

# **New Results from scab-experiments (treatments on fallen leaves and summer-applications)**

Neue Ergebnisse aus den Schorfversuchen  
(Behandlungen des Falllaubs und Sommerspritzungen)

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## **Abstract**

In the leaf-decomposition-trials to reduce the ascospore potential of *Venturia inaequalis* (2003/2004 and 2004/2005) different agents were tested with regard to direct effects on scab and to increasing the attractivity of the leaves for earthworms. TSB (lab medium with soya extracts) had a heavy direct effect on ascospore potential, but in this formulation it cannot be used in organic fruit-growing. Humofix and Bactofil B didn't reduce the potential as strongly as in the trial 2002/2003. A yeast extract and a combination of bean extract with powdered milk increased the attractivity for earthworms. In the trial 2004/2005 the reduction of the ascospore potential was at best to 60 % of the control (powdered milk+Humofix), respecting the loss by earthworms yeast extract+malt showed positive effects. In the experiment about applications against scab in summer 2004 the fluid formulation Sommerschwefel was comparable with wetting sulphur, during the storage season Frutogard and Agromil+BioPluss retarded best the development of late scab lesions on the apples. Why Agromil+BioPluss caused an increasing of superficial scald in April 2005, cannot be explained at the moment.

**Keywords:** apple, organic fruit-growing, apple scab, fallen leaves, storage diseases

## **Introduction**

*Venturia inaequalis* is still an important disease in organic fruit-growing and all measurements to reduce the infection potential should be used. Basing on the results from the years before (Kollar, Pfeiffer 2003; Häfner 2003) further trials were designed round decomposition of scabbed leaves during overwintering on the soil and applications in summer. In summer wetting sulphur and lime sulphur can be sprayed against scab, but both plant protecting agents can cause sunburst on the fruits, if the weather conditions are unfavourable. When preparations are tested in summer, side effects on storage diseases are possible and should be remarked.

## **Material and Methods**

In both experiments (**Experiment 1: Nov. 2003 - May 2004; Experiment 2: Nov. 2004 - May 2005**) about reducing the ascospore-potential during the development of the apple scab on fallen leaves the same methods were used. Every leaf depot started with 170 g heavily scabbed leaves collected from not against scab treated trees of the variety 'Jonagold'. In the first trial, which had more the character of a screening and testing of concentration (see table 1), only one depot per treatment was used. The leaves were deposited directly on soil in the organically cultivated orchard Katzental of the LVWO Weinsberg. Depending from the variant the leaves were sprayed monthly from November to April. In experiment 2 each variant was replicated with three depots, which were deposited on the new organically cultivated area on the research station Heuchlingen of the LVWO Weinsberg. These leaves were sprayed four times from December 2004 to April 2005 (not in February because the leaves were snow-capped).

The ascospore-potential was determined according to Kollar (2000) in spring 2004 on 11 days, in spring 2005 on 8 days during the primary infection season, if possible, the samples were taken out

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close before days with rain. In both years the remaining leaves at the end of the experiment were weighed, the difference to the beginning is the result of natural decomposition by earthworms and removing of samples.

**Table 1:** Enzymes, media and plant preparations in the leaf decomposition trials 2003/2004 in Weinsberg and 2004/2005 in Heuchlingen

Treatments 2003/2004 Weinsberg		Treatments 2004/2005 Heuchlingen	
	untreated	Control	untreated
Humofix 0,01 %	6 x + 3 x Autumn +3 x spring	Yeast extract*, 3%	4 x
Humofix 0,001 %	6 x	Yeast + powdered milk, 3 % + 1 %	4 x
Bactofil B 2 % 0,2 %	6 x	Yeast + malt, 3 % + 3 %	4 x
Malt extract 3 %	6 x	Powdered milk, 1 %	4 x
TSB 9 %, 0,9 %	6 x	Powdered milk + Humofix, 1 % + 0,01 %	4 x
Yeast extract 3 %, 0,3 %	6 x	Lime, 350 kg/ha, 95 % CaCO <sub>3</sub>	1 x
Saccharose 6 %	6 x	Extract from Flores Tiliae, 10 %	4 x
Rohament PL 1 %	6 x		
Rohament PL + TSB	6 x		
Apple juice 100 %, 10 %	6 x		
Extract from beans 50 %, 5 %	6 x		
Extract from beans + powdered milk	6 x		
Contans 2 %	1 x, two times replicated		
Yeasty beer 10 %	3 x		
Extract from Flores Tiliae 10 %	3 x	* Product from Bioreal-Yeast, suitable for organic bakeries	

The variants in experiment 2 had the aim to combine promising extracts from the years before, which either had an influence on the cumulated ascospore potential or which seemed to be more attractive for earthworms.

Apart from the leaf decomposition trials in **experiment 3** different applications were tested in summer 2004, if there were alternatives to sulphur, that can cause sunburn on the skin of apples at high temperatures or high intensity of sun-light. The trees of the varieties 'Delbarestivale' and 'Pinova' were planted in January 2000 in mixed rows (in each row 18 trees of both varieties, 'Pinova' was planted with 1,00 m within the row, 'Delbarestivale' with 1,20 m). The plant protecting agents were sprayed with a Joco-tunnel-sprayer, according to 500 l/ha (2 m wall of leaves). During the primary infection season all trees (also the later control) were treated like one variant of another scab-trial. Before blossom only 400 g Copper/ha were used (without stop-spraying with lime sulphur), during blossom and up to middle of June combinations from protective sulphur-applications and additional lime-sulphur-spraying for stopping current infections followed.

During spring 2004 severe infections happened, especially between May 5<sup>th</sup> and May 10<sup>th</sup> (95 h leaf-wetness with interruptions shorter than 8 hours), at this date the first infections on leaves from the earlier ascospore-infections came out, too. So partly infections of the calyx-leaves or of young fruits were set early, still before the start of experiment 3. The details in table 2 about the quantities of plant protecting agents refer to 2 m wall of leaves. Greemax and BioPluss had been the best ad-

ditives in earlier trials with seedlings (Kollar, Pfeiffer 2003) for improving the rain stability of Agromil (extract from *Citrus* sp.).

**Table 2:** Summer applications 2004 against apple scab at the varieties 'Delbarestivale' and 'Pinova'

Variant	Abbreviation	Plant protecting agent/ha*
Control	Con	Untreated since June 15 <sup>th</sup>
Wetting sulphur	NS	2-3 kg/ha, depending from weather**
Sommerschwefel (fluid)	SoS	2-3 l/ha, analogous to wetting sulphur
Agromil+Greemax	AGR	1,25 kg/ha AG + 50 ml GR
Agromil+BioPluss	ABP	1,25 kg/ha AG + 4 l BP
Frutogard	Frut	5 l/ha

\*Data of applications: 18.06., 22.06., 02.07., 03.07., 08.07., 10.07., 19.07., 10.09. (\*\*normally 2 kg NS/ha, underlined data 3 kg NS/ha).

The following evaluations were done in this experiment: On June 14<sup>th</sup> and on July 22<sup>nd</sup> 2004 the scab infections on leaves of long branches were divided in 4 classes (S0 = without lesions, S1 = 1-2 small lesions, S2 = middle infection, S3 = severe infection). 24 branches were determined for each variant. Scab on the fruits was evaluated directly after harvest in a similar way, at 'Delbarestivale' about 700-800 fruits per variant and at 'Pinova' about 450 fruits per variant. For the russetting of the fruits 4 classes were formed: B1 = without russetting, B2 = < 10 %, B3 = 10-30 %, B4 = > 30 % russeted skin. Apples of the class B3 can still be sold in organic fruit growing. At 'Pinova' during the storage season the development of scab on the fruits and the appearance of Lenticel rot and *Gloeosporium* sp. were remarked in January and April 2005.

## Results from experiments 1 and 2

Summarizing both trials the results were not as obvious as in the diploma-thesis of Häfner (2003). Sometimes in 2004/5 single data of ascospore potential deviated strongly from the other samples without any visible reason. From the screening-experiment 2003/2004 (**Exp. 1**) three groups could be formed (no/small effect, middle effect, high reduction of ascospore-potential), the results are summarized in that way in table 3:

**Table 3:** Cumulated ascospore-potential spring 2004 (calendar-weeks 12-26, control = 100%)

% of control	Preparations (see table 1)
> 60 %	Hum 6x, Hum H, Malt, Ap 0,1, Extr. beans 1,0 + 0,1
40-60 %	Hum F, Hum 0,1, Bact 1,0 + 0,1, TSB 0,1, YE 0,1, Sac, Roh., Ap 1,0, Contans, Fl.Til.
< 40 %	TSB, YE*, Extr. beans + pow. milk*

\* reduction caused by early loss through earthworms, at the last sample-dates no leaves left

Humofix and Bactofil B did not reduce the ascospore potential as clear as the year before, the weather-conditions during the primary ascospore-season were characterized by more rain in spring 2004. But more informations about the attractivity of the sprayed leaves for earthworms could be found: Leaves, on which yeast extract or a combination from bean-extract+powdered milk had been applicated, were drawn earlier into the soil than leaves from untreated control. TSB destroyed the structure of the leaves and reduced the ascospore potential only in the high concentration, which is too expensive for use in orchard.

In **experiment 2** different combinations of yeast extract with other substances were compared with an extract from Flores Tiliae and with a single scattering of lime on the leaves. On April 14<sup>th</sup> and April 18<sup>th</sup> 2005 the highest titers of ascospores were determined, at the other days the titers were lower than 1000 Ascospores/ml. Yeast-extract+malt and lime reduced the cumulated ascospore potential only to 73 % of the control. Yeast extract+powdered milk and powdered milk alone showed no effects. Powdered milk+Humofix and extract from Flores Tiliae had the best reduction, but only to about 60 % of the control.

The humidity of the soil during spring 2005 was high enough to estimate the attractivity of the treated leaves for the earthworms. In the cumulation of the ascospore potential the loss of leaves is only respected in that kind, that at such days, when no leaves were left for taking out samples for determination, no ascospores could be cumulated. At stage ‚green-bud‘ of the apple trees the second time was estimated visually, which percentage of the soil was still covered with leaves in each depot. In table 4 the ascospore titer was „corrected“ by the factor of covering at beginning of April.

**Table 4:** % covering of soil , „corrected“ titers of ascospores on April 14<sup>th</sup> and April 18<sup>th</sup> 2005

Variant	Con	YE	YE+MP	YE+Malt	MP	MP+Hum	Lime	Fl. Tiliae
% covered 04.04.	38	33	35	28	45	35	30	35
Asc. 14.04. corr.	341	850	704	847	513	294	223	458
Asc. 18.04. corr.	1399	638	922	283	1151	803	754	148

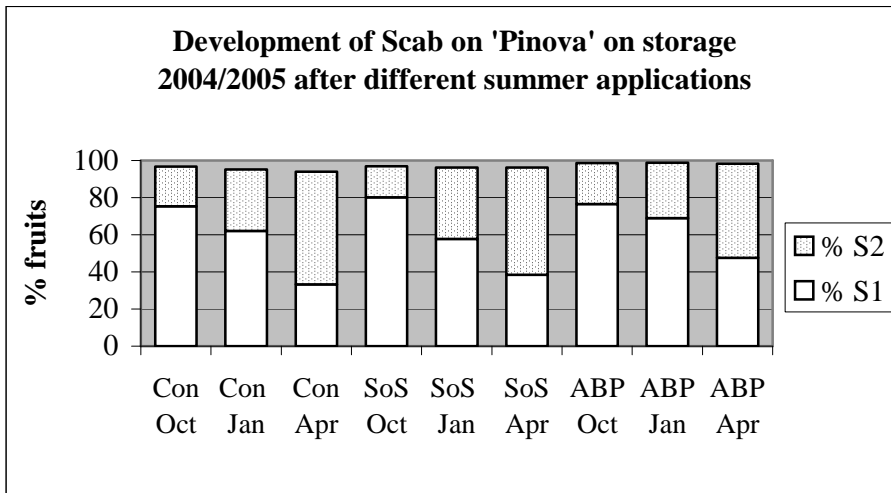
This calculation had a more hypothetical character, for exact data the leaves had to be removed, dried and the weight determined, but this procedure would influence the development of the scab by changes in temperature and humidity. Considering the percentage of covering yeast extract+malt and extract from Flores Tiliae were the best variants at these two high-discharge-dates. The factor „loss of leaves by earthworms“ has a high effect on the total ascospore-potential in an orchard and should not be underestimated.

### Results from experiment 3 (summer applications)

The variety ‚Delbarestivale‘, had at the beginning of the trial about 80-90 % leaves at the long branches in class S0, about 11 % with some small lesions and 2-5 % in class S2. ‚Pinova‘ is less susceptible for scab (it grows calmer and has less leaves on the long branches), here 95 % leaves were without infection and about 3-6 % in class S1, only sometimes a leaf fell into class S2. Five weeks later (July 22<sup>nd</sup>) there could be seen some small differences at the infections of the leaves, Sommerschwefel and Frutogard had a few leaves, that were less infected than control or wettable sulphur.

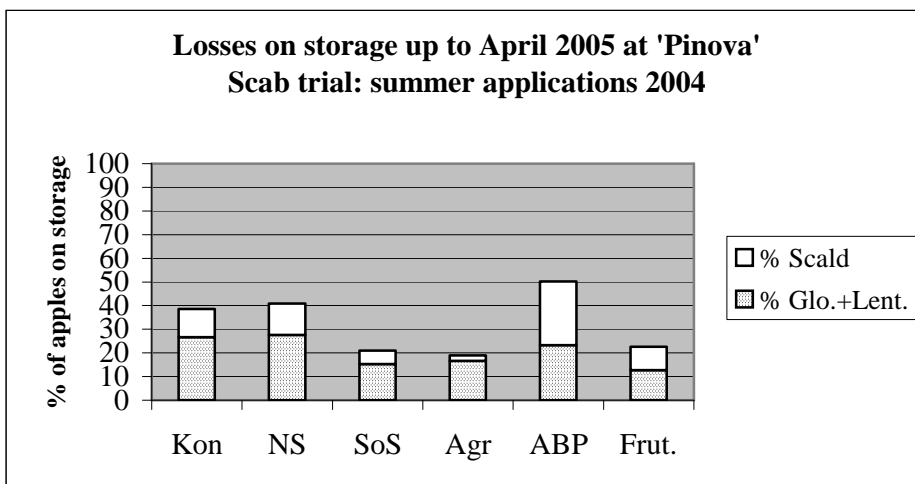
In August at the variety ‚Delbarestivale‘ in the control were only 10,6 % of the fruits without scab, at the best variants (Agromil+BioPluss and Frutogard) about 45 %, the most infections of S3+S4 happened still in spring before the start of the experiment. Sommerschwefel had less apples in classes S3 and S4 than wetting sulphur.

In October at ‚Pinova‘ 75 % of the fruits were without scab (S1) in the control, 21 % in the class S2, the proportion of S1 dropped down to 62 % in January and to 33 % in April 2005 (see picture 1). The increasing of fruit-lesions during storage was delayed by wetting sulphur (64 % S1 in Jan., 43 % S1 in Apr.), and especially by Agromil+BioPluss (69 % S1 in Jan., 48 % S1 in Apr.) and Frutogard (72 % S1 in Jan., 66 % S1 in Apr.). The development of control, Sommerschwefel and Agromil+BioPluss can be compared in picture 1.



**Figure 1:** Development of the percentage of fruits without scab (S1) and with a few small lesions (S2) during storage (October 2004 to April 2005) of 'Pinova' at the variants control, Sommerschwefel and Agromil+BioPluss.

*Gloeosporium sp.* and other storage diseases appeared with different percentages during the storage season, superficial scald was recorded still at the last evaluation in April 2005, mostly at the combination Agromil+BioPluss. In picture 2 losses by *Gloeosporium* and lenticel-rot are summarized in the lower part of the column, other storage-diseases were watched seldom. Sommerschwefel, the fluid formulation of sulphur, and Agromil+Greemax seemed to reduce the infections by *Gloeosporium sp.* and lenticel-rot.



**Figure 2:** Losses during storage-season (sum from October 2004 to April 2005) at 'Pinova' by *Gloeosporium sp.* + Lenticel rot and by scald.

## Discussion and Prospect

Agents for treatments on fallen leaves in organic fruit-growing, which reduce the ascospore potential reliably, are not easy to found. TSB reduces the ascospore potential, but it is a medium from lab with different components, to replace them with completely organic additives is difficult. Therefore

the increasing of the attractivity of the leaves for earthworms by substances like yeast extract, organic milk-powder or malt seems to be easier and can be a good completion to mechanical removing of the leaves in spring with leaf-vacuum cleaners.

In experiment 3 some of the best variants from the trials within a project, which was financed 2002 and 2003 by the Bundesprogramm Ökologischer Landbau, should be proofed in orchard, in comparison to wetting and fluid sulphur formulations. Sommerschwefel seems to be equal to wetting sulphur, but the appearance of sun-burst on the apples was seldom in the year 2004. The citrus-extract Agromil has an effect against scab, this had been tested in labour again in 2005, but the problem of rain-stability could not be solved up to now. The combination with BioPluss has some advantages, but BioPluss itself reduces scab, too, and has a high rain-stability. BioPluss can be used probably more in the summer months with high amounts of rain-fall, but not too close to harvest, because there had been residues on the apples. Therefore in 2005 a similar trial about summer-applications followed at ‚Pinova‘. The development of scab and the appearance of *Gloeosporium* on storage will be evaluated again in January and March/April 2005 to proof the results from 2004.

### Literature Cited

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