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72 THE GREAT LAKES ENTOMOLOGIST Vol. 39, Nos. 1 & 2

EARLY-SEASON PHENOLOGY AND TEMPORAL DYNAMICS OF THE COMMON ASPARAGUS BEETLE, CRIOCERIS ASPARAGI (COLEOPTERA: CHRYSOMELIDAE), IN SOUTHERN MINNESOTA

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ABSTRACT

During the years 1991-1994, studies were conducted to determine the early-season phenology and temporal dynamics of *Crioceris asparagi* (L.) (Coleoptera: Chrysomelidae) in southern Minnesota asparagus. To document the early-season phenology, asparagus plots were sampled for egg, larval, and adult stages of *C. asparagi* during the months of May and June. Temporal dynamics of *C. asparagi* were determined by measuring the diurnal activity of adults and sampling asparagus plots at specific times (7 am, 9 am, 11 am, 1 pm, 3 pm and 5 pm) throughout May and June. We first detected *C. asparagi* adults in early May and they remained active throughout the sampling period. Eggs and larvae were also found; larval infestations on spears, however, were consistently lower than those for eggs. The temporal dynamics of *C. asparagi* adults showed that a higher percentage of asparagus plants were observed to be infested with beetles during the afternoon hours of 1 and 5 pm. The information provided in this paper illustrates the importance of determining the optimum time of day for sampling and will assist in properly targeting sampling efforts in future asparagus research and integrated pest management (IPM) programs.

Asparagus is a high-value specialty crop with an annual on-farm value estimated at approximately $1,111/ha (MAAB 2000). Because of its perennial nature, with stands often exceeding 15 years in production, management of insect pests is critical to maintain the vigor of the stand (Fritz et al. 2005). The common asparagus beetle, *Crioceris asparagi* (L.) (Coleoptera: Chrysomelidae) is an important pest in all asparagus producing regions (Capinera and Lilly 1975a, Taylor and Harcourt 1975, Hutchison et al. 2005) and feeds only on asparagus (Capinera 2001). Although it is widespread throughout the United States, little information has been reported for Minnesota.

In Ontario and Massachusetts, *C. asparagi* overwinters as an adult in dead asparagus spears and leaf litter and emerges when temperatures exceed 10°C (Taylor and Harcourt 1978, Capinera and Lilly 1975a). After emergence, *C. asparagi* adults feed upon the developing asparagus spears for two to three days and then ovposit ca. 2-7 eggs each on the spears. Larvae emerge approximately one week following oviposition and feed upon the developing spear.

Feeding by *C. asparagi* causes yield loss, while the presence of eggs and larvae can significantly reduce the market value of asparagus spears (e.g., Chittenden 1917, Hutchison et al. 2005). In 1991, the annual loss due to *C. asparagi* feeding was estimated to be approximately $1.5 million for the top producing states of Washington, Michigan, and Illinois (Hendrickson, Jr., et al. 1991). Integrated pest management (IPM) programs are generally limited to early-season monitoring and the use of insecticides for the control of *C. asparagi* (McClanahan 1975, Kuhar et al. 2006). In some regions, the parasitic wasp, *Tetrastichus coeruleus* (*Nees*) (=*T asparagi* Crawford) (Hymenoptera:

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Eulophidae), which attacks the egg stage, is known to provide local suppression of *C. asparagi* populations (Capinera and Lilly 1975a). For early-season management, however, suppression of adult *C. asparagi* is critical to minimize egg and larval contamination of spears (Kuhar et al. 2006). Thus, insecticides are typically applied when 5-10% of the spears are infested with adults (Fritz et al. 2005, Hutchison et al. 2005). Historically, recommendations for sampling *C. asparagi* adults have not specified a specific time of day. Preliminary data in Minnesota, however, indicated that estimates of *C. asparagi*, and subsequent IPM decisions, could vary during the day (Hutchison et al. 2005). The objective of this study was to document the early-season phenology of *C. asparagi* adults, eggs and larvae, and the temporal dynamics of *C. asparagi* adults via multi-year phenology studies in southern Minnesota.

MATERIALS AND METHODS

Phenology. Sampling was conducted in an established asparagus planting on the St. Paul campus of the University of Minnesota, from early May through early June. Each plant or spear was sampled for eggs, larvae, and adults of *C. asparagi*. Asparagus was sampled on the following dates: 20, 23, 24, 28, and 31 May (1991); 15, 18, 21, 26, 29 May, 1, 5, and 8 June (1992); 13, 18, 28 May, and 7 June (1993); and 17, 20, 24, 27, 31 May, 3 and 9 June (1994). In 1991, the sample unit consisted of 25 individual spears, sampled per field. In the remaining years, the sample unit consisted of 10-20 plants, which was replicated four times within the field. Each plant consisted of a mean (± SEM) of 7 (± 0.09) spears. Data were recorded on a per plant basis and were later reduced to the mean number per spear.

Temporal Dynamics. In 1993, field studies were also conducted in two established asparagus plantings on the St. Paul campus of the University of Minnesota. Fields were sampled on 21, 25, 26, 28 May, and 3 June. In 1994, sampling was conducted in four established commercial fields (> 5ha) near Owatonna, MN. Fields were sampled on 13 and 26 May, and 1 June. During both years, asparagus was sampled at 7 am, 9 am, 11 am, 1 pm, 3 pm and 5 pm. The sample unit consisted of 20 plants, and was replicated 4 times throughout the field. Each plant consisted of an average (± SEM) of 7 (± 0.08) spears. Counts of all life stages were recorded on a per plant basis and were later reduced to an average per spear.

Degree-Day Calculations. Maximum and minimum temperatures for degree-day determination were obtained from the Midwestern Regional Climate Center (Champaign, Illinois). Air temperature degree-days accumulated from 1 January were calculated using a double sine-wave method and Forecaster software (Ascerno and Moon 1989). The lower developmental threshold was set at 10.0 °C (Taylor and Harcourt 1978).

RESULTS

Phenology. *Crioceris asparagi* adults were detected on the first sample date of each year of this study, typically during the second or third week of May (Fig. 1a). Degree-day estimates for these dates did vary, with the earliest sample period beginning at 120 degree-days (1993), and the latest sample period beginning at 180 degree-days (1991) (Fig. 1b). Adults found during this time reflect survivors of the over wintering population. The population of *C. asparagi* adults fluctuated throughout the remainder of the sampling period. The highest density of *C. asparagi* adults was found in 1991 on 23 May and in 1993 on 12 May (Fig. 1a). The lowest numbers of *C. asparagi* adults were detected during 1992.

Crioceris asparagi eggs were detected during all years of the study (Fig. 2), and were most abundant between 150 and 225 degree-days of all years (Fig. 2b). The

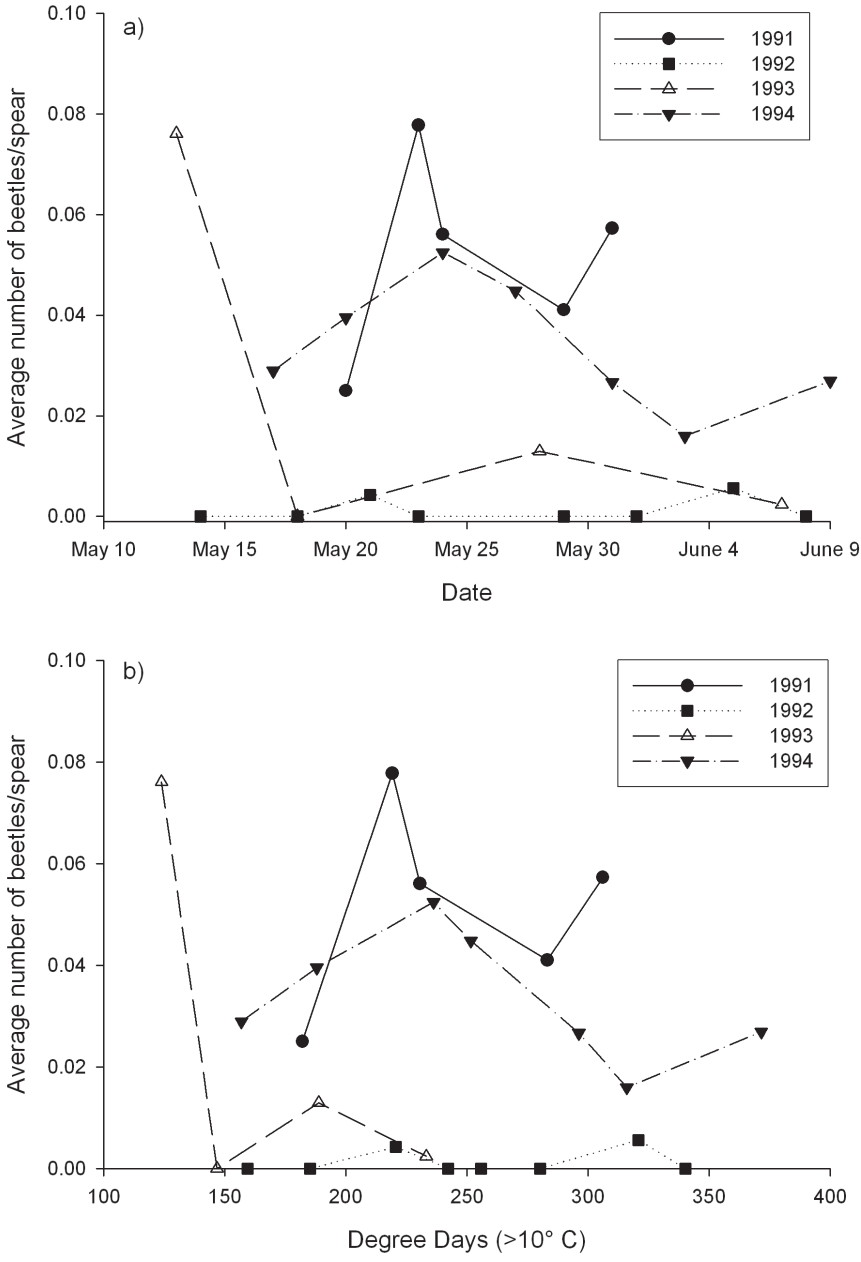

Fig. 1. Phenology of *C. asparagi* adults, St. Paul, MN, 1991-1994.

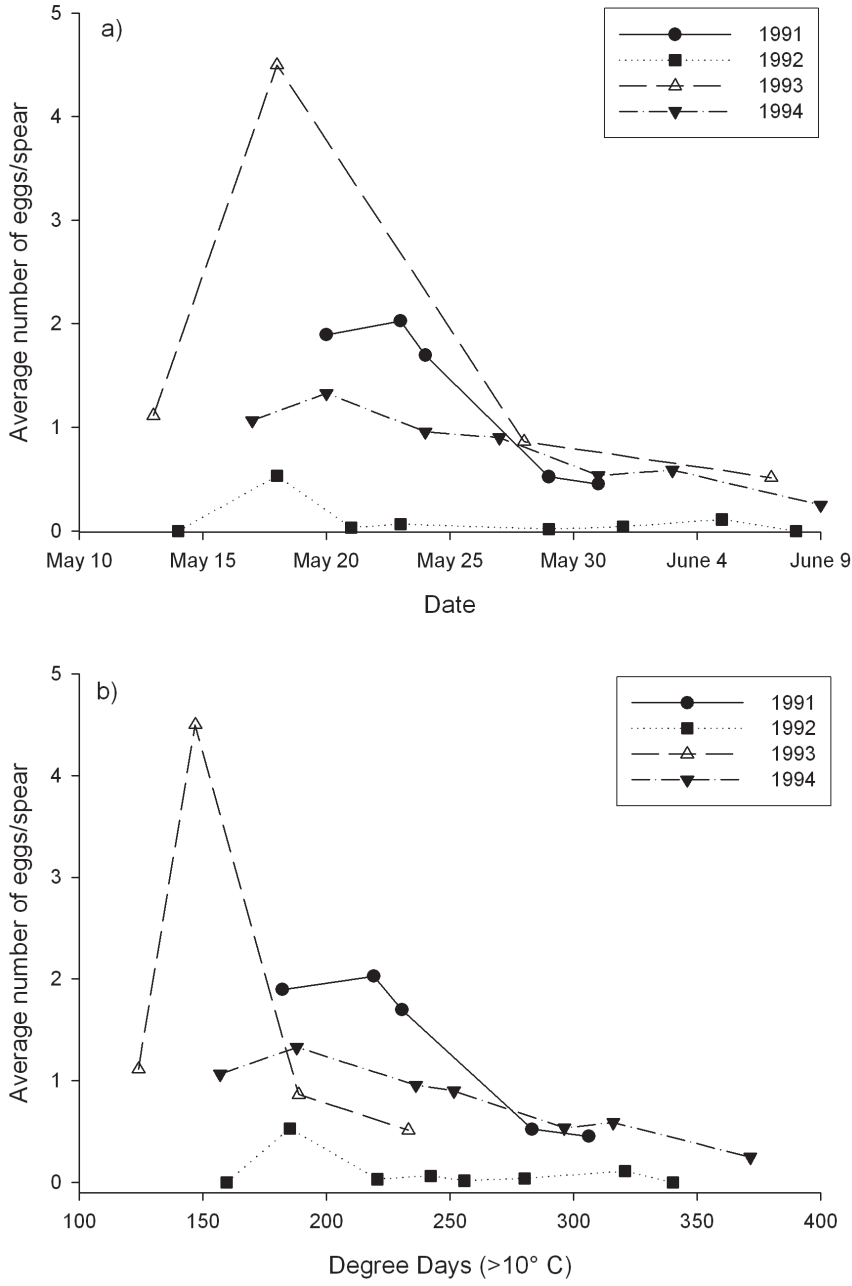

Fig. 2. Phenology of *C. asparagi* eggs, St. Paul, MN, 1991-1994.

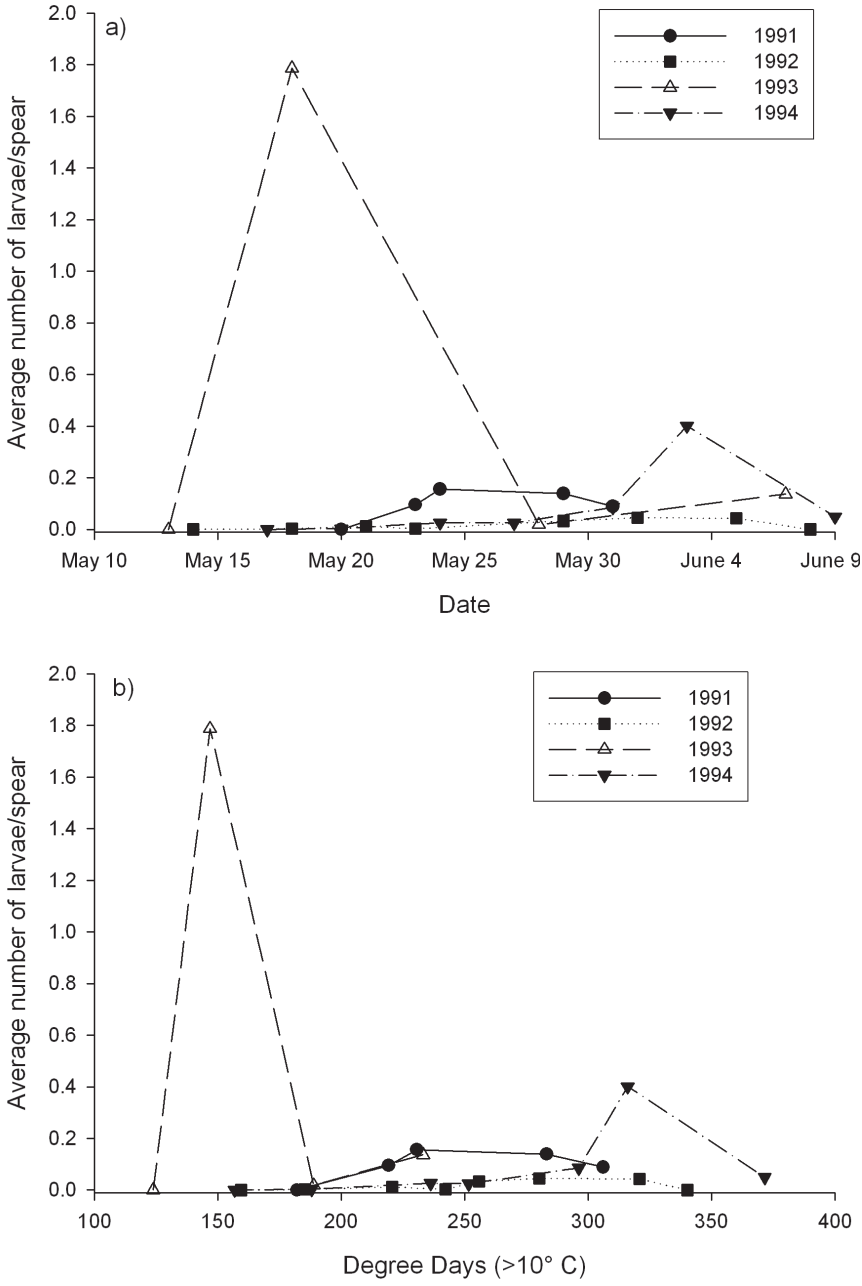

Fig. 3. Phenology of *C. asparagi* larvae, St. Paul, MN, 1991-1994.

peak number of eggs was highest in 1991 at 4.5 per spear and lowest in 1992 at 0.5 per spear (Fig. 2). The number of eggs declined throughout the remainder of the sampling period during all years. Very few larvae were found during all years of this study (Fig. 3). In 1991 and 1992, the peak of the larval population was 0.2 and 0.1 larvae per spear, respectively, and occurred between 225 and 250 degree-days (Fig.3b). In 1993, the larval population peaked at 1.8 per spear, and much earlier at 150 degree-days. In 1994, the peak was 0.4 larvae per spear and did not occur until 315 degree-days (Fig. 3b).

Temporal Dynamics. In 1993 and 1994 a higher percentage of asparagus plants were observed to be infested with *C. asparagi* adults primarily during the afternoon hours, with consistently higher estimates between 11 am and 5 pm (Fig. 4). In 1993 the highest percentage of plants infested occurred during the 3 pm sample, whereas in 1994 the highest percentage of plants infested occurred at 1 pm. The lowest percentage of plants infested generally occurred during the morning samples of 7 and 9 am.

DISCUSSION

Crioceris asparagi adults and eggs were found as early as 120 degree-days (12 May; Figs. 1-2) in 1993 and it is possible that *C. asparagi* was present at this time during the other years of this study. This suggests that sampling for *C. asparagi* adults, in southern Minnesota, should be initiated prior to 120 degree-days, or as early as late April to early May. In addition, because asparagus has a lower developmental threshold (ca. 4.4 °C) than *C. asparagi*

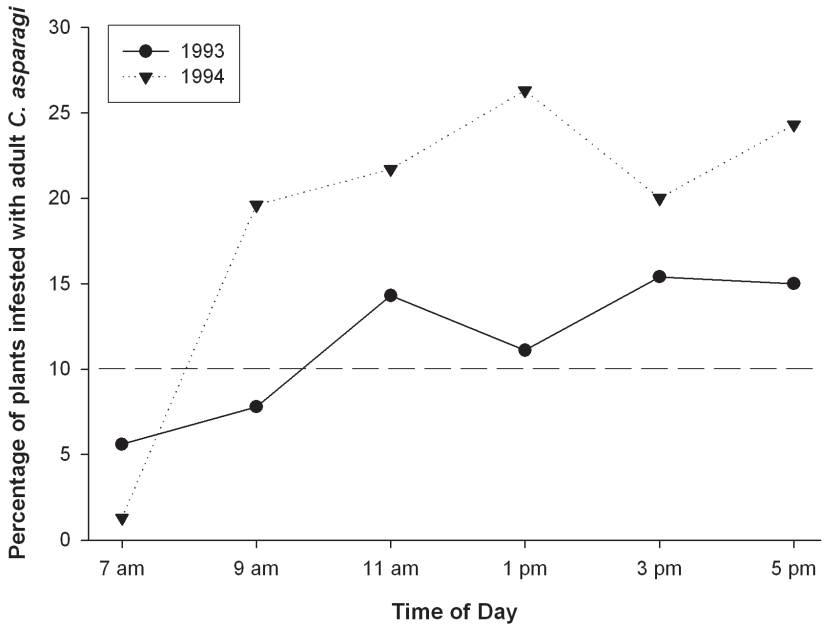

Fig. 4. Temporal dynamics of *C. asparagi* adults, and relationship to the current action threshold (dashed line) 1993 & 1994. Data are presented as the mean over all sample dates and fields.

(>10 °C), sampling initiated at the onset of asparagus growth should ensure early detection and proper assessment of *C. asparagi* beetle activity. Through temporal sampling, we found *C. asparagi* adults to be most abundant during the afternoon hours (1 pm-5 pm, Fig. 4). The current accepted treatment threshold for adult *C. asparagi* is defined as 10% of asparagus plants infested with one or more beetles (Fritz et al. 2005). By sampling during the early morning hours, one could underestimate the infestation level and conclude that the population was below the treatment threshold, and make an incorrect no-treat decision. Data from this study confirms the need to sample *C. asparagi* adults during the afternoon hours to ensure an accurate estimate of the infestation level and to minimize the risk of incorrect IPM decisions.

During all four years of the study, and for nearly all sample dates, *C. asparagi* larval populations were much lower than the corresponding egg infestations (Figs. 2-3). This high level of natural mortality could be due to several factors, including poor egg viability, inclement weather conditions, or predation by natural enemies. *C. asparagi* is host to numerous natural enemies, including lady beetles, stink bugs, assassin bugs, and parasitoids (Capinera and Lilly 1975a). The most significant natural enemy, however, is the predator and parasitoid *T. asparagi,* which is known to occur in Minnesota (WDH, unpublished data). *T. asparagi* acts as a predator by feeding upon newly oviposited *C. asparagi* eggs, and will also parasitize older eggs (Russell and Johnston 1912, Johnston 1915, Chittenden 1917, Capinera and Lilly 1975b). *T. asparagi* are well synchronized with *C. asparagi*, and are thought to be the single most important mortality factor of *C. asparagi*, causing over 50% mortality (Capinera and Lilly 1975a).

The early-season phenology of *C. asparagi*, as described in this paper, is similar to that described for Ontario (Taylor and Harcourt 1975) and Massachusetts (Capinera and Lilly 1975a). In our study, we found adults to be active from early May to early June. In addition we found larval populations to be disproportionately low when compared to the number of eggs, which was likely due to mortality influenced by environmental factors and possibly egg predation by *T. asparagi* (e.g., Capinera and Lilly 1975b). Most importantly, we established that the time of day had a significant impact on population estimates, with adults being most active between the hours of 1 and 5 pm. This new information regarding the importance in time of sampling will assist in properly targeting sampling efforts for asparagus IPM and in future research programs.

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