Observations on the epidemiology of Sooty Blotch in Organic orchards in the Netherlands

Beobachtungen zur Epidemiologe der Regenfleckenkrankheit

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Abstract

From 2002 to 2005 field observations where made on the occurrence of Sooty Blotch (SB) in unsprayed orchards on the apple variety Topaz. First SB symptoms in high inoculum orchards where found after on average 639 leaf wetness hours following the first rain 10 days after petal fall. Even then symptoms where present only on places on the fruits that probably stayed wet longer than the leaf wetness sensors have indicated. Weather stations that are set up to register average orchard conditions are unlikely to detect the wetness conditions that lead to SB infections in critical parts of the orchard.

From the delayed symptom development compared to the published data form USA we concluded that under Dutch conditions the lower temperature retards the symptom development.

In the first month after the first symptoms where found disease progress was slow, but increased towards the harvest. The gradual increase of both disease incidence and severity, and the appearance of the symptoms suggest ongoing new infections on the fruits during summer rather than one major SB infection that spreads on the fruit.

Within a year the disease incidence between orchards varied form 0 to over 90%, but between years the disease incidence in an individual orchard stayed in the same range. This makes disease history an important factor in the panning of a control strategy.

Keywords: Sooty Blotch, epidemiology, control

Introduction

In fruit growing regions in Europe where climatic conditions are very favorable for apple scab infections organic fruit growers plant modern Vf scab resistant varieties like Topaz, Red Topaz and Santana. These varieties combine high yields with good storability and a consumer quality that is equal or better than the standard varieties.

Leaving out all fungicidal treatments on these varieties in summer leads to infections by summer diseases like Soothy Blotch (SB), and in a far lesser extend by Flyspeck. Depending on production region, variety, year and local situation SB-infection of fruits can be up to 100% incidence and severity. Due to increasing demands on the fruit skin quality of organically produced fruits infected fruits can not be sold.

Of the substances allowed crop protection within the European regulation on organic production EU 2092/91 *Annex 2,* Lime sulfur and potassium soap seem to be the most effective materials for the control of SB. However the effectiveness of the control with these materials varies widely between trials (Fuchs 2001, 2002, Kiensle 1995, Zuber, M. 1997)

In 2003 we developed a simulation model for SB in order to find the most important moments for fungicide application. (Trapman 2003) The model was build on published data from research in USA as there are hardly any data published on biology and epidemiology of SB in Europe. In 2003 and 2004 spray schedules based on model output where quite effective, however in 2005 model output did not agree to the field observations, and the output seemed to be very sensible for the logger data used as input. (different types of stations, placement and LW-sensor type).

For validation purposes from 2002 to 2005 field observations where made on the occurrence of SB in organic orchards. The results of these observations are present in respect to:

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1. The moment that first SB symptoms where found
2. The development of the SB epidemic within a year
3. The disease development in the same orchard over years

Material and Methods

Observations where made in organic and in untreated orchards in The Netherlands and Belgium, and in one organic orchard just across the boarder in Germany. The number of orchards included in the survey increased during the years. In the organic orchards observations where made in blocks of at least 4 tot 6 rows wide, and at least 20 trees long that where left untreated during summer. In most cases the same untreated plots where used several years. Al observations where made on the Vf scab resistant apple variety Topaz.

The orchards where visited regularly during summer. For each sample 200 to 500 randomly chosen fruits where examined for Sooty Blotch symptoms. Disease was scored using the scale proposed by Hartman (Hartman 2000):

0 = no symptoms
1 = trace <5% fruit surface has disease symptoms
2 = 5-25% fruit surface diseased
3 = 25-50% fruit surface diseased
4 = < 50% fruit surface diseased

Disease incidence was calculated as percentage fruits with symptoms. Disease severity was calculated as: (% fruits class 1 +(2* % fruits class 2) + (3*% fruits class 3) + (4* % fruits class 4)) / 4.

Weather data where recorded by Metos Compact stations (Pessl Instruments, Weiz, Austria) placed in a shaded tree. The leaf wetness sensor of this station consists of a small piece of filter paper in which the electrical resistance is measured. On each station two leaf wetness sensors where used. Leaves where regarded as wet as long as one of the sensors reads wet.

Results and Discussion

First symptoms

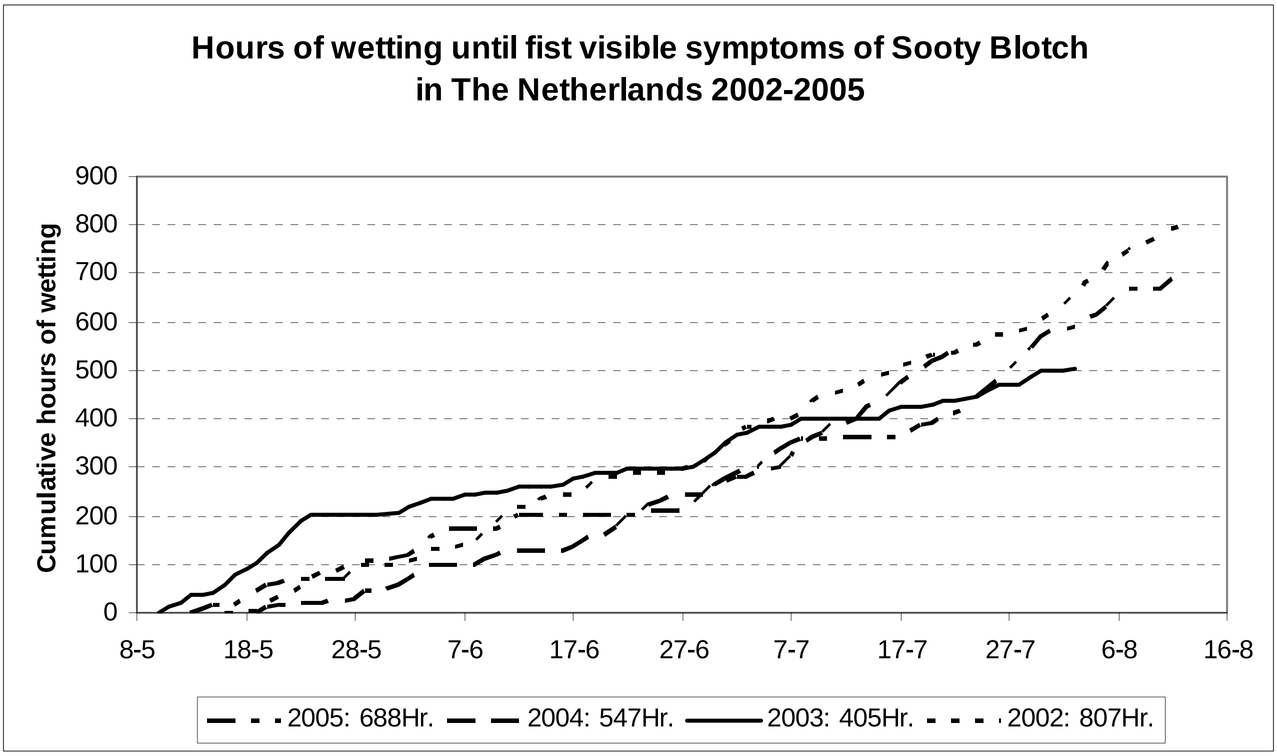
The date first SB symptoms where found each year are noted in table 1. The first symptoms must have appeared in the week before the given date. In 2002, on august 12th several spots where already present, and first symptoms may have occurred little earlier in this orchard. Sure is that on July 22nd (536 Hr. of wetness) no symptoms where visible yet.

In each year, first symptoms where found in all orchards around the same time. First symptoms appeared always on places on the fruits where water gathered, and where prolonged wetness periods occur. E.g: where two fruits touch, where a leaf covers the fruit skin, or at the talk end of the fruit. Never on free hanging fruits. First symptoms where mostly less than 5 mm, hardly distinguishable, small spots found at a very low incidence.

Table 1: First symptoms of Sooty Blotch in the Netherlands.

Year	*Petal fall*	*First rain following 10 days after Petal fall*	*First symptoms*	*Wetness hours till first symptoms *)*
2002	6-5	18-5	14-8	(536-)807
2003	30-4	12-5	3-8	504
2004	6-5	21-5	24-7	547
2005	5-5	16-5	12-7	688
			Average:	637

*) Recorded with a Metos Compact weather station in a shaded tree.



Graph 1: Cumulative hours of wetting beginning at fist rain that occurred 10 days after petal fall.

Graph 1 visualizes the accumulation of wetness hours from the first rain after petal fall of the apple variety Topaz, and the first moment Sooty Blotch symptoms where noted.

In the American literature on SB the moment that first symptoms are appear is regarded as a important moment in the epidemiology. Control strategies are often focused on delaying the first fungicide treatments till this moment. In Carolina Brown and Sutton found the fist SB symptoms on average on 293 wetness hours counting all wetness periods starting the first rain that occurred 10 days after petal fall. In Ohio Ellis found fist SB- Symptoms between 225 and 241 wetness hours in untreated orchards, but in low inoculum orchards not earlier than 392 wetness hours. In Kentucky in the period 1994- 1998 Hartman found first symptoms in high inoculum orchards between 185 and 251 wetness hours after the first rain 10 days after petal fall.

In North Western Europe, first symptoms are not found before 500 wetness hours have passed, and even then only at places that probable have stayed longer wet then the leaf wetness sensors recorded. Brown and Sutton found no relation to temperature as the temperatures in North Carolina during the summer are within the optimum range for the fungi in he SB complex. They already stated that “in environments where the temperatures are cooler ”..” temperature may play a more significant role”. The most obvious reason for the longer wetness periods that are necessary under Dutch conditions is that the average temperature in summer in The Netherlands is much lower than in North Carolina. More observations are necessary to establish the role of temperature in epidemiology of SB in North-western Europe. Most probably the lower temperature under our conditions make that not all rain events rigger SB-infection, and the time between infection and visual symptoms is longer that expected by the North Carolina model.

<u>Disease development within a year</u>

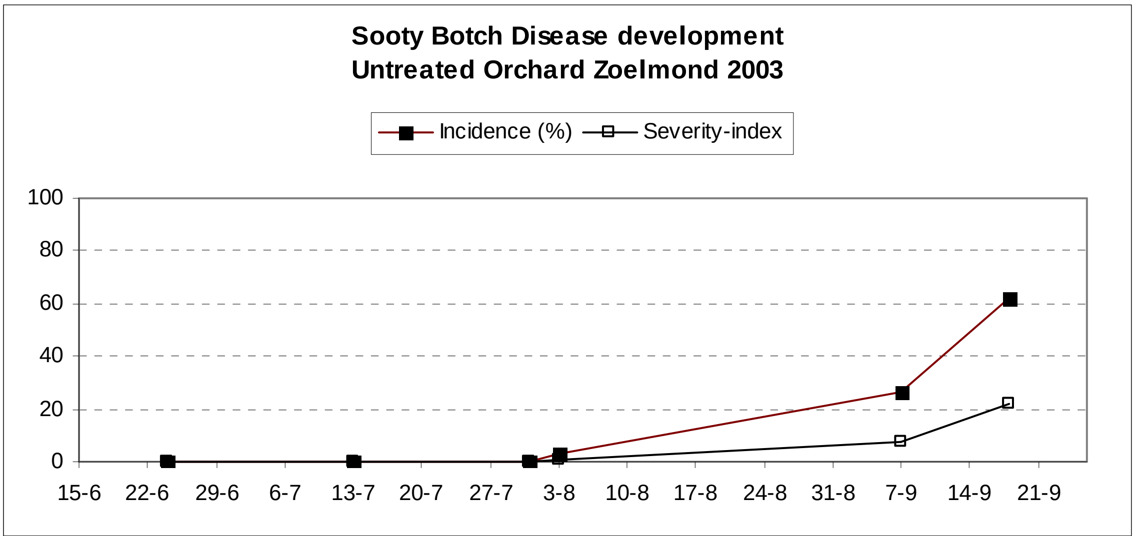
In figure 2 to 4 disease symptom development in 2003, 2004 and 2005 is plotted as monitored in completely untreated orchards with a history of severe Sooty Blotch attack.

Starting from a hardly detectible level, both disease incidence and severity increase during the summer untill harvest. Although on a much lower level, the pattern is the same for unsprayed blocks in organic orchards of which figure 5 gives an example. The strongest disease progress is in the last month before harvest.

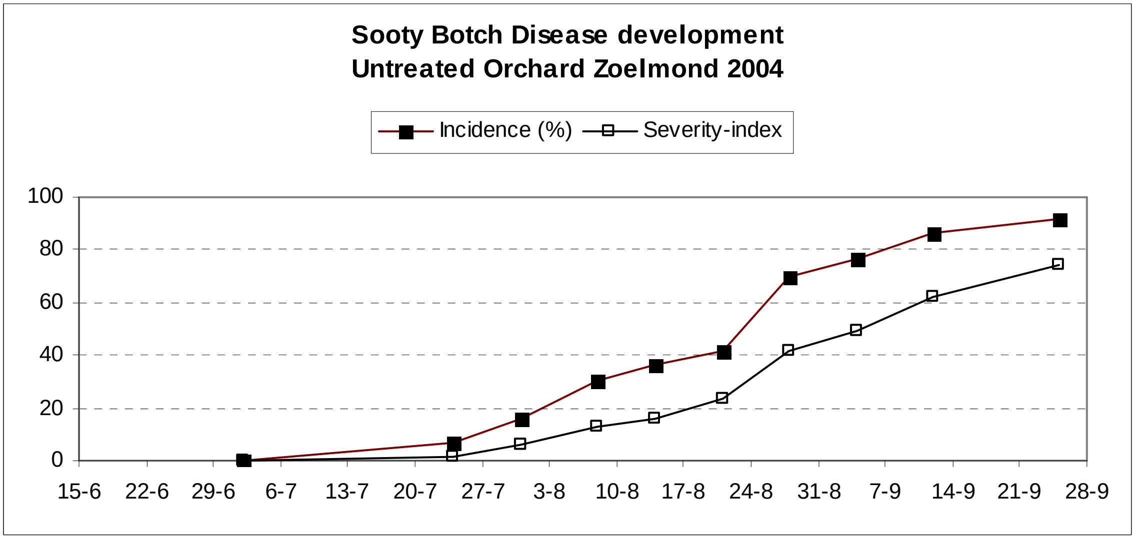
The slow disease progress in the first part of the epidemic again confirms that the moment of “first visible symptoms” under Dutch conditions will be strongly depending on micro climatic conditions and local disease pressure.

The steady increase of both incidence and severity suggest ongoing infections from a source on to the fruits rather than a single major infection. The first fruit infections are as described before on hidden places on the fruit skin. In the last month before harvest symptoms develop all over the fruits and suggest in their appearance that inoculum has been splashed on to the fruits kin. Also fruits are found on witch the symptoms closely follow the path of water streams running over the fruits during rain.

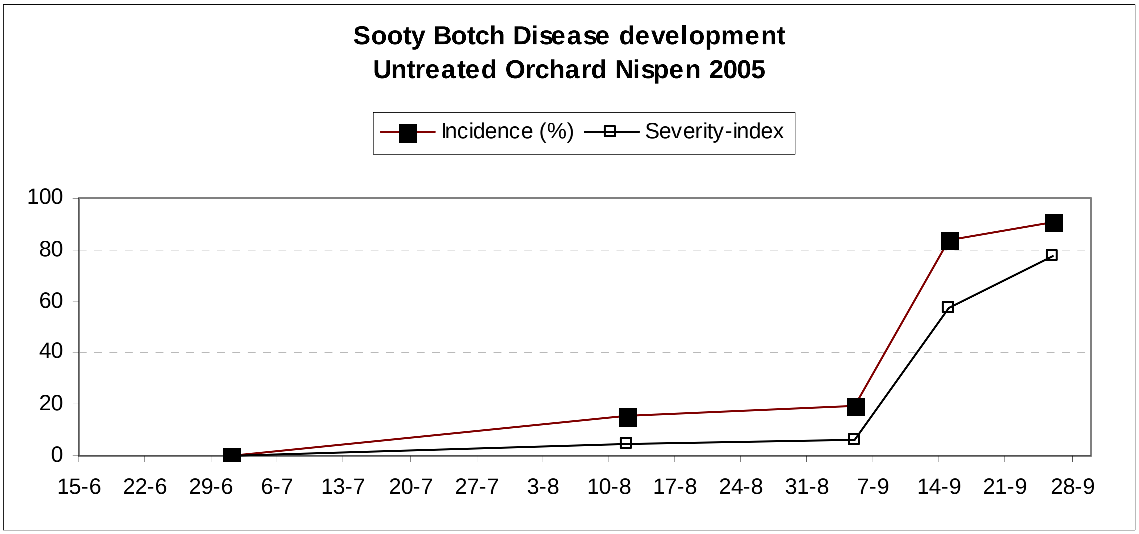
The towards exponential growth of the epidemic at the end of the growing season makes that early maturing Vf-resistant varieties like Santana that are harvested end of august escape from heavy attack. Varieties like Topaz that are harvested end of September have more risk to be infected, and very late ripening varieties like Goldrush have the most chance to be heavily infected by SB.



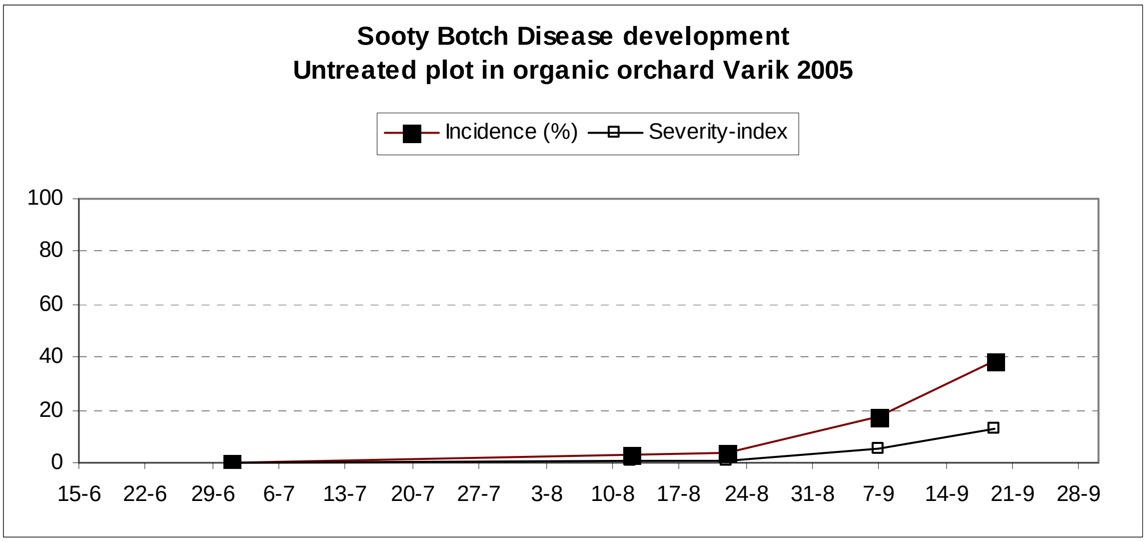
Graph 2: Sooty Blotch disease development in an untreated orchard in 2003, variety Topaz.



Graph 3: Sooty Blotch disease development in an untreated orchard in 2004, variety Topaz.



Graph 4: Sooty Blotch disease development in an untreated orchard in 2005, variety Topaz.



Graph 5: Sooty Blotch disease development in an untreated plot in an organic orchard in 2005 (Topaz).

Disease development from year to year
Table 2 lists the disease incidence at harvest in the orchards involved in the survey. Within the same year the disease incidence varies between the orchards form 0 to > 90% of the fruits. Over the years, with a few exceptions, disease level in the same orchard roughly stays at the same range. The figures in table 2 are only valid for the monitored plots in the orchard, as within the same orchard disease incidence may vary widely. In the same orchard trees in the shade of wind breaks develop more disease than is average for the orchard. Overall in the dataset there is however no correlation to the distance to hedgerows or other possible sources of outside inoculum.
These observations lead to the conclusion that he occurrence of SB on Topaz is strongly depending on local conditions. These might include as well local disease pressure and microclimatic conditions. Local disease history seems a strong indication for infection risk.

Table 2: Percentage fruits with Sooty Blotch symptoms at harvest in untreated orchards or untreated orchard plots. Variety Topaz.

Orchard	*2001*	*2002*	*2003*	*2004*	*2005*
Zoelmond	67	100	64	92	-
Lobith	10	-	2	5	2
Randwijk	35	13	3	0**)	< 1**)
Rees			16	22	26
Mijel			3	27	22
Nispen				100	91
Varik				30-50	38
Kraggenburg				<5	17 *)
Lisserbroek				2	18
Biddinghuizen				<5	3
Glabbeek				2	3
Bierbeek				<1	2
Oostkapelle				0	0
Gabbeek				0	0

*) Next to hedgerow
**) Average of several small untreated plots in a treated orchard.

Conclusions
SB develops within a window of high humidity or leaf wetness and a temperature optimum between 15 and 25 °C. Under these biological provisions the development of SB in the Netherlands is strongly depending on microclimatic conditions that prolong wetness periods. Weather stations that are set up to register average orchard conditions are unlikely to detect the wetness conditions that lead to SB infections in critical parts of the orchard.
In The Netherlands temperature seems to play a more important role in the development of SB symptoms than in Carolina, Ohio and Kentucky. More data are needed to establish the relation between climatic conditions and the development of SB symptoms under sub optimal temperature conditions.
Disease history seems to be a good indication for infection risk, and could be used in combination with harvest time as parameter to set up a control tactic for SB in organic orchards as already suggested by Tamm in Switzerland in 1998.

Literature Cited

Brown, E.M. & Sutton, T.B. 1993: Time of infection of *Gloeodes pomigena* and *Schizothyrium pomi* on apple in North Carolina and potential Control by an Eradicant Spray Program. Plant Disease Vol.77(5) : pp. 451-455

Brown, E.M. & Sutton, T.B. 1995: An Empirical Model for predicting the first Symptoms of Sooty Blotch and Flyspeck of apples. Plant Disease Vol.79(11) : pp. 1165-1168

Ellis, M.A., Madden, L.V. & Wilson, L.L. 1998: Evaluation of an Empirical Model for predicting Sooty Blotch and Flyspeck of apples in Ohio. Ohio State University Extension Bulletin. Research Circular 299-99.

Fuchs, J & Tamm, L. 2001. Untersuchung von Spritz Strategien für ‚Biofa Cocana RF und Schwefelkalk gegen die Regenfleckenkrankheit bei Apfel. Tagungsband Fibl Obstbautagung 31-01-2001 in Frick. pp 13-16.

Fuchs, J.G., Häseli, A. & Tamm, L. 2002: Influence of application strategy of coconut soap on the development of sooty blotch on apple. In: Eco.Fru.Vit, 10th international Conference on Cultivation Technique and Phytopathological Problems in Organic Fruit-Growing und Viticulture, ed. Fördergemeinschaft Ökologischer Obstbau e.V. Weinsberg, pp. 50-54

Hall, J.C., Frank,M., Tuttle,A.F. and Cooley, D.R.1997 ?: Can we predict Flyspeck Development ? University of Massachusetts. Fruit Notes 62(4) Article 6

Hartman, J.R. 1995: Evaluation of fungicide timing for Sooth Blotch and Flyspeck Control, 1994. Fungicide and Nematicide Test 50: p 11

Hartman, J.R. 1996: Evaluation multi-layer fruit bags for Sooty Bloch and Flyspeck Control, 1995. Biological and Cultural Test 11: p 38

Hartman, J.R. 1997: Evaluation of fungicide timing for Sooth Blotch and Flyspeck Control, 1996. Fungicide and Nematicide Test 52: p 31

Hartman, J.R. 1997: Evaluation multi-layer fruit bags for Sooty Bloch and Flyspeck Control, Woodford county Kentucky 1996. Biological and Cultural Test 12: p 45

Hartman, J.R. 1998: Evaluation of fungicide timing for Sooth Blotch and Flyspeck Control, 1997. Fungicide and Nematicide Test 53: p 31

Hartman, J.R. 2000: Covering apple fruits with multi-layer fruit bags reduces defects. Integrated control of pome fruit diseases, IOBC Bulletin Vol. 23(12): pp 17-22.

Hickney, K.D., Lewis, F.H. & Taylor, C.F. 1958: Time of apple fruit infection by *Gloeodes pomigena* and *Mycrothyrella rubi*. (Abstract) Phytopathology 48: pp 462

Johnson, E.M. & Sutton, T.B. 2000: Response of two fungi in the Apple Sooty Blotch Complex to Temperature and Relative Humidity. Phytopathology 90 (4) : pp 362-367

Kienzle, J., Schulz, C., Karrer E. & Bergengruen K. 1995: Regenflecken- ein Dauerthema. Beratungsdienst ökologischer obstbau. Mitteilungen 2-95: pp. 10-15.

Kumar R.A.J and Pandey J.C., 1994: Evaluation of different fungicides for the control of Sooty Blotch and Flyspeck diseases of apple. Cvs. Red Delicious an Buckingham. Progressive Horticulture 26(1-2): 79-81, 1994

Kopff, B 2003: Kopff, Beratungsdienst Biologischer Obstbau, Weinsberg, Personal communication.

Leahy, K, Clark, T, Goodband, E. 2002 ?: Testing Various Methods of Timing Summer fungicides. University of Massachusetts. Fruit Notes 63(4) Article 5

Sharp W.L., & Yoder, K.S. Correlation between humidity periods and Sooty Blotch and flyspeck incidence in Verginia apple orchards. (Abstract) Phytopathology 75 pp. 628

Tamm, L 1997: Regenflecken: Praxiserfahrungen mit einer situationsspezifischen Anwendungsstrategie. In 8. Internationaler Erfahrungsaustausch über Forschungsergebnisse zum Ökologischen Obstbau. Fördergemeinschaft Ökologischer Obstbau E.V., Weinsberg, G

Trapman, M.C. , Tamm, L. & Fuchs, J.G 2004: The effectiveness of winter treatments with Copper or lime sulfur to control Sooty Blotch on apple. In: Eco.Fru.Vit, 11th international Conference on Cultivation Technique and Phytopathological Problems in Organic Fruit-Growing, ed. Fördergemeinschaft Ökologischer Obstbau e.V. Weinsberg, pp. 67-72.

Trapman, M.C. 2004: A simulation program for the timing of fungicides to control Sooty Blotch in organic apple growing. In: Eco.Fru.Vit, 11th international Conference on Cultivation Technique and Phytopathological Problems in Organic Fruit-Growing, ed. Fördergemeinschaft Ökologischer Obstbau e.V. Weinsberg, pp. 56-66.

Zuber, M. 1997: Regenflecken – Vorbeugen mit Kokosseife. ABC Journal 97. p 23