International Journal of Horticultural Science 2014, 20 (1–2): 35–37.
Agroinform Publishing House, Budapest, Printed in Hungary
ISSN 1585-0404

Ascospore dispersal of *Venturia inaequalis* and subsequent development of scab symptoms in a Hungarian organic apple orchard

Holb, I.J., Rózsa, A. & Abonyi, F.

University of Debrecen, P.O. Box 36, H-4015 Debrecen, Hungary (e-mail: holb@agr.unideb.hu)

Summary: In this study, we aimed to study ascospore dispersal of *Venturia inaequalis* and subsequent disease development in an organic apple orchard (Eperjeske) in 2012 and 2013 on apple cultiva 'Mutsu). Burkard spore trap in March and April were used to monitior ascospore concentration and number of scab symptoms were assesed 20 May in both years. Three peaks were detected in ascospore dispersal in the period of examination which was clearly related to the Mills infection periods. On the basis of the incubation period's length in April (15–18 days), the appearance of first symptoms had direct connection with the peak of the ascospore discharge. The largest number of symptoms were observed on those parts of the orchards where where the inoculum sources were accumulated.

Keywords: ascospore, *Venturia inaequalis*, dispersal, organic apple, scab incidence

Introduction

The pseudothecia of the fungus, *Venturia inaequalis* (Cooke) G. Wint. mature on the overwintered, infected leaves on the soil from bud break. If 10–15% of the ascospores are mature, due to rain or significant dew they are ejected into the air to 4-30 mm distance (Aylor, 1990, 1993, 1995; Aylor and Anagnostakis, 1991; MacHardy, 1996; Holb 2004ab). The strength of ejection is supported by the movement energy originating from the osmotic potential of the asci (Aylor and Anagnostakis, 1991). The ascospores getting into the air in that way travel a long distance in the air before successfully reaching the young parts of a plant. This transportation is passive, the spores travel in a raindrop or are moved by the wind.
Keitt and Palmitter (1937) and Keitt et al. (1941) report about significant airborne travel. In the course of their examinations, Keitt and Palmitter (1937) recorded 55 scab lesions on the leaves per shoot in an untreated orchard of cultivar Wealthy. Four years later, Keitt et al. (1941) carried out fruit infection assessment in a plantation divided into two parts on the basis of the applied treatment. On the contrary, Hirst and Stedman (1962) found in their spore trap experiment that the increase in the number of symptoms due to the ascospores from the untreated part of the orchard was negligible in the neighbouring part of the orchard treated with DNOC. Burchill and Hutton (1965) stated/declared that the upper limit of ascospore spread is 15 m. 20 years later Kaplan (1986) recorded the number of ascospores by Burkard spore traps locatec at differen distances from the source of infection. In his orchard with culivar McIntosh he could gather only a minimal amount of ascospores at 21 m distance and the increase in the number of symptoms compared to the other parts of the orchard was insignificant.
In this study, we aimed to study ascospore dispersal of *V. inaequalis* and subsequent disease development in an organic apple orchard.

Materials and methods

Orchard site

The experiment was carried out in an organic orchard located at Eperjeske, Hungary. The orchard was planted with cultivars Mutsu, Jonathan, Prima on M26 rootstocks in 1997. The distance between rows was 5 m, and the distance between trees within a row was 2. The orchard was treated according to the Hungarian Organic Growing Guidelines derived from the IFOAM guidelines (Anonymous, 1989). The 1 ha experimental site was set in 2012 and 2013.

Ascospore concentration and weather

For measuring the ascospore concentration of the air we used Burkard seven day recording volumetric spore traps. From 10 March 21 April spore traps were located in the experimental orchard. The ascospore concentration was calculated by Aylor (1993). Weather conditions were evaluated by determining the Mills infection periods according to Mills and La Plante (1951).

Assessment of the number of symptoms caused by ascospores

The primary leaf bundles of the susceptible cultivar Mutsu were used as biological spore traps and assessed for symptoms. Symptoms were assessed on each second row and on each 10th tree within the row. On each selected tree 40 leaf cluster examined. Number of scab symptoms were determined in each leaf cluster. Assessment were made 4 weeks after the last operation of the spore trap (21 April).

Results

Ascospore concentration in the air

The results of the Burkard spore traps located at different distances were diverse from years. To ease the evaluation the results of spore trapping were combined and we represent one figure for the trappings *(Figure 1).*

One significant and two less significant peaks were detected in ascospore dispersal in the period of examination. The first peak was in mid March, the second at end-March, while the third occurred at mid-April. The number of ascospores in the air are increased with time.

In 2012 the Mills infection periods were severe, medium and low, 3, 4 and 5 times, respectively during 10 March until 30 April. While in 2013 the Mills infection periods were severe, medium and low, 2, 4 and 6 times, respectively during 10 March until 30 April.

Number of symptoms

The first symptoms were detected on 27 April and 5 May in 2012 and 2013 on cv. Mutsu. On the basis of the incubation period's length in April (15–18 days), the appearance of first symptoms had direct connection with the peak of the ascospore discharge (mid-April) in the spring of both years *(Figures 1 and 2).* The symptom number at 20 May ranged between 0 and 20 and it was very heterogeonous in the assessed area *(Figure 2).* The largest number of symptoms (20 scab lesion per leaf cluster) were observed on those parts of the orchards where the largest number of susceptible cultivars were planted and where the inoculum sources were accumulated *(Figure 2).*

Conclusions

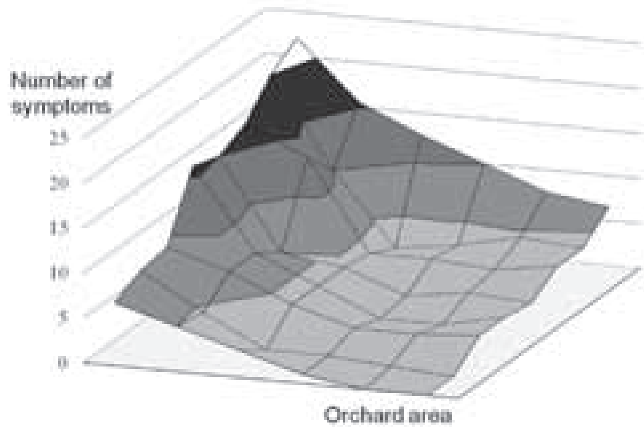

Figure 2: Number of scab symptoms on 20 May on cv. 'Mutsu' in an organic apple orchard (Eperjeske, 2012 and 2013, combined data)

Three peaks were detected in ascospore dispersal in the period of examination which was clearly related to the Mills infection periods.

On the basis of the incubation period's length in April (15–18 days), the appearance of first symptoms had direct connection with the peak of the ascospore discharge.

The largest number of symptoms were observed on those parts of the orchards where where the inoculum sources were accumulated.

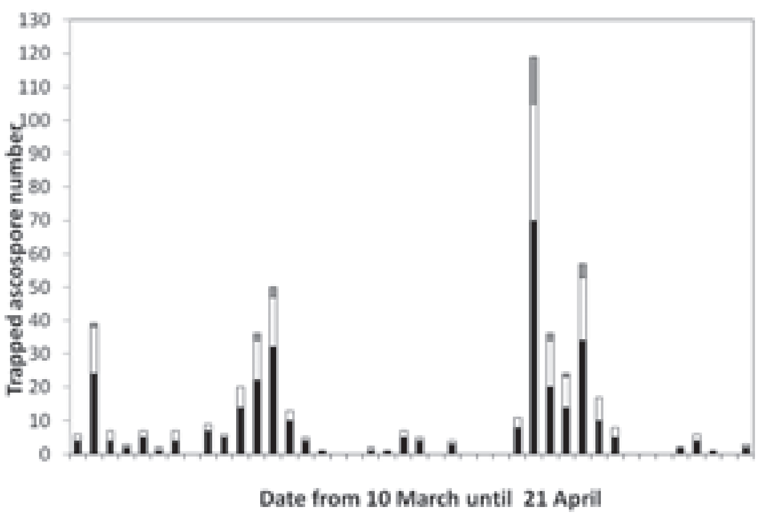

Figure 1: Ascospore dispersal of *Venturia inaequalis* from 10 March until 21 April in an organic apple orchard (Eperjeske, 2012 and 2013, combined data)

Acknowledgements

This research was supported partly by a grant of the Hungarian Scientific Research Fund (OTKA K108333), EU7 PURE programme and by the European Union and the State of Hungary, co-financed by the European Social Fund in the framework of TÁMOP-4.2.4.A/ 2-11/1-2012-0001 'National Excellence Program' under the project number: A2-SZJ-TOK-13-0061.

References

Aylor, D. E. (1990): The role of intermittent wind in the dispersal of fungal pathogens. Ann Rev Phytopathol 28: 73–92.

Aylor, D. E. (1993): Relative collection efficiency of Rotorod and Burkard spore samplers for airborne *Venturia inaequalis* ascospores. Phytopathology 83: 1116–1119.

Aylor, D. E. (1995): Vertical variation of aerial concentration of *Venturia inaequalis* ascospores in an apple orchard. Phytopathology 85: 175–181.

Aylor, D. E. & Anagnostakis, S. L. (1991): Active discharge of ascospores of *Venturia inaequalis*. Phytopathology 81: 548–551.

Burchill, R. T. & Hutton, K. E. (1965): The suppression of ascospore production to facilitate the control of apple scab (*Venturia inaequalis* [Cooke] Winter). Ann Appl Biol 56: 285–292.

Hirst, J. M. & Stedman, O. J. (1962): The epidemiology of apple scab (*Venturia inaequalis* [Cke.] Wint.): III. The supply of ascospores. Ann Appl Biol 50: 551–567.

Holb, I. J., Heijne B. & Jeger M. J. (2004a): Overwintering of conidia of *Venturia inaequalis* and the contribution to early epidemics of apple scab. Plant Dis. 88: 751–757.

Holb, I. J., Heijne, B., Withagen, J. C. M. & Jeger, M. J. (2004b): Spread of *Venturia inaequalis* from a defined source of ascospores into a disease-eradicated orchard section. J. Phytopathol. 152: 639–646.

Kaplan, J. D. (1986): Dispersal gradients and deposition efficiency of *Venturia inaequalis* ascospores and their relation to lesion densities. PhD thesis. University of New Hampsire, Durham, USA.

Keitt, G. W. & Palmitter, D. H. (1937): Potentialities of eradicant fungicides for combatting apple scab and some other diseases. J Agric Res 55: 397–437.

Keitt, G. W., Clayton, C. N. & Langford, M. H. (1941): Experiments with eradicant fungicides for combatting apple scab. Phytopathology 31: 296–322.

MacHardy, W. E. (1996): Apple Scab, Biology, Epidemiology and Management. APS Press. St. Paul, Minnesota, pp. 545.

Mills, W. D & La Plante, A. A. (1951): Diseases and insects in the orchard. Corn. Ext. Bull. 711: 1–100.