

THE EFFECT OF AUTUMN INFECTION OF APPLE LEAVES ON THE OCCURRENCE OF THE CONIDIAL STAGE OF FUNGUS *Venturia inaequalis* (Cooke) Aderh. ON ONE-YEAR-OLD SHOOTS

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Abstract. The aim of the paper was to determine the effect of autumn infestation of leaves for apple cultivars (McIntosh, Idared, Jonagold) on the occurrence of conidia of *Venturia inaequalis* on twigs. It was found that high infestation of apple leaves in autumn is advantageous to conidia overwintering on twigs. Loosely spread hyphae and conidial spores were more frequently observed on twigs in an orchard where no chemical control was employed. The largest amount of conidial spores was recorded on twigs of unprotected McIntosh apple trees as a result of high infestation of leaves in later autumn. A considerably lower amount of conidia was recorded on twigs of Jonagold apple trees. In orchards under chemical control the conidia wintering occurs less frequently and only if leaves were highly infested in the autumn.

Key words: apple scab, conidial spores, overwintering

INTRODUCTION

Attention is paid more and more frequently to the fact that conidial spores of *Venturia inaequalis* [Cooke] Aderh. overwintering on one-year-old shoots of apple trees can be the second source of primary infection. Already at the beginning of the last century Aderhold [1900] wrote that this fungus can overwintered not only on fallen trees, where fructifications of the perfect stage are formed, but on the shoots as well. Information on the wintering of *V. inaequalis* in the tree crowns can be found in a number of older publications: Clinton [1901], Lawrence [1904], Salmon [1908, 1909], Wiesmann [1932, 1935], Winkelmann and Holz [1936]. It is also confirmed in later studies [Moosherr and Kennel 1986, Kennel 1987]. As stated by Grabowski [1999], conidial spores, which are formed on the infected shoots being the place where the mycelium

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overwinters, can also be the source of primary infection in the orchards of southern Poland. Not long ago the occurrence of the conidial stage on the apple tree shoots was associated only with scabby injuries which caused the breaking and flaking off of one-year-old shoots. However, so visible macroscopic symptoms on shoots appear very rarely and only in certain old cultivars, especially in neglected orchards, where strong infection took place [Kennel 1981a, 1981b; Ahrens 1985]. Although favourable conditions for the development of fungus *Venturia inaequalis* occur in Poland, distinct disease symptoms are not frequently encountered on shoots. Nevertheless, the mycelium and conidial spores – the causes of the scab – can appear on them [Grabowski 1991]. Observations conducted by Kennel [1989] showed that the pathogen occurs on one-year-old shoots in the form of loosely placed hyphae, which he called “surface scab”. Conidial hyphae, which in favourable conditions caused primary infection, were formed on the surface of the shoots with such symptoms [Cook 1974, Hill 1975]. Conidial spores were especially numerous in orchards, where strong infection took place in autumn in the year preceding the observations.

The purpose of the studies was to estimate the effect of the autumn leaf infection on the occurrence of “surface scab” on one-year-old shoots in early spring.

MATERIALS AND METHODS

The studies were conducted in the years 2001–2002 in the Sandomierz fruit-growing region in the localities of Obrazów and Zdanów. The observations comprised 12-year-old trees, cultivars McIntosh, Idared and Jonagold in chemically protected and unprotected quarters. The chemical protection was performed in the orchards according to the recommendations for commodity orchards. In 2001 eight fungicide sprayings were carried out in each of the orchards in the period between the beginning of April and the middle of July. On the other hand, in 2002 nine fungicide treatments were performed in the same period. Additionally, one fungicide spraying was carried out in each orchard two weeks before the harvest. Both in the protected and unprotected orchards evaluation of the leaf infection was performed annually in the second half of October, analyzing 100 leaves from each of the ten selected trees of each cultivar. Next, the percentage of the infected leaves was calculated for each of the examined cultivars. At the beginning of April of every year evaluation of the occurrence of the conidial stage on one-year-old shoots was performed on the very same trees. To this aim, 10 one-year-old shoots were taken from each tree from different parts of its crown. The collected shoots analyzed macro- and microscopically in order to find out the occurrence of mycelium and conidial spores on their surface. The number of conidial spores on the shoots was established according to Kennel’s method [1981b].

RESULTS

The studies showed the occurrence of conidial spores of *Venturia inaequalis* on the shoots of the examined apple cultivars in early spring. It was observed that the most conidial spores occurred on the surface of the McIntosh cv. shoots, while the fewest –

on the shoots of Jonagold cv. (tab. 1, 2). The mean number of conidial spores on the shoots of the protected cultivar McIntosh ranged from 1.8 to 2.6 (tab. 1). On the other hand, the number of conidial spores on Jonagold cv. ranged from 0.2 to 1.4 (tab. 2). The number of conidial spores on the shoots was related to the leaf infection in autumn. The atmospheric conditions in the summer of the first year of studies were not favourable for the development of the disease. No rainfalls and high temperature in that period contributed to small infection of the leaves in autumn. That also caused rarer occurrence of "surface scab" on one-year-old shoots. The number of conidial spores occurring on the shoots in spring was much smaller than in the next year of studies. No disease symp-

Table 1. Effect of leaves infection in autumn on conidial stage of *Venturia inaequalis* on shoots in Obrazów (2000–2002)

Tabela 1. Wpływ jesiennego porażenia liści na występowanie stadium konidialnego *Venturia inaequalis* na pędach – Obrazów (2000–2002)

Cultivar Odmiana	Percentage of affected leaves at harvest Porażenie liści jesienią, %				Average number of conidia on the shoot surface Średnia liczba zarodników konidialnych na pędzie			
	Untreated orchards Sady niechronione		Treated orchards Sady chronione		Untreated orchards Sady niechronione		Treated orchards Sady chronione	
	Observation years – Lata obserwacji							
	2000	2001	2000	2001	2001	2002	2001	2002
McIntosh	44	74	16	29	5.9	8.8	1.8	2.6
Idared	30	66	9	26	4.4	7.1	1.1	1.7
Jonagold	21	53	0	17	3.6	5.8	0	1.2

Table 2. Effect of leaves infection in autumn on conidial stage of *Venturia inaequalis* on shoots in Zdanów (2000–2002)

Tabela 2. Wpływ jesiennego porażenia liści na występowanie stadium konidialnego *Venturia inaequalis* na pędach – Zdanów (2000–2002)

Cultivar Odmiana	Percentage of affected leaves at harvest Porażenie liści jesienią, %				Average number of conidia on the shoot surface Średnia liczba zarodników konidialnych na pędzie			
	Untreated orchards Sady niechronione		Treated orchards Sady chronione		Untreated orchards Sady niechronione		Treated orchards Sady chronione	
	Observation years – Lata obserwacji							
	2000	2001	2000	2001	2001	2002	2001	2002
McIntosh	57	92	25	37	6.4	7.9	1.8	2.2
Idared	39	73	14	25	4.1	6.7	1.1	1.9
Jonagold	31	61	9	19	3.6	5.6	0.2	1.4

toms of apple scab were observed on the leaves of Jonagold cv. in the protected orchard of Obrazów in autumn 2000. No occurrence of the conidial stage on shoots was observed in the spring of the following year, either. In the next year, i.e. 2001, stronger leaf infection was observed in autumn, which was due to more favourable conditions for

infection. Like in the first year of studies, the greatest number of conidial spores occurred on the shoots of McIntosh cv, while the smallest in Jonagold cv. In unprotected orchards the studies found out much greater occurrence of the conidial stage on the apple shoots in early spring. Stronger leaf infection was also observed there. In the case of McIntosh, susceptible to apple scab, the infection sometimes reached 92% (tab. 2). The mean number of conidial spores appearing on the shoots in unprotected orchards was related to the infection of the leaves of particular cultivars in autumn. Like in the case of protected orchards, the greatest number of conidial spores appeared on the shoots of McIntosh cv, while the smallest in Jonagold cv (tab. 1, 2). The studies also found out differences in the number of conidial spores on the shoots of the examined cultivars in particular years. Due to less favourable conditions in the summer of 2000, the infection was smaller in autumn, which was associated with a smaller number of conidial spores in spring. The application of fungicides contributed not only to smaller infection of leaves in the vegetative season but it also had influence on the smaller number of conidial spores on the shoots.

DISCUSSION

The conidial stage of *Venturia inaequalis* can occur on one-year-old shoots in early spring, being the source of primary infection [Kennel 1987, Moosherr 1990, van der Scherr and Grabowski 1991, Miedtke 1994]. The occurrence of this stage does not cause any disease symptoms on the shoot bark [Hill 1975, Ahrens 1985]. Kennel [1987] called this phenomenon a “surface scab”. Results of the authors’ own studies also do not confirm the occurrence of macroscopic symptoms on the shoot bark of the examined cultivars and still in early spring the studies observed the presence of mycelium and conidial spores on their surface. A big number of conidia occurring on one-year-old shoots of apple was connected with strong infection of the leaves in autumn. Grabowski [1999], Holb et al. [2004] and Kennel [1987] also stated on the basis on their own observations that strong infection of leaves in autumn contributed to the occurrence of the conidial stage on the shoots in the period of early spring. The studies conducted by Kennel (1989) make it possible to state that a considerable part of conidial spores found on the shoots of the trees at rest are the spores from the leaves infected in the previous year. The number of those spores systematically fell since the beginning of March since they could have been washed off from the shoots. As stated by Grabowski [1999], a considerable increase of the number of conidia in the period of early spring testified to the fact that they were formed on the shoots with the symptoms of “surface scab”.

Observations conducted in the Sandomierz fruit-growing area showed that “surface scab” in the chemically protected orchards occurred less frequently on the shoots, since the leaf infection at the end of the vegetative period was considerably smaller than in the case of unprotected trees. The studies carried out in south Poland also pointed to considerable infection of apple leaves on the occurrence of “surface scab” on the shoots. In chemically protected commodity orchards the wintering of this stage was found out only in the case of strong leaf infection in the second half of the vegetative season preceding the observations [Grabowski 1999]. It was caused, among other factors, by too

early giving up of chemical protection with considerable infectious potential of the pathogen. Lack of chemical treatments (between the beginning of July and the period two weeks before the harvest) causes increased leaf infection in a lot of orchards, which is connected with frequent occurrence of the conidial stage [Miedtke 1994].

The results of studies showed that McIntosh cv., susceptible to apple scab, was infected the most strongly in autumn but that the greatest number of conidial spores appeared on the shoots in spring. A much smaller number of conidial was observed on the shoots of medium-susceptible Jonagold cv. Becker et al. [1992] as well as Moosher [1990] claim that the occurrence of mycelium and conidial spores on the shoots is the property specific to the cultivar.

The results confirmed the occurrence of the conidial stage on the shoots in the period of early developmental stages of apple tree. Conidial spores formed on the shoots in the vicinity of the developing buds can be the source of primary infection in favourable conditions.

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WPLYW PORAZENIA LIŚCI JABŁONI W OKRESIE JESIENI NA WYSTĘPOWANIE STADIUM KONIDIALNEGO GRZYBA *VENTURIA INAEQUALIS* (COOKE) ADERH. NA JEDNOROCZNYCH PĘDACH

Streszczenie. Celem badań było określenie wpływu jesiennego porażenia liści trzech odmian jabłoni (McIntosh, Idared, Jonagold) na występowanie stadium konidialnego *Venturia inaequalis* na pędach. Z przeprowadzonych badań wynika, że silne porażenie liści jabłoni przez *V. inaequalis* w okresie jesieni sprzyja zimowaniu stadium konidialnego tego grzyba na pędach. W sadzie nie objętym ochroną chemiczną znacznie częściej na jednorocznych pędach obserwowano luźno ułożone strzępki grzybni i zarodniki konidialne. Najwięcej zarodników konidialnych spotykano na pędach niechronionej odmiany McIntosh, wiązało się to z silnym porażeniem liści w okresie późnej jesieni. Znacznie mniejsza liczba konidiów obserwowana była na pędach odmiany Jonagold. W sadach chemicznie chronionych zimowanie stadium konidialnego spotyka się rzadziej, występuje ono jedynie w przypadku silnego porażenia liści w okresie jesieni.

Słowa kluczowe: parch jabłoni, zarodniki konidialne, zimowanie

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