Effect of different treatments with oil cakes, plant protection agents and potassium phosphite to control collar rot on Topaz

M. Kelderer[1] & E. Lardschneider[2]

Abstract

*At the end of the 1990s the apple scab-resistant variety Topaz appeared in the apple variety assortment of organic growers in Northern Europe. The variety was accepted due to its resistance to apple scab (*Venturia inaequalis*), its taste and appearance, but soon it became clear that it was extremely susceptible to collar rot (*Phytophthora cactorum*). Already after a few years high tree losses were recorded especially in orchards at replant sites. Different approaches were tested to solve this problem, and satisfactory results were achieved with both copper and Potassium-phosphite treatments. In practice, the problem was eventually solved by using adequate interstem/rootstock combinations.*

Keywords: apple, Topaz, collar rot, oil cakes, lime sulphur, copper, potassium phosphite, calcium hydroxyde, interstem

Introduction

Topaz is a relatively new apple variety developed within the breeding program of the Institute for Experimental Botany in Prague, Czeck Republic. The variety was developed in 1984, and reached Western Europe in the 1990s. Besides for apple scab resistance, the major variety-testers of the European testing facilities certified the variety for acceptable yields, adequate shelf life, and, above all, for its excellent taste and good appearance (Kellerhals et al. 1998, Kemp 1998, Ruess 2002, Stainer et al. 2002). Organic apple growers quickly became interested in this variety. Evidence for their interest are the Topaz Project in Austria (www.agrarprojektpreis.at/page-256.htm) and the numerous new plantings that were established in Germany and Switzerland at the end of the 1990s The initial enthusiasm was soon dampened by the negative characteristics of the variety, and its susceptibility to collar rot (*Phytophthora cactorum*) constituted one of the major problems. Already after a few years, first tree losses were observed, particularly in orchards at replant sites. Tree losses reached 2-digit percentages already after 3 to 4 years. In order to establish the efficacy of different control tools in suppressing collar rot on Topaz, an experimental orchard was established in 2002 in Vinschgau (South Tyrol, Italy). In a first trial the following substances were tested: the plant protection products copper (4 kg pure copper per hectare per year), Calcium-hydroxide, Lime sulphur, and organic fertilizers, known for their activity against collar rot from previous studies (Sharma & Sharma 2003). A second trial was started in 2005 in the same experimental orchard. This second trial aimed at evaluating the efficacy of Potassium phosphite-based treatments in controlling collar rot, and at verifying the possible build-up of phosphoric acid residues in fruits.

All tested products can either be used in organic farming or are under discussion for inclusion into the list of products allowed in organic farming.

Until nowadays in Western Europe approximately 500 ha are cultivated with Topaz (F. Prem 2009, pers. comm.), with the majority being cultivated organically.

[1] M. Kelderer, VZ-Laimburg, 39040 Post Auer, Südtirol, Italien; Markus.Kelderer@provinz.bz.it
[2] E. Lardschneider, VZ-Laimburg, 39040 Post Auer, Südtirol, Italien; Ewald.Lardschneider @provinz.bz.it

Material and Methods

The trial was carried out on the apple variety Topaz in an organic orchard in Naturns (Vinschgau, South Tyrol, Italy). Standard agricultural practices were applied to the study orchard, which is located in the plains of the valley, 540 m above sea level. Mean yearly rainfall amounts to 493 mm, and mean yearly temperature to 9.4°C. The trees grafted onto rootstock M9 were planted in 2002. Distance between rows was 3 m, and the planting distance 1 m.

In trial no. 1, all treatments were tested starting in the planting year (2002). A completely randomized block design was used with 4 replications per treatments and 25 trees per plot. The plant protection products were applied with a knap sack sprayer brand “Solo” by spraying the lower part of the tree trunks up to the first branches close to run-off. The treatments were made in spring and autumn. The total applied water volume was 300 l/ha. The fertilizers, instead, were applied manually in autumn. The tested products and applied dose rates are reported in table 1. In each plot, the number of healthy and collar rot-infested trees was counted at the end of each growing season (from 2004 and 2007), in order to determine the percentage of infested trees in each year and overall percent collar rot infestation in the study period 2004 - 2007.

Table 1: treatments and application rates tested in trial no. 1

Active substance	Commercial name	Producer	Applied rate
Copper + lineseed oil*	Poltiglia bordolese	Manica	3 kg/hl
Lime sulphur	Calcium	Solfotecnica	10 kg/hl
$Ca(OH)_2$	Calce fiocco	Manica	10 kg /hl
Castor meal (6% N)	Castor meal	Alberdingk Boley	150 g / tree
Canola meal (5% N)	none (Land. Hauptverband)	not known	180 g / tree
Control	-	-	-

* 10l/hl mineral oil + 1kg/hl Lecithin were added as adjuvants.

Trial no. 2 started in 2005 and was conducted in a different area within the same study orchard. A large-plot design with 100 plants per plot per treatment was used to compare Potassium-phosphite to an untreated control (Table 2). In any year, the product was applied immediately after bloom. The plant protection products were applied with a knap sack sprayer brand “Solo” by spraying close to run-off. The total applied water volume was 1500 l/ha by a tree height of 2,5 m. Assessments were made in autumn by counting the number of trees infected by collar rot in each treatment and year from 2005 to 2009. The percentage of infested trees in each year and the overall percent collar rot infestation in the study period 2005-2009 was then calculated. Furthermore, in order to verify the possible build-up of phosphoric acid residues in fruits from trees treated with Potassium-phosphite, fruit samples were analyzed for the presence of phosphoric acid at harvest by using the method based on extraction in water and detection via ion chromatography described in Kelderer et al. 2006.

In trial no. 1, the percentages of infested trees recorded in each year and overall percent tree infestation in the study period 2004-2007 were compared across treatments using 1-way ANOVAs followed by Student–Newman–Keuls’ test for post hoc comparison of means

(P<0.05). To improve homoschedasticity, data were arcsen(radq(x/100))-transformed. Data were statistically analyzed using the statistics package PASW 17.

In trial no. 2, data were not statistically analyzed, because samples could not be considered independent samples.

Table 2: treatments and application rates tested in trial no. 2

Active substance	Commercial name	Producer	Applied rate (g/hl)
Potassium phosphite	Fosfid'Or (62% H_3PO_3)	Agrimport	410
Control	-	-	-

Results

In trial no. 1, the first symptoms of collar rot appeared 3 years after planting (2004). Infested trees were observed in the plots treated with Lime sulphur (1.1%), castor meal (2.3%), canola meal (2.3%), and in the untreated control plots (2.2%). However, disease pressure was low, and differences among treatments were not significant (Table 3). Similar results were obtained in 2005 and 2006: no statistically significant differences among treatments were recorded, but first disease symptoms were observed also in the plots treated with Calcium-hydroxyde, while the copper-treated plots remained free of collar rot. In 2007, disease pressure suddenly increased: in autumn, the percentage of collar rot-infested trees reached 2-digit values in the untreated control and in some of the other treatments, and first symptoms were observed also in the copper-based treatment (1.1% infested plants). Differences among treatments in the percentage of infested trees became significant in 2007: the infestation was significantly lower in the copper treatment than in all the other treatments, with the latter not differing significantly from each other. Comparable results were obtained for overall tree infestation, with the copper-based treatment providing best disease control (Table 3).

Tab 3: mean percentage of collar rot-infested trees in the different treatments and years, and overall percent infestation in the study period 2004-2007 (trial no. 1). Different letters within the same column indicate statistically significant differences (Student-Newman-Keuls' test: P<0.05).

% Infestation										
Treatment	**2004**		**2005**		**2006**		**2007**		**Total**	
Copper + linseed oil	0,0	a	0,0	a	0,0	a	1,1	a	1,1	a
Lime sulphur	1,1	a	0,8	a	2,3	a	13,6	b	19,5	b
Ca(OH)2	0,0	a	1,1	a	1,1	a	21,9	b	25,0	b
Castor meal 6% N	2,3	a	2,4	a	2,5	a	11,0	b	19,3	b
Canola meal 5% N	2,3	a	0,0	a	3,2	a	8,2	b	16,1	b
Control	2,2	a	2,4	a	3,2	a	13,0	b	22,9	b
Stderr	0,43		0,49		0,62		0,62		2,32	

In trial no. 2, first disease symptoms were detected 3 years after the beginning of the trial. In 2007, the percentage of infested trees was 4.9% in the untreated control plot and 1.1% in the plot treated with Potassium-phosphite (Table 4). Collar rot attack increased over the following years. Overall infestation during the study period reached 42.6% in the untreated control plot, while in the plot treated with Potassium-phosphite only 4.3% of the trees were attacked by collar rot. In the first 4 study years, no residues of phosphoric acid were

detected in the fruit samples at harvest, while HPO residue levels amounted to 2.3 mg/kg in 2009.

Table. 4: Percentage of collar rot-infested trees in the different treatments and years, and overall percent infestation during the study period 2005-2009 (Trial no. 2).

% Infestation						
Treatment	**2005**	**2006**	**2007**	**2008**	**2009**	**Total**
Potassium phosphite	0	0	1,1	2,2	1,1	4,3
Control	0	0	4,9	20,7	25,6	42,6

Discussion

In our trials Lime sulphur, Calcium-hydroxyde und the tested oil cakes did not provide satisfactory control of collar rot on the apple variety Topaz. A significant reduction of the percentage of infested trees was obtained only with copper (trial no. 1) and Potassium-phosphite (trial no. 2). The use of both active substances in organic farming is currently under discussion due to several reasons. At the moment, copper can be applied on fruit crops for the control of fungal diseases, but due to ecotoxicological and environmental issues many countries would like to withdraw the active substance. Potassium-phosphite may constitute an adequate alternative also against collar rot on Topaz, but currently this active substance is not listed in Annex II of the European regulation for organic farming. People operating in the sector of organic farming (vine growers excluded) are extremely sceptical about the use of Potassium-phosphite, because in many cases the substance leaves detectable residues in the harvested crop. In our trial, detectable residue levels in fruit were found only in the last study year. To basically reduce the disease, since a number of years the nurseries provide trees with the variety grafted on an interstem. Contrary to what was observed by other authors on the effects of interstem length on collar rot occurrence (Sharma & Sharma 2003), in this case the problem could be solved almost completely (R. Stainer, pers. comm., 2002).

References

Ellis M. A. Ferree, D. C., Madden L. V. (1986). Evaluation of metaxyl and captafol soil drenches, composted hardwood bark soil amendments, and graft union placement on control of apple collar rot; *Plant Disease* Vol. **70**, (1), 24-26

Kelderer M., Matteazzi A., Casera C. (2006). Effects of the period of application of K-phosphite on residues on apple fruits. 12th International Conference on Cultivation Technique and Phytopathological Problems in Organic Fruit-Growing, Fördergemeinschaft Ökologischer Obstbau e. V. Weinsberg, (12), 225-227

Kellerhals M., Goerre, M., Krebs, C. (1998). Scab resistant apple varieties: quality, performance and mildew susceptibility; *Obst-und Weinbau*, **134 (3)**, 68-70

Kemp H. (1998): Santana and topaz at present the only suitable cultivars with scab resistance; *Fruitteelt* (Den Haag), **88**, 15, 13-15

Ruess F. (2002). Ertrag und Qualität neuer schorfresistenter Apfelsorten; Ecofruit – 10th International Conference on Cultivation Technique and Phytopathological Problems in Organic Fruit-Growing: Proccedings to the Conference from 4th February to 7th February 2002 at Weinsberg/Germany, 11-15

Sharma A.; Sharma S. K. (2003). Effekt of oil cakes on soilborne disease management and soil microflora in apple; Proceedings of the 7th International Symposium on temperate zone fruits in the tropics ad subtropics; October 14-18, 2003; 341-347

Stainer R., Sansavini S., Pellegrino S. (2001). Il rinnovamento varietale del melo accelerato dall'evoluzione del mercato mondiale; *Rivista di Frutticoltura e di Ortofloricultura*, **63** (7/8), 9-20