Intercrop movement of leafminers

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Once leafminers and their parasites find suitable hosts, they tend to stay put

Two leafminer species cause economically significant crop loss in California — the vegetable leafminer, *Liriomyza sativae* Blanchard, and the recently introduced *L. trifolii* (Burgess). The inability of many currently registered insecticides to control these species, coupled with their capacity for rapid increases in numbers, has led to considerable difficulty in reducing leafminer populations below damaging levels.

Damage

In tomatoes and celery, *Liriomyza* species cause damage primarily by larval feeding inside leaf tissue. The maggots create serpentine mines beneath the leaf epidermis that widen as the larvae increase in size and consume greater amounts of leaf material. Adult females puncture the leaves and insert eggs between the upper and lower epidermal layers or feed on plant exudate. As with larval damage, the feeding punctures can result in a significant reduction in leaf photosynthesis.

Liriomyza sativae has been recognized as a pest of vegetables since the late 1940s, causing the greatest economic losses in tomato. High infestation levels in tomatoes reduce the photosynthetic capability of the plant and can result in premature desiccation and loss of leaves. Tomato fruit is especially sensitive to sunlight before harvest; unprotected fruit may become sun-scorched and susceptible to bacterial infection.

Liriomyza trifolii has migrated or been transported throughout the vegetable-producing regions of California since it was introduced into the state in the late 1970s. In Florida, leafminer damage in celery has been recognized as the primary reason for reduced plant size, increased costs, and withdrawal of many growers from celery production. Even moderate infestations of this leafminer in California celery during the early part of the growing season (up to 1½ months after transplanting) have stunted plant growth and delayed harvest two to three weeks. When such delays cause growers to miss key marketing "windows" such as Thanksgiving or Christmas, economic losses escalate dramatically.

Movement between crops

Leafminer species occur on a wide variety of hosts. Leaf samples taken from commercial growing areas in California have yielded *L. sativae* and *L. trifolii* from both tomatoes and celery. In southern California, tomatoes and celery are commonly grown in adjacent plantings within a single field, but experiments had not evaluated the movement of these species and their parasites between crops. We therefore began studies to examine host selection and population trends of these two leafminer species and associated parasites in adjacent tomato and celery plantings. We also investigated the importance of their migration between crops.

Commercial tomato and celery varieties were planted in adjacent plots, 38 by 280 feet, at the University of California's South Coast Field Station, Santa Ana. Each plot was divided into approximately 100 grids and weekly leaf samples were taken from one randomly selected plant per grid. One tomato leaf or celery leaf (trifoliate) with at least one large active mine was collected from each plant. Leaf samples were taken to the laboratory, where they were stored for at least four weeks to permit development of larvae and emergence of adults. After adult emergence, the leafminers and their associated parasites were identified.

Seven weekly leaf samples were taken in 1981, but tomatoes were sampled for only four weeks in 1982, because plants declined after a severe rain storm. Since leafminers and parasites continued to develop in celery, celery samples were taken two weeks after tomato termination to observe any insect migration.

Host selection

More *L. sativae* emerged from tomato than from celery leaf samples on all sampling dates in both years (table 1). The density of this leafminer in celery samples increased on September 17 and 24, 1981, which coincided with the end of irrigation in a nearby tomato planting. However, populations did not continue to expand in celery: very few were found on October 1. In 1982, *L. sativae* did not migrate to celery even after tomatoes declined.

These results indicate that, although this leafminer can complete development on celery and populations can be sustained at low levels, tomato is the preferred host. *Liriomyza sativae* densities will not be high in celery if tomatoes or other preferred hosts are in the immediate vicinity. Additionally, a change in

TABLE 1. Host preference of *Liriomyza sativae* in tomatoes and celery, 1981 and 1982

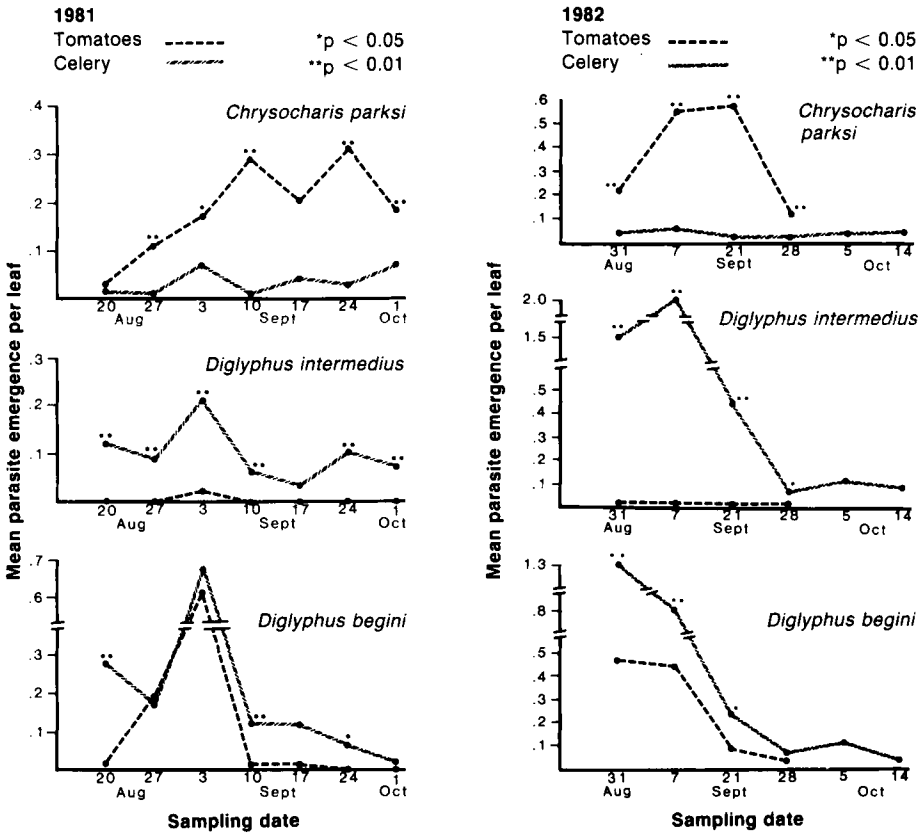
Mean no. *L. sativae* per leaf*					
1981			1982		
Date	Tomatoes	Celery	Date	Tomatoes	Celery
20 Aug	0.11 a	0.07 a	31 Aug.	2.43 a	0.00 b
27 Aug	1.02 a	0.11 b	7 Sep	1.67 a	0.00 b
3 Sep	0.51 a	0.08 b	14 Sep	1.84 a	0.00 b
10 Sep	0.75 a	0.02 b	21 Sep	1.64 a	0.00 b
17 Sep	0.24 a	0.18 a	28 Sep	—	0.01
24 Sep	1.20 a	0.67 b	5 Oct	—	0.00
1 Oct	0.73 a	0.04 b			

*Means in the same row within each year followed by the same letter do not differ significantly ($P < 0.01$), Student's *t*-test.

TABLE 2. Host preference of *Liriomyza trifolii* in tomatoes and celery, 1981 and 1982.

Mean no. *L. trifolii* per leaf*					
1981			1982		
Date	Tomatoes	Celery	Date	Tomatoes	Celery
20 Aug	0.02 a	1.48 b	31 Aug.	0.35 a	4.14 b
27 Aug	0.06 a	0.95 b	7 Sep	0.09 a	3.57 b
3 Sep	0.00 a	1.90 b	14 Sep	0.12 a	0.48 b
10 Sep	0.00 a	0.46 b	21 Sep	0.12 a	1.60 b
17 Sep	0.00 a	1.33 b	28 Sep	—	2.49
24 Sep	0.00 a	0.65 b	5 Oct	—	0.28
1 Oct	0.00 a	1.12 b			

*Means in the same row within each year followed by the same letter do not differ significantly ($P < 0.01$), Student's *t*-test.



Among the dominant leafminer parasites, *C. parksi* was predominant in tomatoes, *D. intermedius* in celery, and *D. begini* somewhat more numerous in celery than tomato in 1981 and 1982.

Defoliation by *Liriomyza sativae* results in sun-scorched tomato fruit (above left). Above right: celery leaves mined by *L. trifolii*. Below: experimental plantings of tomatoes and celery at the University of California South Coast Field Station.

Liriomyza species composition in celery is not likely after termination of a nearby tomato planting.

Liriomyza trifolii demonstrated a marked preference for celery in both 1981 and 1982 (table 2). This finding agrees with earlier reports that this was the dominant leafminer species in California celery-producing areas. Additional research has shown that *L. trifolii* may be displacing *L. sativae* on tomatoes. This trend, already documented in Florida, is of considerable concern to fresh-market tomato growers, since *L. trifolii* is resistant to most pesticides and cannot be controlled during harvest with any of the insecticides currently registered for tomatoes.

One possible solution to this problem is to increase the effective use of biological control agents. To determine the necessary leafminer-parasite relationships, we compared mean numbers of parasites reared from tomato and celery samples. The three most numerous parasite species associated with the leafminer species in tomato and celery were *Chrysocharis parksi* Crawford, *Diglyphus begini* (Ashmead), and *D. intermedius* (Girault).

Significantly more *C. parksi* were reared from tomato than from celery samples on 10 of 11 sampling dates (fig. 1 and 2). Evidently, *C. parksi* preferred either the tomato plant as a habitat or *L. sativae* as a host, since this leafminer was the predominant species on tomatoes. In contrast, *D. intermedius* was more numerous in celery, where *L. trifolii* was the dominant leafminer. Although greater numbers of *D. begini* were collected from celery than from tomato, this parasite was less host- or habitat-specific than the other two parasite species.

Conclusion

Our results indicate that leafminers and their natural enemies are clearly able to discriminate between potential hosts and, once suitable hosts have been located, movement between crops is minimal. Recent studies have shown that *Liriomyza trifolii* and *Chrysocharis* species are more resistant or tolerant to certain insecticides than are the other leafminer and parasite species. Knowledge of host preferences of leafminers and their parasites should prove useful in managing pest populations by manipulating planting dates of susceptible crops and choosing selective insecticides that control leafminers and conserve natural enemies.

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