

# REPCO contribution to the development of products for apple scab control

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**Abstract** – Natural compounds were sprayed according to the RimPro scab warning system from start of bud break until the mid of June. Scab incidence was measured on the leaves and the fruit. Phytotoxicity and russeting was assessed. The natural compounds were sprayed together with sulphur and were compared with the standard biological fungicides copper hydroxide and sulphur alone. Compound E73 + sulphur was the most effective on fruit. Armicarb and Resistim both sprayed with sulphur were comparable in efficacy with Funguran-OH. In our study laminarin (GL 32) did not show any effect on the control of scab on apple.<sup>1</sup>

## INTRODUCTION

Apple scab, caused by *Venturia inaequalis* (Cooke) G. Wint., is one of the most important diseases on apple. *V. inaequalis* infects both leaves and fruit, resulting in severe yield losses and reduced fruit market value. Currently, the strategy for apple scab control relies on multiple applications of fungicides. Also organically grown apples are sprayed with fungicides like sulphur, lime sulphur and copper. Copper is an effective product against apple scab, but because of the environmental pollution and residual effects it is not allowed in the Netherlands and Denmark (Holb et al., 2003). In other European countries the organic apple growing strongly depends on copper fungicides with application of a total of 38 kg copper per ha permitted between 2002 and 2006. But permitted amounts will be reduced stepwise during the following years to avoid environmental risks (Council Regulation (EEC) 2092/91, Annex II). The objective of this study is to find an alternative to copper against apple scab in a modern orchard system by using a product combined with sulphur applications.

## MATERIALS AND METHODS

### *Orchard and equipment*

A field experiment was carried out the summer epidemic of 2004 in the organic orchard of PPO in Randwijk, The Netherlands, during the summer epidemics. The experiment was done on Jonagold (*Malus x domestica* Borkh.) on M 27 rootstock and pruned as slender spindles. Treatments were applied with a handheld spray gun (manufacturer EMPASS, Veenendaal, The Netherlands) with a 1.2 mm ceramic hollow cone nozzle at 1.1-1.2 MPa with a volume of 1000 litre ha<sup>-1</sup>. Spray volumes were cali-

brated depending on the number of trees per hectare. Apple scab infection periods were determined the RimPro warning system (Trapman, 1994).

### *Treatments*

Seven treatments were replicated 6 times, completely randomised within blocks in 2004. Each plot consisted of 5 trees. Observations were only made on the three middle trees of each plot. The treatments were started from start of bud break until 10 June 2004. The treatments that were carried out were: 1) untreated, 2) copper hydroxide (0.2 kg/ha; Funguran-OH), 3) sulphur (4 kg/ha; Thiovit Jet), 4) Potassium bicarbonate (6 kg/ha; Armicarb) and sulphur (4 kg/ha; Thiovit Jet), 5) Potassium phosphonate (2 l/ha; Resistim) and sulphur (4 kg/ha; Thiovit Jet), 6) laminarin (1.5 l/ha; GL 32) and sulphur (4 kg/ha; Thiovit Jet) and 7) E73 (7.5 l/ha) and sulphur (4 kg/ha; Thiovit Jet). Treatments 4, 5, and 6 are combination treatments of a natural compound with sulphur. The natural compound was applied in a more or less weekly schedule. Sulphur was sprayed preventively just before a scab infection period according to the RimPro scab warning system. Treatment 7 was also a combination of a natural compound with sulphur, but was sprayed as a tank mix just before a scab infection. The treatments 2 and 3 were sprayed when an infection was expected. All treatments received 4-5 kg/ha wettable sulphur at weekly intervals from the end of June till harvest on 27 September in 2004. Sulphur was sprayed more frequent during rainy periods.

### *Measurements*

Fifty spur leaf clusters and leaves of thirty extension shoots randomly chosen were assessed. The scab incidence of leaves was calculated as the percentage of leaves diseased. Percentage of diseased fruits was assessed by assessing all the fruits from the 3 middle trees per plot. Scab incidence of fruit was calculated as the percentage of fruit diseased. Flower phytotoxicity was scored by estimating the frequency and intensity of the damage. The three middle trees within a plot were assessed according to the following scale: 0 = No phytotoxicity (pt), 1 = Light pt (1-10%), 3 = Moderate pt (10-33%), 5 = Heavy pt (>33%). For each plot the mean phytotoxicity was calculated. The amount of russeting of the fruit was determined from all the fruits from the 3 middle trees of a plot. The fruit were assessed according to the following scale: 1 = non russet (0%), 2 = light russet (1-10%), 3 = moderate russet (11-33%), 4 =

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heavy russet (>33%). The russetting was expressed as a russet index (RI). The RI = [(number of fruits in scale 1 x 1) + (number of fruits in scale 2 x 3) + (number of fruits in scale 3 x 5) + (number of fruits in scale 4 x 7)]/ total number of fruits.

The apples without scab and less than 10% russet yield in the highest profit and are classified as class 1 apples. The percentage of class 1 apples was calculated by dividing the apples without scab and less than 10% russet from the total number of fruit.

All data were subjected to analysis of regression. T-probabilities were calculated for pair wise comparison of treatment means. Significant F-tests (P < 0.05) were followed by a Least Significance Difference (LSD)-test for pair wise comparisons of treatment means using LSD<sub>0.05</sub> values.

## RESULTS AND DISCUSSION

The treatments with potassium bicarbonate and E73 gave the best scab control. Potassium bicarbonate + sulphur had significant lower scab infestation than copper on the leaves but not on the fruit, E73 + sulphur only on the leaves of the extension shoot and on the fruit but not on the cluster leaf. The treatment potassium phosphonate + sulphur was comparable with copper in efficacy. Laminarin together with sulphur gave no better control than sulphur alone. Copper gave a better control than sulphur (Table 1).

Table 1. Effect of treatments on incidence of apple scab

2004	Cluster leaf	Leaf of extension shoot	Fruit
Treatment schedules	Incidence (%)	Incidence (%)	Incidence (%)
Untreated	21.9 h	85.6 e	96.6 e
Copper	2.2 bcd	25.4 b	39.9 b
Sulphur (TJ)	5.2 ef	47.1 cd	73.5 cd
Potassium bicarbonate + TJ	0.3 a	13.7 a	35.0 b
Potassium phosphonate+ TJ	2.0 bc	19.1 ab	42.0 b
GL 32 + TJ	2.8 cde	38.0 c	65.7 c
E73+ TJ	0.7 ab	13.5 a	14.8 a
F-test	<0.001	<0.001	<0.001

Table 2: Effect of treatments on flower phytotoxicity, fruit russet index and percentage class 1

2004	Flower Phytotoxicity (0-5)	Fruit Russet (1-4)	Yield Class 1 (%)
Treatment schedules	Phytotoxicity (0-5)	Russet (1-4)	Yield Class 1 (%)
Untreated	0.0 a	2.00 a	3.3 a
Copper	0.2 a	3.13 cd	44.1 ef
Sulphur (TJ)	0.0 a	2.26 a	23.6 bc
Potassium bicarbonate + TJ	4.0 c	3.93 e	35.2 de
Potassium phosphonate+ TJ	1.2 b	2.26 a	51.4 f
GL 32 + TJ	0.0 a	2.34 ab	30.4 cd
E73+ TJ	0.7 ab	3.45 d	53.0 f
F-test	<0.001	<0.001	<0.001

The treatments potassium bicarbonate and potassium phosphonate had the highest phytotoxicity on flowers. This did not result in a lower yield per plot (data not shown). Fruit treated with copper, potassium bicarbonate and E73 showed significant more russetting than untreated fruit. The amount of russetting after treatment with potassium phosphonate + sulphur was not significant different from untreated. Potassium bicarbonate gave significantly more russetting than copper. E73 was not significantly different from copper. Although the percent-

age infected fruit of the treatment potassium phosphonate was significantly higher than for the E73 treatment, the percentage fruit in class 1 was not significantly different for this treatment.

Disease pressure and the low dose of copper and sulphur contributed to the high percentage infected fruit. Copper and sulphur were sprayed at a low dose to allow the detection of additional effects caused by the test compounds. In spite of the high disease pressure the use of natural compounds compared with sulphur gave significant control of scab in 2004. The natural compounds were sprayed together with sulphur because it was expected that the efficacy of natural compounds would not be strong enough when they were sprayed alone in an orchard with a high infection risk.

Potassium bicarbonate and E73 gave more russetting compared with untreated and sulphur. The first period up to 4-6 weeks after the bloom is a very sensitive period for russetting of the apples. It might be possible to use other products in that period and use potassium bicarbonate or E73 afterwards to achieve the most effective control schedule with less russetting. The efficacy of potassium bicarbonate against scab was also found before (Heyne et al., 2006; Klederer et al., 2006; Tamm et al., 2006).

## CONCLUSIONS

E73 + sulphur was the most effective compound on fruit. Potassium bicarbonate and potassium phosphonate both sprayed with sulphur were comparable in efficacy with copper. In our study laminarin (GL 32) did not show any effect on the control of scab on apple.

## ACKNOWLEDGEMENT

This work is funded by the European Commission (Project No 501452; Repco) and the Dutch Ministry of Agriculture, Nature and Food quality. We thank R. Anbergen, J. Simonse and M. Trapman, Bio Fruit Advies for their work within this project.

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