Monitoring of pear rust (*Gymnosporangium sabinae*) in Austria and implications for possible control strategies

M. Filipp[1], A. Spornberger[1] and B. Schildberger[2]

Abstract

In recent years pear rust (Gymnosporangium sabinae*) caused serious damages in organically managed pear orchards, on different sites in Eastern Austria, especially in the surroundings of St. Pölten. Therefore the appearance and development of the fungus was monitored over three years 2009-2011 in this area. The infection period and phase of spore discharge were estimated with a spore trap and with observations of symptoms on potted pear seedlings. The results of this monitoring campaign showed a moderate infestation level in pear orchards over the three years with low damage on fruits. In all three years, the main infection period was found to be from end of April to early May. Light infections were observed also from mid of April until the end of May. Later spores were flying until mid of June but did not lead to infections. In an organically managed orchard a reduction of the infestation dependent on the distance to an infected host plant and on treatments with fungicides used in organic growing could be found.*

Keywords: pear rust, *Gymnosporangium sabinae,* organic farming.

Introduction

In 2007 and especially in 2008, pear rust (*Gymnosporangium sabinae)* caused severe damage on leaves, fruits and twigs of pears in many orchards in the area of St. Pölten. In this area most of the organically managed pear orchards in Austria were planted during the last 8 years.

G. sabinae is a host changing fungus which is overwintering on twigs of some cedar species *(Juniperus sabina, J. chinensis, J. x media*). It is infecting pear trees in spring, mostly on leaves and less frequent also on twigs and fruits. Infections from pear to pear are not possible, whereas infections on cedars can reappear every year. Spring precipitation cause a swelling of telial horns on *Juniperus sp.*; in this process the teliospores are germinating and release basidiospores which are transported by wind to pear leaves. Clearing of cedars in the neighbourhood of pear orchards is a well-known method to reduce the infection pressure (Hilber & Siegfried, 1990). However, not in all cases the source (i.e., the infected cedars) can be found, and also quite frequently the owners of the cedars are not willing to cut the plants. Till now there is only few data available on the spreading distance of pear rust in literature, and estimates are reaching from a few hundred meters up to a few kilometres. The effect of fungicides used in organic growing like copper, (lime) sulphur or potassium bicarbonate pear rust is not precisely understood so far and subject of continuous research.

This paper is reporting on the effort to bridge this gap reporting on lessons learned from a detailed field campaign investigating biology, development and possibilities of control of the host changing fungus in 2009-2011.

[1] M. Filipp, Department of Applied Plant Sciences, Division of Viticulture and Fruit Growing, University of Natural Resources and Life Sciences, Austria – 1180 Vienna; martin.filipp@boku.ac.at

[2] B. Schildberger, Federal College and Institute for Viticulture and Pomology, Institute of Chemistry, Biology and Plant Protection, Austria – 3400 Klosterneuburg.

Material and Methods

From 2009 to 2011, the occurrence of pear rust symptoms was monitored in 19 pear orchards in the surroundings of St. Pölten at the end of August. In each orchard the occurrence frequency and the leaf position of pear rust symptoms was recorded on 10 long shoots and 10 short shoots of each cultivar ('Uta' and 'Conference'). At the same time the farmers filed a survey on how serious they see the damage in the actual and the previous year. The survey comprised 5 categories, reaching from 0 (= no damage) to 4 (4=very serious).

A Burkard 7-day recording spore trap was set up in 3 m distance from an infected *Juniperus sabina* in Klosterneuburg, Haschhof. The recording was done from April, 21st to June, 30th in 2010 and from April, 5th to June, 12th in 2011. The sum of collected spores was counted on daily basis.

In spring 2010 and 2011, for each week three (in 2010) or two (in 2011) small potted seedlings of *Pyrus communis 'Bartlett'* were placed outdoor to monitor natural infections. The remaining time those were placed indoors protected from rain and infectious spores. In 2010, the trees were placed in the garden of the University of Natural Resources and Life Sciences Vienna where the next known infected cedar was within about 150 m distance. In 2011, the seedlings were put at Klosterneuburg, Haschhof next to the spore trap and an infected *J. sabina*. The pear seedlings were placed outdoor from 3 Mai 2010 to 26 June 2010 and 12 April to 6 June 2011. The amount of infestations was counted either at the whole tree (2011) or at each tree at 1 to 3 long shoots (2010).

In the years 2010 and 2011 the infestation development on pear trees was also monitored in Vienna (10 shoots – 2010) and St. Pölten (5 shoots – 2011). This data was analysed on dependence with the occurrence and amount of precipitation. On each twig the sum of leaves and the sum and position of pear rust symptoms was investigated once a week.

In an orchard in St. Georgen the influence of the distance (50m, 110m and 170m) between pear trees and an infected host plant (*Juniperus sabina*) was examined. In each distance five pear trees of the cultivar 'Uta' were assessed, infections on two short shoots and two longshots were counted at each tree. Additionally to these three variants with fungicide applications a control variant without fungicide application located in 50m distance to the infected host plant was monitored in the same way.

Results

Monitoring of symptoms on pears on the organically managed farms

The results of the three year field campaign (2009-2011) on 19 farms showed a moderate infestation level with symptoms mainly located on leaves and rarely on twigs. The farmers participating in the survey estimated the infestation level in the years 2009 to 2011 between light and medium, in comparison they conceived the infections in the year 2008 as very severe. (data not shown).

The largest number of infestations was found in 2010 on short shoots and long shots (25.72 and 11.05 per 100 leaves, respectively, see Table 1). In general the frequency of infestations symptoms was always higher on short shoots than on long shoots. Inter-cultivar comparison showed that the cultivar 'Uta' often had fewer infestations than the cultivar 'Conference'. However the statistical analysis of the data showed that significant difference between the cultivars was only found for 2010 on long shoots ($p=0.035$; independent sample T-Test).

Table 1: Average infestation level with *G. sabinae* on pear leaves in the observed orchards (N=19) in the area of St.Pölten

		Symptoms/100 leaves		
		Uta	Conference	Mean
2009	long shoots	5.39	6.20	5.73
2010	long shoots	9.41	13.3	11.05
2011	long shoots	5.98	7.32	6.60
2010	short shoots	28.27	23.03	25.72
2011	short shoots	11.5	14.31	12.81

Temporal development of infections in 2009-2011

2009 was a quite early year regarding the vegetative development in spring and no precipitation occurred from budding to flowering. The first springtime rainfall occurred at the end of April (29th and 30th April) and caused first infections. Pear rust symptoms appeared in this year especially on the 7th to 9th developed leaf on long shoots.

In 2010, first infection symptoms appeared on the 10th of May (Figure 1). As the incubation time of *G. sabinae* is about 3 to 4 weeks (Hilber & Siegfried, 2003), the infection can be related to the rainfall events of April 12th and 15th or the later event of the 20th of April. Our data shows that the main infection period was between early and mid of May when also the highest number of spores could be monitored in the spore trap at Klosterneuburg (Figure 2). Most symptoms occurred at the end of May, and only a small number of new symptoms could be counted in June. From July onwards no new pear rust spots occurred. However, spores were discharged until 21st of June. Infections especially happened on the 3rd to 6th leaf of long shoots. Pear rust symptoms appeared in 2010 on earlier built leaves then in 2009.

The alternately outdoor placed pear seedlings got infected only in the first two settings (3rd Mai to 17th May). The later exposed trees had already stopped growing, and no symptoms did appear (data not shown).

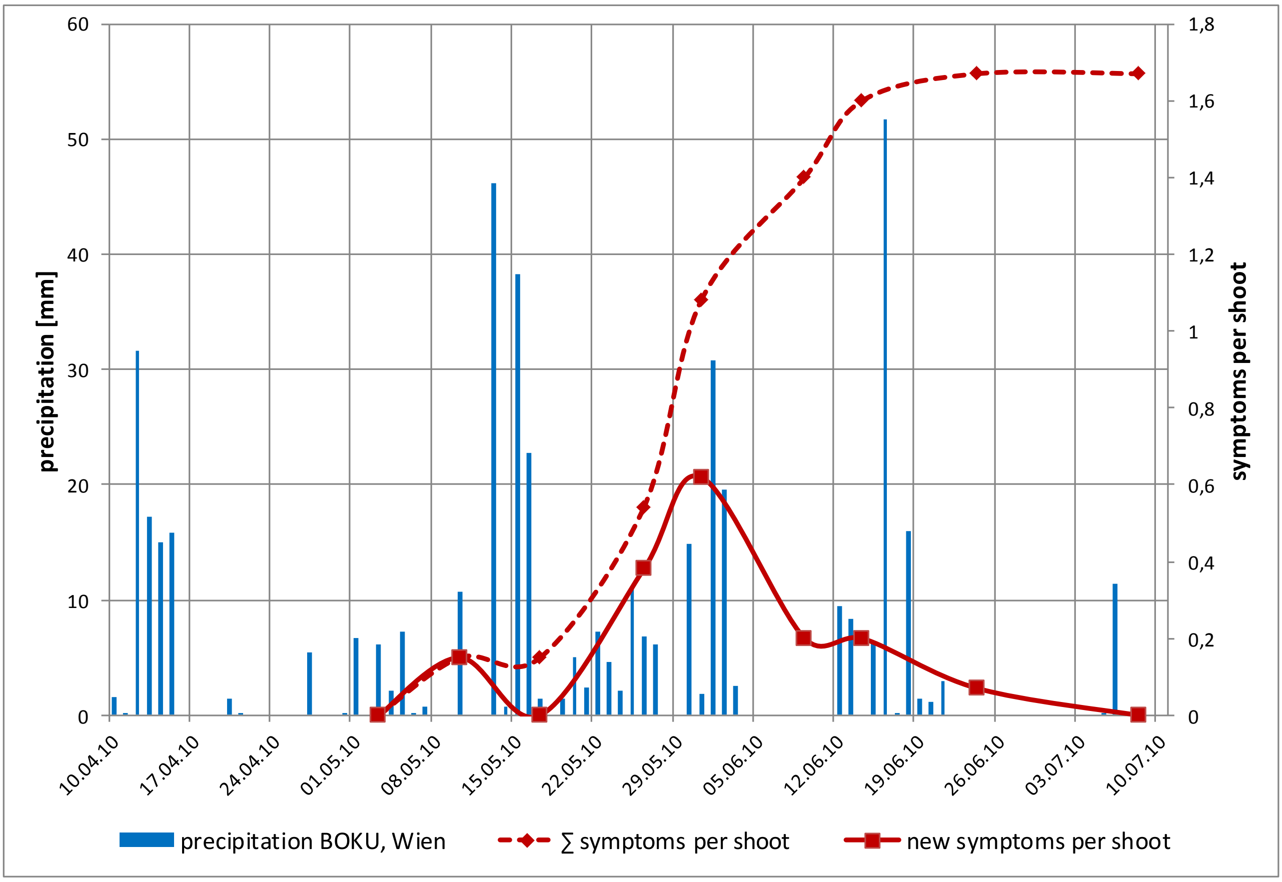

Figure 1: Precipitation amount and infestation development of *G. sabinae* on long shoots on two pear trees (*Pyrus communis, P. pyraster*) in 2010 – Boku, Vienna

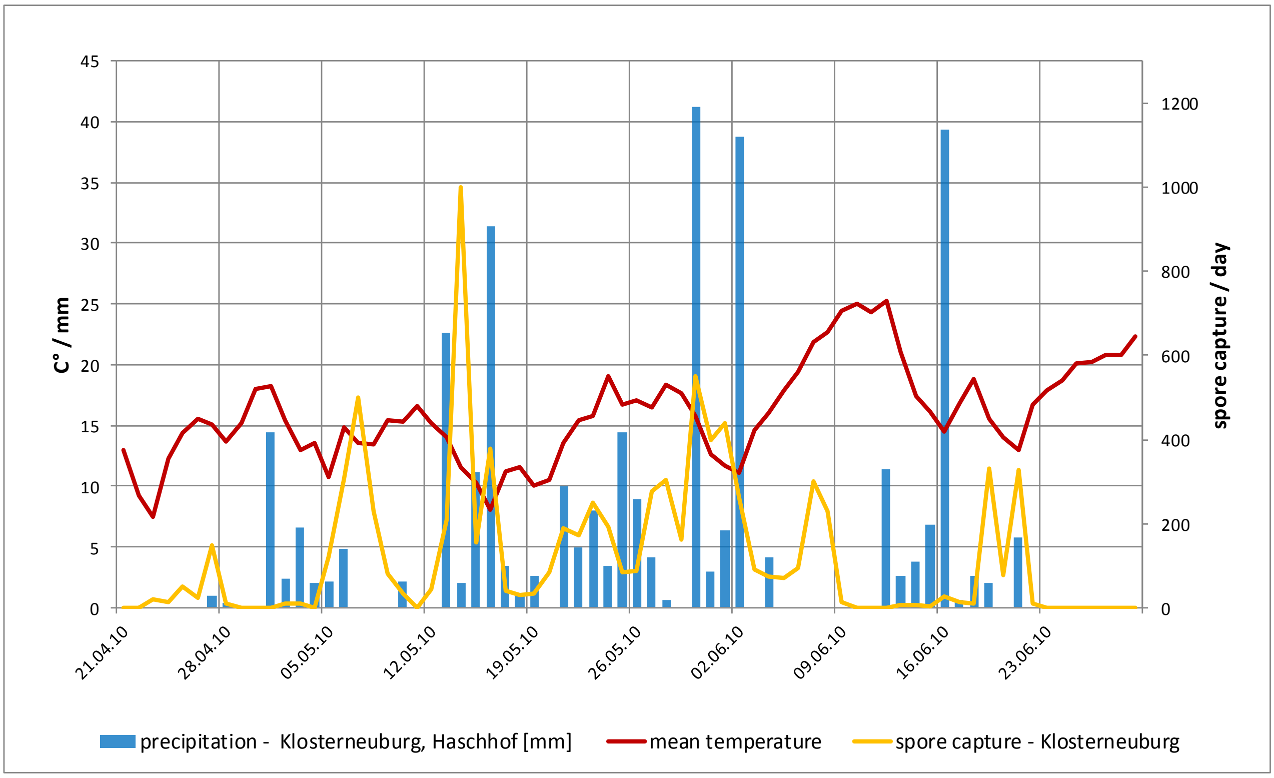

Figure 2: Precipitation amount and discharge of spores of *G. sabinae* on a spore trap in 2010 – Haschhof, Klosterneuburg

In 2011, rainfall events between the 12th and 15th of April didn't led to spore discharge. Expectedly no symptoms could be seen 4 weeks later (Figure 4, 5). For the first time a few spores were observed at the 19th of April. Later rainfall events that occurred at the end of April led to a massive spore discharge (2593 spores – 26.4.2011) and in consequence a large number of new infection symptoms could be monitored between mid and end of May. Also on the potted seedlings an enormous amount of pear rust spots was developed in this week of precipitation (data not shown). These rainfall events also caused an increase of growing and many new susceptible leaves were built. A second rain period in mid of May can be related to new infection symptoms about four weeks later, however not the infection is not accounted as very serious. As in the orchard also the potted trees showed only few symptoms after this event (see Figure 3).

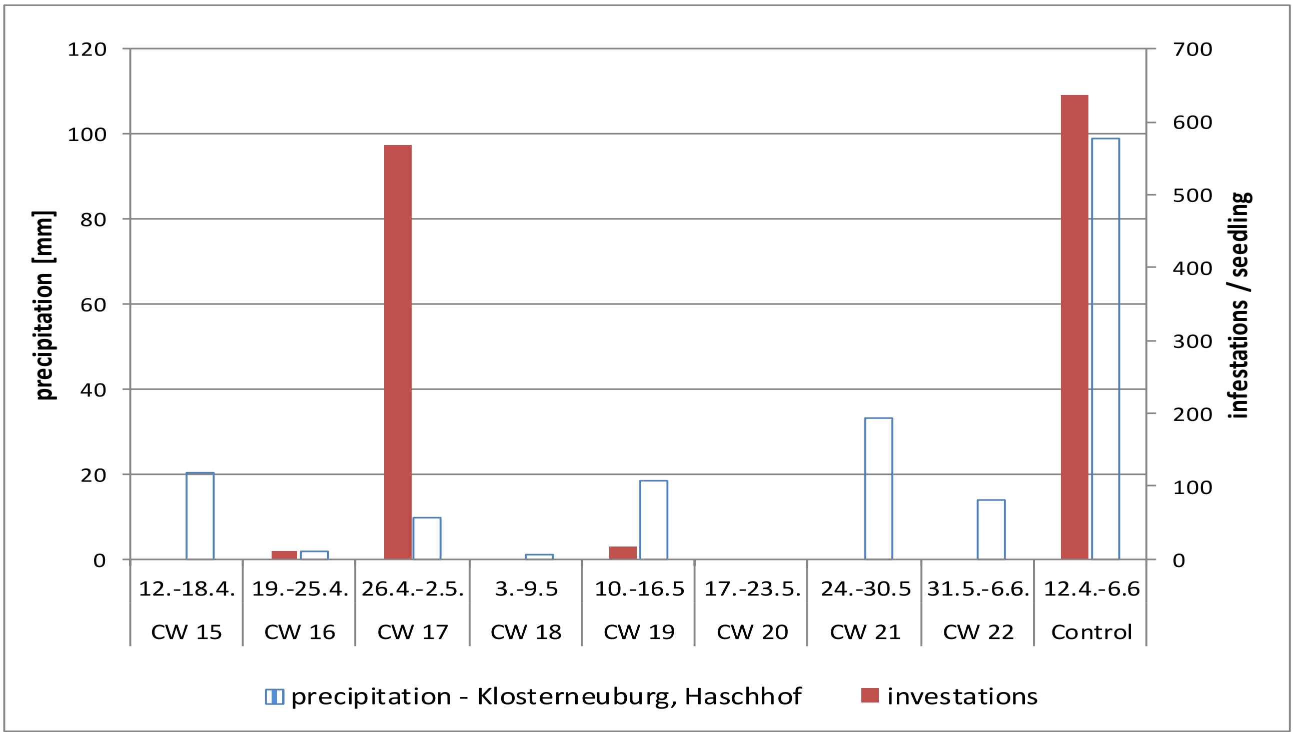

Figure 3: Precipitation amount and infestations on pear seedling in 2011 – Haschhof, Klosterneuburg

Unfortunately due to technical problems with the spore trap details on the sporulation in this time period is not available for the analysis. Later this year a small number of spores were discharged in the first days of June. From the 17th of June onwards no new spots appeared on the monitored shoots.

In this year most symptoms were formed on the 2nd, 4th and 5th leaves (data not shown).

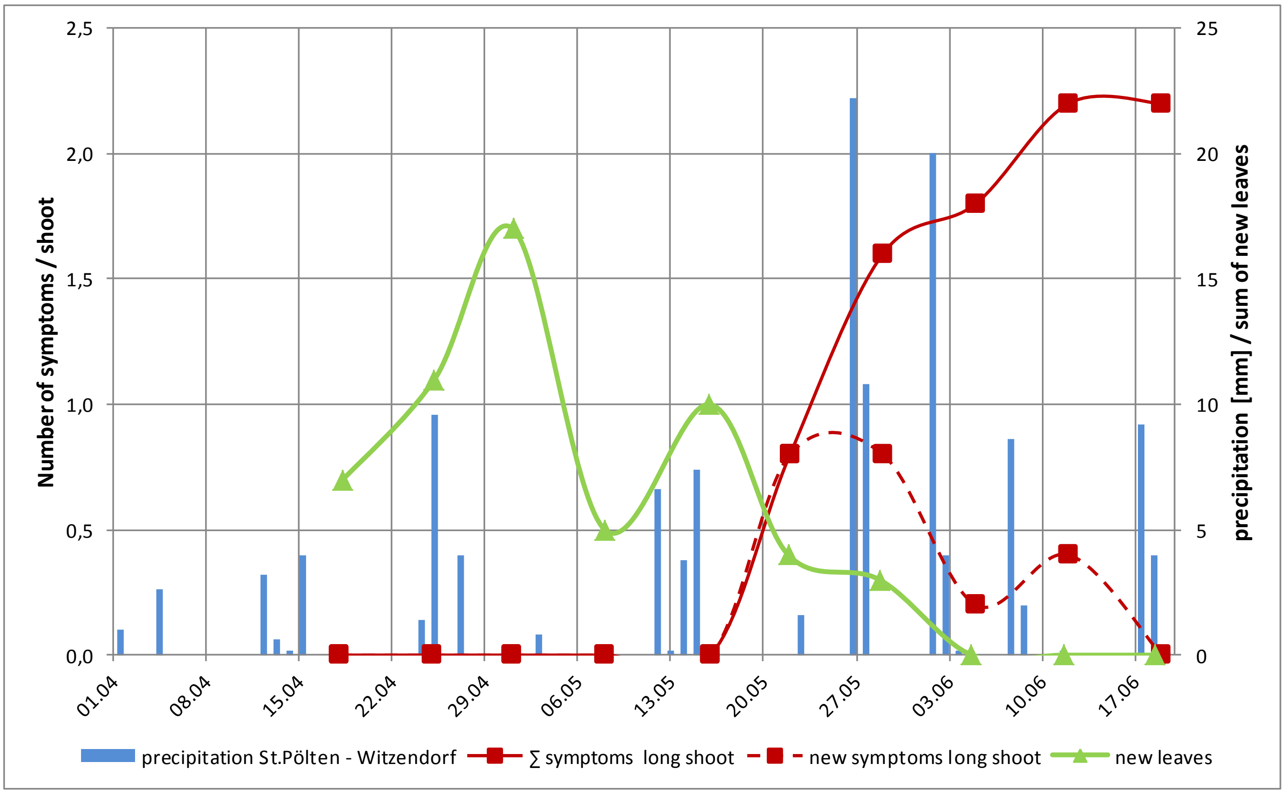

Figure 4: Precipitation amount and infestation development of *G. sabinae* on long shoots on pear trees (cv. 'Uta') in 2011 – Seeben

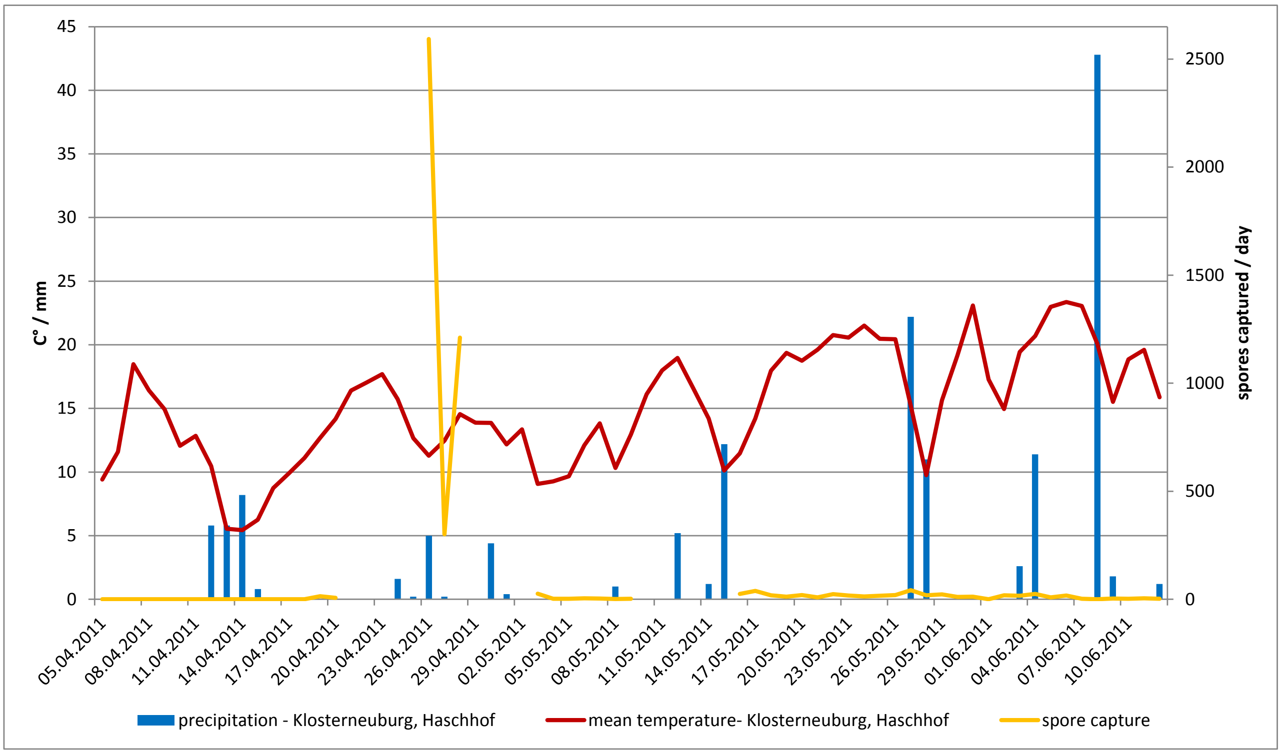

Figure 5: Precipitation amount and discharge of spores of *G. sabinae* on a spore trap in 2011 – Haschhof, Klosterneuburg

Effects of fungicide treatments and host distance on the infestation level in the monitored pear orchard

The first rain period of 2011 (12th to 15th April) with probable infestations in the organic managed pear orchard was protectively treated with 0.5l/ha copper oxychloride (Figure 6), however no infection period was estimated, as the results from the spore trap showed. The main infection period from 24th to 27th of April 2011 was treated as well as a small precipitation event at 3rd of May with 9.86 kg/ha of lime sulphur. The second and less serious period of infection was treated with 0.4 l/ha copper oxychloride (see Figure 6).

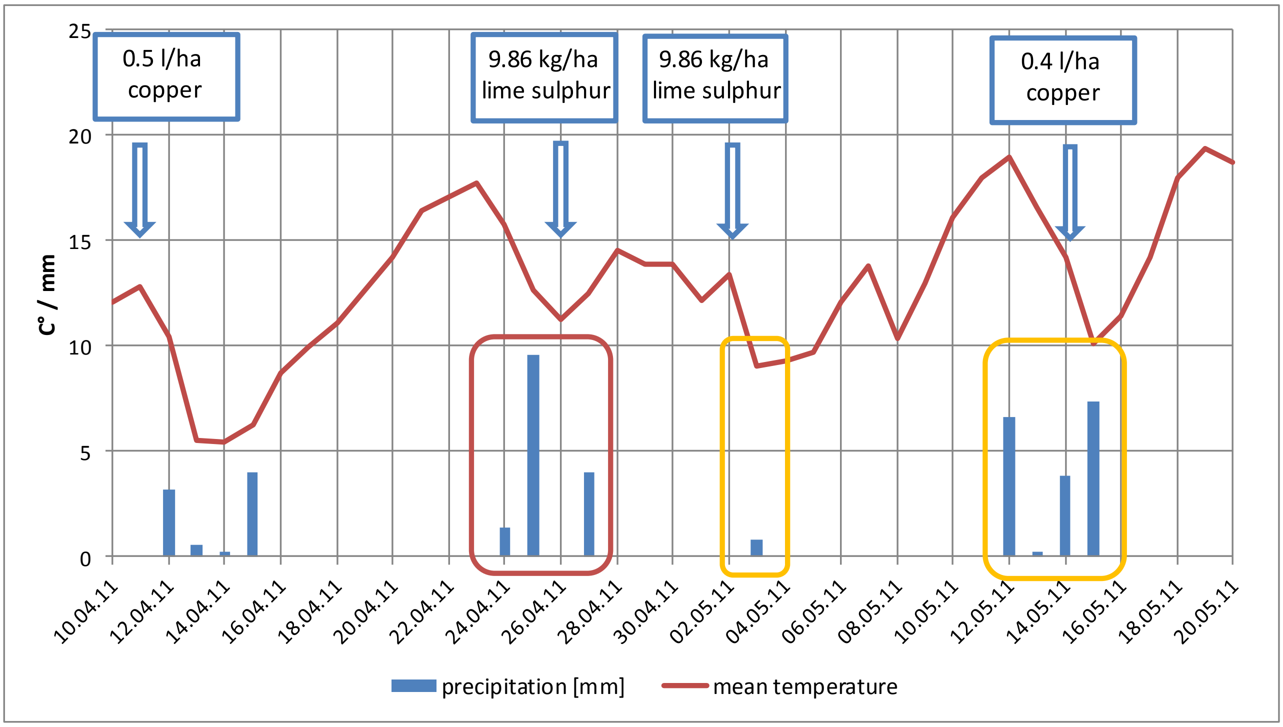

Figure 6: Fungicide treatments and precipitation in the pear orchard (cv. 'Uta') in St. Georgen, Austria in 2011.

The assessment of August 26th showed that the heaviest infections with *G. sabinae* could be found on the untreated control variant in 50 meter distance from the host plant with 33.4 spots per 100 leaves (Figure 7). At the same distance the variant treated with fungicides showed only 9.7 symptoms per 100 leaves. Also the treated trees in further distance showed fewer infestations than the trees in 50 m distance, even though there was no significant difference between all three treated variants (see Figure 7).

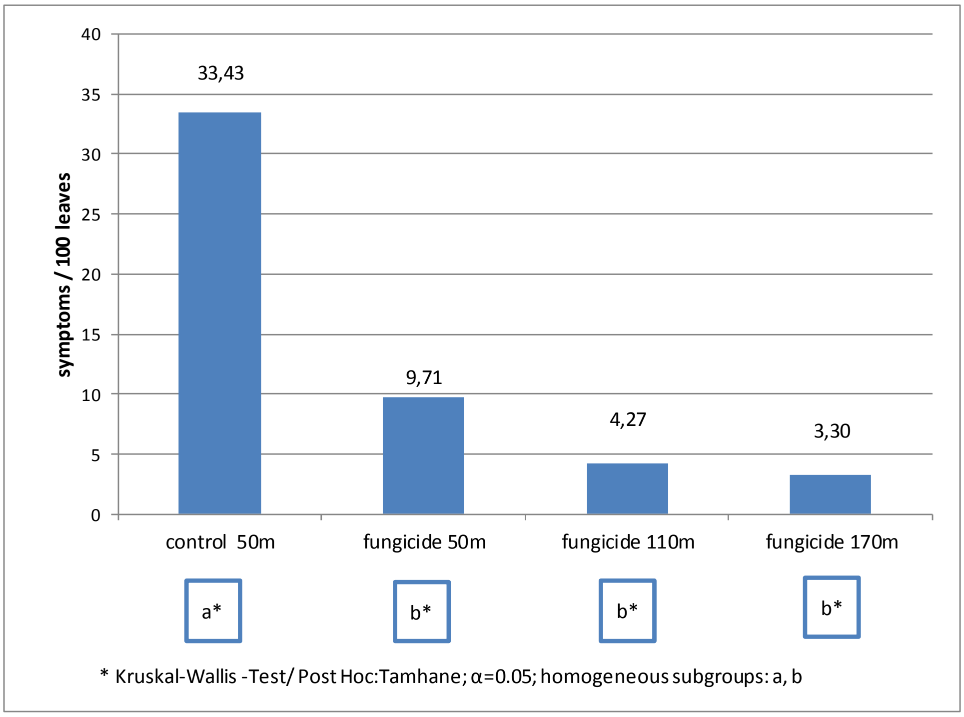

Figure 7: Infestation in depend on host distance and plant treatments

Discussion

The investigations in pear orchards in the surroundings of St. Pölten revealed a much lower infestation level in the evaluation years 2009 to 2011 than in the year 2008, which was designated as a year of heaviest infection on pear leaves, fruits and twigs by the farmers participating in the survey.

Over the three years the main infection period occurred between the end of April and the beginning of May. Light infections also occurred from mid of April till the end of May. The results show that the precipitation event observed at the end of April 2011 caused most infections on early build leaves, whereas infections in the beginning of Mai in 2009 and 2010 led to more infections on later build leaves.

The spore trap showed a spore flying period till beginning or even mid of June, even though no later infections could be monitored on pear leaves. The alternately outdoor placed pear seedlings in 2010 seemed to be only infected during shoot growing. No new infections could be found on the seedlings after terminating growth, even though spores were discharged at this time. Earlier work on pear rust by Hilber *et al*. (1990) showed that artificial infections were only effective on young leaves. In their investigations about the closely related cedar apple rust (*G. juniperi-virginianae*) Aldwinckle et al. (1980) found, that 4 to 8 day old leaves get more lesions than 10 or 12 days old ones. Our results are in good agreement with these studies as after the end of the shoot growing period no more infections were observed at our monitored sites.

When an orchard was treated with fungicides commonly used in organic farming during the estimated main infection periods, the infestation level dropped remarkably by 70 percent. As spore discharge was largest at the end of April the main protection effect could be achieved by lime sulphur application on the 26th of April. These results show the high potential of organic fungicides in the protection of orchards from pear rust and suggest further studies on the effect of other fungicides for organic farming. The direct relationship of infection frequency and distance to the host plant couldn't be proved statistically significant within this analysis, however a decrease of infestations with distance to the host was found. Ormrod et al. (1984) conducted a field study were pear trees in 300 meters distance to a cedar shrub were not infected by *G. sabinae.* They monitored infections in distances up to 150 meters and no effect of the direction of the pear trees from the source. The monitoring at the farms in the surroundings of St. Pölten showed a high risk of serious infections in orchards nearby an infected cedar. In addition almost every orchard monitored showed pear rust symptoms even if no infected cedar could be found in the direct neighbourhood. This provides some evidence that in windy regions like St. Pölten the distance of spore threating could be much higher than 300 meters.

For improving the control of *G. sabinae* a next step is creating a forecast model.

Acknowledgements

The authors acknowledge the financial support by OPST (Obst Partner Steiermark) and the BBK St. Pölten. Special thanks to all farmers that let us visit their orchards and gave us information about their applications and filed the survey and to the BOKU students involved in our seminar project in 2011 and all other helping hands.

References

Aldwinckle, H.S., Pearson, R.C. & Seem, R.C. (1980). Infection periods of Gymnosporangium juniper-virginianae on apple. *Phytopathology* **70**: 1070-1073

Hilber, U.W. & Siegfried, W. (2003). *Merkblatt Gitterrost auf Birnbaum und Wacholder – Sanierungsmassnahmen bei starkem Befall.* Eigenverlag: Eidg. Forschungsanstalt Wädenswil

Hilber, U.W., Schüepp H. & Schwinn, F.J. (1990). Untersuchungen zur Entwicklung des Birnengitterrostes. *Schweizer Zeitschrift für Obst- und Weinbau* **126**: 486ff

Ormrod, D.J., O´Reilly, H.J., Van der Kamp, B.J. & Borno, C. (1984). Epidemiology, cultivar susceptibility, and chemical control of *Gymnosporangium fuscum* in British Columbia. *Canadian Journal of Plant Pathology* **6**: 63-70.