Symptom occurrence and disease management of Marssonina blotch

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Abstract

This article focusses on direct fungicidal regulation of Marssonina blotch of apple trees using customary plant protection products listed for organic production. In a product efficacy test, acid clay achieved best results over two years of trial. Lime sulphur, sulphur and copper had a moderate and potassium carbonate an insufficient efficacy. Another trial design aims to narrow down time windows over the summer, when the application of a fungicide is most effective to curtail disease progression. Such a time window was not found, however. The pure number of applications appeared to be more important than the period of application.

Keywords: Apple blotch, Apple leafspot, *Marssonina coronaria, Diplocarpon mali*

Introduction

Premature defoliation of apple trees caused by *Marssonina coronaria ELLIS & J.J. DAVIS* (teleomorph *Diplocarpon mali Y. HARADA & SAWAMURA*) provides a broad field for research. Biology under central European climate conditions, means of control in organic apple cultivation and susceptibility of different varieties are not fully explored yet. Named after the anamorph, the disease is called either Marssonna blotch or Marssonina leafspot. Symptoms occurred for the first time at Kompetenzzentrum Obstbau-Bodensee (KOB) in 2011 on trees of the variety ‘Topaz’.

In Lake Constance area, the disease affects mainly organically managed orchards with low input of pesticides and untreated orchards for juice production. Subject to the year, the defoliation can start as soon as middle of July and individual trees of highly susceptible varieties like “Topaz” can be almost bare by the middle of August. Infestation on the fruit itself has been found, but presently seems to appear only rarely (Marschall *et al*., 2014, Sharma *et al.*, 2004). The main problem is the early loss of leaf surface area and the subsequent reduction of assimilation capacity.

In this article, we present results from the open field trials focussing on direct regulation of the fungus. In an efficacy test, customary plant protection agents listed for use in organic apple cultivation in Germany were tested in the open field over two years. A second trial aimed to identify most relevant time zones to curtail symptom progression over the summer via fungicidal applications.

The yearly development of Marssonina blotch at KOB without the application of fungicides has been recorded since 2012. These data will be presented first in order to give an overview and a standard for comparison.

Material and Methods

Degree of damage

The development of infestation was visually estimated using a 0-to-9-scale as presented in Table 1.

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Table 1: Scale to visually rate infestation with Marssonina blotch.

Score	Definition of the symptoms
0	no visible lesions
1	only brownish spots detectable, no chlorotic leaves yet
2	few chlorotic leaves detectable
3	few small clusters of chlorotic leaves
4	Many small clusters or a large area of the tree with infested leaves, no immediately apparent defoliation yet
5	Large areas with infested leaves, defoliated branches visible
6	Intermediate
7	immediately apparent defoliation and/or more than half of the leaves infested
8	Intermediate
9	tree almost completely bare, only few leaves left on top or side branches

The average infestation was subsequently converted into the ‘degree of damage’, which is expressed mathematically as percent of maximum possible damage (P):

P = degree of damage in %
$P = \Sigma (n*v) / (9*N) *100$
N = overall number of trees
v = value 0,1,2,3,4,5,6,7,8,9
n = number of trees rated the respective value

Disease development

The progressive development of Marssonina blotch symptoms in the open field was visually examined and recorded during the summer seasons of 2012 to 2017. 120 untreated ‘Topaz’-trees were rated at least weekly using the scheme described above.

Efficacy test of plant protection products

The products tested as well as the application frequencies and strategies for both years are listed in table 2. Details of the application technique are given in table 3.

For calcium hydroxide (product name ‘Ulmer Kalkmilch 36%’) only the liquid overlap was used. The solid parts of the product build a sediment in the canister which is very hard to stir up. For this reason, only the enriched liquid standing on top of the sediment was used. After use, the container was filled up with water again for the next application. The product NEU 1143F was obtained from ‘Neudorff’. Its active ingredient is pelargonic acid.

The research was carried out at an organically managed site at KOB using Topaz on rootstock M9 planted in 2003. The initial infestation with Marssonina blotch was recorded in autumn 2015, to avoid distortion of the test results by infestation in the precedent year. The orchard had a uniformly low degree of infestation, however. Thus, the trial was structured in randomized blocks with four repetitions in 2016. In 2017, the trial site was unequal due to the efficacy trial of the precedent year. Therefore, the blocks were randomized in a way that every product had two repetitions with rather low and two with rather high initial potential from the precedent year.

Table 2: Tested products with dosage and application details, diluted in 500l/ha water.

Year	Product	Dose/ha	Application frequency and strategy
2016	Myco-Sin (acid clay)	10 kg	12 applications: 10.6./20.6./27.6./4.7./11.7./18.7./26.7./ 1.8./8.8./15.8./22.8./30.8. No spraying directly into the rain, but otherwise regardless of the weather.
	Funguran progress (copper)	400 g	
	Curatio (lime sulphur)	12 l	
	Sulphur	5 kg	
	VitiSan (potass. carbonate)	5 kg	
	Calcium hydroxide (liquid overlap)	28 l	
	Kumar (potass. carbonate)	5 kg	
2017	Myco-Sin + Sulphur	10 kg + 2 kg	11 applications: 12.6./20.6./26.6./4.7./11.7./20.7./1.8./ 8.8./14.8./21.8./30.8. Within the given time frame (more or less weekly) rather preventive than curative.
	Myco-Sin (acid clay)	10 kg	
	Curatio (lime sulphur)	12 l	
	Funguran progress (copper)	400 g	
	Sulphur	2 kg	
	Neudorff NEU 1143F	20 l	

Table 3: Application technique used for both trials.

Year	Sprayer type	Spreed in km/h	Pressure in bar	Fan speed	Nozzles	Water volume/ha
2016	JOCO tunnel sprayer type 09G	6	9	high	Albuz orange	500
2017	WANNER taylor made for trials	5	6	adjusted to wind conditions	DG Teejet 80015VS green	500

dentification of relevant periods to curtail symptom progression

The aim of the second trial was to identify time windows during the summer that appear most efficient to directly prevent a further progression of disease symptoms via fungicidal applications. In this trial, lime sulphur was applied between June and August in a roughly weekly routine. The trial site was divided in half and each half into eleven variants. At the first application date, the first half was treated completely. Then with every application date, one variant less was treated. In the second half, only one variant was treated initially, and with every application date one more variant was treated additionally. This setup allows to compare variants that received the same number of applications in different time frames. The dates of applications were the same as given in table 1 with the exception of the 10th of June 2016, which was the first application date for the product test but left out in this trial.

Results

Disease development 2012-2017

Figure 1 shows the progressive development of Marssonina blotch symptoms over the summer seasons of 2012 to 2017 on untreated ‘Topaz’ at KOB.

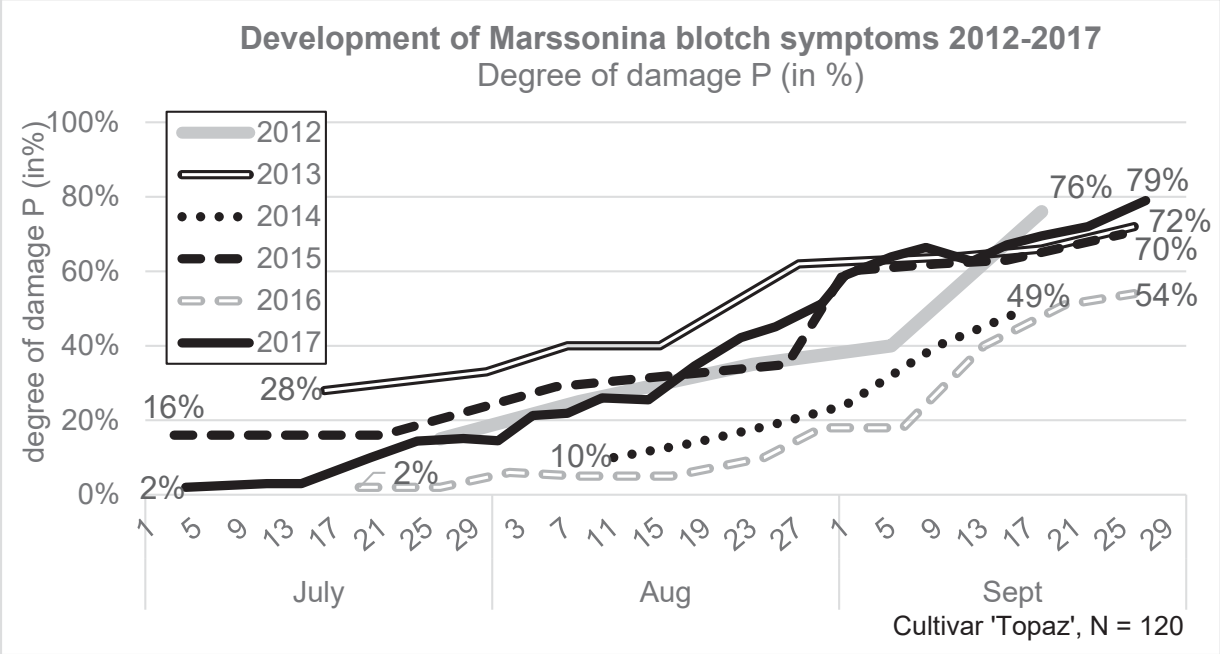

Figure 1: Progressive development of Marssonina blotch symptoms in the open field over the summer seasons 2012-2017. At 0 % no damage is visible, at 100 % all trees are almost without leaves.

Over the years, first symptoms appeared between beginning and middle of July. In the last third of September at harvest time for ‘Topaz’, the degree of damage reached levels between 50 and 80%. A later appearance of first symptoms came along with a lower overall level at the end of the season for the years 2014 and 2016. 2017 was a comparatively early year.

Efficacy of the tested products

The results of the efficacy trials are provided in Figures 2 and 3.

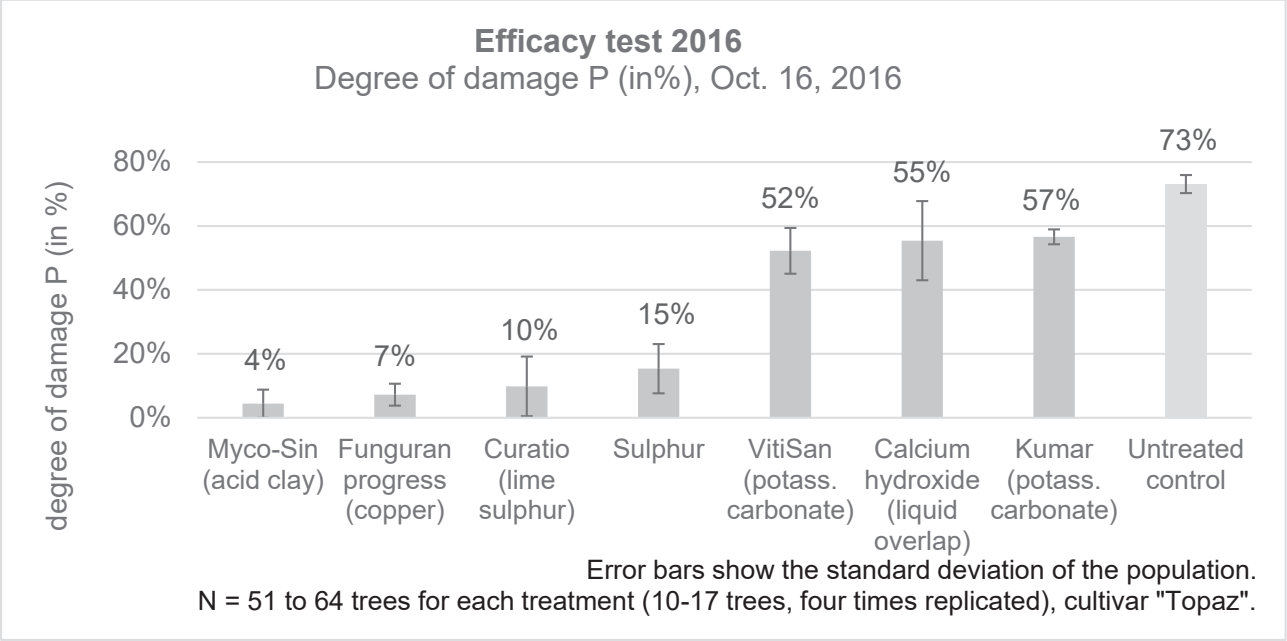

Figure 2: Incidence of Marssonina blotch after treatment with different plant protection products in 2016.

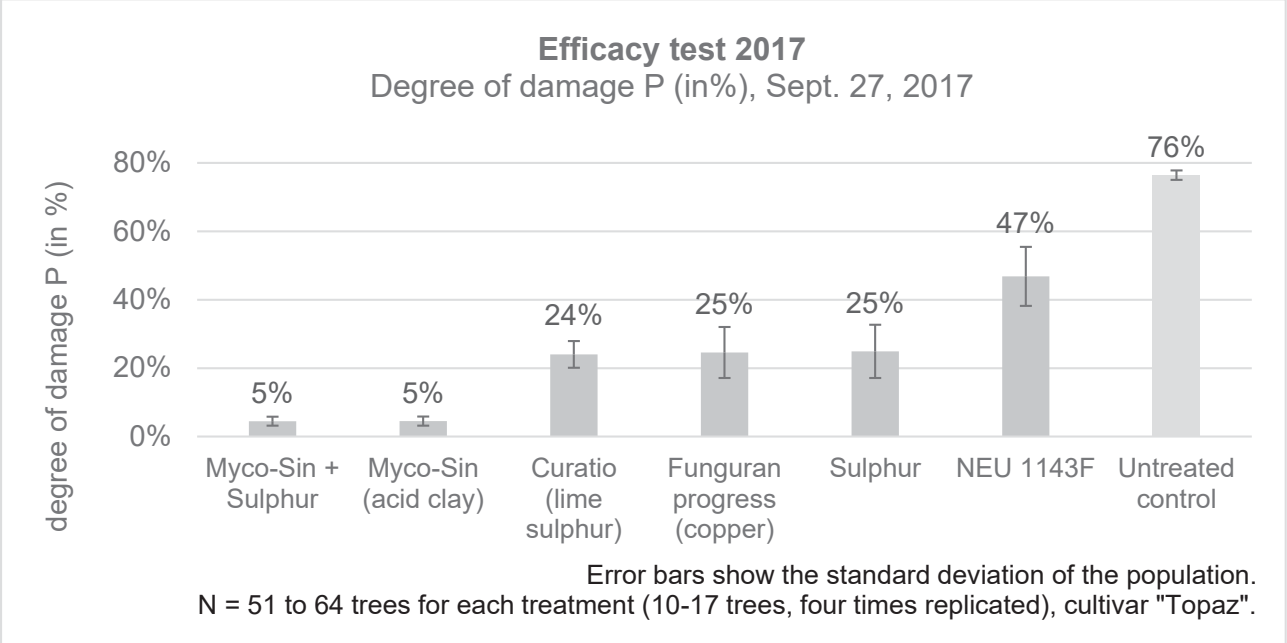

Figure 3: Incidence of Marssonina blotch after treatment with different plant protection products in 2017.

In both years, the acid-clay-product ‘Myco-Sin’ showed the highest efficacy concerning the regulation of Marssonina blotch. The products based on copper, lime sulphur or wettable sulphur had a reasonable effect as well. The efficacy of potassium carbonate was not satisfactory, neither for ‘VitiSan’ nor for ‘Kumar’ (former ‘Armicarb’). The liquid overlap of calcium hydroxide was tested in 2016 but it showed an insufficient efficacy. Due to this one-year-result and the difficult handling of the product, it was not considered again in the following year. In 2017, the newly developed product ‘NEU 1143F’ was included for the first time and showed a low to moderate efficacy.

A noteworthy detail in this trial is the standard deviation in 2017. As mentioned above, the infestation with Marssonina blotch in the precedent year differed between the repetitions in 2017. Each treatment had two rather good and two rather bad repetitions. Nevertheless, the standard deviation does not appear extraordinary high. An expected effect from a suspected ‘initial potential’ was not visible.

Identification of relevant periods to curtail symptom progression

Figures 4 and 5 show the incidence of Marssonina blotch after various numbers of applications with lime sulphur in time windows between June and August. In the middle of the figure, the degree of damage resulting from the maximum of eleven applications between June and August can be found. It was 13% in 2016 and 10% in 2017. Data left of the middle shows the results of variants that were treated since June but did not receive all eleven applications. Accordingly, data right of the middle shows the results of variants which were left untreated first, but then received all remaining applications until the last one on August 30. As a reading example for 2016, six applications from June to the end of July lead to 26% damage, six applications from the end of July to the end of August lead to 24% damage.

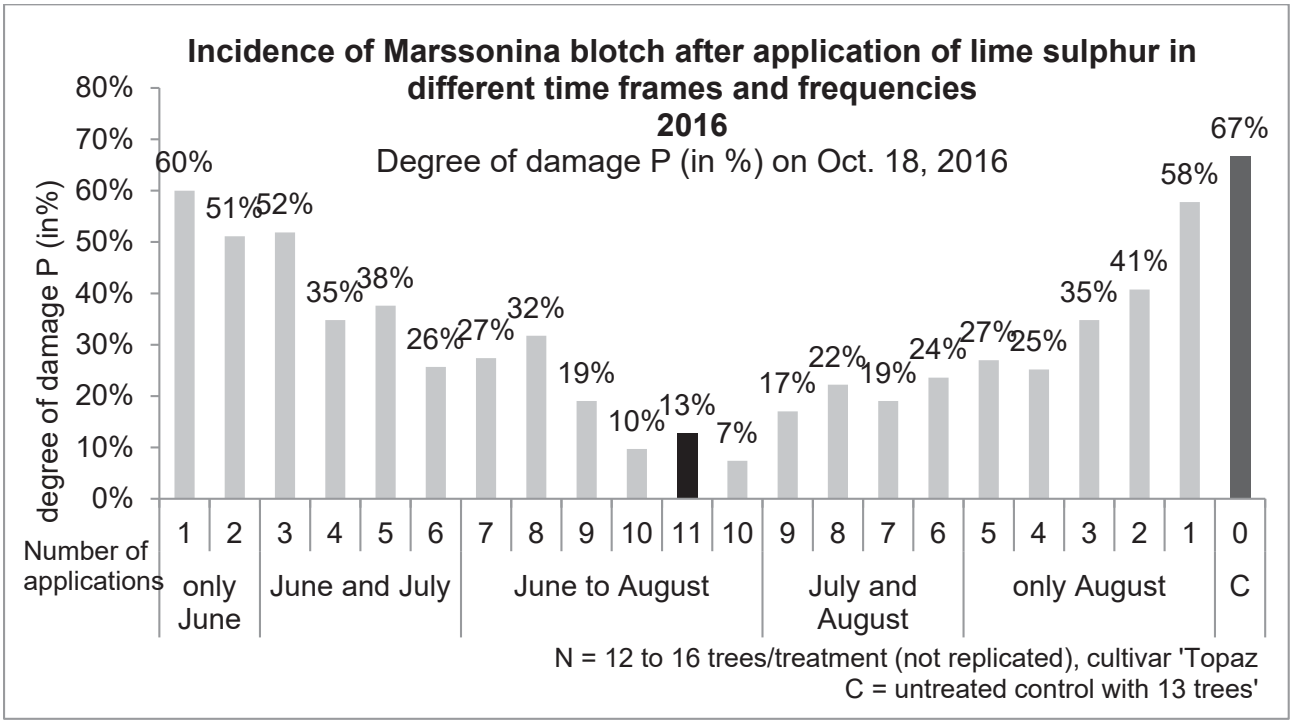

Figure 4: Results for the application of lime sulphur in different time frames and frequencies in 2016.

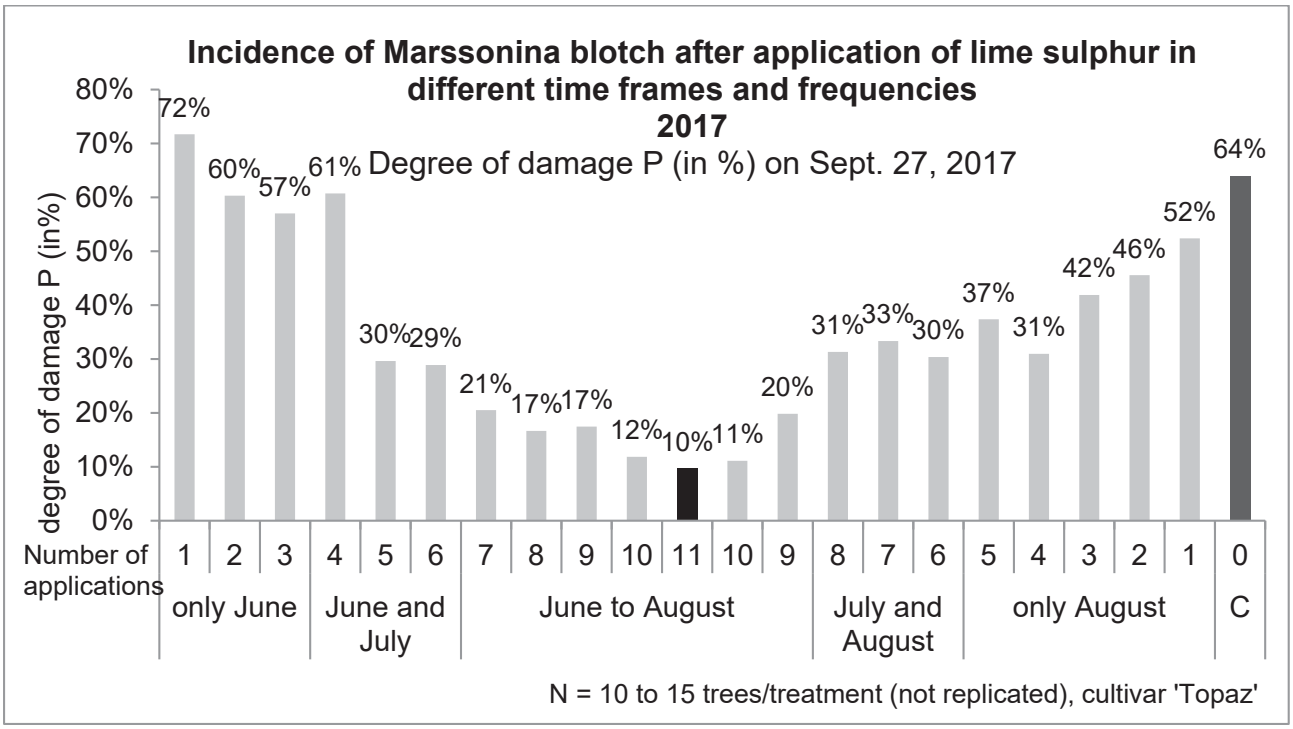

Figure 5: Results for the application of lime sulphur in different time frames and frequencies in 2017.

Discussion

Under open-field conditions, acid clay was the most effective substance to control Marssonina blotch. The efficacy of acid clay was described already by Gruber *et al.,* 2014 for the product ‘Ulmasud’ and by Rühmer 2016 for ‘Myco-Sin’. In practice, however, there are other pathogens like apple scab and sooty blotch to consider as well. The choice of fungicides thus has to be adjusted to the individual situation in each orchard, considering

the disease occurrence as a whole. Therefore, a balanced fungicidal strategy for the summer months will still rely on products based on lime sulphur, sulphur or copper, that showed a lower efficacy against Marssonina blotch but have a higher potential against other pathogens. When trying to reduce the number of runs per season, the miscibility of Myco-Sin with sulphur is helpful. The product NEU 1143F was only tested in one year and needs further research.

From the trials introduced here, it does not seem to be possible to identify limited time frames that are of particular importance to curtail disease progression. Although the data show a certain variation due to the trial design, we believe a trend can be distinguished: The more applications of lime sulphur a variant had, the less damage resulted – the total number of applications had a greater effect than the timing of the application. A randomized trial design and the use of Myco-Sin instead of lime sulphur might return more specific results in future research.

The monitoring of disease development in untreated trees (see figure 1) also implies that there might not be any time frames of specific importance during the months from July to August. When comparing the curve progressions of the six years, it has to be noted that no weather data is included. The development of a fungus typically depends very much on weather parameters like temperature, air humidity and rainfall. Nevertheless, the curves are comparatively homogenous. There are peaks, but the overall impression is a mostly uniform inclination independent from the specific weather conditions. The overall level of infestation that is reached and the date of first symptoms varies much more between the years.

Acknowledgements

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