

Organic apple growing using sanitation treatments against apple scab

Abonyi, F. & Holb, I.J.

Debrecen University, Centre of Agricultural Sciences, H-4015 Debrecen, 138 Böszörményi Street 138, Hungary;
holb@agr.unideb.hu

Summary: Effects of sanitation practices were evaluated on primary and autumn infection by *Venturia inaequalis* in an organic apple orchard at Eperjeske on the moderately scab-susceptible apple cultivar Jonathan in 2005 and 2006. Evaluated sanitation practices were: i) collection of fallen leaves in autumn; ii) destroying fallen leaves by disc cultivation in autumn; iii) spraying fallen leaves with 2% lime sulphur in autumn; iv) spraying fallen leaves with 2% lime sulphur in autumn and then collection of fallen leaves in autumn; and v) untreated control. In both years, most sanitation practices reduced significantly ($P < 0.05$) scab incidence in the primary infection periods compared to untreated control. The highest leaf scab incidence was observed in the untreated plots (26.2 and 24.3% in 2005 and 2006, respectively), while the lowest was in the treatments of spraying fallen leaves with 2% lime sulphur combined with collection of fallen leaves (11.7 and 12.3% in 2005 and 2006, respectively).

Key words: leaf litter density, ascospore production, apple scab, *Venturia inaequalis*, disease incidence, environmentally-benign apple production, high density apple orchard, *Malus x domestica* Bork.

Introduction

Apple scab, caused by *Venturia inaequalis* (Cooke) G. Wint., is one of the most important diseases of apple. In organic apple orchards, 10–26 sprays are applied against apple scab in each season (Ellis et al., 1998; Holb & Heijne, 2001; Holb et al., 2003).

Scab disease management in an organic orchard is highly dependent upon control strategy applied during the primary infection season. As approved fungicides against apple scab are not effective enough in organic apple production, scab-resistant cultivars are suggested to be planted and non-chemical control options are offered for reducing primary inoculum sources (Ellis et al., 1998; Holb & Heijne, 2001; Holb et al., 2003, Holb, 2005, 2006). Apple scab fungus survives on fallen leaves on the orchard floor; therefore, eradication of leaf litter from the orchard floor is a possible control option (Curtis, 1924). Only non-chemical sanitation practices can be used as eradication methods in organic orchards (Anonymous, 1989); therefore, possible non-chemical and simple sanitation practices are eradication of fallen leaves by collection, burning, disc cultivation, ploughing, shredding, lime sulphur or applying antagonists. In early studies (Curtis, 1924), it was demonstrated that if burning, ploughing or collection of fallen leaves were applied separately, then primary inoculum source in the following year could be reduced with 40–70%. Leaf shredding has been investigated from the 1990's (Sutton & MacHardy, 1993; Vincent et al., 2004) and it was shown that leaf shredding resulted in a reduction of 40 to 95% and 45 to

85% in ascospore inoculum and in scab incidence next spring, respectively. Studies from the USA and Canada (Heye & Andrews, 1983; Vincent et al., 2004) showed that the most effective fungal antagonists were *Athelia* and *Microsphaeropsis* spp., with reduction in ascospore production of 70–85%.

The goal of the present study was to test the effect of non-chemical control practices (eradication of fallen leaves by collection, disc cultivation, shredding and lime sulphur) on primary and autumn infection by *V. inaequalis* in an organic apple orchard on a moderately scab-susceptible apple cultivar.

Materials and methods

Orchard site

The study was carried out in an organic apple orchard at Eperjeske in 2005 and 2006. Trees were on M.26 at Eperjeske and bare soil has been maintained in the rows and grass has been grown in the spacings between rows at Eperjeske. Trees were placed with a between-row spacing of 5 m, and a within-row spacing of 2 m in the experimental orchard. The orchard consisted of cvs. Jonagold, Mutsu, Jonathan and Prima. Observations were made on a moderately susceptible apple cultivar Jonathan. Trees were grown according to the Hungarian organic guidelines (Anonymous, 1997). Leaf wetness and temperature were recorded with a Pessl leaf wetness sensor and a digital hygrothermograph. Potential

scab infection periods were calculated from the temperature and leaf wetness data.

Treatments

In both locations, five sanitation treatments were prepared in four replicates in the autumns of 2004 and 2005. Treatments were prepared after leaf fall as follows:

- 1) collection of fallen leaves in autumn;
- 2) destroying fallen leaves by disc cultivation in autumn;
- 3) spraying fallen leaves with 2% lime sulphur in autumn;
- 4) spraying fallen leaves with 2% lime sulphur in autumn and then collection of fallen leaves in autumn;
- 5) untreated control.

Leaf collecting was performed mechanically on 26 November 2004 and 30 November 2005, after defoliation. Disc cultivation was done on 30 November 2004 and 22 November 2006. The orchard soil was sprayed with 2% lime sulphur on 25 November 2004 and 18 November 2005 by a field applicator spray machine.

Assessments and statistical analyses

Scab assessments were made on leaves in autumn and the following spring. Scab incidence in autumn was assessed on ten trees in each replicate on 22 October 2004 and 25 October 2005. Scab incidence in spring was assessed at the end of May in 2005 and 2006. Both in autumn and spring, 4 x 50 leaves per tree were assessed by calculating disease incidence. All data sets were subjected to analysis of variance using the Genstat 5 statistical package. Data were transformed and then significant F-tests were followed by a Least Significance Difference (LSD)-test for comparing the treatment means.

Results and discussion

Disease incidence in autumn

Leaf incidence in autumn 2004 ranged between 42.5 and 48.6% on cv. Jonathan among treatments (Figure 1). Leaf incidence was not significantly different ($P < 0.05$) among the treatments in 2004 (data not shown). Scab incidence ranged between 39.3 and 44.2% on cv. Jonathan in 2005 among treatments (Figure 2). In 2005, leaf incidence was not significantly different ($P < 0.05$) among the treatments (data not shown).

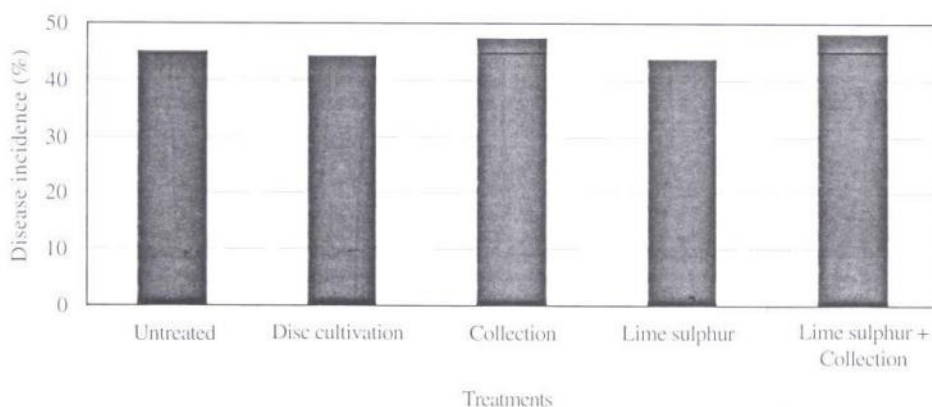


Figure 1 Scab incidence (%) in autumn in five sanitation treatments on cv. Jonathan at Eperjeske, 2004.

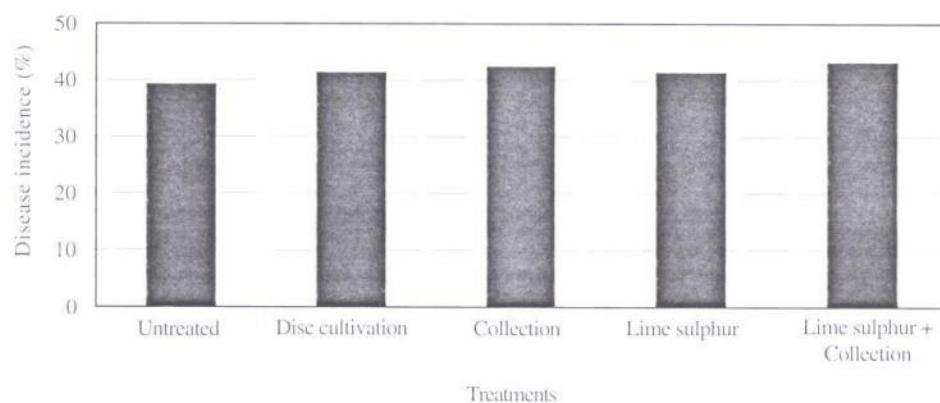


Figure 2 Scab incidence (%) in autumn in five sanitation treatments on cv. Jonathan at Eperjeske, 2005.

Disease incidence in spring

In both years, most sanitation practices reduced significantly ($P < 0.05$) scab incidence in the primary infection periods at the end of May compared to untreated control (Figures 3 and 4). The highest leaf scab incidence was observed in the untreated plots (26.2 and 24.3% in 2005 and 2006, respectively), while the lowest was in the treatments of spraying fallen leaves with 2% lime sulphur combined with collection of fallen leaves (11.7 and 12.3% in 2005 and 2006, respectively). Reduction of scab incidence was significant at $P < 0.01$ in the treatments of leaf collecting compared to untreated plots. Treatments of destroying leaves by disc cultivation and spraying with 2% lime sulphur showed the lowest efficacy in reducing scab incidence in spring (Figures 3 and 4); and their incidence values were significantly lower only in 2005 compared to incidences of untreated plots (data not shown).

Conclusions

This study demonstrated that all examined sanitation treatments reduced primary infection risk of *V. inaequalis* in early spring. However, efficacy of each treatment on scab incidence in spring and autumn was different. Leaf collection and its combination with lime sulphur spray resulted in the highest reduction of scab incidence in spring. In sum, this study showed that sanitation treatments have positive effects in

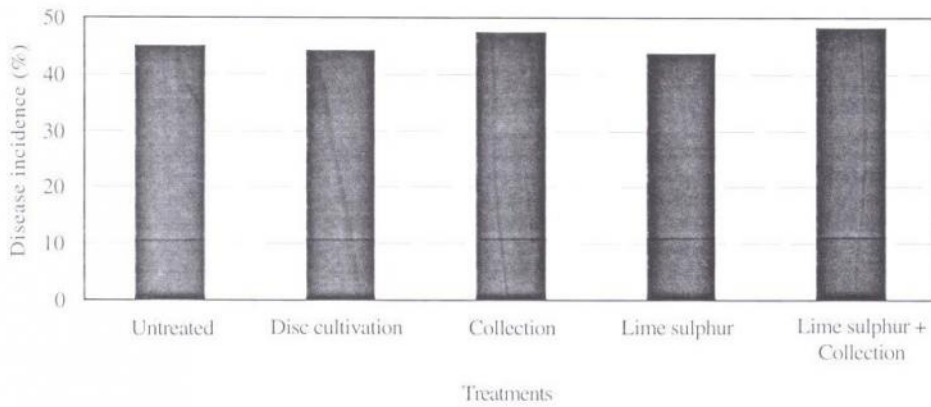


Figure 3 Scab incidence (%) in spring in five sanitation treatments on cv. Jonathan at Eperjeske, 2005.

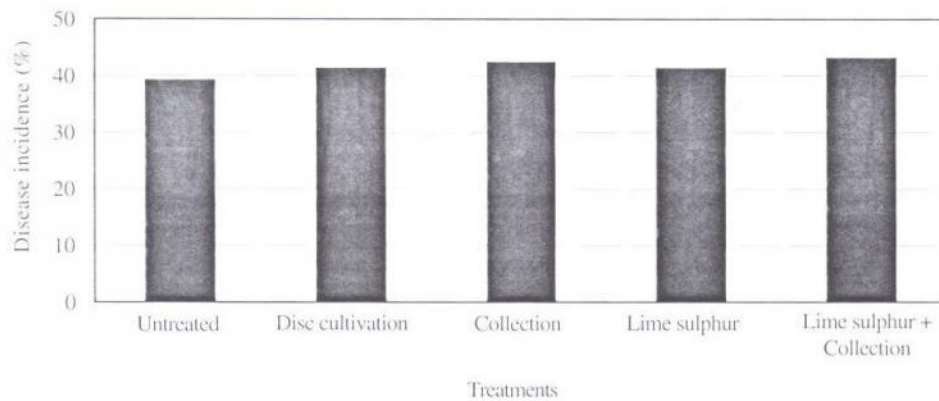


Figure 4 Scab incidence (%) in spring in five sanitation treatments on cv. Jonathan at Eperjeske, 2006.

reducing scab infection in the following spring; however, sanitation practices need to be complemented with other control strategies to further improve organic apple scab control.

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