in the laboratory each year by EpiLogic on their powdery mildew resistance. At the same time their reaction to those fungal races was tested, which have not yet occurred in the Hallertau, but which are widespsread in England and the USA. Young leaves detached from wild hops were inoculated with two different PM isolates each from England which were characterized by the *v1,v2,v3,v5,vB*-virulences (Fig. 4.1). In order to obtain reliable resistance evidence, the tests were always repeated 2-3 times and in the following year the detached leaf assay was again carried out with those wild hops so far judged as resistant. Lastly only 54 of the PM-free wild hops in the greenhouse also showed no fungus attacks in the leaf infection test in the laboratory.

PM testing in the field

Wild hops, which had proved to be resistant in the greenhouse and in the laboratory, were tested under natural infection conditions over several vegetation periods. As only very low infection prevailed in 2003-2006 and in 2002 there was only average to high infection in the "PM yard", the estimated resistance in the field is actually only based on the data of the leaf and cone monitoring in 2002. Therefore convincing field monitorings are only available for 21 wild hops whereby the greenhouse and laboratory results have been confirmed.

Resistance testing in the greenhouse and laboratory can certainly not replace the assessment of resistance in the field. Nevertheless it is quite obvious that optimized test systems with respective repetition of the tests especially in the years with little natural infection can provide reliable evidence for resistance.

New resistance sources and their use

Table 4.2 lists the results from all tests for PM resistance from 2001-2006. Starting with about 15,000 wild hops at the end of the vegetation period 2006 54 wild hops from the most diverse countries of origin were classed as resistant. these hops showed no PM pustules in all the greenhouse and laboratory tests with the various fungal races (*v1-6, vB*). This means that these 54 wild hops carry a new kind of hitherto unknown resistances which in our tests could not be overcome by any of the PM races.

Table 4.2: Resistant wild hops according to greenhouse and laboratory tests over several years; basic material was seeded cones of wild hops. It was possible to confirm their resistance to powdery mildew in 21 wild hops also in the field.

Wild hop origins		**No.**	**Sex**
Germany	Harburg	1	male
	Brunning	1	female
	Staudach	2	female
	Schweinfurt	3	female
	Kleinmachnow	1	male
	Pirna	1	male
		1	female
	Halbinsel Zingst	2	male
	Berlin	3	female
	Eifel	4	female
		6	male
Turkey	Bursa	4	female
		3	male
China /Japan	Descendants of 4 female wild hops by open pollination in a Japanese breeding yard	15	female
		5	male
Sweden	Julyta	1	female
New Zealand	unknown	1	female
Germany*	Neumarkt	16	?
USA*	Missouri	19	?
	Nebraska	2	

* very promising resistant wild hops after 1-year's testing in the greenhouse and laboratory

As hops from Japan, China and Turkey had up to now scarcely been used in European and US breeding programmes, it was not surprising that new resistances were found just in the wild hops from these regions. On the other hand up to 2005 not one PM resistant plant could be found out of more than 1,000 North American, 1,000 Italian and 500 Austrian wild hops.

For the first time in 2006 wild hops came for testing from the Mid-West of the USA and based on the resistance data in the greenhouse and laboratory these plants are regarded as very promising for new PM resistances..

It is certainly amazing that so many resistant wild hops come from the various regions of Germany. This shows that domestic potential for resistant hops has so far not been utilizd fully by the Hüll breeders.

Some of the 54 resistant wild hops had already been crossed into the Hüll breeding material to broaden the genetic basis for powdery mildew resistance and to be able to use these new resistance mechanisms in future Hüll varieties. Particularly interesting are those resistant wild hops which also bring traits into the Hüll breeding material which have so far or scarcely been found such as e.g. the wild hops from Turkey with their drought resistance. Furthermore those wild hops offer an enormous breeding potential which are at home in the American Mid-West or in China and Japan and belong to various *Humulus* species, which until now have hardly been used for breeding (*Humulus lupulus var. neomexicanus*, *H.l. var. pubescens* and *H.l. var. cordifolius*) with their adaptation abilities for completely different climate conditions and pathogenes. Consequently these wild hops offer a host of new traits which together with our Hüll breeding material and breeding varieties will make new combinations possible, with which the manifold demands of the hop and brewing industry on quality and resistance characteristics can be fulfilled.

The work for screening wild hops will be continued in the greenhouse and in the laboratory Wild hops which confirm their resistance to powdery mildew even after a longer selection phase will be used as crossing partners in the breeding program.

In order to facilitate the selection of PM resistant individuals from the descendants of these wild hops, molecular markers will be developed for some resistance genes. At present this work (viz. 4.2.1) is being sponsored by the European Hop Research Council (EHRC).

4.1.2.2 Test systems for PM resistance

The 12 single-spore isolates of *Podosphaera macularis ssp. humuli* used in screening wild hops make it possible to test on all resistance genes so far used in hop breeding. Since 1999 these PM isolates which originate from Germany, England, France and the USA, are maintained by EpiLogic our cooperation partner with considerable know-how and under the appropriate security conditions. Our range of races is constantly being supplemented by new isolates.

Every year in February before the resistance screenings begin in the greenhouse and in the laboratory the virulences of all hitherto and newly obtained PM isolates are determined or tested. At the same time the virulence of the various fungal isolates is tested by using "differential" hop varieties which encompass all the known resistance genes (*R1-R6* and *RB*). Therefore it is guaranteed that the isolates are definitely characterized in their virulence and have not changed through mutation.

The resistance testing systems in the greenhouse and the leaf resistance testing system in the laboratory together with the various fungal isolates have been used since 2000 in many issues concerning powdery mildew:

- in judging the resistance properties of wild hops, breeding lines and foreign varieties
- for reliably assessing mapping populations in the development of molecular markers for PM resistance
- in judging the virulence situation of the PM populations in the hop-growing regions
- in evaluating the effectiveness of known resistances in specific hop-growing regions
- for reliably testing transgene hops
- for determining the sensitivity of various development stages of hops to powdery mildew (Seigner et al., 2003)

They have become crucial "pillars" for successful resistance breeding at the Hop Research Center in Hüll.

Table 4.3: Overview on the various application areas of the PM testing systems in the greenhouse and in the laboratory. The number of the tests carried out from February 2003 until June 2006 underlines the enormous significance of our resistance testing systems for breeding.

2003-2006	Greenhouse		Leaf test in the laboratory	
	Plants	**Monitoring data**	**Plants**	**Monitoring data**
Wild hops	827	3,610	645	2,500
Breeding lines	782	3,350	782	2,575
Varieties	35	115	37	125
Powdery mildew virulence situation			42	2,150
Mapping populations			2,270	10,120
Gene-expression analyses			45	
Transgene hops (since 2004)			26	260
Total	**1,644**	**7,075**	**3,847**	**17,730**

Publications:

Seigner, E., Seefelder, S. and Felsenstein, F. (2002): Research on the virulence spectrum of powdery mildew in hops (*Sphaerotheca humuli*) and for the effectiveness of race-specific resistance genes, Nachrichtenblatt des Deutschen Pflanzenschutzdienstes 54, 2002, 147 − 151.

Seigner, E., Seefelder, S., Haugg, B., Engelhard, B., Hasyn S. (2003): Infection potential of powdery mildew (*Sphaerotheca humuli*) depending on the development stage of the hop (*Humulus lupulus*). Gesunde Pflanzen **55**(2): 29-33.

4.2 Genome analysis and biotechnology in hops

4.2.1 Identifying powdery mildew resistance markers in wild hops

Target

The target of the research project sponsored by the EHRC (European Hop Research Council) "Development of molecular markers linked to powdery mildew resistance genes in hops to support breeding for resistance" means working out molecular selection markers for PM resistance from wild hops. The main object of this work is a wild hop from the Eifel (WH18), which has proved to be resistant to the whole spectrum of all virulent PM races known so far. Besides the PM resistance gene *R2* of the English variety ´Wye Target` which until now is still

effective in the German hop growing regions, the crossing of this *WH18* gene into the Hüll breeding material represents an important step for the long-term preventive control of powdery mildew in hop cultivation. Through working out gene-diagnostic markers for this resistance gene the breeding for PM resistance can in the future be carried out faster and more reliably. In addition the resistance of a Japanese wild hop (Jap-C845) will be tested in this project.

Results

Various PM resistance crosses were carried out for this project. In the resistance testing of the descendants of the individual crosses after artificial PM infection using segregation analyses the effect of a dominant main gene could be confirmed for the resistance of WH18 and for Jap-C845 as well. According to a DNA-pool screening (resistant : susceptible) with 45 AFLP primer combinations (*Eco*RI/*Mse*I) a resistance marker (N_423) could be identified for the Japanese wild hop resistance. Two AFLP markers (GP_290 and EP_292) could be developed for the *WH18*-PM resistance gene derived from the wild hop by using a new enzyme system (*Pst*/*Mse*I). At the same time highly reproducible fragments were produced which are of significance especially when creating genetic maps. In combination with the results from the PM resistance tests it was possible with the markers mentioned to provide evidence on the exact resistance gene constellation of the descendants from a crossing with two resistance parents which each carry the WH18- or the Jap-resistance. Besides the odd susceptible genotype seedlings could be identified which either have the WH18- or the Jap-Resistance. In addition those plants which have both PM resistance genes and are thus of great importance for breeding could be determined . The exact mapping of the resistance genes *WH18* and *Jap-C845* is to be carried out shortly.

An cDNA-AFLP analysis for the molecular testing of the WH18-resistance was also started recently. With this method it is possible to identify directly DNA regions which are activated as defence after pathogene attacks. In the resulting bands it solely concerns informative, coding genome areas. The outset for this cDNA-AFLP screening is a “differential display“ expression analysis. RNA was isolated at different times after inoculation from the leaves of resistant or susceptible descendants from a crossing with the WH18-wild hop as resistant parent (without and following contact with PM). Using this RNA a copy-DNA (cDNA) was synthetized and afterwards analyzed with the AFLP method.

Starting out from the cDNA-AFLP-patterns (Fig. 4.7) differences are sought after between plants with and those without defence reactions, as presumably resistant plants activate special genes for defence. Newly expressed DNA sequences are sought which can show homologies to known resistance genes in other kinds of cultures, thus to identify specific cDNA-AFLPs which play a part in recognising the pathogene and defending against it.. This occurs in collaboration with the Work Group of IPZ 1b, whose experience in the area of expression analysis in malting barley is very helpful.

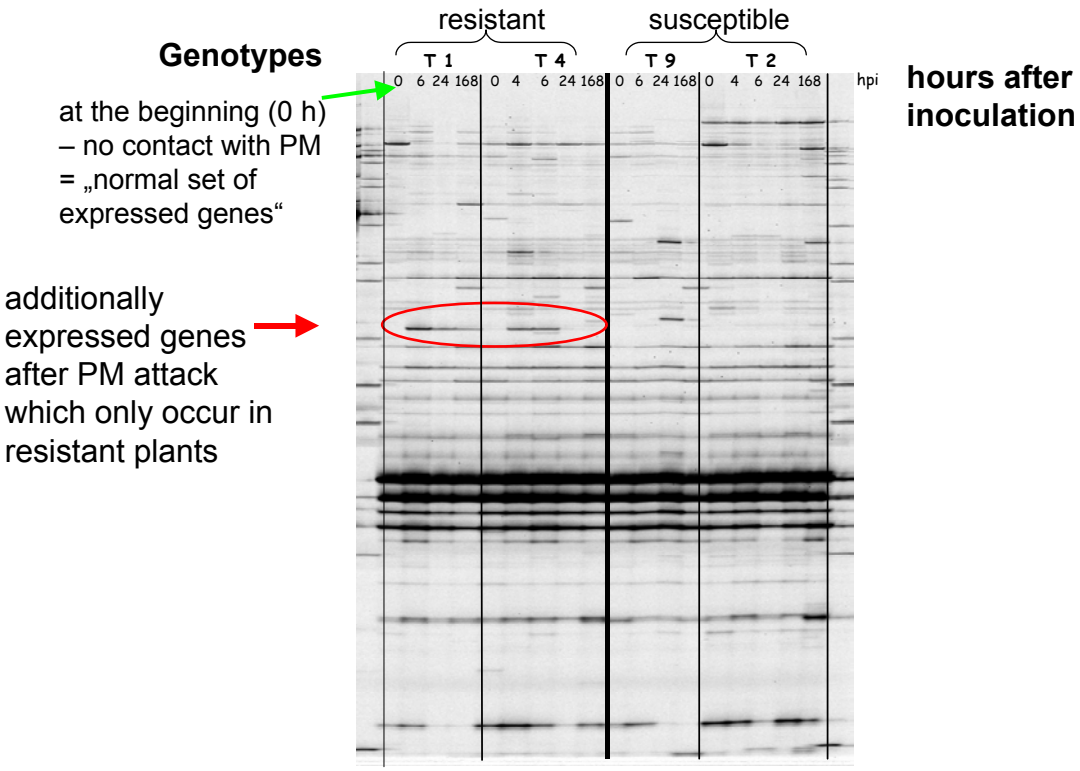


Fig. 4.7: cDNA-AFLP patterns of two resistant or PM susceptible descendants from a crossing with the wild hop WH18 as a resistant parent. Four hours after the first contact with the PM fungus, in resistant plants some genes are newly expressed which possibly play a part in recognizing and/or defending against the pathogen.

4.2.2 Working out an effective method to produce fungus resistant hops via gene transfer

Target

The target of this continued research project is the transfer of resistance genes in important Hüll hop varieties and consequently the expression of an improved tolerance towards fungal pathogenes.

Method

Resistance genes were isolated by PCR from plants and soil bacteria and cloned in diverse vectors. Several resistance gene constructs could be transfered via indirect gene transfer into the hops. Furthermore tests were carried out to optimise the *in vitro* culture.

Results

PCR protocols were further optimised for four bacterial chitinase genes on the way to making new gene constructs for the gene transfer. At the same time diverse proof-reading polymerases were used. Before cloning began all the sequences were tested several times by ordered sequencing.

Meanwhile two of the bacterial chitinases could be cloned through and transfered into two hop varieties via agrobacteria. As a result an improved regeneration ability was ascertained even in the variety "Hallertauer Mittelfrüher". As soon as sufficient plant material is available proof

will be brought at DNA and RNA level in order to confirm the stable insertion and the expression of the chitinase gene. Afterwards the effectiveness of the newly inserted gene is to be tested by *in vitro* infection tests. The two other bacterial chitinases are still in the cloning process.

In order to improve the regeneration of transgene hops, efforts were made to control endogene pathogenes by cultivating meristems as well as through infiltration tests with biocides. Furthermore media with various sources of iron and mixtures of such media were also tested which should contribute to optimising the regeneration protocol.

5 Hop Cultivation, Production Techniques

Johann Portner, Dipl. Ing. agr.

5.1 Nmin test 2006

Nitrogen fertilization according to nach DSN (Nmin) was introduced into the practice and has become an integral part of the fertilizer planning. 3619 hop yards in Bavaria were tested in 2006 for their Nmin content and a fertilizer was recommended.

The development of a number of samples for the Nmin test has been compiled in Table 5.1. The extremely high precipitation in March (113.5 mm) and in April (105.4 mm, Hüll weather station) impeded the technical soil sampling at a depth of 90 cm so that planned samples could no longer be taken to some extent. Compared with the previous year the average Nmin content was about 16 kg lower but still about 11-32 kg above the values in 1999 up to 2003. The nutrients withdrawn in the good crops 2004 and 2005 reduce the Nmin even further which surprisingly enough increased considerably after the dry year 2003.

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 of Nmin tests and average Nmin-contents as well as fertilizer recommendations in hop yards in the Bavarian production areas

Year	No. of samples	Nmin kg N/ha	Fertilizer 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

The number of hop yards tested, the average Nmin 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 and the Spalt production region showed the highest Nmin values. The recommendations for nitrogen fertilizer are consequently reversed.

Table 5.2: Number, average Nmin contents and fertilizer recommended for the hop yards of the districts and production areas in Bavaria 2006

District or production area	No. of samples	Nmin kg N/ha	Fertilizer recommended kg N/ha
Eichstätt	225	107	131
Kelheim	1380	85	153
Pfaffenhofen	1227	81	154
Hersbruck	35	80	138
Landshut	232	77	151
Freising	400	76	155
Hallertau	**3499**	**84**	**152**
Spalt	120	100	130
Bavaria	**3619**	**84**	**151**

The values are listed according to varieties in Table 5.3.

Table 5.3: Number, average Nmin contents and fertilzer recommended in various hop varieties in Bavaria 2006

Variety	No. of samples	Nmin kg N/ha	Fertilizer recommended kg N/ha
Herkules	13	65	170
Nugget	69	66	168
Brewers Gold	9	61	168
Hall. Magnum	790	76	160
Hall. Taurus	347	82	156
Hall. Merkur	19	78	152
Hall. Tradition	586	89	149
Spalter Select	221	90	148
Perle	664	90	147
Northern Brewer	92	91	146
Hallertauer Mfr.	509	79	145
Hersbrucker Spät	191	92	145
Saphir	47	90	143
Target	7	117	123
Spalter	34	134	103
Others	21	68	170
Bavaria	**3619**	**84**	**151**

5.2 Trial for training two or three bines in the case of the hop variety Saphir

The optimum number of bines trained per wire differs considerably according to the hop variety and must be determined individually. With an increasing number of bines per training wire

the labour time for training and retraining the bines increases and possibly the attacks of disease due to the more dense foliage. In the present trial every three years the influence of the number of bines on the yield, the alpha-acid content in % and the alpha-acid yield in kg/ha was investigated in the aroma variety Saphir.

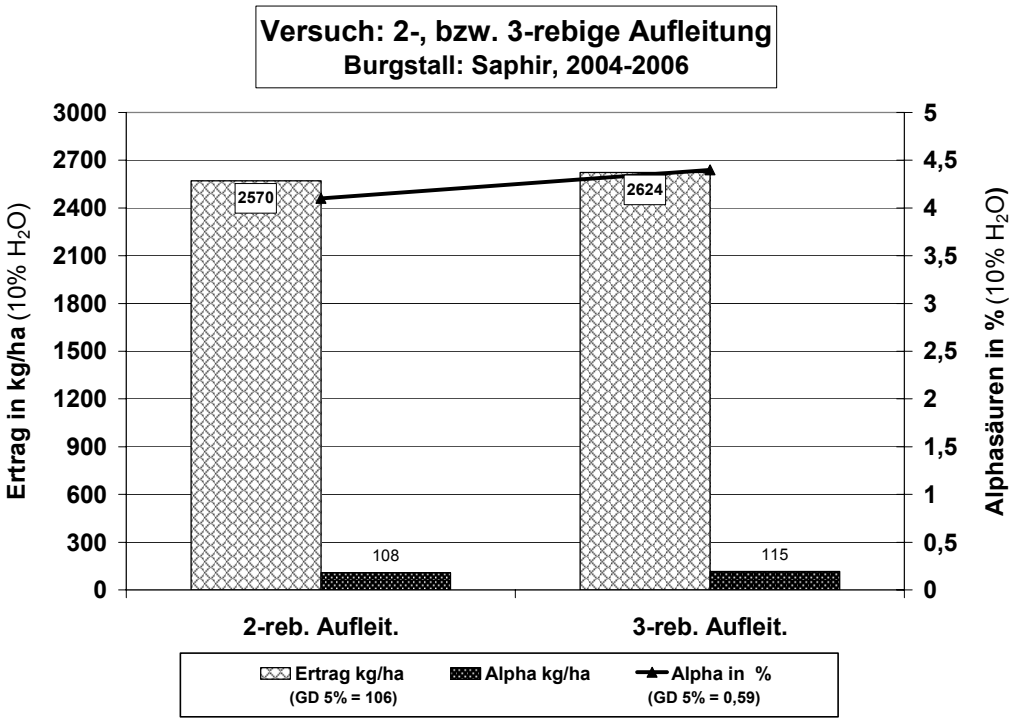


Fig. 5.1: Yields in kg/ha dry hops, alpha-acids in % and in kg/ha when 2 or three bines are trained; variety Saphir 2004-2006

Method

The test area was worked as usual in the practice including training 3 shoots per training wire. Afterwards the person working on the project corrected the respective number of shoots in those plots which were set up for 3 years. The trial plots were 3 rows wide and 12 poles long (9.0 x 18.72 m). According to the trial only the middle row with 24 wires was harvested at the respective optimum harvesting time. In this way marginal influences such as differing incidence of light, lack of nutrients, attacks of disease etc. were taken into account.

Result

The three-year calculation shows a slight but insignificant increase in training the 3-bines not only in the yield in kg/ha but also in the alpha acids in % and in kg/ha. Only in 2005 did the cone monitorings for pests and disease produce somewhat greater attacks of downy mildew and botrytis where 3-bines were trained. The reason is obviously found in the more lush habitus combined with high rainfall in the ripening phase. The assessed yield and alpha-acids for the individual years show the training with 3-bines has an advantage in 2004 and 2005 while in 2006 the training with 2-bines shows a slightly higher yield with the identical alpha-acid content..

For reasons of securing the yield and as a result of the trial the training with 3-bines is recommended for the variety Saphir.

5.3 Comparing various methods for rapidly determining the pH with regard to accuracy and practibility in the Advisory Service

Disturbances of growth often occur in hop-growing which can be traced back to an excess or lack of traces of nutrients. In order to narrow down the possible causes when advising the hop-grower or looking after the hop yard on the spot it is often necessary to determine the pH-value of the soil approximately. The various auxiliary means which are available for this purpose have been tested in this trial for their accuracy and practicability in the practice.

Carrying out the trial

31 samples were taken for determining the pH value from the samples received in Hüll for the Nmin test by the Hopfenring after homogenising and preparation, in order to enable the three different rapid determining methods to be carried out.
Parallel to this, each sample was analysed in the laboratory in Hüll with the pH meter.
The accuracy was tested and evaluated by testing the soils with differing pH values and different soil types. The 31 soil probes tested were classed as follows regarding the type of soil:

Table 5.4: Classing the soil probes tested in various types of soil

No. of samples	Key to soil type	Type of soil
2	01	Sand
2	02	Slightly clay soil sand
2	03	Very clay sand
18	04	Sandy clay
6	05	Light clay
1	06	Heavy clay

Comparison of the rapid determining methods

1. Hellige pH meter

This method which has been tried and tested over a long time is a quick way of determining the approximate pH value. A prefixed indicator solution is dribbled over a tiny soil probe and simultaneously assessed with the colour change for the pH value on a colour scsale from pH 4-9.

2. Soil tester by Messrs. Stelzner

This handy device which functions without electricity measures the pH value with the conductivity by putting it into the ground. A mixed probe of the tested soils was loosely filled into the measuring cylinders (200 ccm) supplied and condensed by striking the measuring cylinder at a height of 10 cm. This was repeated according to the instructions so long until the cylinder was filled up to the top. The electrode formed like a metal cone was then pressed 6.5 cm deep into the full measuring cylinder. After a few seconds the pH value could already be read at the upper scale with a graduation of two tenths.
The device is not suitable for too loose soils or substates. The moisture content of the soil should not fall short of or exceed certain limits and can be controlled with the device.

When observing the mean value of the results over 31 probes then the average is pH 5.60 with the soil tester compared with the laboratory method of von pH 7.29 which corresponds to a deviation of 23.18 %. Deviations of this amount are far too high so that good accuracy could not be confirmed for this measuring method.

3. Determining the pH value by means of a reflectometer (RQ-Flex)

The soil filtrate made for the Nmin test was used for measuring the pH with the RQ–Flex and for measuring in the laboratory with the pH meter. The filtrate gained from the suspension is essential for both methods because the use of unfiltered suspensions would distort the result.
The suspension is made from a homogenised mixed probe, mixed with distilled water in the ratio 1:1 whereby 44 g $CaCl_2$ were added to 30 litres of distilled water.
After consulting the manufacturer Merck the filtrate gained from this suspension is well suited for the test sticks (No.16 996, pH measuring range 4.0–9.0) used in the test.
Result:
After measuring the first probe there were very high deviations compared with the measuring results in the laboratory, so the time the test sticks were immersed was increased to 3 mins. The result showed that the mean averages were close to those of the laboratory method, however on an average the RQ-Flex value was 1.3 pH points below the laboratory test so that even this method is far too inaccurate with an average deviation of 17.83 %.
Besides this cannot be called a rapid method because the time needed was considerably more than originally assumed.

4. Laboratory measuring with the pH measuring equipment (with pH electrode)

The same filtrate (made from the suspension soil:distilled water in the ratio 1:1 and with $CaCl_2$ added) from each single probe in the laboratory was tested with the pH meter for determining the right pH value exactly.
Parallel to this to make sure, each 6th probe was measured again with another pH measuring device. By thecking with the second pH meter the first measuring result was confirmed in the permitted tolerance range. The comparative pH meter showed maximum a deviation of pH 0.1, so that measuring with the laboratory equipment can be described as being very accurate and reliable.
The requirements of the ISO 10390 / 1994 (similar to the procedure of the AQU 1 of the LfL) were observed in this method of determining the pH value.

Test series 2

In a second test series according to the same plan 9 different soil probes (taken from a depth of 30 cm) from Hungary were tested using 4 different methods.
Here too there proved to be a similar trend. The deviations of the rapid determination methods are even higher than in test series 1.

Resumé

Three different methods to determine the pH value rapidly were tested and compared with the exact laboratory method for accuracy and practicability.
The well-tried Hellige test method provided the most exact results and compared with the average result of measurings (1st test series) only had a deviation of pH –0.27. The handling is simple and relatively fast. At 2nd place with regard to accuracy is determining the pH rapidly with the RQ-Flex test strips. However, with an average deviation of pH –1.30 this method is very inaccurate. Besides preparing the filtrate and the long measuring time it takes too long so that this cannot be called a practicable rapid method. The pH meter with the greatest deviation (pH

–1.69) was the soil tester from Stelzner, which shows advantages in the handling but was disappointing due to the inaccurate results.
After consulting Dr. Wurzinger from the AQU 1 Dept. at the LfL in Freising the two latter methods of fast determining the pH should no longer be pursued. Their use in the practice to determine the pH value rapidly therefore cannot be recommended for the advisory service on the spot.

5.4 Chances and economic efficiency of alternative sources of energy in drying hops

Problem
44 litres of heating oil per 100 kg dry hops are required on an average for drying hops. Due to the rise in oil prices the variable drying costs increased in crop year 2006 compared with the crop year 2003 by approx. € 250/ha. With increasingly rising energy prices alternative energies and means of heat recovery are becoming economically more interesting.

Numerous tests and measurings were carried out in 10 different hop farms during the 2006 crop to work out the principle and correlations on the use of alternative energies for drying hops.

Basic correlations
With increasing temperature of the intake air the amount of heating oil used is reduced with the same drying performance. With the heat produced through the alternative sources of energy the intake air for drying is pre-warmed and consequently oil can be saved. How many litres of heating oil can be saved per hour drying time depends on the amount of warmth produced by the alternative source of energy. One litre of heating oil can be replaced when 10 KWh heat is supplied. With the help of this conversion the warmth of the alternative source of energy can be recorded very quickly. Consequently 9 litres of heating oil per hour drying time can be replaced e.g. through a heating with chaff cuttings which supplies 100 KW and has a 90% degree of effectiveness. The heat supplied by the oil burners in the drying plants amounts to 300 – 1200 KWh depending on the size of the kiln. Based on the heat from the oil burners used in the practice it quickly becomes clear that due to the great amount of energy required for drying the hops, the additional alternative sources of heat can only partly be a substitute for heating oil.

Description of trial
In the test farms oil flow meters were installed in the pressure pipes of the oil-burners to enable the oil consumption to be recorded using different drying variants with and without additional alternative sources of energy. In addition the temperature and dampness of the intake air and the extracted air was recorded in the floor kilns and belt dryers. The heat and the effectiveness of the alternative source of energy could be recorded via the change in the intake temperature in different drying variants. It was necessary to record the temperature and relative dampness of the kiln exhaust for observing the same drying processes.

Alternative sources of energy in drying hops
The trials, measurements and recordings were carried out in facilities which have alternative sources of energy, chaff heating, a bio-gas plant and or heating with logs. In the case of **chaff heating and the bio-gas plant** the intake air was pre-heated over a heat exchanger. In the trials differences of 20-80% in effective degrees of the heat reduction over heat exchangers were determined! In two comparative test facilities each with respectively 100 KW chaff heating in one case 8 litres of heating oil and in the other case only 2 litres of heating oil were saved per hour drying time. The deviation was in the different way and positioning of the heat exchanger. For an optimum heat reduction the exchanger must be positioned in the air flow of the intake

air in such a way that the additionally produced heat is fully recorded. In addition to this the heat exchanger must be coordinated to the required air flow and must not affect or change the flowing rates of the drying air.
As far as **heating with logs** is concerned there is a converted hop kiln which was positioned in such a way in the intake air that the air could be pre-warmed. As the kiln floor was only 9 m^2 in this facility, here the effects of increasing intake temperatures could be demonstrated very well on the oil consumption per 100 kg dry hops. Thus to dry 100 kg hops with the same drying conditions and the temperature of the intake air at 15 °C 44 litres, at 25 °C 35 litres and at 40 °C only 33 litres of heating oil were needed. To reach an optimum degree of effectivity in heating with logs logs had to be added every quarter of an hour.

Saving energy by recovering heat from the drying process
As far as hop kilns are concerned, with heat recovery the temperature of the intake air can likewise be increased and consequently the oil consumption can be reduced.
In many hop buildings the air is considerably warmer under the roof than the outside air due to the warmth emitted from the hop kilns and the solar influence. If this warmer air in the building can be used via shafts as intake air for the drying plant, energy can therefore be saved with to a certain extent less trouble. However before undertaking such construction work it is essential that fire regulations are observed, such as the installation of a fire protection flap and dust filters. In addition to this the manufacturer's recommendations for drying plants must be observed!

As with belt dryers the temperature of the extracted air is higher and the relative moisture lower than in the case of hop kilns, heat recovery from this extracted air over heat exchangers is econocially interesting.
Oil savings of approx. 4-8 litres per 100 kg dry hops could be obtained in the tests by increasing the temperature of the intake air by 5-10°C via heat recovery.
If the heat is recovered without additional fans, it is essential that the air conditions in the heating room are checked. With low pressure in the heating room the oil burner needs its own air shaft due to the fire regulations!

Heat recovery from power units

Power units are used in many facilities to produce electricity. 3 litres of heating oil are needed to produce 10 kWh electricity. Two-thirds of the energy used is recovered heat. About half of this can be used to pre-heat the intake air. Consequently 6 litres of heating oil per hour drying time can be substituted e.g. by the usable heat recovered from the power unit with an output of 60 KW and a theoretical degree of 100% effectiveness. As far as heat exchangers are concerned the degree of effectiveness obtained depends on how the generator is positioned. If the recovered heat is fully captured from the air flow of the intake air, degrees of effectiveness of up to 90 % of the usable heat recovered can be obtained. Differences of 10-90% in the degree of effectiveness were determined in the practice.

Economic efficiency
Basically it is interesting to find out how many litres of heating oil per hour drying time can be saved by investing in alternative sources of energy.

1 litre of heating oil corresponds to 10 kWh heat !

In calculating the economic efficiency the costs for alternative sources of energy used, such as chaff or logs must be added. Furthermore the economic efficiency of an investment depends on the useful life, the investment costs and the price of heating oil.

The annual savings for variable drying costs can be calculated from the savings in heating oil costs less the variable costs for the alternative sources of energy.

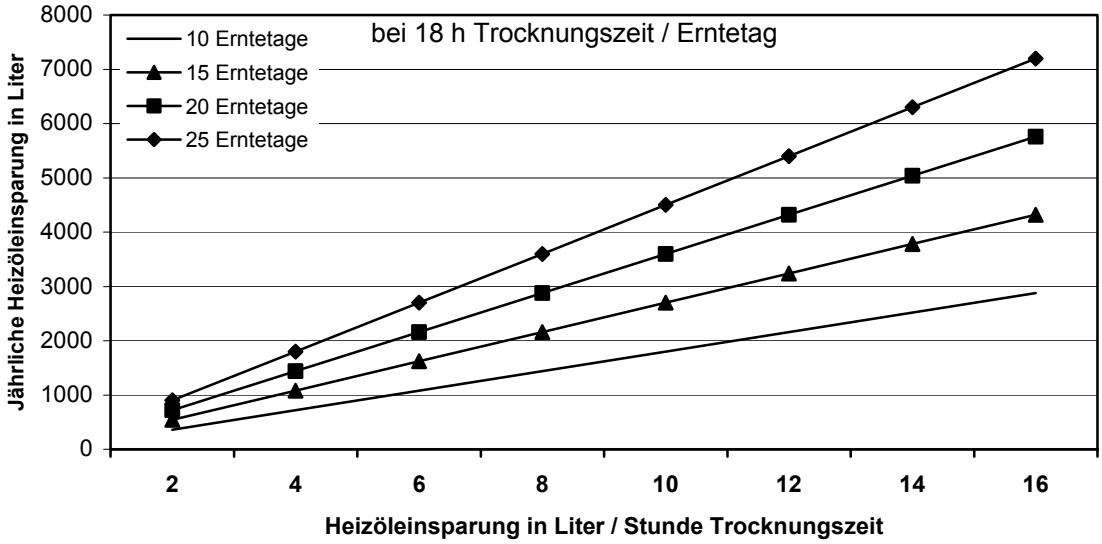


Fig. 5.2: Oil savings depending on the degree of effectiveness of the alternative sources of energy

Decisive are the savings in heating oil per hour drying time by the alternative source of energy. 8 litres of heating oil per hour can be replaced by chaff heating with 100 KW and an 80% degree of effectiveness(=80 KWh usable heat) of the heat available. From the chart it can be seen that in 20 crop days annual heating oil savings of approx. 3000 litres heating oil are possible if calculated with 18 hours drying time per crop day. Consequently €1800 can be saved with the cost of heating oil at 0.6 €/litre. On the other hand costs are nevertheless incurred for the heat available from the chaff. Taking the degree of effectiveness of the heat exchanger into consideration approx. 0.14 m³ (1 m³ chaff ≅ 70 l heating oil) chaff material is needed for the 8 litres of heating oil saved. In this case approx. 50 m³ chaff is fired resulting in 20 crop days and the set drying time of 18 hours per day. Consequently with a price of €15 per m³ chaff costs amounting to €750 are incurred. The difference between the savings for heating oil and the additional costs incurred for chaff therefore produces the variable drying costs actually saved amounting to €1050 per year.
The economic efficiency and the amortisation time for the investment can be determined by means of the variable drying costs saved annually. However basically an investment is only profitable if the fixed costs (e.g. write-offs, insurances, interest rate) from the construction measures and other variable costs (e.g. electricity for chaff heating) do not exceed the savings in drying costs.

5.5 Advisory and training activities

Besides the applied research in the area of hop techniques for cultivating hops the Work Group Hops, Production Techniques (IPZ 5a) evaluates the test results for the practice making them directly available to the hop farmers through special consultations, lessons, training facilities, talks, print media as well as via the internet. The organisation of the peronospora warning service and updating the warning instructions are among their tasks just as much as providing the

specialist service for the hop producer groups and the training for the Hopfenring specialists as multiplicators for the Advisory Service on the spot.

The training and advisory activities during the previous year are summrized as follows:

5.5.1 Information in written form

- The "Green Pamphlet" Hops 2006 – 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 3000 copies by the LfL to the ÄfL and research facilities and distributed by the producer rings to the hop growers.
- LfL Information brochure "Optimal Drying and Conditioning of Hops".
- Up-to-date hop-growing tips and warning service advice was sent to the hop-growers via the Hopfenring fax (2006: 55 faxes à 943 participants) in 37 faxes.
- Likewise up-to-date information was made available at weekly intervals for the weather fax.
- Within the bounds of the DSN soil test 3619 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 3 Hopfenring ER-circulars and in 9 monthly issues of the Hopfen Rundschau.
- With the HSK (Hop Card Index) recording and evaluation programme on 760 cards hop index evaluations were carried out for 240 hop-growers and returned to the farmers in written form.

5.5.2 Internet and Intranet

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

5.5.3 Telephone advice and announcement services

- The peronospora warning service was compiled during the period 09.05.–28.08.2006 by the Work Group Hop Cultivation, Production Techniques in Wolnzach in collaboration with the Work Group Plant Protection in Hüll and updated 76 times so that it could be called up via the answerphone (Tel. 08442/9257-60) or via the internet.
- Tips on hop cultivation with up-to-date notes on pests and diseases as wewll as fertilizer and soil-working measures can be heard over the answerphone in Wolnzach (Tel. 08442/957-401).
- As for special questions on hop cultivation, the trade consultants of the Work Group Hop Cultivation, Production Techniques provided advice in approx. 3,500 cases per telephone or consultations in individual discussions or on the spot

5.5.4 Talks, tours, training facilities and meetings

- A 3-day workshop on business management at the ALF Abensberg
- 7 training courses for the Hopfenring consultants
- 9 hop cultivation meetings in collaboration with the ÄLF
- 47 specialist talks
- 10 trial tours for the hop-growers and the hop industry
- 1 workshop on Hop Drying and Conditioning
- 1 BiLa Seminar Hop Cultivation and Marketing in Abensberg (4 evenings)
- 12 lessons at the Pfaffenhofen Agricultural College for the students in the Hops Faculty
- School Day for the summer semester of the Pfaffenhofen Agricultural College
- 5 hop cultivation seminars for the new fertilizer regulation

6 Plant Protection in Hop Cultivation

Bernhard Engelhard, Dipl. Ing. agr.

6.1 Pests and diseases in hops

Alfalfa weevil *Otiorrhynchus ligustici* L. and wire worm (Elateridae)

The cold, damp weather in April has prevented the pests from a widespread occurrence. Despite to this there were strong attacks in known locations of infestation as well as in small areas in the hop yards.

As there are no effective soil insecticides which can be distributed and have an effect on the hops through watering, the danger of long-term damage on hops is becoming increasingly greater due to the weevil larvae in the soil.

Hop aphid *Phorodon humuli*

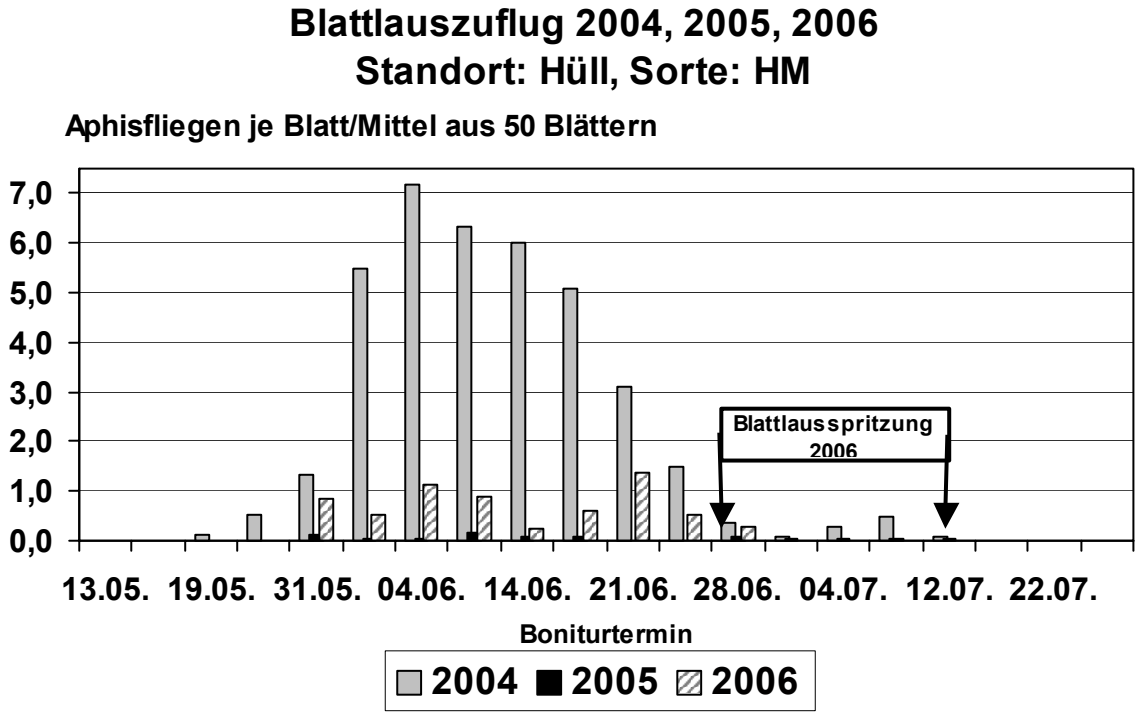


Fig. 6.1.: Aphid migration

The late vegetation start and the cool, rainy April had affected the start of the migration of the winged aphids. The late, moderate migration is unusual. Then it was surprising that the development of the population rapidly increased on the hop plants despite the cold nights at the beginning of June.

The aphid sprayings at the end of June up to mid-July were correctly timed. All aphids could be killed in combination with good effects. As there was no further new migration the aphids

could be well controlled except in the case of a few stands of Hallertauer Magnum. In the hot period in July any populations still present in untreated plots declined.

Two-spotted spider mite *Tetranychus urticae* Koch

The experience that low temperatures in February and March prevent strong attacks of common spider mite was confirmed. The attacks of common spider mite were all in all very few.

Extensive application of the acaricide Vertimec can be traced back to the very good side effect on hop aphids.

Downy mildew *Pseudoperonospora humuli* (Miyabe et Takahashi) Wilson

It was already obvious by the end of April that there were many **primary infections**. This also applied to the tolerant Hüll-bred varieties. Advice to this effect was constantly given up to 23.06 with the beginning of the peronospora warning service at the beginning of May. The control of the primary infection is prerequisite for participating in the peronospora warning service. Primary and secondary infection must be seen strictly apart.

One cause for the long primary infection in many hop yards is that the product Fonganil Gold containing metal-axyl could not be sprayed in time as the yards were impassable for vehicles in April.

The first spray warning to control the **secondary infection** came at the right time on 30.06. for susceptible varieties and on 10.07. for all varieties.

As the infections almost completely stopped in the hot period, no sprayings were necessary at this time. Infection material developed only at the end of the first ten days in August and shortly before the harvest resulted in two very important warnings for protection against downy mildew (peronospora). Sprayings prior to this date would have had no positive effect for this infection.

Consequence: The peronospora warning service also reacted correctly in 2006.

Powdery mildew *Podosphaera humuli* Burrill, botrytis *Botrytis cinerea* Persson

Powdery mildew was no problem in the German hop-growing regions for four years in uninterrupted succession. At eleven locations in the Hallertau with untreated plots mildew was only ascertained at one location. Consequently sprayings would not have been necessary in the majority of cases; however according to current information these preventive sprayings are still necessary to ensure yield and quality.

Botrytis attacks were very few.

Wilt *Verticillium albo-atrum* Reinke et Berthold

The conditions for severe wilt infestation existed due to the damp soils in the spring. It was therefore almost somewhat surprising that few wilt problems occurred. If freshly chopped bines are brought back to the hop yards during the harvest, a somewhat higher infestation trend is recorded.

6.2 Research project "Development of control strategies in organic hop production as alternatives to using plant protectives containing copper and sulphur"

On 30th November 2006 this three-year project financed by the Federal Programme for Ecological Agriculture at the Federal Institute for Food & Agriculture (BLE) was closed. The target formulated was only partly reached, i.e. working out methods to control the pests and diseases in ecological hop cultivation without synthetic plant protectives and substituting or reducing the products containing copper and sulphur. But even the documented failures which arose in the testing work for this target decisively contribute to a realistic up-to-date judgment of the chances of controlling pests and fungal diseases in the ecological cultivation of hops. The detailed report will be published in 2007 in the LfL publication series; here is just a short summary of the most important results and evidence.

Downy mildew or peronospora *Pseudoperonospora humuli*

The tests were carried out in the highly susceptible cv. Hallertauer Mittelfrüher. In none of the three test years did four copper-free variants produce any satisfactory results. As for the variants with reduced amounts of copper in the form of copper-hydroxide the concentration was set too low. With 50% savings on copper the effect was inadequate.

Consequence: The downy mildew cannot be effectively controlled in the ecological hop production without products containing copper. The application quantity with products containing copper-hydroxide must still be adjusted.

Table 6.1: **Tested variants for the control of downy mildew 2004-2006**

Geprüfte Varianten zur Peronosporabekämpfung 2004 - 2006

Schlag "Mus", Herpersdorf, Sorte Hallertauer Mittelfrüher

Variante	2004	2005	2006
Funguran (Cu-oxychlorid)	x	x	x
Cuprozin flüssig (Cu-hydroxid)	x	x	x
DPD GFJ 52-008 (Cu-hydroxid)	-	x	x
Frutogard (phosphithaltig)	x	-	-
Stähler (phosphitfrei)	-	x	x
Kanne Brottrunk	x	-	-
Molke	x	-	-
FungEnd + Öle	-	x	x
„Praxis“ (betriebsübliche Behandlung)	x	x	x
„Praxis“ + Frutogard	-	x	-
unbehandelt	x	x	x

Table 6.2: Spraying dates and amounts of copper actually sprayed in the variants containing copper 2006

Spritzung	Datum	BBCH	Wasser-menge [l/ha]	kg bzw. Liter Produkt			
				Funguran	GF-J52-008	Cuprozin flüssig	Betrieb
1.	19.05.	19	400	0,8	0,6	0,4	Mischung mit weiteren Mitteln
2.	21.06.	37-38	1400	2,8	2,1	1,4	
3.	01.07.	39	1600	3,2	2,4	1,6	
4.	10.07.*	51	1800	3,6	2,7	1,8	
5.	08.08.*	71	2000	4	3	2	
6.	19.08.*	75	2200	4,4	3,3	2,2	
7.	25.08.*	79	2500	5	3,75	2,5	
			Summe Produkt	23,8	17,85	11,9	
			Summe Cu/ha	10,71	5,35	3,57	4
		Cu % zu Funguran		100%	50%	33%	37%

* = Spraying dates according to spray warning

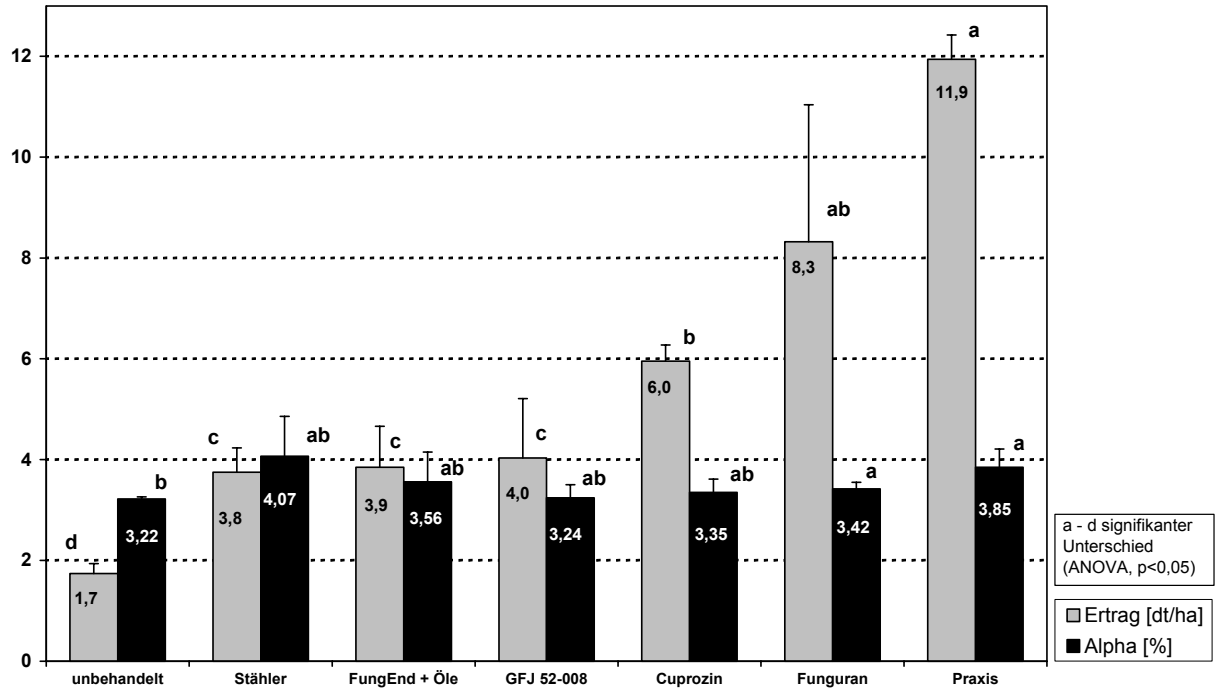


Fig. 6.2: Yield and alpha in various variants to control downy mildew in organic hop production 2006: Results of the experimental harvest in the "Mus" field, cv. HA, Herpersdorf, 05.09.2006.

Hop aphid *Phorodon humuli*

Quassia -a brew made at the farm - always produced the best results in spraying. The effect was even improved by adding soft soap. It is true that NeemAzal T/S showed an effect on aphids but for fairly satisfactory results the effect was inadequate. There were no fundamental differences between sprayed and painted variants. Seen over the whole duration of the test also the effect of the pyrethrins Spruzit Neu was very unsatisfactory. In the painted variants it was clear in the first year of the test that positive results could be expected with the quassia product TRF-002 but this is a question of the amount of active substance used. Under the conditions of the ecological hop production basically the commercial product TRF-002 produced very good results with an amount of active substance of 24 g/ha quassin during two vegetation periods. However at the same time it must be remembered that these were years with few aphid attacks.

Consequence: Efforts should be made to register the finished product TRF-002 in compliance with the Plant Protection Law.

Table 6.3: Development of the aphid population 2006

Entwicklung der Blattlauspopulation 2006 **Läuse pro Blatt**
Schlag Flöz, Herpersdorf, Sorte Perle **Mittelwerte aus je 50 Blättern**

Variante	16.06.2006 1 Tag vor 1. Behandlung	20.06.2006 4 Tage nach 1. Behandlung	30.06.2006 4 Tage nach 2. Behandlung	04.07.2006 10 Tage nach 2. Behandlung	12.07.2006 3 Wochen nach 2. Behandlung
unbehandelt	50	70	73	111	120
Spritzvarianten:					
NeemAzal T/S	55	84	86	165	148
Spruzit Neu	68	80	69	52	117
Quassia	29	43	14	26	10
Quassia plus Schmierseife	40	32	11	7	3
Streichvarianten:					
NeemAzal T/S	45	84	42	97	151
TRF-002 12 g/ha	44	76	24	49	23
TRF-002 24 g/ha	40	51	28	14	4
TRF-002 36 g/ha	32	43	42	8	10

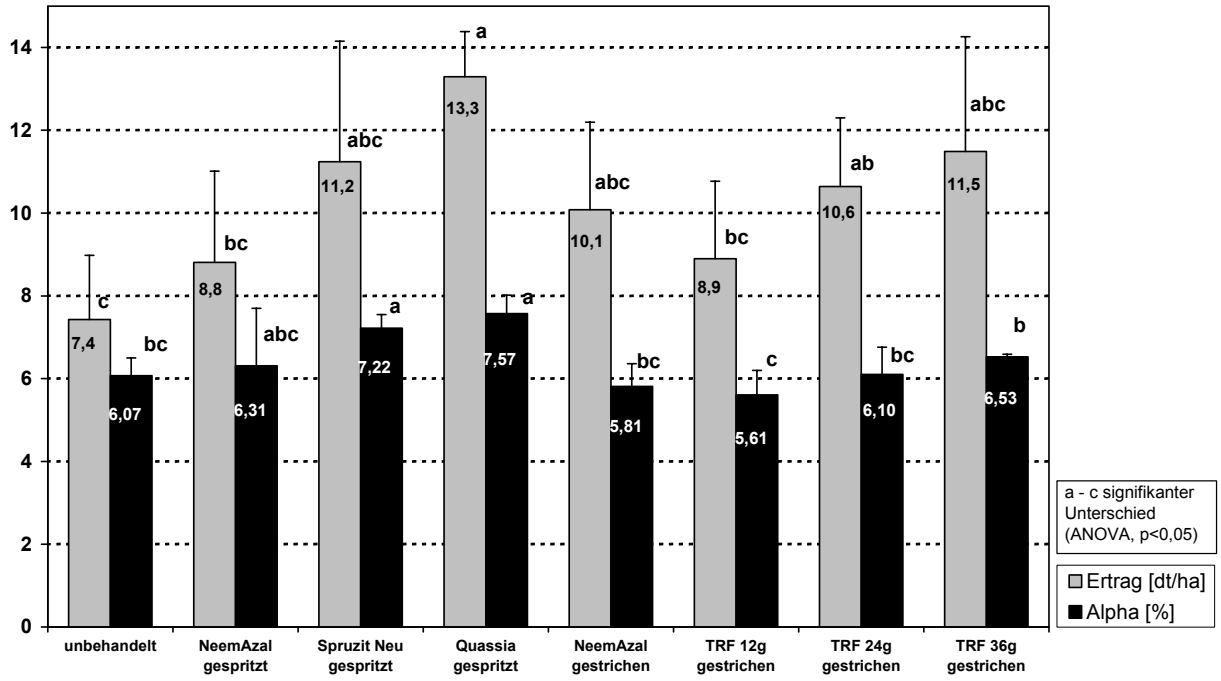


Fig. 6.3: Yield and alpha acids content in various processes for controlling aphids in the organic production of hops 2006: Results of the experimental harvest in the field "Flöz", cv. PE, Herpersdorf, 05.09.2006.

6.3 Virus-free plant material

5,824 plants were tested for virus in 2006..

- **Field of work: Breeding**
  2,128 mother plants tested for ApMV and HMV

- **Propagation farm Eickelmann**
  740 mother plants for ApMV and HMV
  of which: 458 Herkules
  20 Hallertauer Magnum
  18 Hallertauer Mittelfrüh
  10 Spalter Select
  20 Hersbrucker
  130 Hallertauer Tradition
  84 Perle

- **Hallertauer Hop Ring**
  94 ApMV for B-certificate

- **Producer Ring Jura**
  2,092 ApMV for B-certificate

- **Professor Schildbach propagation farm in Turkey**
  56 mother plants for ApMV
  56 mother plants for HMV

- **Own examinations**
  356 ApMV
  302 HMV

7 Hop Quality and Analytics

Dr. Klaus Kammhuber, Dipl. Chemiker

7.1 Introduction

The Work Group IPZ 5d has an important cross-sectional function in the Hops Section IPZ 5. It carries out all the analytical investigations which are needed to support questions on research by the other work groups. Focus is increasingly on the hop plant as a medicinal plant. The study group Evolution of Medicinal Botany at the University of Würzburg nominated hops to be the "Medicinal Plant of the Year 2007". The following physiological properties of hops which are based on reliable scientific research can be called: antimicrobial, sedative, antioxidative, oestrogenic and last but not least even anticarcinogenic. The alpha-acids are regarded as being the primary economic quality characteristic of hops. The essential oils are responsible for the smell and the aroma. Their soothing effect can be used in medicine. The polyphenols have an effect like antioxidants and can capture free radicals. Xanthohumol which is only found in hops has a considerable anticarcinogenic potential. The substance 8-prenylnaringenin is regarded as one of the strongest phyto-oestrogens and consequently gives the hops a slightly oestrogenic effect. Due to these components alternative uses are feasible for hops, e.g. in the food industry, as a constituent for cosmetics and medicines, in functional foods and food additives.

7.2 Varieties with high contents of alpha- and beta-acids

As breeding target for the bitter varieties is firstly the highest possible alpha-acid content without special qualitative requirements, secondly bitter hops should be bred with qualitative requirements such as Hallertauer Magnum and Hallertauer Taurus. Also the beta-acids are increasingly arousing interest, as they prove to be antimicrobial to gram-positive, pathogenic bacteria. In the sugar and ethanol industry they should be a substitute for formalin. This could definitely mean a bigger market for hops. Table 7.1 shows 20 breeding lines and varieties with the highest alpha-acid contents of the 2005 crop in descending order.

Table 7.1: Breeding lines and varieties with the highest alpha-acid contents in the 2005 crop

Breeding line/Variety	Alpha-acids	Beta-acids	ß/a	Cohumulone	Colupulone
2000/109/728	20.9	6.8	0.32	27.2	47.5
2000/108/715	19.9	7.4	0.37	27.7	51.7
Herkules	19.6	6.5	0.33	35.1	55.9
99/061/009	19.4	6.1	0.32	23.0	45.9
99/093/003	19.1	8.2	0.43	23.5	46.8

Table 7.1 (continued)

Breeding line/Variety	Alpha-acids	Beta-acids	ß/a	Cohumulone	Colupulone
2000/109/728	18.9	6.0	0.32	26.5	46.6
Hallertauer Taurus	18.9	6.2	0.33	20.9	45.3
Herkules	18.7	6.4	0.34	31.0	57.4
Hallertauer Taurus	18.7	5.8	0.31	23.2	48.3
2000/078/750	18.7	5.9	0.32	24.7	52.3
Hallertauer Magnum	18.5	6.7	0.36	26.2	51.1
99/093/718	18.4	7.4	0.40	24.2	50.9
Herkules	18.4	6.2	0.34	35.6	56.2
Hallertauer Taurus	18.4	6.4	0.35	22.5	47.2
Hallertauer Magnum	18.3	6.6	0.36	26.0	49.5
2000/070/006	18.2	6.7	0.37	26.3	50.9
2001/103/710	18.1	5.1	0.28	21.6	43.9
99/093/003	18.1	8.0	0.44	24.6	47.2
2000/109/728	18.1	5.3	0.29	26.5	50.0
99/060/011	18.1	6.2	0.34	23.2	46.6

α- and ß-acids in % as is.; analoga in % of the alpha- and beta-acids

Two breeding lines exceed the variety Herkules with regard to their alpha-acid content. Also these two breeding lines have a remarkably low cohumulone proportion with 27 %.

Table 7.2 shows 20 breeding lines and varieties with the highest beta-acid contents of the 2005 crop.

Table 7.2: Breeding lines and varieties with the highest beta-acid contents of the 2005 crop

Breeding line/Variety	Alpha-acids	Beta-acids	ß/a	Cohumulone	Colupulone
96/031/009	**4.8**	**11.9**	**2.45**	**21.7**	**40.8**
96/031/009	5.6	11.8	2.09	19.4	39.7
2002/006/737	4.6	11.3	2.46	17.3	34.6
2002/045/719	**15.3**	**10.6**	**0.69**	**23.9**	**43.4**
2002/006/727	5.6	10.4	1.87	19.5	39.4
2002/033/010	7.7	10.1	1.31	21.6	40.5
2000/109/727	**17.2**	**10.1**	**0.59**	**21.1**	**51.7**
97/071/737	**14.0**	**10.1**	**0.72**	**28.9**	**51.3**

Table 7.2 (continued)

Breeding line/Variety	Alpha-acids	Beta-acids	ß/a	Cohumulone	Colupulone
96/010/024	5.2	10.0	1.92	25.4	41.0
97/025/007	**0.1**	**10.0**	**112.39**	**55.8**	**26.3**
98/009/013	7.3	10.0	1.36	17.9	40.0
96/030/011	5.1	10.0	1.96	16.2	38.6
2003/066/719	6.6	9.8	1.50	29.0	55.6
2003/026/009	6.8	9.8	1.44	21.9	45.9
2000/109/727	16.3	9.8	0.60	21.8	51.8
94/075/758	15.1	9.7	0.64	21.1	42.1
2000/109/727	15.8	9.6	0.61	21.9	51.2
2003/091/005	13.2	9.6	0.73	23.4	46.0
96/030/011	2.9	9.5	3.26	14.4	31.3
96/008/014	9.6	9.5	0.99	21.4	41.0

α- and ß-acids in % as is.; analoga in % of the alpha- and beta-acids

The breeding line 96/031/009 holds the record with 11.82 % beta-acids. The breeding lines 2002/045/719, 2000/109/727 and 97/071/737 are marked not only by a high beta-acid but also by a high alpha-acid content. As for breeding line 97/025/007 obviously the enzyme oxidasis is blocked by a mutation so that only beta-acids and no alpha-acids occur (Fig. 7.13).

7.3 The biogenesis of the hop bitter components in 2006

The alpha-acid content plays an increasingly important part in the payment for hops. Therefore it is important to determine the right time for harvesting the hops in order to obtain the best possible optimum alpha-acid content. Harvesting-time trials were also carried out in 2006 with the most important varieties and these analysed with HPLC; at the same time the biogenesis of the xanthohumol could also be observed for the first time. The figures 7.1 –7.12 show the evaluations.

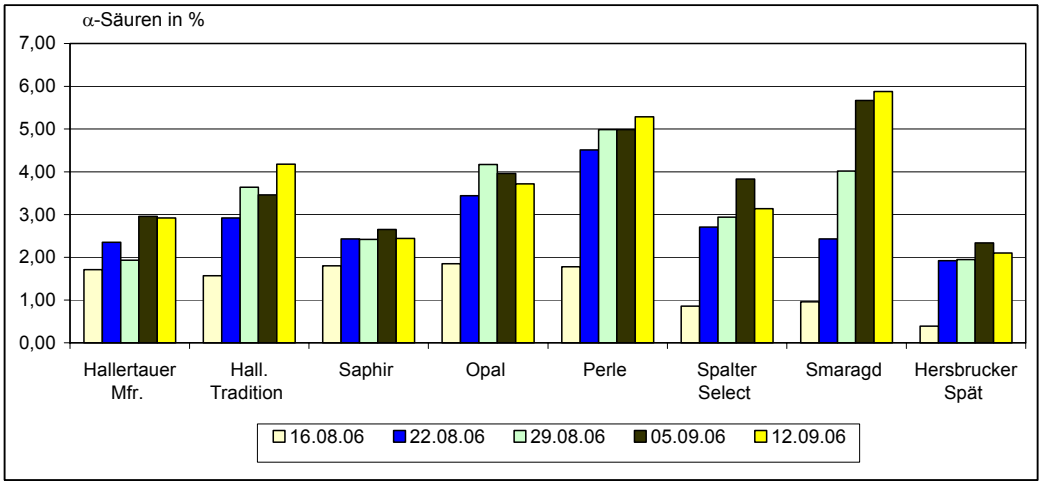


Fig. 7.1: The biogenesis of the alpha-acids in aroma varieties of the 2006 crop

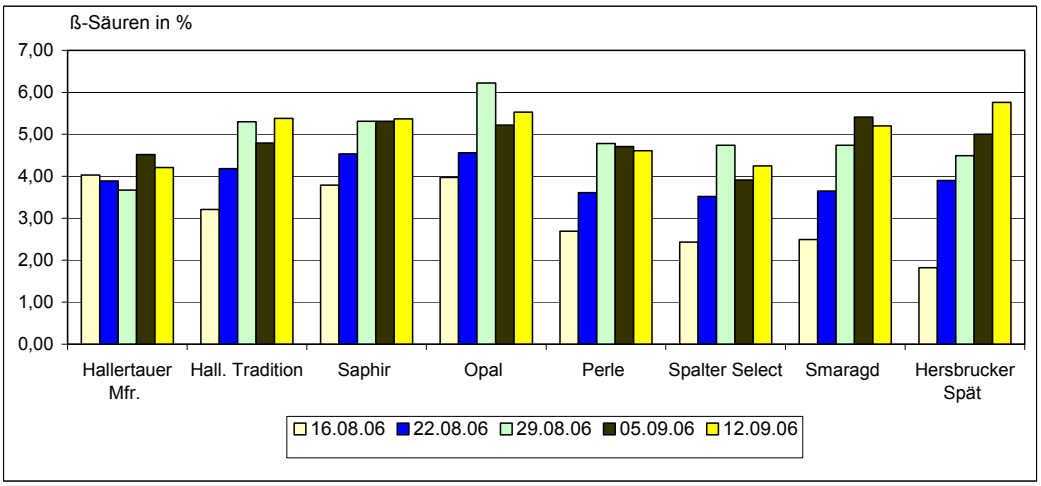


Fig. 7.2: The biogenesis of the beta-acids in aroma varieties of the 2006 crop

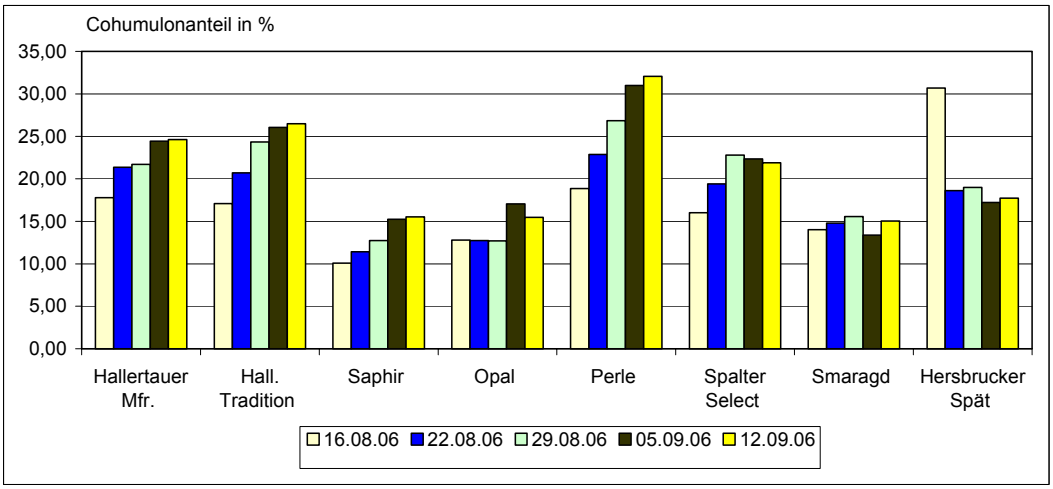


Fig. 7.3: Development of the cohumulone proportion in aroma varieties of the 2006 crop

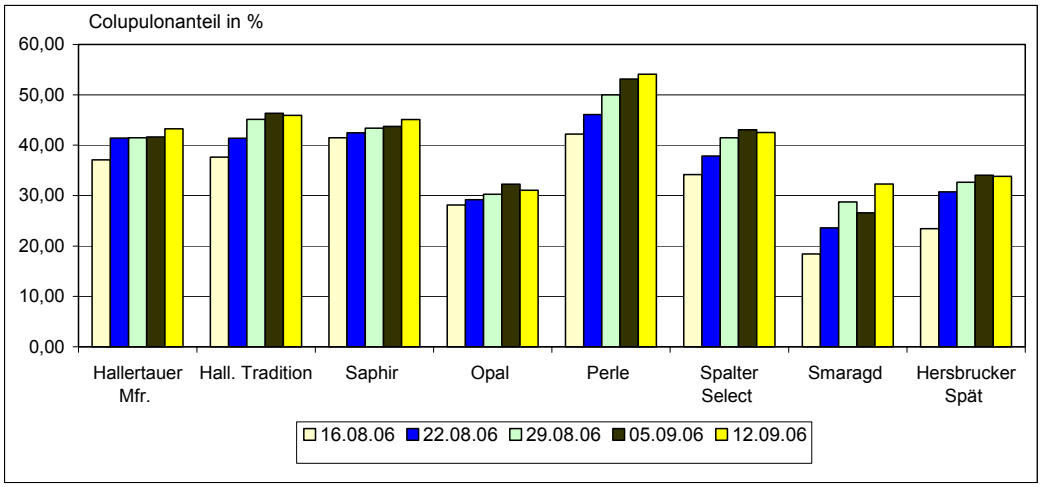


Fig. 7.4: Development of the colupulone proportion in aroma varieties of the 2006 crop

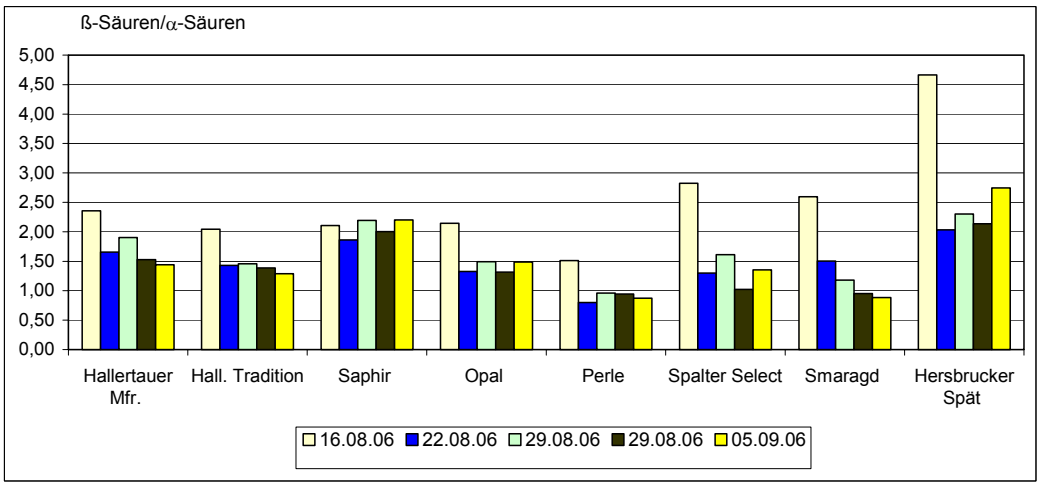


Fig. 7.5: Development of the beta-acid/alpha-acid ratio in aroma varieties of the 2006 crop

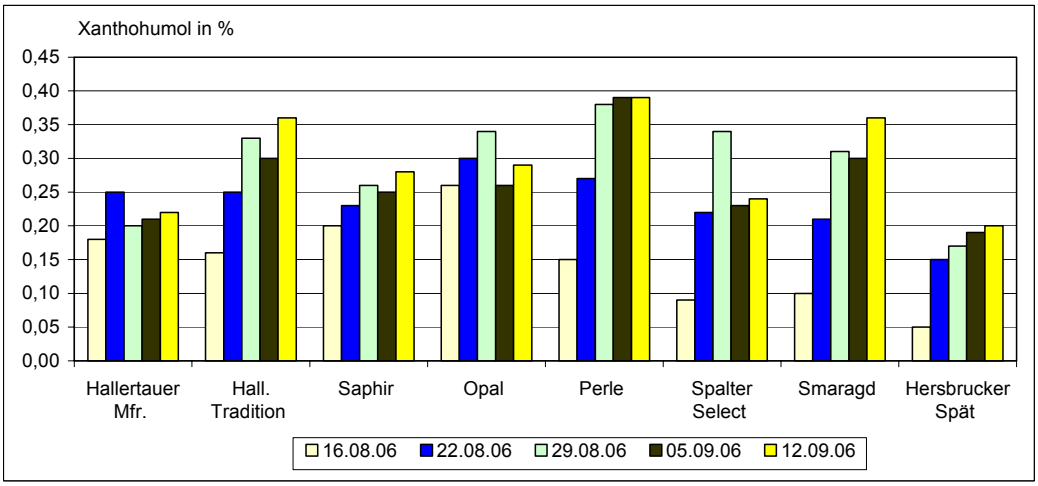


Fig. 7.6: The biogenesis of xanthohumol in aroma varieties of the 2006 crop

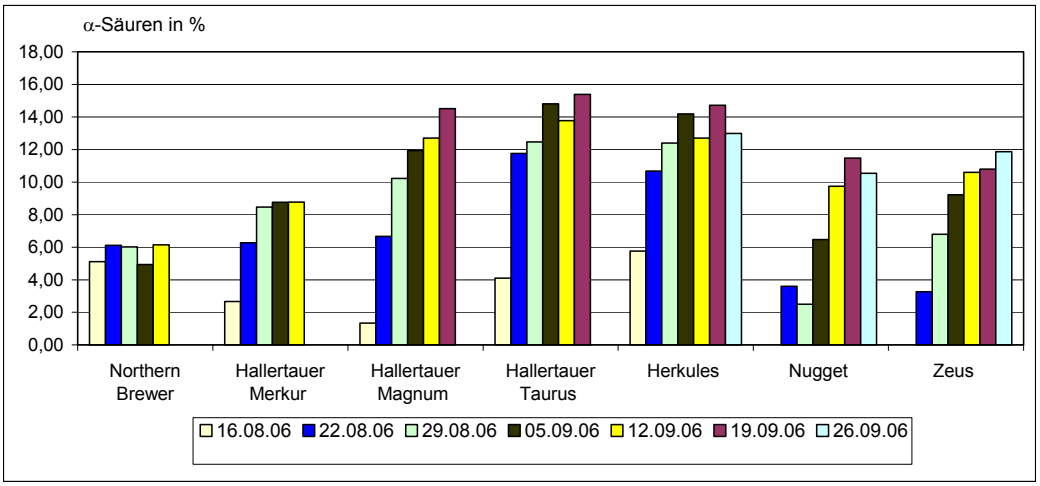


Fig. 7.7: The biogenesis of the alpha-acids in bitter varieties of the 2006 crop

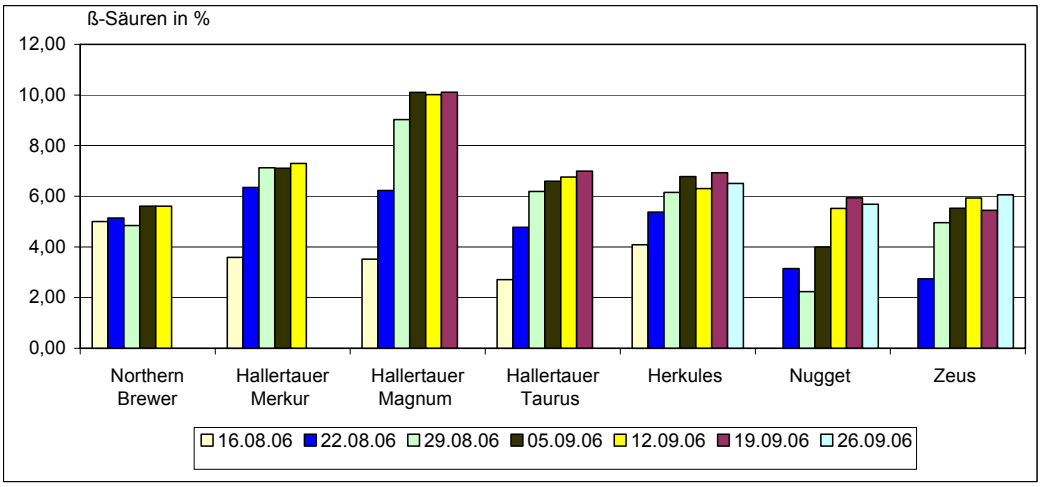


Fig. 7.8: The biogenesis of the beta-acids in bitter varieties of the 2006 crop

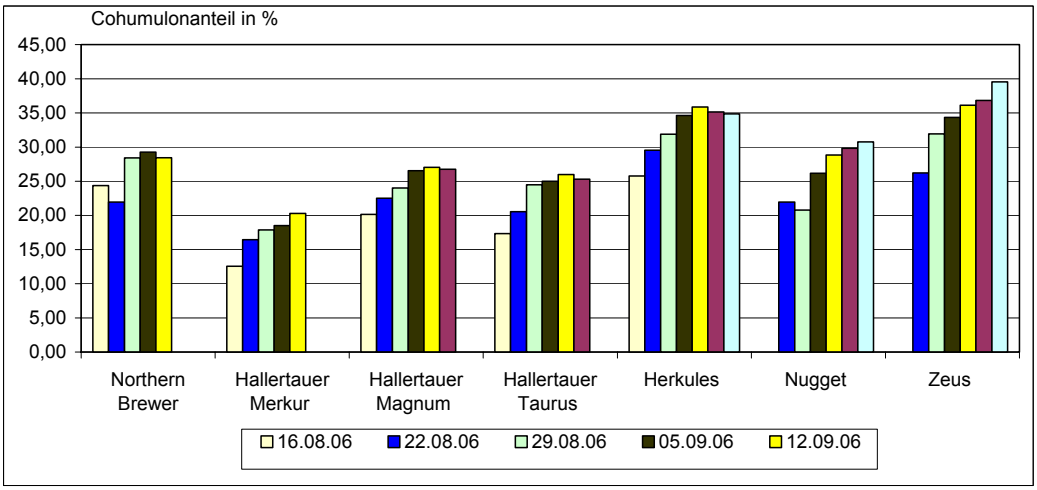


Fig. 7.9: Development of the cohumulone proportion in bitter varieties of the 2006 crop

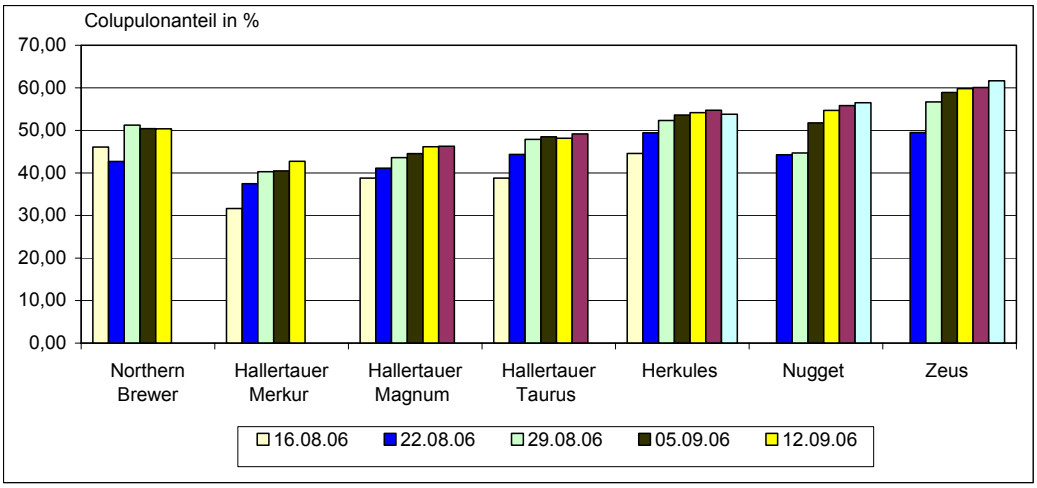


Fig. 7.10: Development of the colupulone proportion in bitter varieties of the 2006 crop

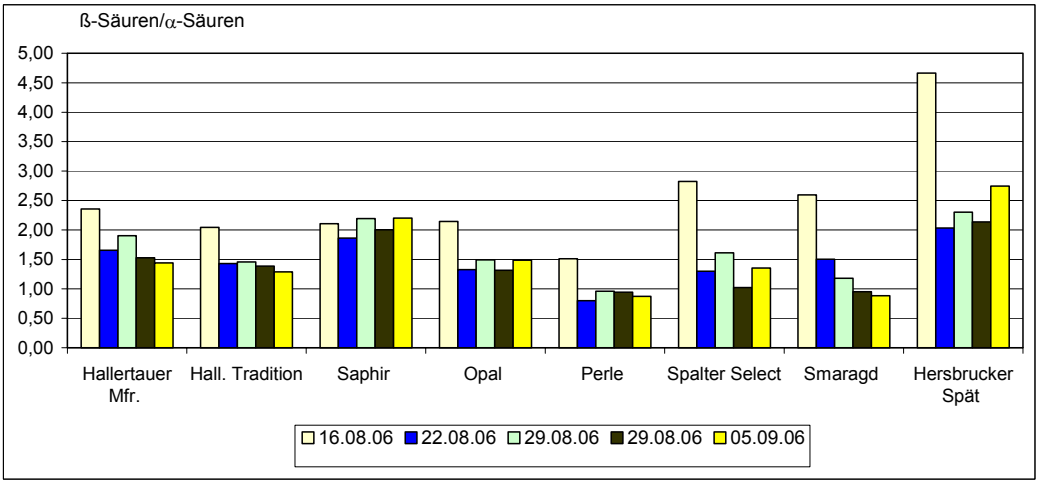


Fig. 7.11: Development of the beta-acid/alpha-acid ratio in bitter varieties of the 2006 crop

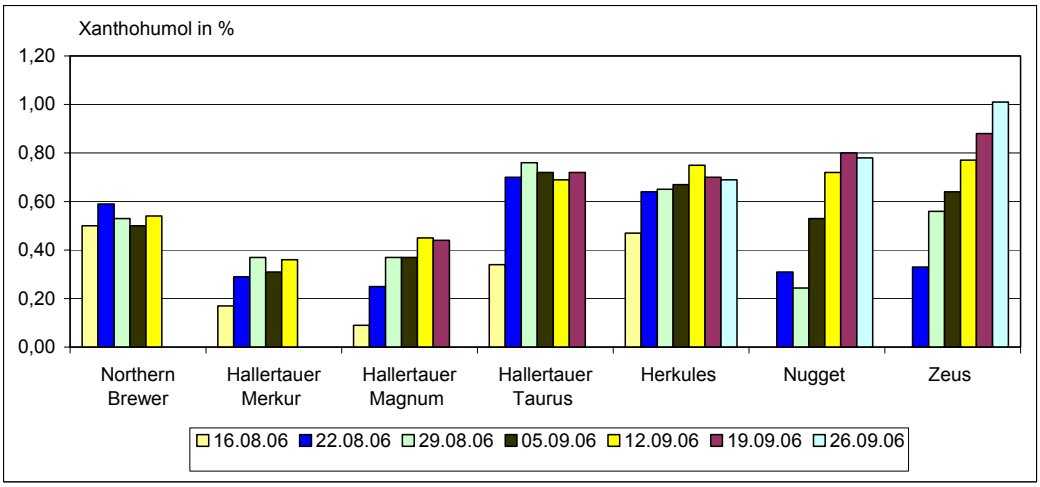


Fig. 7.12: The biogenesis of xanthohumol in aroma varieties of the 2006 crop

From the diagrams it is obvious that the alpha- and beta-acids as well as the xanthohumol constantly increase during the ripening phase, whereby definite differences in variety can be seen in the early and late varieties. Also the cohumulone and colupulone proportions develop upwards. The variety Hersbrucker Spät can be regarded as the only exception. Here the cohumulone proportion is at its highest at the first harvesting time and then becomes less. This work is an important aid in obtaining an optimum alpha-acid content. However the ripening of the alpha-acids depends considserably on the climatic conditions and changes from year to year. Therefore every year investigations must be carried out on the biogenesis of the hop components. In 2006 not only the alpha-acids but also the xanthohumol values were very low. It has not yet been clarified whether the beta-acids are formed first of all in the biosynthesis of the bitter compounds and from these the alpha-acids arise via the desoxyhumulone or whether the biosynthesis route via the desoxyhumulone is taken as joint preliminary stage of the alpha- and beta-acids (Fig. 7.13). As the quotient beta-acids/alpha-acids however decline during the ripening phase it can be assumed that first the beta-acids are formed and then the alpha-acids. Investigations on the lupulin glands of hop leaves confirm this assumption. Lupulin glands of hop leaves form beta-acids and alpha-acids only in traces.

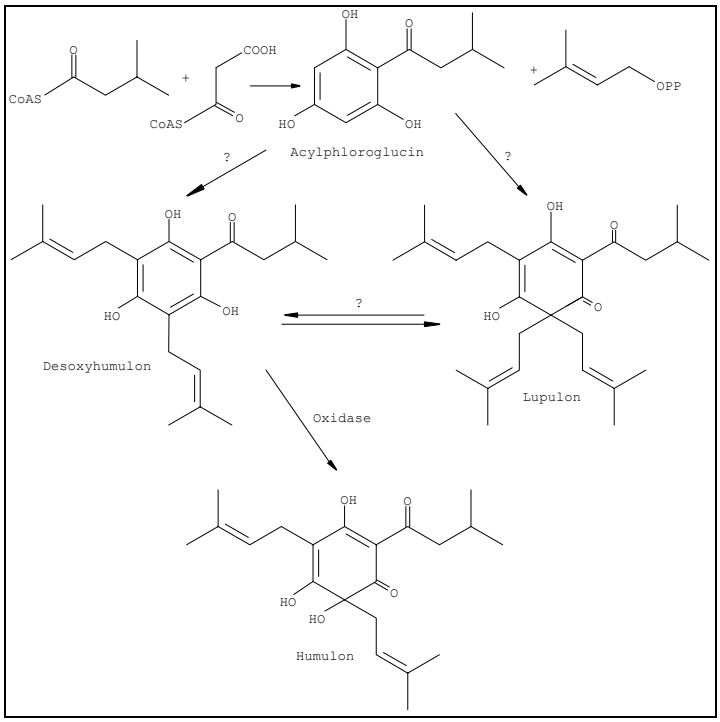


Fig. 7.13: Biosynthesis route of the hop bitter compounds

7.4 World hop range (2005 crop)

This research programme is carried out every year. The target is to determine the quality and variety-specific components of the available domestic and foreign hop varieties in cultivation under the site conditions in Hüll. Table 7.3 shows the results of the crop-year 2005. It can be an aid to allocate unknown hop varieties to a specific variety type.

Table 7.3: World hop range 2005

Variety	Myr cene	2-M.-iso- butyrate	Sub. 14 b	Sub. 15 b	Lina- lool	Aroma- dendren	Ande- canon	Humu- lene	Farne- sene	γ-Muu- rolene	ß-Se- linene	α-Se- linene	Cadi- nene	Seli- nadiene	Gera- niol	α-acids	ß-acids	ß/α	Cohu- mulon	Colu- pulon
Admiral	2809	308	0	18	26	0	6	240	7	7	3	2	15	0	2	15.4	6.9	0.45	35.7	62.5
Agnus	2178	45	1	4	7	1	2	120	0	5	5	4	12	0	1	13.1	7.6	0.58	35.1	55.4
Ahil	2771	212	19	4	9	2	5	143	48	5	6	5	12	0	0	9.6	3.9	0.40	38.8	66.5
Alliance	1071	133	3	2	21	0	4	271	5	8	3	3	16	0	0	4.7	2.5	0.53	27.6	60.8
Alpharoma	1742	115	23	7	11	0	7	239	14	8	5	3	16	0	0	12.0	4.0	0.34	25.7	54.2
Apolon	2595	75	33	6	19	1	1	140	30	5	6	4	9	0	0	8.1	4.0	0.49	33.2	56.4
Aquila	3164	53	2	82	20	25	12	13	0	9	50	54	8	67	0	5.0	3.5	0.69	53.0	74.5
Aromat	1899	28	5	6	27	0	20	283	17	8	10	13	19	0	3	4.6	4.6	1.00	29.6	48.2
Atlas	2185	510	20	5	23	2	1	117	24	6	7	5	10	0	0	6.2	3.4	0.55	45.3	65.3
Aurora	3578	124	4	28	33	0	19	261	23	14	2	2	15	0	0	8.0	4.1	0.51	23.0	51.2
Backa	559	225	3	6	14	0	6	220	8	8	2	2	16	0	0	8.7	7.0	0.80	42.2	58.9
Belgischer Spalter	1282	146	3	6	19	9	12	145	0	10	28	29	14	54	0	6.2	3.4	0.54	22.6	45.7
Blisk	1273	90	11	3	13	0	2	175	42	6	5	5	13	0	2	7.9	3.8	0.47	34.4	61.4
Boadicea	979	43	1	8	3	1	1	116	13	4	5	5	11	0	0	8.6	4.4	0.51	23.7	45.4
Bobek	5564	155	14	70	49	0	12	262	31	5	2	2	17	0	0	6.1	5.7	0.93	25.8	47.5
Bor	2197	78	2	31	9	0	5	254	0	6	3	3	14	0	1	10.8	5.0	0.47	24.2	49.5
Braustern	2622	124	3	34	9	0	5	223	0	7	2	2	14	0	0	7.8	4.8	0.61	27.3	49.9
Brewers Gold	2416	227	8	15	11	0	1	155	0	5	7	6	13	0	0	6.5	3.8	0.59	43.8	69.1
Brewers Stand	5739	472	17	24	39	14	13	50	0	50	56	47	85	57	0	5.6	4.2	0.76	32.9	54.2
Buket	1954	131	3	36	22	0	9	223	13	8	6	5	16	0	1	9.2	5.1	0.55	24.6	48.4
Bullion	1614	154	11	13	16	0	2	120	0	6	6	5	13	0	0	6.3	5.6	0.89	43.4	66.5
Cascade	2071	107	16	4	16	0	4	189	14	7	11	9	15	0	0	6.8	4.4	0.65	32.3	54.1
Chang bei 1	1187	19	5	3	28	0	12	171	9	8	19	17	15	21	0	4.8	4.3	0.89	30.3	47.3
Chang bei 2	1189	11	5	3	29	0	13	197	10	9	17	16	16	22	0	3.7	4.7	1.26	23.0	46.4
College Cluster	675	142	17	6	6	0	3	126	0	4	5	4	9	0	1	8.9	3.0	0.34	21.4	45.0

Table 7.3 (continued)

Variety	Myr cene	2-M.-iso- butyrate	Sub. 14 b	Sub. 15 b	Lina- lool	Aroma- dendren	Ande- canon	Humu- lene	Farne- sene	γ-Muu- rolene	ß-Se- linene	α-Se- linene	Cadi- nene	Seli- nadiene	Gera- niol	α-acids	ß-acids	ß/α	Cohu- mulon	Colu- pulon
Columbia	514	48	20	2	18	0	4	250	0	11	22	19	21	0	0	5.7	6.3	1.11	22.7	42.0
Columbus	2620	139	8	5	8	0	1	149	0	13	11	10	31	9	0	9.8	4.6	0.47	38.8	61.7
Comet	1742	37	5	19	10	0	2	6	0	2	31	36	5	12	0	8.2	4.1	0.50	42.3	62.9
Crystal	590	9	0	4	21	26	9	150	0	10	34	36	14	56	0	3.8	6.6	1.74	20.5	40.6
Density	1090	108	4	0	38	0	10	220	0	7	0	0	14	0	0	4.3	3.4	0.78	41.1	63.4
Diva	2609	31	4	14	20	0	11	266	11	17	119	143	22	0	0	6.3	6.2	0.98	24.5	49.8
Early Choice	2175	150	0	19	12	0	6	215	0	7	55	60	15	0	0	3.4	2.0	0.60	34.1	64.0
Eastern Gold	1258	1	1	3	10	0	5	165	8	18	9	8	35	9	0	12.4	5.5	0.44	27.6	52.5
Eastwell Golding	1262	87	2	7	16	0	4	279	0	8	3	2	16	0	0	5.5	3.7	0.67	23.8	50.7
Emerald	593	28	5	7	7	0	5	272	0	8	4	3	16	0	1	7.0	4.3	0.61	25.3	50.1
Eroica	3357	311	30	96	7	8	4	121	0	5	7	7	11	0	0	9.4	7.9	0.84	41.9	63.2
Estera	1106	140	2	5	16	0	7	243	9	7	3	2	14	0	0	4.1	3.1	0.74	25.6	49.3
First Gold	1971	171	1	6	18	2	8	241	9	8	100	120	20	0	2	8.8	4.2	0.48	29.8	54.6
Fuggle	1386	126	2	5	12	0	6	251	9	10	3	2	15	0	0	5.6	4.0	0.72	26.7	47.5
Galena	3343	340	26	93	6	5	4	175	0	6	7	6	15	0	0	8.8	7.1	0.80	39.8	62.9
Ging Dao Do Hua	1610	427	3	3	23	0	8	173	0	16	48	49	31	0	0	4.9	5.6	1.13	44.1	66.2
Glacier	2702	22	6	5	27	0	7	286	0	7	3	3	17	0	0	7.4	9.2	1.23	14.0	41.2
Golden Star	2310	526	3	3	23	0	6	167	0	16	42	44	30	0	0	4.3	5.0	1.16	46.5	68.4
Granit	1120	75	5	8	5	2	13	171	0	5	7	6	11	0	1	7.6	5.2	0.68	25.5	46.1
Green Bullet	1695	18	13	4	13	0	7	180	0	5	0	0	11	0	0	6.3	3.9	0.61	40.5	67.7
Hallertauer Gold	881	36	26	4	16	0	5	252	0	7	3	3	15	0	0	6.8	5.0	0.73	17.6	42.4
Hallertauer Magnum	6703	120	29	28	8	1	2	271	0	5	2	2	13	0	0	15.1	7.7	0.51	28.6	50.0
Hallertauer Merkur	2679	103	12	8	14	2	5	258	0	12	3	3	15	0	1	14.3	6.4	0.45	18.4	44.7
Hallertauer Mfr.	315	20	2	0	10	0	5	300	0	14	4	3	17	0	0	4.1	6.0	1.45	18.6	37.8
Hallertauer Taurus	11501	225	18	22	43	0	8	266	0	7	71	92	20	0	0	17.0	6.3	0.37	23.2	47.4

Table 7.3 (continued)

Variety	Myr cen	2-M.-iso-butyrate	Sub. 14 b	Sub. 15 b	Lina-lool	Aroma-dendren	Ande-canon	Humu-lene	Farne-sene	γ-Muu-rolene	ß-Se-linene	α-Se-linene	Cadi-nene	Seli-nadien	Gera-niol	α-acids	ß-acids	ß/α	Cohu-mulon	Colu-pulon
Hallertauer Tradition	1476	72	11	3	21	0	5	298	0	13	3	3	15	0	0	6.0	5.6	0.92	22.6	46.0
Herald	4049	297	2	106	8	3	14	210	0	11	33	43	14	0	0	10.3	4.8	0.47	36.8	60.8
Herkules	7335	223	57	77	10	0	5	254	0	5	2	2	14	0	0	17.5	6.2	0.35	30.9	58.7
Hersbrucker Pure	1388	68	3	7	27	11	13	208	0	18	31	34	17	51	0	5.1	3.3	0.65	22.3	43.7
Hersbrucker Spät	839	16	5	4	28	35	12	178	0	25	45	50	17	60	0	3.1	5.4	1.71	20.5	40.4
Horizon	2962	115	6	24	27	2	7	103	7	3	9	9	6	0	0	10.4	6.1	0.59	23.0	49.4
Hüller	695	73	18	2	23	9	6	124	0	42	43	39	70	59	0	4.3	4.3	0.99	29.8	49.3
Hüller Anfang	342	53	7	0	11	0	5	307	0	9	5	5	17	0	0	3.8	5.4	1.42	19.9	44.0
Hüller Aroma	741	65	5	0	20	0	7	340	0	10	4	2	19	0	0	4.7	5.0	1.06	27.2	49.6
Hüller Fortschritt	1442	68	13	0	25	0	10	310	0	9	3	2	17	0	0	4.2	4.9	1.17	29.3	49.8
Hüller Start	556	46	2	3	9	0	11	353	0	12	5	4	21	0	0	3.5	4.5	1.31	27.6	47.3
Japan C 730	1141	1	13	25	18	0	11	93	24	5	6	4	7	0	0	4.8	2.4	0.50	35.5	54.5
Japan C 827	678	7	9	0	9	0	4	254	10	6	2	2	15	23	0	7.4	2.5	0.33	24.5	53.0
Japan C 845	948	12	4	11	5	0	2	268	19	7	3	2	16	0	1	9.3	4.2	0.45	26.2	46.2
Kirin 1	1570	469	2	2	23	0	6	188	0	19	45	46	35	0	0	3.7	4.6	1.23	45.9	69.0
Kirin 2	2107	586	3	4	24	0	6	186	0	21	53	55	38	0	0	4.2	4.7	1.14	47.3	69.2
Kitomidori	745	8	2	7	4	0	2	256	14	7	3	2	16	0	1	8.1	3.7	0.46	27.9	46.6
Kumir	2629	103	3	15	20	2	7	256	6	6	3	2	14	0	1	11.8	5.7	0.48	23.9	46.3
Late Cluster	13744	707	20	54	50	20	18	47	14	69	61	50	137	73	0	5.6	4.6	0.82	33.3	54.1
Liberty	456	29	2	7	14	5	7	250	0	10	10	8	18	12	1	5.6	4.3	0.78	26.3	48.3
Lubelski	2655	9	5	5	23	0	14	290	26	8	3	2	16	0	0	5.4	6.3	1.15	30.4	47.3
Malling	1500	163	0	4	26	0	8	234	8	8	4	3	15	3	0	3.5	2.4	0.67	29.0	51.4
Marynka	2131	227	3	22	11	6	5	128	41	5	5	4	12	0	0	7.7	3.7	0.48	19.8	44.7
Mt. Hood	229	20	9	2	7	0	3	266	0	11	4	3	18	0	0	5.3	7.3	1.39	26.6	45.1

Table 7.3 (continued)

Variety	Myr cene	2-M.-iso-butyrat	Sub. 14 b	Sub. 15 b	Lina-lool	Aroma-dendren	Ande-canon	Humu-lene	Farne-sene	γ-Muu-rolene	ß-Se-linene	α-Se-linene	Cadi-nene	Seli-nadiene	Gera-niol	α-acids	ß-acids	ß/α	Cohu-mulon	Colu-pulon
Neoplanta	1282	77	2	17	7	0	4	208	12	7	3	2	15	0	1	8.4	4.7	0.56	35.7	61.4
Northern Brewer	2668	88	2	37	6	0	4	250	0	7	3	2	14	0	0	9.0	5.9	0.66	26.3	48.6
Nugget	1524	51	2	10	9	1	2	153	0	5	6	6	10	0	0	11.9	5.2	0.44	29.5	56.3
Olympic	1352	50	2	10	11	2	4	152	0	4	6	6	10	0	0	11.6	4.6	0.40	28.2	55.5
Omega	1865	280	15	9	17	0	4	242	0	6	51	63	16	0	1	7.2	3.7	0.52	23.9	49.8
Opal	4106	42	15	25	26	2	6	238	0	10	4	2	15	14	0	8.2	7.1	0.87	13.6	32.9
Orion	700	60	5	4	13	0	3	219	0	8	3	2	15	0	1	8.3	5.1	0.61	29.0	52.7
OT 48	1564	108	5	0	43	0	11	197	0	6	0	0	12	0	0	4.3	3.4	0.79	40.3	62.4
Pacific Gem.	3282	155	17	18	14	0	10	188	0	6	0	2	12	0	0	10.2	6.1	0.59	37.8	65.8
PCU 280	2177	77	1	18	5	0	3	254	0	7	3	3	13	0	0	9.5	4.5	0.47	28.3	53.5
Perle	1219	34	1	17	4	0	3	255	0	8	3	3	14	0	0	8.2	5.0	0.61	29.4	54.6
Phoenix	1885	156	2	8	5	0	6	252	8	10	52	61	16	0	0	11.2	6.3	0.57	26.3	51.1
Pilgrim	5097	331	2	71	10	2	14	270	0	4	72	94	19	0	0	8.2	4.0	0.49	35.3	60.9
Pilot	11533	870	32	147	79	22	57	121	0	11	624	762	46	0	0	8.9	4.5	0.50	36.8	59.7
Pioneer	2735	199	2	122	7	3	19	224	0	5	36	40	16	0	0	10.2	4.6	0.45	34.8	60.3
Premiant	3078	80	3	14	16	2	6	258	10	6	3	2	14	0	0	11.5	6.1	0.53	23.1	47.9
Pride of Kent	1092	33	0	4	25	0	6	257	0	8	4	3	15	0	1	6.2	3.0	0.49	30.4	58.2
Pride of Ringwood	1319	19	2	1	7	0	8	10	0	6	63	73	11	0	0	10.0	4.9	0.49	31.4	56.7
Saazer	1945	0	4	5	26	0	17	304	19	21	6	2	18	0	0	4.2	4.8	1.13	25.3	43.8
Saphir	4730	75	5	30	37	11	20	189	0	15	17	19	13	23	0	3.7	7.6	2.05	12.0	43.8
Serebrianker	673	126	3	4	27	0	5	164	0	12	47	45	20	0	0	2.1	4.3	2.02	32.5	44.8
Sladek	2215	90	3	11	19	2	7	263	6	7	3	3	15	0	1	12.3	5.8	0.47	24.4	46.9
Smaragd	1478	7	13	11	22	0	5	278	0	9	4	3	17	21	0	7.4	5.8	0.78	13.3	32.4
Spalter	2343	0	4	6	31	0	20	303	20	20	2	2	19	0	0	4.6	6.2	1.34	23.6	43.4

Table 7.3 (continued)

Variety	Myr cene	2-M.-iso- butyrate	Sub. 14 b	Sub. 15 b	Lina- lool	Aroma- dendren	Ande- canon	Humu- lene	Farne- sene	γ-Muu- rolene	ß-Se- linene	α-Se- linene	Cadi- nene	Seli- nadiene	Gera- niol	α-acids	ß-acids	ß/α	Cohu- mulon	Colu- pulon
Spalter Select	3419	91	26	8	81	13	15	219	21	8	28	30	17	43	0	4.2	4.4	1.07	23.5	45.6
Sterling	1338	73	3	13	14	2	3	145	0	5	6	6	10	0	0	10.0	4.7	0.47	27.6	53.7
Sticklebract	4159	161	23	12	10	0	8	123	23	4	32	38	10	0	0	13.7	6.6	0.48	37.9	64.0
Strisselspalter	1095	19	4	8	24	29	10	177	0	23	39	43	16	56	0	4.1	6.8	1.66	18.8	38.1
Südafrika	1480	39	0	2	5	0	5	216	0	9	59	63	18	0	1	5.5	4.9	0.90	33.3	52.4
Super Alpha	3536	73	38	17	26	0	10	238	0	7	3	2	14	0	0	12.6	6.7	0.53	34.9	58.7
Talisman	2484	136	2	40	8	0	4	236	0	7	3	2	14	0	0	12.3	6.5	0.53	30.0	52.7
Tettnanger	2022	3	3	6	26	0	17	298	18	18	3	2	19	0	0	4.5	6.2	1.38	22.7	42.0
Toyomidori	2283	182	11	62	14	0	10	161	0	17	9	8	32	9	0	10.5	4.5	0.42	40.7	69.3
Ultra	153	22	2	0	14	0	3	323	0	12	6	5	21	0	1	2.8	4.3	1.55	23.8	45.8
Urozani	2854	3	0	3	51	0	10	166	26	7	13	13	13	22	0	3.3	4.9	1.47	27.9	46.1
USDA 21055	4722	377	3	160	10	0	2	94	48	5	17	19	12	1	0	9.8	4.9	0.50	48.2	71.1
Vojvodina	2285	76	3	21	12	0	6	223	6	7	2	2	14	0	0	7.1	3.9	0.55	28.2	53.7
WFG	1601	4	5	4	31	0	17	188	7	6	0	0	13	0	0	5.8	5.0	0.87	25.4	45.0
Willamette	1307	153	0	4	12	0	3	237	10	9	3	2	14	0	0	4.9	4.3	0.86	34.5	54.5
Wye Challenger	4296	271	5	42	28	0	12	264	6	6	58	67	18	0	0	5.3	4.4	0.82	24.3	47.4
Wye Northdown	1897	72	3	21	9	0	5	241	0	7	3	2	13	0	0	8.2	5.3	0.65	28.0	49.5
Wye Target	3658	158	5	16	20	3	8	150	0	11	8	8	29	6	0	11.6	6.6	0.57	33.7	56.4
Wye Viking	3527	135	6	30	16	0	18	179	46	6	34	37	14	0	0	7.9	5.0	0.63	25.7	42.6
Yeoman	3171	291	12	17	10	0	3	211	0	6	40	40	16	0	2	13.2	6.0	0.45	28.2	50.4
Zatecki	1064	145	1	7	21	0	6	228	7	8	4	2	15	0	0	4.4	3.3	0.75	25.5	48.0
Zenith	1341	83	2	9	18	1	6	239	0	8	75	91	19	0	0	9.3	3.7	0.40	24.2	50.3
Zeus	2176	125	7	5	6	0	1	141	0	18	11	10	38	10	0	9.8	4.2	0.43	37.4	60.8
Zitic	1755	1	2	9	8	3	7	258	6	6	2	2	14	0	2	8.6	6.2	0.72	23.7	45.5

Essential oils = relative values. ß-caryophyllene = 100. alpha- and beta-acids in % as is. Analoga in % of the α– or ß-acid

7.5 Ring analyses on the 2006 crop

Since the year 2000 there has been a supplementary agreement in the hop supply contracts, in which 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 allowed for the results of the analyses. The Work Group IPZ 5d was given the task again in 2006 to organise and evaluate Hopfenring analyses in order to ensure the quality of the alpha-acid analyses.

In 2006 the following laboratories participated in the Hopfenring test

- Hallertauer Hopfenveredelungsgesellschaft (HHV), Werk Au/Hallertau
- NATECO2 GmbH & Co. KG, Wolnzach
- Hopfenveredelung St. Johann GmbH & Co KG, St. Johann
- Hallertauer Hopfenveredlungsgesellschaftchaft (HHVG), Werk Mainburg
- Hallertauer Hopfenverwertungsgenossenschaft (HVG), Mainburg
- Agrolab GmbH, Oberhummel
- Thüringer Landesanstalt for Landwirtschaft (TLL)
- Bayerische Landesanstalt for Landwirtschaft, Arbeitsbereich Hopfen, Hüll

The ring test was started on 12th September 2006 and ended on 10th November 2006, 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 time on 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 per day was always analysed. The results of the analyses were sent back to Hüll a week later and evaluated there. Altogether 34 samples were analysed in 2006. Figure 7.14 shows the configuation of the varieties.

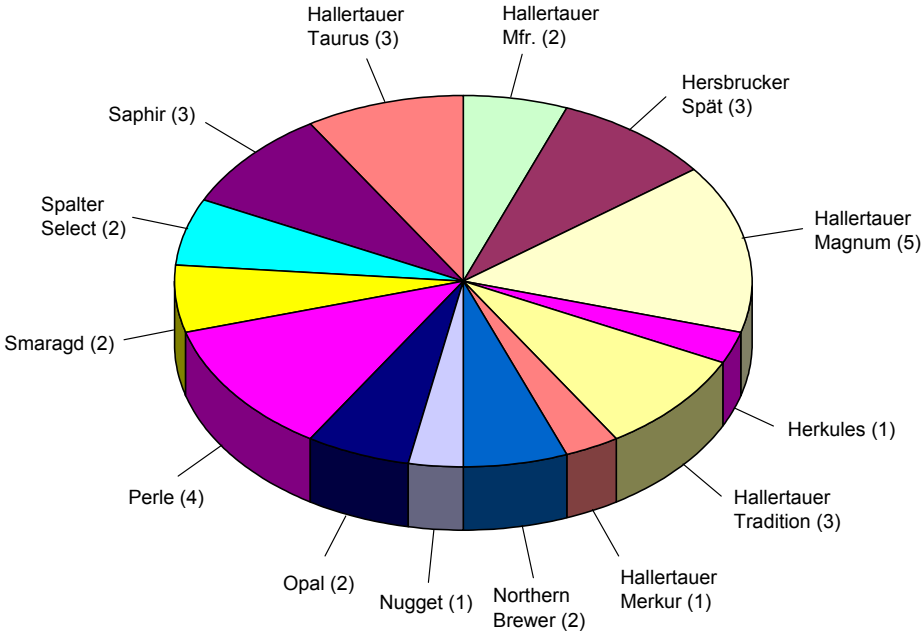


Fig. 7.14: Configuation of varieties in the ring analysis 2006

The evaluations were passed on as quickly as possible to the individual laboratories. As an example of an evaluation Figure 7.15 shows the ring test with the lowest variance.

Nr. 33: HSE (08.11.2006)

Labor	KW		mittel	s	cvr
1	3,73	3,75	3,74	0,014	0,4
2	3,66	3,77	3,72	0,078	2,1
3	3,71	3,62	3,67	0,064	1,7
4	3,87	3,80	3,84	0,049	1,3
5	3,88	3,91	3,90	0,021	0,5
6	3,67	3,63	3,65	0,028	0,8

mean	3,75
sr	0,048
vkr	1,29
sR	0,103
vkR	2,74
sL	0,091
r	0,14
R	0,29
Min	3,65
Max	3,90

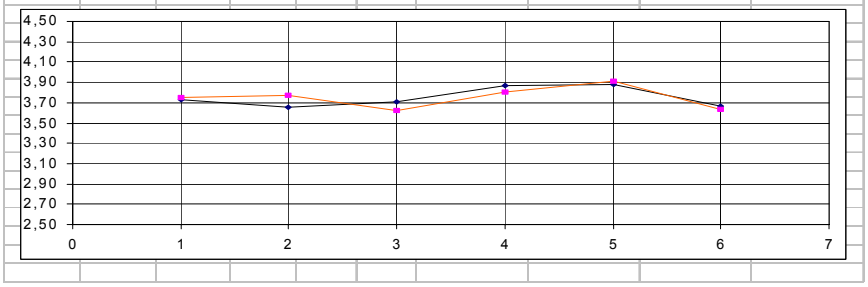


Fig. 7.15: Ring analysis with the lowest variance

As a runaway test between the laboratories the Grubbs Test was calculated according to DIN ISO 5725. 4 runaways were found in 2006. Table 7.4 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 2006.

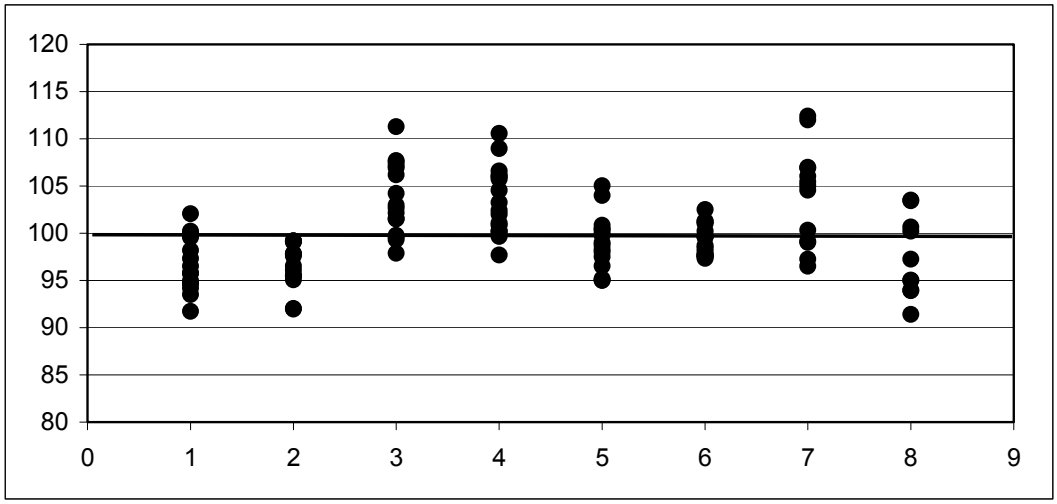
Table 7.4: Tolerance limits of the method EBC 7.4 and their exceedings in the years 2000 bis 2006

	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

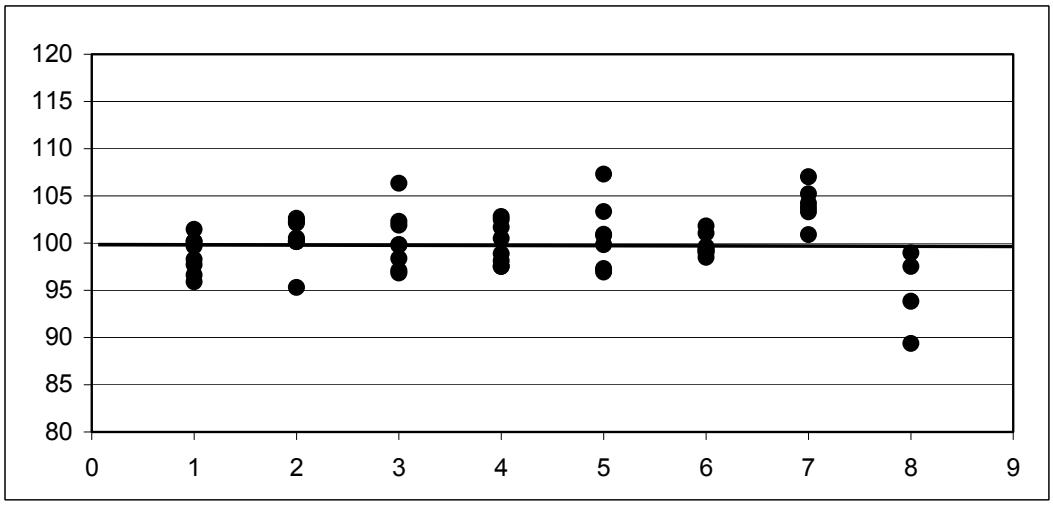
There were altogether 3 exceedings of the permitted tolerance limits in 2006.

All the analysis results are listed in Fig. 7.16 for each laboratory as relative deviations from the mean average (= 100 %) differentiated according to alpha-acid contents < 5 %, > = 5 % and < 10 %, > = 10 %.

Proben mit α-Säurengehalten < 5 %



Proben mit α-Säurengehalten >= 5 % und < 10 %



Proben mit α-Säurengehalten >= 10 %

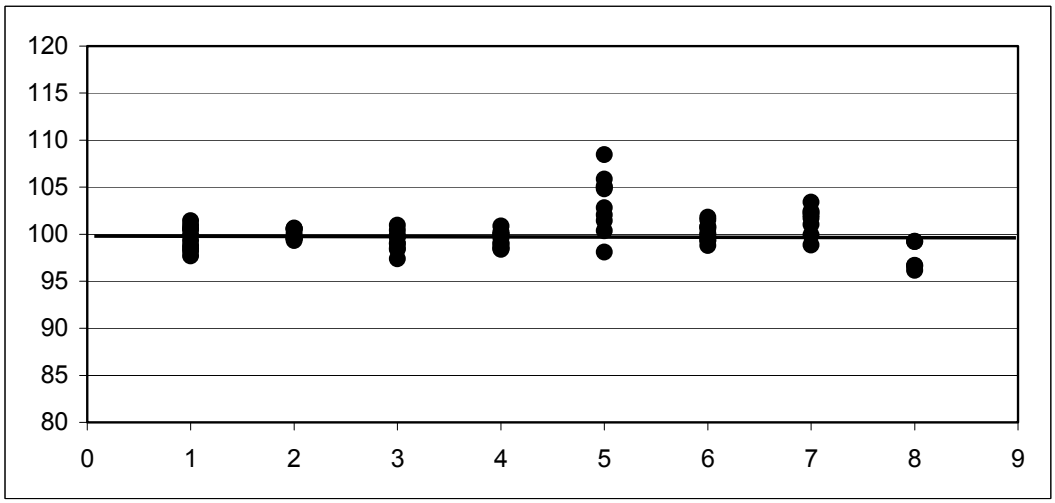


Fig. 7.16: Analysis results of the laboratories relative to the mean average

7.6 Development of a NIR (near infrared reflection spectroscopy)-calibration based on HPLC (high-resolution liquid chromatography)

Every year approx. 2000 breeding lines are analysed in Hüll for their content of alpha-acids. There are more and more hop supply contracts where the content of alpha acids is taken into consideration. Therefore, since 2000 a NIR calibration based on HPLC data has been developed in the Hallertau by Hüll and the laboratories of the hop-processing firms in order to substitute the increasing number of wet-chemical analyses by a cheap fast method. The aim is to improve the NIR method in such a way that an acceptable reproducibility can be obtained for the practice.

In order to construct and check the calibration the samples from the ring trial (s. Point 7.5) will be used. In each case measuring is carried out with NIR und HPLC.

The Figures 7.17 and 7.18 show the mean averages of the contents of alpha-acids and the average r- and R values of both analysis methods in comparison (Ring trial 2006). It can be seen in Figure 7.17 the HPLC values are set at 100% and the NIR values are shown relative to that. However, to judge an analysis method the repeatability (r) and reproducibility (R) are decisive. The repeatability (r) can be interpreted so that the difference between two measusrements under the conditions of utmost minimum variability (same laboratory, same measuring apparatus, same personnel) with a likelihood of 95 % is not greater than r. The reproducibility (R) refers to the utmost maximum variability, i.e. different laboratories, different measuring apparatus, different personnel.

The mean averages can be compared well. However, Figure 7.18 clearly shows that particularly the reproducibility in the NIR method is not as good as in the HPLC method. Therefore there is a relatively great variance between the laboratories. Work must still be done on an improvement. The NIR calibration is extended every year by including new data records. It will be decided by the AHA (Work Group for Hop Analytics) when the reproducibility is good enough to release the calibration for the practice.

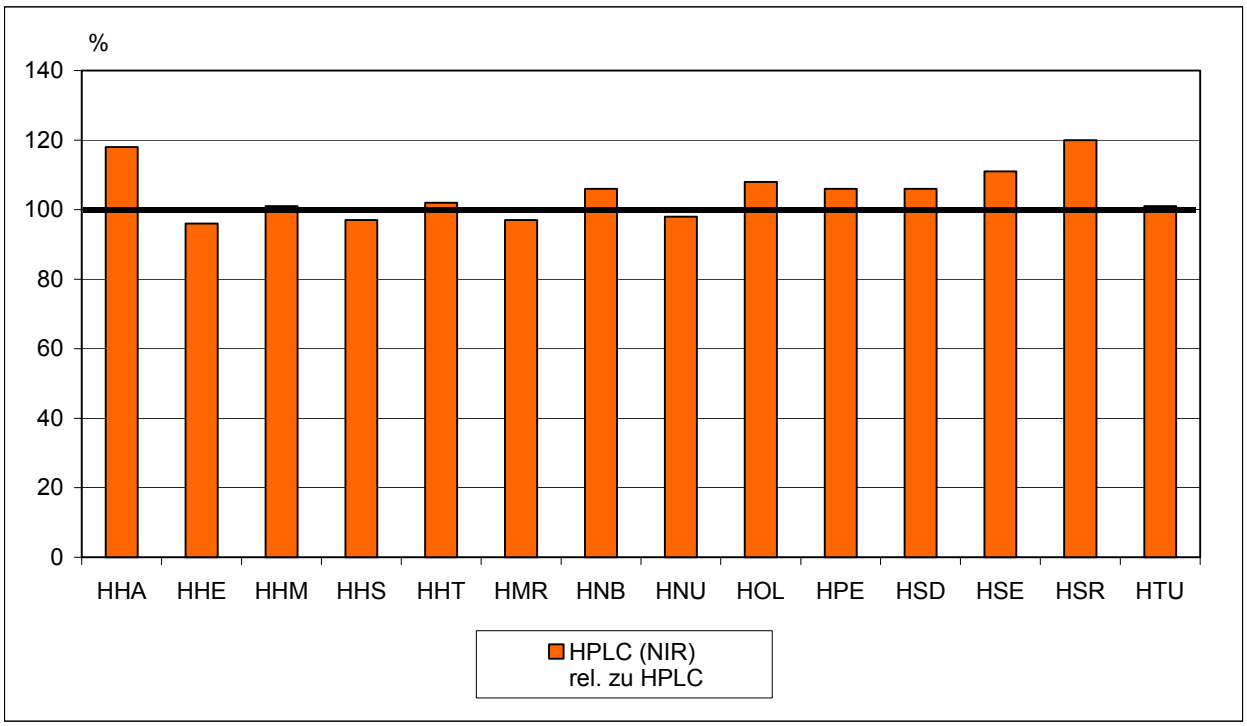


Fig. 7.17: Comparison mean values alpha-acids, HPLC-NIR, Ring test 2006

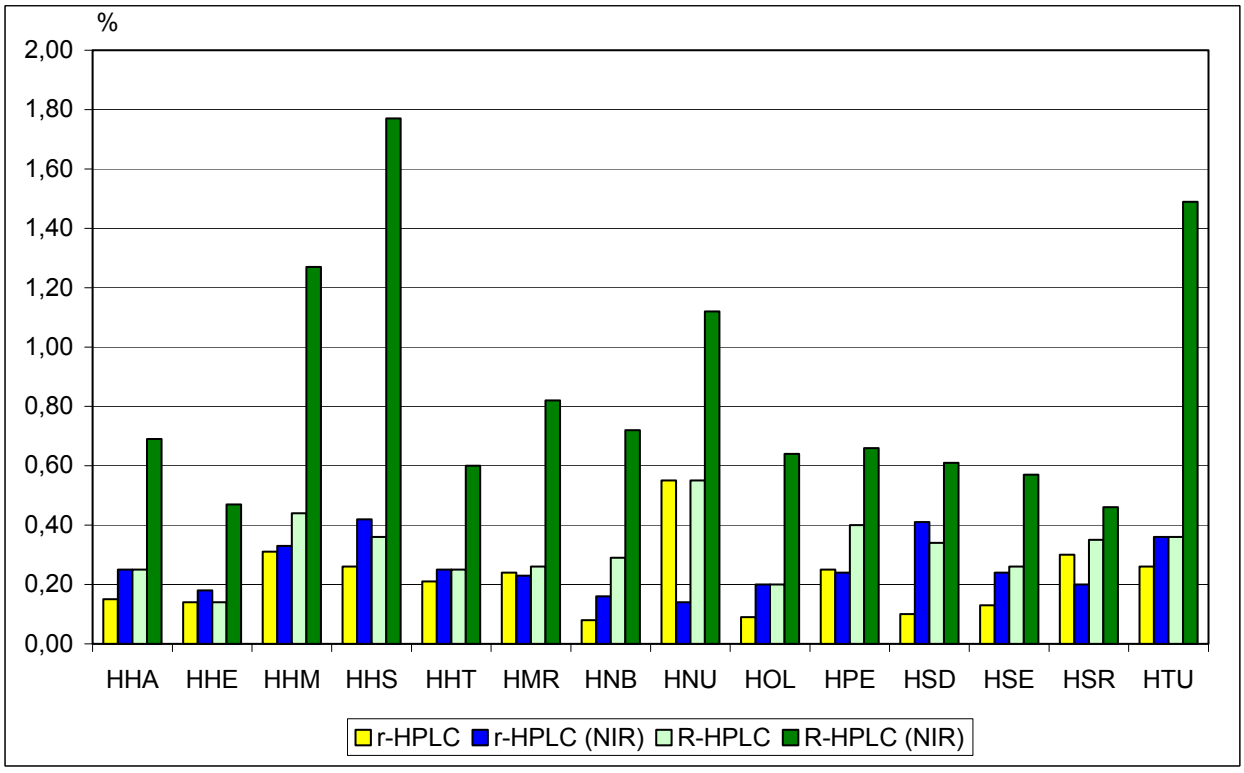


Fig. 7.18: Comparison mean values r/R, HPLC-NIR, Ring test 2006

7.7 Research on plant protective residues in hops of the 2006 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. Also in 2006 it can be ascertained that hops are free of harmful residues from plant protectives.

With the licensing of new products for the control of downy mildew (peronospora) the application spectrum is split. Although in the second half of August 2006 two more spray warnings were necessary, only few active ingredients to control this disease could be found in small quantities. No residues of active ingredients to control hop aphids were determined.

Due to the high costs for the total analysis (approx. € 850,-- per sample) the extent of the analyses also had to be restricted this year to six samples. However, very many analyses will be additionally 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 55 different plant protective active ingredients were analysed in this study. Additionally to the active ingredients permitted at present examinations and checks will be made for previously licensed substances and other ingredients from other cultures (e.g. wine).

Table 7.5: Analyses for residues of plant protectives – 2006 crop

Active ingredients listed according to pest/disease	Max. amount permitted ppm	Milligram per kilogram = ppm					
		R 1/06 HA	R 2/06 PE	R 3/06 TU	R 4/06 HT	R 5/06 SE	R 6/06 HM
Peronospora							
Azoxystrobin	20.0	0.27	n.n.	0.10 u.B.	0.12	n.n.	1.1
Captafol	0.1	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Captan	120.0	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Cymoxanil	2.0	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Dimetomorph	50.0	0.36	1.1	0.40	0.11	0.48	n.n.
Dithiocarbamate	25.0	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Fentin-acetat	0.5	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Folpet	120.0	n.n.	n.n.	n.n.	n.n.	n.n.	7.2
Fosethyl	100.0	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Cupric compounds	1000.0	300.0	111.0	123.0	272.0	78.9	9.6
Metalaxyl	10.0	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.

Table 7.5 (continued)

Active ingredients listed according to pest/disease	Max. amnt. permitted ppm	Milligram per kilogram = ppm					
		R 1/06 HA	R 2/06 PE	R 3/06 TU	R 4/06 HT	R 5/06 SE	R 6/06 HM
Phosphoric acid	*)	13.3	n.n.	n.n.	5.4	n.n.	14.3
Tolylfluanide	30.0	3.1	4.1	n.n.	n.n.	2.9	n.n.
Mildew							
Fenarimol	5.0	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Fenpropymorph	0.1	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Myclobutanil	2.0	n.n.	n.n.	0.25	0.17	n.n.	0.49
Quinoxyfen	1.0	0.14	n.n.	n.n.	n.n.	0.38	n.n.
Triadimefon	10.0	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Triadimenol	10.0	n.n.	< 0.10 u.B	n.n.	n.n.	n.n.	0.53
Trifloxystrobin	30.0	2.1	2.5	1.60	2.3	0.87	n.n.
Botrytis							
Dichlofluanid	150.0	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Procymidon	0.1	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Vinclozolin	40.0	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Hop aphid							
Bifenthrin	10.0	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
3-Hydroxy-Carbofuran	10.0	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Cyfluthrin	20.0	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Lambda-Cyhalothrin	10.0	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Cypermethrin	30.0	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Deltamethrin	5.0	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.
Endosulfan	0.1	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Imidacloprid	2.0	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Mevinphos	0.5	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Omethoat	0.05	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Parathion-methyl	0.1	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Permethrin	0.1	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	0.1	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Pymetrozin	5.0	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Common spider mite							
Abamectin	0.05	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Amitraz	20.0	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Azocyclotin/Cyhexatin	0.1	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Brompropylat	5.0	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Dicofol	50.0	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Fenpyroximate	10.0	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.

Table 7.5 (continued)

Active ingredients listed according to pest/disease	Max. amount permitted ppm	Milligram per kilogramm = ppm					
		R 1/06 HA	R 2/06 PE	R 3/06 TU	R 4/06 HT	R 5/06 SE	R 6/06 HM
Hexythiazox	3.0	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Propargit	30.0	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Alfalfa weevil							
Acephat	0.1	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Carbofuran	10.0	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Methamidophos	0.5	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Methidathion	3.0	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Herbicides							
Cinidon-ethyl	0.1	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Fluazifop-butyl	0.1	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Monolinuron	0.05	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.

n.n. = not detected; u.B. = below the limit of determination

*) = no set maximum amounts of residue

HA = Hallertauer Mittelfrüher HT = Hallertauer Tradition

PE = Perle SE = Spalter Select

TU = Hallertauer Taurus HM = Hallertauer Magnum

Table 7.6: Residue situation in hops of the 2006 crop

Active ingredient (Brand)	Frequency n = 6	ppm min.-max.	ppm max. a-mount	ppm US tolerance
Azoxystrobin (Ortiva)	4	< 0.10 – 1.2	20	20
Dimetomorph (Forum)	5	0.11 – 1.1	50	60
Folpet (Folpan WDG)	1	7.2	120	120
Cupric compounds	6	9.6 – 300.0	1000	ex.
Myclobutanil (Systhane 20 EW)	3	0.17 – 0.49	2.0	5.0
Phosphoric acid	3	5.4 – 14.3	*	*
Quinoxyfen (Fortress 250)	2	0.14 – 0.38	1	3
Tolylfluanide (Euparen WG)	3	2.9 – 4.1	30	30
Triadimenol (Bayfidan)	2	< 0.10 – 0.53	10	-
Trifloxystrobin (Flint)	5	0.87 – 2.5	30	11

* = no set maximum amounts of residue; ex. = exempt

7.7.1 Assessing the results

As in previous years only very 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. No unauthorised hop plant protectives were ascertained whatsoever.

7.7.2 Resumé

The long-term programme for determining residues of plant protectives in hops this year also confirms that hops are free from harmful residues. There is not the least suspicion that the legally permitted maximum amounts have been exceeded. 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 to check for the food control authorities that the variety is authentic

Variety inspections for the food control authorities (district administrator's office)	54
Complaints thereof	0

8 Publications and specialist information

8.1 Overview on public relations work

	No.		No.
Practice information and scientific publications	40	Talks	95
LfL-publications	6	Tours	86
Press releases	1	Exhibitions	4
Contributions in radio and television	4	Education and further training	13
Organisation of specialist meetings, seminars and colloquia	3	Diploma theses	4
Participation in work groups	18	Dissertations	1
Foreign guests	196		

8.2 Publications

8.2.1 Practice information and scientific publications

Engelhard, B.; Eicheldinger, R.; Meyr, G. (2006): Pflanzenschutz 2006 – Die langfristige Lösung noch bestehender Probleme ist erklärtes Ziel aller Beteiligten. Hopfen-Rundschau 5, 115.

Kammhuber, K. (2006): Quercetin und Kaempferol, zwei im Hopfen vorkommende Flavonoide mit positiven Eigenschaften for die Gesundheit, Hopfen-Rundschau International 2006, 52-55.

Niedermeier, E. (2006): Pflanzenstandsbericht. Hopfen Rundschau 57 (6), 147.

Niedermeier, E. (2006): Pflanzenstandsbericht. Hopfen Rundschau 57 (7), 172-173.

Niedermeier, E. (2006): Pflanzenstandsbericht. Hopfen Rundschau 57 (8), 197.

Niedermeier, E. (2006): Pflanzenstandsbericht. Hopfen Rundschau 57 (9), 220.

Niedermeier, E. (2006): Versuche mit stabilisiertem Ammonium-Stickstoff (ENTEC) im Hopfen. Hopfen Rundschau 57 (6), 142-143.

Portner, J. (2006): „Spritzen-TÜV“ für Gebläsespritzen nicht vergessen. Hopfen Rundschau 57 (3), 71.

Portner, J. (2006): Abspritzgeräte und Understockspritzgestänge Underliegen der Prüfpflicht. Hopfen Rundschau 57 (3), 70.

Portner, J. (2006): Aktuelle Hopfenbauhinweise. Hopfenbau-Ringfax Nr. 1; 3; 5; 6; 8; 11; 13; 14; 15; 16; 17; 18; 19; 20; 22; 23; 24; 25; 26; 28; 29; 30; 31; 33; 35; 36; 37; 38; 39; 40; 42; 44; 47; 48; 51; 53; 54

Portner, J. (2006): Bekämpfung von Wildhopfen zur Vermeidung von Befruchtung. Hopfen Rundschau 57 (5), 120.

Portner, J. (2006): Düngebedarfsermittlung for P, K, Kalk and Magnesium. Hopfen Rundschau 57 (3), 66.

Portner, J. (2006): Erste Nmin-Ergebnisse in Hopfen und anderen Ackerkulturen: Empfehlungen zur Stickstoffdüngung 2006. Hopfen Rundschau 57 (3), 65.

Portner, J. (2006): Fachkritik zur Moosburger Hopfenschau 2006. Hopfen Rundschau 57 (10), 240-243.

Portner, J. (2006): Gezielte Stickstoffdüngung des Hopfens nach DSN (Nmin). Hopfen Rundschau 57 (3), 68.

Portner, J. (2006): Hinweise für Hopfenpflanzer zu Aktuelles im Pflanzenschutz und Cross Compliance im Hopfenbau. Hopfenring/Erzeugerring-Information v. 26.07.2006, 1-2.

Portner, J. (2006): Hinweise für Hopfenpflanzer zu Wildhopfenbekämpfung, Änderungen bei den Zulassungen, Gültigkeit von Prüfplaketten, Dokumentation und Rufnummern der Hopfenberatung. Hopfenring/Erzeugerring-Information v. 26.05.2006, 1-2.

Portner, J. (2006): Hinweise zum neuen Nährstoffvergleich 2006. Hopfenring/Erzeugerring-Information v. 14.12.2006, 1-2.

Portner, J. (2006): Kostenfreie Rücknahme von Pflanzenschutzverpackungen PAMIRA 2006. Hopfen Rundschau 57 (7), 175.

Portner, J. (2006): LAR Johann Schätzl verstärkt die Hopfenberatung der LfL in Wolnzach. Hopfen Rundschau 57 (2), 37.

Portner, J. (2006): Peronosporabekämpfung – Planen Sie Ihren Mitteleinsatz. Hopfen Rundschau 57 (6), 147.

Portner, J. (2006): Pflanzenschutzmittel-Entsorgungsaktion. Hopfen Rundschau 57 (2), 44.

Portner, J. (2006): Rebenhäcksel baldmöglichst ausbringen. Hopfen Rundschau 57 (8), 196.

Portner, J. (2006): Richtige Durchführung der Stickstoffbodenuntersuchung. Hopfen Rundschau 57 (2), 45.

Portner, J. (2006): Rodung stillgelegter Hopfengärten. Hopfen Rundschau 57 (6), 151.

Portner, J. (2006): Stefan Fuß vervollständigt das Team der Hopfenberatung. Hopfen Rundschau 57 (12), 297-298.

Portner, J., (2006): Vermeidung von Gewässerverunreinigung beim Befüllen und Reinigen von Pflanzenschutzgeräten. Hopfen Rundschau 57 (7), 172.

Portner, J., Brummer, A. (2006): N_{min}-Untersuchung 2006. Hopfen Rundschau 57 (5), 120-121.

Portner, J., Rossbauer, G., Bauer, M. (2006): Nährstoffaufnahme des Hopfens. Hopfen Rundschau 57 (5), 116-120.

Seefelder, S., Hartmann, St. (2006): Molekulare Ansätze zur Unterstützung der Gräserzüchtung an der LfL, Tagungsband, 50. Jahrestagung der AGGF Straubing vom 31.08.06 bis 02.09.06, Schriftenreihe LfL, 17, 157-160.

Seefelder, S. (2006): Gendiagnostische Methoden zur Verbesserung der Mehltauresistenz bei Hopfen –Ein Beispiel für angewandte Forschung an der Bayerischen Landesanstalt for Landwirtschaft; Brauwelt Nr.17, 483-483.

Seefelder, S., Lutz, A. and Seigner, E. (2006):Development of molecular markers for powdery mildew resistance to support breeding for high quality hops. Monatsschrift für Brauwissenschaft, Mai/Juni 2006 (59), 100-104.

Seigner, E. (2006): Hopfensorten aus dem Hopfenforschungszentrum Hüll für das Original Ittinger Klosterbräu Bierzeit.

Seigner, E., A. Lutz, H. Ehrmaier, B. Engelhard (2006): Herkules – neue mehltauresistente Hochalphasorte des Hopfenforschungszentrums Hüll. HopfenRundschau – International, Jahresausgabe 2006/2007, 40-45.

Seigner, E., A. Lutz, H. Ehrmaier, S. Seefelder und K. Kammhuber (2006): Trends in der Hopfenzüchtung. Brauerei Forum, VLB-Berlin, 8-11.

Seigner, E., Kammhuber, K., Lutz, A., Miehle, H. und Seefelder, S. (2006): Qualitätszüchtung am Hopfenforschungszentrum Hüll. In: Vorträge for Pflanzenzüchtung, Pflanzenzüchtung for bessere Lebens- and Futtermittel, 69, 87-92.

Seigner, E., Lutz, A. und F.G. Felsenstein. (2006): Wild hops – New genetic resources for resistance to hop powdery mildew (*Podosphaera macularis ssp. humuli*). Monatsschrift for Brauwissenschaft, Juli/August 2006 (59), 122-129.

Seigner, E., Lutz, A., Miehle, H. und Seefelder, S. (2006):Hopfenforschungszentrum Hüll- Züchtungsstrategien zur Verbesserung der Resistenz gegen Echten Mehltau. In: Handbuch zum 4. Rohstoffseminar Weihenstephan, Freising, April 2006.

Weihrauch, F. & B. Engelhard (2006): Das Bekämpfungsschwellmodell für Spinnmilben: Auswertung einer Fragebogenaktion. – Hopfen-Rundschau 57 (6): 138-142.

Weihrauch, F. (2006): Hopfenanbau: nur für Spezialisten. Wegweisende Versuchsergebnisse. – Bioland-Fachmagazin für den ökologischen Landbau 05/2006: 14.

8.2.2 LfL-publications

Name	Work group	LfL-publications	Title
Engelhard, B., Kammhuber, K, Lutz, A., Seigner, E., Weihrauch, F.	IPZ 5, GfH (Gesell. f. Hopfenforschung)	Leaflet	Hop Research Center Hüll
Engelhard, B., Kammhuber, K, Lutz, A., Seigner, E., Weihrauch, F.	IPZ 5, GfH	Leaflet	Hop Research Center Hüll
Müller,M., Daniel, G., Doleschel, P., Eder, J., Hartmann, St., Herz, M., Jungbluth, A., Killermann, B., Krützfeldt, B., Mikolajewski, S., Papst, Ch., **Miehle, H**., Reichmann, M., Schweizer, G., Schwarzfischer, A.., **Seefelder, St., Seigner, E.,** Zimmermann, G.	IPZ	LfL-Information	Plant breeding – From the classic breeding up to bio-technology
Münsterer, J.	IPZ 5a	LfL Information	Optimum drying and conditioning of hops
Portner, J.	IPZ 5a	„Grünes Heft“	Hops 2006
Seigner, E., Doleschel, P.	IPZ 5c, IPL-L	Leaflet	Bavarian State Research Center for Agriculture, Institute for Crop Science and Plant Breeding

8.2.3 Press releases

Author(s), Work group	Title
Portner, J., IPZ 5a	Wild hops endanger the quality of Hallertauer hops

8.2.4 Contributions in radio and television

Name /AG	Broad-cast on	Subject	Title of pro-gramme	Station
Engelhard, B., IPZ 5	05.10.06	Products from hops	Wissenshunger	VOX
Engelhard, B., IPZ 5b	28.08.06	Alcohol-free beer	Galileo	PRO7
Lutz, A., IPZ 5c	19.11.06	Hops for the garden	ARD-Ratgeber Heim and Garten	ARD
Seigner, E., IPZ 5c	12.10.06	Genome analysis in breeding plants	Notizbuch	BR 2

8.3 Meetings, talks, lectures, tours, exhibitions

8.3.1 Conferences, symposiums and seminars

Organised by	Date /Place	Subject	(Circle of) Partici-pants
Münsterer J., IPZ 5a	08.12.06, Wolnzach	Workshop: Drying and Conditioning hops	Hop-growers with many years experience in measur-ing technology for drying and conditioning
Portner, J., IPZ 5a	31.01.06, Hüll	Coordinating the advisory notes in the Lfl publication Hops 2006	Colleagues from the Advi-sory and Research facilities of the German hop-growing regions
Portner, J., IPZ 5a	01.08. – 02.08.06, Tettnang	Hop Colloquium	Colleagues from the Advi-sory and Research facilities of the German hop-growing regions

8.3.2 Talks and papers presented

(AG = Work Group)

AG	Name	Subject/Title	Organiser/ Visitor	Date /Place
IPZ 5a	Münsterer, J.	The latest advice on conditioning	LfL/ 35 Hop-growers Ring Group Koppenwall	9.01.2006, Koppenwall
IPZ 5a	Münsterer, J.	HSK-Evaluation 2005	Hop Ring and LfL/ 75 hop-growers	08.02.2006, Niederlauter-bach

AG	Name	Subject/Title	Organiser/ Visitor	Date /Place
IPZ 5a	Münsterer, J.	HSK-Evaluation 2005	Hop Ring and LfL/ 45 hop-growers	09.02.2006, Koppenwall
IPZ 5a	Münsterer, J.	Optimum drying and conditions of hops using technical aids	LfL and ALF Roth/ hop-growers	13.-22.02.2006, Hedersdorf, Spalt, Au/Hallertau, Mainburg, Niederlauterbach, Biburg, Oberhatzkofen
IPZ 5a	Münsterer, J.	Optimum drying and conditioning of hops, new findings	LfL and Pflanzer-Stammtisch Oberlauterbach/52 hop-growers	19.02.2006, Oberlauterbach
IPZ 5a	Münsterer, J.	HSK-Evaluation 2005	LfL/Ring Group Eschelbach, 15 hop-growers	06.04.2006, Eschelbach
IPZ 5a	Münsterer, J.	Optimum drying and conditioning of hops, new findings	LfL/employees of Messrs. Wolf	21.09.2006 Geisenfeld
IPZ 5a	Niedermeier, E.	Hop fertilization, N-losses	Syndicate Qualty Hops Niederlauterbach, TN 32	11.01.2006 Niederlauterbach
IPZ 5a	Niedermeier, E.	Seminar: Fertilization-VO, fertilizing hops	LfL/25 hop-growers	2.03.2006, Wolnzach
IPZ 5a	Niedermeier, E.	Seminar: Fertilization -VO, fertilizing hops	LfL/27 hop-growers	9.03.2006, Wolnzach
IPZ 5a	Niedermeier, E.	Seminar: Fertilization -VO, fertilizing hops	LfL/21 hop-growers	14.03.2006, Wolnzach
IPZ 5a	Niedermeier, E.	Seminar: Fertilization -VO, fertilizing hops	LfL/21 hop-growers	15.03.2006, Wolnzach
IPZ 5a	Niedermeier, E.	Seminar: Fertilization -VO, fertilizing hops	LfL/35 hop-growers	19.03.2006, Wolnzach
IPZ 5a	Niedermeier, E.	Currrent plant protection	Syndicate Quality Hops Niederlauterbach, TN 26	24.05.2006 Niederlauterbach
IPZ 5a	Niedermeier, E.	Currrent plant protection	Hop-growers round table Oberlauterbach	7.06.2006 Oberlauterbach
IPZ 5a	Portner, J.	Shaping the hop cultivation business for the future	MR-Mainburg/ 120 farmer and guests	02.02.2006, Mainburg
IPZ 5a	Portner, J.	Factors influencing the hop quality 2005	Rural trade/ 20 marketeers	07.02.2006, Mainburg
IPZ 5a	Portner, J.	Factors influencing the hop quality 2005	BayWa/ 20 marketeers	08.02.2006, Mainburg
IPZ 5a	Portner, J.	HSK-Evaluation 2005	LfL and Hop Ring/ 15 hop-growers	20.02.2006, Mitterstetten

AG	Name	Subject/Title	Organiser/ Visitor	Date /Place
IPZ 5a	Portner, J.	Cutting equipment – Technology and Methods	Hop Ring/ 40 ISO-certified hop-growers, trade assn.	22.02.2006, Gebrontshau-sen
IPZ 5a	Portner, J.	All around the hop year – Influence of variety and technical production meas-ures for the beer quality	VLB Berlin/ 80 conference partici-pants	08.03.2006, Regensburg
IPZ 5a	Portner, J.	Research results on optimising the drying and conditioning of hops	GfH/ 30 partici-pants	03.04.2006, Wolnzach
IPZ 5a	Portner, J.	Process engineering in the cultivation of hops	FH Weihenstephan/ 10 students	10.05.2006, Weihen-stephan
IPZ 5a	Portner, J.	The latest on plant protection	ALF Roth/ 50 hop-growers	30.05.2006, Obersteinach
IPZ 5a	Portner, J.	The latest on plant protection	Hop Ring and LfL/ 25 hop-growers	28.06.2006, Forchheim
IPZ 5a	Portner, J.	The latest on plant protection	Hop Ring and LfL/ 25 hop-growers	05.07.2006, Niederulrain
IPZ 5a	Portner, J.	The latest on plant protection	Hop Ring and LfL/ 40 hop-growers	07.07.2006, Steinbach
IPZ 5a	Portner, J.	Campaign to control wild hops 2006	Hop-Growers Assn. and LfL/ 20 participants	12.07.2006, Wolnzach
IPZ 5a	Portner, J.	Ways of influencing the wilt attacks	Hop Ring and LfL/ 60 hop-growers	17.08.2006, Koppenwall
IPZ 5a	Portner, J.	Ways of influencing the wilt attacks	Hop Ring and LfL/ 100 Hop-growers	17.08.2006, Oberlauter-bach
IPZ 5a	Portner, J.	Around the hop year – Influence of vari-ety and technical production measures on the beer quality	Agrarian Commit-tee German Brew-ers Federation/ 20 participants	22.08.2006, Hüll
IPZ 5a	Portner, J.	Storm insurance for hop facilities	IGN-Hop Day/ 50 participants	24.08.2006, Niederlauter-bach
IPZ 5a	Portner, J.	Costs of Hop Production	HVG/ 30 INBEV-employees	08.09.2006, Wolnzach
IPZ 5a	Portner, J.	Expert criticism on hops 2006	Stadt Moosburg/ 80 guests	12.09.2006, Moosburg
IPZ 5a	Portner, J.	Ring Consultants 2006 – annual review	Hop Ring Haller-tau/ Ring consult-ants	11.12.06, Wolnzach
IPZ 5a	Schätzl, J	The latest on plant protection	LfL and Hop Ring/ Ring consultants	11.07.2006, Hüll
IPZ 5a	Schätzl, J	The latest on plant protection	LfL and Hop Ring/ Ring consultants	08.08.2006, Hüll
IPZ 5 a	Schätzl, J.	Suitable materials for hop-training and up-to-date infos on hop-growing	LfL and Hop Ring/ hop-growers	23.10.2006-Eschelbach

AG	Name	Subject/Title	Organiser/ Visitor	Date /Place
IPZ 5a	Schätzl, J.	Mounting wires, material and methods	Hop Ring Hallertau/ ISO-certified hop-growers, trade association	23.02.2006, Tettenwang
IPZ 5a	Schätzl, J.	The latest on hop-training material and on plant protection 2006	Hop Ring and LfL/ AK-participants Abens, Grafendorf (Lkrs. FS)	23.03.2006, Abens
IPZ 5a	Schätzl, J.	HSK-evaluation 2005	Hop Ring and LfL/ hop-growers	17.02.2006, Grafendorf
IPZ 5a	Schätzl, J.	HSK-evaluation 2005	Hop Ring and LfL/ hop-growers	13.02.2006, Lobsing
IPZ 5a	Schätzl, J.	The latest on plant protection	LfL and Hop Ring	07.06.2006, Abens
IPZ 5a	Schätzl, J.	The latest on plant protection	LfL and Hop Ring/ Ring consultants	25.07.2006, Hüll
IPZ 5b	Engelhard, B.	Plant protective situation in German hop production – preview on the season 2006	Assn of German Hop-growers e.V.	12.01.06, Hüll
IPZ 5b	Engelhard, B.	Parallel imports of plant protectives	Ring of young hop-growers	24.01.06, Niederlauterbach
IPZ 5b	Engelhard, B.	Plant protection 2006 -Botrytis – Are special insecticides necessary for hops?	Baywa Agrar Rural trade	08.02.06, Mainburg
IPZ 5b	Engelhard, B.	Plant protection 2006 – Applying and taking the licensing situation, export requirements and control thresholds into consideration	IPZ 5 / ALF	13.02. – 21.02.06 8 locations
IPZ 5b	Engelhard, B., Eicheldinger, R.	Are special products necessary for controlling botrytis in hops?	Info evening of the Hop-Growers Association	Mainburg
IPZ 5b	Engelhard, B.	Powdery mildew attacks and other signs of damage in hops of the 2005 crop	AG Independent Quality Appraisal	10.03.06, Wolnzach
IPZ 5b	Engelhard, B.	Investigations on residues of plant protectives in hops over many years	55. German Plant Protection Meeting	26.09.06, Göttingen
IPZ 5b	Engelhard, B.;	*Botrytis* on hop damage and strategies for controlling it	55. German Plant Protection Meeting	26.09.06, Göttingen
IPZ 5b	Weihrauch, F.	Test results in ecological hop production 2005	Bioland-Work Group Hops	08.02.2006, Berching-Plankstetten
IPZ 5b	Weihrauch, F.	How many aphids can the hops cope with? First test results 2005	GfH, TWA	03.04.2006, Wolnzach
IPZ 5b	Weihrauch, F.	Tests for the management of lacewings in the special cultivar hops: state of affairs	AK beneficial arthopods from the DPG and the Dga-aE	15.11.2006, Kleinmachnow
IPZ 5c	Lutz, A.	Hop breeding at the Hop Research Center in Hüll and aroma quality evaluation	Alt-Weihenstephaner Brewers Assn; 45 persons	08.11.06, Freising

AG	Name	Subject/Title	Organiser/ Visitor	Date /Place
IPZ 5c	Miehle, H.	Gene transfer in economically relevant hop varieties to improve the fungal resistance	Producer group of the HVG	19.01.06, Wolnzach
IPZ 5c	Miehle, H.	Gene transfer in economically relevant hop varieties to improve the fungal resistance	Society for Hop Research	03.04.06, Wolnzach
IPZ 5c	Miehle, H.	Gene technology law	S1-Safety instruction	05.04.06, Freising
IPZ 5c	Miehle, H.	Gene transfer in economically relevant hop varieties to improve he fungal resistance	Agrarian Committee of the Brewers	22.08.06, Hüll
IPZ 5c	Miehle, Helga	Gene transfer in hops and beer	Agrarian Committee of the German Brewers Assn.	22.08.06, Hüll
IPZ 5c	Seefelder, S.	Breeding strategies to improve the powdery mildew (PM) resistance in hops	IPZ 5, ÄLF - Hopgrowers /265 personen	14.02., 15.02., 21.02., 22.02. Mainburg, Biburg, Tettenwang, Lindach
IPZ 5c	Seigner, E.	Breeding strategies to improve the PM resistance in hops	IPZ 5, ÄLF - Hopgrowers / 330 Persons	13.-17.02.06, Hedersdorf; Spalt, Au; Niederlauterbach, Oberhatzkofen
IPZ 5c	Seigner, E.	Trends in hop breeding taking the beer market into consideration	VLB-Berlin (Versuchs- and Lehranstalt Berlin, Annual Spring Meeting / 80 persons	08.03.06, Regensburg
IPZ 5c	Seigner, E.	Wild hops– new genetic resources for powdery mildew resistance	Scientific Station for Breweries in Munich	04.07.06, Munich
IPZ 5c	Seigner, E.	PM isolates and leaf resistance test in the laboratory as the basis for the powdery mildew resistance breeding in hops	Wissenschaftliche Station for Brauerei in Munich	04.07.06, Munich
IPZ 5c	Seigner, E.	Breeding for high-quality hops at the Hop Research Center in Hüll	8. GPZ-Tagung (Gesellschaft for Pflanzenzüchtung) / 200 Personen	14.03.06, Freising
IPZ 5c	Seigner, E.	New hop varieties of the Hop Research Center in Hüll for the diversity of the beers	IGN-Hopfenbautag (Interessensgemeinschaft Niederlauterbach)	24.08.06, Niederlauterbach
IPZ 5c	Seigner, E.	Hop Breeding at the Hop Research Center Hüll, Biotechnology, Genome Analysis	Hop Specialists Day, InBev, HVG /40 persons	07.09.06, Hüll

AG	Name	Subject/Title	Organiser/ Visitor	Date /Place
IPZ 5c	Seigner, E.	Hop Research Center in Hüll, Breeding strategies to improve the resistance against hop powdery mildew	Raw commodities seminar 2006, Chair for Brewing Technology I, WZW-Weihenstephan, Bav. Brewers Assn, Ass. Of small private breweries in Bavaria	04.04.06, Freising
IPZ 5d	Kammhuber, K.	The significance of hop components for brewing beer, for health and for other applications	Hop producers meeting	13.02.06 - 22.02.06/ Hedersdorf, Spalt, Au, Mainburg, Niederlauterbach, Biburg, Oberhatzkofen, Tettenwang, Lindach
IPZ 5d	Kammhuber, K.	Differentiation of the world hop range and the Hüll-bred varieties according to alpha-acids and polyphenols and the influence of these components on the beer quality	Scientific Station for Breweries Munich	Munich, 04.07.06

8.3.3 Guided tours

(AG = Work Group; TZ= No. of participants)

AG	Name	Date	Subject/Title	Visiting institution	TZ
IPZ 5	Engelhard, B.	16.02.06	Hop Research Center, Hüll	Dipl.Ing. Doetsch, Paulaner-Brauerei M.	1
IPZ 5	Engelhard, B., Weihrauch, F., Lutz, A.	09.02.06	Issues for virus testing	Colleagues from Hop Research in Zalec, SLO	8
IPZ 5	Engelhard, B., Lutz, A. Kammhuber, K.	05.04.06	Hop Research Center, Hüll Breeding	College for Master Brewers in Ulm	20
IPZ 5	Engelhard, B.,	05.05.06	Hop research	Pfaffenhofen Friends of Nature	35
IPZ 5	Engelhard, B., Waldinger, J.	05.05.06	Hop research	Neighbours	35
IPZ 5	Engelhard, B., Münsterer, J.	11.05.06	Hop research	Martin-Max Foundation	45
IPZ 5	Engelhard, B., Seigner, E., Lutz, A., Kammhuber, K.	12.05.06	Hop research	Austrian Master Brewers & Maltsters Assn.	50

AG	Name	Date	Subject/Title	Visiting institution	TZ
IPZ 5	Engelhard, B., Kammhuber, K.	21.05.06	Hop research	Brewers from SAB	3
IPZ 5	Engelhard, B.	23.05.06	Hop research	BayStMLF, Ept. A	15
IPZ 5	Engelhard, B.	04.06.06	Hop production techniques	LfL, LTB	15
IPZ 5	Engelhard, B., Seigner, E.	18.07.06	Hop research	Students of the TUM	20
IPZ 5	Engelhard, B.	18.08.	Hop research	Colleagues ALF Ingol-stadt	8
IPZ 5	Seigner, E., Miehle, H., Engelhard, B.	22.08.	Symposium	Agrarian Committee DBB (German Brewers Assn.)	35
IPZ 5	Engelhard, B., Seigner, E., Portner, J., Lutz, A.	29.08.	Hop tour	VdH (Assn. of German hop-growers), StMLF	ca. 170
IPZ 5	Seigner, E., Kammhuber, K., Engelhard, B.	31.08.	Hop research	Experts for raw com-modities „The Hite“(Korea), HVG	6
IPZ 5	Engelhard, B.	01.09.	Hop research	LRA, Hallertauer Hop Weeks	25
IPZ 5	Engelhard, B.	02.09.	Hop research	German Cooperative Bank	18
IPZ 5	Engelhard, B.	05.09.	Hop research	Hansa-IN	8
IPZ 5	Engelhard, B., Seigner, E., Kammhuber, K.	07.09.	Hop research	Raw commodity experts from AmBev	
IPZ 5	Engelhard, B.	13.09.	Productions techniques/harvest	Colleagues from Zatec	4
IPZ 5	Engelhard, B., Seigner, E., Kammhuber, K.	18.09.	Hop research	„Bavaren“-Students' society Freising	25
IPZ 5	Engelhard, B., Seigner, E., Kammhuber, K.	15.11.	Hop research	VLB (Berlin Research & Training Center for Brewing) Special course	10
IPZ 5a	Niedermeier, E.	03.07.06	Field inspection	Syndicate Quality Hops N-lauterbach	19
IPZ 5a	Niedermeier, E.	20.07.06	Field inspection	Ring group Eschelbach	17
IPZ 5a	Niedermeier, E.	25.07.06	Field inspection	BBV-Representatives of Geisenfeld council	34
IPZ 5a	Niedermeier, E.	07.08.06	Viewing breeding yard in Hüll and practice stock of Herkules	Hop-growers Wolnzach	16
IPZ 5a	Niedermeier, E.	18.08.06	Excursion consultants Tettnang	Ring junger Hop-growers	36
IPZ 5a	Schätzl, J.	29.06.06	Field inspection	Ring group Koppenwall	26
IPZ 5a	Schätzl, J	06.07.06	Field inspection	Ring group Eberstetten, Güntersdorf	19

AG	Name	Date	Subject/Title	Visiting institution	TZ
IPZ 5a	Schätzl, J.	14.07.06	Field inspection	HPV.Spalt	54
IPZ 5a	Schätzl, J.	24.07.06	Field inspection	Ring group Abens, Grafend.	24
IPZ 5a	Schätzl, J.	17.08.06	Field inspection	ALF Roth, HPV, Hop-growers	58
IPZ 5b	Engelhard, B.	16.05.06	Hop cultivation	Reps for plant protectives	1
IPZ 5b	Engelhard, B. Weihrauch, F.	06.07 06	Plant protection in hops	Hop-growers and scientists from Switzerland	5
IPZ 5b	Engelhard, B.. Weihrauch, F.	01.02.06	Plant protection and variety issues in hops	Organic hop farmers from Denmark	2
IPZ 5b	Engelhard, B.	06.03.06	Hop Research Center, Hüll	Spiess-Urania	2
IPZ 5b	Engelhard, B., Weihrauch, F.	06.05.06	Plant protection in hops	Spiess-Urania; VdH	8
IPZ 5b	Engelhard, B.	09.05.06	Product discussion	Bayer CropScience	5
IPZ 5b	Engelhard, B.	10.05.06	Final assignment	High-school students Pfaffenhofen	2
IPZ 5b	Engelhard, B., Weihrauch, F.	25.07.	Plant protection in hops	Syngenta	15
IPZ 5b	Engelhard, B.	28.07.	Plant protection in hops	American hop-growers	2
IPZ 5b	Engelhard, B., Weihrauch, F.	03.08.	Plant protection symposium	Bayer CropScience	12
IPZ 5b	Engelhard, B.	29.08.	Plant protection symposium	VdH, BMELV, StMLF, Environment Ministry	55
IPZ 5b	Engelhard, B., Eicheldinger, R.	06.03.06	Plant protection issues / planning 2006	Colleagues from Alsace (F)	4
IPZ 5b	Engelhard, B., Eicheldinger, R.	26.04.06	Plant protection in hops	Hop-trading firm from SLO	3
IPZ 5b	Engelhard, B., Weihrauch, F., Lutz, A.	22.05.06	Plant protection in hops	BBA (with President) and BVL; VdH	6
IPZ 5c	Lutz, A.	11.07.06	New hop varieties at the Hop Research Center Hüll	Anheuser-Busch	7
IPZ 5c	Lutz, A.	28.07.06	Judgment of hop varieties	Agricultural School Pfaffenhofen	15
IPZ 5c	Lutz, A.	4.08.06	Breeding research on hops	Research technicians Bayer Crop Science	10
IPZ 5c	Lutz, A.	29.08.06	Hop tour 2006 – New varieties and findings	Hop-growers, politicians	170
IPZ 5c	Lutz, A., E. Seigner	07.09.06	Hop Breeding at the Hop Research Center Hüll	InBev, HVG	40
IPZ 5c	Lutz, A.	07.11.06	Hop Breeding at Hüll	Anheuser-Busch, Dr. Buholzer, Mr. Sammartino	2

AG	Name	Date	Subject/Title	Visiting institution	TZ
IPZ 5c	Miehle, H.	10.03.06	Gene transfer in hops	President LfL + guests	10
IPZ 5c	Miehle, H.	01.06.06	Gene transfer at der LfL	President LfL and StMLF	10
IPZ 5c	Miehle, H.	20.11.06	Gene transfer at the LfL	Rectors conference from Central Asia	50
IPZ 5c	Miehle, H.	21.11.06	Gene transfer generally	President LfL + farmers from Rosenheim	45
IPZ 5c	Seefelder, S.	01.03.06	Hop genome analysis	New Zealand, E. Buck	1
IPZ 5c	Seefelder, S.	28.06.06	Hop genome analysis	Senior “Hop Experts”	25
IPZ 5c	Seefelder, S.	17.07.06	Hop genome analysis	Chem. lab. Technicians for training, Hungary	4
IPZ 5c	Seigner, E.	16.02.06	Hop Research	Asahi Brewery, Japan	2
IPZ 5c	Seigner, E.	01.03.06	Hop Breeding – Classical Breeding and Biotechnology	New Zealand, E. Buck	1
IPZ 5c	Seigner, E.	26.04.06	Hop Research at Hüll and phytosanitary aspects of hop propagation	Reps from Ministry for Agriculture, SLO and sloven. Hop trade	3
IPZ 5c	Seigner, E.	12.05.06	Hop Research Center, Hüll	Federation of Austrian Master Brewers and Brewery Technicians	50
IPZ 5c	Seigner, E.	16.05.06	Hop Breeding	Hallert. hop queens	3
IPZ 5c	Seigner, E.	17.05.06	Hop Research Center, Hüll	Asahi, Japan	1
IPZ 5c	Seigner, E.	06.06.06	Hop Research Center, Hüll and Hop Breeding	BBA (German Biologische Institute), Spiess Urania	9
IPZ 5c	Seigner, E.	28.06.06	Hop Breeding and Biotechnology	Senior “Hop Experts”	25
IPZ 5c	Seigner, E.	14.07.06	Hop Research Center, Hüll breeding yard	Bayer Crop Science, Hop-growers Elbe-Saale	40
IPZ 5c	Seigner, E.	14.07.06	Hop Research Center, Hüll	StMLF Dept B and pensioners	70
IPZ 5c	Seigner, E.	18.07.06	Hop Breeding Research	Students of the LS Technology for Brewery I, WZW	26
IPZ 5c	Seigner, E.	07.08.06	Hop Breeding Research, Biotechnology / Gene Transfer	Russian trainee	1
IPZ 5c	Seigner, E.	21.08.06	Breeding Research in Hüll, breeding yard	Prof. De Keukelaire, hop-growers from Belgium	34
IPZ 5c	Seigner, E.	31.08.06	Hop Breeding at the Hop Research Center Hüll	The Hite Brewery, South Korea, HVG	5
IPZ 5c	Seigner, E.	07.09.06	Hop Breeding at the Hop Research Center Hüll	InBev and HVG	40
IPZ 5c	Seigner, E.	29.09.06	Hop Breeding at the Hop Research Center Hüll	Dr. Ronteltap, Heineken and GfH	3

AG	Name	Date	Subject/Title	Visiting institution	TZ
IPZ 5c	Seigner, E.	15.11.06	Breeding at Hop Research Center Hüll	Excellence in Brewing, VLB-Berlin	10
IPZ 5c	Seigner, E.	07.11..06	Hop Research Center Hüll –	Anheuser-Busch, Dr. Buholzer, Mr. Sammartino	2
IPZ 5d	Kammhuber, K., Engelhard, B.	15.02.06	NIR-Analyses for alpha-acids according to EBC 7.4	Assn. of German hop-growers e.V.	5
IPZ 5d	Kammhuber, K., Engelhard, B.	02.05.06	NIR-Analysis method	VdH	6
IPZ 5d	Kammhuber, K.	12.05.06	Hop analytics	Brewers from Austria	50
IPZ 5d	Kammhuber, K.	06.06.06	Hop analytics	Employees from plant protective firms	5
IPZ 5d	Kammhuber, K.	18.06.06	Hop analytics	Brewing students TUM	10
IPZ 5d	Kammhuber, K.	11.09.06	Hop analytics	5 employees LA Pfaffenhofen	5
IPZ 5d	Kammhuber, K.	07.11.06	Hop analytics	Hop experts from Anheuser Busch	2
IPZ 5d	Kammhuber, K.	31.08.	Hop analytics	Brewers from Hite Brewery (Korea)	3

8.3.4 Exhibitions and posters

(AG = Work Group)

Name of the Exhibition	Exhibits/ or subjects /Posters	Organiser	Duration	AG
Ingolstadt Garten Days with Spring Fair	Hallertau Hops and Hop Research Center in Hüll	with marketing GmbH Ingolstadt	20. – 28.05.2006	IPZ 5
50th Anniversary of the Work Cooperative for Grassland and Fodder (AGGF) in the Society for Botany Sciences	Molecular approaches to support breeding grasses at the LfL	AGGF, IPZ, IAB	31.09. / 01.10.06	IPZ 5c, IPZ 4b
6th Munich Science Days	DNA-analysis in plant breeding – sustainable food production	vdbiol, StMLF Science Days in Munich	21.-24.10.2006	IPZ 1b IPZ 3b IPZ 5c
6th Munich Science Days	Gene transfer at the LfL – Research for the future	vdbiol, StMLF Science Days in Munich	21.-24.10.2006	IPZ 1c IPZ 3b IPZ 5c

8.4 Education and further training

Name, AG	Subject	Participants
Miehle, H., IPZ 5c	Gene transfer in Hops, practical training, 01.02.-14.03. and 01.08.-11.09.	Elodie Herque
Miehle, H., IPZ 5c	Gene transfer in Hops, practical training, 27.02.-03.03.06	Linda Sommer
Portner, J., IPZ 5a	Workshop Business Management for hop farms (3 days)	Hop-growers
Portner, J., IPZ 5a	Current Situation in Hop-growing (7 dates)	Ring consultants
Portner, J., IPZ 5a	Downy mildew and warning service	Students in 1. Sem. Agric. College Pfaffenhofen
Portner, J., IPZ 5a	Botrytis and mildew in hops	Students in 1. Sem. LS Pfaffenhofen
Portner, J., IPZ 5a	Hop wilt, crown rot and viroses	Students in 1. Sem. LS Pfaffenhofen
Portner, J., IPZ 5a	Alfalfa weevil, types of moths and aphids	Students in 1. Sem. LS Pfaffenhofen
Portner, J., IPZ 5a	Common spider mite, PSM-Problems, licensing situation, GfP	Students in 1. Sem. LS Pfaffenhofen
Portner, J., IPZ 5a	School Day Hop Cultivation	Students in 2st Sem. Agirc. College, Pfaffenhofen
Portner, J., IPZ 5a	BiLa-Seminar "Hop Cultivation" (4 evenings)	17 Hop-growers
Portner, J., IPZ 5a	Hop varieties	Students in 1st Sem. Agric. College, Pfaffenhofen

8.5 Diploma theses and dissertations

8.5.1 Diploma theses

AG	Name	Subject/Title Diploma theses	Duration	Consultants at the LfL, Cooperation
IPZ 5a	Seidl, Florian	Research on different jet positions on hop-spraying equipment to improve pesticide spraying	May 05-Nov. 06	H. Portner, TUM Weihenstephan, Dr. Rothmand Prof. Auernhammer
IPZ 5a	Abeltshauser, Thomas	Business development plan of a specialist hop farm in the Hallertau	Jan. 06 – Nov. 06	J. Münsterer, FH Weihenstephan Prof. Alois Scheuerlein
IPZ 5b	Schlagenhaufer, Stefan	Research for possible causes of resistance in hops against powdery mildew	January 2006 – May 2006	B. Engelhard, E. Seigner; TUM Weihenstephan PD Dr.Wolf

AG	Name	Subject/Title Diploma theses	Dura-tion	Consultants at the LfL, Coop-eration
IPZ 5c	Schmid, Sven	Knowledge management – Introduction to an authority based on a job processing system	February 06 – July 06	H. Miehle, K. Voit, University of the German Armed Forces in Munich, Commercial Informatics, Prof. U. Lechner; AIW 2

8.5.2 Dissertation

AG	Name/ Consultant LfL	Subject/Title Dissertation	Dura-tion	Cooperation
IPZ 5c	Seidenberger, R./ Seefelder, S.	Molecular markers for powdery mildew resistance in hops (*Humulus lupulus*)	2004-2007	Prof. Weber, University of Halle

8.6 Participation in Work Groups

Name	Memberships
Engelhard, B.	• Chairman of the Scientific Commission , International Hop Growers` Convention (IHGC) • Member of the German Phytomedical Society
Kammhuber, K.	• Member des Analysis Commitees of the European Brewery Convention (Hop Sub-Commitee) • Member of the Work Group for Hop Analytics (AHA)
Portner, J.	• Member of the Technical Committee for Equipment Recognition Process for the assessment of plant protection apparatus and the Technical Experts for Application Techniques at the BBA
Seigner, E.	• Secretary to the Scientific Comission of the International Hop Growers` Convention • Member of the Editorial Board of "Hop Bulletin“, Institute of Hop Research and Brewing, Zalec, Slovenia • Member of the coordination group “PR work” of the LfL • Member of the Society for Plant Breeding
Weihrauch, F.	• Member of the Study Group Bavarian Entomologists • Member of the German Society for Orthopterology • Director of the Society of German-speaking Odonatologists • Member of the Society for Ecology in the Tropics • Member of the Munich Entomologic Society • Member of the Association to protect Dragonflies in Baden-Wurttemberg • Member of the Worldwide Dragonfly Association • Member of the Red List Work Groups for Bavarian Grasshoppers and Dragonflies of the Bavarian State Office for the Protection of the Environment • Publisher of the magazine "Libellula"

9 Current research projects financed by third party funds

AG= Work group

AG Project Manager	Project	Duration	Costs sponsored by	Cooperation
IPZ 5b B. Engelhard	Development of plant protection strategies in ecological hop production as alternatives to the application of plant protectives containing copper and sulphur	2004-2006	BLE; Bandesprogramm Ökologischer Landbau	Bioland Erzeugerring Bayern e.V., Farms: Prantl, Rohr; Eckert, Eckental
IPZ 5b/IPZ 5c B. Engelhard	Development of a test system for testing the aphid resistance on hop seedlings within the sphere of hop breeding	2005–2008	Erzeugergemeinschaft HVG Anheuser-Busch	
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	2005–2007	Erzeugergemeinschaft HVG	Obster Farm, Aiglsbach
IPZ 5b B. Engelhard	Research on luring antagonist for hop aphids and spider mite	2005–2007	Anheuser-Busch	Swedish University of Agric. Sciences, Alnarp, Schweden; Rothamstead Research, UK
IPZ 5c Dr. Seefelder Dr. Seigner	Development of a molecular selection marker for powdery mildew resistance for the effective support of breeding quality hops	2006-2007	Wissenschaftsförderung der Deutschen Brauwirtschaft e.V.	EpiLogic
IPZ 5c Dr. Seigner A. Lutz	Wild hops – new genetic ressources for the powdery mildew resistance breeding	2003-2006	Scientific Station for Brewing in Munich e.V.	EpiLogic
IPZ 5c Dr. Seigner A. Lutz S. Seefelder	PM isolates and leaf resistance test in the laboratory as a basis for the powdery mildew resistance breeding 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, co-humulone, Xanthohumol and yield	2002 - 2006	Hopsteiner	IPZ 5d
IPZ 5c Dr. Seefelder Dr. Seigner	Development of molecular markers linked to powdery mildew resistance genes in hops	2004 - 2007	Europ. Hop Research Council (EHRC)	EpiLogic
IPZ 5c Dr. Seigner, Dr. Miehle	Gene transfer in economically relevant hop varieties for the improvement of fungal resistance	2005–2007	StMLF, Erzeugergemeinschaft HVG	EpiLogic

The following staff were employed at the Bavarian State Research Center for Agiculture - Institute for Crop Science & Plant Breeding –

at Hüll / Wolnzach in 2006:

10 Personnel IPZ 5 – Hop Department

Coordinator: **Engelhard Bernhard**

Dandl Maximilian
Escherich Ingeborg
Fischer Maria
Hock Elfriede
Maier Margret
Mauermeier Michael
Pflügl Ursula
Presl Irmgard
Suchostawski Chritsa
Waldinger Josef
Weiher Johann

IPZ 5a

Work Group: Hop Cultivation, Production Techniques

Portner Johann

Heilmeier Rosa
Münsterer Jakob
Niedermeier Erich
Schätzl Johann
Fuß Stefan (as from 01.11.2006)

IPZ 5b

Work Group: Plant Protection in Hop Production

Engelhard Bernhard

Ehrenstraßer Olga
Eicheldinger Renate
Hesse Herfried
Meyr Georg
Schwarz Johannes (as from 01.12.2006)
Dr. Weihrauch Florian

IPZ 5c

Work Group: Hop Breeding Research

Dr. Seigner Elisabeth

Ehm Katharina as from 01.08.2006
Hager Petra (née Bauer)
Hartberger Petra until 05.07.2006
Haugg Brigitte until 06.04.2006
Kneidl Jutta
Lutz Anton
Marchetti Sabine
Mayer Veronika
Dr. Miehle Helga
Seidenberger Rebecca (née Schürmer) until 16.08.2006
Dr. Seefelder Stefan

IPZ 5d

Work Group: Hop Quality and Analytics

Dr. Kammhuber Klaus

Neuhof-Buckl Evi
Petzina Cornelia
Weihrauch Silvia
Wyschkon Birgit