Investigating the Use of Hairy Vetch Cover Crop as an Integrated Approach to Manage Powdery Mildew in Winter Squash

Andrew Smith, *Ph.D.*[1], Rick Carr[2], and Gladis Zinati, *Ph.D.*[3]

[1] Chief Operating Officer/Chief Scientist, Rodale Institute, Kutztown, PA
[2] Farm Director, Rodale Institute, Kutztown, PA
[3] Director, Vegetable Systems Trial, Rodale Institute, Kutztown, PA

Introduction

Powdery mildew (*Podosphaera xanthii*) is a major disease of cucurbit crops (e.g. squash, pumpkin, cucumber, melon) in the eastern United States (McGrath, 2000). Powdery mildew symptoms develop on leaf surfaces, petioles and stems of cucurbits, and typically develop first on shaded lower leaves and the undersufaces of leaves and petioles. As infection progresses, yellow spots form on upper leaf surfaces and increase until leaves wither and die. Intensive fungicide programs can effectively manage this disease but these programs can be time consuming and costly. Fungicide options to manage powdery mildew are limited for organic growers and are not always as successful as conventional spray programs. Therefore, an integrated management approach that includes host resistance and biological, physical, and chemical strategies should be considered for all vegetable growers.

Photos: Megan McGrath, Cornell University: characteristic white powdery mildew spores on underside of leaves (left) and yellow spots on upperside and developing lesions on underside of leaves (right).

Hairy vetch (*Vicia villosa*) is a popular cover crop used by many vegetable and field crop farmers as a source of nitrogen and weed barrier in cover-crop based no-till. As a green manure hairy vetch consistantly provides 80 lb or more of readily available nitrogen for the following cash crop (Clark, 2008). Hairy vetch mulch used for no-till tomato production resulted in increased yields (Abdul-Baki et al., 1996; Abdul-Baki et al., 2002), and reduced early blight (*Alternaria solani*) and Septoria leaf spot (*Septoria lycopersici*) (Figure 1) compared to black plastic mulch and bare ground treatments (Kumar et al., 2004; Mills et al., 2002). Although the crop residue reduced splashing of infested soil onto plant vegetation (Mills et al., 2002), further investigation revealed that the mechanism that increased yields and reduced foliar disease may have a molecular basis as well. Genes associated with photosynthesis, plant senescence, and plant defense against pathogens were upregulated and expressed for a longer period of time in tomatoes grown in a no-till hairy vetch compared to a black plastic mulch (Kumar et al., 2004).

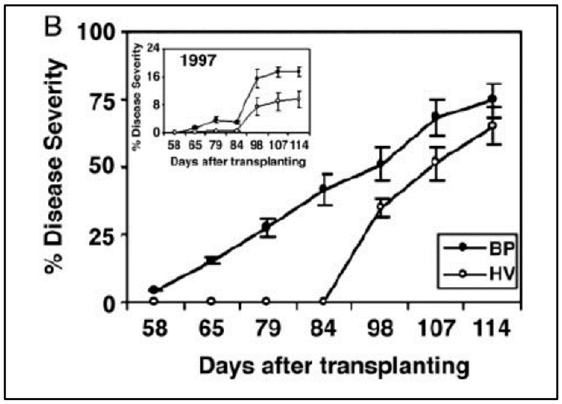

Figure 1. Septoria leaf spot (*Septoria lycopersici*) percent disease severity on tomatoes grown in black plastic (BP) or hairy vetch (HV) mulch. From Abdul-Baki, Mills, Kumar, Teasdale, Coffman, Everts, Anderson 1997 – 2005. USDA-ARS Beltsville, MD

Hairy vetch has been attributed to suppression of soil borne pathogens of cucurbits when incorporated as a green manure (Candole and Rothrock, 1997, 1998; Zhou and Everts, 2004). Fusarium wilt in watermelons was reduced by up to 63% by hairy vetch amended soils depending on cultivar and disease inoculum density in the soil (Zhou and Everts, 2004). In pumpkin (*Cucurbita pepo*) production, a winter annual cover crop of hairy vetch or hairy vetch and cereal rye increased yields and fruit quality while reducing the severity of three plant diseases and the need for fungicide applications compared to bare ground treatments (Everts 2002). In that study, the severity of powdery mildew and Plectosporium blight (*Plectosporium tabacinum*), both foliar diseases, were reduced in two out of three years, and black rot (*Didymella bryonidae*) which causes fruit rot, was reduced in all three years in the hairy vetch mulch treatments. Based on these findings, we conducted a study in 2018 and 2019 to assess the potential for hairy vetch to suppress powdery mildew on winter squash (*Cucurbita moschata*). To our knowledge, the use of hairy vetch to manage powdery mildew in winter squash production has never been investigated in organic or conventional vegetable cropping system.

Field Study

In fall 2017 and 2018, sub-plots of rye and rye-vetch intercrop were introduced into organic and conventional winter squash plots of the Vegetable Systems Trial (VST) at Rodale Institute main campus (Kutztown, PA) as cover crops. The standard cover crop in the conventional system is cereal rye (*Secale cereale*) planted at 100 lbs per acre and the standard cover crop in the organic system is 90 lbs per acre cereal rye and 30 lbs per acre hairy vetch. All cover crops were plowed under in the spring and butternut winter squash cv. Waltham was grown in 4-inch raised black plastic mulch beds and spaced 24 inches apart within each row. Waltham butternut squash was used in all treatments with seeds deriving from conventional or certified organic sources. This cultivar does not have resistance to powdery mildew resistance. Each treatment was replicated four times in a completely randomized block design. Development of powdery mildew in the quadrats with rye or rye-vetch in each plot was assessed using methods from Everts (2002). In brief, over the course of the season starting with initial signs of powdery mildew, all leaves (excluding newly unfolded leaves) within a 3.2 ft (one meter) random transect were assessed for percent coverage of the powdery mildew symptoms on a 0 to 100% scale. The abaxial and adaxial side of each leaf was inspected for percentage of powdery mildew per leaf and the average percent leaf coverage of all leaves assessed within a plot was used for statistical analysis. Plots were assessed every two weeks starting July 2nd and ending August 8th. A single fungicide spray was made on August 1st, 2019. Organic plots were sprayed with Microthiol® Disperss (sulfur-WP) at a rate of 7.0 lb per acre, and conventional plots were sprayed with Bravo® ZN (chlorothalonil) at a rate of 28.2 oz per acre. Field plots were sprayed using an Iva sprayer (Iva Manufacturing, Narvon, PA) with an offset boom at 200 psi and 14 gallons per acre.

Results and Discussion

In this article we are presenting results from 2019 only since record-setting heavy rains in 2018 (http://www.nrcc.cornell.edu/) made fungicide sprays, weed management, and field activities a challenge. Powdery mildew infection increased significantly over the course of the season in all treatments after July 17 (Figure 2). Disease onset was apparent by July 25 and progressed in all treatments. There were no differences in percent infection between organic and conventional plots nor between cover crop treatments (Figure 2).

This result did not meet our expectation that squash grown in sub-plots with hairy vetch would have reduced powdery mildew infection. There was actually a trend, although not statistically significant, towards higher disease severity in the organic rye-vetch sub-plots on two of the six assessment dates. This data is inconclusive and further work is needed to determine the role hairy vetch may provide, if any, on reducing powdery mildew severity or other pathogens as seen in previous studies. This represents one year of data and the previous studies were conducted using a hairy vetch monoculture. It is possible that the inclusion of rye in the cover crop mix with hairy vetch or use of plastic mulch confounded the protective benefit hairy vetch provides. Future studies should be conducted over a longer time period, consider powdery mildew resistant varieties, and include hairy vetch monocultures as well as investigate other cover crops that may suppress disease.

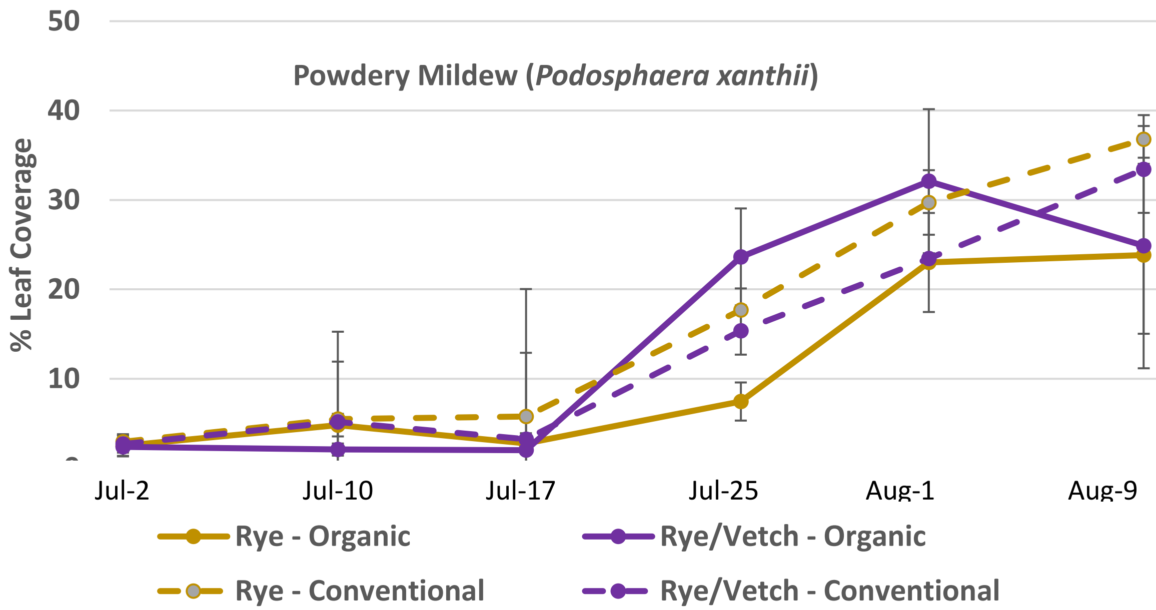

Figure 2. Percent powdery mildew infection on Waltham butternut squash in the Vegetable Systems Trial, Rodale Institute, Kutztown, PA. 2019. Points on the graph are mean (±SEM) percent leaf severity of powdery mildew on each of six observation dates in 2019. Treatments included organic and conventional management and rye only or rye/hairy vetch cover crops with four replicates of each management and cover crop treatment.

Organic Powdery Mildew Management

While there are relatively few organically approved fungicides that provide effective powdery mildew control compared to conventional fungicides, good powdery mildew management in organic systems is achievable. Considering that fungicide resistance can be a challenge in conventional production, good Integrated Pest Management (IPM) is recommended for all vegetable production. Below is a non-comprehenive list of strategies farmers should employ to manage powdery mildew on cucurbits.

- Practice good crop rotation with a minium of two years or more between cucurbit crops.
- Select powdery mildew resistant varieties. This strategy can delay powdery mildew onset and reduce or eliminate the need for fungicide sprays in some cases.
- Practice good sanitation to avoid transporting pathogen inoculum from infected fields on equipment, clothes or other implements.
- Incorporate plant material into the soil to prevent spread of infection to other fields and reduce disease inoculum in future years. In northern areas of the United States cucurbit powdery mildew may not overwinter but moves from the south to the north throughout the growing season as cucurbit crops are planted in succession.
- Plant early to avoid periods when infection is most severe.
- Use chemicals as a last resort but scout fields routinely as good management of powdery mildew requires timely preventative sprays which may be ineffective once spread of the disease is severe. Good coverage is required because organic products are primarily effective only on the plants parts that they come into contact with.
- Organic fungicide options are being tested in university trials and provide some efficacy against powdery mildew. These include
    - Microthiol Disperss and other sulfur based products
    - Nordox and other copper based products
    - JMS stylet oil (mineral oil)
    - Trilogy (neem oil)
    - Timorex Gold (Tea tree oil)

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