Dynamics of the number of *Dasineura vaccinii* (Smith, 1890) (Diptera: Cecidomyiidae) in *Vaccinium macrocarpon* Aiton, 1789 plantation in the vegetation season in Latvia

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APENĪTE I. 2016. DYNAMICS OF THE NUMBER OF *DASINEURA VACCINII* (SMITH, 1890) (DIPTERA: CECIDOMYIIDAE) IN *VACCINIUM MACROCARPON* PLANTATION IN THE VEGETATION SEASON IN LATVIA. – *Latvijas Entomologs* 53: 33-40.

Abstract: The cranberry tipworm *Dasineura vaccinii* (Diptera: Cecidomyiidae) dynamics of American large-fruited cranberry (*Oxycocccus macrocarpus* or *Vaccinium macrocarpon* Aiton, 1789) was studied in the north-east part of Latvia in 2010. Dynamics of *D. vaccinii* flying out and further development is dependent on the plants growth stage that mainly is affected by air temperature and relative humidity in the cranberry plantation in „Lienama – Alūksne" Ltd. The maximum infestation level by *D. vaccinii* was observed during the 1st 10-day period of July when more than half (144%) of all cranberry vertical apical shoots were invaded. In the large-fruited cranberry plantation, two *D. vaccinii* generations were observed: the first generation developed in the 1st 10-day period of June, the second – in the 1st 10-day period of July. Egg hatching of the first generation was delayed by the low minimal air temperature (below 0°C) at the beginning of the vegetation season, but later egg hatching was influenced by the amount and intensity of precipitation, which was not statistically provable. The development course of *D. vaccinii* 2nd–3rd-stage larvae and the intensity of pupation were affected by the maximal air temperature and precipitation during the vegetation season.

Key words: cranberry tipworm, air temperature, relative humidity, larval stages.

Introduction

Cranberry tipworm *Dasineura vaccinii* (Smith, 1890) syn. *D. oxycoccana* (Jonson, 1899) (Diptera: Cecidomyiidae) is widespread wherever the American large-fruited cranberry is cultivated (Медведев 1978; Сидорович, Кудинов et al. 1987; Caruso, Ramsdell 1995; Горленко, Буга 1996; Земкова 1980; Интегрированные системы защиты... 2005). It is the most prevalent and harmful pest in cranberry plantations in Latvia that the present in 9 of the 13 large-fruited cranberry plantations surveyed (Apenīte, Cinītis 2006; Apenīte 2007, 2010a, b and c). The *D. vaccinii* studies at the large-fruited cranberry plantation were carried out from May 2004 to October 2006 at the Latvia and manage at batch information topic of my dissertation (Apenīte 2010a) "Biology, ecology and economical significance of the cranberry tipworm *Dasineura vaccinii* (Smith) in Latvia". The goal of the study was to determinate exact timing of *D. vaccinii* emergence in Latvia.

Methods

Over the vegetation season of 2010, in the farm Lienama – Alūksne Ltd, NE part (57°27'19.35"N; 26°27'15.01"E) of Latvia, studies concentrating on impact of climatic conditions on the course of development of *D. vaccinii* were conducted. At “Kalna purva plantation” of the farm Lienama – Alūksne, the weather data were registered every day (maximum and minimum air temperature, °C; amount of precipitation, mm). The sum of active temperatures during the experimental period were calculated by adding up the daily temperatures of 10°C and above from the beginning of the year:

$$\sum (tn\text{-}10°C) ,$$

where t_n is the average earth air temperature above +10°C.

The field experiment was laid out in a developed high peat moss bog, pH_{KCl} 2.8. It contained the cranberry variety \`Stevens\` planted in 1997. Eight observation sites 30 m^2 of size (3 x 10 m) were set up. The trial started at the end of May and lasted till late middle-August observations. The observations of *D. vaccinii* relative population density were made during the vegetation season, id est. from the time when vertical shoots started to protrude until the beginning of ripening. 100 randomly selected main cranberry vertical shoots per each observation site were cut at the base and immediately placed in polythene bags (18 × 10 cm) with air holes. Samples were delivered in a cold-box (+4°C).

The different stages of *D. vaccinii* (eggs, larval 1^{st}–3^{rd} stages, and pupae) were recorded by opening cranberry apical shoots (N = 100) (Apenīte 2007). Each shoot was analyzed by use of Meiji binocular microscope (used magnification 0.7-4.5x) and microscope CX31 (used magnification 40 and 100x). For the time-series study, the cluster of parametric values was basically used in an arranged sequence using time (days) as an arrangement criterion, calculated from the start of the cranberry vegetation. Correlation analysis was applied to the impact of weather conditions (minimum, maximum and average air temperature, °C; precipitation, mm) on development on the cranberry tipworm by stages (eggs, 3 larval stages and pupae) as well as the sum total (∑). For evaluation of the obtained data, the calculated value was compared with the critical value. The obtained results were analysed with the required materiality level ($p < 0.05$; 0.01) and actual number of observations (Arhipova, Bāliņa 2006).

Results and Discussion

In the vegetation season of 2010, the cranberry tipworm started its emergence in the first 10 day period of June when vertical shoots had protruded and leaves had already developed. The peak of infestation of the cranberry tip worm in the cranberry plantation was observed at the start of July (10.07), when it reached 114% (Fig. 1).

Comparing the changes dynamics of the development and quantities of the cranberry tipworm over the vegetation season 2010, it was established that the development cycle of the second generation took place in the 1^{st} decade of June: from day 33 to 44 of the start of vegetation season and emergence of the cranberry tipworm (Fig. 2).

Over the vegetation season of 2010, imago females had intensive oviposition, laying eggs twice over the season: 1) the first oviposition took place up to day 5 (04.06.), when 85% of the vertical apical shoot tips of large-fruited cranberries were infested; 2) the second oviposition occurred from day 33 to day 40, when the amount of infested vertical apical shoot tips reached 144%. The amount of infested shoot tips at the second oviposition was by 29% larger than that at the start of the vegetation period, i.e., from day 1 to day 5. By correlation analysis it was established that in vegetation season of 2010,

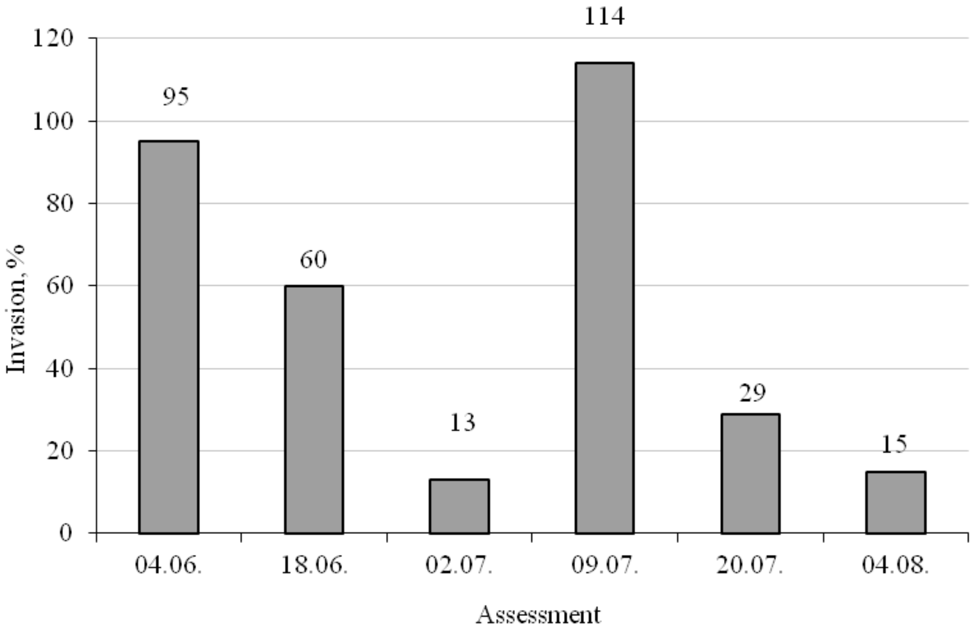

Figure 1. Infestation of cranberry vertical shoots (% from the total number of plants) by *Dasineura vaccinii* (SMITH, 1890) in 2010 vegetation season.

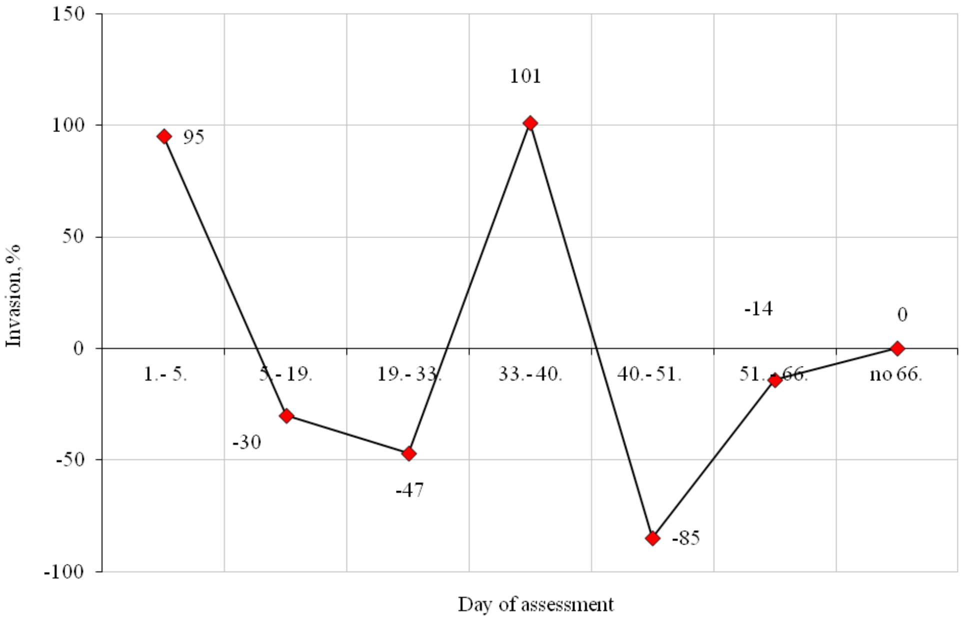

Figure 2. Changes in the dynamics of the number of *Dasineura vaccinii* (SMITH, 1890) on cranberry vertical shoots in 2010 vegetation season, %.

oviposition and its intensity by cranberry tipworm female was largely influenced by the minimum air temperature ($F_{fakt} = 4.33 > F_{0.01} = 1.94$). The laying intensity grew when air temperature increased. The test results for 2010 vegetation season from day 1 to 5 of the cranberry tipworm instars showed 10% infestation of the vertical apical shoots with larvae of all three instars. From day 5 to 19, the development of instars 2 and 3 had increased by 30.8%, while from day 19 to day 33 it had declined. After day 33, under the influence of the maximum air temperature ($F_{fakt} = 3.78 > F_{0.01} = 1.94$) a rapid decline in the larval development was observed due to lack of leaf turgor required for feeding of the newly hatched larvae. The amount of shoots infested with the first instar larvae however, by day 19 of the vegetation period increased up to 12% due to the gradual hatching of larvae from eggs laid on tips of the vertical apical shoots (Fig. 3).

The oviposition of the second generation females on vertical apical shoots took place from day 33 to day 44, when 95% infestation of the vertical apical shoots was established. Under the impact of the elevated air temperature and low relative humidity after day 40, the laying intensity declined rapidly. The 1st instar of newly hatched larvae lacked feed. Consequently the amount of the infested vertical apical shoots infested by the 1st instar larvae from day 40 to day 66 constituted just 2 to 4% (Fig. 4).

In mathematical data processing it was established that the development of the 1st instar larvae over the vegetation season of 2010 was affected both, by the minimum air temperature ($F_{fakt} = 3.418 > F_{0.01} = 1.94$), and the mean air temperature ($F_{fakt} = 2.326 > F_{0.01} = 1.94$), while the 2nd instar larvae development ($p < 0.05$; 0.01) was significantly influenced by both, the minimum ($F_{fakt} = 2.18 > F_{0.01} = 1.94$) and the maximum ($F_{fakt} = 2.36 > F_{0.01} = 1.94$) air temperature. From day 1 to day 19 of the 2010 vegetation season, the

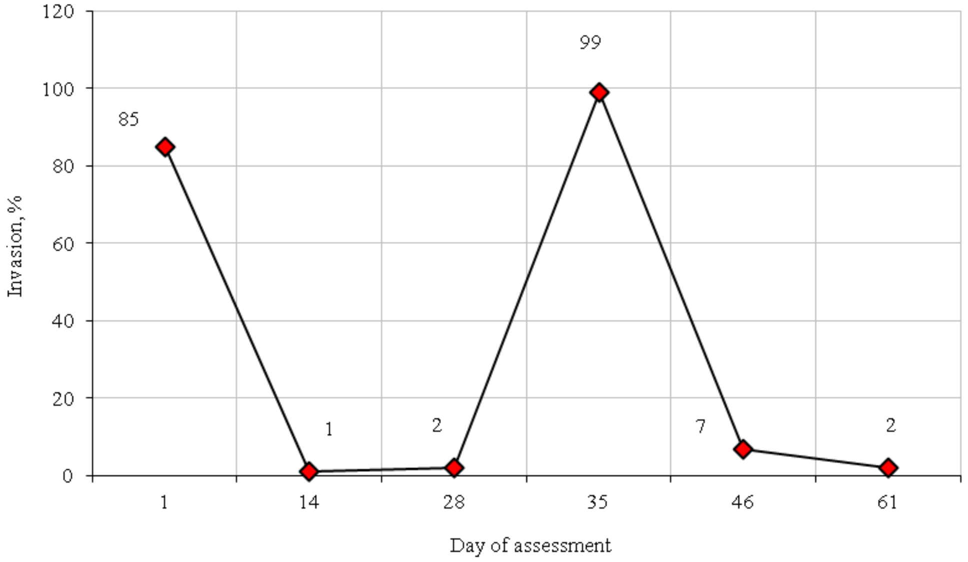

Figure 3. Changes in the intensity of *Dasineura vaccinii* (Smith, 1890) egg laying in 2010 vegetation period, %.

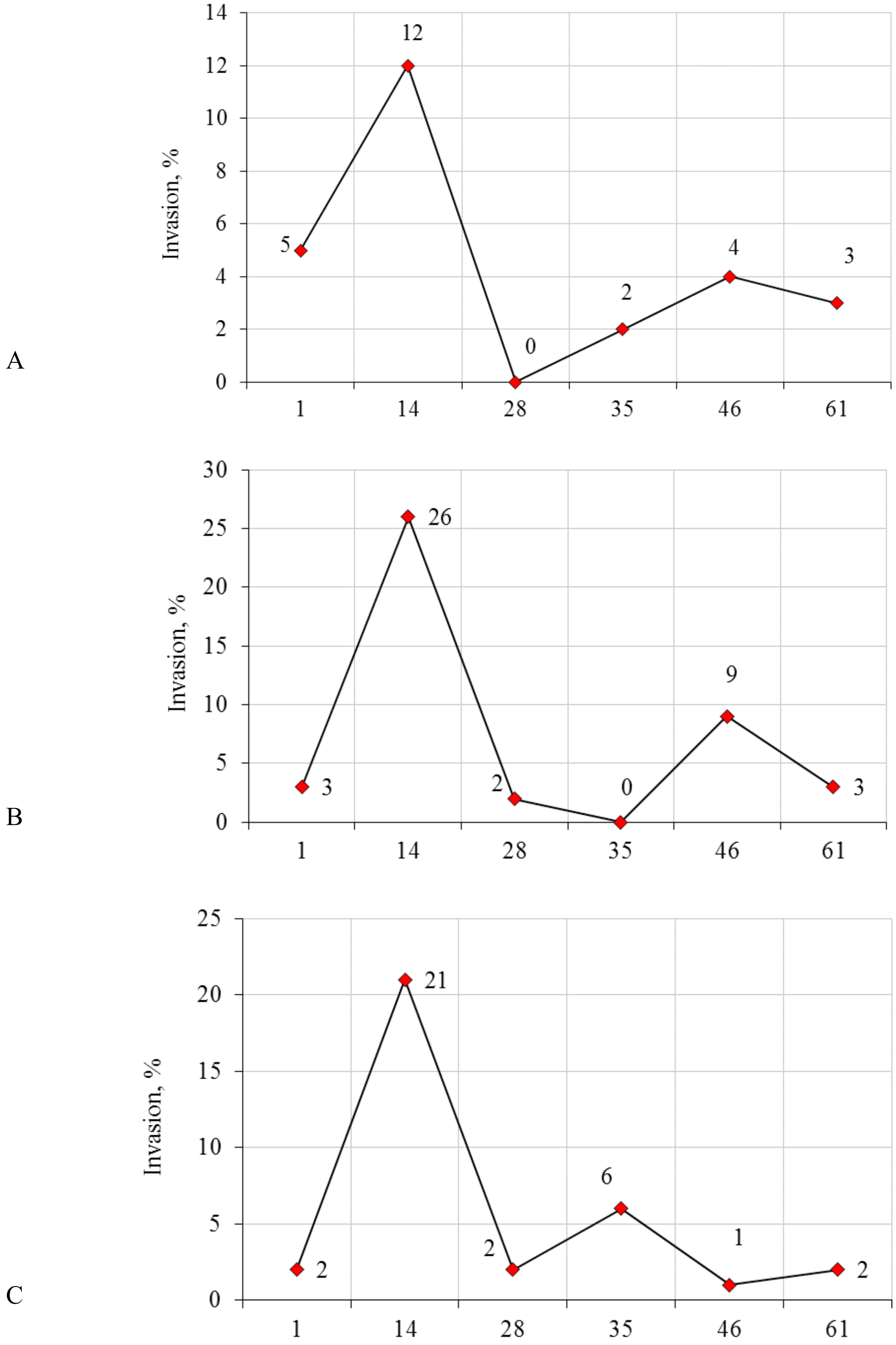

Figure 4. Changes in the intensity of the development of *Dasineura vaccinii* (Smith, 1890) 1st-3rd stage larvae in 2010 vegetation season, %. Day of assessment: A – 1st larval stage; B – 2nd larval stage; C – 3rd larval stage.

development of the cranberry tipworm was very swift: imago females had an intensive oviposition causing 21% of the larvae passing through all three stages and entering pupation. At the start of the vegetation season, the development of the cranberry tipworm was largely influenced by drop of the minimum air temperature and simultaneous increase of the maximum air temperature at the large-fruited cranberry plantation. 21% of the larvae over these 19 days had managed to pass through all the three instars. Despite the high amount of egg-infested shoots (85%) just 7% of the 3rd instar larvae had managed to pupate (Fig. 5).

From day 28 to day 72 in its turn, the pupation intensity gradually decreased evidently under the influence of the development intensity of previous generation population stages (eggs and stage 1-3 larvae) resulting in just 5% pupae-infested shoots found on day 66. Mathematical processing of data showed that the pupation intensity at that time was affected by the low minimum air temperature (especially at night) over the 1st and 2nd ten day period of June.

In 2010, from day 14 to day 28 of the vegetation season, following the temperature increases, the pupation intensity had an upward trend ($F_{fakt} = 1.44 < F_{0.01} = 1.94$): the amount of the shoots infested by the 3rd instar larvae reached 8%. However, starting from the day 46, the pupation intensity of the 3rd instar larvae in the vertical apical shoots gradually decreased (Fig. 5).

The correlation analysis demonstrated that the pupation intensity of the 3rd instar larvae in the 3rd ten day period of July 2010 was influenced by the mean air temperature eggs, instars 1–3, as well as pupae ($F_{fakt} = 4.956 > F_{0.01} = 1.94$). Due to the high temperature (higher than +28°C) and low relative air humidity, the plants lacked leaf turgor required for larval development.

Summarising the research results on the quantity dynamics of the cranberry tipworm in large-fruited cranberry

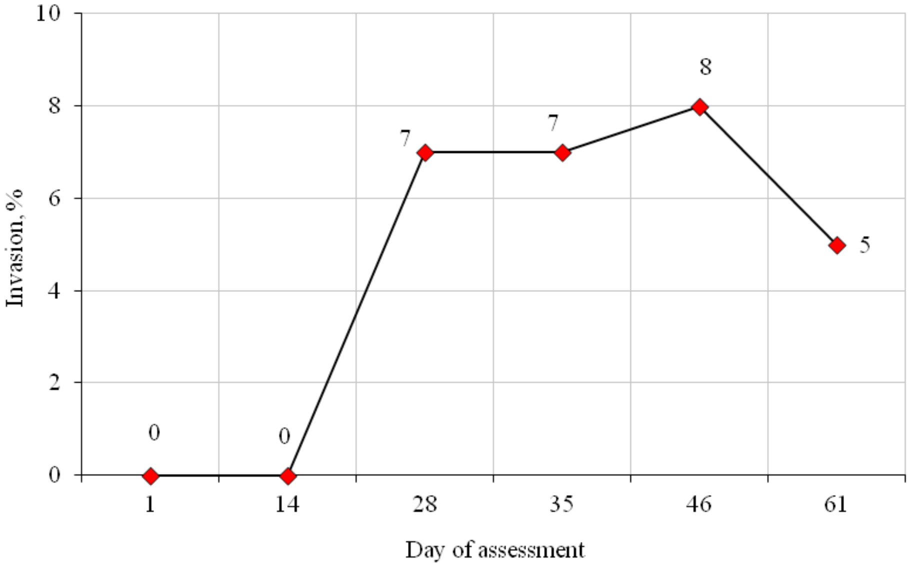

Figure 5. Intensity of *Dasineura vaccinii* (SMITH, 1890) pupal development in 2010 vegetation period, %.

plantation, conclusion can be made that realistic projections on the emergence and development dynamics of the cranberry tipworm over the vegetation season can be made of the moment of the bud elongation of the shoots which is highly dependent upon air temperature and relative humidity at the plantation. Cranberry tipwoms development was not possible due to unfavourable weather conditions affecting growth of the cranberry plants, mostly the new shoots and leaves. Over the vegetation season, the cranberry growing on the plantation was supported through the watering system. With an air temperature increasing at the start of the vegetation season, the emergence and development of the cranberry tipworm population intensified. The peak of infestation was established during the 1st ten day period of July when the infestation level of the vertical apical shoot tips reached 114%.

The research literature contains data (Natural history of the American ... 2010), that in America, where the vegetation season for the large-fruited cranberries starts about a month and a half earlier than in Latvia, the first generation of cranberry tipworms departs from end of May to mid-June, while the second generation: from the start to the end of July: about a month earlier than in Latvia.

At the same time, the number of the cranberry tipworm generations in large-fruited cranberry plantations of Latvia and Ireland (on Prince Edward Island) is similar. After several years of studies it was concluded that in Latvia, the cranberry tipworm produced 2 generations of insects, the first emerging over 1st–2nd ten day period of June, the second – over 1st–2nd ten day period of July, when newly laid eggs were established on the apical vertical shoots of the plants. The hatching of the 1st instar larvae at the start of the vegetation season was affected by the minimum air temperature (lower than 0°C) but later – by the maximum air temperature and precipitation level and intensity which was mathematically unprovable. The development of the 2nd and 3rd instar stages of the cranberry tipworm and their pupation intensity depended upon the maximum air temperature and the precipitation amount over the vegetation season.

All development stages of *D. vaccinii* (eggs, instars 1–3, as well as pupae) over the vegetation season were influenced by the air temperature ($p < 0.01$) and the amount of precipitation. The development of the cranberry tipworm was accelerated at the start of the season by increase of the air temperature. However further increase of the air temperature combined with decrease of the relative humidity hampered its development.

The quantitative peak was reached by *D. vaccinii* at the 1st–2nd ten day period of July when the infestation amount reached 114%. In Latvia, *D. vaccinii* produces two generations of insects per year: the first over the 1st–2nd ten day period of June while the second – over 1st–2nd ten day period of July.

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