

Coleomegilla maculata (Coleoptera: Coccinellidae): Its Predation upon the Colorado Potato Beetle (Coleoptera: Chrysomelidae) and Its Incidence in Potatoes and Surrounding Crops

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ABSTRACT The polyphagous coccinellid *Coleomegilla maculata* DeGeer fed on eggs and small larvae of the Colorado potato beetle, *Leptinotarsa decemlineata* (Say). Prey consumption rates were highly correlated with temperature. This predator did not prefer aphids over potato beetle larvae in choice tests, but consumption of larvae decreased as aphid densities increased. Field cage studies demonstrated that *C. maculata* adults can significantly reduce populations of Colorado potato beetle eggs and small larvae. The incidence of *C. maculata* adults was monitored in early- and late-planted potatoes (*Solanum tuberosum*) in Rhode Island and Michigan. This predator coincided with first-generation Colorado potato beetle prey in early-planted potatoes in both states and with second-generation potato beetle prey in late-planted potatoes in Rhode Island. *C. maculata* also was found in cole crops, snap beans, cucurbits, and sweet corn in 1986 and in alfalfa and sweet corn in 1987, and the highest densities were observed in sweet corn during pollen production. Using observed temperatures and phenological models from the literature, we determined that *C. maculata* has the potential to complete two or three generations per year in Rhode Island and three or four generations per year in Michigan. The actual number of generations is probably dependent on its residence and dynamics in several adjacent crops.

KEY WORDS Insecta, *Coleomegilla maculata*, *Leptinotarsa decemlineata*, predation

MUCH BIOLOGICAL CONTROL RESEARCH has focused on the interactions between coccinellids and aphids in potato (*Solanum tuberosum*) fields (Shands & Simpson 1972; Shands et al. 1972a,b; Mack & Smilowitz 1978, 1980, 1982a,b; Mack et al. 1981; Tamaki 1981), but little attention has been given to the effect of these predators on the Colorado potato beetle, *Leptinotarsa decemlineata* (Say). Riley (1869, 1871, 1872, 1873) observed six coccinellid species feeding on Colorado potato beetle eggs and larvae. Of these, we have found the ladybird beetle *Coleomegilla maculata* DeGeer to be the most abundant species in potatoes in Rhode Island and Michigan (Grodén 1989). It also has been observed feeding on the Colorado potato beetle on wild host plants in Mexico (Cappaert 1988) and Michigan (Mena 1989).

Coleomegilla maculata is a polyphagous predator which Gordon (1985) reported to be primarily aphidophagous. It has been commonly reported feeding on aphids in potatoes (Mack & Smilowitz 1980), corn (Ewert & Chiang 1966), and alfalfa (Hodek 1973). Wright & Laing (1978) suggested that it is found on most crops that support aphid

populations. *C. maculata* is an important egg predator of the European corn borer, *Ostrinia nubilalis* (Hübner) (Bartholomai 1954, Conrad 1959), and the bollworm, *Heliothis zea* (Boddie) (Whitcomb & Bell 1964). Smith (1961) found that this predator completes development when reared solely on pollen. Consumption rates have been determined for *C. maculata* feeding on aphids (Mack et al. 1981), but its potential effect on the Colorado potato beetle is unknown.

The objectives of our study were to determine the effect of adult *C. maculata* on the Colorado potato beetle, and to investigate its occurrence in potato fields in Rhode Island and Michigan.

Materials and Methods

Consumption Rates. *C. maculata* adults were collected in August 1986 and 1987 from potato research fields in Michigan and Rhode Island to determine their daily consumption of immature Colorado potato beetle stages. Predators were held individually in Petri dishes with moist paper toweling and prey in excess of their daily consumption. Forty predators of undetermined sex were given either 20-33 eggs or first-, second-, third-, or fourth-instar Colorado potato beetles (densities, 25, 7, 4, and 2, respectively) and held for 5 d at 22-23°C. Prey consumption was monitored and new prey was added daily. *C. maculata* consumption of Col-

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orado potato beetle eggs was monitored at 15, 20, 25, and 30°C ($n = 25$ per temperature) to determine the influence of temperature. Predators of known sex were handled as described above, and prey consumption was checked daily for 8–13 d. An analysis of covariance (SAS Institute 1985) was performed with temperature as the covariate to determine if consumption varied with the sex of the predator.

Another laboratory study was conducted to determine if consumption of first-instar Colorado potato beetle by *C. maculata* was influenced by the presence of aphid prey. Approximately 500 *C. maculata* adults were collected in alfalfa fields near East Lansing, Mich., in the second week in May 1987. The adults were held at 22°C in ventilated 1-liter plastic cups for 24 h (25 *C. maculata* per cup), after which sluggish individuals or those parasitized by *Perilitus coccinellae* (Shrank) (Hymenoptera: Braconidae) were eliminated from the study. The remaining *C. maculata* adults were held individually in 30.5-cm capped glass lantern globes. The globes were set over 1-liter plastic cups of sand, each with a single *Solanum dulcamara* L. (Tubi-florae: Solanaceae) leaf (trimmed to a standard 20 cm²) held in a water-filled floral stem holder embedded in the sand. *S. dulcamara* was chosen as a host because all prey fed on this host, and the leaves remained turgid over the 24-h duration of the experiment. Ten first-instar Colorado potato beetles were transferred to each leaf, and nonalate aphids were added at densities of 0, 10, 15, 20, 25, 30, or 35 per leaf. Two aphid species were tested. Eleven replicates of each density were established with the green peach aphid, *Myzus persicae* (Sulzer) (Homoptera: Aphididae), and five replicates of each density were established with the potato aphid, *Macrosiphum euphorbiae* (Thomas) (Homoptera: Aphididae). Into each globe, a single *C. maculata* adult was released. The globes were held at 28°C and a photoperiod of 15:9 (L:D) for 24 h, after which the larval and aphid densities were recorded. Regression analyses (SAS Institute 1985) were used to determine the effect of aphid prey density on consumption of Colorado potato beetle larvae by *C. maculata* adults.

Cage Studies. The effect of *C. maculata* on Colorado potato beetle mortality was investigated in Rhode Island in August 1986 using six walk-in screen cages (3.6 by 1.8 by 1.8 m). These cages were erected in a newly tilled area, and two rows of 10 greenhouse-grown potato plants (*S. tuberosum* cv. Caribe) were transplanted into each cage. Potato stems infested with Colorado potato beetle eggs were collected from nearby research plots. Bouquets of stems were placed in 15-cm Pyrex test tubes with water, and the tops of the tubes were sealed with parafilm. These bouquets were set within the cages with the test tubes sunk into the soil so that the infested stems stood within the stems of the transplanted plants. Bouquet stems were secured to existing stems to ensure that they did not

droop away from the plant. Resulting Colorado potato beetle egg densities in the cages were set at 500 eggs per cage in three cages, and 250 eggs per cage in three cages.

At each of these prey densities, *C. maculata* adults were introduced at densities of 0, 10, and 20 predators per cage. Colorado potato beetle eggs and larvae within each cage were censused every 3–4 d for 3 wk. Two-way analyses of variance (SAS Institute 1985) were performed for each weekly interval to determine effects of initial egg and predator densities on prey survival. The data were pooled for the first two sample dates (representing the egg and first-instar of the prey) and all predator cages to examine the relationship between prey density and consumption rates. Available prey at the beginning of each sampling interval was regressed with consumption per predator over the interval. An egg mass was considered a single prey item for this regression because our measure of consumption incorporates the predator's searching efficiency and because Colorado potato beetle eggs are laid in masses.

Field Incidence. The densities of *C. maculata* and the Colorado potato beetles were sampled in early- and late-planted potatoes at two sites in Michigan and two sites in Rhode Island from 1985 to 1987. In Michigan, these included a late planting in 1985, an early and adjacent late planting in 1986 and 1987 at the Michigan State University Kellogg Biological Station (KBS), and at the Michigan State University Potato Research Station (Montcalm). An additional isolated third site with late-planted potatoes at KBS was sampled in 1986 and 1987. In Rhode Island, early and isolated late plantings were established at different sections (separated by 1 km) of the University of Rhode Island research farm in Kingston. The fast-maturing potato cultivar Caribe was used at all sites. Seventy to 150 whole-plant samples were taken at each site per sample date using nondestructive visual counts of all predators and potato beetle life stages (adults, egg masses, and each larval instar) on a plant.

Given the mobility and polyphagous feeding habits of *C. maculata*, we considered it necessary to determine its populations in surrounding crops. *C. maculata* densities and prey densities were monitored in 1986 in plots of alternate crops surrounding the potato research fields at the KBS sites, including cole crops (broccoli and cabbage), snap beans, sweet corn, and cucurbits (squash and cucumber). Nondestructive whole-plant counts of *C. maculata* and possible prey were taken in each plot once per week throughout the growing season using samples of 50 plants for cole crops, 30 for beans, 75 for sweet corn, and 60 for cucurbits. *C. maculata* and their prey were monitored in 1987 at the same sites in two alfalfa fields and two sweet corn plots. Ten samples each consisting of 10 consecutive sweeps with a 36-cm-diameter sweepnet were collected in alfalfa once per week from mid-April to mid-September, and 25 visual whole-plant

Table 1. Consumption of immature stages of the Colorado potato beetle by adults of *C. maculata*

Stage	No. individuals	Daily consumption per predator, $\bar{x} \pm SE$
Eggs	10	7.95 \pm 0.74
1st instars	10	11.20 \pm 0.78
2nd instars	10	3.07 \pm 0.31
3rd instars	5	0.60 \pm 0.16
4th instars	5	0.13 \pm 0.09

samples in each of three varieties of sweet corn were taken once per week from the pretassel stage through harvest.

Pesticides were not used in any plots at the KBS site in Michigan or in any site in Rhode Island during the study. Weeds were controlled by mechanical cultivation. At the Montcalm research site in Michigan, a preemergence herbicide and regular fungicide treatments with chlorothalonil were applied, as is standard for potato production in this area.

Daily maximum and minimum temperatures were recorded in a weather station located at each of the three research sites starting 1 April each year. From these temperature data, degree-day (DD) accumulations were calculated for the following *C. maculata* physiological events (using published degree-day models): first oviposition by overwintered *C. maculata* females (82.2 DD using a base of 15.4°C, Wright & Laing 1978), total development for immature stages (198.8 DD using a base of 13.8°C, Wright & Laing 1978), 236 DD using a base of 11.3°C (Obrycki & Tauber 1978), and preoviposition by summer adults (22 DD using a base of 13.8°C, Mack & Smilowitz 1982b). Degree-day accumulations were calculated by $[(T_{max} + T_{min})/2] - t$ when $T_{min} > t$ and $[T_{max} + t]/2 - t$ when $T_{min} < t$, where t equals the base temperature (Baskerville & Emin 1969). Predictions were made for the first emergence of each *C. maculata* generation by accumulating degree-days for development and

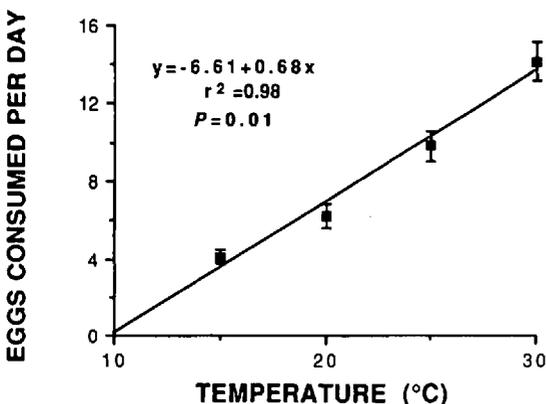


Fig. 1. Daily consumption of Colorado potato beetle eggs by *C. maculata* adults as a function of temperature. Vertical bars, 95% CIs.

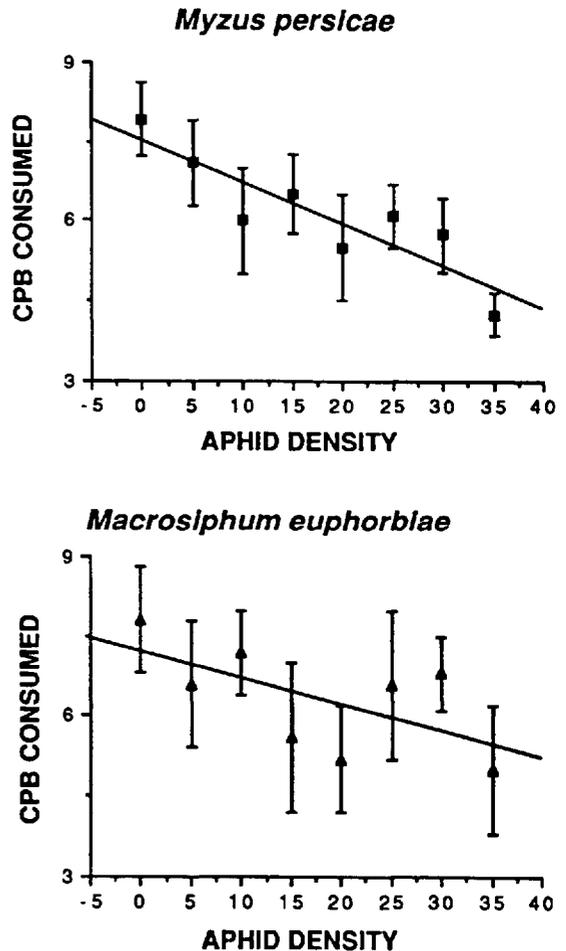


Fig. 2. Consumption of Colorado potato beetle first instars by *C. maculata* adults in the presence of aphids. Vertical bars, 95% CIs.

preoviposition from the predicted first oviposition by overwintered adults.

Results

Consumption Studies. *C. maculata* adults consistently consumed the eggs and first and second instars of the Colorado potato beetle (Table 1). Most individuals that were fed only third-instar Colorado potato beetles consumed a minimum of one larva during the 5-d period. Two of the five individuals that were fed only fourth instars successfully consumed these prey, and one adult *C. maculata* was observed attacking a fourth-instar Colorado potato beetle in the field. There was a significant difference in egg consumption between sexes in adult *C. maculata* ($F = 49.2$; $df = 1, 600$; $P = 0.001$). Over all temperatures, females consumed 9.10 ± 0.24 ($\bar{x} \pm SE$) eggs/d, whereas males consumed 6.64 ± 0.30 eggs/d. Consumption rates of *C. maculata* adults were linearly correlated with temperature over the range of temperatures tested (Fig. 1).

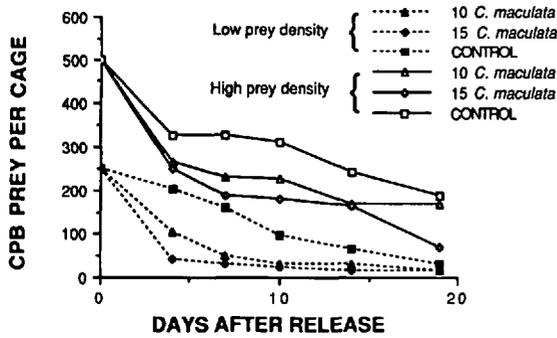


Fig. 3. Predation on cohorts of Colorado potato beetle eggs by *C. maculata* adults in field cages.

The presence of both aphid species decreased consumption of first-instar Colorado potato beetles by *C. maculata* adults ($F = 21.35$; $df = 1, 6$; $P = 0.004$ for *M. persicae* and $F = 3.61$; $df = 1, 6$; $P = 0.106$ for *M. euphorbiae*). Consumption of first instars decreased in a linear manner as aphid density increased (Fig. 2; $y = 7.514 - 0.078x$, $r^2 = 0.78$ for *M. persicae* and $y = 7.218 - 0.061x$, $r^2 = 0.38$ for *M. euphorbiae*). *C. maculata* adults consumed a constant percentage of both aphid species: $78.5 \pm 1.5\%$ for *M. persicae* and $71.3 \pm 2.8\%$ for *M. euphorbiae*.

Cage Studies. *Coleomegilla maculata* adults significantly reduced the survival of Colorado potato beetle cohorts in the cages over the first week of the study (Fig. 3; day 0 through day 7; $F = 19.24$; $df = 2, 2$; $P = 0.049$). Prey survival over this period was greater in the high-egg-density cages than in the low-egg-density cages ($F = 19.4$; $df = 1, 2$; $P = 0.048$). There was, however, no significant difference in survival between cages in the latter 2 wk of the study ($F = 0.48$; $df = 2, 2$; $P = 0.67$). This predator reduced egg and first-instar survival only. Predator consumption increased in a curvilinear manner with prey density (Fig. 4).

Field Incidence. In Rhode Island in all three years, *C. maculata* incidence in potatoes coincided with Colorado potato beetle prey (eggs and first and second instars) in both early- and late-planted potatoes (Fig. 5). Adult *C. maculata* colonized early potatoes between 3 June and 9 June. Their population densities peaked 7–14 d after the peak in prey density. In the late plantings, *C. maculata* adults were detected at the same time as the first available Colorado potato beetle prey. In 1986 and 1987, there were no differences in peak predator densities between the early and late plantings (0.15 ± 0.04 and 0.16 ± 0.04 in 1986 and 1987 early plantings, compared with 0.25 ± 0.05 and 0.14 ± 0.5 in late plantings); however, prey densities were less in the late season (21.12 ± 4.58 and 53.85 ± 4.57 at peak density of total prey in 1986 and 1987 early plantings compared with 4.28 ± 1.35 and 1.96 ± 0.66 in late plantings), resulting in an 8- to 24-fold greater predator/prey ratio in the late plantings.

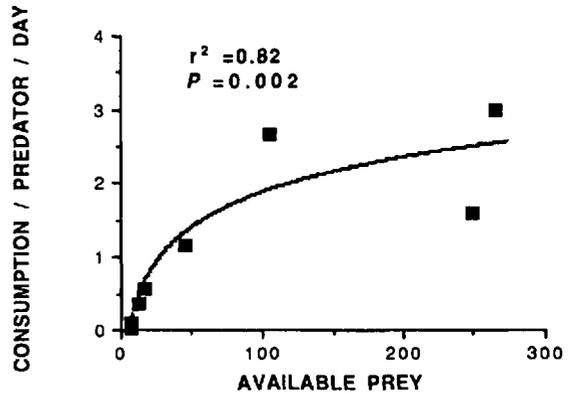


Fig. 4. Daily consumption rate of *C. maculata* adults as a function of prey (Colorado potato beetle egg masses plus small larvae) density in field cages.

In Michigan, adult *C. maculata* populations in potatoes coincided with potato beetle prey in early plantings in 1986 and 1987, but not in the late plantings (Fig. 6 and 7). *C. maculata* adults colonized early-planted potatoes at the KBS site on 9 June 1986 and 7 June 1987. At the Montcalm site, *C. maculata* adults were first observed in potatoes on 19 June 1986 and 3 June 1987. The later first occurrence of *C. maculata* at this site in 1986 coincided with a later buildup of Colorado potato beetle prey. *C. maculata* densities in potatoes in Michigan varied considerably between years and sites irrespective of Colorado potato beetle prey densities.

Of the different crops surveyed at KBS in 1986 and 1987, *C. maculata* adults were found in all plots at some point during the season. Potatoes were the earliest crop colonized by *C. maculata* adults in 1986 (Fig. 8), and adults were found at low densities in this crop throughout the field season. The cole crops and beans at site 1 also were colonized early (in early June). The predator was found only once in broccoli and cabbage plots at site 2. Predator populations did not appear to coincide with aphids on these crop plants. Aphids were present intermittently and at very low densities in these crops at both sites. *C. maculata* incidence in cole crops at site 1 coincided with egg populations of *Artogeia rapae* (L.) (Lepidoptera: Pieridae). Immature Mexican bean beetles, *Epilachna varivestis* Mulsant (Coleoptera: Coccinellidae) also were an apparent prey for *C. maculata* on snap beans. The predators consumed both *E. varivestis* eggs and small larvae readily in the laboratory. *C. maculata* adults colonized the cucurbits in early July. No aphids were observed on these crops, but they were heavily infested with *Diabrotica undecimpunctata howardi* Barber (Coleoptera: Chrysomelidae), *Acalymma vittata* (F.) (Coleoptera: Chrysomelidae), and *Anasa tristis* (DeGeer) (Hemiptera: Coreidae). The sweet corn at both sites was colonized in July in 1986 at the onset of tasseling, when the tassels

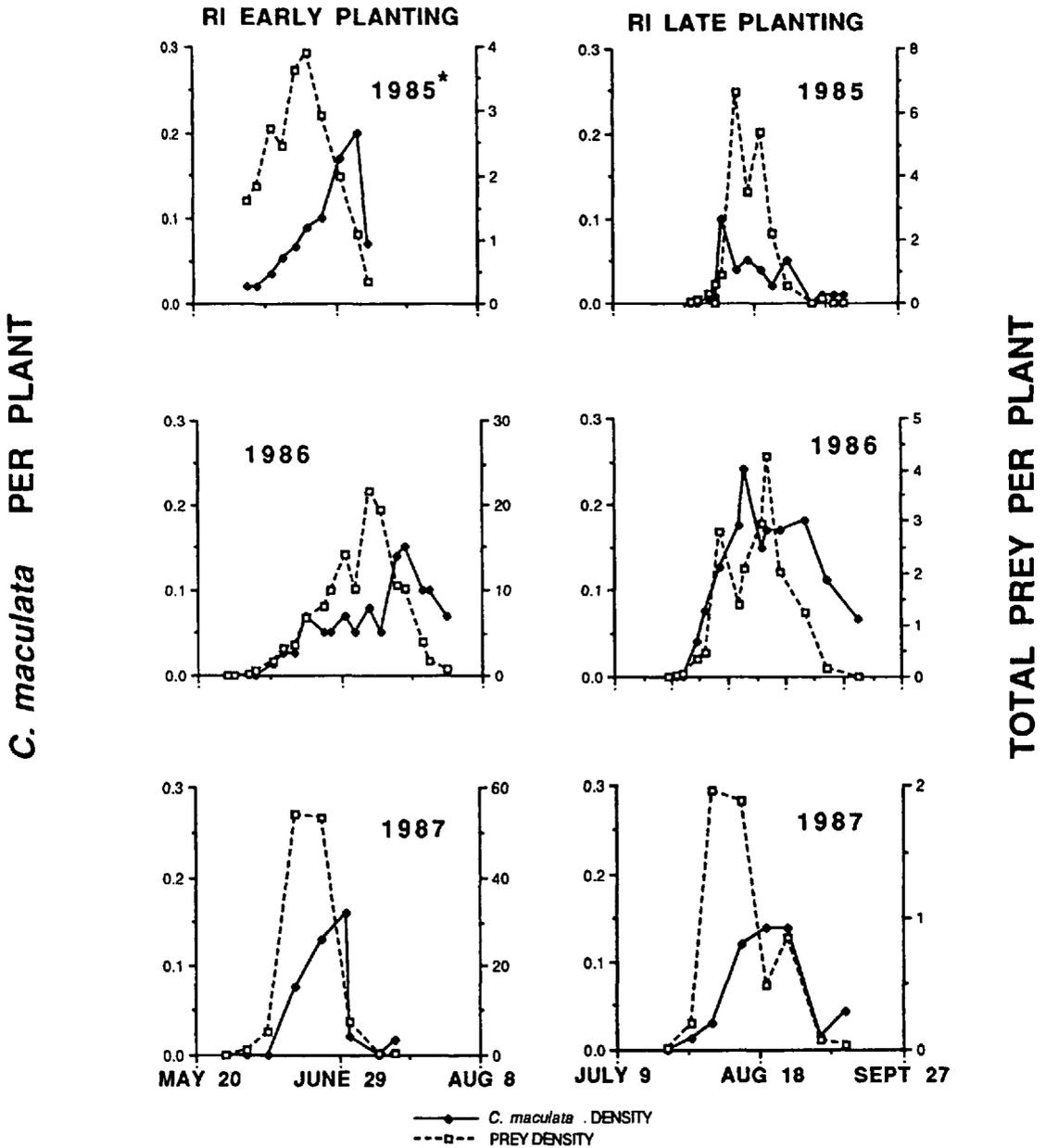


Fig. 5. Densities of *C. maculata* adults and Colorado potato beetle prey per plant in early- and late-planted potatoes in Rhode Island, 1985-1986. Late fields were isolated from early ones. Total prey = egg masses + first and second instars for all plots except the 1985 early planting, where Total prey = egg masses.

at both sites were heavily infested with aphids. Between 23 July and 5 August, *C. maculata* larvae were abundant. There were significant differences in peak *C. maculata* densities between crops ($F = 16.57$; $df = 4, 651$; $P = 0.0001$); corn supported the highest density (0.48 ± 0.79 per plant).

Coleomegilla maculata adults were sampled in alfalfa on 24 April 1987 (Fig. 9). The populations declined in field 1 following the first cutting on 10 May. Adult densities averaged 0.9 ± 0.3 per sample on 8 May and 0.1 ± 0.07 per sample on 4 June. In field 2, adult densities declined from 1.8 ± 0.4 per

sample on 24 May to 0.1 ± 0.4 per sample on 14 July following cutting on 27 May. *C. maculata* adults colonized potatoes in early June and sweet corn again in early July. *C. maculata* populations in potatoes were greater in 1987 than in 1986, with peak adult densities averaging 0.11 ± 0.03 per plant in 1986 versus 0.32 ± 0.06 per plant in 1987. Peak densities did not differ between years in corn (0.52 ± 0.15 per sample in 1986, 0.48 ± 0.10 per sample in 1987).

The predicted *C. maculata* physiological events differed between Michigan and Rhode Island by

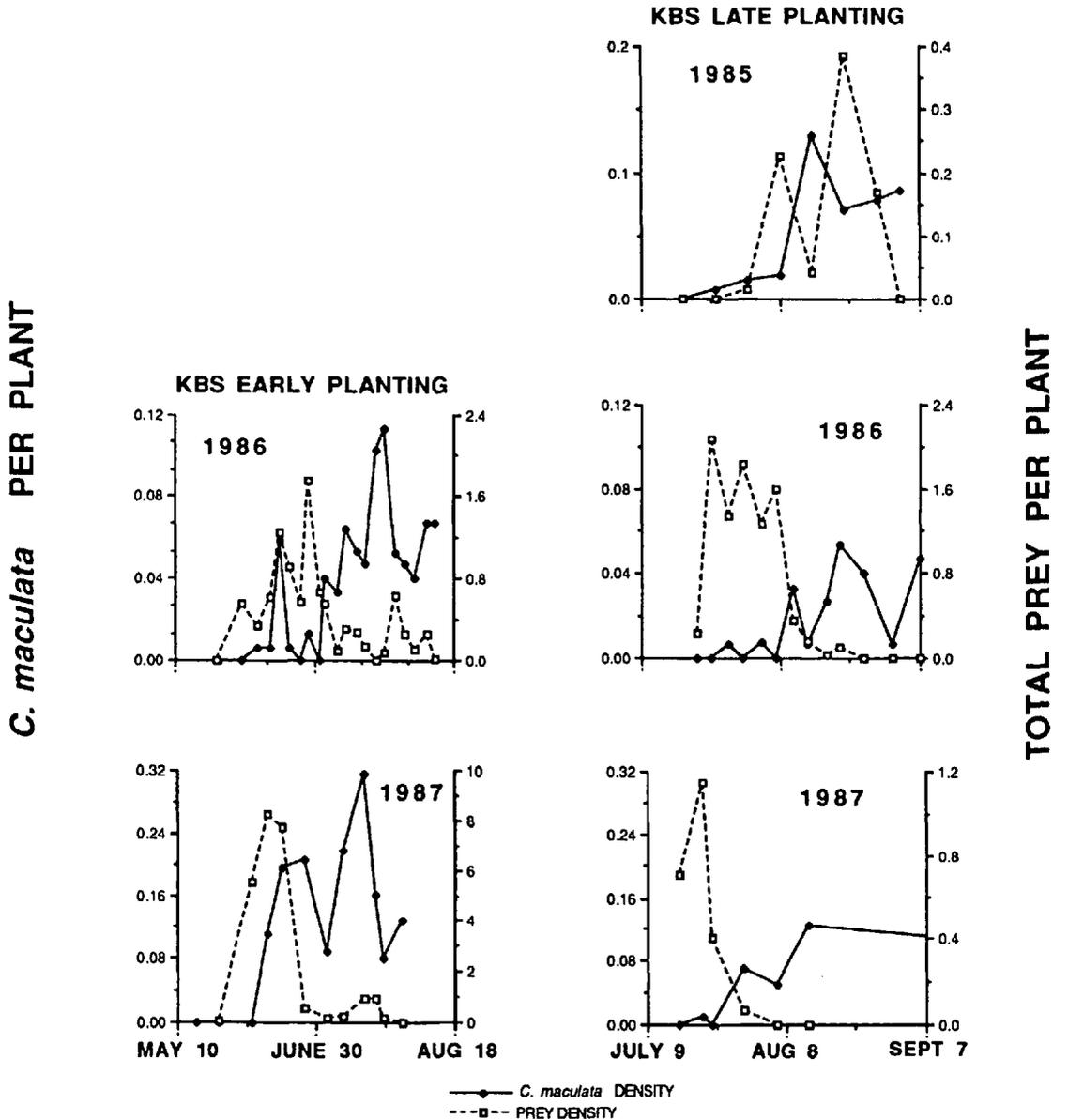


Fig. 6. Densities of *C. maculata* adults and Colorado potato beetle prey per plant in early- and late-planted potatoes at KBS (Kellogg Biological Station) site in Michigan, 1985–1986. Late fields were adjacent to early planting. Total prey = egg masses + first and second instars.

as much as 25 d by the end of the season. Because of the cooler spring temperatures in Rhode Island, the predicted first oviposition by overwintered adults was 12–14 d later than in Michigan in 1986 and 9–17 d later in 1987. *C. maculata* in Rhode Island could complete two or three generations in 1986 and three generations in 1987. In Michigan, it had the potential to complete three generations in 1986 and a possible fourth in 1987.

Discussion

Riley (1869) reported *C. maculata* feeding on the Colorado potato beetle, but previous studies on

the natural mortality of the Colorado potato beetle have not identified *C. maculata* as an important predator species (Harcourt 1971, Tamaki 1981). Our study indicates that *C. maculata* is an important natural enemy of the Colorado potato beetle; it feeds readily on Colorado potato beetle eggs and small larvae. Although some individuals fed on large larvae when confined in a Petri dish, it is doubtful that this predator would handle such large prey in the field. The field cage study demonstrated that *C. maculata* can significantly reduce populations of potato beetle eggs and small larvae, but it has no effect on large larvae. Predation by adult *C. maculata* increased with increased prey densities,

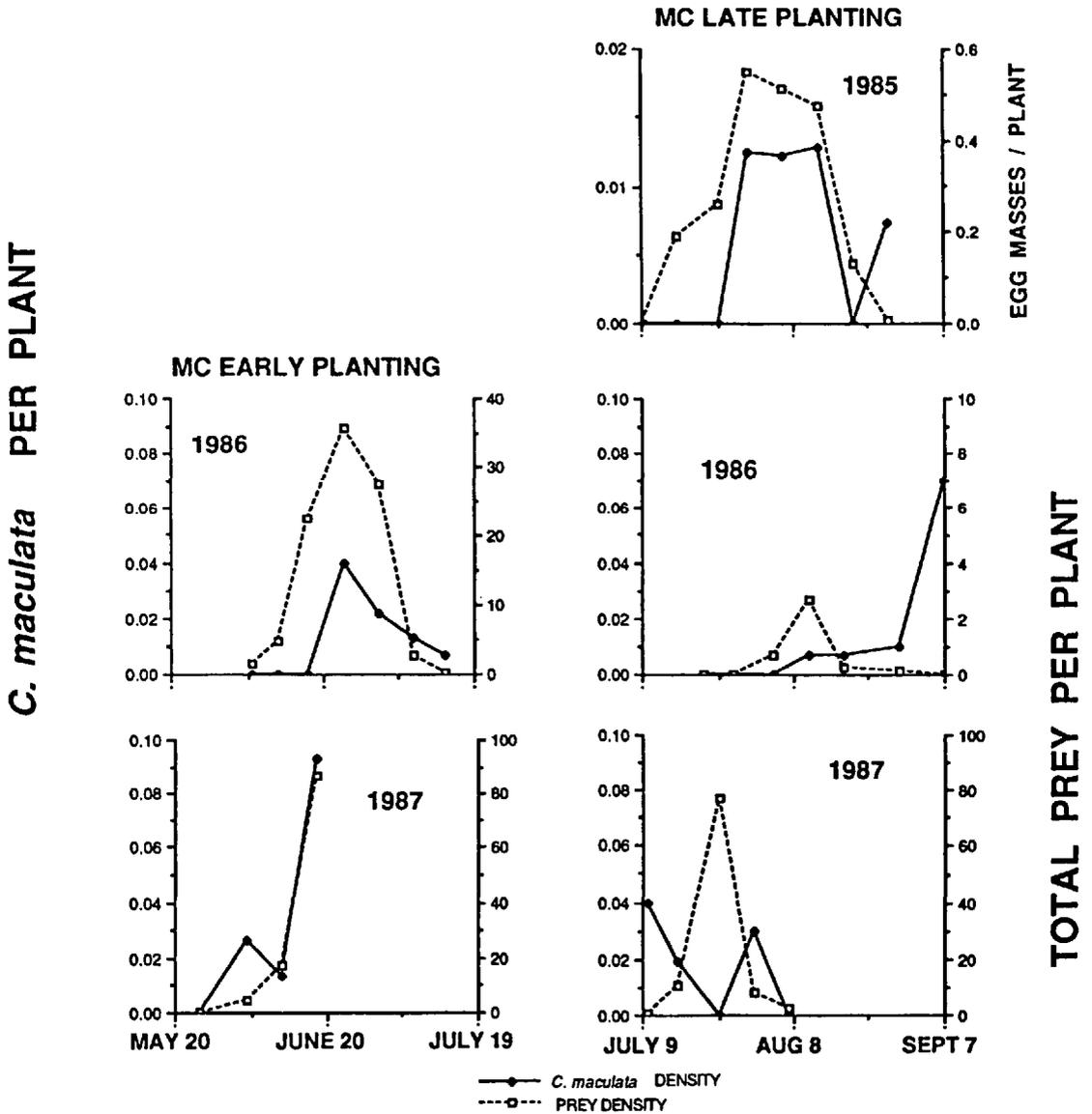


Fig. 7. Densities of *C. maculata* adults and Colorado potato beetle prey per plant in early- and late-planted potatoes at the Montcalm site in Michigan, 1985-1986. Late fields were adjacent to early planting. Total prey = egg masses + first and second instars.

a functional response pattern demonstrated by many insect predators (Hassell 1978).

Coleomegilla maculata consumption of potato beetle larvae was reduced in the presence of alternate prey. Given the linear reduction in potato beetle consumption as aphid density increased and the constant proportion of aphids eaten, we conclude that *C. maculata* adults do not preferentially feed on aphids but on whichever prey type they encounter. Conrad (1959) also reported a reduction in *C. maculata* consumption of European corn borer eggs in the presence of corn pollen and aphids. High densities of aphids in potatoes likely will decrease the effectiveness of *C. maculata* as a potato beetle predator.

Coleomegilla maculata activity in potatoes in the early season appears to be in response to potato beetle prey. Adult predators colonized potatoes when suitable potato beetle prey became available. Other suitable prey were not available on potatoes at this time. Although potato aphids can be found on potatoes in Michigan in early June, their populations do not build up until mid-July and August. Green peach aphids also are a late-season pest on potatoes. Aphid densities from the Montcalm research site in 1986 and 1987 (E. J. Grafius, unpublished data) confirm that in both years, *C. maculata* colonized the plots before aphids.

Population analysis revealed a significant correlation between *C. maculata* densities and sur-

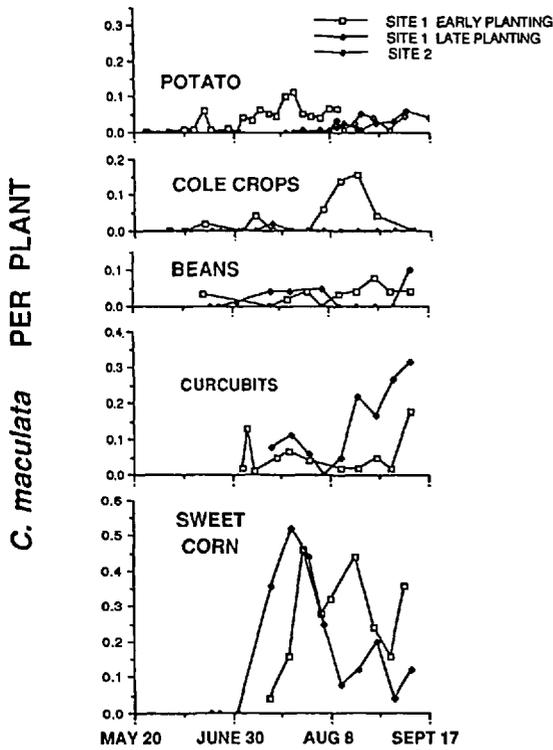


Fig. 8. Densities of *C. maculata* adults in potatoes and surrounding crops at the KBS site in Michigan in 1986.

vival of Colorado potato beetle prey in Rhode Island but not in Michigan (Grodén 1989). This may result from differences in the availability and relative abundance of alternate prey in the late season. The Colorado potato beetle has a much smaller second generation in Michigan than in Rhode Island (Grodén 1989), and the diversity of prey types available on potatoes and surrounding crops increases during this time. *C. maculata* populations are likely responding to total suitable prey densities. In Rhode Island, the Colorado potato beetle constitutes a larger proportion of the predator's total available prey. Aphid population growth in potatoes and other surrounding crops in conjunction with smaller potato beetle populations may be responsible for the lack of synchrony with potato beetle prey in the late season in Michigan.

At the KBS site, *C. maculata* was first observed in late April in 1986 and 1987 feeding on pollen of dandelions (*Taraxacum officinale* Weger) (Campanulatae: Compositae) surrounding alfalfa. Pollen has been shown to be an important food source for this predator (Putman 1964), and Conrad (1959) observed them commonly feeding on dandelion and yellow rocket (*Barbarea vulgaris*) (Rhoeadales: Cruciferae) in the early spring. These predators had colonized alfalfa by 10 May in 1986 and were abundant in this crop on 26 April in 1987, >1 mo before the first observance in potatoes. The predicted first *C. maculata* oviposition at the KBS

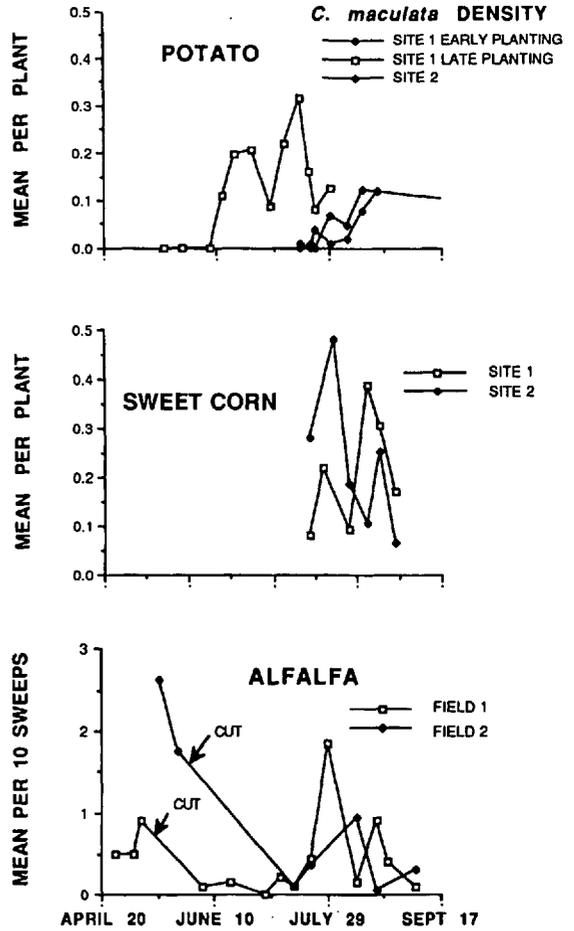


Fig. 9. Densities of *C. maculata* adults in potatoes and surrounding crops at the KBS site in Michigan in 1987.

site was on 13 May in 1986 and on 14 May in 1987. *C. maculata* females that were collected at this site on 10 May in 1986 were ovipositing, as were females collected on 24 May in 1987. Obyrcki & Tauber (1979) reported that photoperiodic control of diapause in this species ends in March in New York and suggest that, after that time, the availability of food sources and temperature could be influencing factors. There is an abundant supply of aphids in alfalfa in Michigan in early May, and with suitable temperatures, overwintered *C. maculata* females may begin ovipositing in that crop before potato plants emerge.

The predicted first emergence of first-generation adults in Michigan was between 19 June and 24 June in 1986 and between 9 June and 11 June in 1987. This predicted emergence in 1987 coincided with the initial colonization of potatoes by *C. maculata* adults, indicating that, in some years in Michigan, this predator may have the potential to go through one complete generation before colonizing potatoes. *C. maculata* had the potential to complete three generations in 1986 and four in 1987.

In 1986, one generation was likely completed before the predators colonized cucurbits or sweet corn. In 1987, they apparently completed two generations before colonizing sweet corn. Conrad (1959) did report that *C. maculata* completed four to five generations per year in Delaware, but Obrycki & Tauber (1978) reported two to three in New York, and Putman (1964) reported two generations per year in Ontario.

The predicted physiological events do not coincide with the observed dynamics of adult *C. maculata* populations sampled at KBS in 1986, although they do so in 1987. Many factors not accounted for in these predictions can influence the observed changes in the populations of this predator. Mortality can shift the population curves if it is not constant throughout the generation. More important, prey type, quantity, and consistency influence the onset of oviposition, fecundity, and larval development and survival in other coccinellids (Baumgaertner et al. 1981, Frazer et al. 1981, Ives 1981) and in this species in particular (Putman 1957; Smith 1960, 1961; 1965a,b,c; Obrycki & Tauber 1979). Also, crop management practices such as cutting alfalfa can strongly influence *C. maculata* mortality and dispersal to different crop plants. Therefore, these predictions reflect only the potential generations of *C. maculata* at each of the study sites, given optimal conditions.

Murdock et al. (1985) argue that polyphagous predators often may provide more effective biological control because their dynamics are not solely dependent on a target pest species but can be positively enhanced by alternate prey. Can a local diversity of crops provide the quantity and consistency of prey to maximize *C. maculata* populations and effectively reduce populations of target pests, or will preferred food sources draw local populations away from target pests? Smith (1965b) demonstrated that previous feeding experience did not affect *C. maculata*'s food preference, but he did report preferential feeding on corn pollen by *C. maculata* adults in laboratory choice tests with aphids. This preference was not exhibited in field studies, however, where a number of factors, including sunlight and plant density, affected local distributions and densities of this predator (Smith 1971). Warren & Tadic (1967) suggest that "the presence of corn and related crops on which *C. maculata* forages favors predation on fall webworm in the immediate vicinity." Andow & Risch (1985) reported lower densities of *C. maculata* in corn-bean-squash polycultures than in corn monocultures, and suggest that for this species, the total abundance of available food is more important in determining local densities than the diversity or temporal dispersion of food sources. From our study, we cannot determine the impact of alternate food sources in adjacent crops on the densities of *C. maculata* in potatoes. Higher local populations of this predator may be produced in alfalfa in years when temperatures are high enough for them to

complete a generation in this crop before prey are available on potatoes. If potatoes are grown in close proximity to this crop, timing the cutting of alfalfa with the availability of potato beetle prey in potatoes may stimulate predator dispersal into this crop and increase control of this pest. On the other hand, the higher predator densities observed in sweet corn in the July and August, and *C. maculata*'s known preference for corn pollen, may indicate that this crop grown in close proximity could draw these predators out of crops such as potatoes, a less-preferred food. A better understanding of the influences of specific prey preferences on the movement of this predator is necessary before it can be effectively managed to maximize its effect on the Colorado potato beetle. It is evident, however, that the dynamics of this species must be studied over the entire landscape rather than within a single cropping system.

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