VIABLE OPTIONS FOR MANAGING ALLIUM LEAFMINER IN ORGANIC ONION PRODUCTION

2018 - Final Report for the Pennsylvania Vegetable Marketing and Research Program

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Introduction

Allium leafminer (ALM), a recent invasive herbivore pest, was confirmed in Lancaster in December 2015 and expanded in spring 2016 to Berks, Chester, Lehigh, Dauphin, and Delaware counties in Pennsylvania. This is a specialist pest that infests plants in the allium family such as onion, leeks, and garlic. Adult and larvae growth stages cause economic damage directly by adults laying eggs on leaves where they tunnel through leaves until they reach allium bulbs to pupate, with yield loss due to culls or non-marketable products.

In 2016, vegetable growers responded to a survey, conducted by the Pennsylvania Vegetable Growers Association (PVGA), indicating research is needed on the impact of plastic mulch, crop rotation and ALM in organic systems. At Rodale Institute, a two-year research project was established in 2018 to evaluate cultural and biological options for managing ALM for organic onion production. Funding by PVGA for year one allowed us to expand our data collection over more sampling dates during the yellow onion growing season in 2018.

The goal of this project was to evaluate the impact of plastic mulch color, cover crop mixtures and the use of row cover on reducing the ALM damage and onion yield. This project will empower allium growers with knowledge and scientifically-based information on viable cultural and biological tools that will improve early detection and management of ALM, and produce greater organic onion yields. The specific objectives of this project were to:

1) Assess the use of different colors of sticky card traps to monitor ALM for early detection and beneficial insects on a weekly basis after planting;
2) Assess plants of three onion varieties for ALM damage grown on plastic mulch and non-plastic mulch and for yield and final damage of onion bulb;
3) Assess the impact of cover crop type on ALM early detection, damage, and onion yield; and
4) Monitor percentage of mycorrhizal colonization and assess its impact on ALM and onion yield.

Materials and Methods

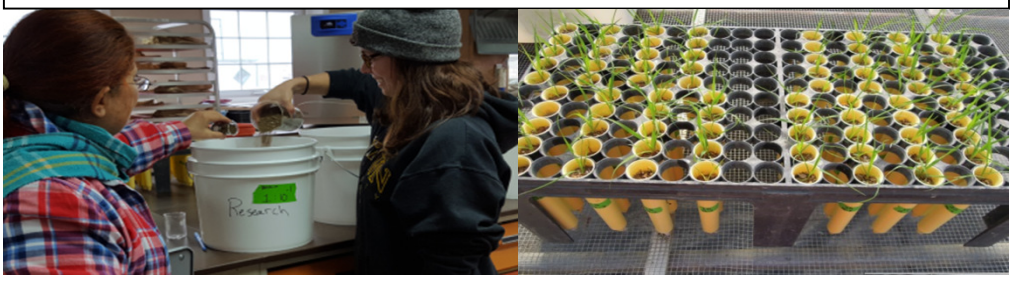
A field experiment was set-up at Rodale Institute in fall 2017. The experimental design was a split-split-split block design with four replications. The treatments included two cover crop mixtures (as main plot), three colored plastic mulches (black, silver reflective, and red mulches, sub-plot) (Photo 1), three yellow onion varieties (Cortland, Telon, and Sedona, as sub-sub-plot), and row cover (0,1, and 1.5 month as sub-sub-sub-plot).

Photo 1. Aerial view of the experimental layout.

One cover crop mixture included white Dutch clover, oats, rye and sunflower (mycorrhizal inducers) whereas the second cover crop mixture included brassicas such as rape, white mustard and tillage radish (non-mycorrhizal inducers). Another section on the same field was cropped with the above-mentioned onion varieties on bare-ground. Only Talon was covered with either 0 or 1 month period of row cover while the other two varieties were covered for 0 month. Seedlings of onions were started in the greenhouse at Rodale Institute in February 2018.

Soil samples were collected early in March before any field activities started (plowing, bed preparation, etc.) These samples were stored in the refrigerator, then serially-diluted into containers (10^{-1} through 10^{-4}) and planted with Bahia grass in the greenhouse for 6 weeks (Photo 2).

Photo 2. Showing preparation of soil dilutions, growing Bahia grass in the greenhouse for determining the most probably number (MPN) of mycorrhizal fungi on Bahia grass.



Then they were assayed later in the season for arbuscular mycorrhizal fungi propagule numbers processed and assessed for most probable number of mycorrhizae (MPN). Onion seedlings from all treatments (bare-ground and plastic) were collected at three sampling periods: a) planting, b) three weeks after transplanting, and c) at harvest. Onion roots from these samples are being assessed for percent root colonization by Dr. David Douds.

Onion seedlings were transplanted into 3-row, 6-ft center wide and 5-ft long beds per treatment in April 2018. The neighboring fields were monitored in March to assess emergence of overwintering Allium leaf miner (ALM) adults. Two colors (blue and yellow- Photo 3) sticky cards were used on a weekly basis, between April and end of May, to assess early detection and monitoring of ALM adult flights then in July to detect the second sighting of ALM adults.

Damage signs on onion leaves were recorded each week during the monitoring period. Onion bulbs were harvested in August 2018, cured for three weeks in a greenhouse and assessed for marketable yield. Onion samples that showed signs of ALM damage were harvested separately and the bulbs were assessed for signs of ALM larva and pupa (Photo 4).

Photo 3. Yellow and blue sticky traps used for assessing ALM population and beneficial insects.

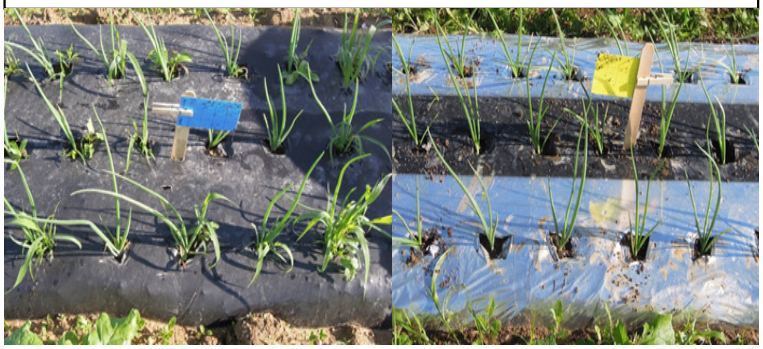
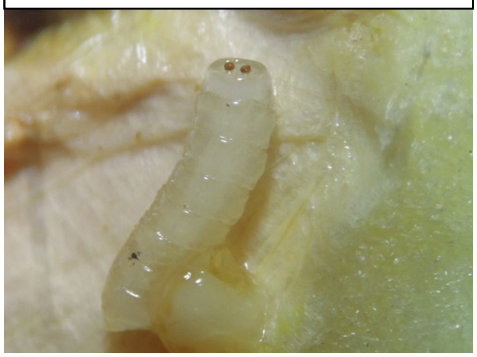


Photo 4. Showing ALM larva in onion bulb.



Results

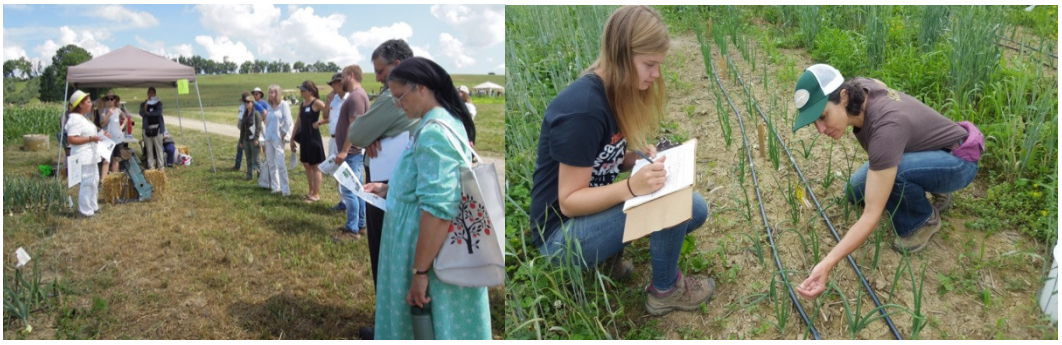
1- ALM and parasitoids (beneficial insects) were more attracted to yellow sticky cards than blue colored-sticky cards.
2- A few onion plants that were grown on black plastic mulch, in two out of the four replicates, and previously cropped with mycorrhizal-inducing cover crop mixture (oats, sunflower, Dutch white clover, and rye) showed ALM damage on leaves but not on bulbs. On the other hand, none of the onion plants grown on any plastic mulch and previously cropped with non-mycorrhizal-inducing cover crop mixture (tillage radish, rape, white mustard), showed any evidence of ALM damage on leaves and bulbs.
3- Only onion plants grown on bare-ground with no row cover showed ALM damage at the beginning of the season but the leaf damage did not translate into bulb damage but in two bulbs (Cortland and Sedona) with 0 month row cover.
4- Irrespective of the cover crop mixture, Talon and Cortland onions yielded the least when grown on red plastic mulch (ranged between 9,815 lb/acre and 11,600 lb/acre) and were of similar yield when grown on either black or reflective mulch (11,780 lb/acre to 12,490 lb/acre). However, Sedona onion yields were greatest when grown on black plastic (16,950 lb/acre) after brassica cover crop than those in either red or reflective mulch (11,780 lb/acre). Sedona yields were within the range of Talon and Cortland yields averaging 10,700 lb/acre when grown after non-brassica cover crop.
5- In the brassica cover crop mixtures, covering onion seedlings with row cover for 1 month or 1.5 months increased Sedona onion yields (17,500 lb/acre) when grown on either black or silver reflective plastic mulch than those without row cover (averaging 12,500 lb/acre). However, Sedona yields were not significantly different (averaging 11,600 lb/acre) whether they were covered or not covered with row cover and grown in black or silver reflective mulch that was previously cropped with mycorrhizal-inducing cover crop mixtures.
6- The mean MPN was 8.43 in soils that was previously cropped to Brassica non-mycorrhizal-inducing and 24.88 in those cropped with mycorrhizal-inducing cover crops. These values are in line with our expectations, as brassica cover crops impede mycorrhizal propagule number and colonization of soil with mycorrhizal fungi.

7- Data on percent root colonization of onion roots collected at planting and three weeks after planting are currently being analyzed.

Outreach and training/education

In the first year of this project, the experimental research site was showcased during the Rodale Institute's field day on July 20, 2018 (Photo 5a). The field day was very successful and attended by 428 attendees. Printed flyers on the objectives and preliminary results, from year one of this project, were distributed to the visitors. Total of eight interns were trained on this project. Two out of eight were research interns that were hired and trained on this project (Photo 5b).

Photo 5a (left) Dr. Zinati showcasing the experimental site, and **5b** (right) two interns getting trained on recording ALM damage.



Discussion

The information gained from this first year project showed that the yellow sticky card can be used as a viable and quick tool detect the appearance and monitoring of ALM adult early in the season and later in July. Also, it can be useful tool to monitor parasitoids and other beneficial insects that populate during the growing season. Thus, onion growers could benefit from using yellow stick cards early in March through mid-April to detect early emergence and mating of ALM by monitor the surroundings of the fields before transplanting onions. Also, they can use these traps when installed between onion seedlings throughout the growing season.

Our results showed that ALM female adults started to show signs of laying eggs and signs of damage on onion leaves start two weeks after transplanting onion seedlings into bare-ground beds that were previously cropped to mycorrhizal-inducing cover crops. It is important to note that these seedlings were not covered with row cover. However, signs of ALM damage start to show three weeks after transplanting onion seedlings into bare-ground soil that was previously cropped with brassica cover crop. While the connection between the impact of cover crop and ALM and mycorrhiza was not yet made, we are currently working on the data to deduce any correlations.

The use of row cover for one month to cover onion seedlings was enough. Using row cover would be also another viable tool for allium growers to use for protecting the young seedlings from any ALM attack early in the season. Beyond one month, we did not see significant improvement in yield or further protection from ALM, possibly due disappearance of ALM female adults at that time. Unlike Cortland and Talon, Sedona yield can be 46% greater when grown in beds where soils were previously cropped to brassica cover crop mixture and covered with black plastic.