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Leafminer Management on Desert Vegetables

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Vegetable Leafminer, *Liriomyza sativae*
American Serpentine Leafminer, *Liriomyza trifolii*

Distribution and Host Plants

These native *Liriomyza* leafminer species are closely related, have a similar biology and because they have a similar appearance, are often misidentified. *L. sativa* is the more commonly found on vegetables and melons during the summer and fall, whereas L. trifolii is more abundant during the spring and early summer. These two species attack a wide range of plants and have been reported on over 50 host crops including carrot, celery, cucumber, broccoli, cabbage, lettuce, melon, onion, pepper, potato, squash, and tomatoes. They can also be found in varying intensity during the summer on cotton, alfalfa, and safflower. Ornamental flower crops such as chrysanthemum, gerbera, gypsophila, and marigold are readily attacked as well as a number of broad-leaved weed species such as nightshade, sunflowers and groundcherry.

Description and Seasonal Development

Leafminers have a relatively short life cycle. The optimal temperature for development is about 85-90 °F and development ceases below 50 °F. The entire life cycle can be completed in less than 3 weeks under ideal conditions. Several generations may be produced during each growing season in Arizona. The eggs are very small and laid into the leaf just beneath the upper surface. After 2 to 4 days, larvae hatch and begin feeding on plant mesophyll tissue just below the upper surface of the leaf (Plate 1A). Black hook-like mouthparts are apparent in all instars, and can be used to differentiate the larvae. The winding tunnels (mines) that result from their feeding are initially small and narrow, but increase in size as the larvae grow (Plate 1B). Larvae emerge from the mines after completing three instars in as little as 7 days in fall growing conditions. The mature larva cuts a slit in the upper surface of the mined leaf, emerges from the mine and drops to the soil where it often burrows into the soil to form a puparium. The reddish brown puparium requires about a week to mature. Adults emerge as small, shiny black and yellow flies with a bright yellow triangular spot on the upper thorax between the wings. Subtle differences in color exist between the two species (Plate 1). *L. sativae* adults have a shiny black mesonotum whereas, *L. trifolii* has a grayish black mesonotum. Also, the black hind margin of the eyes of *L*. sativa distinguishes it from *L. trifolii*, which has eyes with yellow hind margins. Female flies' make numerous punctures (stipules) of the leaf surface with her ovipositor, and then uses these punctures for egg laying. Both female and adult flies feed on the plant secretions caused by the oviposition stipules. Female flies can produce as many as 600 eggs over their life span. Adults are weak fliers, and often are blown by the wind. Female flies can live for as long as 4 weeks.

Economic Damage

The numerous oviposition sites by adult female flies can result in a stippled appearance on foliage. However, the primary damage caused by leafminers is the mining of leaves by larvae. Larvae mine between upper and lower leaf surfaces creating winding tunnels that are initially small and narrow, but increase in size as the larvae grow This not only results in destruction of leaf tissue, but both leaf mining and stippling can greatly reduce the photosynthetic activity in leaves. Extensive mining may cause premature leaf drop, which can result in lack of shading and sun scalding of fruit. Wounding also allows entry of bacterial and fungal diseases.

- Lettuce: *Liriomyza* leafminers can readily damage all lettuce and leafy vegetable crops. Problems with leafminers are often most severe when lettuce is grown adjacent to or near cotton or melon fields. On crops planted in August or September, *L. sativae* is usually the predominant species, but by February and March, *L. trifolii* usually predominates. Mining of leaves by the larvae is the principal cause of plant damage (Plate 2A, 2B). The mines reduce plant photosynthesis, render harvestable portions unmarketable, and under wet, humid conditions can provide an access for fungal pathogens. When populations are high at stand establishment, plants may be killed or stressed to the point where pathogen can easily infect the plant. Leafminers can also cause damage after harvest. Larvae that cut out of the leaf tissue after harvest will sometimes pupate in between the leaves. These pupae not only act as contaminates, but will often die and rot, providing a substrate for postharvest pathogens to infect the lettuce.
- Celery: Leafminers can be a problem in celery, particularly as petioles begin to elongate. Damage from mines typically begins in the leaves, but larger larvae can travel down the petioles and into harvestable portions of the plant. This can result in having to remove outer petioles from the plant at harvest, reducing size and yield. In addition, under heavy pressure, larvae that cut out of the leaf tissue after harvest will sometimes pupate in among the heart.
- Cole Crops: Leafminer will feed and develop on cole crops, but they seldom cause significant damage. Broccoli and cauliflower plants with four or more leaves are rarely damaged by leafminers, regardless of population numbers. However, excessive mining of cotyledons at stand emergence can delay plant growth.
- Melons: *Liriomyza* leafminers can cause significant economic damage to melon plants, particularly in *L. sativae* on summer and fall plantings. Mining of leaves by the larvae can cause direct injury to seedling plants by removing chlorophyl and reducing the plants photosynthetic capacity (Plate 2C). Mines and feeding punctures also produce an entrance for pathogenic organisms. Excessive leaf mining in older plants can cause leaves to dry, resulting in sun burning of fruit and reduction in yield and quality. In severe infestations, leafmining may cause plant death, particularly to seedlings or transplant watermelons. Damage to mature plants can occur when attempting to hold the crop longer for a second or third harvest.

Management of Leafminers

Monitoring/Sampling

Yellow-sticky traps can be placed on the edges of fields to monitor adult activity and detect movement from surrounding areas. Traps can also assist in determining species composition. Young seedlings should be monitored regularly for the presence of adult oviposition stipules and newly developing mines In lettuce, most mines occur on the cotyledons and first true leaves (Plate 1B). After thinning, sample leaves from the middle portion of the plant. In melons, during the first 2 to 3 weeks after planting, count leaf mines on the largest leaf on 5 plants in each of 5 areas of the field, especially in watermelons. After the first 3 to 4 weeks the fifth leaf below the growing point should be sampled for the presence of leafminers and their condition. Hold the leaf up to light and with a 10-14x hand lens look at mines for live leafminer larvae (they are clear yellow with movement in its mouthparts or gut), dead larvae (dark brown or black with no movement) or parasitized larvae (have dark cigar shaped bodies inside the immobile larvae) (Plate 1A). In celery, transplants should be carefully examined for any leafminer larvae present. In all crops, the presence of adults on plants is a indicator that fields should be monitored closely.

Cultural Practices

Cultural management can help reduce potential problems with leafminers. When possible, avoid planting adjacent to cotton and alfalfa, or infested melon fields, especially those near harvest. Crop residue of fields infested with leafminers should be destroyed as soon as possible after harvest. Shredding of crop residue before tillage is more effective in killing larvae in plant material than tillage alone. Leafminer larvae may be able to complete their development in leaf materials that have been removed from the plant for several days depending on weather conditions. Deep plowing is also useful as it is difficult for adult flies to emerge from anything but a shallow layer of soil. Destruction of weeds in and around fields is recommended as these can serve as sources of adult infestations. Row covers applied at planting and removed at first bloom have been shown to exclude leafminer adults. Melons plants that are not stressed for moisture or by other environmental factors can often better tolerate leafminer injury.

Natural / Biological Control

Natural enemies, primarily parasitioid wasps can maintain leafminer population below damaging levels. Predators and diseases are not considered to be important, but both larvae and adults are susceptible to general predators, and in particular ants. These natural enemies commonly keep leafminer populations low, unless killed by non-selective insecticides applied to control other pests such as beet armyworm, cabbage loopers and whiteflies. Choose selective pesticides for treating other pests when possible to avoid creating a secondary outbreak of leafminer.

Insecticidal Control

Applications of insecticides should be considered during critical crop growth stages when mining is excessive or adult flies are abundant. Because leafminer damage cannot be reversed, harvestable portions of the plant must be protected. In lettuce, if leafminer populations build to high levels when seedlings have 2-4 leaves, chemical treatment should be initiated. After heading, the action threshold for leafminers in lettuce is an average of one or more active mines (live larvae) per leaf except on the marketable portions where damage cannot be tolerated. Leafy vegetables grown for fresh-cut bagged salads have a very low tolerance for mined leaves or pupae. In melons, insecticide treatments may be necessary to prevent economic damage if populations of adults and larvae build to high levels when seedlings have 2-4 leaves and parasitism is low. For older watermelon plants, chemical treatment is recommended if an average of 5 live larvae per leaf is found. For cantaloupes, insecticide treatment is recommended if an average of 3 larvae per leaf is found. Cole crop plants with six or more leaves are rarely damaged by leafminers, however if edible parts are mined, especially cabbage, chemical control may be justified.

It is important to identify the predominant leafminer adult species present as L*. trifolii* can be much more difficult to control with insecticides than *L. sativae*. Many pyrethroid, organophosphate and carbamate insecticides are no longer effective against *L. trifolii*, whereas *L. sativae* adults are still relatively susceptible to many pyrethroids. However, most of these insecticides are highly disruptive to naturally occurring biological control agents, particularly parasitoids that affectively control leafminer larvae. Consequently, use of selective insecticides for control of worms and whiteflies will often preserve leafminer parasitoids so that treatment will not be necessary.

Several newer insecticides are available for controlling leafminer. These compounds have translaminar activity and can penetrate the leaf surface where they contact or are ingested by the developing larvae. This includes Radiant and Coragen/Exirel/Durivo/VoliamXpress, which also have good activity against lepidopterous larvae. This is often a good choice for early leafminer infestations when beet armyworm and cabbage looper are present. Higher rates may be required for control when *L. trifolii* is the predominant species. Radiant has activity against adults as well. Agri-Mek is another highly effective translaminar compound for leafminer larvae. Residual control will vary with rate, and it is not highly effective against the adult flies. Use of a penetrating adjuvant (i.e., MSO) with these products will likely improve control. Other insecticides such as TriGard and neem products (i.e., Azi-Direct) act as IGRs, so an application when larvae first appear is most effective.

Leafminer - Leafy Vegetable Insecticides by IRAC group and mode of action

Group	Sub-group	Mode of Action	Chemical sub-group or active ingredient	Product Name
1	**B**	Acetylcholine esterase inhibitors	Organophospahtes	Diazinon, Dimethoate,
3		Sodium channel modulators	Pyrethroids, Pyrethrins	Asana, Renounce, Capture, Mustang, Warrior, Pyrellin
5		Nicotinic Acetylcholine receptor agonists (allosteric) (not group 4)	Spinosyns	Success, Entrust, Radiant
6		Chloride channel activators	Avermectins	Agri-Mek
17		IGR, Molting disruptor	*Cyromazine*	Trigard
18	**B**	IGR, Ecdysone agonists / molting disruptors	Azadiractin	Aza-Direct, Ecozin, Neemix
28		Ryanodine receptor modulators	Diamides	Coragen, Durivo, Voliam Xpress, Exirel

Leafminers on Lettuce

		Alternatives for Leafminer Control at Specific Lettuce Crop Stages									
			Stand establishment		Thinning to Heading				Heading to Harvest		
Insecticide	IRAC MOA	Pre-plant Soil	Coty-1 leaf	2-4 leaf	5-8 leaf	9-15 leaf	15-20 leaf	Pre - head	Early heading	2-5" head	4-6" head
Radiant, Success	5										
Dimethoate	1B		•	•	•	•					
Endosulfan	2A		•	•	•	•	•	•	•	•	•
Pyrethroids	3		•	•	•	•	•	•	•	•	•
Agrimek	6										
Trigard	17										
Aza-Direct	18		•	•	•	•					
Coragen	28										
Durivo, Voliam	28										
Exirel, Verimark	28										

• to be used in combination with a different IRAC mode of action

*** *Always consult the label before applying any pesticides.*

Plate 1. A) larvae mining lettuce cotyledon , B) feeding damage to lettuce cotyledon, C) Leafminer adult; *Liriomyza sativae,* D) **Leafminer adult**; *Liriomyza trifolii*

Plate 2. A) damage to head lettuce leaf , B) damage to romaine leaf , C) damage to cantaloupe leaf , D) damage to alfalfa leaf.