

Diglyphus-System

Leafminers puncture holes in the leaves to feed on plant juice and/or to deposit an egg in it. The larvae chew mines through the leaf. The damage can mount up considerably. The parasitic wasp *Diglyphus isaea* and its partner *Dacnusa sibirica* are efficient biological control measures of this pest.

LEAFMINERS

Leafminers (*Liriomyza* spp.) are dipterous insects, just like the common housefly. In Europe three species of *Liriomyza* occur: the tomato leafminer (*L. bryoniae*), the serpentine leafminer (*L. trifolii*) and the pea leafminer (*L. huidobrensis*). In these three species adult females measure about 2 to 3 mm. They are black with yellow, having a conspicuous yellow spot on their back. Only specialists are able to distinguish the three leafminer species. Males are a little bit smaller (1.5 mm).

With her barbed ovipositor, a female leafminer pierces holes in the upper surface of the leaf to extract plant sap (feeding spots). Males do not have an ovipositor, so they make use of the feeding spots made by females for their food. In such a puncture a female can also deposit an egg. Feeding spots are round and egg spots are oval.

The egg hatches into a tiny fly larva that immediately starts eating its way through the leaf. There are three larval stages. In the first stage, the larva is transparent, but later, depending on the species, it turns dirty-white to yellow-ocre (*L. trifolii*).

Just before pupation, the larva cuts a sickle-shaped hole in the leaf cuticle and wiggles its way out. It usually lets itself fall off the leaf to pupate in the soil or between the folds of the plastic in case of substrate culture. Sometimes, however, the pupae stay hanging on the leaf. Depending on the species, the pupa is yellow to (reddish) brown. The development time from egg to adult depends largely on temperature. For the serpentine leafminer, it takes 12 to 14 days at 30°C (86°F) and 54 to 61 days at 15°C (59°F). The first generations at the beginning of the cropping season often come in waves.

An adult female lives for 1 to 2 weeks. The number of eggs she deposits depends on the species, the host plant and on the temperature. It can vary from several tens to some hundreds. Leafminer damage occurs on many vegetables and ornamentals. In ornamental crops, the feeding spots already reduce the aesthetic value of the plant. Leafminers do not only reduce photosynthesis of the leaves, but can also cause withering or early shedding of the leaves. Finally, feeding spots can also be an entrance for all kinds of diseases.

DIGLYPHUS ISAEA

Diglyphus isaea is a black parasitic wasp of 2 to 3 mm long that occurs naturally in Europe, North-America and Asia. The short segmental antennae avoid confusion with *Dacnusa sibirica*, another parasitic wasp against leafminers. Females are slightly bigger than males, and can be recognized by the yellow stripe on the hind legs.

The female *Diglyphus* punctures a leafminer larva of the late 2nd or 3rd stage to paralyze the larva. Then she deposits an oval egg next to the leafminer larva. Therefore *Diglyphus* is called an ectoparasite. Out of the egg a *Diglyphus* larva emerges, that feeds on the leafminer larva. The *Diglyphus* larva has 3 stages. The first instar larva is transparent, the second instar is yellowish, and the third instar is bluish green. In the last stage the larva crawls a little bit back in the mine to pupate. With excrements it builds six columns around it, which separate the lower and upper leaf epidermis. These columns can easily be seen by the naked eye through the leaf as six black spots. First the pupa is green, but it turns to black later on. Finally, a new adult parasitic wasp leaves the mine through a round hole in the upper side of the leaf.

The total development time takes 13 days (at 25°C or 77°F) to 33 days (at 16°C or 60.8°F). The adult wasp lives for 10 days (at 25°C or 77°F) to 32 days (at 20°C or 68°F) and deposits in total about 200 to 300 eggs. This is why a *Diglyphus* population already increases faster than a leafminer population from 15°C (59°F) on.

To feed, a female *Diglyphus* punctures leafminer larvae of the late 1st and 2nd stage and sucks them empty (host feeding). At 20°C (68°F) she kills about 70 larvae for feeding only.

A predated leafminer larva can be recognized by a short mine that stopped early.

While searching for leafminers, the *Diglyphus* female alights on mined leaves. She then drums on the leaf surface with her antennae to locate a pest larva. At lower leafminer densities she has more problems with locating a larva.

APPLICATION

Diglyphus isaea is used as a biological leafminer control agent in several greenhouse vegetables (e.g. tomato, sweetpepper, melon...) and ornamentals (gerbera, chrysanthemum...). As outside temperatures improve (in May in temperate regions), *Diglyphus* often occurs naturally in greenhouses. *Diglyphus* parasitizes as well the tomato leafminer as the serpentine leafminer and the pea leafminer.

The most important benefit of *Diglyphus* is the fast population build-up that enables it to control an increasing leafminer population in a short period of time. At lower leafminer densities (in early spring in temperate regions) the wasp is however less efficient than *Dacnusa sibirica* in locating preys. Therefore, at lower leafminer densities, Biobest recommends to start with a mixture of 90 % *Dacnusa* and 10 % *Diglyphus* (Dacnusa-Mix-System) in temperate climates. At higher pest densities or later in the season, only *Diglyphus* can be released at a rate of minimally three weekly introductions of 0.1 *Diglyphus*/m². The fast population growth of *Diglyphus* will enable the parasitic wasp to catch up with the leafminer population. To control larger populations, the selective pesticide cyromazine (Trigard) can be applied, which is harmless for the parasitic wasps.

An additional advantage of *Diglyphus* is the fact that it can easily be visually detected, which facilitates the follow-up of the population growth.

DIGLYPHUS-SYSTEM

Diglyphus is presented in tubes of 250 adult wasps. To release them, the tube should be held low in the crop, in order to enable the wasps to escape and to start looking for leafminer larvae. *Diglyphus* is best released soon after arrival. If necessary, it can be stored for a short time at 6 - 10°C (42.8 - 50°F).

ADVANTAGES

- **Applicable to many crops;**
- **Parasitizes the three common leafminer species;**
- **Fast population growth;**
- **Activity of parasitized leafminer larva immediately stops;**
- **Larvae and pupae easily detectable;**
- **Feeds on leafminer larvae (host feeding).**