Efficacy evaluation of plant protection products for Alternaria blotch (*Alternaria spp*) control in organic apple production

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Abstract

An increased occurrence of the fungal disease Alternaria *blotch of apple, sometimes resulting in severe production losses, has been observed in South Tyrol in recent years. In integrated production, up to now the disease could be effectively contained with the fungicides currently available on the market. The studies conducted in 2010 and 2011 aimed at evaluating the efficacy of several plant protection products allowed in organic farming against* Alternaria *blotch of apple. Lime sulphur and acid clay were tested in both 2010 and 2011. Potassium bicarbonate was tested only in 2010, while algae extract and copper sulphate were tested only in 2011. Up to now, satisfactory results were obtained only with the acid clay-based product Ulmasud.*

Keywords: Apple, Alternaria, Acid clay, Ulmasud, Lime sulphur

Introduction

The fungal species belonging to the genus Alternaria are pathogenic fungi affecting plants of worldwide distribution (Jones *et al*., 1997). Several different cultivated crops are affected. Especially hazardous for fruit growing, and thus also for the fruit growing area South Tyrol, is the species *Alternaria alternata* apple pathotype (*Alternaria mali* Roberts). In the orchards in South Tyrol, the first records of this disease occurred at the beginning of the 1990-ies. Initially the disease appeared only in isolated orchards, but soon it spread over the entire area. Infections are most severe on the cultivars Gala, Golden Delicious, and Crips Pink, and occasionally also Granny Smith can be affected (Marschall *et al*., 2004).

A. alternata is commonly regarded as a weakness parasite. It develops and overwinters saprophytically on non-living organic matter and in soil, and spreads by forming numerous spores producing host-specific toxins during germination, which are responsible of its pathogenicity.

Affected fruits exhibit brown or black circular, pinpoint-sized spots, frequently with brown or red borders, on lenticels. Affected leaves exhibit brown spots that later enlarge and finally result in leaf drop. First symptoms of infection usually appear in spring on leaves and/or fruits, from end of flowering to mid June. Under conditions of warm temperatures and adequate humidity, damage increases over time up to harvest (Marschall *et al.,* 2006).

In integrated production systems, acceptable levels of control can be achieved with the fungicides currently available on the market. In organic production, instead, studies on adequate and effective control strategies are still in progress.

Material and methods

The studies on the efficacy evaluation of plant protection products for Alternaria blotch control in organic production were conducted in 2010 and 2011. The trials were conducted in an apple cultivar Golden Delicious orchard (rootstock: M9) located in Auer (South Tyrol, Italy). The study orchard had been planted in 2000. In addition to the treatments for Alternaria blotch control, all treatments commonly applied in organic orchards were carried out during the primary season (from June to September), while no additional fungicide

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sprays were applied during the secondary season. The active ingredients of the formulated products tested in 2010 and 2011, product names, distributors, and tested field rates are reported in Table 1 and 2.

Table 1: Description of the plant protection products tested in 2010

Active ingredient	Product name	Distributor	Applied rate (/100 l)
Lime sulphur	Polisolfuro di Calcio	Polisenio	1 kg, after July 0,8 kg
Acid clay	Ulmasud	Biofa	1 kg
Potassium bicarbonate	Vitisan	Biofa	1 kg
Untreated Control	-	-	-

Table 2: Description of the plant protection products tested in 2011

Active ingredient	Product name	Distributor	Applied rate (/100 l)
Lime sulphur	Polisolfuro di Calcio	Polisenio	1 kg, after July 0,8 kg
Acid clay	Ulmasud	Biofa	1 kg
Alga extract	RB1	ICAS	400 ml
Copper sulphate (20%)	Poltiglia Disperss	Cerexagri	100 g
Untreated Control	-	-	-

In both study years, a randomized block design with 4 replicates of 10 trees each per treatment was used. To prevent biasing of data due to border effects, each experimental plot was shielded from the other plots by additional trees and rows. Treatments were applied using a motorized sprayer for experimental trials and a spray volume of 1500 l/ha. All treatments were applied at weekly time intervals from June to September in 2010 and from June to mid August in 2011.

In both study years, assessments on Alternaria blotch were conducted at the end of August by counting the number of infected fruits and leaves on respectively ca. 200 fruits and 40 shoots. The percentage of infected fruits and leaves was then calculated.

The percentages of infected fruits and leaves recorded in the two study years were compared across treatments using 1-way ANOVAs, followed by Tukey's test for post-hoc comparisons of means.

Results

In 2010, 25% of fruits were infected by *Alternaria* blotch in the untreated control. Ulmasud considerably reduced the percentage of infected fruits (10%), but differences among treatments failed significance due to high variability among plots (Table 3). In 2011, the percentage of diseased fruits in the untreated control amounted to 14%, and was significantly lower in plots treated with Ulmasud (1.4%) than in untreated control plots (Table 5).

In 2010, the percentage of infected leaves was significantly lower in plots treated with lime sulphur and Ulmasud than in untreated control plots (Table 4). The efficacy of Ulmasud in reducing percent leaf infection was confirmed also in 2011 (Table 6): in the plots treated with the acid clay-based product, 57% of leaves showed disease symptoms, while leaf infection was highest in the plots treated with the RB1-based product (81%).

Trial 2010

Table 3: Percentage of fruits infected by Alternaria blotch in the different treatments in 2010

Treatment	% affected fruits	N	Std. Deviation	Std. Error of Mean	Tukey HSD*
Lime sulphur	25.2	4	11.0	5.5	a
Ulmasud	10.0	4	6.5	3.3	a
Vitisan	23.4	4	4.7	2.4	a
Untreated control	25.2	4	5.7	2.8	a

* Different letters indicate statistically significant differences (Tukey HSD test: P=0.05)

Table 4: Percentage of leaves infected by Alternaria blotch in the different treatments in 2010

Treatment	% affected leaves	N	Std. Deviation	Std. Error of Mean	Tukey HSD*
Lime sulphur	93.5	4	3.2	1.6	a
Ulmasud	93.2	4	3.7	1.8	a
Vitisan	99.0	4	.1	.0	b
Untreated control	98.9	4	.9	.5	b

* Different letters indicate statistically significant differences (Tukey HSD test: P=0.05)

Trial 2011

Table 5: Percentage of fruits infected by Alternaria blotch in the different treatments in 2011

Treatment	% affected fruits	N	Std. Deviation	Std. Error of Mean	Tukey HSD*
Lime sulphur	11.0	4	4.8	2.4	ab
Ulmasud	1.4	4	1.8	.9	a
RB1	9.5	4	4.7	2.4	ab
Copper	5.9	4	4.0	2.0	ab
Untreated control	13.9	4	6.2	3.1	b

* Different letters indicate statistically significant differences (Tukey HSD test: P=0.05)

Table 6: Percentage of leaves infected by Alternaria blotch in the different treatments in 2011

Treatment	% affected leaves	N	Std. Deviation	Std. Error of Mean	Tukey HSD*
Lime sulphur	67.3	4	9.5	4.8	ab
Ulmasud	56.9	4	10.1	5.0	a
RB1	81.0	4	4.7	2.3	b
Copper	72.9	4	9.6	4.8	ab
Untreated control	71.0	4	10.9	5.5	ab

* Different letters indicate statistically significant differences (Tukey HSD test: P=0.05)

Discussion

Alternaria blotch is considered one of the major problems on apple in South Tyrol. In recent years, in addition to infection on leaves, disease symptoms appeared with increased frequency also on fruits, often resulting in up to 100% fruit damage.

In the trials conducted in 2010 and 2011, the fungicides most commonly used in organic farming, that is lime sulphur, copper, potassium bicarbonate and acid clay, were tested for Alternaria blotch control. The products were applied during summer, in some cases by using high field rates and application frequencies. The acid clay-based product Ulmasud was the only fungicide showing acceptable levels of disease control, with a mean efficacy according to Abbott (1925) on fruits of approximately 60% in 2010 and 90% in 2011.

Additional studies are needed to evaluate the efficacy of copper, because in the trials herein reported this active substance has been tested at a relatively low field rate (20 g copper/100 l). In previous studies conducted on pear in Emilia Romagna (Italy), copper applied at higher field rates provided extremely promising control of *Stemphylium vesicarium* (Antoniacci *et al.,* 2006), a fungus with a disease progression very similar to that of Alternaria blotch.

In addition to the evaluation of new biological plant protection products, future studies focusing also on the efficacy of sanitary measures for the control of Alternaria blotch, are warranted.

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