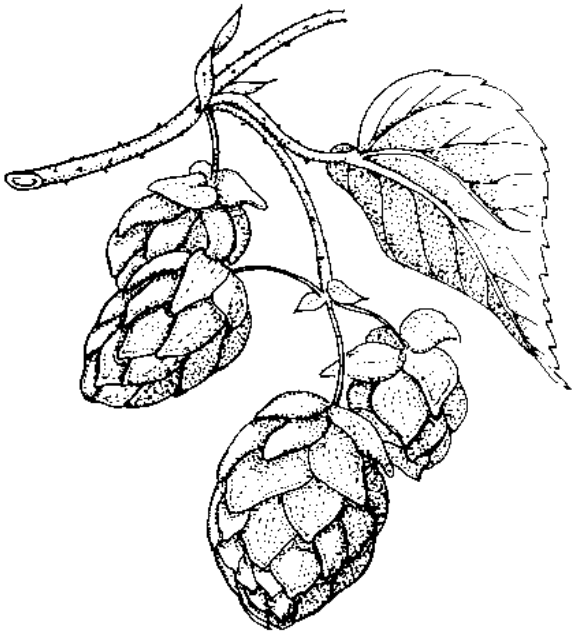
Bayerische Landesanstalt für Landwirtschaft

Gesellschaft for Hopfenforschung

Annual Report 2005
Special Crop Hops



Bavarian State Research Center for Agriculture

- Institute for Crop Science and Plant Breeding -

and

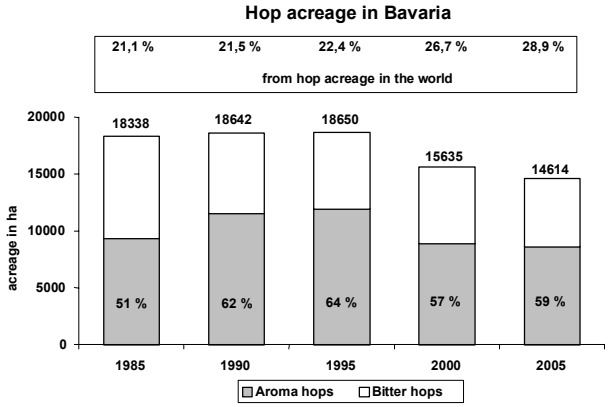
the Society of Hop Research

April 2006

LfL Information

Preface

In times of a declining economy, state institutions and private industry first tend to save on the research expenditure. Decisions which cost money and are only profitable and successful in the long run are not opportune at times when money is short.
The German hop research and the hop industry in private, cooperative and state organisations are taking other paths. In his lecture "Why do we need hop research?" the President of the Association of German Hop Growers, Dr. Johann Pichlmaier, makes an important declaration for hop research as prerequisite for the survival of the German production regions: "The Hop Research Center in Hüll is the basis for our competitiveness on the global market". This strategy of the entire hop industry to maintain hop research at the present extent is conveyed to the policymakers at every appropriate opportunity.
Despite the rising beer consumption, within 15 years the hop acreage worldwide has decreased by half to around 50.000 hectares.



During this time the Bavarian hop acreage has also decreased but only by about 22 %. The proportion in the global acreage increased to almost 30 %. Varieties suited to the needs of the market in the high-alpha as well as in the aroma sector bred at the Hüll breeding station have decisively contributed to this development. In addition to this there is a packet of production methods for environmentally compatible production. Every year new research results are produced such as e.g. to optimise how the hops are treated after harvesting, which are conducive to the pursuit for outstanding qualities. The hop-growers are given a tool which they can apply with their skills.
The processing works of the hop-trading firms also play an important role in securing the location. Short routes and close cooperation with the scientists will also be essential in the future in order to maintain the standard already achieved.

Georg Balk
Chairman of the Management Board
of the Society of Hop Research

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

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1 Research Projects and Main Research Areas of the Hops Dept.

1.1 Current research projects

Wild hops – new genetic resources for breeding powdery mildew resistance

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

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

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

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

Assisted by: LA A. Lutz, LTA J. Kneidl; S. Hasyn (EpiLogic)

Duration: 01.03.2003 –30.04.2006

Objective: The aim of this project is to identify new, unknown resistances in the wild hop germplasm. These new, still fully effective powdery mildew resistant genes are to be used for crossing in and enlarging the genetic basis in the Hüll breeding material.

Results:

- Since 2001 more than 10,000 wild hops have been tested for their powdery mildew (PM) resistance in the greenhouse and in the laboratory. For testing in the greenhouse PM races were used which represent the virulence spectrum of the PM populations prevailing in the Hallertau (with the virulence genes *v3, v4, v6, vB*). In the laboratory the reaction of the wild hops was screened in comparison with two English PM isolates of the *v1-, v2-* and *v5* virulence type.
- Up until 2005 54 wild hops could be selected which have proved to be resistant to all the PM races used so far for testing in the greenhouse and in the laboratory (*v1, v2, v3, v4, v5, v6, vB*).
- Some of the wild hops have already been used as crossing partners in order to incorporate the new resistances in the Hüll breeding material and in future varieties.
- Molecular selection markers will be worked out for the resistance gene of two wild hops to establish a more reliable and faster screening for resistance to the powdery mildew in the future.

Working out an effective method to produce fungus-resistant hops by gene transfer

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: HVG Hopfenerzeugergemeinschaft (*HVG Hop Producer Group*)
Bayerisches Staatsministerium für Landwirtschaft und Forsten
(*Bavarian State Ministry for Agriculture & Forestry*)

Project Manager: ORRin Dr. E. Seigner

Assisted by: Dr. H. Miehle, P. Hartberger

Duration: 01.01.2005 – 31.12.2007

Target:

The aim of this continued research project is to transfer resistance genes into important Hüll hop varieties and consequently achieve pronounced tolerance towards fungal pathogens.

Results:

- Transformation trials with the hop chitinase gene *HCH1* could be concluded for the most part. Besides the 'Saazer' hop variety several transgenetic plants were also regenerated for the first time worldwide with the variety 'Hallertauer Mittelfrüher'.
- PCR protocols for four bacterial chitinases as well as two *verticillium* resistance genes were optimised further:

  - at the moment the four bacterial chitinases are being cloned into diverse vectors.

  - it was possible to clone the two *verticillium* resistance genes into binary vectors. The first plants have been transformed.

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

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

Financed by: HVG Hopfenverwertungsgenossenschaft e.G.(*Hop Producer Group)*

Wissenschaftsförderung der Deutschen Brauwirtschaft e. V.
(*Scientific Fund of the German Brewing Industry*)

Project Manager: Dr. S. Seefelder; ORRin Dr. E. Seigner

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

Assisted by: Dr. S. Seefelder, LTA P. Bauer (up to 30.06.03), LTA L. Logothetis, CL V. Mayer, LA A. Lutz, LTA J. Kneidl, ORRin Dr. E. Seigner

Duration: 01.05.2002- 31.06.2005

Target:

To work out molecular selection markers to accelerate breeding for powdery mildew (PM) resistance

Results:

- For the first time in the course of the present project a resistance gene could be mapped for hops on a genetic map. This applies to the PM resistance gene *R2* of the variety ´Wye Target`. This mapping is based on a segregating population from crossing the breeding lines 84/8/24(*R2*) x 98/44/49.
- First of all the phenotypical resistance data of the *R2* mapping population was gained by artificial infection with a defined PM isolate.
- In a mapping effort with altogether 620 AFLP and 17 micro-satellite markers the *R2* gene was mapped together with 6 PM resistance markers at intervals of 1.7 up to 2.6 cM on the hop genome.
- All the PM resistance markers identified so far could be verified in altogether 4 mapping populations with 120 plants.
- Furthermore several markers could be developed for the PM resistance gene *Rbu* of the variety Buket. Two markers (Rbu-279 and Rbu-284) with 3.0 or 8.3 cM respectively show a very close linkage to the gene location.
- By using the molecular markers for the two resistance genes *R2* and *Rbu,* within the progeny of a practical beeding program it was possible to identify hop seedlings with double resistance based on *R2* und *Rbu.*

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

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:	Hopsteiner, Mainburg,
Project Manager:	Dr. S. Seefelder
Coordination:	Dr. E. Seigner
Cooperation:	P. Matthews, S. S Steiner, USA
Assisted by:	Dr. S. Seefelder, LTA P. Bauer, CL V. Mayer, LTA J. Kneidl, LA A. Lutz

Target:

The aim of this research project is to identify DNA markers for components relevant for brewing. Beyond that efforts are being made to describe agronomic characteristics valuable for breeding such as e.g. yield and form of cones on the molecular basis.

Results:

- This project is based on a mapping population from crossing ´Spalter Select` x male Hüll breeding line 93/9/47. This mapping population comprises 139 female plants, each plant is being grown in Germany and the USA at two different locations and this repeated three times.
- 556 hop samples were harvested in the test year 2005 at each of the standardised experimental yards in Hüll and Rohrbach.
- Important phenotypical data was gained from altogether 1,112 hop samples.
- So far approx. 812 segregating molecular markers (AFLPs and microsatellites) have been identified within the mapping population for the planned QTL calculation. These markers form the basis for a genetic map.
- The necessary chemical data for the calculation is being gained at present by analysing all the hop samples.

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

Sponsored by:	Bayerische Landesanstalt für Landwirtschaft, *(Bavarian State Research Center for Agriculture)* Institut für Pflanzenbau und Pflanzenzüchtung (*Institute for Crop Science and Plant Breeding*)
Financed by:	EHRC (European Hop Research Council - Carlsberg Breweries, Heineken, InBev, Hopfenveredlung St. Johann, Hallertauer Hopfenveredlungsgesellschaft /Hopsteiner)
Project Manager:	Dr. S. Seefelder; ORRin Dr. E. Seigner
Assisted by:	R. Schürmer, Dr. S. Seefelder, LA A. Lutz, LTA J. Kneidl
Cooperation:	Dr. F. Felsenstein, EpiLogic GmbH Agrarbiologische Forschung und Beratung, Freising
Duration:	01.12.2004 - 30.11.2007

Target:

To work out molecular selection markers for powdery mildew resistance from wild hops in order to accelerate the breeding of PM resistant hops.

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

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:	Busch Agricultural Resources International, Inc. (BARI);
Project Manager:	Ltd. LD B. Engelhard
Assisted by:	Bernhard Engelhard, Dr. Klaus Kammhuber, Renate Huber, Herfried Hesse, Florian Amberger
Duration:	2003 – 2006
Targets:	1. Determining main infection periods (primary and secondary infection) 2. Developing a forecasting model for the well-aimed control of powdery mildew

Methods:

The test programme 2005 was highly diversified; it embraced plot trials, strip trials with empty plots and practical trials.

a) New products were tested at two locations (Holzhof, Oberempfenbach) in plot trials repeated three times. The spraying times corresponded solely to the provisional mildew forecasting model.

b) Two small-scale weather stations (50 m apart) were operated and evaluated at the Reitersberg location. According to observations by the hop-grower first of all the infection always occurs in a shady area. Young hop plants were set out on two places and changed after each spray warning.

c) In collaboration with the colleagues in the plant protection industry six rows of hops in each hop-yard were treated following the spray warning at eight locations according to the "4th model" and the "5th model". One plot of approx. 500 metres at each location was not treated.

d) 34 hop-growers with 56 hop-yards are taking part in verifying the forecasting model. During the whole season the hop-growers were given (as also in the tests a - c)) up-to-date assessments by fax according to the model as well as specific advice on the likely course of infection.

Seven agrar-meteorological stations were evaluated in the Hallertau..

Results:

- For very susceptible varieties the spray warnings were sent out on 15th and 30th June as well as on 11th July. These warnings were made to minimize the risk; the guidelines relating to the model were **not** totally fulfilled. The fact that these were critical infection periods is proved by some reports on mildew pustules occurring at this time.

- On 16th August there was a spray warning for all varieties which were due to be harvested after 5th September. This was preceded by six connected parts of the day with likely conditions for infection.
- The evaluation of the cone samples from all locations showed that as good as no mildew could be found in the Hallertau in 2005. Also no infected cones were found in the 11 locations with untreated plots. When harvesting was later, mildew could be found in isolated cases of the samples for the Independent Quality Appraisal.

  At the date on 16th August the cones were probably already resistant to the spores (ageing resistance) and consequently the attacks were slight.
- Odd pustules were found on the young plants at the Reitersberg location during the last two weeks in June. The hop plants were cultivated further outside the Hallertau. Half of each in a sunny and half in a shady location respectively. At the shady location the mildew increased enormously, at the sunny location there was no further increase.
- The provisional powdery mildew forecasting model produced correct values in 2005.

Which hop aphid attacks (*Phorodon humuli*) can be tolerated at the time when the cones are forming in hops?

Sponsored by:	LfL, Institut für Pflanzenbau und Pflanzenzüchtung (LfL, *Institute for Crop Science and Plant Breeding*)
Financed by:	Erzeugergemeinschaft Hopfen HVG e.G.; (*Hop Producer Group HVG* e.G.)
	Busch Agricultural Resources International, Inc. (BARI)
Project Manager:	Ltd. LD B. Engelhard
Assisted by:	Dr. F. Weihrauch, M. Felsl, M. Fischer, A. Neuhauser
Duration:	01.04.2005 – 31.03.2009

Targets:

For decades the Hop Advisory Service has warned:"The hops must be free of aphids at the time when the cones are forming. If isolated aphids are found another control measure is essential!"

Target of the project is to verify this: Can – and if so, under which prerequisites (e.g. variety, time) – a certain number of hop aphids be tolerated per leaf, without the cones suffering with respect to quality and quantity at the time of harvesting? So far there have been no test results over several years and no publications on this subject .

Results:

In 2005, as a preliminary trial to a more extensively planned study, plots (each approx. 380 m^2) were planted in 14 practice yards (four varieties: HM, HT, PE, SE) which served as spraying windows without insecticide treatment to control the unchecked aphid development in the respective yard and which was monitored weekly. Additionally, an experimental harvest was carried out in two yards of each variety, respectively. At the time of harvesting only two HM plots showed total damage by hop aphids. As for the yields and alpha contents ascertained, there were significant losses of 10 or 40% in the case of two other yards (1 HM, 1 HT). The other ten untreated plots visually showed either no aphid damage and/or no significant differences at all in yield and quality in the trial harvests. Nevertheless, the cone inspections showed that despite this in two other plots that at first sight were only slightly infected there was an even more definite aphid infestation of cones: In one HM plot the cones were infested by 92 %, and in one PE plot by 30 %. To sum up, in the extremely weak hop aphid year 2005 there would not have been any or hardly any aphid damage worth mentioning in eight of 14 trial yards without treatment with insecticides.

Development of plant protection strategies in organic hop production as alternatives for 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:	Federal German Program for Ecological Agriculture in the Federal Institute for Food & Agriculture (BLE)
Project Manager:	Ltd. LD Bernhard Engelhard
Cooperation:	Bioland e.V.
Assisted by:	M. Eckert, A. Bogenrieder, Dr. F. Weihrauch
Duration:	01.04.2004 – 30.11.2006

Target: To control the pests and diseases in ecological hop production without synthetic plant protectives and to substitute and/or reduce the products containing copper and sulphur. Effective products should be approved or licensed in compliance with the law on plant protection.

Results:

As in 2004 the tests were carried out in the hop-yards of the following farmers: N. Eckert, Herpersdorf (seal district of Hersbruck) and G. Prantl, Ursbach (seal district of Abensberg), all recognised organic farms. The trials were made to control the following pests:

a) Powdery mildew (1 location)
Calium bicarbonate + Micula adhesive), powdered whey for spraying, reacre painted, wettable sulphur
- no infestation even in untreated plots, therefore no treatment necessary

b) Downy mildew (1 location)
Plant tonic “Stähler“, FungEnd + oils, Funguran, Du Pont (GFJ 52-008, Cuprozin fl., applicable variant, applicable variant plus Frutogard
- the copper-free variants "Stähler“ and "FungEnd“ have been monitored at the end of the season with 60 % of the infected cones, the variants containing copper (incl. applicable variants) with 1-7 % infected cones.
- the actual amount of copper (Cu) distributed during the season was between 4 kg/ha (practice) and 10.0 kg/ha (DuPont). The residues analysed were between 8.1 ppm Cu (untreated) and 289 ppm Cu (Funguran)

c) Hop aphid (2 locations)
Ground quassia wood, ground quassia wood plus soft soap, NeemAzal + TSForte, Spruzid Neu, TRF 12 g/24 g/36 g Quassin painted in each case, rape oil painted, NeemAzal + TSForte paintede.
- rape oil produced no effect; however this evidence was very important
- with altogether few attacks of aphids the TRF, as well as quassia plus soft soap produced the best yields and the best effects.
- cone samples for residue analyses are still being stored in the cold room but regrettably there are no standardised methods for the active ingredients.

Differentiating between a selection of the worldwide hop spectrum and the Hüll-bred varieties regarding alpha-acids and polyphenols and the influence these components have on the beer quality

Sponsored by:	Bayerische Landesanstalt für Landwirtschaft, *(Bavarian State Research Center for Agriculture)* Institut für Pflanzenbau und Pflanzenzüchtung (*Institute for Crop Science and Plant Breeding*)
Financed by:	Wissenschaftliche Station for Brauerei in Munich e.V.
Project Manager:	RR Dr. K. Kammhuber
Cooperation:	Versuchsbrauerei St. Johann (Hopfenveredelung St. Johann GmbH & Co. KG) - (Research Brewery)
Assisted by:	CTA B. Wyschkon, RR Dr. K. Kammhuber
Duration:	01.11.2003 – 31.03.2005
Target:	The aim of the project is to find out whether hop varieties with extremely different components have a noticeable influence on the quality of the beer, which also involves brewing trials.

Results:

The entire global hop spectrum available in Hüll (altogether 118 samples) was analysed with an HPLC method which makes it possible to analyse all six principal bitter substances and xanthohumol in one go. In addition the whole content of the polyphenols and flavanoids were determined from these samples.

Of 13 varieties which differ very much as to their contents of cohumulone, adhumulone and polyphenol, brewing trials were carried out in the St. Johann Research brewery. The beers were tasted by a group from Hüll and the team from St. Johann. Great differences were ascertained in the beers where a high polyphenol content most clearly showed a positive influence on the beers.

The analytical part of the project was published in the Hopfenrundschau International 2005. A publication on the results of the brewing trials is to follow.

1.2 Main Research Areas

1.2.1 Main research area: Breeding

Breeding powdery mildew-resistant high-quality hop varieties in the aroma and bitter sector

Project Manager:	ORRin Dr. E. Seigner
Assisted by:	LA A. Lutz, LTA J. Kneidl
Cooperation with:	Dr. F. Felsenstein, EpiLogic GmbH Agrarbiologische Forschung und Beratung, Freising

Target:

The main focus in the Hüll breeding work is on developing high-quality varieties suited to the needs of the market and the environment. As a good to very good resistance or tolerance towards downy mildew (*Pseudoperonospora humuli*) and the *Verticillium* wilt disease has already been incorporated in the Hüll-bred varieties, work has been going on for some years now to improve the resistance to powdery mildew (PM).

Measures:

- 112 specific crossings with PM resistant crossing partners were carried out in 2005 in the aroma and/or bitter sector.
- 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. Hüll varieties and 12 foreign varieties as well as 114 female, 38 monoecious and 129 male breeding lines were likewise integrated in this greenhouse test.
  - Only individuals which were classed as resistant were examined for their PM resistance after the resistance test in the greenhouse and in the field under natural infection conditions and without the use of fungicides (approx. 4,000 seedlings per crop year).
- Testing for PM resistance in the laboratory (detached leaf assay)
  - At the moment 13 different PM isolates with characterised virulence genes are available for testing in the Petri dish. Consequently it is possible to test almost all the resistances so far used worldwide in breeding.
  - In order to test for resistance to PM races which have not yet occurred in Germany, 12 varieties, 281 breeding lines and 145 wild hops were tested in the detached leaf assay following artificial inoculation with an English PM isolate.
- Work is only being continued on breeding research with hops which show resistance to powdery mildew in all the tests.

1.2.2 Main Research Areas: Hop Production and Production Methods

Testing and further development of the EDP water economy model HyMoHOP for controlling watering requirements in hop-growing

Project Manager: LOR J. Portner

Assisted by: LA J. Münsterer

Cooperation with: Dr. P. Capriel, Institut for Agrarökologie, Ökol. Landbau und Bodenschutz, Freising

Dr. T. Rötzer, Munich

The aim of the project is to develop an EDP water economy model which calculates the water household of the hops (potential and actual evaporation, interception, soil water content, drainage and waterings) in daily steps from meteorological data. At the same time the type of soil, the phenology of the hops and optional waterings are taken into account.

The determination of soil parameters and the weekly measuring of soil water contents at the Hüll and Ilmendorf locations were necessary for further calibration and to validate the model. The practicality of the model was tested in a watering trial at both locations.

Due to weather conditions with plentiful rainfall in 2005 the further development could only be realized to a limited extent and the practicality could not be fully clarified. The watering trial will therefore be repeated in 2006. It is planned to introduce the model into practice as an internet application.

Optimising the application technique for spraying apparatus

Project Manager: LOR J. Portner

Assisted by: LOR J. Portner, F. Seidl (graduand)

The tests begun in 2004 to optimize the spraying coverage above all in the top area of the hop plants were continued. Here the focus was on testing various jets with variation on the pressure, the travelling speed and the position of blowers in various development stages of the hops. The measurement of the spray coating on the hop leaves was carried out at three different heights with water-sensitive paper. The wetting was quantified with the aid of image analysis equipment (ScAnalysisrs).

The results will be evaluated in the form of a dissertation.

Analyses on the accrual, specific gravity and nutrient content of chopped bines at the time when they are distributed

Project Manager: LOR J. Portner

Assisted by: LOR J. Portner, LA J. Münsterer

Cooperation with: IAB 2b

To determine the fertilizer required, the return supply of nutrients from organic materials must be calculated at the time when distributed. The analyses at the time of distribution should take into account any changes in the quantity of chopped bines and the nutrient contents through the hot-rotting phase. By determining the specific gravity it is easier for the farmer to assess the amount distributed and thus calculate the nutrients when fertilizing.

In order to verify the results from 2004 the trial was repeated with the same hops.

Determing the optimum hartesting-time for the variety Saphir

Assisted by: LOR J. Portner, LA A. Lutz

Duration: 2004 – 2006

Saphir was grown as a new variety on 188 ha.

In order to determine the optimum harvesting-time in the Hallertau, 20 training wires were harvested from one stand of field hops and this repeated at intervals of 3-4 days. The harvesting was carried out on five harvesting dates. Evaluation was with regard to yield, alpha-acid contents, arom and exterior quality (picking, colour, cone development and defects).

Training trials with the varieties Hallertauer Taurus and Saphir

Assisted by: LA E. Niedermeier

The more bines per training wire the more time is needed for training and retraining the hops and the greater spread of infection due to the dense foliage. As always however, for the economic success the optimum yield is of decisive importance. The hop-training trials are important to find the optimum number of bines per training wire for the newer varieties. 2005 was the third year of the trial for the variety Taurus, the variety Saphir was in the second year of the trial.

N fertilizing trial with Entec (stabilised nitrogen fertilizer)

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Assisted by: LA E. Niedermeier

The fertilizing trial with the stabilised fertilizer Entec was last carried out at the Hüll location in 2005. Compared with the 0 plot and a customary fertilizer it is to be tested with differing target values how far the yield can be increased or to what extent it is possible to increase the alpha-content with Entec.

Midway during the three trial years no significant differences could be determined between the fertilizing variants.

1.1.3 Main Research Areas: Hop Quality and Analytics

Developing a NIR calibration based on HPLC data

Project Manager:	RR Dr. K. Kammhuber
Cooperation with:	Dr. M. Biendl, Hallertauer Hopfenveredelungsgesellschaft mbH J. Betzenbichler, Hallertauer Hopfenveredelungsgesellschaft mbH R. Schmidt, NATECO$_2$ GmbH & Co. KG U. Weiss, Hopfenveredelung HVG Barth, Raiser GmbH & Co KG
Assisted by:	CL E. Neuhof-Buckl, CTA B. Wyschkon, RR Dr. K. Kammhuber
Duration:	The project was started in September 2000, it is still open-ended.

Since the year 2000 a NIR calibration based on HPLC data is being developed by Hüll and the laboratories of the hop-processing firms, in order to substitute the increasing number of wet-chemical examinations by a cheap fast method. The target is to improve the NIR method in such a way that an acceptable repeatability and reproducibility can be attained for the practice.

Every year the existing calibration is to be extended and improved by the calibration. Within the Work Group for Hop Analytics (AHA) it was decided that this method is then suitable for the practice and can be used as an analytical method for the hop supply contracts, if it is at least just as exact as the conductrometric titration according to EBC 7.4.

2 Weather Conditions 2005

Bernhard Engelhard, Dipl. Ing. agr.

Although the temperatures were considerably too high in the first two weeks in January, overall the winter 2004/2005 must be rated as very cold.

After many years it was a winter with particularly plentiful snowfall from the end of February until mid-March, any growth was halted with the cold spell at the end of January (-20°C) and the mean temperataures of –3.6 °C in February. After the snow had melted from mid-March onwards it was difficult to drive through the hop-yards as the ground was not frozen. The nitrogen stocks with 100 kg Nmin/ha were in fact lower than 2004 (127 kg Nmin) but higher than the mean average over many years.

For the spring work there were only a few days left to drive through the hop-yards when the ground was dry. In many cases it could not be avoided that the ground became compacted through driving over it nor could the risk of increasing wilt disease be avoided. Also the "stripping the lower bines" and "training work" was made difficult by frequent heavy rainfall up until mid-May. Due to night frosts on some days it was not possible to carry this work out in the morning.

After the vegetation began comparatively late – around 24th March – the vegetation was delayed for a long time two weeks behind the average over many years. A hot period in May (3 days with max. temperatures > 30°C) promoted the growth; but the development up until the harvest was about a week behind compared with the average over 10 years. However it should be mentioned that compared with the 1980s of the past century it could be termed a completely normal development.

Plentiful rain which was well distributed, low temperatures (above all in August for the lupulin production) and little (intensive) sunshine in 2005 were prerequisite for above average crops and high to very high alpha-acid contents. The ripening and optimum harvesting time for the individual varieties was again about 3-4 days later compared with the "late harvest in 2004". The overwhelming majority of the hop-growers also took this into account.

A special feature of the weather conditions in 2005 was the development of the alpha yield per hectare. While normally, except for a few varieties such as TU and NU, the percentage of alpha-acid contents reached its maximum relatively quickly, in 2005 there was a constant rise in the alpha-acid content for all varieties up until the harvest. As in every year the yield increased evenly. A late harvest consequently produced above-average alpha-acid yields per hectare.

Nevertheless the good yields of a late harvest had to be "paid for" with a poor to considerably below average exterior quality. The cause of the frequent poor exterior quality was due to pollinated cones with seeds at the base of the bracteoles. Due to the long flowering period the proportion of pollinated cones was exceptionally high.

More effects of the weather conditions on pests and diseases are described in Chapter 6.1.

Table 2.1: Weather data (monthly mean averages or monthly totals) from 2005 compared with the 10- and 50-year mean averages

Month		Temperature at height of 2 m Average (°C)	Min.∅ (°C)	Max.∅ (°C)	Relat.air moisture (%)	Precipitation (mm)	Days w. Preceipit. >0.2 mm	Sunshine (hrs.)
January	2005	-0.4	-4.9	4.0	83.2	60.8	16.0	105.5
∅	10-j.	-1.4	-4.5	2.0	88.5	40.3	10.6	63.2
	50-j.	-2.4	-5.1	1.0	85.7	51.7	13.7	44.5
February	2005	-3.6	-8.7	1.3	84.8	62.3	14.0	82.7
∅	10-j.	1.2	-3.2	6.1	82.9	33.3	11.1	99.9
	50-j.	-1.2	-5.1	2.9	82.8	48.4	12.8	68.7
March	2005	2.0	-4.2	8.3	79.5	45.7	9.0	157.3
∅	10-j.	4.2	-0.3	9.5	79.4	61.1	13.4	142.7
	50-j.	2.7	-2.3	8.2	78.8	43.5	11.3	134.4
April	2005	9.3	3.7	15.0	73.6	123.9	13.0	179.3
∅	10-j.	8.0	2.5	13.8	74.0	51.0	10.6	170.1
	50-j.	7.4	1.8	13.3	75.9	55.9	12.4	165.0
May	2005	13.1	6.5	19.7	74.5	96.2	15.0	238.7
∅	10-j.	13.7	7.5	19.8	72.3	79.3	11.7	214.1
	50-j.	11.9	5.7	17.8	75.1	86.1	14.0	207.4
June	2005	17.1	10.2	23.5	71.6	90.1	12.0	249.3
∅	10-j.	16.6	10.1	22.8	72.7	93.2	14.5	232.6
	50-j.	15.3	8.9	21.2	75.6	106.1	14.2	220.0
July	2005	17.9	12.2	24.4	78.7	148.0	18.0	207.1
∅	10-j.	17.5	11.6	23.7	75.5	103.5	16.0	220.3
	50-j.	16.9	10.6	23.1	76.3	108.4	13.9	240.3
August	2005	15.7	10.6	21.6	83.1	174.6	13.0	163.4
∅	10-j.	17.9	11.7	24.8	75.8	71.4	11.2	225.3
	50-j.	16.0	10.2	22.5	79.4	94.9	13.3	218.4
September	2005	14.4	9.2	21.3	86.3	57.6	10.0	188.5
∅	10-j.	12.8	7.6	19.0	81.2	71.5	12.1	163.9
	50-j.	12.8	7.4	19.4	81.5	65.9	11.4	174.5
October	2005	9.6	4.6	15.9	89.0	57.9	7.0	127.9
∅	10-j.	9.2	5.2	14.0	86.1	68.3	13.8	107.0
	50-j.	7.5	2.8	13.0	84.8	60.0	10.4	112.9
November	2005	2.0	-1.7	5.4	94.9	49.2	10.0	42.9
∅	10-j.	3.1	0.1	6.5	90.0	57.0	11.4	65.4
	50-j.	3.2	-0.2	6.4	87.5	58.8	12.6	42.8
December	2005	-1.4	-4.2	1.3	94.3	45.4	14.0	48.7
∅	10-j.	-0.2	-3.2	2.6	89.4	38.5	12.2	56.2
	50-j.	-0.9	-4.4	1.6	88.1	49.1	13.3	34.3
Year 2005		8.0	2.8	13.5	82.8	1011.7	151.0	1791.3
10 –yr mean average		8.5	3.7	13.7	80.6	768.5	148.6	1760.6
50 – yr mean average		7.4	2.5	12.5	81.0	828.8	153.0	1663.0

The 50-year mean average applies to the years 1927 up to and including 1976, the 10-year mean average applies to the years 1995 up to and including 2004.

3 Statistical Data on Hop Production

Johann Portner, 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	1611	10.66
1987	4 613	4.18			
1988	4 488	4.41			
1989	4 298	4.64			
1990	4 183	5.35			

Table 3.2: Acreage, number of hop farms and average area under hops in the German production regions

Production region	Hop acreagae				Hop farms				Hop acreage per farm in ha	
	in ha		Increase + / Decrease - 2004 up to 2005				Increase + / Decrease - 2004 up to 2005			
	2004	2005	ha	%	2004	2005	farms	%	2004	2005
Hallertau	14 515	14 221	- 294	- 2.0	1 370	1 297	- 73	- 5.3	10.59	10.96
Spalt	388	395	+ 7	+ 1.8	98	95	- 3	- 3.1	3.96	4.16
Tettnang	1 220	1 200	- 20	- 1.6	196	186	- 10	- 5.1	6.22	6.45
Baden. Bitburg and . Rhineland-Palaatinate	20	20	±0	± 0	3	3	± 0	±0	6.67	6.67
Elbe-Saale	1 333	1 332	- 1	- 0.1	32	30	- 2	- 6.3	41.66	44.40
Germany	17 476	17 167	- 309	- 1.8	1 699	1 611	- 88	- 5.2	10.29	10.66

The Hersbruck production region has come under the Hallertau since 2004

Figure 3.1: Hop acreage in Germany and in the Hallertau production region

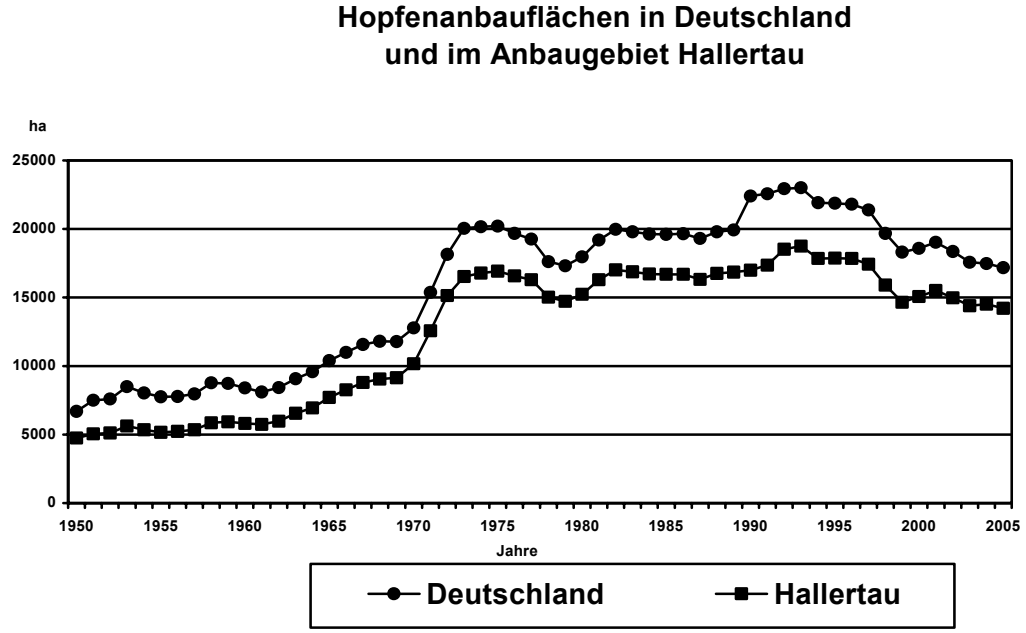
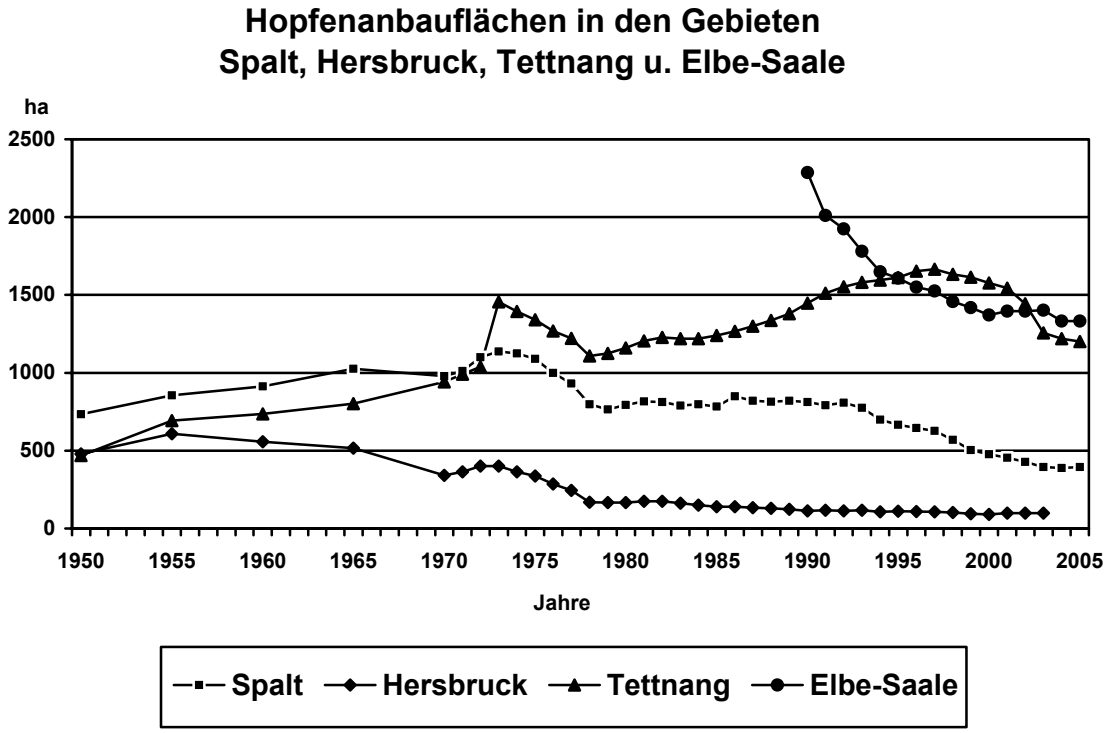


Figure 3.2: Hop acreage in the regions Spalt, Hersbruck, Tettnang and Elbe-Saale



The Hersbruck production region has come under the Hallertau since 2004

3.1.2 Hop Varieties

As far as the hop varieties in 2005 are concerned, there was another shift in favour of the aroma varieties. The proportion of aroma varieties in 2005 is now 58.86 % compared with 56.59 % in 2004. The bitter varieties have a proportion of 41.14 % of the acreage compared with 43.41 % in 2004.

The increase in acreage in the case of aroma hops is particularly due to the expansion of Hall. Tradition (+ 214 ha), Perle (+ 97 ha), Hallertauer Mfr. (+ 44 ha) and Saphir (+ 5 ha). Of the new aroma varieties Opal and Smaragd 19 hectares of each weregrown. All the other aroma varieties showed a slight decrease in acreage.

In the case of the bitter varieties the acreage of all varieties (except for the new variety Herkules + 26 ha) was reduced.

The exact distribution of the varieties over the production regions can be seen in Table 3.3.

Figure 3.3: Distribution of varieties in 2005 in Germany

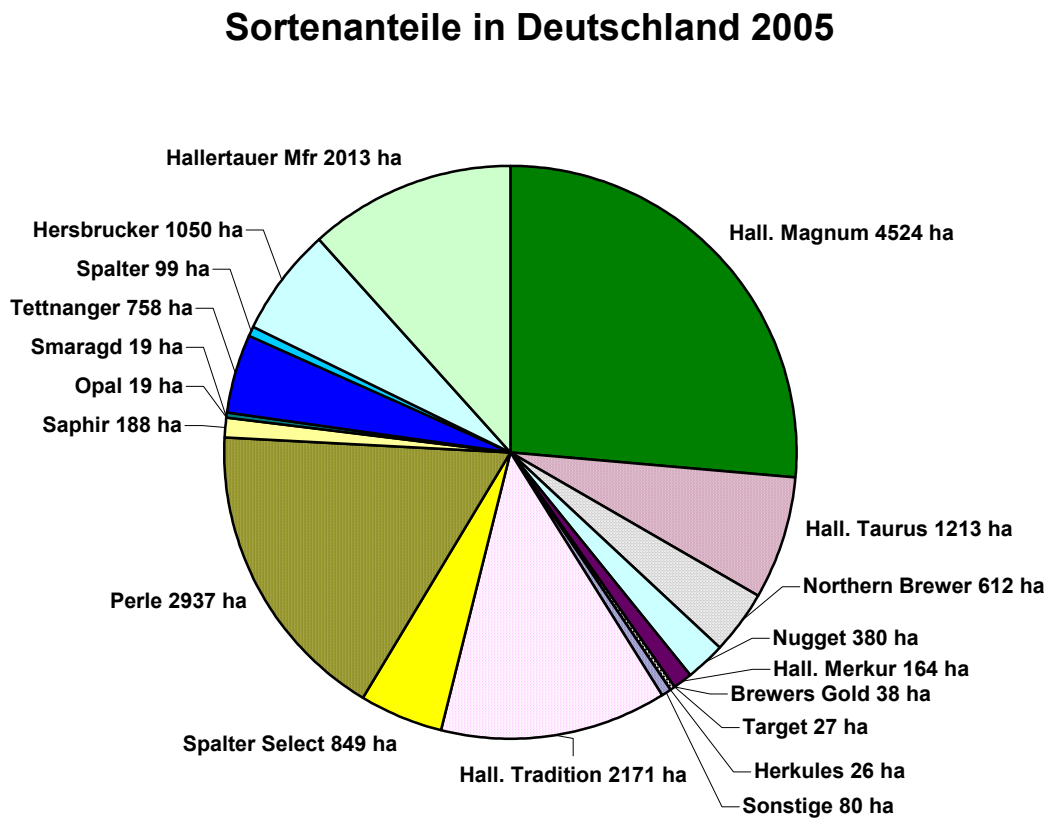


Table 3.3: Hop varieties in the German production regions in ha in 2005 Aroma varieties

Production region	Total acreage	HA	SP	TE	HE	HÜ	PE	SE	HT	SR	OL	SD	Aroma varieties	
													ha	%
Hallertau	14.221	1.492	4	2	1.041	1	2.789	732	2.116	188	19	19	8.304	59.09
Spalt	395	113	95		9		23	115	26				381	96.57
Tettnang	1.200	407		756									1.163	96.92
Baden. Bit-burg u. Rheinpfalz	20	1				2	6	2	3				14	73.63
Elbe-Saale	1.332						119		24				143	10.77
Germany	17.167	2.013	99	758	1.050	2	2.937	849	2.171	188	19	19	10.105	58.86
Variety proportion **in %**		11.73	0.58	4.42	6.12	0.01	17.11	4.95	12.64	1.09	0.11	0.11		

Change in varieties in Germany

2004 ha	17.476	1.969	102	790	1.195	3	2.840	851	1.957	183			9.890	56.59
2005 ha	17.167	2.013	99	758	1.050	2	2.937	849	2.171	188	19	19	10.105	58.86
Change in ha	- 309	+ 44	- 3	- 32	- 145	- 1	+ 97	- 2	+ 214	+ 5	+ 19	+ 19	+ 215	+2.17%

Table 3.3: Hop varieties in the German production regions in ha in 2005 Bitter varieties

Production region	NB	BG	NU	TA	HM	TU	MR	CTS	HS	RE	Sonst.	BitterstoffVarietyn	
												ha	%
Hallertau	423	38	318	23	3.660	1.177	116	7	26	13	17	5.818	40.91
Spalt					5		8					13	3.43
Tettnang											37	37	3.08
Baden. Bit-burg u. Rheinpfalz					2	3						5	26.37
Elbe-Saale	189		62	4	857	33	40	2			2	1188	89.23
Germany	612	38	380	27	4.524	1.213	164	9	26	13	56	7.061	41.14
Variety proportion **in %**	3.56	0.22	2.14	0.16	26.35	7.06	0.96	0.05	0.15	0.07	0.33		

Change in varieties in Germany

2004 ha	665	39	450	33	4.869	1.273	200	11		14	32	7.586	43.41
2005 ha	612	38	380	27	4.524	1.213	164	9	26	13	56	7.061	41.14
Change **in ha**	- 53	- 1	- 70	- 6	- 345	- 60	- 36	- 2	+ 26	- 1	+ 24	- 525	- 6.92%

3.2 Crop Situation in 2005

The 2005 hop crop in Germany amounts to 34 465 520 kg (= 689 310 ctr.) compared with 33 207 364 kg (= 664 147 centner) in 2004. The crop volume is about 1 258 156 kg (= 25 163 centner) above the previous year's result; this means an increase of about 3.79 %.

The yields per hectare and comparative figures in Germany are shown below.

Table 3.4: Yields per hectare and comparative figures in Germany

	1999	2000	2001	2002	2003	2004	2005
Crop ctr./ha or kg/ha	30,5	31,5	1660 kg (33,2 Ctr.)	1758 kg (35,2 Ctr.)	1442 kg (28,8 Ctr.)	1900 kg (38,0 Ctr.)	2008 kg (40,2 Ctr.)
Relative to 100% (longterm ∅ =35 Ztr.)	87,1	90,0	94,9	100,6	82,40	108,6	114,8
Acreage in ha	18.299	18.598	19.020	18.352	17.563	17.476	17.167
Total crop in ctr. or. kg	558.247	585.841	31.576.465 kg = 631.529 Ctr.	32.270.635 kg = 645.413 Ctr.	25.325.768 kg =506.515 Ctr.	33.207.364 kg = 664.147 Ctr.	34.465.520 kg = 689.310 Ctr.

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

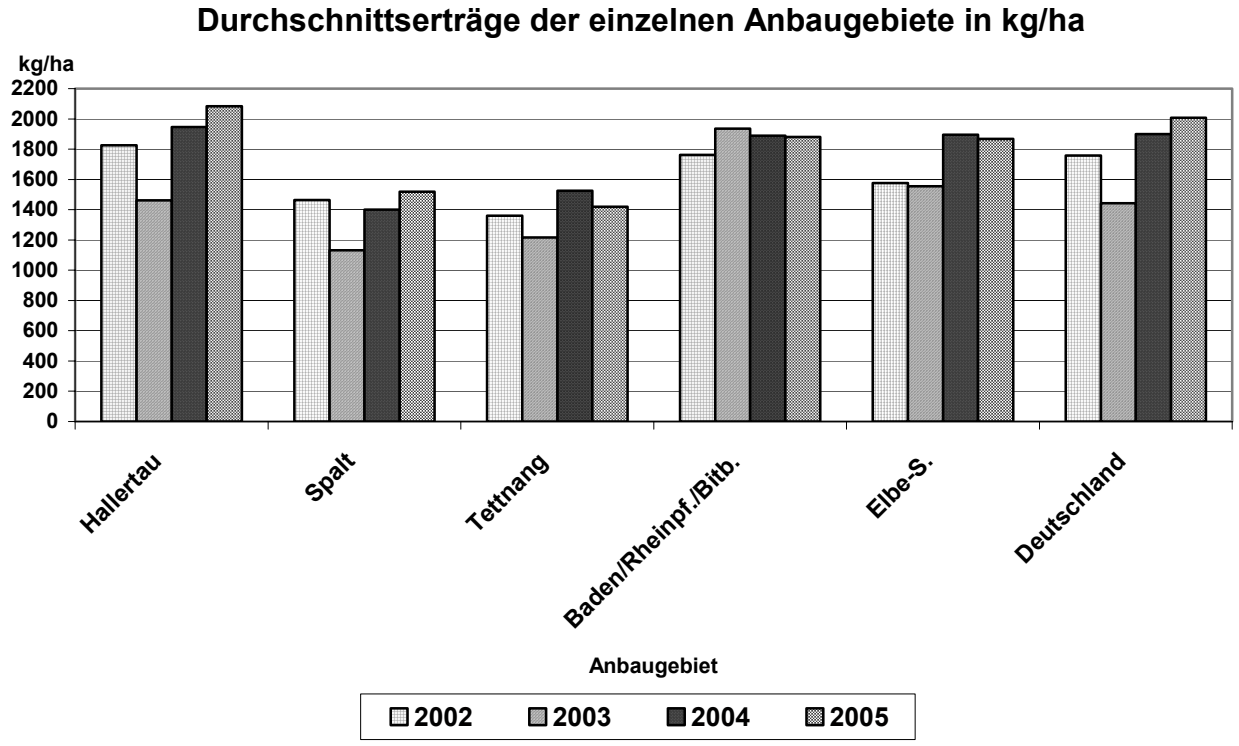


Figure 3.5: Crop volume in Germany

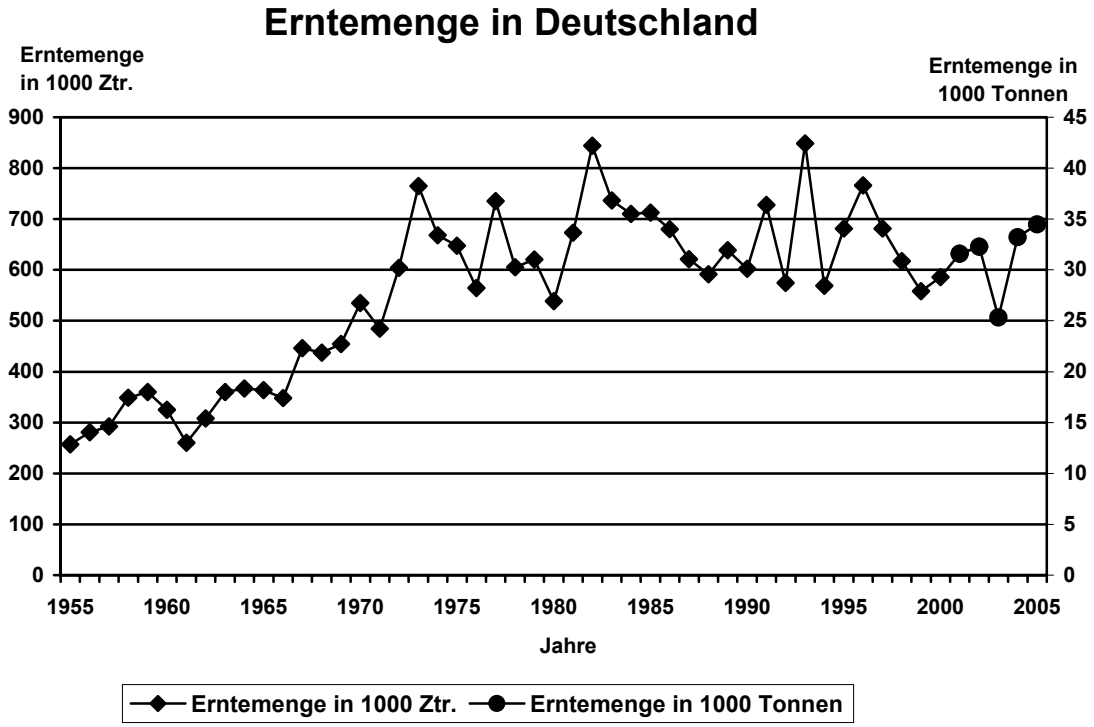


Figure 3.6: Average crop per ha hop acreage in Germany

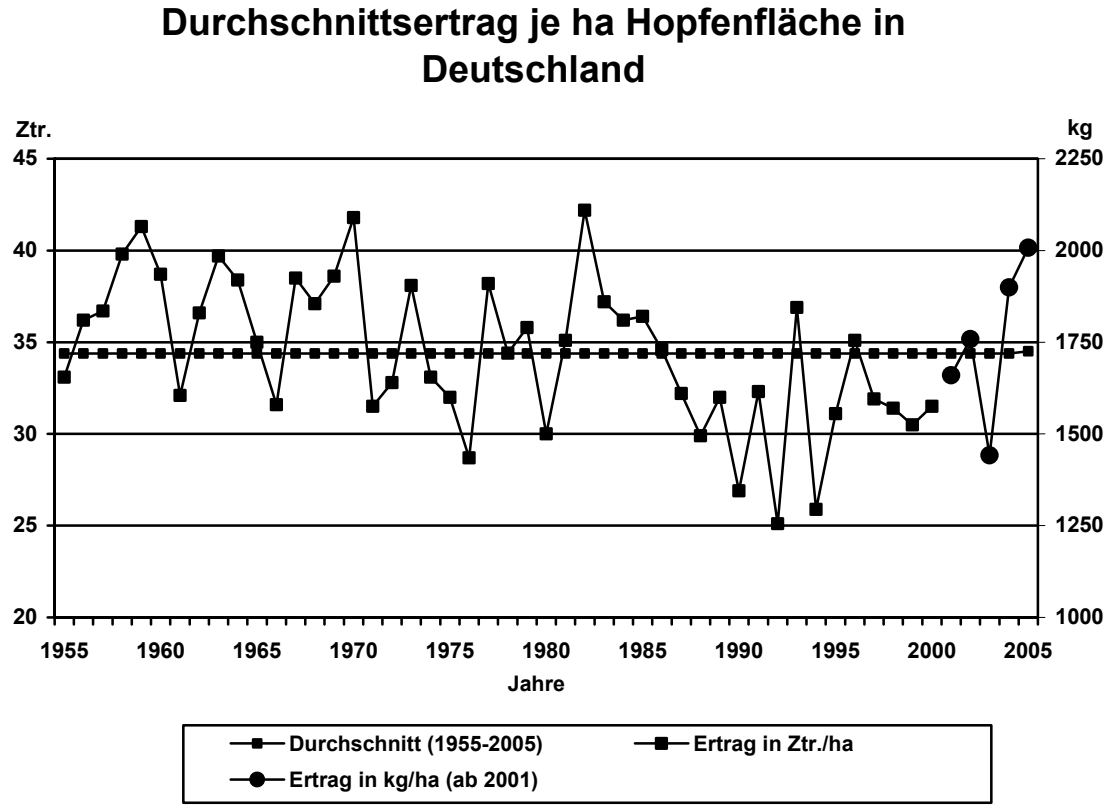


Table 3.6: Yields per hectare in the German production regions

Production region	Yields in centner/hectare total acreage (as from 2001 in kg/ha)								
	1997	1998	1999	2000	2001	2002	2003	2004	2005
Hallertau	32.8	32.5	31.2	33.6	1724	1825	1462	1946	2084
Spalt	26.5	22.1	28.2	20.9	1298	1464	1131	1400	1518
Hersbruck	28.3	28.8	23.5	26.8	1233	1306	983	- *	- *
Tettnang	31.2	26.8	28.3	16.4	1212	1360	1216	1525	1419
Bad./Rheinpf. Bitburg	34.9	30.1	31.4	31.6	1445	1763	1936	1889	1881
Elbe-Saale	23.6	27.5	27.3	30.0	1594	1576	1555	1895	1867
Ø Crop ctr.ha Germany	31.9	31.4	30.5	31.5	1660 kg	1758 kg	1442 kg	1900 kg	2008 kg
Total cop Germany	681 035	617 181	558 247	585 841	31 576 to 631 529	32 271 to 645 413	25 326 to 506 515	33 207 to 664 147	34 466 to 689 310
Acreage Germany	21 381	19 683	18 299	18 598	19 020	18 352	17 563	17 476	17 167

* From 2004 onwards the Hersbruck production region has come under the Hallertau region

Table 3.7: Alpha-acid values of the individual hop varieties

Prod. Region/Variety	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**5 yr. Ø**	**10 yr. Ø**
Hallertau Hallertauer	5.4	5.4	4.7	4.1	4.9	4.6	4.6	3.1	4.3	4.4	**4.2**	**4.6**
Hallertau Hersbrucker	4.3	4.7	3.7	2.1	4.9	3.0	3.2	2.1	3.0	3.5	**3.0**	**3.6**
Hallertau Hall. Saphir									3.4	4.1		
Hallertau Perle	8.5	9.3	6.7	7.0	8.1	7.0	8.6	3.9	6.4	7.8	**6.7**	**7.3**
Hallertau Spalter Select	5.7	6.8	5.5	4.5	6.4	4.8	6.0	3.2	4.9	5.2	**4.8**	**5.3**
Hallertau Hall. Tradition	6.8	7.0	5.6	6.0	7.1	6.3	7.2	4.1	6.3	6.3	**6.0**	**6.3**
Hallertau North. Brewer	10.5	10.8	9.1	9.0	10.1	9.6	10.1	6.0	9.8	9.8	**9.1**	**9.5**
Hallertau Hall. Magnum	14.2	16.9	14.0	13.4	14.4	13.9	14.6	11.7	14.8	13.8	**13.8**	**14.2**
Hallertau Nugget	10.7	13.6	11.2	10.0	12.9	11.9	12.4	8.5	10.6	11.3	**10.9**	**11.3**
Hallertau Hall. Taurus		16.6	13.7	15.9	15.6	15.7	16.5	12.3	16.5	16.2	**15.4**	
Hallertau Hall. Merkur									13.5	13.3		
Tettnang Tettnanger	4.8	5.4	4.0	3.8	4.9	4.4	4.6	2.6	4.7	4.5	**4.2**	**4.4**
Tettnang Hallertauer	5.0	5.5	4.3	4.2	4.8	4.5	4.8	3.1	5.0	4.8	**4.4**	**4.6**
Spalt Spalter	5.6	5.6	4.4	3.8	4.0	4.4	4.6	3.1	4.4	4.3	**4.2**	**4.4**
Elbe-Saale North. Brewer		9.3	8.1	8.0	9.8	7.6	8.8	6.0	8.5	8.7	**7.9**	
Elbe-Saale Hall. Magnum		15.4	12.4	12.2	14.0	13.9	13.9	10.2	14.0	14.4	**13.3**	

Source: Work Group Hop Analysis (AHA)

4 Hop Breeding Research

ORRin Dr. Elisabeth Seigner, Dipl. Biol.

4.1 Classical breeding

4.1.1 Crossings 2005

Altogether 112 crossings were carried out in 2005. The basis for breeding is a stable resistance / tolerance towards *Pseudoperonospora* (downy mildew), powdery mildew, crown rot and wilt. The number of crossings are shown together with the respective breeding targets in Table 4.1.

Table 4.1: Breeding targets for the 2006 crossings

breeding sector combined with resistance /tolerance to various hop diseases	further breeding objectives	number of crossings
aroma type	none	26
	new powdery mildew resistance deriving from wild hops	12
	resistance to hop aphids	1
	suitability for low trellis	4
high alpha acids type	none	48
	new powdery mildew resistance deriving from wild hops	3
	high content of xanthohumol	10
	suitability for low trellis	6
	tolerance to lethal pathotyes to *Verticillium*	2

4.1.2 Wild hops – new resources to breed for powdery mildew resistance

Powdery mildew (P*odosphaera macularis sp. humuli*; formerly S*phaerotheca humuli*) has been no big problem in hops over the past three years. Nevertheless the risk still exists that under suitable weather conditions massive attacks of powdery mildew (PM) in susceptible varieties can incur drastic losses in yield and quality. Therefore efforts are continuing in breeding to close the resistance gap step-by-step as regards powdery mildew in aroma and high-alpha varieties.

Extensive investigations of the virulence spectrum of PM populations in Germany, France, England and the USA (Seigner et al., 2001; sponsored by the Scientific Research Fund of the German Brewing Industry) showed that all resistance genes known at present in hop breeding worldwide, are already broken by PM races with respective virulence genes. These resistances to powdery mildew are still only effective very regionally. At present in the Hallertau only the resistances which come from the English varieties ´Wye Target`and ´Zenith` convey effective

protection.. It is therefore absolutely necessary to find new sources of resistance which can presumably be found above all in wild hops. So a very extensive collection of wild hops has been built up since 2001which due to its wide geographic origins (Germany, Austria, Belgium, Hungary, Italy, Finland, Russia, Sweden, Turkey, USA, Japan, China, New Zealand) is regarded as an important new genetic resource.

Since 2001, more than 15,000 wild hops have been examined within a project sponsored by the Scientific Station for Brewery in Munich in the greenhouse and laboratory for their resistance to powdery mildew. In this way new types of so far unknown resistance genes were identified in the wild hop germplasm. Resistant wild hops have to some extent already been crossed into Hüll breeding material to enlarge the genetic basis for PM resistance and to be able to utilize new resistance mechanisms in future Hüll varieties.

Powdery mildew tests in the greenhouse

In 2001 resistance screening in the wild hop germplasm was started in the greenhouse. Since then more than 15,000 wild hops have been tested for their PM resistance. From 2003 onwards the tests are being carried out under optimized infection conditions because the PM races of the *v3-, v4-, v6-, vB*-virulence type predominant in the Hallertau were made available as inoculation materials from our cooperating partner EpiLogic, Agrarbiologische Forschung und Beratung, Freising, for the tests in the greenhouse. Hops with complementary resistance genes (*R3, R4, R6* and *RB*) are infected by these PM pathotypes. Due to the high spread of infection in the greenhouse which is achieved with the PM strains grown in the laboratory, the data collected here on disease resistance to powdery mildew can be classed as very reliable.

Following the 2005 season 85 wild hops were selected which showed no attacks whatsoever on their leaves or only light spots on their leaves which can be classed as defensive reactions towards the fungus.

Powdery mildew tests in the laboratory

In the greenhouse wild hops classed as being resistant were continued to be examined annually by Epilogic in the laboratory for PM resistance. The reaction to those PM races was tested, which have not occurred yet in the Hallertau but which are already wide spread in England and the USA. Young leaves cut off from wild hops were inoculated each time with two different PM isolates from England, which were characterised by the *v1,v2,v3,v5,vB*-virulences. To obtain reliable resistance results the tests in the laboratory were always repeated 2-3 times.

Only 54 wild hops (Table 4.2) showed no fungal attacks in the greenhouse as well as in the detached leaf assay in the laboratory.

Outlook

Work for the wild hop screening is being continued in the greenhouse and in the laboratory. Wild hops which also confirm their resistance to powdery mildew even after a longer selection phase are used as crossing partners in the breeding programme.

Afterwards in order to facilitate the selection of PM resistant indivuals from the descendants of these wild hops molecular markers will be developed for some resistance genes. At the present time the work on this is being sponsored by the European Hop Research Council (EHRC).

Table 4.2: Resistant wild hops following tests over several years in the greenhouse and laboratory; initial material: fertilized cones of wild hops

Wild hops -Origin		**No.**	**Sex**
Germany	Harburg, Donauries	1	male
	Brunning, Eggenfelden	1	female
	Staudach	2	female
	Schweinfurt, Traustadt	3	female
	Kleinmachnow	1	male
	Pirna, Saxony	1	male
	Eastern Germany	1	female
	The Baltic, Zingst Peninsular	2	male
	Berlin	3	female
	Eifel	4 6	female male
Turkey	Bursa	4 3	female male
China /Japan	Descendants from 4 female wild hops after open pollination in a Japanese hop yard	15 5	female male
Sweden	Julyta	1	female
New Zealand	unknown	1	female

The PM isolates and the detached leaf assay system which were used for PM resistance testing of the wild hops will be used beyond that for many problems around the powdery mildew. They have become decisive “pillars” for successful resistance breeding at the Hop Research Center Hüll.

The leaf resistance test system (Fig. 4.1) and the PM isolates with characterised virulences are used in manifold ways :

- in assessing the resistance of breeding lines and varieties from other countries
- for the reliable assessment of resistance in the case of mapping populations in developing molecular markers for PM resistance
- in evaluating the effectiveness of known resistances in specific hop-growing regions
- in judging the virulence situation of PM populations also in practice farms in the Hallertau
- for reliable testing of transgenetic hops

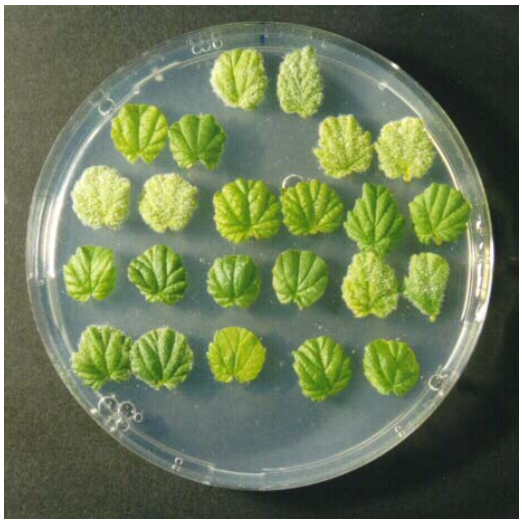


Fig. 4.1: Detached leaf assay for testing the resistance reaction to powdery mildew in

4.1.3 Newly bred varieties from the Hop Research Center Hüll

Nowadays Hüll-bred varieties are being grown on more than 70 % of the German hop acreage. This proves that hop-growers as well as brewers in Germany and worldwide are convinced by the Hüll aroma- and high-alpha varieties. The available spectrum of Hüll varieties with excellent brewing quality, improved resistance to disease and a good yield is extended further with the introduction of the new aroma varieties ´Smaragd` and ´Opal` as well as the high-alpha variety ´Herkules`. All these new varieties are making an important contribution towards ensuring the competitiveness of German hops on the world market.

´Smaragd` and ´Opal` – the new aroma varieties

These two Hüll varieties are marked by an outstanding aroma which differs distinctly from the varieties available at present. With the use of ´Opal` and ´Smaragd` the brewers are given the chance, particularly in the sector of premium and special beers to offer the consumer new beers which can improve the market chances of the brewing industry. For the hop-grower both varieties bear outstanding agronomic properties.

Genetic background

The two aroma varieties are siblings and descend from a crossing from the Hüll-bred variety ´Hallertauer Gold` x male wild hops Ku II/18.

The "old" Hüll-bred variety ´Hallertauer Gold` stands out for its favourable agronomic properties, an average alpha-acid content and an excellent aroma, which is very similar to the land race ´Hallertauer Mfr.`. Disadvantages are only the incomplete wilt tolerance and a strong susceptibility to powdery mildew. The father, a wild hop from the area of Kulmbach, proved to be an ideal crossing partner due to its very low cohumulone content, the slight susceptibility to PM as well as its having a healthy crown. The crossing in of Ku II/18 was made primarily in order to bring in low cohumulone contents into the existing Hüll breeding material.

Table 4.3: Properties of the new aroma varieties

Aroma Variety	Yield kg/ha	Resistance			Aroma- und Brauqualität			
		Vertic.-wilt	downy mildew	powdery mildew	aroma points (1-30)	aroma quality	α-acids (%)	Co-humulone (%)
Smaragd	1.850	+ +	+ +	-	26 Linalool 1,3% Farnesen <1%	full lasting spicy, sweet, fuity	4-6	13-18
Opal	1.850	+	+ +	+/-	26 Linalool 1,3% Farnesen <1%	full lasting spicy, sweet	5-8	13-17

Resistance: ++ good-very good; +/- good to low; - low

Aroma points (maximum no. of points out of 30): 26 = very fine hop aroma

Brewing trials

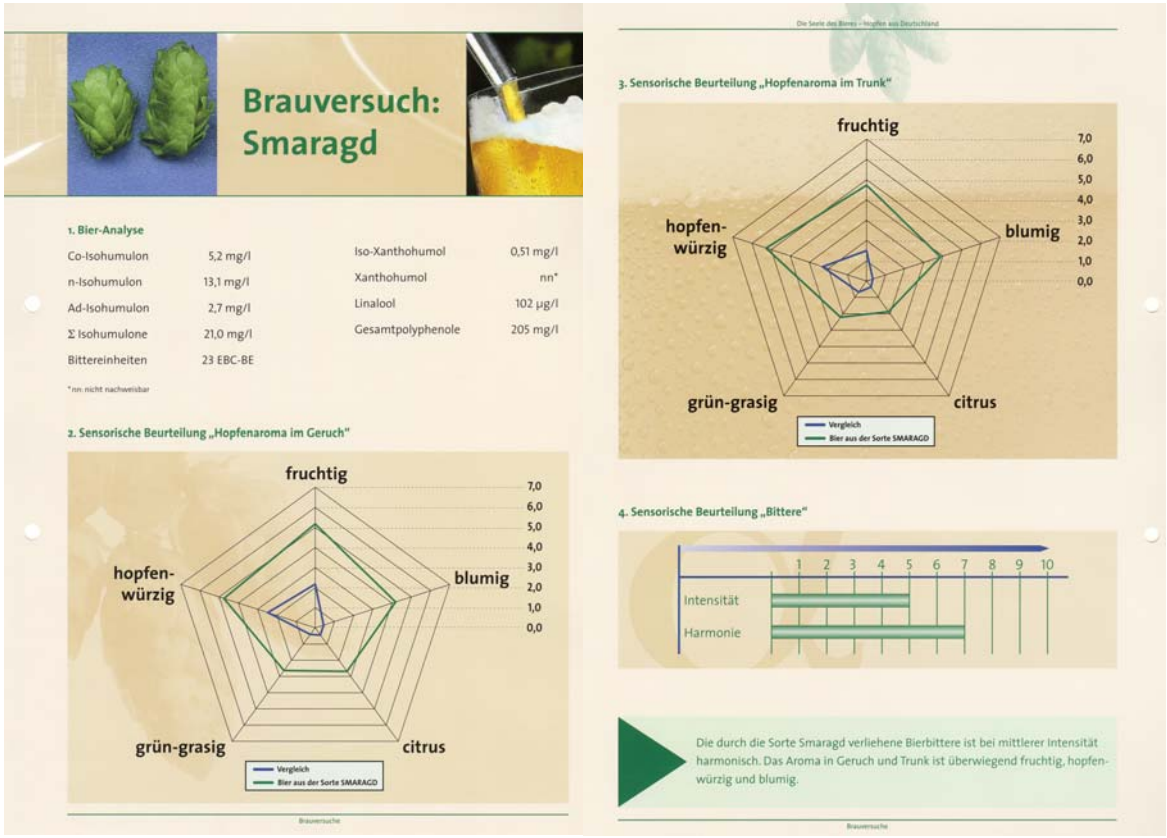


Fig. 4.2 : Beer analysis and tasting in pure variety brews with ´Smaragd` (Source: Variety Portfolio of the CMA and the German Hop-Growers' Association "The Spirit of the Beer – Hops from Germany"

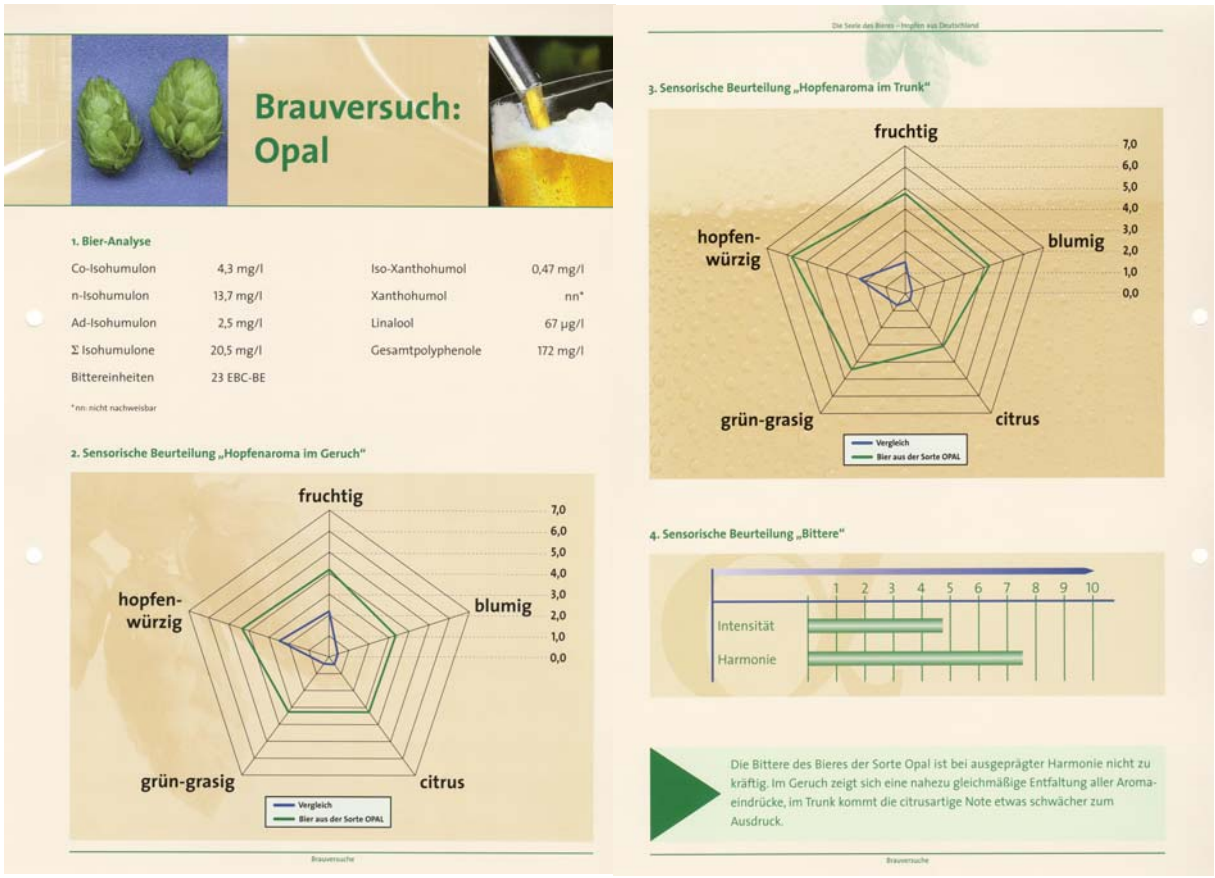


Fig. 4.3 : Beer analysis and tasting in the case of pure variety brews with ´Opal` (Source: Variety Portfolio of the CMA and the German Hop-Growers' Association "The Spirit of the Beer – Hops from Germany"

For an exact characterisation of the aroma and taste profile when using ´Smaragd` and ´Opal` brewing trials were carried out at the Department for Brewing Technology (Prof. Back) at the TU-Weihenstephan and beyond that pure variety brews in the Research Brewery St. Johann. At the same time detailed beer analytics as well as a sensory judgment by experienced tasters was likewise carried out. The hop aroma was judged in smell and in the drink as well as the beer bitterness. The results shown in Fig. 4.2 and 4.3 have been taken from the variety portfolio of the CMA and the Association of German Hop Growers.

´Herkules` – the new high-alpha variety

´Herkules` is convincing above all by its high alpha-acid yield up to 400 kg alpha-acids/ha. Therefore this variety can contribute to guaranteeing the competitiveness of the hop-growers on the global market. For this reason in December 2003 the application for European variety protection was made by the Variety Registration Office of the European Union in Angers/France. The registration of the variety is expected in spring 2006.

Genetic background

´Herkules` descends from a crossing of the Hüll-bred variety ´Hallertauer Taurus` with the powdery mildew-resistant breeding line 93/9/41. At the same time very good brewing properties were successfully combined with resistance to powdery mildew, downy mildew and wilt.

With the new high-alpha variety ´Herkules` the Hop Research Center Hüll offers the hop-growers a robust, extremely productive high-alpha variety with a definitely improved resistance to powdery mildew compared with ´Hallertauer Magnum` and ´Hallertauer Taurus` (Table 4.4).. ´Herkules` widens the spectrum of high-alpha varieties which allow it to adjust the bitterness in the beer considerably more economically and in addition put a pleasant hop aroma into the beer. This is proven by brewing trials (Fig. 4.4).

Table 4.4: : Hüll high-alpha varieties in comparison

High-Alpha Variety	Yield kg/ha	Resistance			Aroma and Bitter Quality					
		Vert.-wilt	downy mildew	Powdery mildew	aroma points (1-30)	aroma quality	α-acids (%)	β-acids (%)	Cohumu-lone (%)	kg α-acids per ha
Herkules	2.500	+	+	+	21	full lasting spicy	12-17	4-6	32-38	400
Hallertauer Magnum	2.000	+ +	+	- - -	22	full lasting spicy	11-16	5-7	21-29	280
Hallertauer Taurus	1.850	+	+	- -	23	full lasting fruity, sweet	12-17	4-6	20-25	280

Resistance: ++ good to very good; + good; -- low to very low; --- very low
Aroma points (maximum 30 points): 21-23 = pleasant hop aroma

Brewing trials

So that interested breweries in the next years have sufficient hops of the newly bred varieties ´Smaragd`, ´Opal` and ´Herkules` (Fig. 4.4) available for brewing trials, the big hop-trading firms were already supplied with up to 1,000 plants in spring 2004 for trial production. The other interested hop-trading firms can buy pellets of the breeding lines via the HVG. Then sufficient hops will be available with the 2006 crop for all brewing trials.

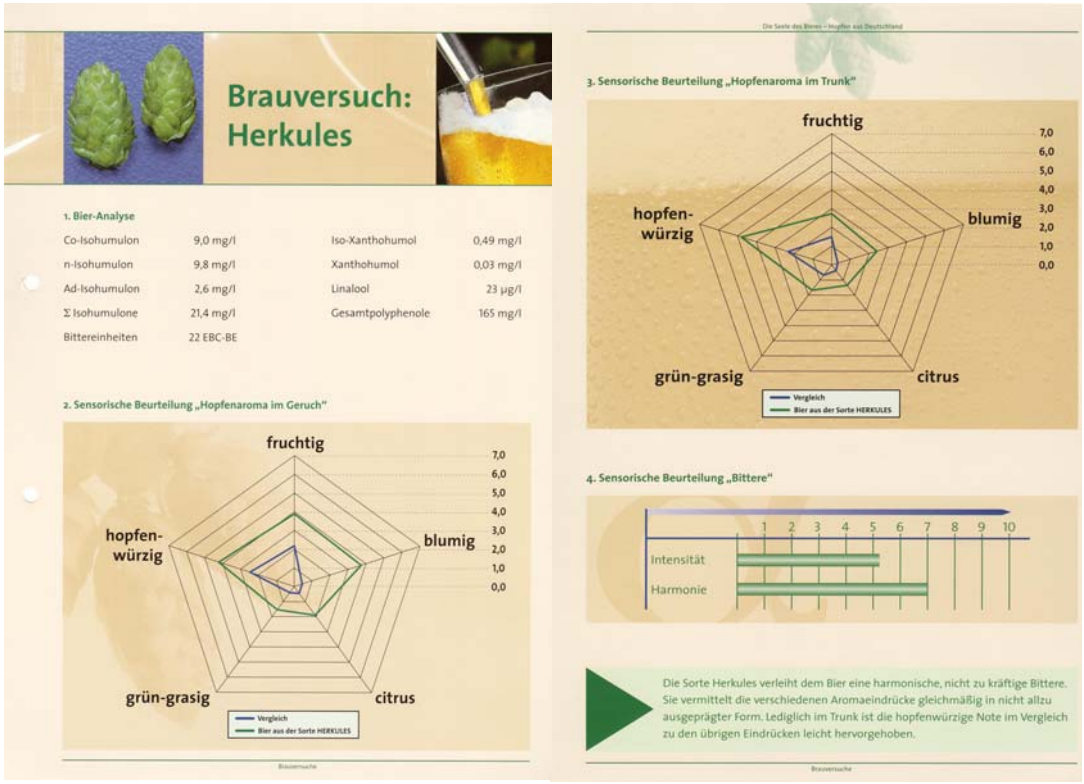


Fig. 4.4 : Beer analysis and tasting in the case of pure variety brews with ´Herkules` (Source: Variety Portfolio of the CMA and the German Hop-Growers' Association "The Spirit of the Beer – Hops from Germany"

4.2 Genome analysis in hops

4.2.1 Development of molecular selection markers for powdery mildew resistance to support breeding of quality hops

Hop powdery mildew, caused by the fungal pathogen P*odosphaera macularis spp. humuli,* is so far the most important disease in hops worldwide. Therefore hop research intends to speed up the breeding for powdery mildew (PM) resistance using molecular markers for special PM resistance genes.

During the course of a project (B80) sponsored by the Scientific Research Fund of the German Brewing Industry for the first time worldwide a resistance gene could be mapped in the hop genome.The PM resistance gene concerned is *R2* from the English variety ´Wye Target`. Contrary to many other phenotypically described and meanwhile broken PM reistance genes in hops, this *R2* gene so far conveys protection against all PM races in Germany. Thus this resistance is anchored in the Hüll breeding material.

After extensive segregation analyses (resistant : susceptible) based on several mapping populations (crossings: resistant x susceptible) the presence of a dominant powdery mildew resistance gene could be confirmed. In the following molecular screening of the resistant and susceptible plants with 91 AFLP primer combinations several DNA markers were identified, which only occur in resistant seedlings and in the resistant parents of the respective crossings. Using 620

AFLP and 17 microsatellite markers the *R2* gene could be mapped in the vicinity of six powdery mildew resistance markers at a distance of 1.7 up to 2.6 cM on the hop genome.

Furthermore several markers could be developed for the powdery mildew resistance gene *Rbu* of the Slovakian variety ´Buket`. Two markers (Rbu-279 and Rbu-284) show a quite close linkage to the gene with 3.0 or 8.3 cM.

A decisive advantage of the selection via markers (marker-supported selection) is obvious when trying to pyramid various resistance genes in one individual. By combining two or several genes it is expected to gain protection with longer effectiveness against powdery mildew. In the usual resistance test in the greenhouse, laboratory or in the field a phenotypical differentiation between plants with single or multiple resistance is not possible. By using the molecular markers for the two resistance genes *R2* and *Rbu* for the first time it was possible to find hop seedlings with double resistance based on *R2* and *Rbu* (Fig. 4.5) within the progeny from a breeding programme.

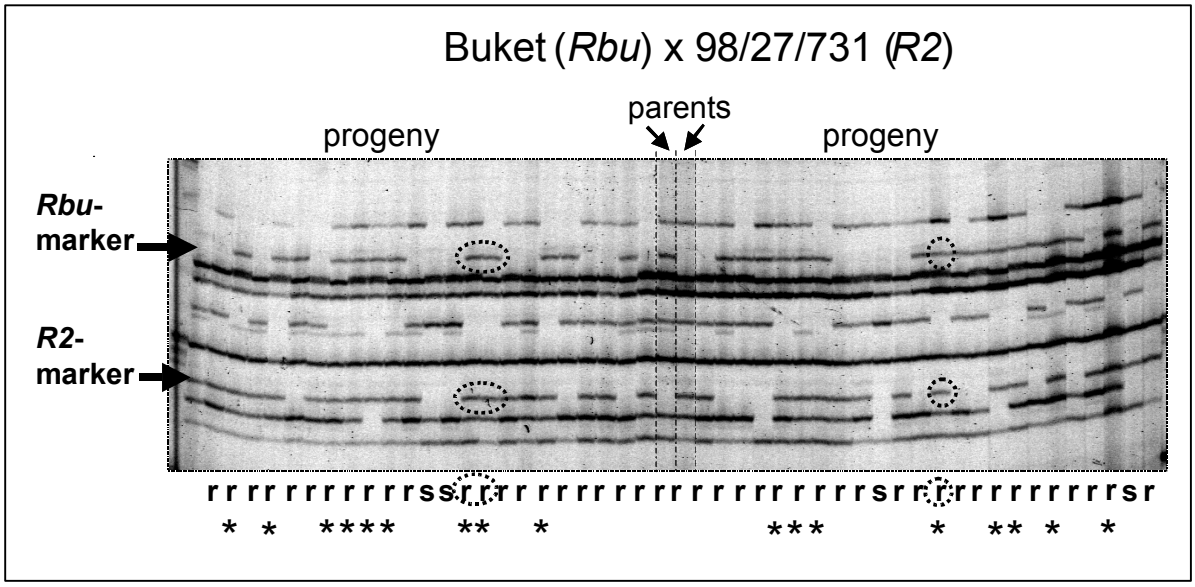


Fig. 4.5: Seedlings with a double resistance (*) from a crossing of two powdery mildew resistant parents, which only carry one resistance gene each (*R2* or *Rbu*), can be identified by identifying both resistance markers in their DNA pattern (= genetic finger print).

Outlook

Based on the results of the current research project, work will now begin to investigate the most important male and female breeding lines to see whether these powdery mildew resistance markers occur or whether they are missing in order to verify them in subsequent routine crossings in hop breeding. In addition efforts will now be made to research the effective mechanism of this *R2* powdery mildew resistance. At the same time those markers should be identified which are directly on the coding area of the hop DNA. These markers could then e.g. be correlated directly with a specific gene sequence responsible for resistance.

4.3 Biotechnology

4.3.1 Gene transfer in economically relevant hop varieties to improve their fungus resistance

Target of the continued research project is to transfer resistance genes into important Hüll hop varieties and therefore achieve improved tolerance towards fungal pathogenes.

The transformation trials with the hop chitinase gene *HCH1* have for the most part been completed. Besides the hop variety 'Saazer', for the first time worldwide also the variety 'Hallertauer Mittelfrüher' several of the plants selected for Kanamycin were regenerated and tested by means of **PCR** (i.e. at DNA level) as actually transgene. The first regeneration of 'Hallertauer Mittelfrüher' after the reistance gene had been transferred can be rated as the first sign of an increased resistance to the endogenously occurring pathogenes in the *in vitro* culture.

Via an enriching culture followed by a **ketolactose test** persisting agrobacteria could be excluded in these plants, so that these have actually taken in the desired gene stably in their own genome. The results of the PCR and the ketolactose test, to prove the integration of the chitinase gene and at the same time the omission of endogenous agrobacterial infections, could also be simultaneously and definitely confirmed by means of a **Multiplex PCR**. In further tests the activity of the transferred resistance gene was checked at RNA level. Tthe results of the **RT-PCR** were positive without exception. The presence of the desired RNA was also proven in all transgenetic plants. This means that the transformed gene is in fact constitutively exprimed i.e. is persistently active and is transcribed into a matching RNA.

In the first infection tests with **powdery mildew** on *in vitro* plants resistant, tolerant and susceptible genotypes in Petri dish scale were found among the transgenetic 'Saazer' plants. Convincing infection tests with greenhouse plants are planned for 2006.

Parallel to the running transformation trials it was possible to take further reistance genes into the selection. In this way PCR protocols for four bacterial chitinases as well as two *verticillium*-resistance genes could be further optimized. Using a classic PCR it was possible to equip the two v*erticillium*-resistance genes with desired restriction sites and clone them in a CaMV-35S promoter. With the binary vector made 'Saazer'- and 'Hallertauer Mittelfrüher' internodia have already been transformed. First 'Saazer'-plants are being regenerated at the present time and will be available at the beginning of 2006 for follow-on tests. The four bacterial chitinases are being cloned at the present time in diverse vectors. Transformation ready constructs are expected in mid-2006 or at the end of the year.

5 Hop Production, Production Techniques

Johann Portner, Dipl. Ing. agr.

5.1 Nmin test 2005

Nitrogen fertilization in accordance with DSN (Nmin) has been introduced into the practice and has become an integral part of fertilizer planning. 3904 hop yards were tested in Bavaria in 2005 for their Nmin content and a fertilizer was recommended..

The development of a number of the samples for the Nmin test has been drawn up in Table 5.1. Compared with the previous year the average Nmin content was about 27 kg lower but about 30-50 kg/ha higher than in the previous years. The therefore comparatively high Nmin value may be surprising especially as the yields and nutrient deletions of the crop year 2004 were very high. However, repeated tests with so-called runaways confirm the high level. The results show that the nitrogen dynamics in the soil are subject to various influential factors and it is not possible to balance them similar to the nutrients phosphor and potash.

With regard to calculating the N fertilizer requirements and fertilizer recommendations there were no changes compared with the previous years.

Table 5.1: Number of Nmin tests and average Nmin contents as well as fertilizer recommended in hop yards in the Bavarian production regions

Year	Number 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

In Table 5.2 the number of hop yards tested for the Bavarian production regions the average Nmin value as well as the resulting average nitrogen fertilizer calculated has been compiled for the Bavarian production regions based on the administrative districts. It is certain that the district of Eichstätt and the Spalt production region showed the highest Nmin values and the seal district of Hersbruck the lowest Nmin value. The nitroger fertilizer recommendations are correspondingly the reverse.

Table 5.2: Number, average Nmin contents and fertilizer recommended in the hop yards of the admin. districts and production areas in Bavaria 2005

Production Region	Admin. District / Production Area	No. of samples	Nmin kg N/ha	Fertilizer recommended kg N/ha
Hallertau	Kelheim	1533	100	141
	Pfaffenhofen	1273	95	142
	Freising	441	106	132
	Landshut	259	95	136
	Eichstätt	239	115	125
	Hersbruck	36	70	150
Average	**Hallertau**	**3781**	**99**	**139**
Spalt		**123**	**115**	**127**
Bavaria		**3904**	**100**	**139**

In Table 5.3 the values are listed according to varieties.

Table 5.3: Number, average Nmin contents and fertilizer recommended for various hop varieties in Bavaria 2005

Variety	No. of samples	Nmin kg N/ha	Fertilizer recommended kg N/ha
Nugget	83	77	157
Hall. Magnum	895	85	151
Target	12	91	148
Hall. Taurus	377	99	145
Hall. Merkur	28	102	138
Hersbrucker Spät	240	102	137
Hallertauer Mfr.	530	90	136
Brewers Gold	10	104	136
Hall. Tradition	579	108	133
Northern Brewer	110	109	132
Perle	700	111	131
Spalter	39	98	126
Spalter Select	232	124	126
Saphir	41	112	123
Sonstige	28	100	140
Bavaria	**3904**	**100**	**139**

5.2 Volume, relative density and nutrient content of bine choppings from the 2004 and 2005 crops at the time when it is distributed

The return of nutrients from organic fertilizers or crop remains should be taken into consideration when calculating the fertilizer requirements. As the bine choppings are not transported back to the hop yards in the same amount, it is necessary to ascertain and deduct the quantities and nutrient contents separately.

Target of the tests was to determine how far the bine choppings alter through the hot-rotting phase inasmuch as volume, weight and nutrient content are concerned. As organic fertilizers are rarely weighed in agricultural facilities, but the volume of the transport vehicles is known, the recordedrelative density of the bine choppings at the time of distribution was also of interest.

Method:

On two agricultural farms in the 2004 and 2005 harvests the bine choppings from hop yards of a defined size of the varieties Perle, Hallertauer Magnum and Hallertauer Taurus were stored in the open air on a separate heap as usual in the practice. After the harvesting was finished the bine choppings were laden with a front-end loader onto manure or compost distributor, weighed and driven off. The conversion to their relative density was made with defined loads (level loading) by calculating the transport volume.

Samples were taken at various places in the heap and repeated 6 times to determine the nutrient content. After pre-drying and separating the wire pins the nutrient contents were analysed in collaboration with IAB 2b.

Results:

The **volume** of bine choppings varies considerably according to the year, farm and variety. The to some extent considerably higher values in 2005 can be traced back to the high rainfall prior to the harvest and during the storage of the bine choppings. Naturally the chopping material had higher water contents and was soggy with rainwater.

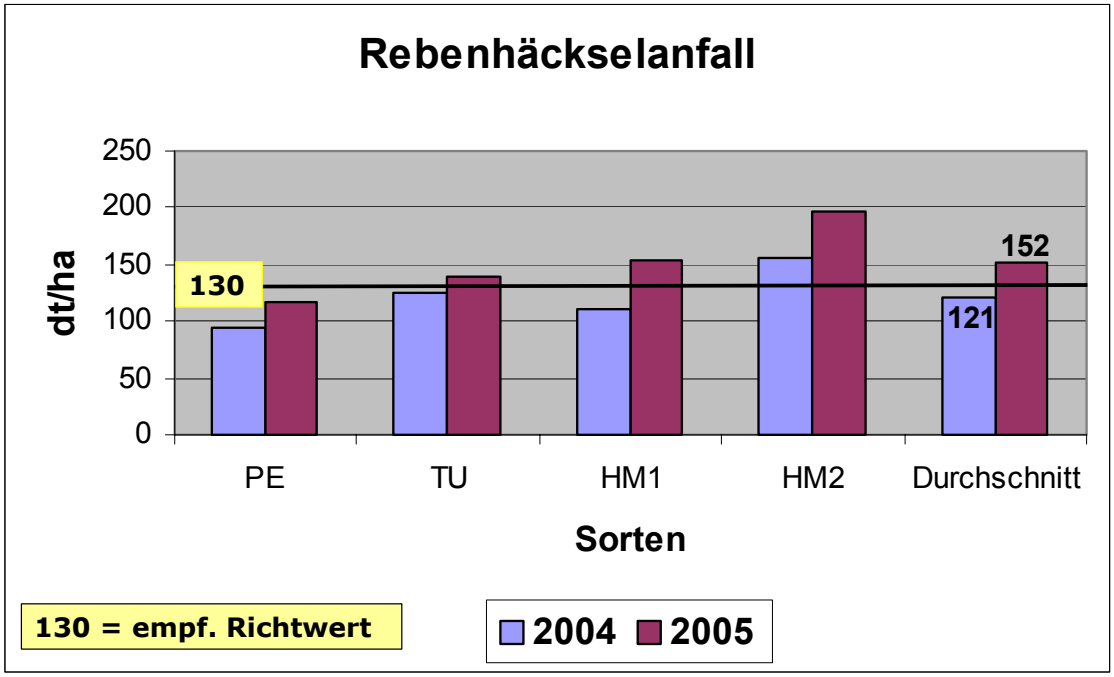
The differences betweeen the farms can be traced back to differing crop and weather conditions.

Differences in variety of up to 100 % are also known from older tests.

The hitherto recommended target value of 130 dt/ha bine choppings on an average was for the most part confirmed whereby corresponding increases must be made for the productive new bitter hop varieties with a high yielding level. Compare Fig. 5.1.

The **relative density** determined for the bine choppings at the time when it was distributed varied according to the year, farm and variety from 320 up to 363 kg/m^3 in 2004 and from 361 up to 407 kg/m^3 in 2005. If a certain amount of compacting and overloading is taken into consideration compared with the dimensions of the transport vehicle, then in the practice an average relative density of 360 kg/ m^3 can be assumed.

Figure 5.1: **Amount of bine choppings with various hop varieties and farms in the years 2004 and 2005**



Greater fluctuations are also in the **nutrient contents**.
When comparing with the recommended targets in the "Hops Green Pamphlet" it is noticeable that there are definite differences in the K_2O-, MgO- and CaO content. Other unpublished tests in earlier years also confirm these deviations. The existing rule-of-thumb figures should therefore be discussed again taking into consideration all the available trial results.

Table 5.4: **Comparison of the average values of the bine choppings trials in the years 2004–2005 with the recommended targets in the "Hops Green Pamphlet"**

	Average 2004 und 2005				Total Average all varieties	Hops Green Pamphlet
	Farm A			Farm B		
	PE	TU	HM1	HM2		
Volume (dt/ha)	106	132	133	177	**137**	**130**
Relative density (kg/m³)	368	372	364	343	**361**	-
Nutrient contents (kg/t FS) (in 27 % TS) Ø 6 WH						
PH value	6.3	6.7	7.2	6.5	**6.7**	-
Org. Subst.	243	226	230	230	**232**	-
Total N	8.0	6.2	7.0	6.9	**7.0**	**5.5**
NH_4-N	0.4	0.3	0.3	0.3	**0.3**	-
P_2O_5	1.7	1.4	1.8	1.9	**1.7**	**2.0**
K_2O	5.0	4.2	4.3	6.3	**4.9**	**7.7**
MgO	3.2	3.0	3.1	2.2	**2.9**	**1.2**
CaO	15.4	16.3	17.3	13.0	**15.5**	**6.0**
S	0.7	0.6	0.7	0.6	**0.6**	-

5.3 Trials with stabilized ammonium nitrate (ENTEC) in hops

Target:

The fertilizing trial was planned with the company BASF over five years. The influence of the ammonium stabilized N fertilizer on yield, formation of components and plant health is to be investigated at two locations and on two hop varieties.

Entec 26 is an N fertilizer with the nitrification inhibitor dimethylpyrazolphosphate on the basis of ammonium sulphate salpetre which was also used as a comparative fertilizer.

Method:

Test data:

Trial location Hüll
- Variety: Hallertauer Mittelfrüher
- Duration of trial: 2001–2005
- Soil type: coarse clay (loess)

Trial location Gambach
- Variety: Hersbrucker spät
- Duration of trial: 2001–2004 (broken off in 2004 at request of the firm)
- Soil type: clayey sand

Trial stages, identical at both locations with four repeats respectively
- 1 = No N fertilizer at all
- 2 = Ammonium sulphate salpetre (26 % N), $^1/_3$ at beginning of April, $^1/_3$ at end of May, $^1/_3$ at end of June or else beginning of July, according to recommendation of the DSN soil test
- 3 = Entec 26 (26 % N), $^1/_3$ at beginning of April, $^2/_3$ in second week in June
- 4 = Entec 26 (26 % N), ½ at beginning of April, ½ in second week in June

For the trial stages 2-4 each time two N targets were laid down with 240 or else 160 kg N/ha. The Nmin value determined in the spring was deducted from the N set value. The difference was broadcast with a mineral fertilizer at the above-mentioned times.

An organic fertilizer was excluded during the duration of the trial.

Yields and alpha-acid values

The results of the yields in kg/ha dry hops and the alpha-acid values in % standardized over the trial years 2001-2004[1)] or 2001-2005[2)] respectively are shown in the following charts. The average Nmin values and the N fertilizer doses of the respective trial variants can be taken from the enclosed tables.

[1)] Gambach

[2)] Hüll

Figure 5.2: ENTEC Trial 2001 - 2004

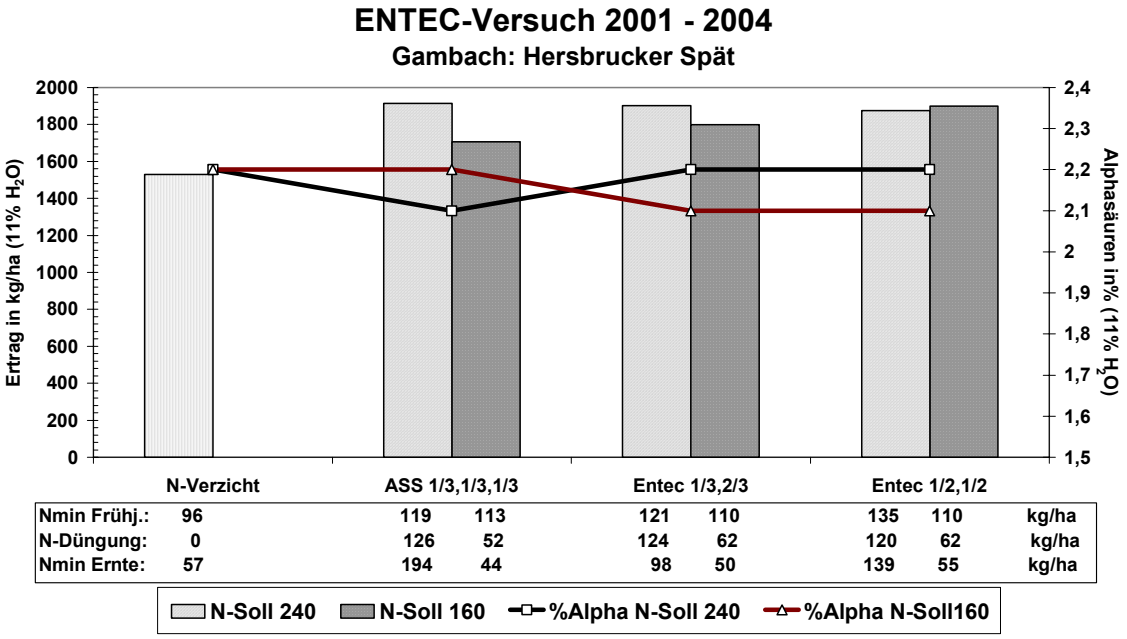
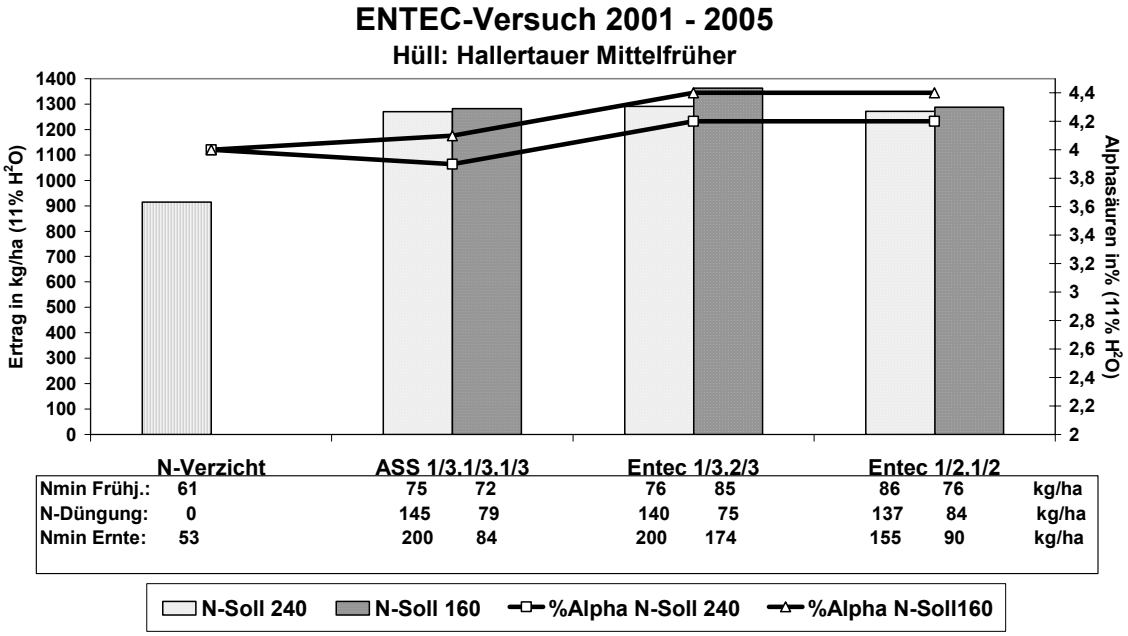


Figure 5.3: ENTEC Trial 2001 - 2005



The unfertilized plots show a drop in yield of approx. 20% or 30% respectively at the locations.

The yield and alpha-acid differences in the fertilized varients at both locations are standardized over the trial years with a marginal difference of 5% statistically not covered. The tolerance limits in the alpha-acid test according to conductometric titration according to EBC 7.4 is up to 6,2% +/- 0,3% in the case of alpha-acids.

The slight differences in yield depend to a great extent on the location and variety. While the Hüll location with the variety Hallertauer Mfr. and the accumulating soil inclines towards the N target 160, the tendency at the Gambach location with the variety Hersbrucker Spät and the very porous soil inclines towards the N target 240.

Nmin values and fertilization

The Nmin values in the spsring and the resulting N fertilization doses must be rated equally over all the trial variants.

The average Nmin values of the sampling show a greater spread directly after harvesting which however does not influence the Nmin result in the spring.

With the N target 160 following harvesting less nitrate and ammonium nitrogen is found in the soil than in the variants N target 240. The relatively balanced Nmin values in the spring over all variants can only be explained with an increased mineralisation of the organically bound nitrogen, especially when the surprisingly high Nmin values of the 0 plots are taken into consideration.

Wilt influence at the Hüll location

Table 5.5: Results of the laboratory analyses on *verticillium*

Plot No.	Number of wires with hops appearing to die off [2]		Lab. test (sample taken 29.08.05)	Lab. test	
	24.08.05	29.08.05		2002	2004
1.1.3		1 (Hasenup tos)		n.n.	-
2.1.2		2	yes	-	-
2.1.3	1 (rabbit-bite)	5	yes	n.n.	-
2.1.4	2	6	yes	n.n.	-
2.2.3	1	1	yes	-	-
2.2.4	2	4	n.n. [1]	yes	-
3.1.1		5	n.n. [1]	-	-
3.1.3	1	3	n.n. [1]	-	-
3.2.3				n.n.	-
3.2.4		8	?	-	-
4.1.3			yes	n.n.	-
4.1.4	2	4	n.n. [1]	--	-
4.2.4	2 (rabbit bite)	2	n.n. [1]	-	yes

[1] zoosporangies of *fusarium* or *phoma* were found on the plant samples without v*erticillium*.

[2] As a rule still being harvested.

During the trial period 2001-2005 "wilt" only occurred in the years 2002, 2004 and 2005.

The summary in the above table shows that

- in the monitoring on 24.08.05 the signs of attacks were considerably less than on 29.08.
- the optic judgment of the vitality allows no cetain conclusion on fungus attacks, i.e. that with a later harvesting perhaps more wires would have been infested.

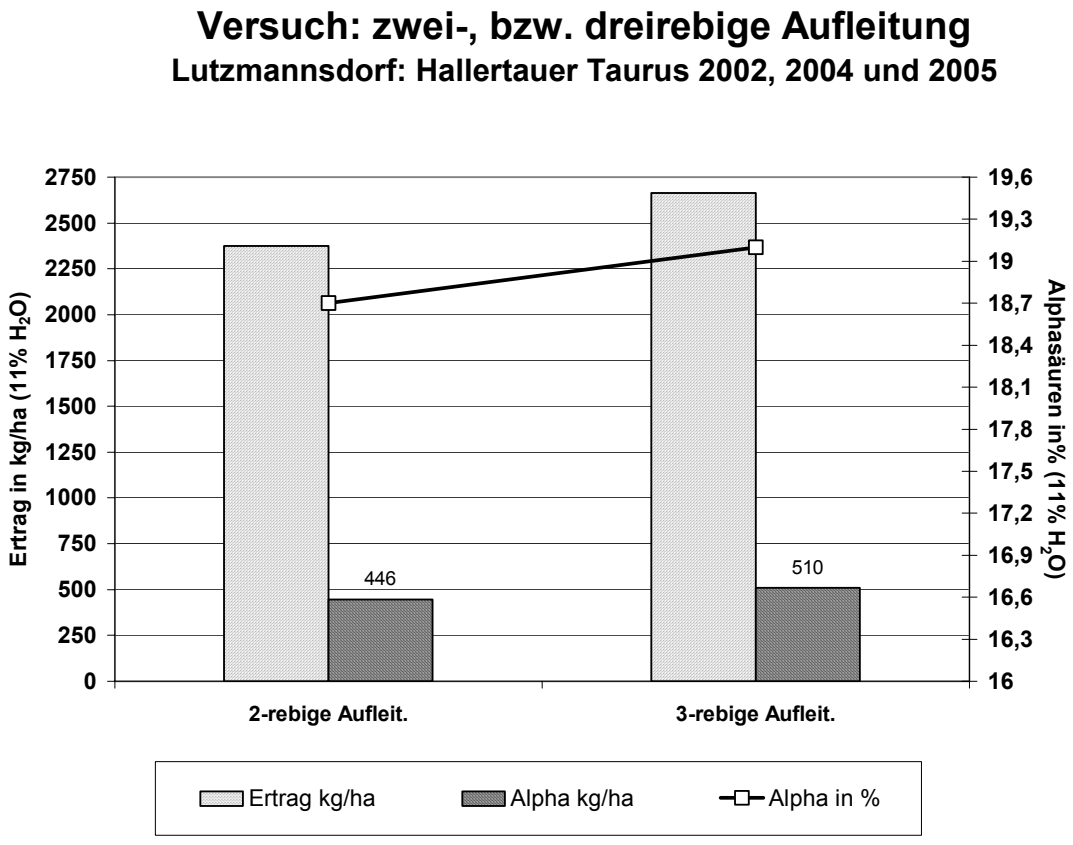
As for the dead bines of the Entec plots a slighter attack wtih verticillium could be proven at the time of harvesting.

5.4 Hop trials with two or three bines each of the variety Hallertauer Taurus

The optimum number of the trained shoots per training wire can be ascertained very differently and individually depending on the variety. In the trial discussed every three years with the variety Hallertauer Taurus the influcence of the number of shoots on the yield and the alpha-acid content were investigated. The harvesting of the trial plots repeated three times respectively was carried out in the optimum stage of ripeness.

The results in Fig. 5.4 show that not only the yield in kg/ha dry hops but also the alpha-acid content in % and in kg/ha with the three-bine training wire had the advantage. The extra yields can be significantly ensured. The evaluation of the individual years do not produce a different picture.

Figure 5.4: Trial: two- or three-bine trained hops



5.5 Investigations on the vitality of the variety Hallertauer Mfr. according to different harvesting dates in the previous years

To harvest the hop cones the bines are cut off before the actual physiological ripeness in order to obtain an optimum exterior quality. Above all this applies to the aroma varieties especially for the Hallertauer Mfr. In the case of this variety special customer wishes even tend to obtain a special aroma flavour through a somewhat earlier harvest. When harvested too early the yield is wasted and the plant weakened in its vitality as the storage of reserves in the rootstock has not yet been completed at this time. Conspicuous results on this provided a three-year harvest trial with regard to the variety Hallertauer Mfr. In the plots with the later harvest dates during the course of the years definitely stronger plants with not so bad attacks of wilt could be found. (compare Fig. 5.5). In order to record the effects of various harvest times statistically in the 2005 harvest the various plots of the previous years were monitored and harvested on the same date. According to the harvest date and this repeated four times, 20 training wires respectively were monitored and harvested as far as possible due to the wilt infestation.

Figure 5.5: Differences in vitality depending on the time of harvesting

Late harvest-time T 5 – T 7 Earlier harvest-times T practice

The harvest-time trial was carried out in the years 2002-2004 and the vitality trial in the year 2005 for Hallertauer Mfr. in a hop yard at the Busch Farm in Hüll. The harvest dates of the various years can be seen in Table 5.6.

Table 5.6: Harvest dates for the harvest-time trial 2002-2004 and the vitality trial 2005 with Hallertauer Mfr. in Hüll

Termin	2002	2003	2004	2005
T 1	14.08.	07.08.	16.08.	29.08.
T 2	19.08.	11.08.	19.08.	
T 3	22.08.	14.08.	23.08.	
T 4	26.08.	18.08.	26.08.	
T 5	29.08.	20.08.	30.08.	
T 6	02.09.	22.08.	02.09.	
T 7	05.09.	25.08.	06.09.	
T Practice	22.08.	10.08.	25.08.	

The harvest was much earlier In the dry year 2003. In order to make a comparison between the years the harvest dates (T) were numbered from 1-7 and the results of the various years recorded for each date (T). In 2005 additionally 4 plots were harvested from the adjacent practice yard in order to obtain a comparison with the usual farming practice.

Results

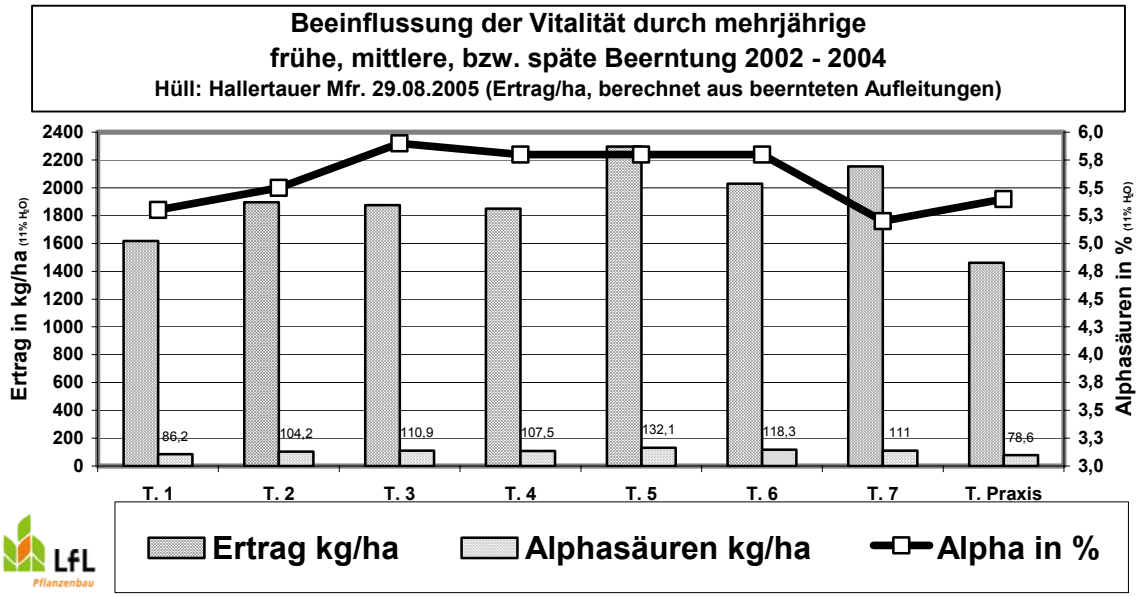
20 training wires from 10 double crowns were monitored four times shortly before the harvest. The results are listed in Table 5.7.

Table 5.7: Wilt attacks in the comparative plots

Harvest time	Wilt attacks 2005 Ø of repeat in %	Fluctuation margin of the repeat in %
T 1	**41**	**0 - 80**
T 2	**16**	**5 - 40**
T 3	**24**	**0 – 80**
T 4	**21**	**0 – 45**
T 5	**19**	**0 – 55**
T 6	**13**	**0 – 30**
T 7	**18**	**15 – 25**
T Practice	**16**	**5 - 35**

The presumed differences in wilt attacks between the harvest times were not significant due to the great fluctuations between the repeated monitorings. Nevertheless the plots with the late harvest times appeared to have developed more strongly and with lesser attacks of verticillium or were only attacked at a later date. A yield and alpha-acid comparison is shown in the following table.

Figure 5.6: Yield and alpha-acids with Hallertauer Mfr. in Hüll 2005 at various harvest times in the previous years



The alpha-acid contents fluctuate on the average of plots investigated by 5.2% (T practice) up to 5.9 % (T 3). The sizes of the yields confirm the optical impression that the plots with the later harvest times in the previous years (T5 – T7) produced stronger plants with higher yields.

5.6 Advisory and training activities

Besides the applied research in the field of production techniques for hop cultivation, the Work Group Hops, Production Techniques (IPZ 5a) has the task of preparing the test results for the practice and making them directly available to the hop-farmers through special consultations, training facilities, by talks as well as on the internet. Organising the peronospora ((downy mildew) warning service and updating the warning instructions are also among their tasks as well as providing a specialist service for the hop producer groups. The training of the ring advisors has been extended to multiplicators for the advisory service on the spot.

In the course of the administrative reform on 01.07.2005 the hop advisory service was shifted from the agricultural offices to the State Institute for Agriculture. Since then the advisory service has officially been taken care of by the Work Group Hops, Production Techniques in Wolnzach.

The training and advisory service activities are summarized as follows:

5.6.1 Information in written form

- The "Green Pamphlet" Hops 2005 – Cultivation, Varieties, Fertilization, Plant Protection, Harvest – was updated together with the Work Group Plant Protection in agreement with the Advisory Bureaus of the Federal States of Baden-Wurttemberg, Thuringia, Saxony and

Saxony-Anhalt and distributed with a circulation of 3060 pamphlets by the LfL to the ÄfL and research facilities and by the producer groups to the hop-growers.

- Up-to-date hop-growing tips and warnings were sent via the Hopfenring fax (2005: 53 faxes to 937 participants) were sent to the hop-growers in 30 faxes.
- Likewise up-to-date information was made available at weekly intervals for the weather fax.
- In the DSN soil test 3904 results were checked for plausibility and released for despatch to the hop-growers.
- Advisory notes and specialist articles for the hop-growers were published in 3 ER Hopring circulars and in 8 monthy issues of the Hopfen Rundschau.
- With the data collection and evaluation programme HSK hop-index evaluations were carried out for 320 hop-growers on 980 cards and returned to the farmers in written form.

5.6.2 Internet and Intranet

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

5.6.3 Telephone consulting and announcement services

- The peronospora (downy mildew) warning service was drawn up during the period 10.05.–23.08.2005 by the Work Group - Hop Cultivation, Production Techniques in Wolnzach in collaboration with the Work Group - Plant Protection in Hüll and updated 72 times so that it can be accessed via the answer-phone (Tel. 08442/9257-60) or via the internet.
- Tips on hop cultivation with up-to-date notes on pest and diseases as well as fertilizer and soil-working measures can be heard via the answer-phone in Wolnzach (Tel. 08442/957-401).
- The trade consultants of the Work Group Hop Cultivation, Production Techniques gave advice on special questions concerning hop cultivation per telephone or in individual discussions or on the spot in approx. 3,500 cases.

5.6.4 Tours, training facilities and meetings

- One work discussion with a trial inspection for the consultants of the ÄLF
- 7 training courses for the Hopfenring consultants
- 9 hop cultivation meetings in collaboration with the ÄLF (690 participants)
- 45 specialist talks at meetings held by other organizers
- 14 test tours for the hop-growers and the hop industry
- 1 EDV training courses on the hop index with 15 participants.
- 4 hop-growing seminars for drying and conditioning hops with 95 participants
- 1 BiLa seminar hop cultivation and marketing in Abensberg (4 evenings)
- 6 lessons at the Pfaffenhofen Agricultural College for the students studying hop cultivation

6 Plant protection in hop cultivation

Bernhard Engelhard, Dipl. Ing. agr.

6.1 Pests and diseases in hops

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

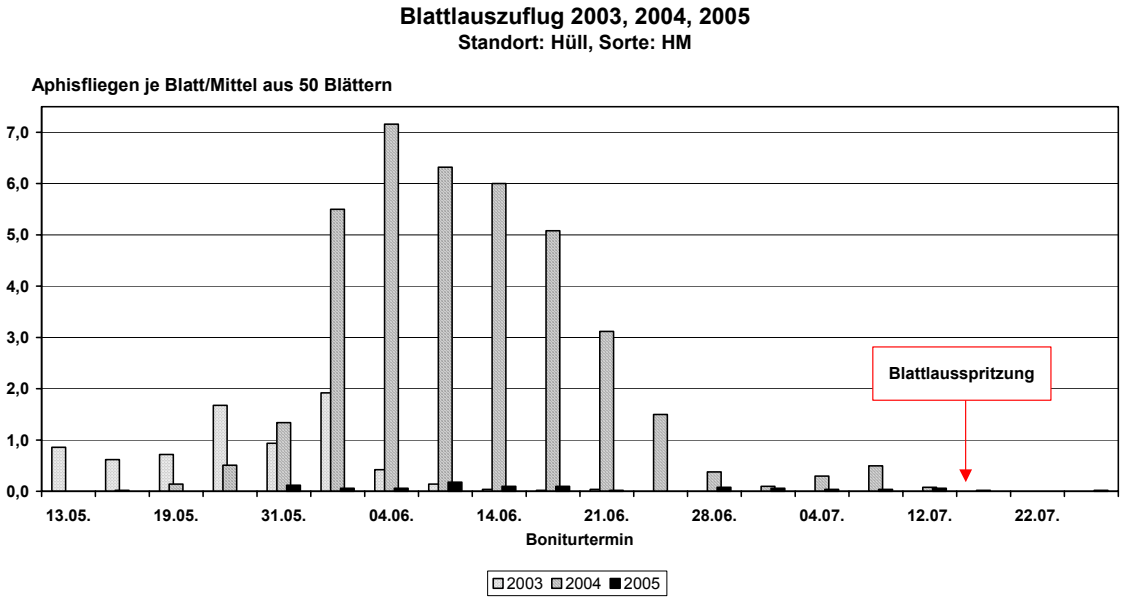
One product Karate Zeon is available to control the alfalfa snout weevil. Counting the beetles on the hop shoots above ground has shown that feeding activity is considerably reduced by using Karate Zeon. However, prerequisite for this effect is that the beetles appear on the surface when the weather is warm and they are directly affected. Only a few dead beetles were found in inspections; the degree of effectiveness is around 30-50% (as also with other products). It is not known where the remaining beetles compared to untreated plots stay.

A problem that arises more and more frequently is that rootstocks of the hop plants are so badly damaged by the soil pests, presumably predominantly by the larvae, that nests of missing rootstocks arise which make time-consuming replanting necessary.

The number of reports on the occurrence of wire worm has increased compared to past years.

Hop aphid *Phorodon humuli* (Schrank)

Figure 6.1: Aphid migration 2003 - 2005



The number of alate aphids per leaf can hardly be seen in the chart as the maximum density counted was 0.5 alate aphids on an average of 50 leaves. The weather conditions must have hindered their multiplication on the winter hosts. Also remarkable is that migration began very late

on 31st May (normally two weeks earlier). Until 15th July alate aphids could be found time and time again which still caused the population to increase towards the end of the season.. This is why hop lots at the later harvest time from 5th September onwards were still often badly infested by aphids. The principle "Few problems at the outset bring trouble at harvest-time" applied again.

Two-spotted spider mite *Tetranychus urticae* Koch

The cool, rainy weather conditions over long periods of time has kept the population of spider mites at an unusually low level. In inspections the control threshold was reached only on approx. 1/3 of the areas. Despite intensive searches no hop yard could be found which would have been suitable for carrying out a test; the spread of common spider mite was too low and too patchy.

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

With six spray warnings for susceptible varieties and four warnings for tolerant varieties the necessary control measures were above the mean average over many years. Alone in August three spray warnings were necessary up until shortly before the harvest.

The season already began with bad primary infections. Again and again spikes were ascertained up to a height of 4 m on the hops.

Due to primary infections and frequent rainfall the control of downy mildew was difficult in the season 2005. Due to the hop-growers' good experience with the warning service and the good choice of effective fungicides, only few attacks of downy mildew appeared on the cones.

Powdery mildew *Podosphera humuli* Burrill, Botrytis *Botrytis cinerea* Persson

For three years in a row powdery mildew was no problem in the German production regions. A critical phase for possible infections was the beginning of July and mid-July respectively – individual pustules were found; the weather conditions were not encouraging for widespread infection. According to the current mildew forecasting model there was a high likelihood of infection from 14th - 16th and 20th – 23th August. There were still late mildew attacks in susceptible varieties; altogether the presumably already present ageing resistance prevented more infections.

Botrytis attacks were unusually frequent in the years 2000 – 2005. Therefore the reasons will be discussed in more detail under 6.2.

Wilt *Verticillium alboatrum* Reinke et Berthold

The preconditions for a high infestation with wilt existed in the spring due to the wet soil. Therefore it was almost surprising that few wilt problems occurred. If fresh bine choppings are brought back to the hop yard then there is a somewhat higher tendency to attacks with wilt.

6.2 Botrytis – a universal fungus on almost all cultivars even on hops

Target

Botrytis (*Botrytis cinerea*) is a disease that only used to cause greater damage in hops once every 7-10 years. However in the years 2000 – 2005 there were four years with above-average infection. As seen in the monitoring data of the Independent Quality Ascertainment (NQF) and

this can be proven with data from the Work Group Hop Breeding, there are big differences in the varieties:

Hallertauer Merkur	very strong susceptibility
Hallertauer Magnum	very strong susceptibility
Hallertauer Taurus, Nugget	strong susceptibility

The other varieties are average to slightly susceptible. Taking into consideration the present attacks a decision should be made whether special plant protectives must be tested to control the disease (Botryticide) and be licensed or whether alternative strategies are adequate to reduce the damage.

Method

From viniculture and the cultivation of asparagus - two cultivars which are regularly attacked by botrytis - seven plant protectives are known which are successful in providing good to very good control and which are licensed under the plant protection law. After respective checking and registration these products could principally also be used for hops. The costs per treatment would run into approx. € 120 per hectare and per application. There are also fungicides with side effects on botrytis.

In order to justify the use of plant protectives, central biological data on the disease must previously be judged and taken into consideration:

- The fungus *Botrytis cinerea* occurs at any time all over the world.
- The fungus has a high genetic adaptability; consequently resistance breeding is difficult.
- The fungus feeds mainly on dead material especially if plenty of compounds containing sugar and nitrogen are available (in flowers, cones).
- Very good infection conditions exist through the spores (which are always present in the air)
  - a) if weakened, sensitive tissue is present,
  - b) if there is no air circulation only slight circulation,
  - c) if temperatures between 10°C and 20°C prevail (= optimum; ability to live between –3°C and 31°C) and
  - d) if leaves are wet over many hours.
- Infection and visable attacks can occur within 12-24 hours. However, from viniculture it is known that infections can occur during the burr, remain latent in the tissue and the damage is first seen on the grapes.

Results

Basically the **damage pattern** on the hop cones can easily be perceived, especially if the spores are still visible on the brown bracteoles, on the tip or also in the middle of the cones. There are also similar brown discolourings on the bracteoles

- when there are the so-called "dying cones" (a physiological disorder) and
- when the bracteoles are fertilized. Through the formation of seeds at the basis of the bracteoles they ripen earlier and change brown within two or three days and the cones change colour as in botrytis.

When evaluating weather data it is seen that in the years with high attacks of botrytis during the cone-forming phase each time there are several days on which the optimum biological weather requirements for the fungus are fulfilled. These correlations are missing in the years with few attacks (except for 2004).

The use of plant protectives must always be made as a precautionary measure according to the current knowledge. So far there has not been a definite forecasting method for the cultivation of any outdoor crops for the optimum spraying date, i.e. many control measures are purely preventive (often with little success).

Test results to control the powdery mildery (*Podosphera humuli*), where the spraying dates were carried out according to the prevailing mildew forecasting model, produce a good reduction in the infection with botrytis according to the plant protective used:

Witterung – Infektion – Befall 2000

Datum	°C	Regen mm	Std. >90 % rel.LF
06.08 07.08 08.08.	13,0 –16,0 12,8 – 20,8 12,5 – 21,4	14,1 in 16 Std. 6,2 in 5 Std. 4,2 in 4 Std.	24 18 17
18.08	14,3 – 21,9	4,5 in 5 Std.	16
21. 08.	13,8 – 21,7	16,9 in 8 Std.	12
27.08.	14.6 – 30,9	4,4 in 8 Std.	10
Erster Botrytisbefall im Versuch Hofen nach dem 14.08 und vor dem 28.08.			

Doldenbonitour:	Spritztermine:
Unbehandelt = 2,40 % Befallshäufigkeit Bellis = 0,35 % „ Folicur = 0,15 % „ Systhane 6W= 2,00 % „	02.08. und 17.08.

Witterung – Infektion – Befall 2005

Datum	°C	Regen mm	Std. >90 % rel.LF
15.08.	12,8 – 16,7	9,0 in 13 Std.	13
21.08. 22.08. 23.08.	15,9 – 21,5 16,0 – 18,5 13,4 – 16,4	21,2 in 10 Std. 17,3 in 10 Std. 6,8 in 5 Std.	20 22 24
An den Standorten Holzhof und Oberempfenbach kein Botrytisbefall vor dem 15.08.05. Erste Bonitur mit Botrytis am 25.08.			

Doldenbonitour:	Spritztermine:
Unbehandelt = 13,0 % Doldenbefall; gew.Mittel = 1,20 Bellis = 1,9 % „ ; gew.Mittel = 1,02 Systhane = 7,2 % „ ; gew.Mittel = 1,13	11.08. und 19.08.

The spraying dates in 2000 and 2005 were in each case (coincidentally) prior to possible infection periods with botrytis and when using plant protectives with effects on botrytis produced a definite reduction. Bellis with Boscalid has an active ingredient with the focus on combatting botrytis. It is expected that the product will be licensed for hops.

No monitoring data from field trials is available for 2002. In 2004 from 13th/14th and from 19th –21th August there were also weather conditions which correspond to the optimum of the biological rating – but there was no botrytis.

Variety changes:

It can be expected that the very susceptible varieties mentioned under "Target" will be reduced on the hop acreage due to the introduction of new varieties with low susceptibility.

Conclusion:

Taking into consideration the costs for botryticide, the uncertain optimum application date for these products and the probable acreage development for susceptible hop varieties, the testing and licensing of special preparations to control botrytis will be omitted. The side effects of licensed fungicides to combat the disease should be used to a greater extent.

6.3 The control threshold model for two-spotted mites: evaluation of a survey with questionnaires

In the year 2001 work began on presenting to the public a model developed at the Hop Research Centre in Hüll in the years 1998 to 2000 to combat the common spider mite (*Tetranychus urticae*) with the help of a control threshold. In the following years this model was passed on to the hop growers via numerous training courses above all with the support of the Hopfenring. After a limited period of five years, it was naturally of greatest interest for us as those responsible for the control threshold model whether and how it has been established by the hop-growers for use in the practice, what it has hitherto produced at the final count and where there may still be problems in the application.

To obtain answers to these questions we decided to start an anonymous survey with questionnaires in which we wrote to 200 farms to obtain a representative account for the Hallertau. The 200 farms were selected according to the random sample principle from the address file of the ISO farms and ring group farms of the Hopfenring Hallertau e.V. which we were gratefully given only for this purpose. These farms were written to at the beginning of February 2006 requesting them to fill out a two-page questionnaire. As the whole procedure was completely anonymously and a prepaid envelope was also enclosed, there was a pleasingly high response with the return of 123 questionnaires (61,5 %) and this allowed a detailed evaluation of the answers. As in fact these 123 farms additionally represent almost 10 % of all the present hop farms in the Hallertau for the most part these anonymous answers should be representative for the whole hop cultivation in the region.

General answers, referring to feedback from 123 farms:

Size of farm (hop acreage) of the farms questionned: up to 5 ha: 2.4 %. 5 up to 10 ha: 12.2 %. 10 up to 15 ha: 20.3 %. 15 up to 20 ha:18.7 %. 20 up to 25 ha: 17.1 %. 25 up to 30 ha: 5.7% %. 30 up to 35 ha: 10.6 %. 35 up to 40 ha: 6.5 %, 7.3% made no statement on the hop acreage. The average hop acreage per farm was 18.8 hectares (standard deviation ± 9.4 ha).

Seal district of the farm: Farms from at least 12 of the 14 seal districts responded, only Langquaid and Nandlstadt did not crop up in the questionnaires. Altogether 21.1 % of the questionnaires contained no information on the seal district, otherwise Maynburg and Wolnzach were leading in the response 16.3 % each), followed by (8.1 %), Geisenfeld and Pfaffenhofen a.d. Ilm (7.3 % each), Altmannstein and Au i.d. Hallertau (6.5 % each) Siegenburg (5.4 %)

Neustadt a.d. Donau (2.3 %) as well as Abensberg, Hohenwart and Rottenburg a.d. Laaber (0.8 % each).

Problems with spider mites have 88.6 % of the farms regularly every year according to their own replies, altogether at least half of all farms (56.9 %) even have such problems every year on 75 up to 100 % of their hop acreage. Only 8.1 % of the farms seldom have problems with common spider mite and only one farm (0.8 %) stated they had no problems whatsoever with spider mites.

Using the model to control the spider mites in the farm: Here the answers were almost balanced, 63 (51.2 %) of the farms stated that they are working with the model and 60 (48.8 %) had so far managed without it. With regard to seal districts the acceptance for the model seems to be highest in Au (six of eight farms), Geisenfeld (7/9) Maynburg (13/20) and Neustadt (3/3). In Wolnzach the ratio was balanced (10/20), obviously the model is regarded more sceptically in Altmannstein (2/8), Siegenburg (2/7), Pfaffenhofen (3/9) and Pfeffenhausen (4/10). The three individual farms which responded from Abensberg, Hohenwart and Rottenburg were all using the model.

The **area**, on which **the model within the farm** has so far been used, varies. Of the 58 farms which provided information, 28 (48,3 %) used it on the entire hop acreage, on an average the model was used so far on 68.3 % of the farming area.

Reasons for rejecting the model: Of the 60 farms which have not used the model so far, the following reasons were mentioned (multiple answers were possible):

1. The red spider mite is unpredictable: 40 (66.7 %)
2. I prefer to trust my experience and spraying techniques: 36 (60.0 %)
3. Too much time and work needed for inspections: 30 (50.0 %)
4. I don’t know the model or have not gone into it yet: 23 (38.3 %)
5. The model is not suitable for the practice: 10 (16.7 %)
6. I don’t understand the model:5 (8.3 %)
7. I have had bad experience with the model: 5 (8.3 %)
8. I think the model is useless: 3 (5.0 %)

As another quite significant point for not considering the model the aphid side effects of the acaricide Abamectin (trademark Vertimec) was mentioned by 24 of the rejecting farms (40.0 %), which for this reason has been used in standard practice since 2004 in the Hallertau on the greater part of the areas to control the hop aphid, no matter whether spider mites are in the hops or not – more about this below. This problem was also recognised by those farms which are using the model, altogether this point was explicitly expressed by 53 of the 123 farms (43.1%). Five of the farms which have not used the model so far (8.3 %) in addition stated that they wanted to use the model when an effective insecticide is licensed (at the same time omitting the"inherent necessity" to use Abamectin).

Actual savings by using the model: Of the 63 farms which have used the model so far, 26 (41.3 %) stated that they consequently needed less acaricides. In the case of 33 farms (52.4 %) the use of acaricide had so far remained unchanged, but nevertheless they frequently mentioned the problem of the aphid side effect. Four farms provided no answers and in none of the cases was more acaricid needed when using the model.

15 farms were able to make more accurate quantifiable answers on the actual lesser use of acaricide through the model: The assessed savings ranged from 10 to 50 % and were around 30.9 % on an average. The hop acreage of these 15 farms was between 3.2 and 38.3 ha and was on an average 22.0 ha (standard deviation (± 11.17). Taking into consideration these statements the farms in which the model functioned therefore on an average achieved savings (assuming € 140.- for one acaaricide treatment per hectare) of € 952.- per farm and per year (€ 140.- x 22 ha x 30.9 %).

The most concrete answer to this question was given by a hop-grower from the seal district of Maynburg who wrote: "*Since 2003 I have saved one treatment annually through the red-spider model for Magnum and Taurus (6 ha x 170 € x 3years = 3060 €). In the case of Perle and Select I have saved altogether two sprayings since 2003 (5 ha x 170 € x 2 = 1700 €). A model which helps both us and the environment.Many thanks. PS For mildew too please!*"

Problems in using the model were reported by 27 of 63 farms (42.9 %). These concerned above all the monitoring required for the model (19 cases), as well as on the success of control measures (four cases), understanding the model (three cases) and the pre-harvest interval (one case).

Average use of acaricides in the past three years: According to the farms (n = 80 questionnaires) for the pronounced spider mite summer in 2003 1.50 (standard deviation ± 0.52) acaricide sprayings per hectare were made on an average. In the normal below-average spider mite summer 2004 (n = 81 questionnaires) on average there were 1.10 (± 0.31) and in the extremely weak spider mite year 2005 (n = 82 questionnaires) on average 0.94 (± 0.27) acaricide treatments per hectare. However the years 2004 and 2005 were already marked by a widespread use of Abamectin as a mixed partner to optimize the certainty of the hop aphid effect, which most of the farms are aware of: As for the question whether a part and what percentage of the acaricide sprayings in 2004 and 2005 were solely for controlling hop aphids, 47 of 81 farms answered that first and foremost they had used acaricide to control aphids; the proportion assessed by the farms themselves was on an average 53.5 %. For the year 2005 this trend became even clearer: here 54 of 82 farms thought that the acaricide sprayed had predominantly served to control aphids, with their own assessed proportion of 68.4 % on an average.

In our opinion these figures on the one hand prove very well the actually necessary use of acaricide taking into consideration the different conditions each year, on the other hand the enormous potential savings which also continues by using the model – at the latest as soon as an effective, licensed insecticide is available again (that this effectiveness will unfortunately only be limited in time, is not up for discussion here). In any case an average of 1.5 acaricide treatments in 2003 have corresponded well to the actually necessary conditions in this summer of the century. If the 53.3% is deducted from the 1.1 sprayings for 2004, which the farms attribute themselves to combatting aphids, an average use of acaricides of 0.51 sprayings per hectare remains – the fitting reflection of a rather below-average spider mite summer. For the extremely weak spider mite year 2005 0.94 treatments were reported, of which 68.4 % are solely attributed to the control of aphids. Here there remain on average 0.30 real spider mite treatments per hectare which are certainly still somewhat too many for the actual conditions of this year, but in the practice will no longer be easy to undercut.

The **problem of using Abamectin to control hop aphids** was known in almost every farm and was explicitly and to some extent mentioned in detail on 43.1% of all questionnaires. Therefore statements such as these were definitely justified: "*I find this survey not quite fitting because since Vertimec has been licensed for a longer period practically every hop-grower uses the mixture Vertimec – Confidor to control aphids, with spider mite control into the bargain.*"

That the acceptance of the spider mite model is definitely counteracted by the effect on aphids by Abamectin can also be seen in statements like the following: "*Spider strategy occurs from the aphid strategy as long as the aphid preparations are not stronger*" - "*I think the model is useless as long there is an acaricide that is RECOMMENDED anyway as a mixed partner for the control of aphids!!*". The last comment is certainly logical and justified and also the following pragmatism which was expressed in the same form on at least a third of the questionnaires can be understood: "*1 x Vertimec with aphid spraying + LI 700: outstanding effect + spider + aphids – that is the certain part*." However the following statement must definitely be contradicted *"Forecasting model has become superfluous in the past few years through the aphid control"*. First of all the evaluation of the survey proves that nevertheless more than half the farms accept the model and to some extent use it successfully: "*In normal years I can manage without [acarcicide]. ... But in spider mite years (=hot and dry) it is no fun. Then it is dear. The model is super! Keep it up!*" A second point seems to have just been suppressed: The good aphid effect of Abamectin in the years 2004 and 2005 apart from the infection situation through spider mites resulted in almost complete coverage in the Hallertau. However when using the model 2004 only about half and in 2005 maximum a quarter of the actual acaricide used was necessary, to which the following comment applies: *"In 2005 I would have been able to reduce the acaricide treatment by at least 50% through the model, if I had not needed Vertimec to control the aphids*." But obviously nobody remembers that the use of only one active ingredient in the past few years with complete coverage usually very quickly resulted in weaknesses in effectiveness due to resistance forming in the detrimental organisms. Taking the present case of Abamectin additionally there is not only the risk that the aphid effect diminishes but rather that its own classification of the active ingredient, i.e. to control the spider mite, in future diminishes in its effect considerably faster through this "overkill". It only remains to hope that the following comments will soon become reality: *"Can be implemented with good aphid preparation"*.

The following comments provide information etc. as where the **acceptance problems for the model** can be traced back to: "*Regarding the future weather conditions it is difficult to develop complete trust in the model ... in my view still more certainty must be integrated in the control thresholdwith regard to the later weather (hot or cold)*" - *"Once the spider attacks got out of control (in actual fact the attacks were underestimated) – therefore the better the sureness in spraying the better you can sleep!*" - "*There is still no real confidence in the model. Perhaps training should be held again during the hop season*." - *"The Ring consultant should concern himself with the model and then pass the advice on to us."* - "*Waiting until the control threshold is not appropriate in the practice because the development of the weather cannot be forecasted far enough ahead*." - "*This model cannot alwqys be applied to each and every hop yard (light soil, heavy soil, south slope, north slope)*" - "*If the spider mite is already spotted in May-June I treat the whole areas to be sure, if it multiplies a lot in August,nothing more can be done due to the waiting time.*" - *Problem: No insecticide with a short waiting time available for treating late attacksl*". Actually all these comments only prove the lack of information about the spider mite model, which could be solved by giving the hop-growers more training. Here is definitely more need for action on the part of the LfL as well as by the Hopfenring in order to eliminate the errors of judgment or myths in the following comments: "*I don't use the model, as if I don't spray every year to control the spider mite (already sprayed 7 years ago),the spider mite spreads out more and more, i.e. in the 2nd or 3rd yearI have to begin spraying against spider mite at the beginning of June and then I will probably not get through with one spraying ...*" - "*At least one treatment is always necessary!!! There was never a year without spider mite."*

Of course we are aware that a main problem for the acceptance of the spider mite model is the time-consuming inspection for the hops, as the following statements demonstrate: "*I know the model very well and have also used it. But too much time is needed to count the spiders and the*

eggs.“ - *"It takes a lot of time and you often find the spider too late. It appears differently in the hop yard*.“ - "*I think the model is good and use it when attacks are widespread (according to the respective year) on all areas under hops, but it is relatively time-consuming!*“ Everybody must understand that the model does not function without monitoring by the user and each farmer must decide for himself whether the targets, the optimized treatment with the corresponding savings are worthwhile.

At the final count however there is definitely **positive feedback** as well. The comment "*The model is good to find the right time for the first spraying. If however there are still attacks of spider mite between 15th and 25th July (especially in the case of late varieties), I make a second treatment without using this model*.“ already demonstrates that this hop-grower already acts intuitively just as the model would also advise him. Help in calculating the optimum dates for sprayings was frequently mentioned: "*The model helps me ... to assess better whether I should spray again or not.*.“ - "*The model helps me most of all in the inspection at the end of July to decide whether to spray or not to spray*.“ - "*I feel more confident [since using the model] in treating the hops*.“ Besides savings in acaricide another advantage was mentioned: "*Acaricide savings in the 2nd spraying were only mimimum; monitoring marks probably a little better*“ - "*Of 9 Agrolab receipts n 2003 I only had 2 with a slight attack of red spider! The model is super* ...“. As a final remark it would be a gain if most of the hop-growers had a similar view of the model as this: "*I think the model is a good orientation. The spider mite is regarded much more calmly* .“

6.4 Virusfree plant material

4,368 plants were tested in the year 2005 for virus.

- **Work Section: Breeding** 3,248 mother plants for ApMV and HMV

- **Propagation facility Eickelmann**

  517 mother plants for ApMV and HMV

  of which: 230 Herkules

  36 Perle

  112 Hallertauer Tradition

  100 Smaragd

  3 Opal

  36 Taurus

- **Own examinations**

  43 ApMV and HMV

7 Hop Quality and Analytics

Dr. Klaus Kammhuber, Dipl. Chemiker

7.1 Introduction

It is the task of the Work Group IPZ 5d to carry out all the analytical investigations which are needed to support the test questions of the Hops Section IPZ 5. Analytical parameters possess an ever increasing significance in the qualitative assessment of hops. The content of alpha-acids is regarded as the primary economic quality characteristic of hops, as it represents a criterion for the bitter potential. The antimicrobial activity of the beta-acids is utilized to replace formalin in the sugar industry and ethanol production. Other important groups of hop components are the essential oils and the polyphenols. In the case of essential oils linalool has cristallized as an indicator for a good hop aroma.in beer (dissertation D. Kaltner). The polyphenols have very many positive properties for health as they act as antioxidants and can be scavengers for free radicals.. In recent years especially xanthohumol, which belongs to the polyphenols, aroused considerable interest by the general public, because xanthohumol has a scientifically guaranteed good anti-carcinogenic potential. The properties of the polyphenols can open up applications for hops outside the brewery, e.g. as additives for cosmetics, medicines and food.

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

On the one hand a high content of alpha-acids without particular qualitative requirements is desired as a breeding aim in the bitter varieties, on the other hand bitter hops should be bred with qualitative requirements like Hallertauer Magnum and Hallertauer Taurus. Also the beta-acids above all compared with gram positive, pathogen bacteria prove to be antimicrobial and bacteriostatic; this is why tests are being made in the sugar and ethanol industry whether they can replace formalin. This would definitely mean the use of a larger quantity of hops. Table 7.1 shows 20 breeding lines and varieties with the highest alpha-acid contents of the 2004 crop listed in descending order.

Table 7.1: Breeding lines and varieties with the highest alpha-acid contents of the 2004 crop

Line/Variety	Alpha-acids	Beta-acids	ß/a	Cohumulone	Colupulone
2000/109/728	20.9	5.7	0.27	24.2	48.9
2001/093/714	19.9	6.3	0.31	26.5	51.6
Herkules	19.7	6.0	0.30	30.3	60.4
Hallertauer Taurus	19.5	5.0	0.26	23.8	48.7

Table 7.1 continued:

Line/Variety	Alpha-acids	Beta-acids	ß/a	Cohumulone	Colupulone
2001/093/702	19.5	6.7	0.34	24.8	48.8
94/075/758	19.4	7.6	0.39	22.5	44.6
99/061/009	19.1	5.6	0.29	22.7	45.9
2000/118/716	18.8	4.8	0.25	28.9	60.7
2001/095/024	18.7	6.1	0.33	21.7	43.5
99/093/718	18.3	6.1	0.33	25.4	52.9
2001/093/715	18.3	6.5	0.36	23.3	44.2
2003/091/018	18.3	5.2	0.29	30.6	57.4
99/060/011	18.3	4.9	0.27	25.3	50.0
94/075/766	18.2	7.1	0.39	28.6	53.3
94/075/761	18.2	6.3	0.35	18.1	38.3
96/069/037	18.1	6.0	0.33	24.3	48.1
93/010/036	18.1	6.0	0.33	26.4	52.0
Hallertauer Magnum	18.1	6.2	0.35	26.3	48.9
Hallertauer Merkur	17.9	5.8	0.33	20.2	42.6
2003/093/014	17.9	5.1	0.29	26.8	53.3

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

Two breeding lines exceed the variety Herkules with regard to the alpha-acid content. Also remarkable is the low cohumulone proportion of these two breeding lines.

Table 7.2 shows 20 breeding lines and varieties with the highest beta-acid contents of the 2004 crop listed in descending order

Table 7.2: Breeding lines and varieties with the highest beta-acid contents of the 2004 crop

Breeding line/variety	Alpha-acids	Beta-acids	ß/a	Cohumulone	Colupulone
2001/093/719	**10.3**	**12.2**	**1.18**	**18.8**	**40.6**
96/031/009	4.4	11.8	2.68	33.7	42.3
2003/067/002	**12.3**	**11.3**	**0.91**	**27.1**	**52.8**
96/010/024	7.0	10.4	1.48	26.3	41.6

Table 7.2 continued:

Breeding line/variety	Alpha-acids	Beta-acids	ß/a	Cohumulone	Colupulone
96/031/009	4.0	9.5	2.39	18.4	38.7
97/071/737	14.6	9.4	0.64	28.6	50.1
Glacier	6.5	9.3	1.43	18.2	39.4
96/030/011	5.4	9.2	1.71	22.4	39.8
2003/067/005	16.5	8.9	0.54	27.7	46.4
96/008/014	5.4	8.8	1.64	30.9	43.8
2001/070/717	6.4	8.8	1.37	21.3	42.9
2003/067/007	13.3	8.7	0.65	29.1	47.7
97/076/754	14.0	8.6	0.61	32.7	52.4
96/030/041	5.2	8.6	1.66	12.6	37.4
2001/093/024	11.8	8.5	0.72	27.0	43.8
97/026/006	5.3	8.5	1.60	20.4	39.5
94/075/248	14.8	8.5	0.57	23.8	44.5
96/008/014	4.4	8.4	1.91	34.7	44.3
97/025/007	**0.2**	**8.4**	**38.11**	**34.5**	**31.2**
2002/006/737	7.9	8.3	1.05	25.9	43.3

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

In the biosynthesis of the alpha-acids first of all the beta-acids arise and from these the alpha-acids form via the desoxy-humulones. A high content of beta-acids is at the expense of the alpha-acid contents. The breeding lines 2001/093/719 and 2003/067/002 have a very high beta-acid content and a relatively high alpha-acid content. The breeding line 97/025/007 synthesizes alpha-acids only to a very slight extent, obviously the transformation of the beta-acids to alpha-acids is blocked in the case of this breeding line.

7.3 World hop range

This research programme is carried out every year. The aim is to determine the quality and variety-specific components of the available domestic and foreign hop varieties in cultivation under the conditions available at the location in Hüll. Table 7.3 shows the results of the crop year 2004. It can serve as an aid to allocate unknown hop varieties to a specific variety type.

Table 7.3: World hop range 2004 crop

Variety	Myr-cene	2-M.-iso-butyrate	Sub. 14b	Sub. 15	Lina-lool	Aroma-dendren	Unde-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/a	Cohu-mulone	Colu-pulone
Admiral	8291	847	3	41	41	0	10	275	20	7	6	6	24	0	0	17.1	5.4	0.32	37.4	74.8
Agnus	5956	97	1	9	11	2	4	124	0	6	4	4	15	0	0	12.7	4.6	0.36	30.8	53.4
Ahil	6125	357	36	6	19	0	8	197	83	7	5	3	17	0	0	10.0	4.2	0.42	32.4	59.5
Alliance	1964	163	0	2	26	0	6	285	7	8	4	3	21	0	0	4.8	2.3	0.49	25.6	52.1
Alpharoma	2044	227	17	8	14	0	9	300	24	10	6	3	23	0	0	5.6	2.8	0.51	27.1	51.8
Apolon	10504	224	72	20	40	6	5	196	93	7	6	4	14	0	0	10.7	4.4	0.41	26.2	51.8
Aquila	4856	89	0	108	27	31	18	61	0	11	52	61	11	80	0	6.4	3.2	0.50	46.8	70.6
Aromat	1983	17	5	5	37	0	18	314	27	11	11	8	27	0	0	3.7	4.6	1.25	30.7	46.0
Atlas	6807	900	40	14	27	4	2	186	74	7	7	5	18	0	0	9.7	4.2	0.44	36.0	63.1
Aurora	8207	176	4	40	47	0	39	275	52	7	3	2	23	0	0	11.4	4.2	0.37	26.2	54.1
Backa	3888	633	6	19	38	0	9	265	24	9	3	2	17	0	0	9.4	5.3	0.56	40.7	63.7
Belgischer Spalter	4142	245	0	13	32	8	11	143	0	9	26	29	16	45	0	6.3	2.7	0.43	24.2	51.6
Blisk	4826	363	23	7	28	0	3	207	68	8	6	4	23	2	0	8.1	3.6	0.45	34.0	58.4
Bobek	12652	305	17	96	80	0	27	266	48	9	8	6	27	0	0	7.1	5.4	0.76	31.1	50.4
Bor	6021	231	3	61	15	0	9	288	0	7	2	1	15	0	0	9.9	4.1	0.42	26.6	52.5
Braustern	4313	181	2	53	11	0	7	252	0	7	2	1	16	0	0	10.6	4.4	0.41	27.8	53.9
Brewers Gold	4093	243	11	21	12	0	3	175	0	6	6	5	18	0	2	9.0	3.7	0.41	37.4	67.9
Brewers Stand	17257	697	38	51	46	23	14	77	0	39	52	52	84	68	0	10.9	4.5	0.41	26.0	48.3
Buket	6114	356	4	110	41	0	23	250	39	9	3	2	22	0	0	9.0	4.4	0.49	24.4	48.7
Bullion	3031	311	20	22	19	3	3	165	0	7	7	7	18	0	0	8.7	4.5	0.52	36.9	60.7
Cascade	5033	539	49	13	40	0	9	237	19	17	21	15	40	0	0	6.5	4.8	0.73	34.3	51.9
College Cluster	1532	226	21	13	12	0	5	174	0	6	5	3	13	0	0	8.4	2.4	0.28	25.5	53.6
Columbus	3942	131	12	11	10	0	2	140	0	17	11	9	39	12	0	13.4	5.2	0.39	32.9	60.7

Table 7.3 continued

Variety	Myr-cene	2-M.-iso-butyrate	Sub. 14b	Sub. 15	Lina-lool	Aroma-dendren	Unde-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/a	Cohu-mulone	Colu-pulone
Comet	940	41	8	10	9	0	2	11	0	2	38	40	2	11	0	8.9	4.0	0.51	36.1	57.5
Density	3356	217	4	4	45	0	18	281	0	9	4	2	31	0	0	4.3	3.2	0.74	36.2	58.5
Eastern Gold	1235	2	0	4	8	0	5	182	12	20	9	8	40	11	0	10.9	5.3	0.49	27.5	51.8
Eastwell Golding	2669	180	0	8	22	0	7	284	0	8	4	2	20	0	0	6.2	3.1	0.50	25.4	52.0
Eroica	4823	666	57	144	7	12	8	175	0	5	10	10	16	0	0	10.3	6.9	0.67	39.5	64.4
Estera	2210	116	1	3	25	0	8	288	22	9	3	2	21	0	0	5.0	3.0	0.60	26.9	48.8
First Gold	5672	706	4	17	42	6	16	265	12	9	119	133	20	0	0	9.3	3.7	0.40	29.4	58.3
Fuggle	4591	255	3	9	34	0	9	256	26	8	3	1	24	0	0	4.4	2.4	0.55	25.3	50.4
Galena	4763	541	43	143	7	11	8	185	0	7	6	5	22	0	0	10.5	6.8	0.65	40.8	63.6
Ging dao do hua	1934	721	1	3	25	0	9	273	0	23	54	54	44	0	0	5.0	4.8	0.96	47.9	60.2
Glacier	2667	39	2	6	33	0	8	276	0	8	5	4	28	0	0	5.1	7.7	1.50	19.6	39.8
Golden Star	2086	796	0	3	22	0	7	274	0	23	48	47	44	0	0	5.1	4.5	0.90	46.8	60.1
Granit	2599	156	4	15	8	4	16	225	0	6	6	6	15	0	0	8.3	3.8	0.46	24.7	48.9
Hallertauer Gold	2862	88	30	6	30	0	12	305	0	9	3	1	22	0	0	7.3	4.9	0.67	22.6	45.1
Hallertauer Magnum	10834	234	42	40	11	0	6	278	0	6	2	1	18	0	1	16.1	5.7	0.35	26.3	45.0
Hallertauer Merkur	5214	264	18	9	27	3	6	281	0	8	2	1	18	0	0	15.3	4.6	0.30	19.8	43.3
Hallertauer Mfr.	742	21	2	1	18	0	6	324	0	10	4	3	24	0	0	4.8	5.4	1.13	20.1	42.7
Hallertauer Taurus	15993	148	18	35	49	0	10	249	0	7	55	63	23	0	0	17.7	4.6	0.26	22.5	44.8
Hallertauer Tradition	2550	92	10	2	38	0	11	303	0	9	3	1	22	0	0	8.1	4.4	0.55	26.1	50.1
Herald	12364	903	6	213	23	7	27	182	0	6	24	26	15	0	0	12.5	4.4	0.35	34.6	68.8
Herkules	7924	335	64	99	9	0	8	288	0	6	3	2	22	0	0	18.1	5.8	0.32	30.9	60.7
Hersbrucker Pure	3998	184	4	10	47	10	16	233	0	10	21	23	24	33	0	5.2	2.7	0.52	24.7	51.1
Hersbrucker Spät	2509	118	9	8	63	57	17	166	0	16	58	58	24	65	0	2.9	5.4	1.90	20.8	38.2
Horizon	4055	196	7	21	30	4	7	141	12	5	8	6	11	0	0	12.3	6.6	0.54	26.3	48.5
Hüller Anfang	355	34	6	0	16	0	8	317	0	12	7	5	23	0	0	3.3	3.4	1.04	21.2	42.8

Table 7.3 continued

Variety	Myr-cene	2-M.-iso-butyrate	Sub. 14b	Sub. 15	Lina-lool	Aroma-dendren	Unde-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/a	Cohu-mulone	Colu-pulone
Hüller Aroma	636	44	5	2	23	0	7	317	0	12	4	2	24	0	0	4.5	3.7	0.83	23.6	47.1
Hüller	6053	292	34	10	34	14	10	152	0	38	38	37	75	47	0	7.6	4.5	0.60	29.1	49.6
Hüller Fortschritt	967	29	9	2	26	0	10	317	0	11	5	4	23	0	0	4.3	4.4	1.03	25.8	45.3
Hüller Start	455	18	0	1	11	0	10	330	0	14	5	4	25	0	0	3.2	3.7	1.15	24.3	45.5
Yesp. C 730	1069	4	11	27	14	0	8	164	30	6	7	10	13	5	0	4.4	3.3	0.74	34.5	53.6
Yesp. C 827	1048	39	7	3	10	0	5	297	17	10	4	19	21	21	0	5.6	2.6	0.48	26.9	50.4
Kirin 1	1681	537	2	4	17	0	6	282	0	23	40	40	43	0	0	5.3	4.8	0.89	49.3	61.4
Kirin 2	1551	654	2	3	18	0	7	281	0	23	50	49	44	0	0	5.3	4.5	0.84	45.7	60.1
Kitomidori	1176	14	3	11	5	0	3	284	23	8	3	3	17	0	0	10.1	5.0	0.49	25.5	48.9
Kumir	5766	143	4	37	26	3	9	267	21	7	2	1	18	0	0	12.5	4.3	0.34	22.1	46.1
Late Cluster	32006	1063	60	95	71	35	26	37	10	55	73	74	130	95	0	10.5	4.4	0.42	20.6	44.7
Liberty	862	75	2	2	31	0	10	302	0	11	4	3	22	0	0	3.7	2.8	0.77	21.7	43.8
Lubelski	2952	0	6	4	36	0	16	292	47	10	4	2	25	0	0	6.8	5.4	0.79	25.9	45.6
Malling	4387	292	3	7	41	0	8	271	25	9	3	1	16	0	0	5.1	2.3	0.45	29.8	56.5
Marynka	7171	380	5	70	16	6	8	139	123	7	4	3	14	0	0	10.3	3.7	0.36	20.0	48.7
Mount Hood	340	53	16	2	20	0	6	280	0	13	5	3	24	0	0	3.5	4.2	1.20	23.2	42.4
Neoplanta	2768	228	0	33	9	0	8	225	28	8	2	1	19	0	0	8.6	3.7	0.43	33.9	61.6
Northern Brewer	4625	187	2	49	11	0	6	245	0	7	2	1	16	0	0	10.6	4.4	0.41	27.3	53.5
Nugget	1797	76	3	10	16	0	4	183	0	6	7	5	15	0	0	10.87	4.5	0.41	29.8	55.5
Olympic	1765	61	3	10	13	3	4	173	0	5	6	5	12	0	0	12.5	5.1	0.41	28.9	54.0
Omega	3549	402	16	11	25	0	6	285	0	7	58	63	18	0	0	6.6	3.2	0.48	25.2	53.1
Opal	7623	126	21	28	51	4	12	222	0	7	3	7	19	19	2	10.1	4.9	0.49	17.5	38.8
Orion	1245	98	6	6	17	0	7	230	0	8	3	1	18	0	0	8.7	4.9	0.57	31.3	54.0
OT 48	2628	204	0	0	53	0	18	281	0	10	6	3	31	0	0	5.0	3.6	0.73	37.8	58.4
PCU 280	3328	128	0	14	8	0	5	271	0	6	4	2	17	0	0	9.6	3.5	0.37	26.8	53.4

Table 7.3 continued

Variety	Myr-cene	2-M.-iso-butyrate	Sub. 14b	Sub. 15	Lina-lool	Aroma-dendren	Unde-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/a	Cohu-mulone	Colu-pulone
Perle	1430	64	1	16	7	0	6	269	0	8	4	3	19	0	0	6.6	3.5	0.53	33.3	59.0
Phoenix	3128	148	0	5	7	0	4	242	13	6	43	56	18	0	0	14.2	4.8	0.34	22.8	46.1
Pilgrim	9050	652	6	145	21	7	28	265	0	7	64	68	23	0	0	9.9	3.6	0.36	34.4	69.4
Pilot	8059	581	24	72	68	15	37	164	0	10	254	268	28	0	0	8.9	4.1	0.47	32.4	60.6
Pioneer	6214	580	3	143	15	5	26	202	0	7	28	29	18	0	0	9.9	3.7	0.37	33.8	66.4
Premiant	6165	134	5	32	26	3	8	264	15	6	2	1	22	0	1	12.9	4.5	0.35	23.1	48.6
Pride of Kent	2300	75	1	3	39	0	10	305	0	9	3	2	19	0	0	4.9	2.1	0.43	27.0	53.3
Pride of Ringwood	1743	18	1	2	7	3	10	39	0	7	73	95	14	0	0	8.4	5.8	0.68	29.4	50.4
Progress	25839	1036	55	79	61	30	22	42	0	57	74	75	121	102	0	10.9	4.5	0.42	25.3	47.5
Saazer	1999	0	0	0	32	0	17	302	34	10	4	2	31	0	0	4.5	4.2	0.94	27.2	45.4
Saphir	4143	96	4	22	41	13	33	202	0	8	16	17	15	22	0	3.6	5.2	1.44	12.8	43.1
Serebrianca	410	56	3	3	34	0	8	193	0	16	47	45	28	0	0	2.5	4.4	1.78	23.1	39.3
Sirem	2226	6	5	4	38	0	16	302	36	12	4	2	26	0	0	5.6	4.8	0.86	25.9	44.5
Sladek	6696	153	4	37	28	2	9	268	22	7	4	2	16	0	0	11.6	3.8	0.33	24.0	49.7
Spalter	2638	3	8	7	62	0	23	332	31	15	4	2	29	0	0	5.5	5.2	0.95	26.8	46.3
Spalter Select	6393	145	12	9	107	20	30	202	54	11	32	34	22	51	0	5.4	4.0	0.74	23.2	45.2
Sterling	1286	71	3	10	12	2	3	170	0	6	8	8	13	0	0	10.2	4.2	0.41	28.4	54.3
Sticklebract	5609	410	16	18	11	0	10	156	28	6	47	51	17	0	0	7.3	5.2	0.72	39.4	66.2
Strisselspalter	1798	110	9	9	48	42	11	197	0	14	45	44	21	58	0	3.7	5.7	1.54	22.3	39.8
Talisman	6821	270	5	74	12	0	6	238	0	7	2	1	14	0	0	11.2	4.4	0.40	27.8	54.9
Tettnanger	3547	8	0	5	31	0	15	285	57	9	4	2	28	0	0	5.7	5.7	1.01	24.7	43.3
Toyomidori	2093	204	13	58	10	0	13	220	0	20	9	8	41	8	0	12.0	5.3	0.44	34.7	62.1
Ultra	309	20	0	1	13	0	4	326	0	10	4	3	22	0	0	1.9	3.5	1.80	25.1	41.5
USDA 21055	6842	514	4	236	11	0	3	124	73	6	19	21	15	0	0	11.9	4.0	0.33	41.0	78.0
Vojvodina	3996	184	0	26	13	0	10	256	7	8	3	2	20	0	0	6.0	3.0	0.51	31.8	56.5

Table 7.3 continued

Variety	Myr-cene	2-M.-iso-butyrate	Sub. 14b	Sub. 15	Lina-lool	Aroma-dendrene	Unde-canon	Humu-lene	Farne-sene	γ-Muu-rolene	ß-Se-linene	α-Se-linene	Cadi-nene	Seli-nadiene	Gera-niol	α-acids	ß-acids	ß/a	Cohu-mulone	Colu-pulone
WFG	3102	32	12	6	40	0	17	289	32	10	4	0	28	0	0	5.5	5.0	0.91	24.9	45.3
Willamette	2714	172	2	6	22	0	3	253	26	7	4	3	19	0	0	5.1	3.4	0.66	35.6	56.2
Wye Challenger	8096	622	6	38	47	0	14	283	0	8	61	67	25	0	0	4.8	3.8	0.79	26.6	51.9
Wye Northdown	5330	179	0	17	22	0	4	233	0	7	2	1	17	0	0	8.9	4.9	0.55	27.5	49.3
Wye Target	6564	409	5	35	33	0	10	164	0	11	9	9	32	5	0	13.2	5.4	0.41	34.7	63.9
Wye Viking	8836	268	10	63	23	0	15	209	104	6	29	30	18	0	0	9.5	4.8	0.50	22.4	44.6
Yeoman	6166	458	22	31	13	0	8	234	0	6	37	41	16	0	0	13.2	4.5	0.34	26.0	50.7
Zatecki	1725	84	2	6	23	0	8	298	17	9	3	2	20	0	0	5.6	2.9	0.52	27.7	50.4
Zenith	4483	119	3	20	30	0	8	280	0	8	77	86	19	0	0	7.9	3.0	0.38	24.9	53.3
Zeus	3944	105	11	10	10	0	2	160	0	19	12	10	40	12	0	13.0	5.9	0.45	31.4	56.1
Zitic	6279	6	2	27	14	6	10	270	21	6	2	1	17	0	0	6.7	4.4	0.65	25.3	46.1
Zlatan	2144	0	0	0	45	0	19	308	32	12	4	2	24	0	0	4.6	4.6	1.00	25.0	45.8

Essential oils = relative values, ß-caryophyllene = 100; α- and ß-acids in % as is; analoga in % of the α- or ß-acids

7.4 Research on the influence of the production region on hop components

The American brewery Anheuser-Busch is of the opinion, that the variety Hallertauer Mfr. grown in the Hallertau is more stable with regard to storage and brewing quality than the same variety grown in Tettnang. Comparative analyses should provide initial information on this. The HSI (Hop Storage Index), the total oil content, the alpha- and beta-acids as well as the polyphenol content were ascertained from ten samples each of the variety Hallertauer Mittelfrüher from the production regions Hallertau und Tettnang. The samples were scattered over the production area and were also drawn at different harvest-times.

The Figures 7.1 and 7.2 show the measuring results. The HSI is a non-dimensional parameter, the total oil content is stated in ml/100 g hops, the α-, ß-acids content and polyphenol content in % referring to hops as is. In each case the confidence range is entered where the average is found with 95 % likelihood, if this range is not overlapped, then the values do not differ significantly. With the HSI there is no difference between the production areas. The total oil content and the alpha-, beta-acid content is higher in the samples from Tettnang but the polyphenol content is higher with the Hallertauer samples. This could be a reason for the greater stability in the Hallertau as polyphenols possess a considerable antioxidative potential. The somewhat harsher climate in the Hallertau possibly makes the variety Hallertauer Mfr. more stable in the Hallertau.

Figure 7.1: Comparison of Hallertauer Mfr. Hallertau-Tettnang, HSI, total oils

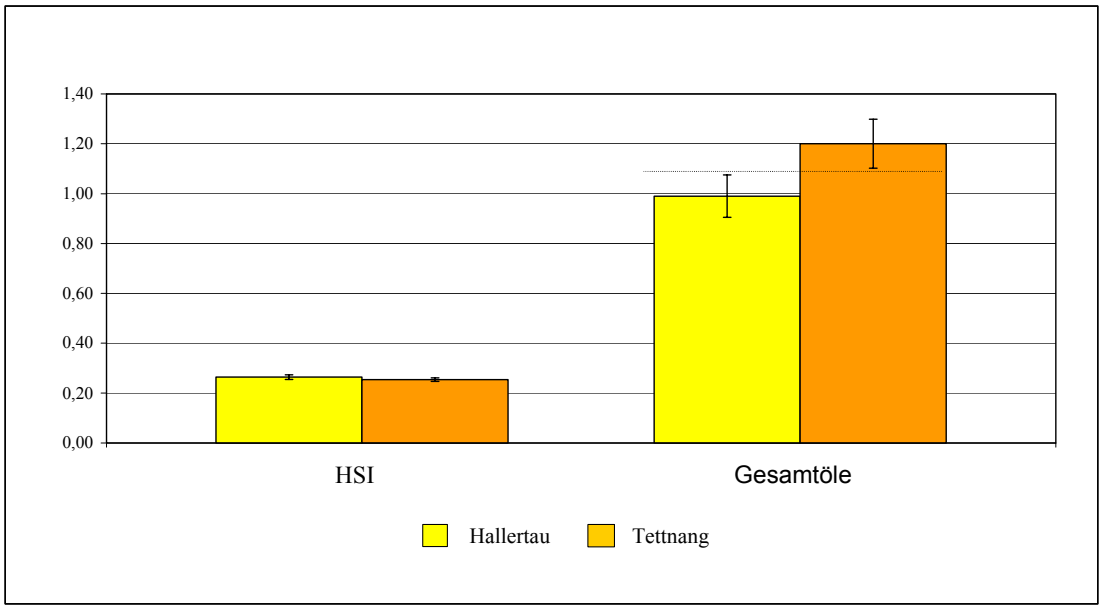
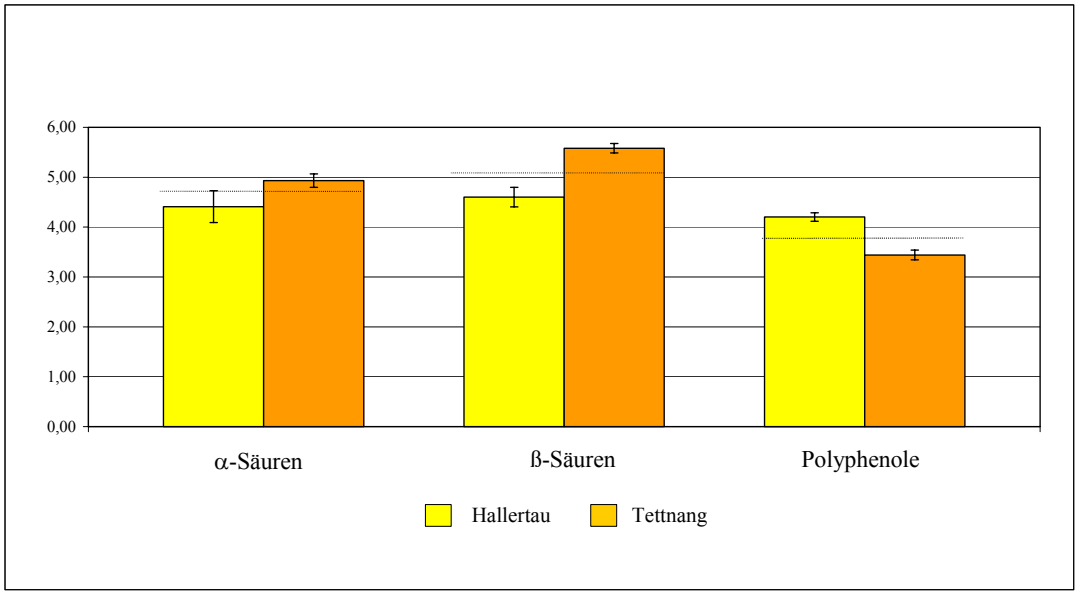


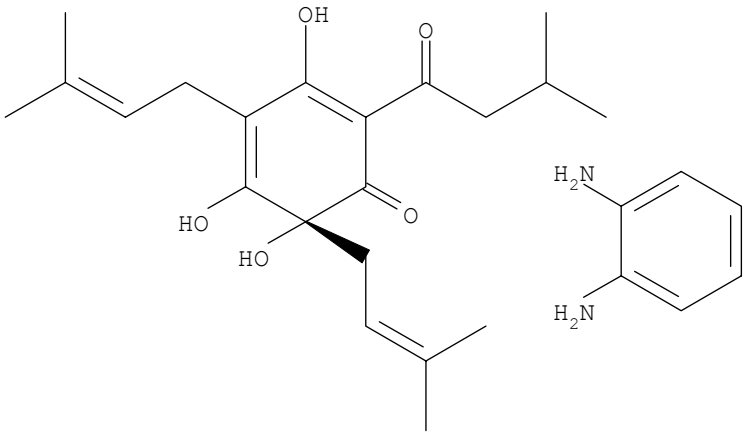
Figure 7.2: Comparison of Hallertauer Mfr. Hallertau-Tettnang, α-acids, ß-acids, polyphenols



7.5 Substituting the pure alpha-acids by the ortho-phenylendiamin-complex in the stability control of the international calibrating extract ICE 2

In the Work Group for Hop Analytics (AHA) a stability control of the international calibrating extract ICE 2 is carried out twice a year (spring, autumn). If a significant reduction can be seen, a new calibrating extract must be introduced. According to the AHA protocol so far the stability test is made with pure alpha-acids, which are isolated from a CO2 extract. A preliminary stage of the alpha-acids is the ortho-phenylendiamin complex from which the alpha-acids are released. (Fig. 7.3). Work is now being done to replace the pure alpha-acids by the ortho-phenylendiamin complex. Prerequisite for this is that the complex is stable and this appears to be the case. The stability control of the ICE 2 could be carried out considerably faster. The co-humulone content of the complex is 5.29 %, the n-adhumulone content 69.13 %, which makes a total alpha-acid content of 74.42 %. Theoretically the complex has an alpha-acid content of 76.97. The complex therefore has a purity of 96.69 %. The EBC will be reported on this work, in addition the results of the stability control will also be published in the international brewing press.

Figure 7.3: Ortho-phenylendiamin complex of n-humulone



7.6 Hop Ring analyses of the 2005 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 have to carry out the further examinations and which tolerance ranges are allowed for the results of the analyses. The Work Group IPZ 5d was also given the task again in 2005 to organise and evaluate ring analyses in order to ensure the quality of the alpha-acid analyses.

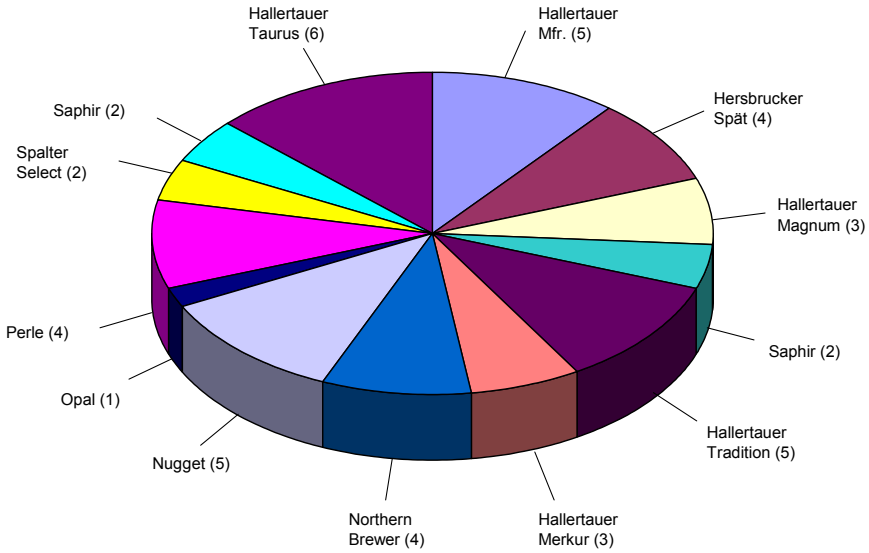
In 2005 the following laboratories participated in the collaborative trial

- Hallertauer Hopfenveredelungsgesellschaft (HHV), Werk Maynburg
- Hallertauer Hopfenveredelungsgesellschaft (HHV), Werk Au/Hallertau
- NATECO2 GmbH & Co. KG, Wolnzach
- Hopfenveredlung St. Johann GmbH & Co. KG, St. Johann
- Hallertauer Hopfenverwertungsgenossenschaft (HVG), Mainburg
- Agrolab GmbH, Oberhummel
- Agrar- und Umweltanalytik GmbH (AUA), Jena
- Bayerische Landesanstalt for Landwirtschaft, Arbeitsbereich Hopfen, Hüll

The test was started on 05.09.2005 and ended on 25.11.2005 as during this time most of the hop lots had been examined in the laboratories. Thanks go out to Mr. Hörmannsperger (Hopfenring Hallertau) who provided the sample material. Each sample was taken only from one bale, in order to guarantee the maximum homogeneity. Every Monday the samples were ground in Hüll with a hammer mill, separated with a sample divider, vacuum packed and brought to the individual laboratories. On the following weekdays one sample was always analysed daily. The

results of the analyses were returned a week later to Hüll and evaluated there. In 2005 altogether 46 samples were analysed. Figure 7.4 shows the composition of the varieties.

Figure 7.4: Composition of varieties in the RingAnalysis 2005



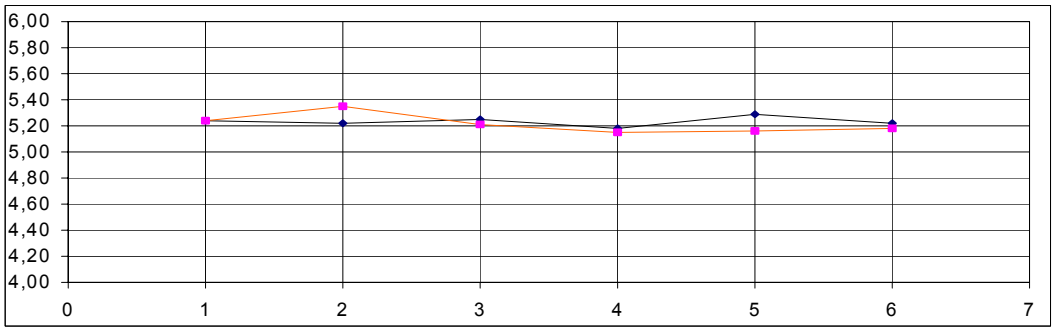
The evaluations were passed on to the individual laboratories as quickly as possible. Figure 7.5 shows as an example of an evaluation in the Ring Test with the lowest variance.

Figure 7.5: Ring Analysis with the lowest variance

Nr. 32: HSE (02.11.2005)

Labor	KW		mittel	s	cvr
1	5,24	5,24	5,24	0,000	0,0
2	5,22	5,35	5,29	0,092	1,7
3	5,25	5,21	5,23	0,028	0,5
4	5,18	5,15	5,17	0,021	0,4
5	5,29	5,16	5,23	0,092	1,8
6	5,22	5,18	5,20	0,028	0,5

mean	5,22
sr	0,056
vkr	1,08
sR	0,057
vkR	1,08
sL	0,006
r	0,16
R	0,16
Min	5,17
Max	5,29



The Grubbs Test was calculated according to DIN ISO 5725 as a outlier test between the laboratories. One outlier was found in 2005. Table 7.4 shows the tolerance limits (d critical, Schmidt, R., NATECO2, Wolnzach) taken from the Analytica-EBC (EBC 7.4, conductometric titration) and their exceedings in the years 2000, 2001, 2002, 2003, 2004 und 2005.

Table 7.4: Tolerance limits of the EBC method 7.4 and their exceedings in the years 2000, 2001, 2002, 2003, 2004 and 2005

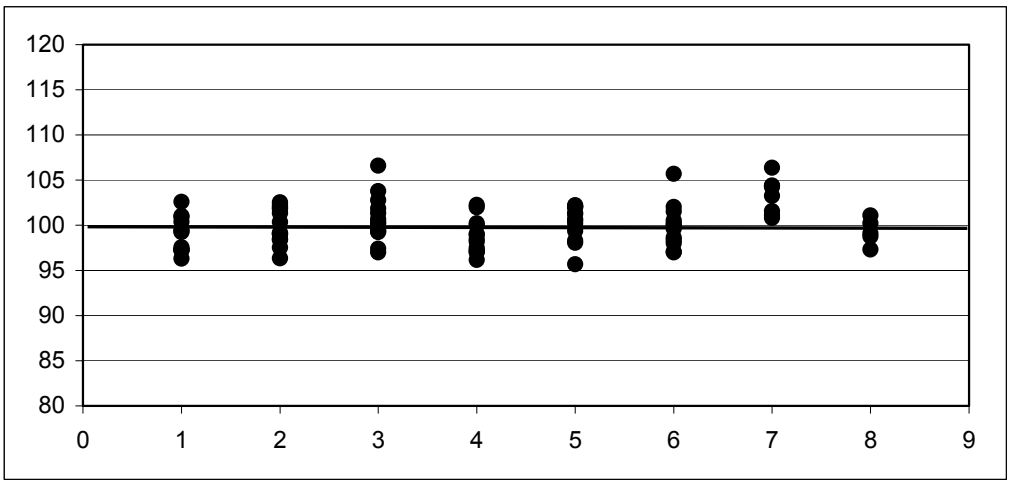
	up to 6.2 % α-acids	6.3 % - 9.4 % α-acids	9.5 % - 11.3 % α-acids	As from 11.4 % α-acids
d critical	+/-0.3	+/-0.4	+/-0.5	+/-0.6
Exceedings in year 2000	0	3	0	3
Exceedings in year 2001	2	1	0	2
Exceedings in year 2002	4	Range	0.6	0.8
Exceedings in year 2003	1	1	1	0
Exceedings in year 2004	0	0	0	4
Exceedings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

In 2005 there were altogether 5 exceedings of the permitted tolerance limits..

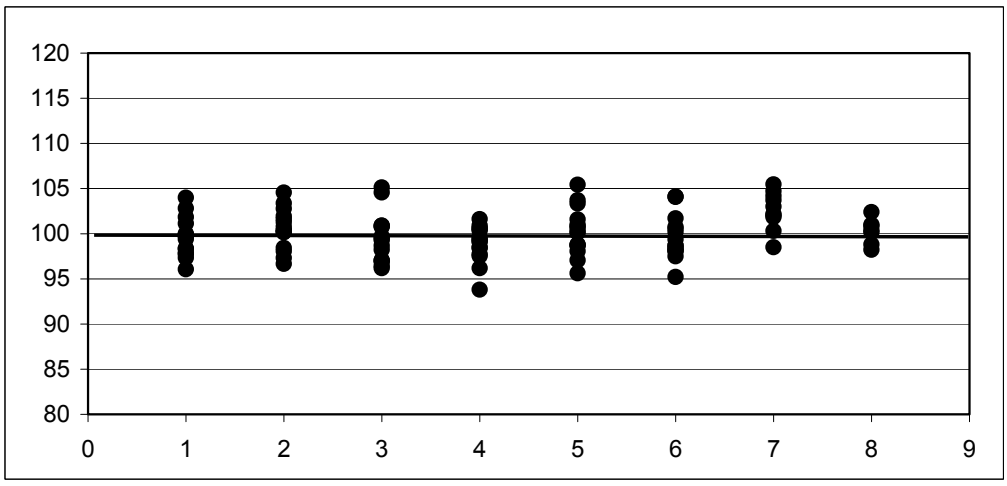
In Figure 7.5 all the analysis results for each laboratory are compiled as relative deviations from the average value (= 100 %) differentiated according to content of alpha-acids < 5 %, > = 5 % and < 10 %, > = 10 %.

Figure 7.5: Analysis results of the laboratories relative to the average

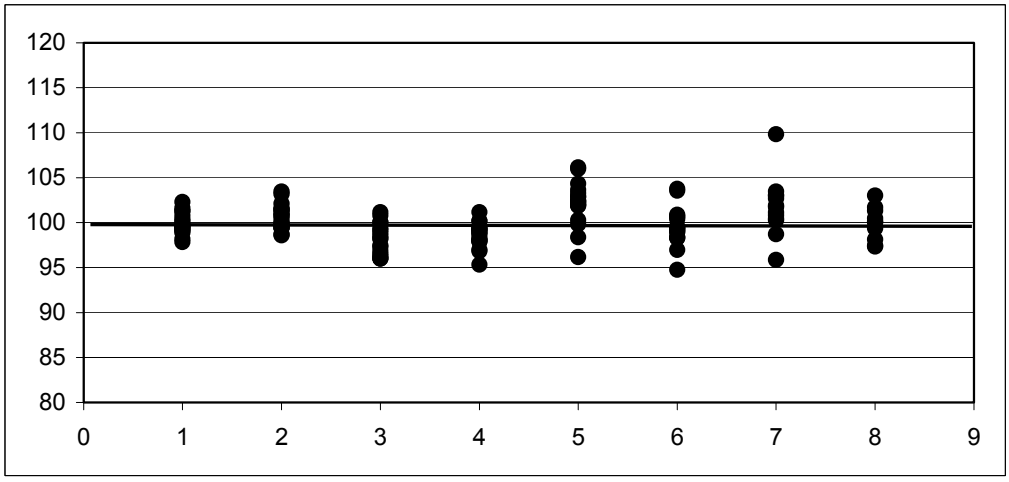
Proben < 5 % α-Säurengehalt



Proben >= 5 % und < 10 % α-Säurengehalt



Proben >= 10 % α-Säurengehalt



7.7 Development of a NIR (near infrared reflection spectroscopy)-calibration based on HPLC (high-performance 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 replace the increasing number of wet-chemical analyses through 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 of the Ring trial (s. Point 7.6) will be used. Every sample was measured by NIR and HPLC.

The Figures 7.6 and 7.7 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 2004). It can be seen in Figure 7.6 that the mean averages conform very well. 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 the 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 Figure 7.7 clearly shows that r and R are greater with the NIR method than with the HPLC method. 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.

Figure 7.6: Comparison of mean averages alpha-acids, HPLC-NIR, Ring Trial 2004

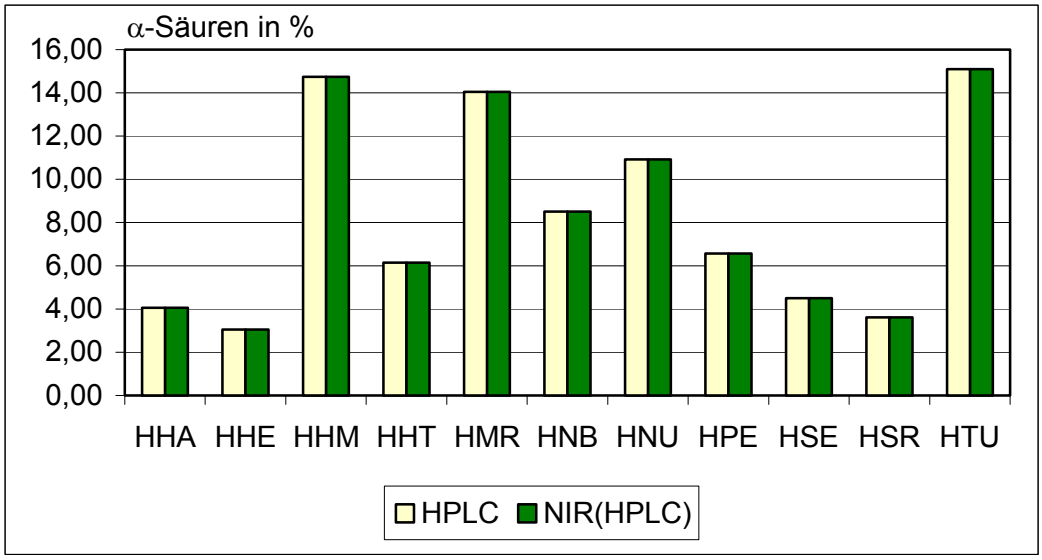
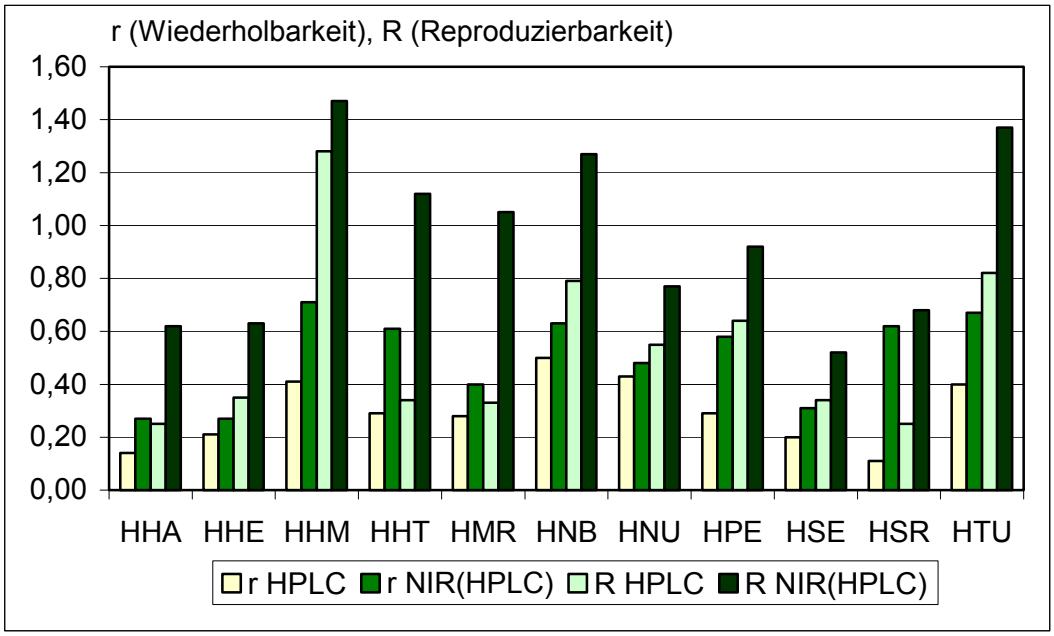


Figure 7.6: Comparison mean averages r/R, HPLC-NIR, Ring Trial 2004



7.8 Differentiating a selection of the world hop range and the Hüll-bred varieties according to alpha-acids and polyphenols and the influence of these components on the qualilty of the beer.

The aim of this project is to find out whether varieties with extremely varied components have a noticeable effect on the quality of the beer. The Scientific Station for Brewing in Munich has financed this project with € 50.000.

The analytical work was carried out in 2004 and published in the Hopfenrundschau International 2005. In 2005 brewing trials were carried out with selected varieties and breeding lines at the St. Johann Research Brewery. Table 7.5 shows the selection criteria and the selected varieties and breeding lines.

Table 7.5: List of varieties and breeding lines which were selected for the brewing trials

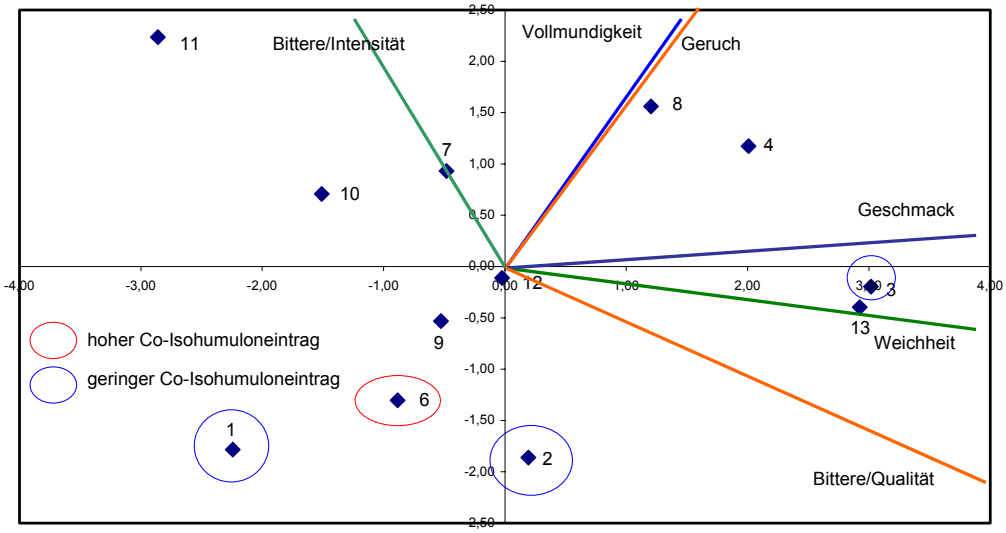
Selection criteria	Variety/breeding line
low cohumulone content	Saphir, Smaragd, Merkur
high cohumulone content	Pilgrim
low adhumulone content	Agnus, Premiant
high adhumulone content	83/63/51, Pride of Ringwood
high polyphenol content	Saazer, Pride of Ringwood, Serebrianca
low polyphenol content	95/094/816 (Herkules), Zitic

The beers were tasted by a group from Hüll and the team from St. Johann. The judgment criteria were bitterness/intensity, bitterness/quality, body, smell, taste, mellowness. The judgments were offset with a principal component analysis, so that they can be shown on a two-dimensional

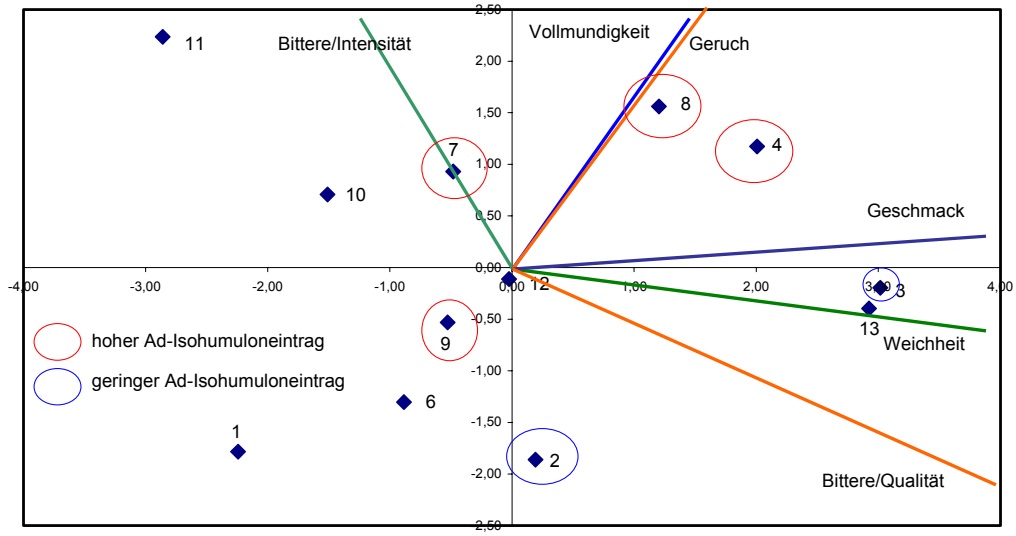
level. Figure 7.7 shows the evaluation. The individual contributions of the judgment criteria are also marked in the diagrams. Body and smell are well correlated. Also smell, mellowness and bitterness/quality point in the same direction. Bitterness/intensity and bitterness/quality are correlated negatively.

Figure 7.7 **Diagram of the tasting results after offsetting with a principal component analysis**

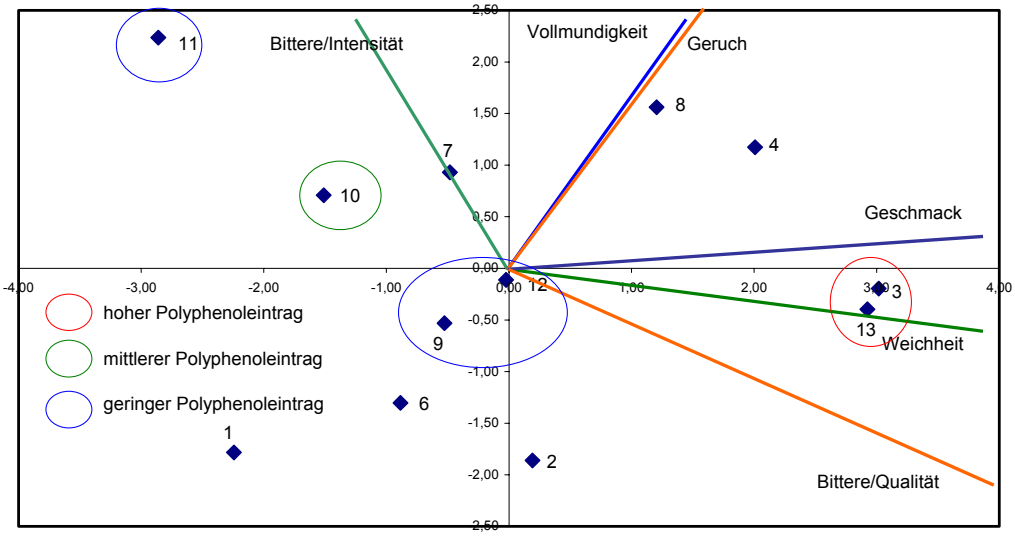
Cohumulone contribution



Adhumulone contribution



Polyphenol contribution



1 =	Merkur	6 =	Pilgrim	10 =	Saazer
2 =	Smaragd	7 =	Premiant	11 =	Herkules
3 =	Saphir	8 =	83/63/51	12 =	Zitic
4 =	Agnus	9 =	Pride of Ringwood	13 =	Serebrianca

From the diagram it can be seen that the variety Herkules contributes the most to the bitterness/intensity. With regard to flavour, mellowness the varieties with the greatest polyphenol contribution, i.e. Saphir and Serebrianca, were judged the best. The cohumulone and adhumulone impact shows no definite tendency. An article about this project is planned for brewing publications.

7.9 Analyses on plant protective residues in hops of the 2005 crop

The annual inspections for plant protectives in hops provide a very good overview on the actual situation regarding the use of plant protectives. Contrary to many assumptions hops are free of harmful residues of plant protectives.

The application spectrum is spread out with the registration of new products to control the downy mildew (Peronospora). This can be seen in the increasing number of low values with cupric compounds, although in 2005 there was an uninterrupted high spread of infection in the months July and August and an above-average treatment was often necessary. Another spray warning to combat the downy mildew had to be made shortly before the harvest began.

The very low values of "Folpet“ are very pleasing in the Hallertauer hops – this is a sign for the responsible use of the active ingredients. The choice of all licensed chemicals over the long season from May until August can be assessed very positively regarding a resistance management to maintain the active ingredients over a long term. The extremely low residue values with altogether only one product from the group of insecticides (aphid control) and acaricides (to control the common spider mite), reflect the low spread of infection. The hop-growers have reacted to the situation this year with less control measures and have saved on plant protectives.

Due to the high costs for the total analysis (approx. € 1,100,-- per sample) the extent of the analyses also had to be limited to six samples this year. However, a great many analyses will additionally be made in the residue laboratories of the Hopfenveredelungswerke (hop-refining works). The variety Hallertauer Mittelfrüher is constantly being inspected for the active ingredients analysed in this study.

Although considerably less chemicals are used in the practice altogether 55 different plant protective preparations were analysed in this study. In addition to the active ingredients licensed at present, previously licensed chemicals and those known from other cultures (e.g. viniculture) are analysed and inspected.

7.9.1 Selecting the samples

Spread over the weighing-in and certifying season 2005 altogether 110 hop samples from all the important varieties of the Hallertau production region were delivered to Hüll to the Hops Dept. of the Bavarian State Research Center for Agriculture (LfL) by the Hopfenring Hallertau e.V. The samples were marked only with the name of the variety and the bale number. Therefore the LfL did not know the names of the hop farms.

At the LfL two hop samples were selected from these samples for each five hop varieties mentioned in the Table and a mixed sample was made for each variety. The extensive residue analyses of a mixed sample from two single samples are justified as the lots delivered to the buyers (breweries) are generally put together from more than two individual lots. The sample "R1/05 HM“ consists of one single sample.

The variety selection extends over varieties which are very susceptible to disease and varieties very susceptible to pests (e.g. Hallertauer Magnum – HM -), as well as slightly susceptible varieties (e.g. Hallertauer Tradition –HT -); early ripening (e.g. Hallertauer Mittelfrüher -HA-) and late-ripening varieties (e.g. Hallertauer Taurus); varieties with low acreage (e.g. Northern Brewer -NB-) and high acreage (e.g. Perle -PE-).

The analyses were carried out at the Bioanalytik Weihenstephan (formerly Landwirtschaftliche Hauptversuchsanstalt HVA) of the Technical University (TUM) in Freising-Weihenstephan. Table 7.6 shows the results.

Table 7.6: Analyses for residues of plant protectives – 2005 crop

Active ingredients listed According to pest/disease	Max. permittd ppm	Milligramm per kilogram e= ppm					
		R 1/05 HM	R 2/05 NB	R 3/05 HT	R 4/05 TU	R 5/05 PE	R SE
Peronospora							
Azoxystrobin	20	n.n.	0.88	1.7	0.29	0.76	0.29
Captafol	0.1	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Captan	120	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	n.n.	0.46	0.19	n.n.	0.10	3.80
Dithiocarbamate	25	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Fentin-acetate	0.5	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Folpet	120	n.n.	n.n.	31.1	n.n.	n.n.	23.9
Fosethyl	100	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Cupric compounds	1000	428.0	382.0	82.7	202.0	272.0	40.6
Metalaxyl	10	0.11	n.n.	n.n.	n.n.	n.n.	n.n.
Phosphoric acid	*)	5.8	< 5.0 u.B.	< 5.0 u.B.	5.2	< 5.0 u.B.	n.n.
Tolyfluanide	30	n.n.	n.n.	n.n.	0.64.	n.n.	n.n.
Powdery 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	<0.10 u.B.	<0.10 u.B.	0.12	< 0.10 u.B.	n.n.	0.23
Quinoxyfen	1	n.n.	0.18	0.18	n.n.	n.n.	n.n.
Triadimefon	10	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Triadimenol	10	n.n.	0.13	n.n.	n.n.	n.n.	n.n.
Trifloxystrobin	30	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Botrytis							
Dichlofluanide	150	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	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Hop aphid							
Bifenthrin	10	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
3-Hydroxy-Carbofuran	10	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Cyfluthrin	20	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Lambda-Cyhalothrin	10	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Cypermethrin	30	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Deltamethrin	5	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	0.17	0.12	0.10	n.n.	< 0.10 u.B.	n.n.
Mevinphos	0.5	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.

Table 7.6 continued

Active ingredients listed According to pest/disease	Maximum amounts ppm	Milligramm per kilogram = ppm					
		R 1/05 HM	R 2/05 NB	R 3/05 HT	R 4/05 TU	R 5/05 PE	R 6/05 SE
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	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Spider mite							
Abamectin	0.05	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Amitraz	20	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	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Dicofol	50	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Fenbutatinoxide	0.1	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Fenpyroximate	10	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Hexythiazox	3	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Propargit	30	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Alfalfa weevil							
Acephate	0.1	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Carbofuran	10	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Methamidophos	2	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
Methidathion	3	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 traceable;
u.B. = below determination limit
*) = no maximum amount of residue laid down
HM = Hallertauer Magnum NB = Northern Brewer
HT = Hallertauer Tradition TU = Hallertauer Taurus
PE = Perle SE = Spalter Select

7.9.2 Judging the results

As in past years only few active ingredients were detected. In all cases the values were considerably below the legally permitted maximum amounts in compliance with the current regulation on maximum amounts in the respective amendment. No non-licensed plant protectives were ascertained at all in the hops. Table 7.7 shows a summary of the analyis results.

Table 7.7: Residue situtation in hops of the 2005 crop

Active ingredient (brand-name)	Fre-quency	ppm min.-max.	ppm max. a-mount	ppm US Tolerance
Azoxystrobin Ortiva	5	0.29 – 1.7	20	20
Dimetomorph (Forum)	4	0.10 – 3.8	50	60
Folpet (Folpan WDG)	2	23.9 – 31.1	120	120
Cupric compunds	6	40.6 – 428.0	1000	ex.
Metalaxyl (Ridomil Gold Combi)	1	0.11	10	20
Myclobutanil (Systhane 20 EW)	2	0.12 – 0.23	2.0	5.0
Imidacloprid (Confidor)	3	0.10 – 0.17	2.0	6
Phosphoric acid	2	5.2 – 5.8	*	*
Quinoxyfen (Fortress 250)	2	0.18	1	3
Tolylfluanid (Euparen WG)	1	0.64	30	30
Triadimenol	1	0,13	10	-

* = no maximum residue laid down; ex = exempt

7.9.3 Resumé

The long-term programme to detect plant protective residues in hops this year again confirms that hops are free of harmful residues. There is not the least suspicion that the legally set amounts were succeeded. Consequently it can be ruled out that plant protectives have a negative effect on the beer.

7.10 Checking that the variety is authentic

It is the duty of the Work Group IPZ 5d to prove to the food control authorities that the variety is authentic.

Variety inspections for the food control authorities (district admin. offices) 99
Complaints thereof 35
50 samples were taken by the Kelheim district admin. office from a large lot. 35 of these samples did not correspond to the variety stated.

8 Publications and specialist information

8.1 Overview of public relations work

	No.		No.
Practice information and scientific publications	73	Scientific talks	98
LfL-publications	2	Guided tours	95
Press releases	1	Exhibitions	2
Contributions in radio and television	2	Education and further training	10
Organisation of expert meetings, seminars and colloquia	13	Diploma theses	3
Participation in work groups	17	Dissertations	1
Foreign visitors	119		

8.2 Publications

8.2.1 Practice informations and scientific contributions

Engelhard, B. (2005): Forschungsvorhaben und Forschungsschwerpunkte der Arbeitsgruppen „Hopfenbau, Produktionstechnik“ und „Pflanzenschutz im Hopfenbau“. Hopfen-Rundschau 56 (6), 145-148.

Engelhard, B. (2005): Untersuchungen auf Pflanzenschutzmittelrückstände im Hopfen der Crop 2005. Hopfen-Rundschau 56 (12), 308-310.

Engelhard, B. (2005). The impact of weather conditions on the behavior of powdery mildew in infecting hop (Humulus). Acta Horticulturae (ISHS) 668, 111-116. http://www.actahort.org/books/668/668_14.htm

Engelhard, B., Huber, R., Meyr, G. (2005): Pflanzenschutz 2005 – Lücken bei Pflanzenschutzmittel gegen Bodenschädlinge und zum Hopfenputzen konnten noch nicht geschlossen werden. Hopfen-Rundschau 56 (5), 121-129.

Kammhuber, K. (2005); Differenzierung des World hop ranges nach Bitterstoffen und Polyphenolen, Hopfen-Rundschau International 2005/2006, 42-46.

Münsterer, J. (2005): Optimale Konditionierung von Hopfen. Hopfen-Rundschau 56 (8), 206-207.

Niedermeier, E. (2005): Pflanzenstandsbericht. Hopfen-Rundschau 56 (6), 152.

Niedermeier, E. (2005): Pflanzenstandsbericht. Hopfen-Rundschau 56 (7), 179.

Niedermeier, E. (2005): Pflanzenstandsbericht. Hopfen-Rundschau 56 (8), 204-205.

Niedermeier, E. (2005): Pflanzenstandsbericht. Hopfen-Rundschau 56 (9), 229.

Niedermeier, E., Schinagl, S. (2005): Auftreten und Bekämpfung des Mayszünslers im Hopfen. Hopfen Rundschau 56 (7), 176-179.

Portner, J. (2005): Aktuelle Hopfenbauhinweise. Hopfenbau-Ringfax Nr. 2; 6; 8; 10; 11; 12; 13; 14; 15; 16; 17; 18; 20; 21; 22; 23; 24; 26; 27; 28, 29, 30, 32, 33, 34, 37, 39, 40, 45, 46, 47.

Portner, J. (2005): Hopfenbau. KTBL-Faustzahlen for Landwirtschaft 13. Auflage, 458-465.

Portner, J. (2005): Hinweise für Anbauer der Sorte Hallertauer Mittelfrüher. Hopfenring/Erzeugerring-Information v. 28.06.2005, 1-3.

Portner, J. (2005): Hinweise for Hopfenpflanzer zu Schlagkarteiauswertung, Fortbildungsveranstaltungen, Zulassungsende von PSM, KuLaP-Förderung, Bodenuntersuchung und Nährstoffvergleich. Hopfenring/Erzeugerring-Information v. 28.10.2005, 1-3.

Portner, J. (2005): Erste Nmin-Results in Hopfen und anderen Ackerkulturen: Empfehlungen zur Stickstoffdüngung 2005. Hopfen-Rundschau 56 (3), 66.

Portner, J. (2005): Düngebedarfsermittlung for P, K, Kalk und Magnesium. Hopfen-Rundschau 56 (3), 67.

Portner, J. (2005): Gezielte Stickstoffdüngung des Hopfens nach DSN (Nmin). Hopfen-Rundschau 56 (3), 67.

Portner, J. (2005): Pflanzenschutzmittel-Entsorgungsaktion. Hopfen-Rundschau 56 (4), 93.

Portner, J. (2005): Hopfenvermarktung 2004 nach Anbaugebieten und Sorten in der Bundesrepublik Germany und der Hallertau. Hopfen-Rundschau 56 (4), 103-104.

Portner, J. (2005): Rodung stillgelegter Hopfengärten. Hopfen-Rundschau 56 (6), 146.

Portner, J. (2005): Benetzungsversuche zur Optimierung der Applikationstechnik bei Sprühgeräten. Hopfen-Rundschau 56 (6), 148-149.

Portner, J. (2005): Development eines EDV-Wasserhaushaltsmodells zur Bewässerungssteuerung in Hopfen. Hopfen-Rundschau 56 (6), 149-150.

Portner, J. (2005): Peronosporabekämpfung – Planen Sie Ihren Mitteleinsatz. Hopfen-Rundschau 56 (6), 158.

Portner, J. (2005): Kostenfreie Rücknahme von Pflanzenschutzverpackungen PAMIRA 2005. Hopfen-Rundschau 56 (7), 162.

Portner, J., (2005): Vermeidung von Gewässerverunreinigung beim Befüllen und Reinigen von Pflanzenschutzgeräten. Hopfen-Rundschau 56 (7), 181.

Portner, J. (2005): Rebenhäcksel baldmöglichst ausbringen. Hopfen-Rundschau 56 (8), 200.

Portner, J. (2005): Optimale Trocknung und Konditionierung. Hopfen-Rundschau 56 (8), 207.

Portner, J. (2005): Anfall, Raumgewicht und Nährstoffgehalt von Rebenhäcksel zum Zeitpunkt der Ausbringung. Hopfen-Rundschau 56 (9), 228-229.

Portner, J. (2005): Fachkritik zur Moosburger Hopfenschau 2005. Hopfen-Rundschau 56 (10), 262-266.

Portner, J., Lutz, A. (2005): Ermittlung des optimalen Erntezeitpunktes bei den Sorten Hallertauer Mfr. und Saphir. Hopfen-Rundschau 56 (7), 174-175.

Portner, J., Niedermeier, E., Brummer, A. (2005): N_{min}-Untersuchung 2005. Hopfen-Rundschau 56 (5), 120-121.

Schmidt, R., Biendl, M., Kammhuber, K., Anderegg, P. (2005): Results von Alpha-Untersuchungen in Hopfenpartien der Ernten 2002 bis 2004, Hopfen-Rundschau 56 (8), 201-204.

Schmucker, F., Seigner, E. (2005): Neue Hopfensorten aus Hüll. Brauindustrie 4, 6.

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Seigner, E. (2005): Die Wissenschaftliche Kommission bringt Hopfenexperten aus aller Welt zusammen. Hopfen-Rundschau 56 (11), 276-280.

Seigner, E. (2005): Tagung der Wissenschaftlichen Kommission in South Africa. Hopfen-Rundschau 56 (5), 120.

Seigner, E., Lutz, A., Radic-Miehle, H., Seefelder, S., Felsenstein, F.G. (2005): Breeding for powdery mildew resistance in hop (*Humulus*): Strategies at the Hop Research Center, Huell, Germany. Acta Horticulturae 668: 19-30. http://www.actahort.org/books/668/668_1.htm.

Weihrauch, F. (2005): Evaluation of a damage threshold for two-spotted spider mites, *Tetranychus urticae* Koch (Acari: Tetranychidae), in hop culture. Annals of Applied Biology 146 (4), 501-509.

Weihrauch, F. (2005): Stand der Dinge bei Einsatz und Etablierung von Raubmilben zur Kontrolle von *Tetranychus urticae* in der Sonderkultur Hopfen (Acari: Phytoseiidae, Tetranychidae). Phytomedizin 35 (1), 33-34.

Weihrauch, F. (2005): Überwinterungsraten von Chrysoperla-Arten in „Florfliegenhotels“ im Hopfenanbaugebiet Hallertau (Neuroptera: Chrysopidae). Galathea, Supplement 18, 43-49.

Weihrauch, F. (2005): Versuche zum Management von Florfliegen in der Sonderkultur Hopfen: Stand der Dinge (Neuropterea: Chrysopidae). DgaaE-Nachrichten 19 (3), 149-150.

Weihrauch, F., Moreth, L. (2005): Behavior and population development of *Phorodon humuli* (Schrank) (Homoptera: Aphididae) on two hop cultivars of different susceptibility. Journal of Insect Behavior 18 (5), 693-705

8.2.2 LfL publications

Name	Work group	Lf L publications	Title
Work Section Hops	IPZ 5	Lfl-Information	Annual Report 2005 Special Cultivar Hops
Portner, J.	IPZ 5a	"Green Booklet“	Hops 2005

8.2.3 Press releases

Autor(en), Arbeitsgruppe	Titel
Seigner, E., IPZ 5c	Two ministers visiting the Institute for Crop Science and Plant Breeding

8.2.4 Contributions in radio and television

Name	Date	Subject	Programme title	Station
Engelhard, B., IPZ 5	04.05.05	New hop varieties	News	BR 1
Engelhard, B., IPZ 5	24.08.05	HopResearch in Hüll	Zeitspiegel	BR 3 (TV)

8.3 Meetings, scientific talks, lectures, guided tours, exhibitions

8.3.1 Conferences, symposiums, and seminars

Organised by	Date/Place	Subject	(Circle of) Participants
Münsterer, J. , Niedermeier, E. , IPZ 5a	13.01.05, Wolnzach	Picking techniques	Hop-growers,1 Seminar; 55 participants
Münsterer, J., IPZ 5a	18./19./20.01, 15.02., 3./11./14./15.03. Abensberg, Maynburg, Steinbach, Wolnzach,	Drying and conditioning of hops	Hop-growers,(8 Seminars with 230 participants),
Portner, J., IPZ 5a	01.02.05	Coordinating the advisory notes in the LfL-publication Hops 2005	Colleagues from the Advisory & Research facilities of the hop-growing regions, Wolnzach
Engelhard, B., Seigner, E., IPZ 5	19.-24.02.05, George, South Africa	Scientific Commission of the IHGC	Scientists researching hops from all the hop-growing countries in the world, representatives of the hop and brewing industry
Engelhard, B., Portner, J., IPZ 5	21.-22.06.05	Symposium on Plant Protection	Fed. Authorities, plant protective firms, associations
Portner, J., IPZ 5a	2.-3.08.05	Hop Colloquium	Colleagues from the Advisory & Research facilities in the German hop-growing rgions

8.3.2 Scientific Talks

(AG = Arbeitsgruppe)

AG	Name	Subject/Title	Organiser/ Visitor	Place/Date
IPZ 5	Engelhard, B.	Report on the conference of the Scientific Commission	IHB	Lanzhou /China
IPZ 5	Engelhard, B.	Reasons why the Hallertau became the biggest single hop-growing region	IGN (Interested Group Niederlauterbach)	Wolnzach
IPZ 5a	Portner J.	Optimizing the application technique for spraying apparatus	Lagerland / Employees of the rural trade	Maynburg 27.01.05
IPZ 5a	Portner J.	Optimizing the application technique for spraying apparatus	BayWa / employees of the BayWa	Maynburg 31.01.05
IPZ 5a	Portner J.	Optimizing the application technique for spraying apparatus	IPZ 5 u. LwA LA / Hop-growers	Oberhatzkofen 10.02.05
IPZ 5a	Portner J.	Optimizing the application technique for spraying apparatus	IPZ 5 u. LwA PAF / Hop-growers	Niederlauterbach 10.02.05
IPZ 5a	Portner J.	Optimizing the application technique for spraying apparatus	IPZ 5 u. LwA PAF / Hop-growers	Lindach 11.02.05
IPZ 5a	Portner J.	Optimizing the application technique for spraying apparatus	IPZ 5 u. LwA Abensberg / Hop-growers	Biburg 14.02.05
IPZ 5a	Portner J.	Optimizing the application technique for spraying apparatus	IPZ 5 u. LwA Abensberg / Hop-growers	Maynburg 14.02.05
IPZ 5a	Portner J.	Optimizing the application technique for spraying apparatus	IPZ 5 u. LwA Roth / Hop-growers	Hormersdorf 15.02.05
IPZ 5a	Portner J.	Optimizing the application technique for spraying apparatus	IPZ 5 u. LwA Roth / Hop-growers	Spalt 15.02.05
IPZ 5a	Portner J.	Optimizing the application technique for spraying apparatus	IPZ 5 u. ER Jura / Hop-growers	Lobsing 18.02.05
IPZ 5a	Portner J.	Uncovering and pruning the hops	Hopfenring Hallertau / ISO-certif. Hop-growers	Hüll 24.02.05
IPZ 5a	Portner J.	Developing an EDP-watering model for hops	Society for Hop Research / TWA-meeting	Wolnzach 04.04.05
IPZ 5a	Portner J.	Optimizing the application technique for spraying apparatus	Hopfenring Hallertau / ISO-certif. Hopfenpflanzer	Hüll 12.04.05
IPZ 5a	Portner J.	Optimizing the application technique for spraying apparatus	Hopfenring Hallertau / ISO-certif. Hopfenpflanzer	Hüll 13.04.05
IPZ 5a	Portner J.	Plant protection – Application technique in hops	IPZ 5a / Work discussion	Hüll 11.05.05
IPZ 5a	Portner J.	Latest on plant protection	LfL and Hopfenring / Hop-growers of the Ring groups	Eberstetten 30.06.05
IPZ 5a	Portner J.	Latest on plant protection	LfL and Hopfenring / Hop-growers of the Ring groups	Forchheim 01.07.05
IPZ 5a	Portner J.	Latest on plant protection	LfL and Hopfenring / Hop-growers of the Ring groups	Attenbrunn 05.07.05
IPZ 5a	Portner J.	Latest on plant protection	LfL and Hopfenring / Hop-growers of the Ring groups	Landersdorf 06.07.05

AG	Name	Subject/Title	Organiser/ Visitor	Place/Date
IPZ 5a	Portner J.	Latest on plant protection	LfL and Hopfenring / Hop-growers of the Ring groups	Niederlauter-bach 06.07.05
IPZ 5a	Portner J.	Latest on plant protection	LfL and VLF Abens-berg / Hop-growers	Niederlauter-bach 09.08.05
IPZ 5a	Portner J.	Latest on plant protection	LfL and Ring jyoung hop-growers / hop-growers	Niederlauter-bach 11.08.05
IPZ 5a	Portner J.	Harvest-time trial Hallertauer Mittel-früher; Techn. aids for drying and conditioning of hops	Hopfenring / Hop-growers with HA	Walkertshofen 16.08.05
IPZ 5a	Portner J.	Latest on plant protection	LfL and ALF Moos-burg/ hop-growers	Hüll 18.08.05
IPZ 5a	Portner J.	Expert criticism, hops 2005	Town oa Moosburg und Barley Farmers Assoc./ invited Visitings and farmers	Moosburg 13.09.05
IPZ 5a	Portner J.	Hops 2005 – external quality and fertilized hops	GfH annual talk	Hüll/ 01.12.05
IPZ 5a	Portner J.	Sensor techninology in hop cultivation	IPS and. IPZ / work discussion	Wolnzach/ 08.12.05
IPZ 5a	Portner J.	Annual Review 2005	Hopfenring / Ring consultants	Wolnzach/ 15.12.05
IPZ 5a	Münsterer, J.	Optimum drying and conditioning of hops	IHT / Hop-growers and hop-merchants	Aiglsbach 18.01.05
IPZ 5a	Münsterer, J.	Optimum drying and conditioning of hops	Jura Producer Ring	Marching, 24.02.05
IPZ 5a	Münsterer, J.	Optimizing the application technique for spraying apparatus	IPZ 5 u. LwA Erding/ Moosburg / Hop-growers	Au i.d. Hall. 16.02.05
IPZ 5a	Münsterer, J.	Watering hops	Hop-growers	Niederlauter-bach 17.02.05
IPZ 5a	Münsterer, J.	New experience in conditioning hops	HR Jura / Hop-growers	Marching 24.02.05
IPZ 5a	Münsterer, J.	Evaluation meeting for hop index HSK 2005	Hopfenring / Hop-growers	Niederlauter-bach 03.03.05
IPZ 5a	Münsterer, J.	Evaluation meeting for hop index HSK 2005	Hopfenring / Hop-growers	Mitterstetten 09.03.05
IPZ 5a	Münsterer, J.	Evaluation meeting for hop index HSK 2005	Hopfenring / Hop-growers	Eschelbach 10.03.05
IPZ 5a	Münsterer, J.	Evaluation meeting for hop index HSK 2005	Hopfenring / Hop-growers	Grafendorf 16.03.05
IPZ 5a	Münsterer, J.	Evaluation meeting for hop index HSK 2005	Hopfenring / Hop-growers	Steinbach 17.03.05
IPZ 5a	Münsterer, J.	Evaluation meeting for hop index HSK 2005	Hopfenring / Hop-growers	Lobsing 21.03.05
IPZ 5a	Münsterer, J.	Evaluation meeting for hop index HSK 2005	Hopfenring / Hop-growers	Koppenwall 22.03.05
IPZ 5a	Münsterer, J.	Optimum drying with belt dryers and conditioning	Hop-growers	Elbe-Saale 06.07.05
IPZ 5a	Niedermeier, E.	New test results from the sector of fertilization	Lagerland / Employees of the rural trade	Maynburg 27.01.05

AG	Name	Subject/Title	Organiser/ Visitor	Place/Date
IPZ 5a	Niedermeier, E.	New test results from the sector of fertilization	BayWa / Employees of the BayWa	Maynburg 31.01.05
IPZ 5a	Niedermeier, E.	New test results from the sector of fertilization	IPZ 5 and LwA LA / Hop-growers	Oberhatzkofen, 10.02.05
IPZ 5a	Niedermeier, E.	New test results from the sector of fertilization	IPZ 5 and LwA PAF / Hop-growers	Niederlauter-bach, 10.02.05
IPZ 5a	Niedermeier, E.	New test results from the sector of fertilization	IPZ 5 and LwA PAF / Hop-growers	Lindach 11.02.05
IPZ 5a	Niedermeier, E.	New test results from the sector of fertilization	IPZ 5 and LwA Abens-berg / Hop-growers	Biburg 14.02.05
IPZ 5a	Niedermeier, E.	New test results from the sector of fertilization	IPZ 5 and LwA Abens-berg / Hop-growers	Maynburg 14.02.05
IPZ 5a	Niedermeier, E.	New test results from the sector of fertilization	IPZ 5 and LwA Roth / Hop-growers	Hormersdorf 15.02.05
IPZ 5a	Niedermeier, E.	New test results from the sector of fertilization	IPZ 5 and LwA Roth / Hop-growers	Spalt 15.02.05
IPZ 5a	Niedermeier, E.	New test results from the sector of fertilization	IPZ 5 and ER Jura / Hop-growers	Lobsing 18.02.05
IPZ 5a	Niedermeier, E.	Fertilizing hops latest news based on test results	AK-Business manage-ment in hops, LwA Abensberg	Abensberg 2.03.05
IPZ 5a	Niedermeier, E.	Fertilizing hops latest news based on test results	Ringgruppe Eschelbach	Eschelbach 10.03.05
IPZ 5a	Niedermeier, E.	Hop asparagus: delicatessen rediscov-ered	District Admin. Office Pfaffenhofen and Hotel and Restaurant Assn.	Rohrbach 24.03.05
IPZ 5a	Niedermeier, E.	Plant protection in hops 2005	Hop-growers Wolnzach	Wolnzach 24.05.05
IPZ 5a	Niedermeier, E.	Plant protection in hops 2005	IGN Niederlauterbach	Niederlauter-bach 25.05.05
IPZ 5a	Niedermeier, E.	Plant protection in hops 2005	Hop-growers Oberlauterbach	Oberlauterbach 15.06.05
IPZ 5a	Niedermeier, E.	Plant protection in hops 2005	Ringruppe Eschelbach	Eschelbach 14.07.05
IPZ 5a	Niedermeier, E.	Herbicide trials in hops and latest on plant protection	Hop-growers Wolnzach	Wolnzach 8.08.05
IPZ 5a	Niedermeier, E.	Harvest-time trial Hallert. Mfr.; Techn. aids for drying and conditioning of hops	Hopfenring / Hop-growers with HA	Starzhausen 17.08.05
IPZ 5b	Engelhard, B.	Results of the interim test for eco-hops	Bio-Land	Plankstetten, 26.01.2005
IPZ 5b	Engelhard, B.	Plant protection recommendations 2005	Baywa Landhandel IPZ 5 – LwÄ	Maynburg
IPZ 5b	Engelhard, B.	Cooperation in the licensing of plant protectives	Hop-Growers Assn.	Maynburg
IPZ 5b	Engelhard, B.	Developing and testing a forecasting model for Powdery Mildew in Hops in Bavaria	Scientific Commission, Intern. Hopfenbaubüro (IHB)	George, Süd-afrika, 23.02.05
IPZ 5b	Engelhard, B.	Latest plant protection problems in hops	Bayer CropScience	Langenfeld
IPZ 5b	Huber, R.	Plant protection recommendations 2005 within the hop-growing meetings	LfL	Maynburg, Au, Lobsing (3 Veranst.)
IPZ 5b	Engelhard, B.	Forecasting models in hop-growing	Ringgruppe	Eschelbach

AG	Name	Subject/Title	Organiser/ Visitor	Place/Date
IPZ 5b	Engelhard, B.	Treatment acc. to the "Reductionsprogramme for chemical plant protection" and their realization in German hop cultivation	Assn. of German Hop-Growers	Wolnzach
IPZ 5b	Engelhard, B.	Mildew forecasting model	IHGC (Internat. Hop-Growers Convention)	Lanzhou /China
IPZ 5b	Engelhard, B.	Evaluating the mildew forecast 2005	IPZ 5b	Hüll, 06.12.05
IPZ 5b	Huber, R..	Plant protection recommendations 2005 within the hop-growing meetings	Landhandel	Maynburg
IPZ 5b	Huber, R.	Plant protection recommendations 2005 within the hop-growing meetings	BAYWA	Maynburg
IPZ 5b	Huber, R.	Plant protection 2005	Work Circle	Abensberg
IPZ 5b	Weihrauch, F.	Test results in Organic Hop Cultivation 2004	Bioland e.V.	Plankstetten 26.01.2005
IPZ 5b	Weihrauch, F.	Plant protection in hops with special focus on the two-spotted spider mite	AfL Abensberg	Abensberg 14.03.2004
IPZ 5b	Weihrauch, F.	Trials for the use and promotion of beneficial organisms in hops	GfH, TWA	Wolnzach 04.04.2005
IPZ 5b	Weihrauch, F.	Trials for the management of lacewings in the special crop hops	Work circle "Neuropterology“ of the German Society for General & Applied Entomology	Schloss Schwanberg (Rödelsee) 01.05.2005
IPZ 5c	Seigner, E.	Breeding and development of hop varieties at the Hop Research Center Hüll	Scientific Commission (WK), IHGC	George, South Africa, 21.02.05
IPZ 5c	Seigner, E.	Transfer of a resistance gene into hops	WK, Intern. Hopfenbaubüro (IHGC)	George, South Africa, 21.02.05
IPZ 5c	Seigner, E.	Administrative Meeting of the Scientific Commission, I.H.G.C.	WK, IHGC	George, South Africa, 22.02.05
IPZ 5c	Seigner, E.	Gene transfer Introduction, present situation in Germany	InWent, IPZ	Freising, 22.03.05
IPZ 5c	Seefelder, S.	Mapping of a powdery mildew resistance gene in hops.	Scientific Commission	George, South Africa 23.02.05
IPZ 5c	Seefelder, S.	Impressions of a hop convention in South Africa	End of Year Celebration IPZ	Freising, 21.12.05
IPZ 5c	Seefelder, S.	Practical use of the genome analysis in hops	Society for Hop Research (GfH)	Wolnzach, 04.04.05
IPZ 5c	Seefelder, S.	Genome analysis in hops – a powerful tool for improving an essential raw material in brewing	EBC (European Brewery Convention)-Symposium	Prag, 19.05.05
IPZ 5c	Schürmer, R.	Development of molecular markers linked to powdery mildew resistance genes in hops	EHRC- Europ. Hop Research Council	St. Johann, 07.10.05
IPZ 5c	Schürmer, R.	Development of molecular selection markers to support the breeding of quality hops	Colloquium	Halle, 17.11.05
IPZ 5c	Seigner, E.	Hop Breeding – current research	IPZ 5c, IPZ-L, EHRC (European Hop Research Council)	Freising, 05.04.05
IPZ 5c	Seigner, E.	Hop breeding – present situation	CSU Frauenunion	Freising, 15.04.05

AG	Name	Subject/Title	Organiser/ Visitor	Place/Date
IPZ 5c	Seigner, E.	Wild hops – new resources for breeding mildew resistance	Scientific station for brewing in Munich	Munich, 14.06.2005
IPZ 5c	Miehle, H.	Gene transfer in hops	Scientific station for brewing in Munich	Munich, 14.06.2005
IPZ 5c	Seefelder, S.	Molecular markers to support breeding for mildew resistance	Agrarian Committee of the German Brewers Assn.	Hüll, 25.08.2005
IPZ 5c	Seigner, E.	Research at the Hop Research Center Hüll to meet the demands of the market – today and tomorrow	Drinktec, AITB (Assn. of the ital. brewery technicians)	Munich, 16.09.2005
IPZ 5c	Seigner, E.	Hop breeding in Hüll in the service of the brewing and hop industry	Technical College teachers of the German Brewery and Maltsters Assn.	Hüll, 14.10.05
IPZ 5d	Kammhuber, K.	Determining bitter compounds with NIR based on HPLC calibaration	Society for Hop Research	Wolnzach, 04.04.05
IPZ 5d	Kammhuber, K.	Differentiation of the world hop range and the Hüll-bred varieties acc. to alpha-acids and polyphenols and the influence these components have on the quality of the beer.	Scientific station for brewing in Munich	Munich

8.3.3 Guided Tours

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

AG	Name	Date	Subject/Title	Visiting institution	TZ
IPZ 5	Engelhard, B.		Hop research/hop cultivation	Students of the Metz Polytec.	20
IPZ 5	Engelhard, B.	01.07.05	Overview on hop research	TUM-DLG Tester	35
IPZ 5	Engelhard	04.07.05	Overview on hop research	Uni Augsburg Geography students	40
IPZ 5	Engelhard, B., Seigner, E.	05.07.05	Overview on hop research/hop breeding	Brautechnologie-Studenten, WZW Lehrstuhl Prof. Back	20
IPZ 5	Engelhard, B., Kammhuber, K.	12.07.05	Overview on hop research/hop analytics	NATECO$_2$	20
IPZ 5	Engelhard, B.	01.09.05	Hop research in Hüll	District Council Pfaffenhofen	45
IPZ 5	Engelhard, B., Seigner, E.	14.09.05	Hop research in Hüll	Anheuser-Busch; Top-Management	6
IPZ 5	Engelhard, B.	13.04.05	Overview on hop research	Sch. for Master Brewers Ulm	10
IPZ 5	Engelhard, B.	21.04.05	Overview on hop research	Management Augustinerbräu	1
IPZ 5a	Niedermeier, E.	14.07.05	Present siutation on attacks pests/diseases	Ringgruppe Eschelbach	17
IPZ 5a	Niedermeier, E.	26.07.05	Influence of the cutting time, differentiated variety development, structure of soil, aphid and mildew attacks	Hop-growers from the district of Geisenfeld	53
IPZ 5a	Niedermeier, E.	08.08.05	Newly bred varieties and MCPA trial	Hop-growers Wolnzach	18
IPZ 5a	Niedermeier, E. Münsterer, J. Lutz, A.	11.08.05	Watering trial, newly bred varieties	Ring young hop-growers	100

AG	Name	Date	Subject/Title	Visiting institution	TZ
IPZ 5a	Niedermeier, E.	10.09.05	Hop Research Centre in Hüll, problems	Group of self-marketeers from Sweden	11
IPZ 5a	Niedermeier, E.	28.09.05	Hop Research Centre in Hüll and fertilizing trials in hops	Fa. Kali & Salz	8
IPZ 5a	Portner, J.	16.06.05	Test for chemical hop cleansing; Pflant protection situation in hops	AK Business management hops	15
IPZ 5a	Portner, J.	26.07.05	Cuprous toxity and lack of boron in hops, test for chemical hop cleansing	Hop advisors at the ÄLF	10
IPZ 5a	Portner, J. Münsterer, J. Lutz, A.	09.08.05	Watering trial, newly bred varieties, trial to control weeds in hop-growing	VLF Abensberg	70
IPZ 5a	Portner, J. Lutz, A.	10.08.05	Cuprous toxicity, watering trial, newly bred varieties	VLF Landshut	25
IPZ 5a	Portner, J.	17.08.05	Newly bred varieties, heating with chips with heat exchanger	AK Business management hops	15
IPZ 5a	Portner, J. Lutz, A.	18.08.05	Watering trial, newly bred varieties, trial to control weeds in hop-growing	VLF Moosburg	30
IPZ 5a	Portner, J.	25.08.05	Presentation of various hop varieties and yards	TWA, German Brewers Assn.	20
IPZ 5a	Portner, J. Niedermeier, E.	30.08.05	Hop tour (BusbegProject Manager)	State Minister and invited guests	150
IPZ 5b	Engelhard, B.	04.08.05	Current plant protection trials	BAYER AG	6
IPZ 5b	Engelhard, B.	30.08.05	Hop tour	Lkrs. Kelheim	120
IPZ 5b	Engelhard, B.	07.09.05	Plant protection techniques	DLG Committee Experiments	15
IPZ 5	Engelhard, B., Weihrauch, F., Huber, R.	22.04.05	Current plant protectives in hop-growing	Participants PS Symposium	38
IPZ 5b	Huber, R.		Tour of the Hop Research Centre	FA Geisenheim	3
IPZ 5b	Huber, R.		Hops in general	Traunstein High School	25
IPZ 5b	Huber, R.		Spraying tower trials	Jura farmers	35
IPZ 5b	Huber, R.		Spraying tower trials and outdoors	Syngenta	20
IPZ 5b	Huber, R.		Tour of Reserach Centre and outdoors	Stähler	3
IPZ 5b	Huber, R.		Tours of the trials	BAYER, DOW	22
IPZ 5c	Seigner, E.	27.01.05	Current breeding research in hops	Anheuser-Busch	5
IPZ 5c	Miehle, H.	22.03.05	Gene transfer in hops, potatoes and barley	InWent	35
IPZ 5c	Seigner, E.	01.04.05	Bio-technology at the IPZ	StMLF, Minister Miller, Hungarian delegation from the Agrar Ministry	7
IPZ 5c	Miehle, H.	15.04.05	Gene transfer in hops	CSU-Womens Assn.	8
IPZ 5c	Seigner, E.	15.04.05	Hop breeding	CSU-Womens Assn.	8
IPZ 5c	Schürmer, R.	30.06.05	Tour in the culture house and cell yard	BUGA, Munich	60
IPZ 5c	Lutz, A.	22.06.05	Hop Research Centre in Hüll	Seniors of the Bavarian State Institute for Agriculture	50

AG	Name	Date	Subject/Title	Visiting institution	TZ
IPZ 5c	Engelhard, B. Lutz, A.	23.06.05	Hop breeding	AK Agrarjournalisten	12
IPZ 5c	Seigner, E., Lutz, A.	05.07.05	Breeding research in hops	Students of the WZW, Brewing Faculty	15
IPZ 5c	Lutz, A.	13.07.05	Hop Breeding at Hüll	Managers at Anheuser-Busch	3
IPZ 5c	Seigner, E.	13.07.05	Hop Breeding at Hüll	Electrotechnology Club, Seniors	45
IPZ 5c	Lutz, A.	16.07.05	Work at the Hop Research Centre in Hüll	Geography teachers from Ingolstadt	26
IPZ 5c	Lutz, A.	19.07.05	Newly bred varieties	Jura hop supporters	50
IPZ 5c	Lutz, A.	27.07.05	Breeding research in hops, Presentation of `Herkules`	Ringgruppe Abens	15
IPZ 5c	Seigner, E.	27.07.05	Hop Breeding at Hüll	Institute for Plasma Physics, MPG, Garching	20
IPZ 5c	Seigner, E.	28.07.05	Hop Breeding at Hüll	Syngenta Agro	15
IPZ 5c	Seigner, E.	29.07.05	Hop Breeding at Hüll	Uni.Halle, Prof. Weber mit Students of the Agrar Faculty	8
IPZ 5c	Lutz, A.	01.08.05	Hop Breeding at Hüll	Anheuser-Busch	2
IPZ 5c	Seigner, E.	01.08.05	Hop Research	Anheuser-Busch	2
IPZ 5c	Lutz, A.	03.08.05	Hop research at Hüll	Regulars from Hop Museum Wolnzach	15
IPZ 5c	Lutz, A.	04.08.05	Work at the Hop Research Centre in Hüll	Aix-la-Chapelle Society for garden culture	50
IPZ 5c	Engelhard, B., Lutz, A.	05.08.05	Current breeding lines	Committee HVH	12
IPZ 5c	Lutz, A.	05.08.05	Breeding research in hops	Committee Hop-Growers Assn.	
IPZ 5c	Lutz, A.	09.08.05	Breeding research in hops	Society of Agricultural College Graduates (VLF) Abensberg	
IPZ 5c	Lutz, A.	10.08.05	Breeding research in hops	VLF Landshut	
IPZ 5c	Lutz, A.	10.08.05	Breeding research in hops	Interest Group Niederlauterbach and Hop Regulars Oberlauterbach	
IPZ 5c	Lutz, A.	11.08.05	Breeding research in hops	Hallertau Hop-Growers Ring	
IPZ 5c	Miehle, H.	11.08.05	Gene transfer in hops	Trade School Straubing	2
IPZ 5c	Engelhard, B., Lutz, A.	17.08.05	Current breeding lines	HVG Supervisory Board	14
IPZ 5c	Lutz, A.	17.08.05	Breeding research in hops	Board of the Hop-Processing Cooperative	30
IPZ 5c	Lutz, A.	18.08.05	Breeding research in hops	Tour District Council Freising	
IPZ 5c	Seefelder, S.	25.09.05	Tours through the plant cell and House of Culture at the BUGA	Science days at the BUGA	
IPZ 5c	Seigner, E.	23.08.05	Hop research at Hüll	Seniors from Degussa, Marl	35
IPZ 5c	Seigner, E.	23.08.05	Hop research at Hüll	Hopsteiner and representatives of the Bavaria Brewery, Holland	5
IPZ 5c	Seigner, E.	14.09.05	Hop Research at Hüll	Hopsteiner, InBev	3
IPZ 5c	Seigner, E.	14.09.05	Hop Research at Hüll	Anheuser-Busch	5
IPZ 5c	Seigner, E.	14.10.05	Hop research at Hüll	Trade school teachers in the German Brewery and Malters Assn.	25

AG	Name	Date	Subject/Title	Visiting institution	TZ
IPZ 5c	Seigner, E.	18.10.05	Hop Breeding and Research at Hüll	Kirin, Japan, Dr. Pichlmaier, HVG	7
IPZ 5c	Seigner, E.	24.10.05	Hop Research at Hüll, Flavonoides	Interbrew, Belgiun	3
IPZ 5d	Kammhuber, K.	22.06.05	Analytics of the hop components	Pensioners from the hop industry	40
IPZ 5d	Kammhuber, K.	03.08.05	Overview Hüll	Hop-growers from England	3
IPZ 5d	Kammhuber, K.	23.08.05	Hop analytics	Hopsteiner	5
IPZ 5d	Kammhuber, K.	14.09.05	Hop analytics	Anheuser Busch	3
IPZ 5d	Kammhuber, K.	14.09.05	Hop analytics	Hopsteiner	3
IPZ 5d	Kammhuber, K.	10.10.05	Hop analytics	Prof. Heilmann UNI Regensburg	5
IPZ 5d	Kammhuber, K.	14.10.05	Hop analytics	Beer brewers from Doemens	20
IPZ 5d	Kammhuber, K.	18.10.05	Hop analytics	Brewers from Kirin	7
IPZ 5d	Kammhuber, K.	26.10.05	Hop analytics	Brewers from Interbrew	2

8.3.4 Exhibitions and posters

(AG =Work Group)

Name of exhibition	Exhibits/ Projects or subjects/posters	Organiser	Duration	AG
BUGA 05	Arranging the Culture House; - improved quality and resistance to disease with bio-technology	StMLF, vdBiol (Assn. of German Biologists), etc.	28.04. – 09.10.05	IPZ, IPZ 5c
BUGA 05	"Hallertauer Hops and Bavarian Beer" in the pavillon of the Bavarian State Government	STMLF, etc.	29.08.- 12.09.05	IPZ 5

8.4 Education and further training

Name, Work group	Subject	Participants
Niedermeier E., IPZ 5a	Organisation and tasks of the LfL, Work Section Hops	Scholars from BS Pfaffenhofen
Portner J., IPZ 5a	Low trellis systems, spraying techniques in hop-growing	Students from the LS Pfaffenhofen
Portner J., IPZ 5a	Drying and conditioning of hops	Students from the LS Pfaffenhofen
Portner J., IPZ 5a	Present situation in hop cultivation	Ring consultants (7 dates)
Portner J., IPZ 5a	Hop varieties	Students from the LS Pfaffenhofen (12 hop-farmers)
Portner J., IPZ 5a	Cultivation and varieties	BiLa course at the ALF Abensberg (32 hop-framers)
Portner J., IPZ 5a	Fertilization in hop-growing	BiLa course at the ALF Abensberg (32 hop-farmers)
Portner J., IPZ 5a	Plant protection in hop-growing	BiLa course at the ALF Abensberg (32 hop-farmers)
Portner J., IPZ 5a	Crop, quality, processing, marketing and profitability of hops	BiLa course at the ALF Abensberg (32 hop-farmers)
Seigner, E., IPZ 5c	Hop research	Trainee from Russia

8.5 Diploma theses and dissertations

8.5.1 Diploma theses

AG	Graduand/ Tutors at the LfL	Subject/Title Diploma thesis	Duration	Cooperation with
IPZ 5a	Seidl, Florian/ H. Portner	Research to optimize the application techniques in spraying apparatus for hops	May 2005-April 06	TUM Weihenstephan Prof. Auernhammer
IPZ 5c	Kindsmüller Georg/ A. Lutz	Optimizing a bio-test for the susceptibility to hop aphids for hop varieties and breeding lines	March-Aug. 05	FH Weihenstephan Prof. Ebertseder
IPZ 5d	Ottl, Christine/ K. Kammhuber	Research on the bio-synthesis of the hop bitter compounds	May – Oct. 05	Prof. König, Uni Regensburg

8.5.2 Dissertation

AG	Name/ Tutors at the LfL	Subject/Title Dissertation	Zeitraum	Cooperation with
IPZ 5c	Schürmer, R./ Seefelder, S.	Molecular markers for powdery mildew resistance in hops (*Humulus lupulus*)	2004-2007	Prof. Weber, Universität Halle

8.6 Participation in work groups

Name	Memberships
Engelhard, B.	• Chairman of the Scientific Commission in the 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 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"

The following staff were employed at the Landesanstalt für Landwirtschaft - Institute for Crop Science and Plant Breeding – at Hüll / Wolnzach in 2005:

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Haugg Brigitte	as from 18.08.05
Hartberger Petra	
Kneidl Jutta	
Köster Petra	up to 31.05.05
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IPZ 5d

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