Organic Vegetable Production and Management

Thursday afternoon 1:00 pm

Where: Grand Gallery (main level) Room A & B
MI Recertification credits: 2 (1B, COMM CORE, PRIV CORE)
OH Recertification credits: 0.5 (presentations as marked)
CCA Credits: SW(0.5) PM(1.5)
Moderator: Vicki Morrone, Outreach Specialist for Organic Fruit and Vegetable Growers, MSU

1:00 pm	Ecological Weed Management in Organic Vegetables (OH: 2B, 0.5 hr) • Eric Gallandt, Weed Ecology and Management, Univ. of Maine
1:40 pm	Permanent Beds in Organic Vegetable Systems • Mark Hutton, Extension Vegetable Specialist, Univ. of Maine Cooperative Extension, Monmouth, ME
2:05 pm	Tarping Soils to Minimize Tillage and Reduce Weeds • Ryan Maher, Extension Specialist - Cornell Small Farms Program
2:25 pm	Which Biopesticides are Most Effective and Why? • Krista Coleman, Biopesticide and Organic Support - IR-4 Project, Rutgers Univ.
3:05 pm	Session Ends

Ecological Weed Management in Organic Vegetables

Eric Gallandt
Professor of Weed Ecology and Management

Sonja Birthisel
Ph.D. Student

Bryan Brown
Ph.D. Student

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Weeds remain a challenging production problem in organic vegetables, with most farmers relying heavily on cultivation to minimize losses in crop yield and quality. Cultivation efficacy, i.e., the proportion of weeds killed by a given event, is generally low and highly variable. We measured cultivation efficacy at 70 locations in a 2-acre field of silage corn following cultivation with sweeps on Danish S-tines. Efficacy (percent mortality) averaged 67%, and ranged from less than 1% to 100%. Thus, on average, 33% of the seedlings present at the time of cultivation survived. The performance of this cultivator is typical, and would not be a problem on a field with a very low germinable seedbank and consequently a relatively low density of weed seedlings. Consider a recent survey of organic farms in northern New England. Germinable seedbanks ranged from 2,775 to 24,678 seeds m^{-2} (Jabbour et al., 2014). At the high end of this range, resulting seedling densities will be very high, and thus, 33% survival is still an unacceptable density of weeds. There are three possible solutions to this problem of low, variable and density-independent efficacy: cultivate more, cultivate better, or start with fewer weed seedlings.

Cultivating more is the simplest solution. Repeated events, each killing 67% of the survivors, may be performed until a satisfactory density is achieved. This, however, is risky, due to uncertain weather, and problematic in that each shallow soil disturbance event encourages another flush of germination and a new cohort of seedlings. There are also the issues of labor demands, costs, fossil fuel use, soil compaction and crop injury.

A second possible solution is to cultivate better; i.e., more precise, closer to the crop row, with optimal timing and adjustment and tool choice to improve efficacy. We recently tested the idea of "stacking" cultivation tools to increase mean efficacy and reduce variability, with very promising results. The combination of tine and torsion weeders, for example, provided evidence of synergy, achieving 90% control of our mustard surrogate weeds. This is well above the expected additive effects expected from the tools' individual efficacy values of 30% and 15% control for the tine and torsion weeders, respectively. These results are for studies conducted with field corn, which is tolerant of relatively aggressive cultivation, and may not be transferable to more sensitive crops like carrot or beet. The strategy, however, is certainly worth testing in a much wider range of crop, weed and soil conditions.

Lastly, starting with fewer weed seedlings will improve the outcomes of all physical weed control events, and there are several proven strategies to achieve this. When time and soil conditions permit, establishing a stale seedbed is always a good idea. We recently completed two years of solarization and tarping studies, attempting to accelerate and more effectively creating a stale seedbed. Solarization with clear plastic for two weeks raised the soil temperature up to 116 F at a 2-inch depth, reducing subsequent weed seedling densities by 80%. Occultation with silage tarps was similarly effective to solarization early in the summer, but solarization performed better later in the summer.

Preempting weed seed rain, even for one season, can dramatically reduce the germinable weed seedbank the following year. While this is a challenging strategy in full-season crops, there are many short-season vegetables that could be grow sequentially, effectively providing a year of zero weed seed rain. Many farmers consider managing the weed seedbank to be a fool's errand, owing to the legendary seed longevity of many weed species. While it is true that *some* seeds may persist for many years, *most* do not. In fact, the half-lives for many important agronomic weeds is less than a year, including, for example, common lambsquarters, redroot pigweed, crabgrass. This essentially means that their seedbanks decline by half each year. In our research station and on-farm experiments, zero seed rain treatments reduced the subsequent year's weed seedbank by 45% to 93%. It is worth noting that some weed species are indeed more persistent; wild radish and velvetleaf, for example, are less sensitive to a single season of zero seed rain.

Once weed seeds enter the seedbank, the most effective means for removing them is to promote their germination, and thoughtfully timed fallow periods can be useful in this regard (Gallandt 2006; 2014). Growers who are not land limited can consider alternating cash crops with fallowing and cover crops, a strategy used by the Nordells to virtually eliminate weeds on their diversified organic vegetable farm. Disturbance and timing are key to this strategy, both in promoting germination of weeds that can be killed with subsequent tillage events, and in terminating cover crops before weeds set seed (Mirsky et al., 2010). Although cover crops are frequently described as central to weed management on organic farms, well-known for their allelopathic and competitive effects on weeds, disturbance events associated with cover crop establishment and termination are far more important (Gallandt 2003). Knowledge of weed species emergence periodicity is important for timing disturbance events to promote germination and thus seedbank depletion, and would vary from early spring for problematic winter annuals, to later in June and July for summer annals. Likewise, observation of weeds infesting cover crops should guide their termination to prevent further seed rain. Once weed seedbank levels are reduced using fallowing and short-season cover crops, full-season soil-improving or N-supplying cover crops can be used.

If it is not possible to terminate a weedy cash or cover crop before seeds mature and seed rain begins, the best strategy is to mow and wait until spring to incorporate residues. This strategy aims to keep newly shed weed seeds at the soil surface where they are more likely to be found by seed predators, and in the spring, more likely to germinate. Although fall plowing a weedy mess is indeed cathartic, deep burial of weed seeds both protects them from predators and promotes dormancy, ensuring a more abundant and longer-lived seedbank.

Weed management focused on cultivating seedlings has an appealing focus despite its challenges. Expanding this effort to manage the weed seedbank, both minimizing seed rain or "credits," and maximizing germination and predation or "debits," may seem a daunting, long-term prospect. Similarly, mulching strategies require a longer-term vision, trusting that added expense and effort early in the season will pay off later. Based on our surveys and interviews with organic farmers in northern New England, there are successful farmers who emphasize each of these philosophies and associated strategies (Jabbour et al., 2013). We recently completed two years of field research comparing cultivation and the so-called "critical weed-free period" management to longer-term strategies, including zero seed rain and mulching, using organic onion as the test crop. Surprisingly, based on weed control, crop yield and net economic return, zero seed rain and a hay-mulched system out-performed the more commonly used critical weed-free period system. Furthermore, based on assessments of soil quality parameters, the hay-mulched system provides multiple short- and long-term benefits. While there is not a single "best management" strategy for weeds in organic vegetables, there are many tradeoffs to consider, and the short-term, seedling-focused management may not always be the best choice. Ultimately, there are many reasons to consider a more multi-faceted approach to weed management, relying on multiple stresses, or "Many Little Hammers" (Liebman and Gallandt, 1997).

For more information:

YouTube channel: zeroseedrain
Website: https://umaine.edu/weedecology/
Blog: https://gallandt.wordpress.com/

Literature Cited:

- Gallandt, E. R. (2003). Soil-improving practices for ecological weed management. In Inderjit (Ed.), Weed Biology and Management (pp. 267–284). Kluwer Academic Publishers, The Netherlands.
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- Mirsky, S. B., Gallandt, E. R., Mortensen, D. A., Curran, W. S., & Shumway, D. L. (2010). Reducing the germinable weed seedbank with soil disturbance and cover crops. Weed Research, 50(4), 341–352.

Tarping Soils to Minimize Tillage at Small-Scales

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There is growing interest in using tarps as a weed management tool on small-scale organic vegetable farms. Tarps are impermeable, durable black plastic managed as temporary soil covers to prepare beds for planting. They can be used to help suppress weeds between crops, either ahead of planting or after harvest, and farmers have found greater labor flexibility with crop management. After tarps are removed they can be reused and integrated in rotations over multiple seasons. Research in permanent bed organic vegetable systems in Freeville, NY and Monmouth, ME over 2 years (2015-2016) has shown that tarps can provide multiple benefits that improve the performance of reduced tillage systems. Tarps were applied a minimum of six weeks ahead of planting cabbage (yr1) and winter squash (yr2) in a no-till production system. Crops were grown in straw mulch, compost mulch and without mulch to evaluate tarping under different no-till methods. Tarping was also compared to no-till without tarps and conventional rototilling. In both years, tarps killed emerged weeds and created weed-free planting conditions without soil disturbance. The greatest advantages were seen in the unmulched crop. Tarped beds required less labor for hand weeding over the growing season, about 1/3 of the time when compared to no-till without tarps (yr1). Tarping also dramatically reduced the amount of weeds present at crop harvest in the unmulched crop. Tarps had a large effect on spring soil conditions. Soil temperatures were greater under tarps for each of the mulches. When tarps were removed, the amount of soil nitrogen available to plants was over four times greater than the unmulched rototilled soil (yr2). Tarp effects on crop yields depended on the year and mulch used but were similar to or greater than the other tillage systems. Tarping could be a valuable tool for organic farmers to effectively minimize tillage while improving weed control and crop productivity.

WHICH BIOPESTICIDES ARE MOST EFFECTIVE AND WHY?

KRISTA COLEMAN
THE IR-4 PROJECT
BIOPESTICIDE AND ORGANIC SUPPORT

Key points

- What is The IR-4 Project?
- What is a biopesticide?
- Should I use biopesticides on my farm?
- How do I know a biopesticide is effective?
- How can I bring attention to my farm's biggest pest?

WHAT IS THE IR-4 PROJECT?

The IR-4 Project

- The IR-4 (Interregional Research Project No.4) is involved in making sure that pesticides are registered for use on minor crops
- Since 1963, we have been the major resource for supplying pest management tools by developing research data to support new EPA tolerances and labeled product uses
- We help by conducting research on minor use pesticides that would not otherwise be profitable to manufacture

FOOD USE | BIOPESTICIDE & ORGANIC | ORN HORT | PUBLIC HEALTH

4 PROGRAM AREAS

IR-4 Biopesticide and Organic Support

Our primary objective is to further the development and registration of biopesticides for use in pest management systems for specialty crops or for minor uses on major crops

Where we are coming from:

- Biopesticide Program 1.0
  - Regulatory Support & Research Grants
- Biopesticide Program 2.0
  - Organic Support & Demonstration
- Limited human and financial investment
- Biopesticide Program 3.0
  - Respond to research priorities developed from votes at the Biopesticide Workshop

Dedicated resources to help develop technology

Vegetable Projects Developed from Workshop Votes (Funding 2017-2018):

- Downy Mildew of Spinach
- Weeds in Vegetables
- *Agrobacterium tumefaciens* in Greenhouse Tomato
- Phorid Fly on Mushroom
- Pepper Weevil on Greenhouse Pepper
- Black Rot (*Xanthomonas*) of Brassicas

WHAT IS A BIOPESTICIDE?

BIOCHEMICAL **MICROBIAL** **PIPs**

Naturally occurring substances that control pests (biochemical pesticides), microorganisms that control pests (microbial pesticides), and pesticidal substances produced by plants containing added genetic material (plant-incorporated protectants) or PIPs.

What are some of the advantages of using biopesticides?

- Usually less toxic than conventional pesticides
- Generally affect only the target pest and closely related organisms, so natural predators are kept alive
- Often effective in very small quantities and often decompose quickly, resulting in lower exposures and largely avoiding pollution
- Excellent component of Integrated Pest Management programs

Reference to: https://www.epa.gov/ingredients-used-pesticide-products/what-are-biopesticides

SHOULD I USE BIOPESTICIDES ON MY FARM?

Trends with Biopesticides in Farming

Significant involvement in pest management before 1950's

⬇

Snake oils/farmers "burned"

⬇

New technology/small business

⬇

Large scale adaption of products that work

⬇

Major new investments

Biopesticides for Organic Pest Management

- Many perform best in Integrated Pest Management- paired with habitat manipulation, biological controls, modification of cultural practices, and use of resistant varieties
- NOT all biopesticides are approved for organic production!
  - Verify if approved for organic production and registered in your state prior to any application
  - Look for the Organic Materials Review Institute (OMRI) symbol
  - Check National Organic Program (NOP) list of petitioned substances: https://www.ams.usda.gov/rules-regulations/organic/national-list/petitioned

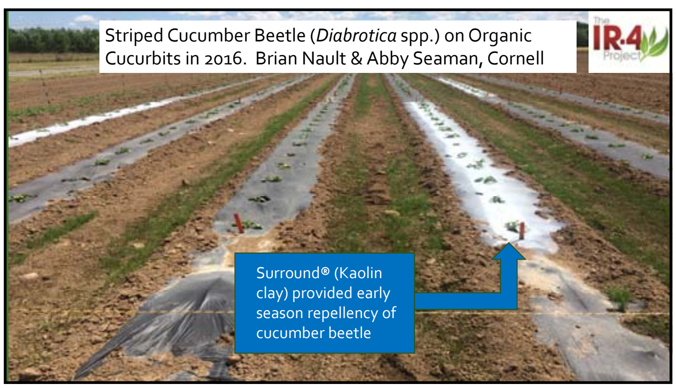
HOW DO I KNOW A BIOPESTICIDE IS EFFECTIVE?

Replicated field trials that produce reliable efficacy data!

Field Trials

- Control: *A variable held constant*. In this case, fields are treated with water rather than pesticides. This makes sure any effects in experimental plots are attributed to the pesticides.
- Standard: *A level of quality or attainment*. Biopesticides are often compared to conventional pesticides as standards. Whichever pesticide is known to work, or typically used, is the standard.

Striped Cucumber Beetle (*Diabrotica* spp.) on Organic Cucurbits in 2016. Brian Nault & Abby Seaman, Cornell



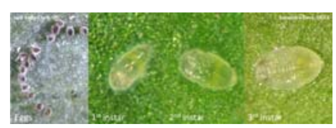
Whitefly on Greenhouse Tomato, 2015-2016

Hugh Smith, University of FL

- Plots treated with Sivanto™ (Flupyradifurone) followed by M-Pede® (Potassium salts of fatty acids) possessed densities of 1st instar nymphs which were lower than the water-treated plots
- PFR-97™ (*Paecilomyces fumosoroseus*) alone or with Sivanto were best at reducing densities of 2nd and 3rd instar nymphs

Rajagopalbabu Srinivasan, Univ. of GA

- M-Pede® was comparable with the conventional standard Sivanto™ in reducing immature populations



Whitefly total- all life stages

Treatment	Pre-treatment	Week 4
Non-treated Control	16.40±4.02	66.70±11.38ab
Botanigard	13.55±2.98	80.25±16.50a
PFR-97	13.00±3.72	95.5±17.22a
Requiem Prime	15.55±4.88	52.6±10.21ab
M-Pede	21.75±6.45	52.20±7.51ab
Sivanto	6.90±2.16	3.5±1.30cd
Sivanto	10.00±3.86	10.95±3.1c
Sivanto + Botanigard	13.40±4.71	4.60±1.69c
Sivanto + PFR-97	14.10±4.06	5.95±1.06c
Sivanto + Requiem Prime	10.35±6.33	2.15±0.42d
Sivanto + M-Pede	7.75±2.11	3.60±2.20cd
VST-006330	11.70±3.65	8.70±1.75c
Statistics	Df=11; F=0.96	Df=11; F=7.59
P value	0.4822	<0.0001

Rajagopalbabu Srinivasan. University of Georgia, Tifton

Spot and Speck of Tomatoes, 2015

Gary Vallad, University of FL

- Cueva® (Copper octanote) reduced disease severity
- Sil-Matrix™ (Potassium silicate) was statistically effective with low disease pressure, but ineffective with higher disease pressure

Shouan Zhang, University of FL

- The tank mix of CEASE® (*Bacillus subtilis*) and Milstop®(Potassium bicarbonate), and the tank mix of Double Nickel®(*Bacillus amyloliquefaciens*) and Cueva® had no effect on disease reduction 78 days after inoculation

Spot, Speck and Canker of Tomatoes 2015

Mary Hausbeck, Michigan State Univ.

- The tank mix of CEASE® and Milstop® had significantly more lesions than several other treatments

Canker (*Clavibacter*) of Tomatoes, 2015-2016

Sally Miller, The Ohio State Univ.

- Copper (Cueva®) among the best treatments
- Other treatments EXCEPT Double Nickel® were as effective as copper
- CEASE® and Milstop® did not significantly reduce blossom end rot

Clavibacter- Tomato. Sally Miller, 2016

Gray- Similar to non-inoculated control

Treatment and rate	19 Aug		26 Aug	
	severity (%)	incidence (%)	severity (%)	incidence (%)
(1) Non-treated non-inoculated	6.3 ef	37.7 cd	13.0 d	54.2
(2) Non-treated inoculated	15.5 a	66.2 ab	28.8 a	85.2
(3) Actigard 50WG 0.25 oz/100 gal drench (6,7)[y] fb K-Phite 7LP 3.0 qt/A (1-12)[x]	6.0 ef	41.3 bcd	11.8 d	58.8
(4) CEASE 4 qt/100 gal + MilStop 2 lb/100 gal (2-5)[z] Serenade Opti 20.0 oz/A + Milstop 2.0 lb/A (1-12)[x]	9.8 c-f	47.9 a-d	16.3 bcd	59.9
(5) Double Nickel LC 1.0 qt/100 gal drench (1-5,7)[y] Double Nickel LC 1.0 qts/A (1-12)[x]	14.3 ab	68.2 a	28.8 a	77.0
(6) K-Phite 7LP 3.0 qt/A + AgriPhage CMM 1 pt/50 gal/A (1-5)[z] + Actigard 50WG 0.25 oz/100 gal drench (6,7)[y] fb K-Phite 7LP 3.0 qt/A + AgriPhage CMM 1 pt/50 gal/A (1-12)[x]	6.8 ef	43.7 a-d	15.3 cd	64.5
(7) K-Phite 7LP 3.0 qt/A + AgriPhage CMM 1 pt/50 gal/A (1-5)[z] K-Phite 7LP 3.0 qt/A + AgriPhage CMM 1 pt/50 gal/A (1-12)[x]	7.5 ef	50.8 a-d	16.8 bcd	71.5
(8) Cueva 2.0 qt/A (1-5)[z] Cueva 2.0 qt/A (1-12)[x]	10.3 b-e	58.0 abc	17.5 bcd	66.7
(9)Manzate ProStik 75DF 2.0 lbs/A foliar (1-5)[z] Actigard 50WG 0.25 oz/100 gal drench (6,7)[y] fb Manzate ProStik 75DF 2.0 lb/A (1-12)[x] + Actigard 50WG 0.33 oz/A (1,3)[x] + Actigard 50WG 0.50 oz/A (5,7)[x] + Actigard 50WG 0.75 oz/A (9,11)[x]	7.0 ef	52.5 a-d	17.5 bcd	70.7
(10)	12.5 abc	69.0 a	24.5 ab	76.9
(11)	5.5 f	27.9 d	13.8 d	38.5
(12)	11.5 a-d	64.2 ab	24.0 abc	76.0
P value	0.0001	0.0450	0.0128	0.1686

Weeds in Sweet Potato, 2016

Mark VanGessel- University of Delaware

Weed wiper bar in sweet potatoes (reduced to paint roller testing due to small plot size)

Ammonium nonanoate

- Axxe® (Ammonium nonanoate) had much more activity on Palmer amaranth than OMRI-approved Avenger AG® (Citris oil) when applied with painter rollers
- Excellent potential as organic herbicide, needs approval

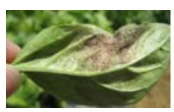
Downy Mildew of Organic Basil, 2015

Richard Raid, University of FL

- Cueva® applied on a weekly basis was not significantly different from the untreated check, nor was the Double Nickel® and Cueva® tank mix
- The most efficacious treatments were those containing Sil-Matrix™ and Procidic® (Citric acid)

Margaret McGrath, Cornell Univ.

- There were symptoms on only 1-3 out of 10 plants treated with Regalia® (*Reynoutria sachalinensis*), Procidic®, and MilStop®



Spotted Wing Drosophila, 2015-2016

Across multiple locations and years Entrust® (Spinosad) alone and in rotation with Grandevo® (*Chromobacterium subtsugae*) has provided the best overall control in organic production. Future work will focus on extension demonstration trials and Attract and Kill techniques.

For further details on all trials see:

http://ir4app.rutgers.edu/biopestPub/pnnProjects.aspx

HOW CAN I BRING ATTENTION TO MY FARM'S BIGGEST PEST?

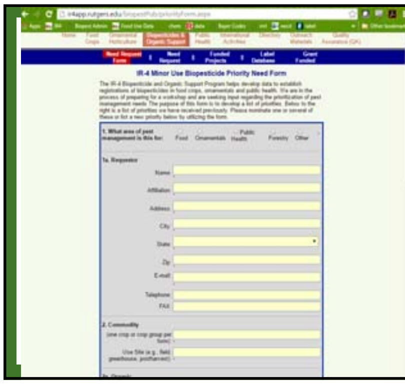
Biopesticide & Organic Support Site

http://ir4.rutgers.edu/biopesticides.html

Our website contains efficacy reports, label descriptions, pest management requests, and regulatory projects

Submit your pest management needs!

If you have a pest management need that requires assistance, select "Submit New Priority Need"



Proceed to fill out the form and click "Submit"

These needs will be voted on during the Biopesticide Workshop in September 2018

Needs with the most votes will be researched

Future Funding

- Is our research important to you? We need your help to keep it going!
- IR-4 funding flat for last five years
  - Lower than in 2009, while expenses rise
- IR-4's Federal authorizing language does not allow universities to charge overhead
  - Universities under intense fiscal challenges, some can no longer absorb these costs
- Reduction in research to balance budget

What can you do?

Become an active participant in efforts by commodity associations/food processors and other organizations to educated and advocate for increased funding for IR-4 from the US Congress

Private sector: Establish or increase an annual unrestricted contribution to IR-4

Educate others in your networks about the contributions of IR-4 to crop protection and food production. Let them know of the critical fiscal challenges IR-4 is facing

Please help us make connections with others who can help!

THANK YOU!

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