BIOLOGICAL CONTROL 2, 159–165 (1992)

Habitat Use Patterns by the Seven-Spotted Lady Beetle (Coleoptera: Coccinellidae) in a Diverse Agricultural Landscape

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Received March 30, 1992; accepted June 29, 1992

Studies were conducted during 1989 and 1990 to describe the habitat use patterns of the seven-spotted lady beetle, *Coccinella septempunctata* Linnaeus. The study site consisted of seven treatments arranged in forty-two 0.91-ha plots. Maize, soybean, wheat, alfalfa, *Populus*, and successional habitats were represented. Habitats were sampled weekly (from late May to the end of August) using yellow sticky traps, sweep net samples, and visual observations. *C. septempunctata* was detected in all habitats during both years. Habitat preference, however, depended upon availability of prey and habitat disturbance. In 1989, wheat supported *C. septempunctata* populations early and mid-season, while *Populus* supported more *C. septempunctata* later in the season. In 1990, alfalfa was dominant early in the season, soybean in the mid-season, and successional and alfalfa late in the season. The results indicate that both cultivated and uncultivated habitats play an important role in supporting populations of *C. septempunctata*.

KEY WORDS: Insecta; *Coccinella septempunctata*; habitat partitioning; biological control.

INTRODUCTION

The seven-spotted lady beetle, *Coccinella septempunctata* Linnaeus, is a Palearctic species which has been released and successfully established in several regions of the United States (Angalet *et al.*, 1979; Cartwright *et al.*, 1979; Hoebeke and Wheeler, 1980; Tedders and Angalet 1981; Obrycki *et al.*, 1982, 1987; Schaefer *et al.*, 1987). This beetle was introduced from 1957 to 1973 as a biological control agent for several aphid species (Angalet *et al.*, 1979). The first intentional releases of *C. septempunctata* in Michigan were made prior to 1985 in Berrien County (USDA, 1991). In recent years, this species has become established in Michigan (USDA, 1990). Studies by Sirota (1990) show that it is the dominant early season coccinellid species in southern Michigan agricultural landscapes.

C. septempunctata is widely distributed in Eurasia where it preys on several aphid species in a variety of agroecosystems (Hodek, 1973; Honek, 1985). Studies in Eurasia indicate that *C. septempunctata* prefers herbaceous plants in sunny habitats and is associated with a wide range of aphid species (Honek, 1985). In cultivated areas, this species prefers forage legumes (alfalfa and clover) and spring cereals (mainly barley) over other agricultural crops, while occasionally occurring at low density in bean, sugar beet, maize, and potato (Honek, 1982). *C. septempunctata* moves between crop habitats in search of food. Ruzicka *et al.* (1986) reported that *C. septempunctata* from surrounding pea plants, *Pisum sativum* L., controlled an outbreak of the aphid, *Phrodon humuli*, on hop. The habitats can influence the population size and distribution of coccinellids. Perrin (1975) observed that populations of the aphid, *Microsiphum carnosum* (Bukt.), on perennial stinging nettle, *Urica dioica* L., supported populations of *C. septempunctata* and *A. bipunctata* L. early in the season, before aphids appeared on cultivated plants. Cutting of nettle at various times could be manipulated to either increase or decrease *C. septempunctata* populations and retain them in the nettle or force them into surrounding crop fields.

Very little research has been conducted on habitat use patterns by *C. septempunctata* in the United States. Knowledge of habitat preference is essential for developing strategies to use and enhance the biological control potential of this species, and to understand any potentially negative interactions that it may have with other predatory insects. We conducted a study during 1989 and 1990 in a diverse agricultural landscape to determine the temporal partitioning of *C. septempunctata* among various habitats.

MATERIALS AND METHODS

The study site is located on the Kellogg Biological Station (KBS), Hickory Corners, Michigan. The study site consists of forty-two 0.91-ha plots, divided into six

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TABLE 1

Habitat Treatments and Planting Dates in 1989 and 1990

1989 treatments	Planting date	1990 treatments	Planting date
Maize (CT) *Zea mays* Hybrid: Great Lakes 582	May 3, 1989	Soybean (CT) *Glycine max* Variety: Pioneer 9278	May 28, 1990
Maize (NT) *Zea mays* Hybrid: Great Lakes 582	May 3, 1989	Soybean (NT) *Glycine max* Variety: Pioneer 9278	May 28, 1990
Wheat (LIO) *Triticum aestivum* Variety: Augusta	November 11, 1988	Maize (LIO) *Zea mays* Hybrid: Great Lakes 582	May 1, 1990
Wheat (ZIO) *Triticum aestivum* Variety: Augusta	November 11, 1988	Maize (ZIO) *Zea mays* Hybrid: Great Lakes 582	May 1, 1990
Populus *Populus × euramericana* Variety: Eugenii	April 24, 1989	Populus *Populus × euramericana* Variety: Eugenii	Previous year's crop
Alfalfa *Medicago sativa* Variety: Big 10 Great Lakes	April 27, 1989	Alfalfa	Previous year's crop
Succession Predominantly annual weeds, dominant species: *Panicum didotomiflorum,* *Chenopodium album,* *Amaranthus retroflexus,* *Abutilon theophrasti*	Plowed in Spring 1989 and abandoned	Succession Predominantly biennial weeds, dominant species: *Conyza canadensis,* *Trifolium pratense,* *Barbarea vulgaris,* *Potentilla norvegica*	

Note. CT, conventional tillage; NT, no tillage; LIO, low-input organic based; ZIO, zero-input organic based. Alfalfa cutting dates in 1989: July 4, August 16; 1990: May 31, July 6, and August 17.

blocks with seven treatments randomly assigned in each block (Table 1). Treatments 1 and 2 are both maize soybean rotations, representing conventional, high-input grain production. Treatment 1 is conventionally tilled and treatment 2 is no-tillage. Treatments 3 and 4 represent low-chemical-input and zero-chemical-input treatments, respectively; both are wheat–maize–soybean rotations with a legume (hairy vetch) cover crop. Treatments 5 and 6 are perennial biomass crops, planted to alfalfa and *Populus,* respectively. Treatment 7 is native succession, abandoned after plowing in spring 1989 (Table 1).

Sampling of Coccinellidae in these diverse habitats was accomplished using double-sided yellow sticky panels (22.5 × 14.0 cm, unbaited Pherocon, Zoecon, Palo Alto, CA) suspended 100 cm above the soil surface. Five permanent sampling sites, ca. 15 m apart, were established in each plot and an individual trap was placed at each site. Traps were monitored weekly by counting and removing *C. septempunctata* adults. Traps were changed every 2 weeks.

1989 sampling. Sampling was initiated on May 18 and continued until August 30. In addition to trap monitoring, sweep samples were collected (50 sweeps per treatment) in all treatments each week beginning June 21, to get an indication of the presence of *C. septempunctata* larvae and prey species. Sweep samples were collected from the edge to the center of the plot by making 50 sweeps using a standard sweep net (37.5 cm diameter). Sweep samples were put in a paper bag, labeled, and taken to the laboratory for examination. The number of *C. septempunctata* adults in each sample was recorded. In the *Populus* treatment, an outbreak of brown poplar aphid occurred in late July. Weekly visual examination of 50–100 trees in *Populus* treatments from August 8 to August 30 documented *C. septempunctata* adults and aphid incidence.

1990 sampling. Plots planted with maize in 1989 were planted with soybean and plots planted with wheat in 1989 were planted with maize. Therefore, wheat was absent and soybean was a new addition to the landscape (Table 1). During 1990, traps were set up on May 23 and monitored as in 1989. Traps were set up in maize and soybean on June 6. In addition to trap monitoring, 20 sweep samples were collected weekly in soybean, alfalfa, and successional plots to get an indication of the presence of *C. septempunctata* larvae and prey species. Visual observations were made in maize and *Populus* by counting adult *C. septempunctata* for 2 min. During this 2-min period the number of plants with aphids was also recorded. In *Populus,* 15 trees were examined weekly in each plot and the numbers of adult *C. septempunctata*

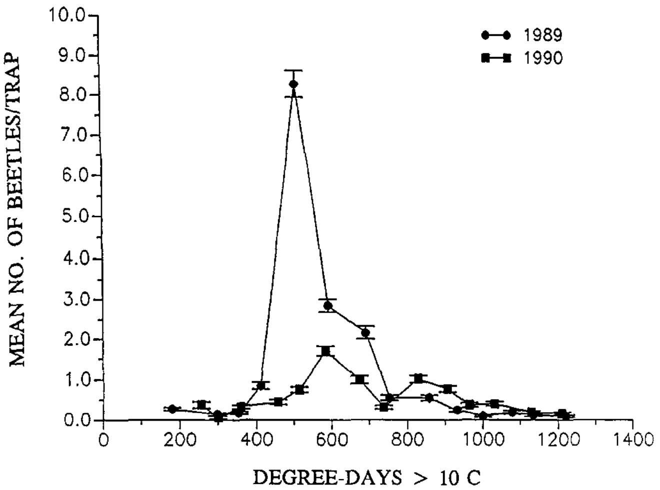

FIG. 1. Seasonal trends of adult *C. septempunctata* abundance over all habitats during 1989 and 1990. Data are means of yellow sticky trap catches with error bars representing SEM.

and aphid incidence (number of plants with aphids) were recorded.

Weather information. During both years, weather data were collected from an automated weather station (CR21) maintained at the Kellogg Biological Station. Daily maximum and minimum temperature was obtained from the weather database (initialized on 1 January) and degree-days above 10°C were computed using the method of Baskerville and Emin (1969).

Data analysis. Plot means of adult *C. septempunctata* abundance were computed for each date and subjected to two-way analysis of variance using a randomized complete block model (STATISTIX 1989). Treatment means in dates with significant F ($P \geqslant 0.05$) values were separated using the LSD mean separation procedure (STATISTIX, 1989). Trap catch data in treatment habitats for each individual date were converted to percentage *C. septempunctata* adults trapped based on the total number of adults trapped in all the habitat treatments. This was done to examine the trends of relative importance of different habitats during the growing season.

RESULTS AND DISCUSSION

Adults of *C. septempunctata* were present from the onset of sampling in both 1989 and 1990 (Fig. 1). The results from this and other concurrent studies examining ecology of coccinellids in agricultural and uncultivated habitats on the KBS showed that adults emerge from overwintering sites during the spring (late April) degree-days (DD) 56–DD 78 in 1989 and 1990, respectively. Eggs were observed in both years during late May–early June (DD 233–DD 301). F1 larvae were observed during early–mid June in each year (DD 298–DD 359). The summer generation (F2) adults began to emerge mid–late June (DD 411–DD 457) and population peaked during late June (DD 510) in 1989 and early July (DD 585) in 1990 (Fig. 1). After peak emergence, the adults select suitable habitat and forage until they seek overwintering sites in late August–early September.

C. septempunctata were trapped in all treatment habitats on most of the sampling dates (Table 2). Prior to June 14, there were no significant differences in the number of *C. septempunctata* among treatments. On June 14, however, significantly more adults were found in alfalfa, *Populus,* and successional treatments than in maize. On June 21, wheat held significantly more adults of *C. septempunctata* than any other habitat. At peak *C. septempunctata* abundance (June 28), wheat and alfalfa contained significantly more adults than other treatments. Populations of *C. septempunctata* in maize dropped dramatically on July 5 to approximate its populations in *Populus* and succession. Populations of *C. septempunctata* in wheat and alfalfa remained significantly higher. Populations in maize continued to drop on July 12, with populations in wheat significantly higher than populations in *Populus,* alfalfa, and successional. After wheat had been harvested on July 26, *Populus,* successional, and alfalfa plots contained more *C. septempunctata* than maize. Throughout the season there were no significant differences in *C. septempunctata* abundance between the conventional and no-tillage maize treatments or the low- and zero-input wheat treatments.

Although the number of beetles caught was lower in 1990 than in 1989, *C. septempunctata* was again detected in all habitats (Table 3). When sampling was initiated in late May, more *C. septempunctata* adults were trapped in alfalfa than in *Populus* and succession habitats; the differences, however, were not significant. The number of *C. septempunctata* trapped in alfalfa declined due its cutting on May 31 and did not rebound until late June. On June 12, when all crops were initially sampled, a significantly lower number of *C. septempunctata* occurred in *Populus* and successional habitats than in maize, soybean, and alfalfa. *Populus* remained the least favored habitat throughout the season. On July 3, maize and alfalfa treatments had significantly more *C. septempunctata* than other habitats. However, by July 10, all habitats except *Populus* contained an equal number of *C. septempunctata.* A higher number of *C. septempunctata* in maize during late June and early July appeared to be mainly due to the presence of vetch (cover crop) which supported aphid prey. Soybean, successional, and alfalfa had significantly more *C. septempunctata* from July 17 to August 1 than maize and *Populus.* These habitats continued to have a higher number of *C. septempunctata* throughout the season; soybean replaced successional with the highest number of bee-

TABLE 2

Mean Number of Adult *C. septempunctata* Trapped in Different Habitats in 1989

	May 24 DD 180		June 7 DD 298		June 14 DD 354		June 21 DD 411		June 28 DD 510		July 5 DD 592		July 12 DD 691	
Treatment[a]	*N*	Mean ± SEM	*N*	Mean ± SEM	*N*	Mean ± SEM	*N*	Mean ± SEM	*N*	Mean ± SEM	*N*	Mean ± SEM	*N*	Mean ± SEM
Maize CT	6	0.27 a ± 0.08	4	0.09 a ± 0.09	6	0.03 c ± 0.03	6	0.68 bc ± 0.18	6	7.03 b ± 0.64	6	1.77 b ± 0.31	6	0.53 c ± 0.18
Maize NT	6	0.27 a ± 0.09	4	0.25 a ± 0.16	6	0.10 bc ± 0.06	6	0.83 bc ± 0.19	6	7.80 b ± 0.59	6	1.90 b ± 0.30	6	0.50 c ± 0.12
Wheat LI	6	0.20 a ± 0.08	4	0.15 a ± 0.10	6	0.34 ab ± 0.11	6	1.73 a ± 0.32	6	11.50 a ± 0.83	6	4.17 a ± 0.41	6	4.50 a ± 0.51
Wheat ZI	6	0.23 a ± 0.10	4	0.08 a ± 0.08	6	0.37 a ± 0.10	6	1.43 ab ± 0.25	6	12.72 a ± 0.89	6	4.24 a ± 0.43	6	3.77 a ± 0.46
Populus	6	0.43 a ± 0.11	6	0.06 a ± 0.06	6	0.13 abc ± 0.08	6	0.17 c ± 0.08	6	3.80 c ± 0.37	6	1.53 b ± 0.26	6	1.21 b ± 0.23
Alfalfa	6	0.27 a ± 0.09	6	0.21 a ± 0.11	6	0.13 abc ± 0.06	6	0.70 bc ± 0.21	6	10.90 a ± 0.92	6	4.04 a ± 0.53	6	2.27 b ± 0.30
Success.	6	0.27 a ± 0.09	3	0.20 a ± 0.20	6	0.17 abc ± 0.08	6	0.40 c ± 0.13	6	4.43 c ± 0.43	6	2.37 b ± 0.26	6	2.27 b ± 0.33

	July 18 DD 753		July 26 DD 858		August 2 DD 932		August 9 DD 1001		August 17 DD 1079		August 22 DD 1135		August 30 DD 1221	
	N	Mean ± SEM	*N*	Mean ± SEM	*N*	Mean ± SEM	*N*	Mean ± SEM	*N*	Mean ± SEM	*N*	Mean ± SEM	*N*	Mean ± SEM
Maize CT	6	0.03 c ± 0.03	6	0.03 c ± 0.03	6	0.07 b ± 0.05	6	0.00 b ± 0.00	6	0.00 b ± 0.00	6	0.03 bc ± 0.03	6	0.03 ab ± 0.03
Maize NT	6	0.07 c ± 0.05	6	0.17 c ± 0.09	6	0.07 b ± 0.05	6	0.00 b ± 0.00	6	0.00 b ± 0.00	6	0.00 c ± 0.00	6	0.07 ab ± 0.05
Wheat LI	6	1.28 a ± 0.23		*										
Wheat ZI	6	1.27 a ± 0.21		*										
Populus	6	0.21 c ± 0.09	6	0.93 b ± 0.13	6	0.66 a ± 0.13	6	0.46 a ± 0.13	6	0.77 a ± 0.17	6	0.33 a ± 0.11	6	0.20 a ± 0.07
Alfalfa	6	0.31 c ± 0.11	6	0.25 c ± 0.12	6	0.10 b ± 0.06	6	0.03 b ± 0.03	6	0.19 b ± 0.09	6	0.07 bc ± 0.05	6	0.00 b ± 0.00
Success.	6	0.70 b ± 0.17	6	1.37 a ± 0.18	6	0.40 a ± 0.11	6	0.03 b ± 0.03	6	0.03 b ± 0.03	6	0.20 ab ± 0.07	6	0.17 ab ± 0.07

Note. Number below date corresponds with degree – days (DD) 10°C accumulation on the sample date. N, Number of replications (each replication consisted five traps); CT, conventional tillage; NT, no tillage; LI, low input; ZI, zero input.
[a] Means within a column followed by the same letters are not significantly different (LSD $P = 0.05$).
* Wheat harvested.

tles on August 24 and 30. Alfalfa was not sampled after its final cutting on August 17. During 1990, the tillage regimes (conventional and no-tillage) in soybean or input levels (low and zero input) in maize did not affect *C. septempunctata* abundance. Throughout the season, there were never significant differences in *C. septempunctata* abundance among tillage regimes in soybean or input levels in maize.

Results during 1989 and 1990 showed that *C. septempunctata* used all habitats, with its preference changing with crop disturbance and the availability of food (aphids) (Figs. 2 and 3). Data from the two maize (conventional and no-tillage), two wheat (low- and zero-input), and soybean (conventional and no-tillage) treatments were combined since there were never significant differences within these treatments. The importance of habitats that support a prey base very early in the growing season is of particular note. At the time of *C. septempunctata*'s first appearance in late April, none of the spring crops had been planted. In this agroecosystem, only alfalfa, wheat, *Populus,* and successional plots were available as habitats for these early emergers. These treatments were important early season habitats for *C. septempunctata* in 1989 as they contained the earliest vegetation and potential prey base. The importance of alfalfa in supporting *C. septempunctata* population diminished in mid-July due to its harvesting which forced adult *C. septempunctata* to leave. *Populus* and successional habitats were also replaced by wheat. As a fall-planted crop, wheat began developing early in the spring and supported a varied aphid prey. In particular, the English grain aphid (*Macrosiphum avenae* [Fab.]) was very abundant. Wheat proved to be the preferred habitat in mid-season for *C. septempunctata* beetles until its senescence and eventual harvest in late July. After wheat harvest, *Populus* quickly emerged as the preferred habitat for *C. septempunctata* adults in late July and early August. Prior to late July *Populus* was one of the least preferred habitats. An increase in brown poplar aphid, *Chaitophorus* sp., population was apparently responsible for the increase in *C. septempunctata* (Fig. 4). *Populus* remained the preferred habitat for *C. septempunctata* adults until the end of August when sampling was terminated.

In 1990, perennial habitats were again important early in the season, with alfalfa, successional, and *Populus* supporting *C. septempunctata* populations until annual crop habitats became available. No one habitat was important in supporting the *C. septempunctata* population in mid-season in 1990 as wheat had in 1989. Of notable importance was the occurrence of the aphid, *Uroleucon* sp., on horse weed, *Conyza canadensis,* in successional plots beginning on July 10 (Fig. 5). This abundant food supply not only supported *C. septempunctata,* but induced a second generation. On August 7, as many as 10 *C. septempunctata* larvae were collected in 20

TABLE 3

Mean Number of Adult *C. septempunctata* Trapped in Different Habitats in 1990

	May 30 DD 256		June 6 DD 301		June 12 DD 359		June 20 DD 457		June 27 DD 514		July 3 DD 585		July 10 DD 674	
Treatment[a]	*N*	Mean ± SEM	*N*	Mean ± SEM	*N*	Mean ± SEM	*N*	Mean ± SEM	*N*	Mean ± SEM	*N*	Mean ± SEM	*N*	Mean ± SEM
Soybean CT		*		*	6	0.43 ab ± 0.13	6	0.41 ab ± 0.14	6	0.37 ab ± 0.11	6	1.43 b ± 0.22	6	0.75 ab ± 0.15
Soybean NT		*		*	6	0.50 a ± 0.15	6	0.43 ab ± 0.11	6	0.77 ab ± 0.13	6	1.40 b ± 0.28	6	1.50 a ± 0.27
Maize LI		**		**	6	0.57 a ± 0.16		**	6	0.97 a ± 0.21	6	2.03 ab ± 0.34	6	0.97 ab ± 0.16
Maize ZI		**		**	6	0.57 a ± 0.12		**	6	1.07 a ± 0.20	6	2.50 a ± 0.26	6	1.30 a ± 0.24
Populus	6	0.30 a ± 0.12	6	0.03 a ± 0.03	6	0.07 b ± 0.05	6	0.13 b ± 0.06	6	0.17 b ± 0.08	6	0.23 c ± 0.08	6	0.30 b ± 0.09
Alfalfa	6	0.63 a ± 0.16		***	6	0.13 ab ± 0.06	6	0.90 a ± 0.19	6	1.11 a ± 0.19	6	2.83 a ± 0.37		***
Success.	6	0.23 a ± 0.11	6	0.10 a ± 0.06	6	0.10 b ± 0.06	6	0.40 ab ± 0.11	6	0.86 a ± 0.21	6	1.46 b ± 0.33	6	1.13 a ± 0.26

	July 17 DD 738		July 25 DD 829		August 1 DD 907		August 8 DD 965		August 15 DD 1032		August 24 DD 1130		August 30 DD 1212	
	N	Mean ± SEM	*N*	Mean ± SEM	*N*	Mean ± SEM	*N*	Mean ± SEM	*N*	Mean ± SEM	*N*	Mean ± SEM	*N*	Mean ± SEM
Soybean CT	6	0.60 a ± 0.17	6	1.59 a ± 0.26	6	1.13 ab ± 0.20	6	0.56 b ± 0.11	6	0.37 ab ± 0.12	6	0.40 a ± 0.13	6	0.13 b ± 0.06
Soybean NT	6	0.37 abc ± 0.10	6	1.60 a ± 0.22	6	0.79 bc ± 0.16	6	0.33 c ± 0.09	6	0.40 b ± 0.10	6	0.39 a ± 0.11	6	0.43 a ± 0.10
Maize LI	6	0.22 bc ± 0.08	6	0.93 bc ± 0.17	6	0.37 cd ± 0.10	6	0.07 bc ± 0.05	6	0.27 b ± 0.08	6	0.07 b ± 0.05	6	0.03 b ± 0.03
Maize ZI	6	0.15 bc ± 0.08	6	0.90 bc ± 0.19	6	0.33 cd ± 0.09	6	0.41 bc ± 0.12	6	0.17 b ± 0.08	6	0.07 b ± 0.05	6	0.10 b ± 0.07
Populus	6	0.03 c ± 0.03	6	0.07 d ± 0.05	6	0.17 d ± 0.08	6	0.03 c ± 0.04	6	0.07 b ± 0.07	6	0.03 b ± 0.03	6	0.14 b ± 0.07
Alfalfa	6	0.37 abc ± 0.11	6	0.57 cd ± 0.16	6	1.10 ab ± 0.18	6	1.13 c ± 0.07	6	0.77 a ± 0.16		***		***
Success.	6	0.43 ab ± 0.14	6	1.50 ab ± 0.33	6	1.53 a ± 0.32	6	1.07 a ± 0.23	6	0.80 a ± 0.22	6	0.23 ab ± 0.09	6	0.17 b ± 0.08

Note. Number below date corresponds with degree-days (DD) 10°C accumulation on the sample date. N, number of replications (each replication consisted five traps); CT, conventional tillage; NT, no tillage; LI, low input; ZI, zero input.

[a] Means within a column followed by the same letters are not significantly different (LSD $P = 0.05$).

* Traps not set up due to delayed planting.

** Traps not set up due to cultivation to remove cover crop vetch.

*** Traps removed from plots to facilitate alfalfa cutting.

sweeps in succession plots. On August 7, no *C. septempunctata* larvae were recovered in any of the other treatments. Second generation adults presumably resulting from these larvae were observed in mid-August.

For beneficial predatory species to survive in an agricultural ecosystem and contribute to biological control, the landscape must support them throughout their life cycle by providing needed resources. This diverse system demonstrates the potential benefits to *C. septempunctata* of the inclusion of a variety of habitats in a given landscape. *C. septempunctata* is believed to overwinter in uncultivated areas in woodlots or perennial

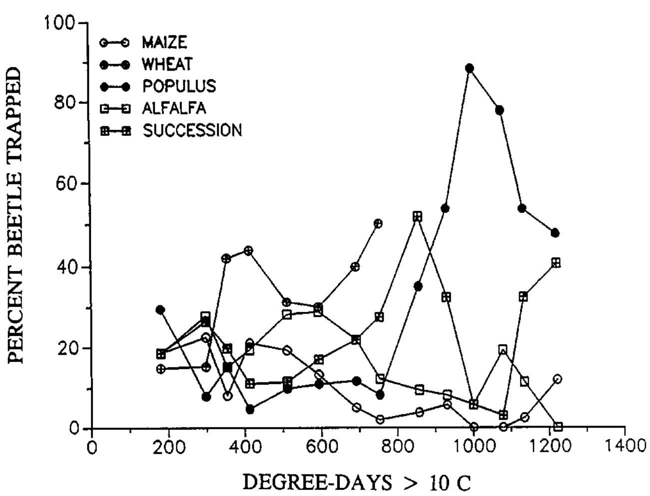

FIG. 2. Relative partitioning of *C. septempunctata* adults among habitat types throughout the 1989 season. Within each sample period the percentage catch of all habitats sums to 100%.

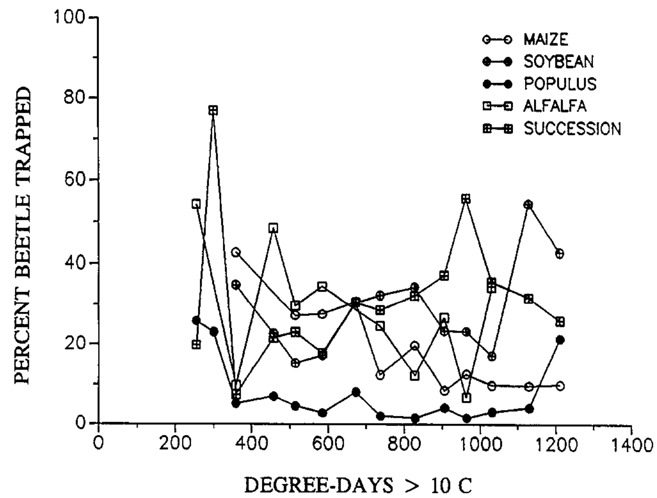

FIG. 3. Relative partitioning of *C. septempunctata* adults among habitat types throughout the 1990 season. Within each sample period the percentage catch of all habitats sums to 100%.

vegetation (Hemptinne, 1988). The KBS landscape provides abundant areas for such overwintering. The *Populus* treatment is a perennial habitat with relatively minor disturbance. This habitat was used by *C. septempunctata* early each year, probably because it is one of the few habitats in the study area actively growing at that time. *Populus* was extremely important in 1989 when it supported a large prey base late in the season.

Alfalfa also is a perennial habitat but it is subjected to disturbance by harvesting. Although alfalfa supports large prey populations primarily pea aphid, *Acyrthosiphon pisum* (Harris), regular disturbance prevents it from becoming a dominant habitat for *C. septempunctata* populations. Sirota (1990) reported that large populations of *C. septempunctata* perish if the cutting of alfalfa is ill timed. The effect of disturbance on *C. septempunctata* was also noted by Perrin (1975). Our successional treatments contained a mixture of annual, biennial, and perennial herbs which also were important habitats early both years. Similar to *Populus* in 1989, *C. canadensis* growing in these plots provided a large abundance of prey in 1990 and supported a high number of *C. septempunctata* late in the season.

The row crops present in this system also differed in their importance to *C. septempunctata.* Winter wheat in 1989 contained a large number of aphid prey and supported 30–50% of the total *C. septempunctata* populations for 6 weeks in 1989. Although wheat is an annual crop, fall planting allowed early growth and colonization by aphids the following spring. Without this feature it is doubtful that wheat would have supported large populations of the *C. septempunctata* for such a length of time. Maize and soybean were the most ephemeral of the crops. Each provided relatively little prey for *C. septempunctata* but potentially benefited from the predator that was present even if they were not retained for long periods.

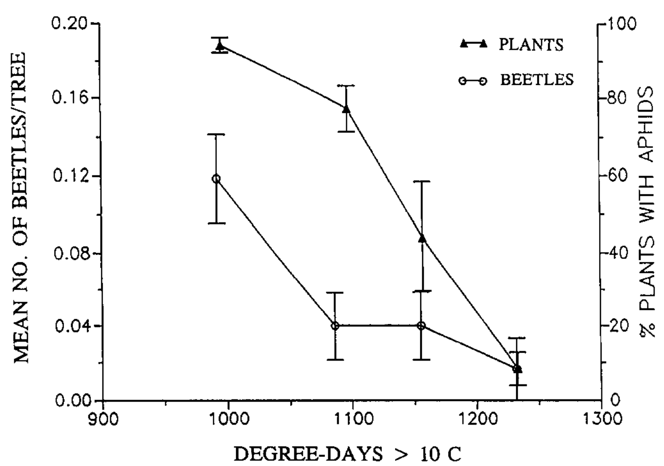

FIG. 4. Incidence of brown aphid (*Chaitophorus* sp.) and *C. septempunctata* (C7) abundance from visual observations in *Populus* from August 8 to August 30, 1989.

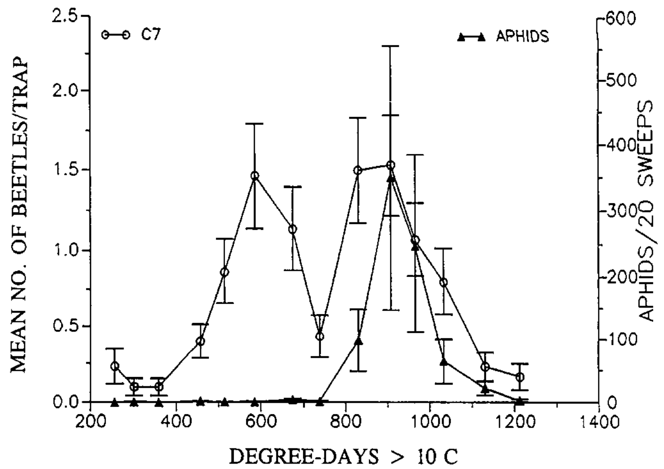

FIG. 5. Abundance of aphid (primarily *Uroleucon* sp.) and *C. septempunctata* (C7) in native succession plots from May 30 to August 30, 1990.

ACKNOWLEDGMENTS

This research was made possible with funding from the National Science Foundation (NSF) Long Term Ecological Research (LTER) program in Agricultural Ecology at Michigan State University (BSR 87-02332). Aspects of this study were also partially supported by NSF Grant BSR 89-06618 and a grant from the Rackham Foundation.

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