

DEVELOPMENT AND TESTING OF A FORECASTING MODEL FOR POWDERY MILDEW IN BAVARIAN HOPS



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DEVELOPMENT AND TESTING OF A FORECASTING MODEL FOR POWDERY MILDEW (PODOSPHAERA MACULARIS) IN BAVARIAN HOPS

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Abstract

With the introduction of cultivars susceptible to Hop Powdery Mildew (HPM) in the Hallertau, this disease became gradually unpredictable in the growing region. As hitherto no prediction on the epidemiology of HPM was possible, there was no alternative to preventive fungicide applications even if the risks of infection were low. Infestation and damage by HPM are very variable from year to year, most likely due to varying weather conditions.

We compared weather parameters in varying sequences with the actual situation of HPM infection in the years 1997 to 2004, and empirically deduced a preliminary forecasting model for HPM in Bavarian hop growing regions.

Introduction

Infection and economic damage of Hallertau hops by Hop Powdery Mildew *Sphaerotheca humuli* (De Candolle) Burrill (HPM) are varying from year to year clearly recognizable (Figs 1 and 2).

Fig. 1.

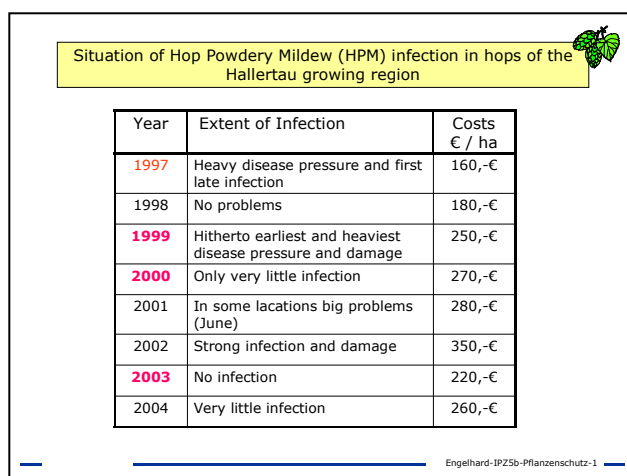
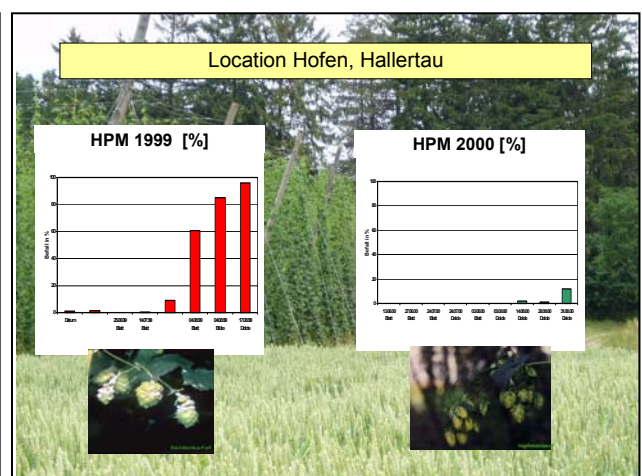


Fig. 2



In the years 2000, 2003 and 2004 an enormous amount of fungicides was applied, although many sprayings would not have been necessary from a later point of view. The differences between 1999 and 2000 were especially grave: Although in a trial in 1999 all HPM-infested

hop plants had been chopped and left in the field, in 2000 the plants of the same field showed no infection at all. This was the starting point for the consideration that the key for a control strategy had to be searched in the differing weather parameters of those two years.

Material and methods

Under consideration of different data on the epidemiology, weather parameters of the months from April to July of the years 1999 and 2000 were layered according to a great variety of distinctive marks, and compared with data on HPM infection recorded in the trials.

Fig. 3:

Preconditions for the time of possible HPM infection	
According to the preliminary forecasting model to control HPM	
Temperature	
05.01 - 20.00 hrs	$\varnothing > 10\text{ }^{\circ}\text{C}$
20.01 - 05.00 hrs	$\varnothing > 10\text{ }^{\circ}\text{C}$
Intensity of sunshine in Watt-hours (Wh)	
05.01 - 20.00 hrs	$\Sigma < 4.000\text{ Wh/m}^2$
Rainfall	
05.01 - 20.00 hrs	$\Sigma > 1\text{ mm}$ or > 5 mm the night before
20.01 - 05.00 hrs	$\Sigma > 0,1\text{ mm}$ or > 1 mm the day before
„Call for spraying“ after five consecutive day-periods	

Fig. 4:

Detailed weather data in periods with probable high infection with Hop Powdery Mildew						
Date	Time	$^{\circ}\text{C}$ (min-max)	mm	Wh/m ²	Wind m/sec	
20.05.99	09 ⁰⁰ - 20 ⁰⁰	15.8	13.0 – 18.6	1.4 (3 hrs)	2260.9 (max 620)	0.1-0.5 (10 hrs)
	21 ⁰⁰ - 08 ⁰⁰	12.0	10.9 – 12.4	2.6 (12 hrs)		0.4-1.7 (12 hrs)
21.05.99	09 ⁰⁰ - 20 ⁰⁰	12.8	12.1 – 13.2	17.5 (10 hrs)	247 (max 45)	0.7-2.4 (12 hrs)
	21 ⁰⁰ - 08 ⁰⁰	11.5	11.4 – 12.7	23.6 (5 hrs)		0.5-0.8 (7 hrs)
22.05.99	09 ⁰⁰ - 20 ⁰⁰	12.5	11.7 – 13.3	1.5 (6 hrs)	943.0 (max 157)	0.1-0.8 (8 hrs)
	21 ⁰⁰ - 08 ⁰⁰	11.5	9.3 – 11.7	7.2 (6 hrs)		0.1-0.4 (6 hrs)

Humidity: at night 99%; at day 90 – 99%, on May 20 until 14.00 hrs < 80%

After numerous attempts with varying handicaps, the values shown in Figure 3 were determined, which are in good accordance with the HPM infection level in the Hallertau. The following handicaps were essential for the determination of those intermediate stages:

- Differentiation between average values during daytime and night;
- Consideration of the intensity of sunshine.

As a comparison to the analysis of meteorological handicaps (Fig. 3), the assessed infection levels in official trials for pesticide registrations and the overall infestation of cones in the “Neutral Quality Assessment” procedure was used.

The detailed analysis of weather data in periods with probable infection of hops by HPM resulted regularly in values as shown in Figure 4.

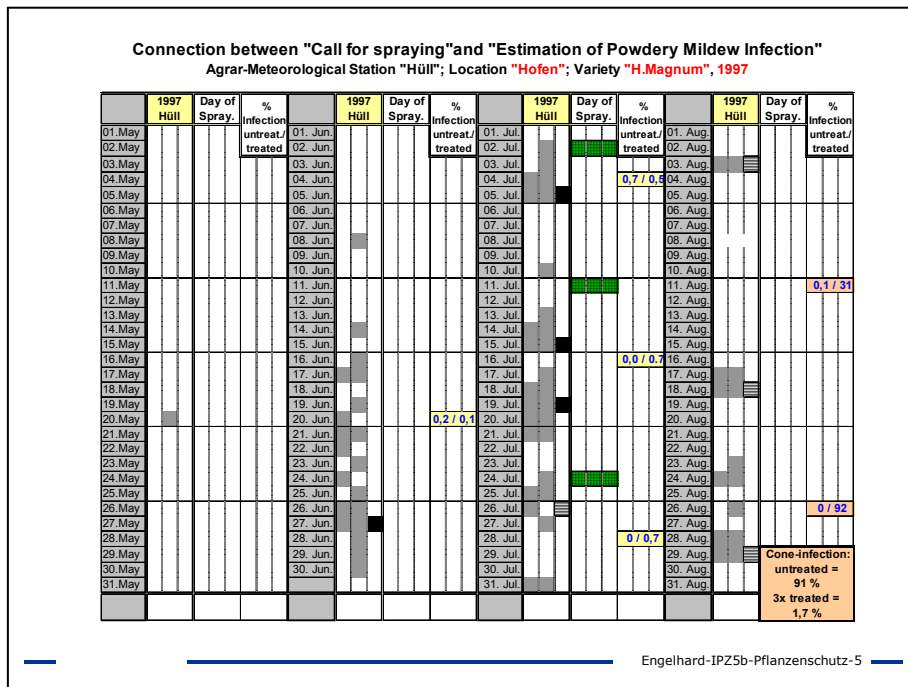
As a basis for the analyses serve weather stations, which are able to put hourly average values for various parameters at one’s disposal. Within Bavaria, a network of 123 according weather stations exists. Seven of those weather stations can be used for the model in the hop growing region.

Results

With the beginning of the examination of the model in 2004, a “call for spraying” was sent out as soon as the assumed weather conditions for HPM infection had been met at two consequent days. Under consideration of modified handicaps regarding intensity of sunshine and rainfall by night after the 2004 field season, a “call for spraying” in future will be sent out as soon as: assumed conditions for HPM infection are met at five consequent day periods.

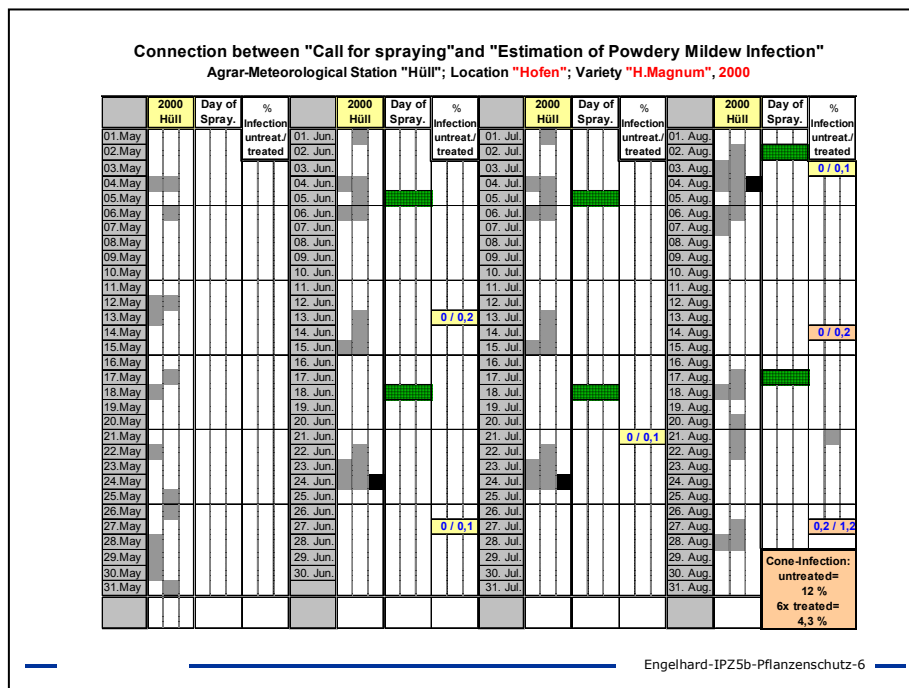
Comparisons of the model were made at different locations in the years 1997 – 2004. Three especially extreme examples are presented:

Fig. 5:



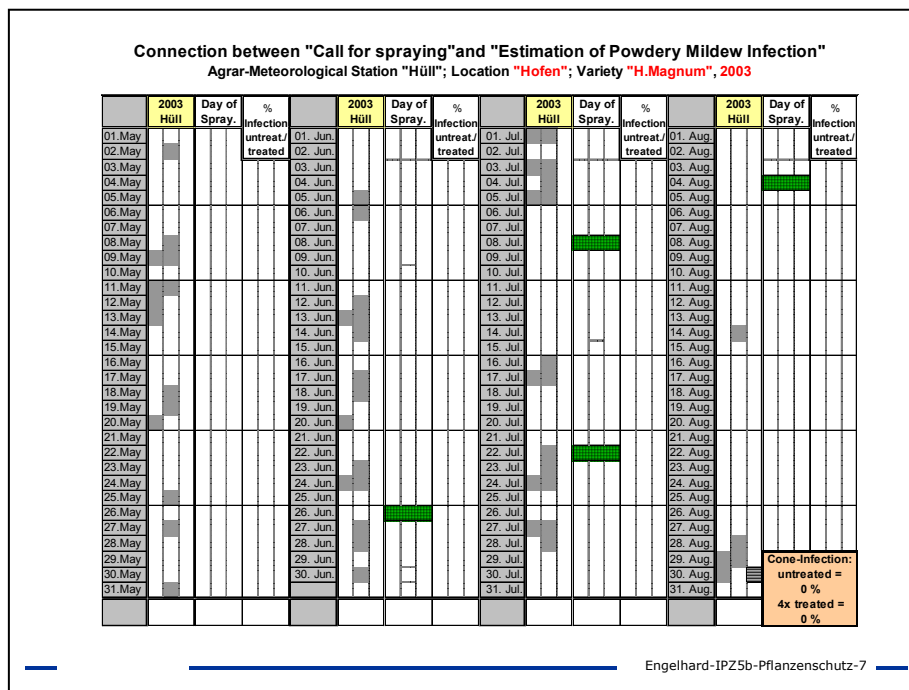
Despite heavy disease pressure, hops were kept uninfested with only three fungicide applications. The timings of "calls for spraying" were shortly before the applications (purely by chance)!

Fig. 6:



Despite little infection at harvest time (12 % cone infection in untreated plots), six fungicide applications did not lead to a substantial success in controlling HPM. The sprayings were in all cases timed in a way that they had been carried out clearly outside the periods calculated as infection periods by the preliminary forecasting model.

Fig. 7:



In the year 2003, untreated experimental plots showed no HPM infection at all. Four fungicide applications that had been carried out would not have been necessary. The preliminary forecasting model did not trigger any "call for spraying".

Discussion

The empirically determined weather conditions as handicaps for a forecasting model for HPM are in the years from 1997 to 2004 in good accordance with the numbers of "calls for spraying" and the actual HPM infection situation in the field. The analyses from different weather stations indicate that the preliminary model can also be used on a large scale, e.g., for the entire Hallertau growing region.

The preliminary forecasting model is pending further evaluation in additional tests in the field. Especially the period of time that may lie between a "call for spraying" and the actual fungicide application needs further checking. Additionally, in experimental plots it has to be examined what group of pesticides can be used at certain periods of time.

Acknowledgements

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