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DEVELOPMENT OF *APHIS SPIRAECOLA* PATCH (HEMIPTERA: APHIDIDAE) ON APPLE

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Abstract: *Aphis spiraecola* is a recently found pest on apple in Bulgaria, where it develops in the absence of secondary hosts. The aphid has displaced the native species *Aphis pomi* DeGeer in some regions of the country. Its development, from newborn nymph to adult female takes, in laboratory conditions, 9–10 days at 22–24°C or 6–7 days at 28–30°C. The average fecundity of one female at both temperatures is 9.5–10.5 nymphs. Under field conditions, in May and July of 2007 and 2008, the full development lasted 8.1–8.6 days of average, and the average fecundity of one female was 20.7–21.2 nymphs. About 67% of them became adults, but more than 20% of the females died without having progeny. Theoretically, the species could develop twenty and more generations per the vegetation period of apple.

Key words: apple, spiraea aphid, *Aphis spiraecola*, *A. pomi*, development-time, fecundity

INTRODUCTION

The origin of *Aphis spiraecola* Patch (spiraea aphid) is Far East. In North America, it was found in 1907, in Australia – in 1931, in Mediterranean region – around 1939, in Africa – in 1961. Today the species is distributed in the temperate and tropical zone of the whole world (Blackman and Eastop 1989).

A. spiraecola is a polyphagous insect. The primary hosts are *Spiraea* spp. and *Citrus* spp. The species has a great number of secondary hosts from over 20 botanical families and 65 genera, mainly from Caprifoliaceae, Compositae, Rosaceae, Rubiaceae and Rutaceae. The citrus species are the most important agricultural hosts; this is why another scientific and common name is also used – *A. citricola* Van der Goot (green citrus aphid). In the USA and Iran a high infestation on apple was also observed, with a holocyclic development. The species is anholocyclic in many parts of the world (Kranz *et al*. 1977; Hodjat and Eastop 1983; Blackman and Eastop 1989; Pfeiffer *et al*. 1995; CABI 2005).

In Bulgaria, *A. spiraecola* was found in 2006 on apple where it developed without secondary hosts, mainly in young orchards and nurseries. The aphid displaced a native species green apple aphid (*Aphis pomi* DeGeer) in some southern regions of the country (Andreev *et al.* 2007; Rasheva and Andreev 2007).

The alimentary properties of the host affect all biological parameters of pest insects, such as the rate of development, fecundity, survivorship, etc. In Japan, differences were found between populations of *A. spiraecola*, which developed on *Spiraea* spp., and populations developed on *Citrus* spp. in the time of hatching of winter eggs and in the rate of population growth after migration on different secondary hosts (Komazaki 1991).

Most of research on this pest was carried out on citrus species because of their importance. More than 40 generations per year were reported in Southern Italy (Kranz *et al*. 1977; Blackman and Eastop 1989; INRA 2008). Investigations on some other plants were also reported (Lyla and Joy 1992; Wang and Tsai 2000), but still not enough data about development of *A. spiraecola* on apple are available.

The aim of this research was to investigate the development of *A. spiraecola* on apple, because the species becomes an important pest on this fruit tree in Bulgaria.

MATERIALS AND METHODS

Two experiments in laboratory conditions were carried out at the temperature 22–24°C (average 23±1.0°C) and at 28–30°C (average 29±1.0°C). A relative air humidity (60–75%) and photoperiod (16/8 hours – light/dark) were the same for the two variants of temperature. Individuals from last nymph instars of *A. spiraecola* were placed on apical leaves of cut-off apple shoots, and then put in glass containers with a nutrient solution. The number of surviving individuals was recorded daily. After their maturation, the number of the progenies, till the last day of their life was also recorded. The new-born nymphs were removed after counting. The average mortality, average

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life span and fecundity of adult aphids were estimated after concluding the experiments. More than 100 individuals were observed in every variant.

Two experiments were carried out at the same conditions, in order to determine duration of the nymphal stage. Adult apterous aphids were placed on the top leaves of apple shoots. Three to five new-born nymphs were observed daily, until all of them became adults. The adult females and the rest of nymphs were removed from shoots with a painting brush. The percentage of nymphs that reached the adult stage was estimated at the end of the trials.

The lower temperature threshold was determined by the method of Blunk (1923).

Similar experiments were carried out under field conditions, during the period of 19.07–04.08.2007 and of 05.05–23.05.2008. The observations were conducted in the experimental orchards of the Agricultural University and in the Fruit-Growing Institute at Plovdiv, on apple shoots, naturally infested by small colonies of *A. spiraecola*. The surplus individuals were removed with painting brush. More than 100 individuals were observed in each case.

Meteorological parameters for the period 19.07–04.08.2007 were the following: average temperature for the whole period – 26.3°C, with a maximal daily value exceeding 30°C and minimal values between 15.2°C and 22.4°C. The average relative air humidity was 50.6%, with the values varying between 36% and 56%. There were no strong winds or rainfall that could disrupt a normal aphid life and the observations.

Meteorological parameters for the period 05.05–23.05.2008 were as follows: average temperature for the whole period – 16.0°C, with maximal values between 20°C and 30°C and minimal values were between 6.0°C and 12.4°C. The average relative air humidity was 68.6%, with the values varying between 58% and 81%. There were no strong winds and only light rainfall during the first 6 days that could influence the normal aphid development or the observations.

RESULTS AND DISCUSSION

Laboratory experiments showed the expected result, which indicated that the duration of preimaginal period of *A. spiraecola* was longer at lower temperature (23±1.0°C). Under this condition new-born nymphs became adults after 9–10 days, with the average value of 9.7 days. At 29±1.0°C this period lasted 6–7 days, with the average of 6.7 days (Fig. 1).

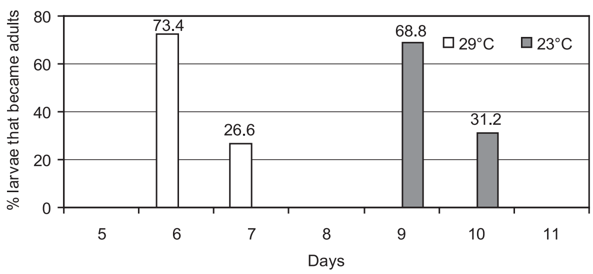

Fig. 1. Duration of nymphal stage of *A. spiraecola* on apple shoots in laboratory conditions at 23°C and 29°C (±1.0°C), relative humidity 60–70% and photoperiod 16/8 h

The estimated lower temperature threshold (t_0) for nymphs of *A. spiraecola* is 10.4°C. This comparatively high value for lower temperature threshold is understandable for a subtropical species like *A. spiraecola*. The threshold differs from a value reported for this species estimated by Wang and Tsai (2000) on other host plants and this could explain the appearance of *A. spiraecola* later in the spring, compared with other aphids on apple in Bulgaria.

Adults of *A. spiraecola* lived longer at lower temperature, too. The average lifespan was 5.6 days, but some aphids survived 9 days and the percentage of mortality was rather uniformly distributed (Fig. 2). High temperature leads to a shorter lifespan of aphids, the average value being 4.3 days. It was noted that mortality increased rapidly after the 3rd day of observations.

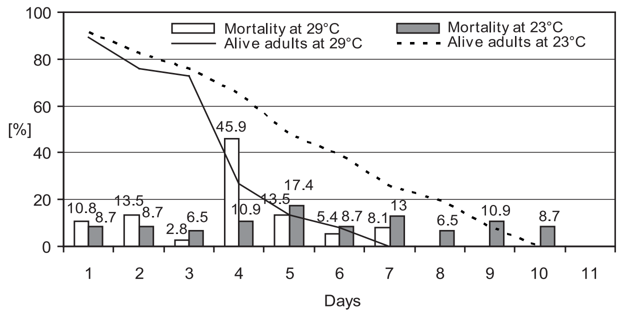

Fig. 2. Survival of apterous adults of *A. spiraecola* on apple shoots in laboratory conditions at 23°C and 29°C (±1.0°C), relative humidity 60–70% and photoperiod 16/8 h

Females usually gave birth to nymphs from the first to the last day of their life; however some aphids died without progeny. At both temperatures, more than 89% of the aphids tested gave progeny. The fecundity of one adult female at 23°C varied from 2 to 37 nymphs, with the average of 12.4 nymphs. The fecundity at 29°C was lower and varied between 2 and 13 nymphs, with the average of 10.2 nymphs (Fig. 3).

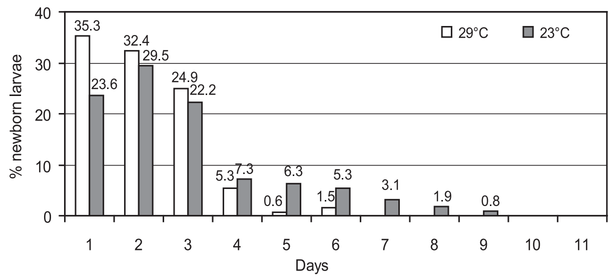

Fig. 3. Fecundity of apterous adults of *A. spiraecola* on apple shoots in laboratory conditions at 23°C and 29°C (±1.0°C), relative humidity 60–70% and photoperiod 16/8 h

Aphids had similar characteristics in both observed periods at field conditions, irrespective of different temperatures in May (2008) and July (2007). Apterous adult aphids lived 2–10 days (5.3 days on average) in July and 1–7 days (average 4.7 days) in May. The difference was not great and, unexpectedly, adults lived longer at higher temperatures in July (Fig. 4). Probably a temperature over 30°C delayed some of their biological processes.

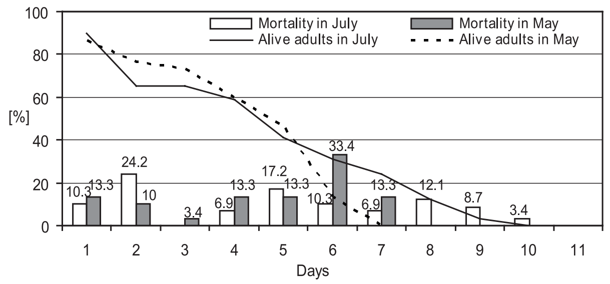

Fig. 4. Survival of apterous adults of *A. spiraecola* on apple shoots under field conditions in May and July

During the first two days only individuals that had no progeny died. They constituted a significant part of the population – 23.3% in July and 34.5% in May. The aphids with progeny lived 4–10 days (6.7 days on average) in July and between 2–7 days (5.4 days on average) in May. The highest mortality in July was observed on the 5th day – 17.2% and in May on the 6th day – 33.4%.

The fecundity of apterous aphids under field conditions was in July 20.7 nymphs on average and varied between 4 and 44 for particular individuals. In May, aphids gave birth to 2–37 nymphs, but the average value was slightly higher – 24.6 nymphs. Females were giving birth to nymphs from the first to the last day of their life (Fig. 5). The number of newborn nymphs increased till the 3rd day and declined later.

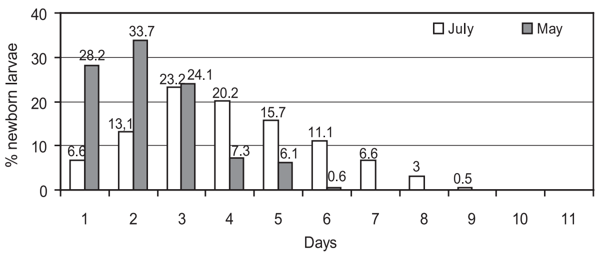

Fig. 5. Fecundity of apterous adults of *A. spiraecola* on apple shoots under field conditions in May and July

Under field conditions, the new-born nymphs were feeding actively and became adults on average after 8.1 days in July and after 8.9 days in May. The duration of nymphal stage varied from 6 to 10 days in July and took a day more in May (Fig. 6). This is a too short period for maturity, even for an aphid. The difference is about one day and hence it could be concluded that the population density of *A. spiraecola* may increase with a rather constant rate during the whole vegetation period, irrespective of the variation in the temperature regime.

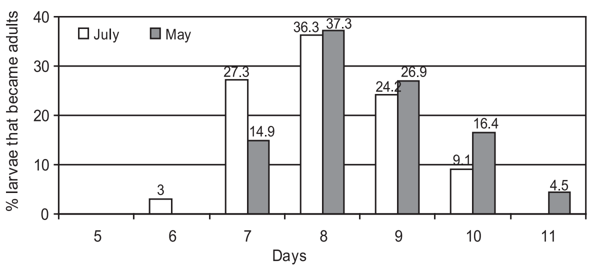

Fig. 6. Duration of nymphal stage of *A. spiraecola* on apple shoots under field conditions in May and July

All individuals that became adults for 6 days in July, died without giving progeny. Most of the aphids that had a longer nymphal stage gave progeny, even as early as the next day after their maturity. No such negative tendency was observed for adults with the shortest nymphal period of development (7 days) in May. So, irrespective of duration of the nymphal stage, the aphids had progeny.

The main part of the population of each new generation of *A. spiraecola* appeared for 8–10 days in both periods of observation (different months). The species had an extremely short life cycle and theoretically the pest could develop over 20 generations per vegetation period of apple in Bulgaria.

About 67% of new-born nymphs successfully became adults (67.5% in July and 66.9% in May). This value is very high for an aphid and gives us a proof for a very good adaptation of *A. spiraecola* on apple as a feeding host under climatic conditions of South Bulgaria.

The experiments carried out under field conditions revealed that approximately 45% of individuals from late spring and summer generations successfully completed their metamorphosis – up to fertile female adults and could give progeny of more than 20 nymphs.

CONCLUSIONS

Under laboratory conditions the development of *A. spiraecola* from new-born nymph to adult female at laboratory conditions takes 9–10 days at 22–24°C and 6–7 days at 28–30°C. The average fecundity of one female at both temperatures is 9.5–10.5 nymphs.

Under field conditions the average development time is 8.9 days in May and 8.1 days in July. The average fecundity of one female is 20.7–21.2 nymphs. About 67% of them become adults, but more than 20% of the females die without having progeny.

Theoretically the species can develop over 20 generations per vegetation period on the apple in South Bulgaria. *A. spiraecola* apparently becomes an extremely dangerous pest on apple in the areas where it appears.

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POLISH SUMMARY

ROZWÓJ MSZYCY *APHIS SPIRAECOLA* PATCH NA JABŁONI

Mszyca *Aphis spiraecola* Patch (Homoptera: Aphididae) została ostatnio wykryta w Bułgarii jako szkodnik jabłoni. Występuje jako mszyca jednodomna, bez gospodarzy wtórnych. W niektórych rejonach kraju wyparła rodzimy gatunek mszycy jabłoniowej *Aphis pomi* DeGeer. W warunkach laboratoryjnych okres rozwoju – od wylęgu larw do dorosłej samicy – trwał 9–10 dni, w temperaturze 22–24°C lub 6–7 dni w 28–30°C. W obu wymienionych zakresach temperatur, jedna samica rodziła średnio 9,5–10,5 larw. W warunkach polowych, w maju i lipcu 2007 i 2008 roku, rozwój jednego pokolenia trwał średnio 8,1 lub 8,6 dni, a średnia płodność jednej samicy wyniosła 20,7 lub 21,2 larw. Spośród nich 67% osiągnęło stadium dorosłych owadów; jednakże ponad 20% samic zginęło nie wydając potomstwa. Teoretycznie, gatunek ten mógłby w warunkach Bułgarii rozwijać ponad 20 pokoleń w ciągu okresu wegetacyjnego.