Resistance management in Vf apple scab resistant organic apple orchards

Resistenz Management in Vf Schorf resistente ökologische Apfelanlagen

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Abstract

Modern Vf scab resistant apple varieties open the way for organic growers to lower fungicide input, higher yields, better skin quality, more biological control for mites and insect pests and better consumer acceptance of their management practices. Manny examples in the past years have shown however that the Vf resistance can be easily overcome by local scab populations in north-western Europe. Discussions during the meetings of the IOBC working group Diseases in Orchards in 2000 in Fontevraud (France) and in 2003 in Lindau (Germany) lead to a set of management practises necessary to prevent gene-fulx, and selection towards Vf virulence in the local apple scab populations.

Eleven orchards of the Vf resistant apple variety Santana that where planted between 1998 and 2000 where monitored for apple scab lesions on fruits form 2002 to 2005. The results where evaluated in respect tot the applied resistance management practices. We conclude that fungicide treatments on the major primary scab infections are the key factor in the resistance management on Vf resistant apple varieties. From a practical viewpoint these early season fungicide applications are also necessary for the control of powdery mildew, as the main Vf- resistant apple cultivars appear to be relatively susceptible to powdery mildew.

For private gardens apple varieties with field resistance to apple scab should be advised, not Vf resistant varieties.

Keywords: Apple Scab, Vf-resistance, Resistance management

Introduction

The promises of Vf resistant apple varieties

For the organic production of common commercial apple varieties like Elstar, Jonagold and Golden Delicious in north western Europe 20 to 30 applications of sulfur, lime sulfur and or copper salts per year are required for the control of apple scab. Even with this high input successful control of the disease is not guaranteed.

Modern Vf scab resistant apple varieties like Topaz, Red Topaz and Santana keep promises for organic fruit growers. These varieties combine Vf resistance against apple scab with high yields, good storability, and a consumer quality that is equal to better than common commercial varieties.

However the system advantages go beyond that. 20 tot 30 fungicide treatments per year make consumers doubt whether that is what is meant by ‘organic’ fruit production.

The management of apple scab with moderate effective fungicides places a enormous pressure on the growers during the entire growing season. Growing Vf varieties is experienced by the producers as a big relief in their work.

The phytotoxic effects of the inorganic fungicides used reduce the total production and skin quality of the fruits.

And last but not least, the toxic effects of sulphur and lime sulphur on beneficial insects and mites reduce the possibilities for natural control of spider mites and insect pests in organic orchards.

So growing Vf resistant apple varieties opens the way to lower chemical input, higher yields, better quality, more biological pest control and overall by all means a more sound organic production system.

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The need for 'resistance management'

The past 20 years many cases have been reported of the occurrence of apple scab lesions on Vf resistant varieties in Europe. In the Netherlands as early as in 1979 symptoms of apple scab have been found on the varieties Priam, Prima, Priscilla and Sir Pize on the former experimental orchard De Schuilenburg. (Blommers 1983) On the former national research station at Wilhelminadorp the first scab symptoms on Vf resistant varieties where noted in 1984. A relieve severe break true occurred in 1997. (Kemp 1998) Evers since we had repeatedly cases in which scab symptoms where found in orchards planted with Vf resistant varieties in the Netherlands as well as in other European countries.

As Vf scab resistance seems to be overcome so quickly by the scab fungus, organic growers and advisors doubt whether Vf resistant varieties can hold their promises, and if it isn't better to save the necessary investments in marketing and stick to the common commercial varieties.

During the meetings of the IOBC working group Diseases in Orchards in 2000 in Fontevraud (France) and in 2003 in Lindau (Germany) this problem was discussed. The working group concluded that genetic information to overcome Vf resistance is probably percent in local apple scab populations in North western Europe. We agreed that specific management practises are necessary to prevent gene-fulx, and selection towards Vf virulence in the local apple scab populations.

Based on present knowledge and as outcome of the discussions in the IOBC working group the following measures are advised for planning and management of Vf resistant orchards in The Netherlands:

Table 1: The four measures for resistance management in Vf resistant apple orchards

	Measures	*Impact on local apple scab population*
1	Do not plant Vf- resistant varieties together with susceptible apple varieties	• Limits the absolute dimension of the scab population in the orchard • Limits the genetic variability in the scab population
2	Keep distance between Vf- orchards and orchards with susceptible varieties	• Prevents Gen-flux towards the resistant orchard
3	Treat with fungicides on major primary infections	• Second selection criteria for spores to be able to infect plant tissue. • Limits the absolute scab population in the orchard
4	Apply sanitary measures during winter.	• Limits the absolute dimension of the scab population in the orchard

Until now this is a logical, scientific sound set of measurements. But it this feasible in practice ? And do these measurements deliver measurable results in retarding or preventing the local scab population to overcome of the Vf resistance ?

This contribution has to bee seen as a feedback from the field to proceed the discussion on the necessity and practical possibilities for resistance management in Vf scab resistant orchards.

Material and Methods

Form 1998 onward larger blocks of the Vf resistant variety Santana where planted by organic growers. The need and principles of resistance management where communicated tot the growers by advisers and researchers. To a larger or lesser extend the layout and management practises where made according the principles outlined in Table 1. The last Orchard is not an orchard but a collection of 6 different Vf resistant cultivars in a private garden.

1. In one orchard 10% pollinator trees of the low scab susceptible varieties Alkmene and Discovery where planted in-between the Santana trees. In another orchard a *Malus floribunda* selection was planted as pollinator trees. In all other orchards Vf resistant varieties where used for pollination.
2. The distance of the Santana orchards to the scab susceptible orchards was variable. Grubbing out an old plantation and replanting it with Vf resistant varieties often does not allow a reasonable distance between the Vf orchard and existing orchard blocks with susceptible varieties.
3. In orchard 1 to 8 *(table 2)* fungicide treatments where made on the mayor primary apple scab infections during spring. Often additional treatments with low dosage of sulphur (2-3 kg /ha) where made to control mildew as Santana is very susceptible to apple mildew. The total number of fungicide applications ranged from 3 to 13 treatments per year. In orchard 9, 10 and 11 no fungicide applications where made.
4. The application of urea is not allowed in organic framing, and materials with comparable effects on leaf decay and prevention of perithecium formation that could be used in organic farming are not found yet. Sanitary measures are limited to shredding and mulching leafs in autumn, and turning the soil with mechanical weed cleaning machines. The majority of the growers specifically applies these sanitary measures. Due tot higher soil activity because the use of organic fertilisers, the leaf decomposition in organic orchard is noticeable better than in integrated orchards even without any specific sanitary measures. At but break most of the leafs are decomposed.

Table 2: Management details on the orchard blocks that where monitored

Orchard		Planting (year)	Surface (ha.)	Grass or mechanical weed cleaning	Resistance management			
					1	2	3	4
					Susceptible varieties between ?	Distance to susceptible varieties (m.)	Treatments on mayor primary infections	Sanitary measures
1	Dronten	1998	1.0	Mechanical	Yes *)	0	Yes	Yes
2	Lisserbroek	1998	1.5	Mechanical	No	50	Yes	Yes
3	Zeeland	1999	1.5	Mechanical	Yes **)	25	Yes	Yes
4	Meijel	1999	1.0	Mechanical	No	50	Yes	No
5	Tuil	2000	0.6	Grass mulch	No	0	Yes	No
6	Geldermalsen	1998	0.5	Mechanical	No	0	Yes	No
7	Randwijk	1999	0.8	Mechanical	No	50	Yes	Yes
8	Rees	2000	0.5	Mechanical	No	50	Yes	Yes
9	Lobith	1998	1.5	Long grass	No	500	No	No
10	Nispen	2001	0.5	Long grass	No	>1000	No	No
11	Burgh-Haamsteede	2000	Few trees	Long grass	No	25	No	No

*) 10% pollinator trees of low scab susceptible varieties Alkmene and Discovery
**) 10% pollinator trees of Malus Evereste

The Santana orchards are now 4 tot 8 years old. The last 4 years the occurrence of apple scab was monitored by checking at least 500 randomly chosen fruits shortly before harvest. In cases where no scab was found in the sample, but fruits with scab symptoms where found outside the sample the incidence was noted an <0.1 % scabbed fruits.

Results

Table 3: Percentage fruits with apple scab at harvest

	Orchard	*2002*	*2003*	*2004*	*2005*
1	Dronten	0	0	0	0
2	Lisserbroek	**0.8**	0	< 0.1	< 0.1
3	Zeeland	0	0	0	0
4	Meijel	< 0.1	0	0	0
5	Tuil	< 0.1	< 0.1	< 0.1	0
6	Geldermalsen	0	0	0	0
7	Randwijk	< 0.1	0	< 0.1	0
8	Rees			0	0
9	Lobith	0.5	3	**83.0**	**98.4**
10	Nispen		> 1% *)	**54.5**	**100**
11	Burgh-Haamsteede			**~ 5 *)**	**65.3**

*) Growers estimation

In orchard 3 apple scab symptoms where found on leaves in the planting year (1999) but never since. In most of the orchards some fruits with apple scab symptoms where found in the last four years. In orchard 1 to 8 the scab incidence kept at a low level. In orchards 9, 10 and 11 however scab incidence increased dramatically. In 2004 and 2005 in orchard 9 and 10 there a large part of the leaves dropped already in June because of severe apple scab infections.

Discussion and Conclusions

Looking for differences in the applied resistance management between the orchards where Vf was overcome, and those where scab incidence stayed at a low level, the most obvious difference is that orchard 9,10 and 11 did not receive fungicide applications on key moments during primary season. This seems to be the most important factor tot prevent the scab to build up in the Vf resistant orchard.
From these data no conclusions are possible on the contribution of sanitary measurements to the situation as also other orchards lacked these treatments. As outlined before, leaf degradation in organic orchards is very rapidly, and at but break very little leaves are still present, even without specific sanitary measures.
The relative large distance to susceptible orchards in the case of orchards 9 and 10 did not prevent the build-up of a Vf virulent scab population.

Our conclusion is that fungicide treatments on the major primary scab infections are the key factor in the resistance management on Vf resistant apple varieties. This conclusion is supported by the observation that in north western Europe both on isolated Vf resistant trees planted in private gardens, and Vf resistant orchards blocks planted at research institutes or on commercial fruit farms that do not receive any fungicide treatments, apple scab mostly develops within a few years.

From a practical viewpoint these early season fungicide applications are also necessary for the control of powdery mildew, as the main Vf- resistant apple cultivars appear to be relatively susceptible to powdery mildew.

Leaving Vf resistant apple cultivars completely unsprayed as still is done on many research stations in Europe, as well as in private gardens is unwise, and poses a great danger on the commercial Vf resistant orchards in the region. For private gardens apple varieties with field resistance to apple scab should be advised, not Vf resistant varieties.

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