ORGANIC FARMING RESEARCH FOUNDATION

fostering the improvement and widespread adoption of organic farming

2026 Research Summary for Cooperative Agreement on Conservation Benefits of Organic Management

Delivered on June 16, 2026

Prepared for NRCS under Cooperative Agreement No. FBC24CPT0013867

USDA Natural Resources Conservation Service

Table of Contents

INTRODUCTION

This document provides a summary of the latest organic agriculture research across a variety of topics, meant to provide NRCS staff, organic producers, and other interested parties with in-depth educational information on the conservation benefits of organic management. Each section provides bulleted highlights of the research, followed by a comprehensive summary. At the beginning of each section, you will also find a list of NRCS resource concerns and conservation practice standards that are meant to be generally applicable to each section and the literature contained within it. If you are interested in a copy of any of the cited papers, please follow up with us via email at office@ofrf.org.

This research summary was produced with support from the United States Department of Agriculture's Natural Resources Conservation Service (USDA-NRCS) under Cooperative Agreement No. FBC24CPT0013867. The contents are solely the responsibility of the authors and do not necessarily reflect the views of USDA-NRCS.

1. Weed, Insect, and Disease Management in Organic Systems

NRCS Resource Concerns (RCs) Addressed	Applicable Conservation Practice Standards (CPS)
• Plant: Plant productivity and health, Plant pest pressure • Soil: Soil erosion, Soil organism habitat loss or degradation, Organic matter depletion • Animal: Terrestrial habitat for wildlife and invertebrates • Air: Emissions of greenhouse gases (GHGs), Emissions of ozone precursors • Water: Nutrients transported to water, Pesticides transported to water	• 327 Conservation Cover • 328 Conservation Crop Rotation • 329 Residue and Tillage Management, No-Till • 336 Soil Carbon Amendment • 340 Cover Crop • 345 Residue and Tillage Management, Reduced Till • 386 Field Border • 422 Hedgerow • 511 Forage Harvest Management • 590 Nutrient Management • 595 Pest Management Conservation System

Highlights from Recent Research

- Cultural and mechanical weed management -
  - Organic no-till planted soybean yield can be increased and weed biomass decreased by increasing soybean seeding rate and decreasing N application rate (Menalled et al., 2021).
  - Combining early planting, 1.5x seeding rate, and pre-emergent mechanical weed control can increase chickpea yield and decrease weed biomass (Miller and Hubbel, 2024).
- Non-chemical insect control -
  - Monitoring field edges for spotted wing drosophila eggs and first instar larvae provides earlier detection compared to field interior monitoring, and the use of parasitoid wasps in these uncropped landscapes can reduce drosophila populations (Levenson et al., 2025 Stahl et al., 2024).
  - Earlier alfalfa harvest and timely removal of alfalfa windrows can reduce weevil populations and also reduce subsequent alfalfa losses (Herreid et al., 2024).
  - Results from organic sweetpotato research highlight the low risk of using cover crops in sweetpotato production and the importance of crop variety selection for wireworm control (Pellegrino et al., 2021).
- Disease management with anaerobic soil disinfestation -
  - Readily-decomposable carbon amendments used during anaerobic soil disinfestation can suppress *Fusarium* spp., nematodes, and contribute to a reduction in weed seed germination (Littrell et al., 2025; Singh et al., 2025).

Managing Weeds - Cultural and Mechanical Strategies

Weed management remains a top priority for organic farmers, and can be especially challenging for those in the process of transitioning to organic certification as they move away from reliance on agrochemicals. Tillage is often relied on to control weeds prior to crop planting, with frequent in-season cultivation used to remove weeds as the crop grows, but this can be destructive to soil health and structure. Many farmers are interested in other weed management tactics that move away from frequent soil disturbance while still maintaining a balance between crop yields, weed control, and soil health.

A field study was conducted in Ohio during the three- year transition to organic using a typical row crop rotation of corn (*Zea mays* L.) – soybean [*Glycine max* (L.) Merr.] – small grain to evaluate standard conventional tillage to a stale seedbed with a delayed planting approach (Osterholz et al., 2025). A stale seedbed approach involves multiple, shallow cultivation events to stimulate flushes of weed emergence, depleting the weed seedbank and creating a "clean" seedbed prior to planting. The study also examined whether poultry manure (carbon-rich) or bloodmeal (nitrogen-rich) fertilizer sources influenced weed populations and crop yields. The stale seedbed with delayed planting approach resulted in 7% lower crop yields, but this was likely due to the delay in planting since this treatment led to lower weed density during the crop season compared to the standard approach (Osterholz et al., 2025). **However, weed populations overall increased during the three years across treatments, emphasizing that multiple approaches are needed to manage weeds during the transition to organic to prevent a buildup of the weed seedbank.** While it was hypothesized that the poultry manure fertilizer would result in better weed control due to slower, extended nutrient release matching the demand of the crop rather than the weeds, no differences in weed populations or crop yield were observed between fertility sources (Osterholz et al., 2025).

Reducing tillage at different points in the crop rotation offers a way to improve soil health and also reduce labor and fuel usage. However, this can result in a tradeoff with weed control, and underscores the importance of cultural tactics such as cover cropping, crop seeding rates, and nutrient management. Increasing crop seeding rate can bolster crop:weed competition through competition for resources, greater crop canopy, and greater light interception; decreasing nitrogen fertilizer rate can increase biological N-fixation, bolstering legume crop growth over non-legume weeds. No-till planting organic soybean into a cereal rye (*Secale cereale* L.) cover crop mulch at various soybean seeding rates and soil nitrogen rates was examined across two field sites in New York (Menalled et al., 2021). Soybean seeding rates were approximately 75,000, 150,000, 225,000, and 300,000 seeds per acre. Sodium nitrate (15-0-2) rates included 0, 56, and 111 pounds per acre. **Results showed the lowest weed biomass with the highest soybean seeding rate and lowest nitrogen rate, while soybean yield increased with seeding rate regardless of nitrogen rate** (Menalled et al., 2021). These results further support the use of multiple weed management tactics to balance weed control and crop yield.

The success of using an increased seeding rate can, however, be dependent on crop type and agroecological location. Organic chickpeas, mainly grown in the Northwest and Plains regions, see reduced yields from weeds due to the crop's slow maturation, open canopy, and short height. Field trials were conducted across two years in Montana to determine the effects of cultural (seeding rate and seeding date) and mechanical (shallow tillage, flaming) weed management strategies on chickpea stand density, yield, and weed biomass (Miller and Hubbel, 2024). Planting date was determined by soil temperature, and the early planting date treatment was sown in mid- to late-April each year, with the late planting date occurring 10-14 days later. Seeding rate treatments were 1x, 1.5x, and 2x, with the standard 1x rate being 4 seeds/ft^2. Chickpea stand density was affected by planting date and seeding rate, but not mechanical weed control, with earlier planting increasing chickpea stand density by 1.13-1.48x compared to later planting. **Using a 1.5x seeding rate increased chickpea stand density by 32% compared to the 1x standard rate, but increasing the seeding rate to 2x did not provide additional chickpea stand density increases beyond that.** Pre-emergence mechanical weed control strategies had variable efficacy across years due to weather, and significant reductions in weed biomass were only achieved when these strategies were combined with cultural ones. **Overall the use of early planting, increased seeding rate, and either shallow tillage or flaming all combined resulted in an 84% reduction in weed biomass. Chickpea yield was increased with any of the cultural or mechanical strategies, and this yield effect was greatest when all strategies were combined - integrating early planting, 1.5x seeding rate, and one of the pre-emergent mechanical weed control strategies increased chickpea yield 6-fold from 128 lb/ac in control plots to 812 lb/ac** (Miller and Hubbel, 2024). These results support the idea of “stacking” practices to achieve high levels of weed control while also seeing positive yield effects.

Managing Spotted Wing Drosophila

Insect pests pose a threat to crop yields by reducing the amount of the crop that can be sold as marketable by USDA grading standards, making it crucial for organic farmers to rely on a suite of integrated pest management (IPM) tactics. Spotted Wing Drosophila (SWD, *Drosophila suzukii*) is an invasive exotic pest that has become the leading pest of berries and stone fruits for both organic and conventional producers, causing an estimated $718 million in losses annually (Tait et al., 2021). SWD is especially difficult to control because its most destructive life phase (larval) lives inside the fruit, shielded from exposure to pest control applications. In addition, multiple wild fruit-bearing plants (blackberry, pokeweed, elderberry, autumn olive) provide alternate hosts for SWD. Faced with a zero-tolerance level (infested fruit is unmarketable), both organic and conventional growers have had to abandon low-spray IPM strategies and spray frequently to interdict adult flies before they lay eggs in the fruit. This has resulted in unsustainable increases in insecticide sprays that threaten biodiversity and agroecosystem health (Levenson et al., 2025; Tait et al., 2021). In the absence of natural enemies that control its populations in its regions of origin, SWD has spread rapidly across North America. Furthermore, SWD shows potential to rapidly evolve resistance to pesticides that use spinosyn, an active ingredient in NOP-allowed insecticides that initially proved effective against this pest (Ganjisaffar et al., 2022; Tabuloc et al., 2024).

Several organic research efforts are underway to build an organic IPM toolbox that integrates physical, behavioral, and biological controls with limited use of NOP-allowed pesticides. Red panel sticky traps with lures to capture adult male SWD is an effective adult-based monitoring tool (Panthi et al., 2022). However, checking fruit from the field edge for SWD eggs and larvae gives earlier and more accurate warning of an SWD outbreak. Compared to the standard practice of spraying every three days to control SWD, spraying only when fruit samples showed infestation reduced applications from 21 to 13 and improved net returns for organic blueberries in Oregon (Yeh et al., 2023). Based on multiple field studies with blueberry (GA, MI, OR) and blackberry (NC), Levenson et al. (2025) **found that monitoring eggs and first instar larvae in fruit collected at field edges provided detection two weeks earlier than monitoring later life stages or in field interiors, resulting in less pesticides needed.**

Classical biological control – utilization of natural enemies collected from an exotic pest's locale of origin – has yielded the parasitoid wasp *Ganapsis kimorum*, an east-Asian insect that lays eggs in larvae of SWD in fruit with a high degree of specificity, posing very low risk to nontarget insects. The parasitoid egg hatches into a larva that consumes the pest and eventually emerges as an adult capable of parasitizing more SWD larvae (Stahl et al., 2024). *G. kimorum* overwinters with its host in the soil, and can provide season-long biocontrol for early, mid, and late-maturing fruit crops. It has been successfully introduced and established in PA, DE, MD, and GA, and the Pacific Northwest, and adventive populations (not linked to deliberate human introduction) have been documented in WA and British Columbia (Stahl et al., 2024). *G. kimorum* reduces but does not eliminate SWD, and thus functions as one component of an IPM strategy, not as a stand-alone control. It establishes most effectively when released in or near non-crop areas that offer wild food sources for its host (e.g., natural areas or conservation buffer plantings). **The parasitoid's greatest benefit may be to reduce SWD populations in unmanaged landscapes near fruit crops, thereby lowering SWD pest pressures region-wide.** For more information on this pest, check out Michigan State University's [Management Recommendations for Spotted Wing Drosophila in Organic Berry Crops].

Non-Chemical Methods for Alfalfa Weevil Control

In the Northwest and Plains regions of the US, producers of alfalfa (*Medicago sativa* L.) are becoming increasingly interested in non-chemical ways to manage the alfalfa weevil (*Hypera postica* Gyllenhal) due to the insect's ability to cause severe yield and quality loss and its development of insecticide resistance. Manipulating harvest timing to occur when the weevil has not completed its lifecycle may offer a way to reduce weevil damage, but must be timed to consider tradeoffs with yield and quality, as these two alfalfa parameters are inversely related (Orloff and Putnam, 2004). To better understand these relationships, pre- and post-harvest sampling was conducted in 34 alfalfa fields over three years in Colorado, Montana, and Wyoming (Herreid et al., 2024). Across these 34 locations, producers harvested alfalfa anywhere from late May to early July, with the alfalfa growth stage averaging between early to late bud stage. Alfalfa weevil density and damage decreased post-harvest, **supporting earlier harvests which can expose weevil larvae to conditions which result in their mortality.** It was also observed that **producers who more quickly removed alfalfa windrows from the field had lower weevil densities**, as these windrows may house weevils who move back into the growing alfalfa crop and continue to feed. This timely removal can not only reduce weevil populations but also reduce subsequent alfalfa losses (Herreid et al., 2024).

Wireworm Control in Sweetpotato

Lack of effective non-chemical methods for wireworm (*Coleoptera: Elateridae*) control has limited producers in the Southeastern US from transitioning sweetpotato (*Ipomoea batatas* L.) to organic. Wireworms, which are the larval stage of the click beetle, are a soil-borne root feeder during their larval stage. This feeding leaves holes in root crops like sweetpotato, reducing yield and the amount of marketable product. While many producers are interested in the benefits of cover cropping, it has been documented that cover crops can act as a "green bridge" for soil-borne pests, providing them with habitat and food and therefore a higher proportion of larvae surviving the winter (Favetti et al., 2017; Jackson and Harrison, 2008). Two field studies were conducted in North Carolina to examine the effects of cover cropping and different sweetpotato varieties on wireworm damage in organic production (Pellegrino et al., 2021). Cover crops consisted of rye, vetch, and rye plus vetch. One cover crop treatment was treated as a reduced-till system, where the cover crops were terminated with a roller crimper prior to sweetpotato transplanting. This was compared to a "fully incorporated" cover crop treatment that utilized full tillage for field prep and cover crop termination. A split-plot design was used to nest sweetpotato varieties within these cover crop treatments. One "susceptible" variety (Covington) and one resistant variety (Monaco) were used. **The effect of cover crop treatment was not significant across the field studies, but sweetpotato variety was important for reducing wireworm damage. Covington sweetpotato saw an average of 19.3% damaged roots whereas Monaco sweetpotato had an average of 6.2%** (Pellegrino et al., 2021). Results from this study highlight the low risk of using cover crops in organic sweetpotato production and the importance of sweetpotato variety selection.

Managing Diseases - Anaerobic Soil Disinfestation

Specialty crops such as strawberries, tomatoes, and other fruits and vegetables are prone to a wide range of diseases, microbial pathogens, and plant-parasitic nematodes. Non-organic production often utilizes soil fumigants such as 1,3 dichloropropene, chloropicrin, and metam sodium to destroy diseases and pathogens prior to planting high-value crops. The use of these materials on USDA certified organic or transitioning-to-organic farms is prohibited due to potential effects on nontarget beneficial soil organisms.

Anaerobic soil disinfestation (ASD) is an alternative to soil fumigation that has shown promise for reducing populations of microbial plant pathogens, parasitic nematodes, and also weed seeds. In this process, a readily decomposable organic C amendment is tilled into the soil, followed by irrigating the soil to saturation under an airtight tarp which is left in place for several weeks. This results in a burst of anaerobic microbial activity that suppresses or kills the pathogens and pests, partly through the lack of oxygen and partly through the release of volatile organic substances (acetic and butyric acids, ketones, and other natural compounds) and soluble reduced cations of iron (Fe^{2+}) and manganese (Mn^{2+}) (Littrell et al., 2024, 2025). A wide range of materials have been utilized to carry out ASD treatments including rice hulls, wheat bran or middlings, molasses, soybean meal, mustard seed meal, cover crops (grown *in situ* and incorporated), manure, poultry litter, slaughter byproducts, brewers' spent grain, grape pomace, other food processing byproducts, and various combinations of these materials designed to achieve desired outcomes (Liu et al., 2023, 2025; Singh et al., 2025; Shrestha et al., 2021a, 2021b). ASD often promotes the growth of beneficial microbes which can lead to development of a more disease-suppressive soil microbiome (Di Gioia et al., 2024a; Ono-Raphel et al., 2025). In addition, the ASD method adds organic materials that nourish soil life and help build soil organic carbon reserves.

While some ASD trials have given pest/pathogen control equivalent to conventional fumigation, outcomes have varied considerably depending on factors such as the amendments utilized, to weather, soil conditions, crop species, and target pathogens and pests. In addition, C and N in the organic amendments must be properly balanced to ensure effective disinfestation and to avoid either tying up N (C:N too high) or creating a surplus of N (C:N too low) (Littrell et al., 2025; Shrestha et al., 2021a, 2021b). One practical barrier to adoption of ASD is availability and cost of the organic amendments, which are applied at a recommended rate of 4 g C/kg soil (0.4% w/w) (Liu et al., 2025; Shrestha et al., 2021b), or roughly 5 tons/ac amendment dry weight.

Trials at University of Tennessee showed that the ratio of lignin (decay-resistant plant organic C) to N in cover crop residues plays a key role in efficacy. **Tilling in a wheat cover crop at the vegetative stage or early reproductive stage (C:N ~25:1) for ASD treatment suppressed two pathogens responsible for strawberry root rot disease while fully mature wheat (C:N ~80:1) was ineffective.** When readily decomposable materials (molasses and soybean protein isolate) were combined at various amendment ratios, the protein-rich mixtures released the most volatile fatty acids during the ASD process, yet all ratios of the amendments suppressed the harmful strawberry pathogen *Fusarium oxysporum* (Littrell et al., 2025). The study also documented several key environmental and management factors in ASD efficacy. Suppression of *F. oxysporum* became less pronounced as soil clay content and soil pH increased (Littrell et al., 2024). Thus, if lime is recommended, it should be applied after ASD treatment is complete. Also, in greenhouse and field trials, ASD was more effective against *Fusarium* spp. pathogens at soil temperatures of 77-95°F than 59-77°F (Shrestha et al., 2021a).

Researchers at Clemson University are evaluating an IPM strategy for organic sweetpotato that utilizes ASD in combination with plastic film mulch and weed-tolerant cultivars with resistance to southern root knot nematodes. An initial greenhouse study with 20 sweetpotato genotypes showed that a **pre-plant ASD treatment using chicken manure and molasses reduced nematode populations by at least 60% and up to 90% for some genotypes, reduced weed cover by 79%, and nearly doubled sweetpotato biomass two months after planting** (Singh et al., 2025).

Two challenges with ASD for high tunnel tomatoes in the mid-Atlantic region include the cooler spring/fall temperatures in this region, and sourcing local, low-cost amendments (Di Gioia et al., 2024b). **Readily decomposable amendments with a C:N ratio <20, such as wheat middlings (byproduct of wheat flour milling) or a crimson clover cover crop, gave the best results with ASD for tomato production.** The treatment caused a shift in the bacterial community, which recovered to pre-treatment status during tomato production, with an increase in beneficial microbial species (Ono-Raphel et al., 2025).

2. Nutrient Management in Organic Systems

NRCS Resource Concerns (RCs) Addressed	Applicable Conservation Practice Standards (CPS)
• Plant: Plant productivity and health • Soil: Soil organism habitat loss or degradation • Water: Nutrients transported to groundwater	• 317 Composting Facility • 328 Conservation Crop Rotation • 336 Soil Carbon Amendment • 340 Cover Crop • 513 Annual Forages for Grazing Systems • 590 Nutrient Management

Highlights from Recent Research

- Cattle manure use in the Plains & Northwest -
    - A one-time, heavy application of cattle manure can enhance wheat yields and provide soil health benefits a few years after application, but only in years with sufficient soil moisture (Carr et al., 2025).
    - Raw dairy manure may be easier for soil microbes to break down and provide plant-available N to crops in the short term, while composted manure provides stable, slow-release N (Hurisso et al., 2024).
- Alternatives to liquid fish fertilizer application in carrots -
    - Cyano-fertilizer has the ability to enhance carrot yield, length, and quality compared to traditional liquid fish fertilizers, and foliar seaweed application can reduce the amount of unmarketable deformities on carrots, such as root knobs (Wickham and Davis, 2023).

Cattle Manure Use in Organic Systems

The NOP requires producers to use plant- and animal-derived fertilizers, with animal manures and legumes being popular sources. In semiarid agroecosystems, producers face challenges when supplying adequate N and P to crops, and they must also contend with low and inconsistent precipitation. These fertility and precipitation challenges can lead to reductions in crop yield and quality. Legume green manures (LGM) are one option for maintaining soil fertility in organic grain rotations in semiarid regions. However, grain yields can suffer in years with limited precipitation if there is not enough time for soil water to "recharge" between the LGM and grain crop. Animal manure applications may provide an alternative to LGMs, while also providing soil health benefits including building soil organic matter (SOM).

A four-year study was conducted on certified organic land in Montana to evaluate the impact of a one-time beef cattle manure application at different rates, and the resulting effects on winter wheat yield and quality (Carr et al., 2025). Beef cattle manure was applied at the main plot level at rates of 0, 5, 11, or 22 tons/acre, using a manure spreader and incorporated with a tandem disk. The manure was applied once in May at the start of the study in all treatments. Crop rotation was applied at the subplot level, and included:

- Winter wheat after summer fallow
- Winter wheat after legume green manure (LGM)
- Summer fallow (SF)
- Legume green manure (yellow sweetclover; *Melilotus officinalis* (L.) Lam).

Results showed that applying beef cattle manure one time at the highest rate increased wheat yields in wheat preceded by either SF or LGM in years three and four of the study, but not in years one and two. Additionally, no wheat yield differences were detected at manure application rates <11 tons/acre (Carr et al., 2025). **This suggests that a one-time, heavy application of cattle manure may enhance wheat yields and provide soil health benefits a few years after application.** The authors did note that drought conditions were present in the first two years, which likely affected nutrient availability. Wheat grain yield was more variable when wheat was preceded by the sweetclover LGM than when preceded by SF, and this was influenced by precipitation. Wheat yields for the wheat-after-LGM treatment were 60% lower than yields for the wheat-after-SF treatment in two of four years of the study. The researchers postulate that these yield reductions were the result of decreased soil water availability due to the sweetclover LGM; in other words, insufficient amounts of water re-accumulated between LGM termination and the wheat crop. **Overall, this shows that cattle manure can help improve crop yields in this growing region, but only with sufficient soil moisture.**

With an increasing consumer demand for organic dairy and meat products, producers are looking at incorporating annual forage crops into their rotations between vegetable harvest and winter cover crop planting to be used for organic hay. Teff (*Eragrostis tef* [Zucc.] Trotter) is one warm-season annual forage that has the potential to be incorporated into such a rotation because it is fast-growing and can be harvested as an organic hay crop. This could provide soil cover between vegetable and cover crop growing periods, as well as an additional source of income for producers or a way to reduce off-farm inputs on crop-livestock farms. However, forages often experience yield and quality declines with low soil N fertility, and organic producers face the challenge of synchronizing amendment decomposition, specifically the release of plant-available N (PAN), with crop demand (Lazicki et al., 2020; Lynch et al., 2004).

A research study was conducted in Colorado on certified organic land during two consecutive teff forage growing seasons to determine the effects of different manure amendments on short-term N mineralization, microbial biomass carbon (MBC), and microbial biomass nitrogen (MBN) (Hurisso et al., 2024). The treatments included: 1) fresh dairy manure (DM), 2) composted dairy manure (DMC), and 3) an unamended control. Amendment application rates were determined based on amendment N content, SOM, and residual soil nitrate levels, and were applied each year to supply approximately 110 lb/ac PAN during year 1 and approximately 50 lb/ac during year two. The reduction in target PAN between years one and two aimed to account for potential N release from the previous year's amendments. Teff dry matter yield and N uptake were also measured. Results showed that net N mineralization in fresh DM-amended soil was significantly higher than that of DMC-amended and unamended control soils during the first summer forage growing season (Hurisso et al., 2024). Based on soil cores and ion resin bag data, the proportion of fresh DM N that was mineralized to PAN ranged from 24% to 35% of total added N. In comparison, the proportion of DMC N that was mineralized was 7%, **suggesting that fresh dairy manure may be easier for soil microbes to break down than composted dairy manure and may provide PAN in time to support forage growth during the first growing season. Conversely, composted dairy manure may act as a stable, slow-release fertilizer.** No differences in MBC and MBN were observed between manure treatments and are likely more strongly influenced by sampling time and depth than by amendment. The lack of treatment differences may also be due in part to the annual tillage-induced soil disturbance that took place. Teff N uptake and dry matter yield were both greater in the fresh DM treatment compared to DMC (~14% difference) and the unamended control (~23% difference).

Effects of Liquid and Foliar Amendments on Organic Carrot Production

Liquid fertilizers, such as fish fertilizers, are often used by farmers to supply crops with supplemental N mid-season as it is easier to control N inputs and application rates for liquid fertilizers than it is for other organic N sources. However, liquid fertilizers can be costly, and transporting fertilizers to the farm can have a large carbon footprint. Cyanobacterial fertilizer (cyano-fertilizer) is an alternative to traditional liquid fish fertilizers and is derived from cyanobacteria (blue-green algae), an N-fixing prokaryote. Cyanobacterial fertilizers are rich in N and can be produced on-farm at a relatively low cost; as such, cyanobacterial fertilizer has the potential to be an environmentally and economically sustainable source of N fertilization for organic cropping systems (Sterle et al., 2021; Yoder and Davis, 2020). Phytohormones are chemical compounds produced by plants that can regulate mechanisms such as growth, development, nutritional value, water use efficiency, and response to external stimuli. Applying phytohormones (often in the form of purchased seaweed extracts) to crop foliage or as a soil soak can provide yield and quality benefits to a crop, although research on this subject is still developing (Sukor et al., 2022; Wenz et al., 2019).

Carrots in particular must be "spoon-fed" N over the growing season to reduce carrot forking and splitting which affect the amount of marketable crop (Kelley et al., 2009). Research at Colorado State University evaluated the impact of liquid organic fertilizers and phytohormones on organic carrot yield and quality across two growing seasons (Wickham and Davis, 2023). The four liquid fertilizer treatments included: 1) unfertilized control, 2) cyano-fertilizer, 3) hydrolyzed (cold-processed using naturally occurring enzymes) fish fertilizer, and 4) non-hydrolyzed (heat processed to concentrate nutrients) fish fertilizer. All fertilizers were applied at equal N application rates (regardless of differing initial N concentrations) via injection into a drip irrigation system. Phytohormone treatments were applied at the subplot level and consisted of 1) foliar seaweed, and 2) no foliar seaweed.

Results showed that cyano-fertilizer may enhance carrot yield, length, and quality compared to traditional liquid fish fertilizers, but results can vary by year (Wickham and Davis, 2023). The cyano-fertilizer treatment resulted in the highest carrot yield and length in year one, but no differences were detected in year two. With yield and quality being greater than or equal to the other fertilized treatments, this suggests cyano-fertilizers are a viable alternative to liquid fish fertilizer. **Foliar seaweed application had no effect on carrot yield in either year, but did decrease the percent of carrots with undesirable root knobs.** The foliar seaweed product contained salicylic acid which is known to improve crop resistance to root-knot nematodes, although nematodes were not measured in this study (Branch et al., 2007).

3. Soil Health and Soil Biology

NRCS Resource Concerns (RCs) Addressed	Applicable Conservation Practice Standards (CPS)
● Plant: Plant productivity and health ● Soil: Soil organism habitat loss or degradation, Organic matter depletion, Compaction ● Water: Naturally available moisture use, Nutrients transported to groundwater, Salts transported to groundwater ● Air: Emissions of greenhouse gases (GHGs)	● 311 Alley Cropping ● 325 High Tunnel System ● 328 Conservation Crop Rotation ● 336 Soil Carbon Amendment ● 340 Cover Crop ● 379 Forest Farming ● 381 Silvopasture ● 512 Pasture and Hay Planting ● 590 Nutrient Management ● 595 Pest Management Conservation System

Highlights from Recent Research

- Building soil organic carbon (SOC), soil health, and the soil microbiome -
    - Building SOC via living roots supports a wider range of soil functions including nutrient cycling and nitrogen mineralization, water-holding capacity, crop yield stability, and weather/climate resilience (Villarino et al., 2021).
    - Tilling in cover crops with a low C:N ratio can stimulate microbial activity and the formation of SOM, and also increase water holding capacity and volumetric water content in both the cover crop and cash crop growing phases compared to cover crops with a high C:N ratio (Salehin et al., 2024).
    - Inoculating organic vegetable transplants with diverse, native arbuscular mycorrhizal fungi supports soil health and can boost crop yields (Koziol and Bever, 2023).
- Organic high tunnel production considerations -
    - A review of high tunnel production literature and focus groups/interviews with producers highlighted the need for technical assistance related to adaptive nutrient management, irrigation strategies, and soil health in high tunnel environments (Pierre et al., 2024).

Building Soil Organic Carbon (SOC)

Soil organic carbon (SOC) comprises about 50% of soil organic matter (SOM), which plays a central role in building and maintaining soil health, fertility, and agricultural resilience. Most forms of soil degradation entail a loss of SOC, and conservation practices restore soil health by rebuilding SOC stocks and the soil biotic community. Because SOC is a major global carbon pool, recouping historical losses of SOC through regenerative soil and crop management helps to mitigate climate volatility and the adverse effects on plant and ecosystem health. All SOC formation and all CO_2 removal begin with plant photosynthesis, which leads to a critical question: *what proportion of plant biomass carbon generated through conservation practices such as cover cropping, pasture and hay planting, and agroforestry ultimately becomes SOC?*

Villarino et al. (2021) undertook a systematic review of 35 isotope tracer studies of plant-soil carbon dynamics in the field and lab to address this question and gain a deeper understanding of SOC formation and cycling. SOC formation efficiency (SOC_{FE}) is defined as the percentage of plant carbon inputs to the soil that become SOC. Plant carbon that is partitioned belowground (roots + rhizodeposition) has a much higher SOC_{FE} than aboveground biomass carbon (Villarino et al., 2021). For plants with shoot:root biomass ratios near 1:1 (mostly perennials), roots + rhizodeposition account for 81% of SOC accruals from plant photosynthesis. For plants with shoot:root biomass ratios near 6:1 (typical of annual crops selected for high yields), 43% of SOC accrual comes from below ground sources. For every 2 lb root biomass C formed by annual cash crops, cover crops, perennial grasses, and trees, an additional 1 lb of rhizodeposition C is added to the soil (Villarino et al., 2021).

Two main fractions of SOC consist of particulate organic carbon (POC) or "active SOC," much of which is directly plant-derived; and mineral-associated organic carbon (MAOC) or "stable SOC," comprised mainly of microbially processed organic carbon. These fractions play vital roles in soil functions including nutrient cycling, plant-available N, and food for soil organisms (POC); and long-term carbon storage, aggregation, and cation exchange capacity (MAOC). Rhizodeposition throughout the plant's life cycle and root residues left when the plant dies play complementary roles in building SOC. POC is higher in root residues compared to aboveground plant biomass, and MAOC from rhizodeposition averages 46%. Because rhizodeposition is rich in simple carbohydrates, it stimulates microbial activity which can lead to a small net consumption of POC, yet is highly efficient in forming MAOC. Thus, living roots play a key role in forming the most stable form of SOC, and hence in carbon sequestration.

Practical implications of this understanding of SOC dynamics include:

- Maintain continuous living roots to the maximum extent practical.
- Choose crops, cultivars, and rotations that develop and maintain high root biomass to build POC, MAOC, and total SOC.
- Building both forms of SOC via living roots supports a wider range of soil functions including nutrient cycling and nitrogen mineralization, water-holding capacity, crop yield stability, and weather/climate resilience.
- Perennial crops and perennial-based farming systems have a much greater capacity to build SOC and restore soil health than systems composed only of annuals.

Soil Biological Responses to Organic Practices

The transition to organic production can temporarily reduce yields as producers shift from soluble to organic nutrient sources, because transitioning soils may take several years to develop capacity to deliver plant-available nutrients through biological processes. Field trials were conducted in Texas to track changes in soil microbial activity during transition to an irrigated organic cover crop-cotton-peanut rotation in comparison to conventional production with or without cover crops (Ellman-Stortz et al., 2024). Soil respiration, potentially mineralizable carbon (C-MIN), and activities of two soil enzymes (one carbon-cycling and one nitrogen-cycling) were monitored during the second year of transition, from just before cover crop termination through peanut harvest. Microbial biomass and fungal:bacterial ratio were estimated at the time of cover crop termination by phospholipid fatty acid analysis (PLFA).

Organic inputs (cover crops plus composted manure) began to modify soil biological activity and the microbial community by the second year of transition (Ellman-Stortz et al., 2024). This was most evident in the PLFA analysis at the time of cover crop termination. Both cover crop and composted manure boosted total PLFA (microbial biomass), and fungal:bacterial ratios were higher with cover crops than without. Manure compost boosted the carbon-cycling soil enzyme when applied at the time of peanut planting. Cover crops that attained 900-3,000 lb/ac biomass enhanced total soil respiration and conserved soil moisture compared to no cover crop. Organic peanut yields were 21% lower than conventional yields when pre-plant nutrients were not applied in either treatment, and 18% higher than conventional yields when organic peanuts received manure compost and conventional peanuts received soluble fertilizer (Ellman-Stortz et al., 2024). **Overall, these findings show that:**

- Soil health parameters, especially microbial biomass, can begin to respond to cover crops and manure compost as soon as the second year of organic transition.
- The slower release of nutrients in manure compared to soluble fertilizer can benefit the effectiveness of peanut nodulation.
- Organic management does not necessarily reduce peanut yields.
- Cover crops may not always “rob” moisture from irrigated organic crops.

In a study of cotton production during organic transition in a high-rainfall region of Texas (College Station), a winter cover crop - summer cotton rotation was implemented for three years, comparing cover crops of Austrian winter pea, oats, turnip, a mix of all three, and a no-cover control (Salehin et al., 2024). Cover crop biomass, carbon (C), and nitrogen (N) were measured in spring just before cover crop termination by roller-crimper. Poultry litter (PL) and cover crop residues were disked in before cotton planting. Static gas chambers were installed to measure greenhouse gas (GHG) emissions, including carbon dioxide (CO_2), nitrous oxide (N_2O), and methane (CH_4), during the cotton growing seasons and the final (year 3) cover crop growing season. Sensors were placed 6 inches from the gas chamber bases to monitor soil temperature and moisture.

Cumulative CO_2 emissions were 40% higher for the mix than for no-cover in the first cotton crop, while cover crop treatment had non-significant effects on CO_2 emissions in cotton and cover crops during year three (Salehin et al., 2024). Incorporation of PL, high cover crop biomass, lower cover crop C:N ratio (turnip, winter pea, mixture), and heavy rainfall events stimulated microbial respiration, leading to high CO_2 emissions, especially after PL application. N_2O emissions were generally low, except for a sharp spike after PL was incorporated with cover crop residues, and smaller spikes after rainfall events. **Cumulative N_2O emissions during the cotton season were lower in treatments with cover crops than no-cover.** However, heavy weed pressure and untimely rainfall in year three delayed cultivation, and the resulting high weed biomass may have masked cover crop treatment effects on GHG emissions.

Although cover crops consumed soil moisture while they were growing, soil volumetric water content (VWC) during all cotton growing seasons were as high or higher in cover crop treatments than no cover. **When cover crops with a lower C:N ratio (pea, turnip, mix) were tilled in, they stimulated microbial activity and formation of SOM, and thereby increased soil water holding capacity by approximately 0.2 cm^3/cm^3.** CO_2 emissions increased with VWC and with temperature (65-82°F) in *moist soil* (VWC 0.35-0.4), but decreased with temperature during *hot, dry* summer conditions (soil temperature 75-100°F; VWC 0.1-0.3) (Salehin et al., 2024). Overall, the incorporation of cover crops in organic cotton systems has the potential to moderate soil temperature extremes and conserve soil moisture during the cotton growing season, without additional contributions to GHG emissions if proper species selection and termination are considered.

Managing the Soil Microbiome

In lieu of soluble fertilizers, organic producers rely on a diversity of soil microbes to process plant- and animal-derived inputs to maintain soil health and fertility, release nutrients to crops, and maintain yields and agroecosystem resilience. A growing number of organic producers use microbial inoculants to enhance soil biological functions, and new research has begun to document the incredible complexity of soil microbial communities, including multispecies interactions amongst fungi, bacteria, and plant roots (Ray et al., 2020).

Root-symbiotic arbuscular mycorrhizal fungi (AMF) are among the most frequently used microbial inoculants in organic production, and AMF play a central role in plant nutrition for many field crops, fruits, and vegetables. However, frequent tillage, synthetic inputs, and low-diversity rotations tend to degrade the diversity and efficacy of AMF in agricultural fields. Based on multiple studies indicating that inoculants derived from a farm's locale ("native AMF") may outperform commercial AMF inoculants, Koziol and Bever (2023) tested this hypothesis in an organic high tunnel tomato and pepper production trial in Kansas. They developed an inoculant based on strains of seven AMF species collected from a nearby undisturbed native prairie, and tested the inoculum on five heirloom tomato cultivars, two bell peppers, two jalapeños, and one shishito pepper. These inoculated cultivars were compared to non-inoculated transplant treatments of the same cultivars.

For the inoculated treatment, inoculant containing ~130 AMF spores was placed in each planting hole for transplanting tomato and pepper starts into high tunnel beds, and yields were recorded throughout the season for both inoculated and non-inoculated treatments. **The native multispecies AMF inoculum significantly improved yields of all tomato cultivars, especially during early harvests, which enhanced access to lucrative early-season markets.** Peppers showed greater variability in response to the native AMF, ranging from nonsignificant effects in the jalapeños and one bell pepper to a 1.2 lb/plant increase in total harvest of 'Islander' bell pepper and 3.9 lb/plant increase for 'Mellow Star' shishito pepper. **These results validated the hypothesis that native AMF derived from local undisturbed plant communities can support effective AMF symbiosis in organic vegetable crops grown in disturbed (tilled) soils, and that placing inoculant in planting holes at 130 spores/plant is sufficient to promote the desired association** (Koziol and Bever, 2023).

Soil Health in High Tunnel Production

A growing number of organic and non-organic specialty crop farmers are adopting high tunnel (HT) systems for vegetable and fruit production. High tunnels extend the growing season, allow specialty crop growers to diversify their produce, serve earlier and later markets, and can improve net returns in the short run. **However, intensive production with fertility inputs, tillage, higher temperatures, and the exclusion of natural rainfall create soil health stresses unique to the HT environment that can deplete soils and undermine the long-term sustainability of HT systems.** These include soil fertility limitations, salinity buildup, alkaline pH, accelerated oxidation of SOM, soilborne plant pathogens, compaction, and a lack of research-based soil test protocols and recommendations for HT soils.

Pierre et al. (2024) undertook a review of HT soils research (68 publications), Extension materials (58 publications), and farmer practices and observations (focus groups and interviews with 30 HT producers) to characterize current knowledge, research priorities, and technical assistance needs related to HT soil health and fertility management. **This review found that farmers often increase nutrient inputs to sustain intensive HT crop production, and participants with >5 years' experience with HTs reported yield declines resulting from diseases, salinity, and nutrient issues that they had not encountered in open field production** (Pierre et al., 2024). High fertilizer application rates can lead to reduced nutrient use efficiency, declining plant health, elevated soil salinity, and nutrient imbalances that promote physiological disorders and render produce unmarketable. A majority of producers interviewed used compost as their primary means to maintain SOM. Many noted that this resulted in elevated P, other nutrients, and salts. Producer strategies to mitigate salinity include choosing low-salt compost and fertilizers, flush-irrigating HT soils, leaving the structure uncovered for a few months when plastic needs to be changed to allow natural rainfall to leach salts, and using moveable tunnels.

Focus groups revealed that soil compaction can become a major problem after 5-10 years of HT production, yet little research has been conducted on the role of soil compaction in limiting HT nutrient cycling and crop growth (Pierre et al., 2024). Excluding rainfall reduces foliar diseases and improves marketability but renders the HT system entirely dependent on irrigation. **Producers noted a lack of practical guidance on water management and its impacts on nutrient cycling and soil biota in HT systems**. HT producers and researchers have found that warmer temperatures, year-round irrigated production, and limited crop rotation have led to increased occurrence of multiple soilborne pathogens (*Fusarium, Verticillium, Sclerotinia, Rhizoctonia, Colletotrichum*, and several downy mildew genera) and root-knot nematodes (RKN, *Meloidogyne* spp.). Experienced HT producers have had success managing diseases with soil solarization, soil steaming, or anaerobic soil disinfestation (ASD), but they have concerns about the impacts of these treatments on soil biota and nutrient cycling. **This comprehensive review led to the following recommendations** (Pierre et al., 2024):

- Development of adaptive nutrient and SOM management strategies that address the complexities of HT production and changes in HT soils over time.
- Mitigation strategies for diseases based on research on the impacts of solarization, steaming, and ASD on soil physical, chemical, and biological conditions, and on economic returns.
- Water monitoring technology and irrigation strategies to optimize microbial activity, nutrient release, and crop-available moisture and limit nutrient leaching and salt buildup.
- Development of technical assistance for HT producers that center soil health from the time of HT construction through multiple years as the system transitions from "field soil" to "HT soil" conditions and HT-specific soil challenges arise.

4. Diversified Cropping Systems

NRCS Resource Concerns (RCs) Addressed	Applicable Conservation Practice Standards (CPS)
• Plant: Plant productivity and health, Plant pest pressure • Soil: Soil organism habitat loss or degradation • Animal: Feed and forage balance	• 328 Conservation Crop Rotation • 340 Cover Crop • 528 Grazing Management • 590 Nutrient Management • 595 Pest Management Conservation System

Highlights from Recent Research

- Integration of chickens into organic vegetable rotations -
  - Broiler chicken integration into vegetable-cover crop rotations increases soil nitrate N, soil P, and soil microbial biomass carbon (Bilenky et al., 2024).
- Intercropping in semiarid regions -
  - Intercropping legume and non-legume crops in semiarid growing environments can provide greater weed control, and greater cash crop grain weight and grain protein content (Fernandez et al., 2025).
- Utilizing mushrooms for animal nutrition -
  - Mushrooms as a feed additive in poultry diets may aid in animal growth, immune health, and feed utilization, and also offer mushroom producers a market for mushroom stems which are often discarded as waste (Salahuddin et al., 2025).

Integrating Chickens into Organic Vegetable Systems

Animal-crop integration offers an opportunity for producers to cycle nutrients on the farm and reduce the amount of off-farm inputs that are needed. Integrating chickens into small-scale, diversified organic vegetable farms can provide benefits to soil health, biodiversity, pest management, and farm income (Carey et al., 2025). However, it is important to consider the potential effects of raw chicken manure in close proximity to vegetable production due to potential nutrient buildup, leaching from raw chicken manure, or presence of pathogens like *E. Coli*. In Iowa, a three-year study evaluated the incorporation of broiler chickens into a diversified organic vegetable rotation and the effects on soil nutrients and food safety (Bilenky et al., 2024). Annual treatments consisted of:

- Control (vegetable double crop – winter cover crop; no chicken incorporation)
- V-P-CC (vegetable crop – poultry – winter cover crop)
- V-CC-P (vegetable crop – summer cover crop – poultry

Vegetables represented a typical diverse rotation on an organic vegetable farm, including broccoli, lettuce, and spinach; the winter cover crop was cereal rye (*Secale cereale* L.) while the summer cover crop was crimson clover (*Trifolium incanatum*) plus oats (*Avena sativa*). Chickens were housed in floorless movable coops and provided with space typical of a pasture-raised system, allowing them to graze on vegetable crop and cover crop residues, with organic chicken feed fed as needed to provide a complete ration.

Poultry integration, regardless of timing in the rotation, increased soil nitrate N (NO_3-N) 2x when measured after poultry removal (approximately 40-50 days of grazing), and also increased soil phosphorus (P) by 45% and 13% in years two and three of the experiment, respectively (Bilenky et al., 2024). Lettuce marketable yield was 38% higher in the V-CC-P treatment compared to the V-P-CC treatment, likely due to higher residual N. No differences in spinach yield were observed. **Integration of poultry also increased microbial biomass carbon (MBC) by an average of 25% across treatments and sampling dates** compared to the no poultry control**.** While *E. coli* and *Salmonella* spp. were found in the soil in the experimental plots in years two and three of the experiment, no pathogens were detected on the leaf surfaces of crops. **The authors suggest treating poultry-vegetable integration as if raw manure has been applied and following National Organic Program (NOP) regulations for manure application (§ 205.203) and crop harvest timing, which requires 120 days from application to harvest for crops whose edible portions have contact with the soil.**

Intercropping in Semiarid Regions

Intercropping involves growing two or more crops at the same time and in the same area of land. This practice offers the potential to increase biodiversity, land use efficiency, and crop productivity via greater resource use efficiency (Duchene et al., 2017). Intercropping may be of value in more water-limited agricultural regions such as the prairies and Northwest and give producers a way to boost crop yield and quality compared to monocultures or using green manures. A two-year organic intercropping study was conducted in Saskatchewan, Canada to determine if this practice affected weed control and crop yield and quality. A legume and non-legume were evaluated as monocultures and intercropped together - one treatment included lentils (*Lens culinaris* Medik.) plus yellow mustard (*Sinapis alba* L.); the other treatment included field pea (*Pisum sativum* L.) plus oat (Fernandez et al., 2025).

Results of this study showed some benefits and tradeoffs that should be considered when intercropping legumes and non-legumes in a semiarid environment (Fernandez et al., 2025). **Either intercropping treatment increased weed control by an average of 65% compared to monocultures. Oats had 25% greater grain weight when intercropped with field pea, and pea grain protein content was greater in this treatment as well. Non-legumes tended to have higher tolerance to intercropping compared to legumes, as observed by the legume's 2-3x lower crop biomass and 32% lower grain yield in the intercropped treatments compared to their monocultures.** The authors also made visual observations that no lodging occurred in the pea-oat intercrop, with the pea plants "climbing" the oat plants (Fernandez et al., 2025). This supports the idea that intercropping a climbing legume with a cereal crop provides the legume with physical support and reduces lodging in the cereal crop (Bedoussac et al., 2015).

Mushrooms for Animal Nutrition

Organic producers are prohibited from using antibiotics and growth hormones for raising livestock, and many non-organic producers are interested in feed additives that reduce reliance on these due to growing antibiotic resistance and increased attention from consumers on animal health. **Mushrooms as a feed additive (in the form of dry powder or stems) in poultry diets may aid in animal growth, immune health, and feed utilization, also offering mushroom producers a market for mushroom stems which are often thrown out as "waste."** Salahuddin et al. (2025) conducted a comprehensive review on the utilization of mushrooms for poultry nutrition, looking at effects on variables such as chicken growth, meat quality, egg production, and immune and metabolism responses. While this review was not organic-specific, the results are applicable to all poultry producers, so long as organic producers were to source organically-grown mushrooms.

Incorporating mushrooms into poultry diets has been found to increase chicken growth, mainly through improved nutrient absorption and through better gut health from an increase in beneficial gut microbes that reduce pathogenic bacteria presence in intestines. Egg production and meat tenderness have also seen improvements - bioactive compounds in mushrooms, such as β-glucans, glycoproteins, terpenoids, and polyphenols enhance metabolism and immune cell activity, protecting the animal's body against oxidative stress. These benefits have also been found to extend beyond the chicken's life, with better meat tissue integrity during storage due to improved meat oxidative stability and free radical scavenging. Stems from *L. edodes* (shiitake) and *P. ostreatus* (oyster) mushrooms in particular have high antimicrobial properties which have exhibited reductions in poultry infections, which could reduce non-organic production's reliance on antibiotics while improving the industry's biosecurity. Overall, the benefits of feeding mushroom dry powder or stems to poultry as a feed additive are numerous, giving mushroom growers an additional market while also offering a way for non-organic producers to lessen reliance on antibiotics and growth hormones.

5. Crop and Agronomic Considerations

NRCS Resource Concerns (RCs) Addressed	Applicable Conservation Practice Standards (CPS)
• Plant: Plant productivity and health, Plant pest pressure • Soil: Organic matter depletion, Concentration of salts or other chemicals	• 325 High Tunnel System • 328 Conservation Crop Rotation • 340 Cover Crop • 484 Mulching • 590 Nutrient Management • 595 Pest Management Conservation System

Highlights from Recent Research

- Effects of different mulches -
  - A red clover living mulch can suppress weeds in organic corn production, but should be undercut to create a planting strip and flame weeded to balance weed control with crop yield (Brockmueller et al., 2025).
  - A sorghum-sudangrass+field pea living mulch can provide an alternative to black plastic mulch systems while still maintaining high water infiltration and crop yield (Bozzolo et al., 2025).
- Organic dry bean cultivar evaluations -
  - Specialty dry bean cultivars yield lower than commercial cultivars, but consumers have indicated a preference for specialty cultivars and willingness to pay a premium for these dry beans (Everest et al., 2025).
- Organic sweetpotato production considerations -
  - Sweetpotato research suggests that a horizontal stem cutting planting orientation and a later harvest can both increase organic sweetpotato yield and the proportion of that yield that can be classified as US No. 1-grade, which can boost producer profits (Woodard et al., 2024).
- Transitioning organic grains -
  - In corn-soybean-wheat rotations, tillage intensity can be reduced without compromising cash crop yield, as long as cover crop termination is strategic and row cleaners are used to successfully plant into high cover crop residue (Neelipally et al., 2025).

Effects of Different Organic Mulches

Weed management and soil health are of high importance to organic producers, but achieving high levels of weed control often comes at the expense of soil health due to the reliance on soil disturbance for killing weeds. Living mulches – cover crops that are actively grown alongside the cash crop – offer an opportunity to reduce tillage while also suppressing weeds. However, living mulches may compete with the cash crop if not managed properly. A field study was conducted over two years in Wisconsin to examine the impacts of several living mulch management practices – including undercutting, flaming, roller-crimping, and high-residue cultivation – on the performance of a red clover living mulch in an organic grain corn system and potential effects on weed control and corn yield (Brockmueller et al., 2025). Treatments consisted of:

- Pre-corn planting tillage strategy: undercutting the red clover to create a planting strip vs. no-till direct seeding corn into the clover living mulch (an "unmanaged" pre-plant comparison)
- Post-corn planting clover management: flame weeding of the red clover vs. no flame weeding
- In-season red clover management: inter-row roller crimping vs. high-residue cultivation, or a combination of the two

Compared to no-till corn planting into the red clover living mulch, undercutting the red clover to create a planting strip or flame weeding the clover after corn planting resulted in greater corn yield. Undercutting resulted in an average yield of 86 bu/ac and flame weeding 79 bu/ac, compared to 60 bu/ac in the no-till treatment. Greater yield is likely attributed to an increase in soil temperature caused by soil disturbance in the undercutting treatment, which can lead to quicker crop emergence. Termination of the living mulch can also reduce competition for N. Inter-row roller crimping two and four weeks after corn planting did not affect red clover biomass at the end of the growing season. Red clover biomass between the crop rows averaged 465 lb/ac in the high-residue cultivation treatment compared to 741 lb/ac in the roller crimping treatment, **suggesting that high-residue cultivation can affect the living mulch's ability to suppress weeds through its biomass, but this may not always translate to a crop yield effect.** Corn yield averaged 70 bu/ac and 74 bu/ac in the high-residue cultivation and roller crimping treatments, respectively. Effects on weed management varied and depended on treatment, and were likely attributed to where soil disturbance occurred in the treatments (in or between the crop row). Undercutting red clover increased weed biomass in the crop row, and high-residue cultivation increased weed biomass between the crop row. Soil disturbance can stimulate weed seed germination, and coupled with living mulch disturbance, can create an environment for weed emergence and growth (Brockmueller et al., 2025). Overall, combining undercutting of the living mulch to create a planting row prior to crop planting, and subsequent flame weeding and roller crimping of the mulch in between the rows has the most potential to improve corn yields while balancing soil disturbance and weed control.

Plastic (polyethylene) mulches are permitted for use in organic production, and many producers use these for weed management, soil moisture retention, and to increase soil temperatures to support crop yields. However, there are concerns with the sustainability of plastic mulches, particularly regarding plastic waste and microplastic pollution. Living mulches or the use of rolled cover crop residues are of interest to producers to lessen reliance on plastic mulches. Research on these different mulches was conducted over two years in California, comparing black plastic mulch with a white clover living mulch, a roller-crimped sorghum-sudangrass+field pea mix, and a roller-crimped buckwheat+field pea mix (Bozzolo et al., 2025). The influences of these mulch treatments on soil properties, weed control, and organic strawberry yield were examined.

In both years, **pre-harvest soil sampling showed that soil C and N were highest in the sorghum-sudangrass+pea treatment, averaging 43% and 23% higher than the plastic mulch, respectively.** Soil C and N were not different between treatments at post-harvest soil sampling. SOM did not differ between treatments in year one, but was higher in the sorghum-sudangrass+pea treatment compared to plastic mulch in year two. **The living mulch and rolled cover crop mulches all demonstrated higher water infiltration rates compared to plastic mulch, but the plastic mulch maintained soil moisture better than the other mulches by 19-24%.** While the buckwheat treatment produced the greatest amount of cover crop biomass, this treatment also saw the highest weed biomass, likely due to the rapid decomposition of the buckwheat which reduced competition with weeds. Strawberry yield was measured monthly from April through July, and **in the first month the plastic mulch treatment produced twice as much as the other mulches** (~3,700 lb/ac), pointing to the ability of plastic mulches to support early-season yield through soil warming and moisture retention. **However, when analyzing total yield across the season, the sorghum+field pea mix had comparable yield to the plastic mulch (~21,000 lb/ac over the four months), providing a promising alternative to producers interested in reducing plastic mulch use while still maintaining soil cover.**

Organic Dry Bean Cultivar Evaluation

Consumer interest in niche and culturally-diverse food presents an opportunity for organic producers to add specialty and heirloom crop cultivars into their crop rotation. Dry beans (*Phaseolus vulgaris*) are one such example, with growing interest in different bean cultivars in specialty marketplaces and in restaurants. Dry bean production in the US drastically declined early in the 20th century due to diseases such as bean common mosaic virus (BCMV) (*Potyvirus phaseovulgaris*) and white mold (*Sclerotinia sclerotiorum*), but breeding and cultivar improvements have helped dry bean performance. In order to understand cultivar and agronomic performance in organic systems, cultivar trials were conducted over two years at four different research farm locations (New York, Vermont, Maine, and Wisconsin) (Everest et al., 2025). 32 dry bean cultivars were evaluated, including commercially available black, pinto, navy, small red, and several specialty cultivars such as Southwest Gold, Tiger's Eye, Desert Song, and Rojo Chiquito. In addition to these cultivar trials, in-person surveys were conducted to assess consumer taste, texture, and appearance preferences, as well as willingness to pay certain dollar amounts for different cultivars.

On average, **the commercially available cultivars (black, pinto, navy, small red) had higher yields than the specialty cultivars**, averaging 3,255 lb/ac and 2,373 lb/ac, respectively (Everest et al., 2025). Black and navy beans had the highest "uprightness" than all other cultivars, which is important for ease of bean harvest. Pod height showed greater variability across cultivars. **Consumers who participated in the surveys indicated a greater preference for the specialty cultivars** based on bean flavor, texture, and seed coat appearance, and indicated a willingness to pay up to $11 per pound for organically-produced specialty dry beans (Everest et al., 2025). These agronomic results and consumer preferences are important for organic producers to consider, and **indicate the potential for producers to sell lower yielding specialty cultivars in high-value markets**.

Organic Sweetpotato Production Considerations

Sweetpotato is a major crop in many countries, and its production and interest in the US continue to grow as new cultivars become available. However, many commercial cultivars are susceptible to yield, quality, and marketability losses due to pest, disease, fertility, and environmental variables, and research is needed on non-chemical management for the crop. A comprehensive review was conducted by George et al. (2024) to assess current knowledge on organic sweetpotato pest management and other agronomic considerations, and how this impacts producers.

Sweetpotato pests consist largely of wireworm and sweetpotato weevil (*Cylas formicarius* F.), as well as root-knot nematodes (RKN; *Meloidogyne* spp.). As discussed previously, Pellegrino et al. (2021) highlighted the importance of cultivar selection as a primary method for wireworm control. George et al. (2024) found that use of pheromones and traps have been effective for weevil control, as well as the release of sterile weevils to reduce populations. RKN control can be difficult, as nematodes spread quickly and cause significant damage. **One of the best options highlighted in this review for RKN control is a diverse crop rotation, particularly one that includes non-host crops and cover crops, as well as the use of "clean" seed or stems that did not come from RKN-infected fields**. These methods are also recommended for management of common sweetpotato diseases like Sclerotial blight (*Sclerotium rolfsii*), Slime molds (*Fuligo violacea* or *Physarum plumbeum*), and Rhizoctonia stem canker (*Rhizoctonia solani*). For weed management in sweetpotato, organic producers most often use tillage and crop rotation. It is also suggested to consider sweetpotato cultivars, like Carolina Bunch, that have either erect or semi-erect growth – this results in greater crop height, more branching, and a denser canopy that can compete more successfully with weeds (George et al., 2024). Sweetpotatoes may also have value for beneficial insects such as pollinators. Although sweetpotatoes reproduce vegetatively, they produce flowers in late summer, which could support local pollinator communities. There is also interest in using pollinators like honey bees as biomonitors for sweetpotato diseases by collecting pollen and analyzing pathogen assays.

Finding ways to increase sweetpotato yield is important for organic producers in order to keep up with rising domestic demand. Unrooted stem cuttings are typically transplanted vertically in the soil. In other countries, it is common for sweetpotatoes to be planted in a horizontal fashion, which led to research to test this planting orientation in North Carolina, a large producer of organic sweetpotato. An organic field trial was conducted over two years to evaluate vertical and horizontal stem cutting planting orientation, as well as stem cutting length (10 or 15 inches), and either early or late harvest (104 or 125 days after planting) (Woodard et al., 2024). Across treatments, the cultivar 'Monaco' was used. Results showed 16% higher marketable yield with vertical planting orientation in year one, but no differences were found in year two. However, when analyzing just US No. 1-grade sweetpotato yield, horizontal planting orientation resulted in 18% greater yields on average and made up a higher proportion of the total marketable yield compared to the vertical planting orientation treatment (63% versus 56%, respectively). Stem cutting length did not differ between planting orientations and did not affect yields. Across treatments, the later harvesting date increased marketable yields by 49%. **These results suggest that a horizontal stem cutting planting orientation and a later harvest can both increase organic sweetpotato yield and the proportion of that yield that can be classified as US No. 1-grade, which can boost producer profits** (Woodard et al., 2024).

Transitioning to Organic Grains

During the three-year transition period to certified organic production, producers can face many challenges related to implementing a more diverse crop rotation, controlling weeds, and maintaining cash crop yields. Many organic producers rely on tillage for weed control, amendment incorporation, and seedbed preparation. In parts of the Southeast US, a high percentage of farms practice conservation tillage (USDA NASS, 2018). This region's hot and humid climate can pose additional management challenges for organic producers (Robertson et al., 2013). To study these challenges during the transition-to-organic period, research was conducted in Tennessee using four organic grain systems that varied in tillage, cover crop, fertility management, and crop rotational sequence (Neelipally et al., 2025). Cropping systems were as follows: 1) maximum yield system (MYS) to maximize production, 2) sustainable yield system (SYS) to balance yield and ecological benefits, 3) ecologically conscious system (ECS) to maximize ecological benefits, and 4) low input system (LIS) with no external fertility inputs. Cash crops were the main research plot and included corn, soybean, and wheat, with the four cropping systems implemented within these main plots. The cover crop in year one was triticale plus radish (used across all cropping system treatments), but cover crops differed in subsequent years and were chosen to reflect the goals of the different cropping systems. Tillage also varied by cropping system, with off-set and pickup disking occurring in the more intensive systems and incorporation of no-till planting, roller crimping, and/or flail mowing occurring in the less intensive systems. Due to the overall complexities between these systems, they are not fully described here, and more information can be found in the *Figure 1* cropping system diagram in the research paper (Neelipally et al., 2025).

The results from this study, which mimicked potential ways to transition a typical corn-soybean-wheat rotation to organic production, highlighted that it is possible to reduce tillage intensity without compromising yield with the caveat that cover crop management (particularly termination) must be strategic to not reduce crop yield (Neelipally et al., 2025). Overall, the MYS and SYS treatments resulted in the highest cover crop biomass and also the greatest weed suppression; conversely, the LIS treatment saw the lowest cover crop biomass and lowest weed suppression. The LIS treatment also had lower crop yields compared to all other treatments, and these fertilized treatments (MYS, SYS, ECS) all produced "satisfactory" yields for the region. With grain yields of the reduced-tillage SYS and ECS treatments being similar to those of the intensive tillage system (MYS), proper management can allow tillage reductions without compromising yield. The researchers credit this partially to careful integration of multiple tactics, such as machinery optimization, where it was found that **utilization of row cleaners permitted successful soybean establishment in high cover crop residue**.

LITERATURE CITED

Bedoussac, L., E.P. Journet, H. Hauggaard-Nielsen, C. Naudin, G. Corre-Hellou, E.S. Jensen, L. Prieur, and E. Justes. 2015. Ecological principles underlying the increase of productivity achieved by cereal-grain legume intercrops in organic farming. A review. Agronomy for Sustainable Development, 35:911-935. https://doi.org/10.1007/s13593-014-0277-7.

Bilenky, M.T., A. Nair, M.D. McDaniel, A.M. Shaw, E.A. Bobeck, and K. Delate. 2024. Integrating pastured meat chickens into organic vegetable production increased nitrogen and microbial biomass with variability in presence of *E. coli* and *Salmonella spp*. Renewable Agriculture and Food Systems, 39:1-19. https://doi.org/10.1017/S1742170524000012.

Bozzolo, A., J. Pecenka, and A. Smith. 2025. Living Mulches, Rolled Cover Crops, and Plastic Mulch: Effects on Soil Properties, Weed Suppression, and Yield in Organic Strawberry Systems. Plants, 14:3385. https://doi.org/10.3390/plants14213385.

Branch, C., C.F. Hwang, D.A. Navarre, and V.M. Williamson. 2007. Salicylic Acid is Part of the *Mi-1*-Mediated Defense Response to Root-Knot Nematode in Tomato. Molecular Plant-Microbe Interactions, 17:351-356. https://doi.org/10.1094/MPMI.2004.17.4.351.

Brockmueller, B., J. L. Drewry, L. Vereecke, E.M. Silva, and B. Luck. 2025. Mechanical management strategies improve corn production in organically managed living mulch systems. Agronomy Journal, 117:e70100. https://doi.org/10.1002/agj2.70100.

Carey, A.M., C.R. Dutter, K. Mbacke, M.D. McDaniel, and A. Nair. 2025. Integrating poultry improves soil health and vegetable yield in organic, cover-cropped system. Agriculture, Ecosystems and Environment, 382:109499. https://doi.org/10.1016/j.agee.2025.109499.

Carr, P.M., M.M. Volkman, S.I. Fordyce, B.S. Crookston, M.A. Yost, and J.R. Reeve. 2025. Cattle manure impacts on organic wheat production in the northern Great Plains. Canadian Journal of Plant Science, 105:1-13. dx.doi.org/10.1139/cjps-2025-0008.

Di Gioia, F., J.C. Hong, X. Zhao, N. Xu, J. Ono-Raphel, B. Morrison, R. Balaguer, C. Roman, K. Arrington, D. Moreira Calix, J. Desaeger, F. Dini-Andreote, C. Schmidt, Z. Gao, R. Chalam, L. Fronk, T. Ford, T. Elkner, Y. Goodiel, K. Demchak, A. Formiga, B. Gugino, J. Kaye, and E. Rosskopf. 2024a. Advancing organic amendment-based soil management approaches: a paradigm shift from soil disinfestation to nourishing soil health. Acta Horticulturae, 1410:1-8. https://doi.org/10.17660/ActaHortic.2024.1410.1.

Di Gioia, F., R. Balaguer, F. Pierre, B. Morrison, J. Ono-Raphel, L. Passerini,L. Vecchia, K. Demchak, C. Roman, C. Schmidt, B. Gugino, T. Elkner, J.C. Hong, F. Dini-Andreote, and E. Rosskopf. 2024b. Optimizing anaerobic soil disinfestation for high tunnel specialty crop production systems in the U.S. Mid-Atlantic region. Acta Horticulturae, 1410:133-142. https://doi.org/10.17660/ActaHortic.2024.1410.19.

Duchene, O., J.F. Vian, and F. Celette. 2017. Intercropping with legume for agroecological cropping systems: Complementarity and facilitation processes and the importance of soil microorganisms. A review. Agriculture, Ecosystems & Environment, 240:148-161. https://doi.org/10.1016/j.agee.2017.02.019.

Ellman-Stortz, L., K. Lewis, T. Gentry, P. DeLaune, E. Pierson, and N. Boogades. 2024. Early impacts of cover crop selection on soil biological parameters during a transition to organic agriculture. Agrosystems, Geosciences & Environment, 7:e20532. https://doi.org/10.1002/agg2.20532.

Everest, E.F., K.A. Loria, M.R. Ryan, I. Krezinski, H.M. Darby, B. Brockmueller, C.G. Stedden, E.M. Silva, T. Molloy, E.B. Mallory, J. Crawford, and V.M. Moore. 2025. Organic dry bean cultivar evaluation in the Northeast and Upper US Midwest: Opportunities for growers and food systems. Agronomy Journal, 117:e70195. https://doi.org/10.1002/agj2.70195.

Favetti, B.M., T.L. Braga-Santos, A. Massarolli, A. Specht, and A.R. Butnariu. 2017. Pearl millet: a green bridge for lepidopteran pests. Journal of Agricultural Science, 9:92–97. https://doi.org/10.5539/jas.v9n6p92.

Fernandez, M.R., P. Lokuruge, L. Abdellatif, N. Waelchli, J.Y. Leeson, M.P. Schellenberg, and S. Chalmers. 2025. Intercropping of oat or mustard with legumes under organic management in the semiarid Canadian Prairie. Agronomy Journal, 117:e70056. https://doi.org/10.1002/agj2.70056.

Ganjisaffar, F., B.E. Gress, M.R. Demkovich, N.L. Nicola, J.C. Chiu, and F.G. Zalom. 2022. Spatio-temporal variation of spinosad susceptibility in *Drosophila suzukii*, a three-year study in California's Monterey Bay region. Journal of Economic Entomology, 115:972-980. https://doi.org/10.1093/jee/toac011.

George, J., G.V.P. Reddy, P.A. Wadl, W. Rutter, J. Culbreath, P.W. Lau, T. Rashid, M.C. Allan, S.D. Johaningsmeier, A.M. Nelson, M.L. Wang, A. Gubba, K.S. Ling, Y. Meng, D.J. Collins, S.K. Ponniah, and P.H. Gowda. 2024. Sustainable sweetpotato production in the United States: Current status, challenges, and opportunities. Agronomy Journal, 116:630-660. https://doi.org/10.1002/agj2.21539.

Herreid, J.S., T.A. Rand, D.M. Cockrell, F.B. Peairs, and R. Jabbour. 2024. On-farm harvest timing effects on alfalfa weevil across the Intermountain West region of the United States. Frontiers in Insect Science, 4:1324044. https://doi.org/10.3389/finsc.2024.1324044.

Hurisso, T.T., J.G. Davis, F.H. Stonaker, D.A. Goldhamer, and J.E. Brummer. 2024. Comparison of dairy manure versus compost effects on short-term nitrogen mineralization and microbial biomass in organic annual forage production system. Agrosystems, Geosciences & Environment, 7:e20555. https://doi.org/10.1002/agg2.20555.

Jackson, M.D., and H.F. Harrison Jr. 2008. Effects of a killed-cover crop mulching system on sweetpotato production, soil pests, and insect predators in South Carolina. Journal of Economic Entomology, 101:1871–1880. https://doi.org/10.1603/0022-0493-101.6.1871.

Jernigan, A.B., J. Kao-Kniffin, S. Pethybridge, and K. Wickings. 2024. Microarthropods improve oat nutritional quality and mediate fertilizer effects on soil biological activity. Agronomy Journal, 116:2007-2033. https://doi.org/10.1002/agj2.21597.

Kelley, W.T., G. MacDonald, and S.C. Phatak. 2009. Commercial Production and Management of Carrots. University of Georgia Extension. https://fieldreport.caes.uga.edu/publications/B1175/commercial-production-and-management-of-carrots/.

Koziol, L., and J.D. Bever. Crop Productivity Boosters: Native Mycorrhizal Fungi from an Old-Growth Grassland Benefits Tomato (*Solanum lycopersicum*) and Pepper (*Capsicum annuum*) Varieties in Organically Farmed Soils. Microorganisms, 11:2012. https://doi.org/10.3390/microorganisms11082012.

Lazicki, P., D. Geisseler, and M. Lloyd. 2020. Nitrogen mineralization from organic amendments is variable but predictable. Journal of Environmental Quality, 49:483-495. https://doi.org/10.1002/jeq2.20030.

Levenson, H.K., S. Van Timmeren, A. Babu, R. Isaacs, A.A. Sial, V. Walton, and H.J. Burrack. 2025. Crop edge sampling and early life stage detection for improved monitoring of spotted-wing drosophila, *Drosophila suzukii* (Diptera: Drosophilidae), in berry crops. Journal of Economic Entomology, 118:2951-2958. https://doi.org/10.1093/jee/toaf122.

Littrell, J.J., B.H. Ownley, and D.M. Butler. 2024. Unraveling the interplay: Soil biogeochemical factors shaping the efficacy of anaerobic soil disinfestation in suppressing Fusarium root rot of strawberry. Phytopathology, 114:1782-1790. https://doi.org/10.1094/PHYTO-09-23-0323-R.

Littrell, J.J., B.H. Ownley, Z.R. Hansen, K.D. Gwinn, and D.M. Butler. 2025. Role of organic amendment composition and soil texture in modulating volatile fatty acids, Fe/Mn reduction, and Fusarium oxysporum suppression during anaerobic soil disinfestation in neutral to alkaline soils. Phytopathology, 115:1134-1144. https://doi.org/10.1094/PHYTO-12-24-0423-R.

Liu, D., J. Samtani, C. Johnson, X. Zhang, D.M. Butler, and J. Derr. 2023. Brewer's spent grain with yeast amendment shows potential for anaerobic soil disinfestation of weeds and Pythium irregulare. Agronomy, 13:2081. https://doi.org/10.3390/agronomy13082081.

Liu, D., J.B. Samtani, and D.M. Butler. 2025. Effect of anaerobic soil disinfestation with yeast amendment on weed control and strawberry yield. HortScience, 60:1510-1520. https://doi.org/10.21273/HORTSCI18692-25.

Lynch, D.H., R.P. Voroney, and P.R. Warman. 2004. Nitrogen availability from composts for humid region perennial grass and legume-grass forage production. Journal of Environmental Quality, 33:1509-1520. https://doi.org/10.2134/jeq2004.1509.

Menalled, U.D., S.J. Pethybridge, C.J. Pelzer, R.G. Smith, A. DiTommaso, and M.R. Ryan. 2021. High Seeding Rates and Low Soil Nitrogen Environments Optimize Weed Suppression and Profitability in Organic No-Till Planted Soybean. Frontiers in Agronomy, 3:678567. https://doi.org/10.3389/fagro.2021.678567.

Neelipally, R.T.K.R., A. Chhetri, D. Saha, S. Cui, and S. Jagadamma. 2025. Agronomic responses of transitioning organic grain rotations employing multi-tactic tillage and cover cropping strategies. Agronomy Journal, 117:e70095. https://doi.org/10.1002/agj2.70095.

Ono-Raphel, J.G., G.F. Custer, K. Arrington, B. Morrison, J. Kaye, E. Rosskopf, F. Dini-Andreote, and F. Di Gioia. 2025. Effects of carbon sources on soil bacterial community dynamics during anaerobic soil disinfestation in an organic tomato production system. Agriculture, Ecosystems and Environment, 381:109448. https://doi.org/10.1016/j.agee.2024.109448.

Orloff, S., and D. Putnam. 2004. Balancing yield, quality, and persistence. Proceedings, National Alfalfa Symposium. Davis, CA: University of California Cooperative Extension.

Osterholz, W., S. Culman, C. Herms, and D. Doohan. 2025. Weed control approach but not fertility source influenced yield and weed populations during grain-based transition to organic production. Agronomy Journal, 117:e70038. https://doi.org/10.1002/agj2.70038.

Panthi, B., K.R. Cloonan, C. Rodriguez-Saona, B.D. Short, D.M. Kirkpatrick, G.M. Loeb, N.C. Aflitto, N. Wiman, H. Andrews, F.A. Drummond… and A.A. Sial. 2022. Using Red Panel Traps to Detect Spotted-Wing Drosophila and its Infestation in US Berry and Cherry Crops. Journal of Economic Entomology, 115:1995-2003. https://doi.org/10.1093/jee/toac134.

Pellegrino, A.M., A.L. Woodley, and A.S. Huseth. 2021. Understanding the Relationship Between Wireworm (Coleoptera: Elateridae) Damage, Varietal Resistance, and Cover Crop Use in Organic Sweetpotato. Journal of Economic Entomology, 114:2127-2134. https://doi.org/10.1093/jee/toab118.

Pierre, J.F., K.L. Jacobsen, A. Wszelaki, D. Butler, M. Velandia, T. Woods, R. Sideman, J. Grossman, T., Coolong, B. Hoskins, A.L.B.R. da Silva, P. Ginakes, M. Kleinhenz, X. Zhao, C. Rivard, and R.E. Rudolph. 2024. Sustaining Soil Health in High Tunnels: A Paradigm Shift toward Soil-centered Management. Hort Technology, 34:594-603. https://doi.org/10.21273/HORTTECH05460-24.

Ray, P., V. Lakshmanan, J.L. Labbé, and K.D. Craven. 2020. Microbe to Microbiome: A Paradigm Shift in the Application of Microorganisms for Sustainable Agriculture. Frontiers in Microbiology, 11:622926. https://doi.org/10.3389/fmicb.2020.622926.

Robertson, G.P., T.W. Bruulsema, R.J. Gehl, D. Kanter, D.L. Mauzerall, C.A. Rotz, and C.O. Williams. 2013. Nitrogen–climate interactions in US agriculture. Biogeochemistry, 114:41-70. https://doi.org/10.1007/s10533-012-9802-4.

Salahuddin, M.D., V. Balan, K.G. Stamps, A.A.A. Abdel-Wareth, M. Mohammadi, W.K. Kim, W. Zhu, and J. Lohakare. 2025. Harnessing mushrooms for poultry nutrition: Boosting health, immunity, and productivity. Poultry Science, 104:105223. https://doi.org/10.1016/j.psj.2025.105223.

Salehin, S.M.U., N. Rajan, J. Mowrer, K.D., Casey, P. Tomlinson, A. Somenahally, and M. Bagavathiannan. 2025. Cover crops in organic cotton influence greenhouse gas emissions and soil microclimate. Agronomy Journal, 117:e21735. https://doi.org/10.1002/agj2.21735.

Singh, S., M. Cutulle, W. Rutter, P.A. Wadl, B. Ward, and C. Khanal. 2025. Anaerobic Soil Disinfestation as a Tool for Nematode and Weed Management in Organic Sweetpotato. Agronomy, 15:548. https://doi.org/10.3390/agronomy15030548.

Shrestha, U., B.H. Ownley, A. Bruce, E.N. Rosskopf, and D.M. Butler. 2021a. Anaerobic soil disinfestation efficacy against *Fusarium oxysporum* is affected by soil temperature, amendment type, rate, and C:N ratio. Phytopathology, 111:1380-1392. https://doi.org/10.1094/PHYTO-07-20-0276-R.

Shrestha, U., K.J. Swilling, and D.M. Butler. 2021b. Amendment properties affect crop performance, leaf tissue nitrogen, and soil nitrogen availability following soil treatment by anaerobic soil disinfestation. Frontiers in Sustainable Food Systems, 5:694820. https://doi.org/10.3389/fsufs.2021.694820.

Stahl, J.M., X. Wang, P.K. Abram, A. Biondi, M.L. Buffington, K.A. Hoelmer, M. Kenis, F. Lisi, M.V. Rossi-Stocconi, M.L. Seehaausen, A. Vossen, W.H.L. Wong, and K.M. Daane. 2024. *Ganaspis kimorum* (Hymenoptera: Figitidae), a promising parasitoid for biological control of *Drosophila suzukii* (Diptera: Drosophilidae). Journal of Integrated Pest Management, 15:44. https://doi.org/10.1093/jipm/pmae036.

Sterle, D.G., F. Stonaker, S. Ela, and J.G. Davis. 2021. Cyanobacterial Biofertilizer as a Supplemental Fertilizer for Peaches: Yield, Trunk Growth, Leaf Nutrients and Chlorosis. Journal of the American Pomological Society, 75:165-174. https://www.pubhort.org/aps/75/v75_n3_a5.htm.

Sukor, A., F.S.M. Amer, J. Vanamala, and J.G. Davis. Phytohormones in organic fertilizers influence β-carotene concentration and marketable yield of lettuce (*Lactuca sativa*). Acta Horticulturae, 1348:15-22. https://doi.org/10.17660/ActaHortic.2022.1348.2.

Tabuloc, C.A., C.R. Carlson, F. Ganjisaffar, C.C. Truong, C.H. Chen, K.M. Lewald, S. Hidalgo, N.L. Nicola, C.E. Jones, A.A. Sial, F.G. Zalom, and J.C. Chiu. 2024. Transcriptome analysis of *Drosophila suzukii* reveals molecular mechanisms conferring pyrethroid and spinosad resistance. Nature Scientific Reports, 14:19867. https://doi.org/10.1038/s41598-024-70037-x.

Tait, G., S. Mermer, D. Stockton, J. Lee, S. Avosani, A. Abrieux, G. Anfora, E. Beers, A. Biondi, H. Burrack… and V.M. Walton. 2021. *Drosophila suzukii* (Diptera: Drosophilidae): A Decade of Research Towards a Sustainable Integrated Pest Management Program. Journal of Economic Entomology, 114:1950-1974. https://doi.org/10.1093/jee/toab158.

Temmen, D., J. Randall, and I. Popova. 2023. Utilization of mustard seed meal extract for improving soil health in a small-scale organic potato cropping system. Communications in Soil Science and Plant Analysis, 54:345-355. https://doi.org/10.1080/00103624.2022.2112596.

USDA NASS. 2018. 2017 Census of Agriculture. www.nass.usda.gov/AgCensus.

Villarino, S.H., P. Pinto, R.B Jackson, and G. Piñeiro. 2021. Plant rhizodeposition: A key factor for soil organic matter formation in stable fractions. Science Advances, 7:eabd3176. https://doi.org/10.1126/sciadv.abd3176.

Wenz, J., J.G. Davis, and H. Storteboom. 2019. Influence of light on endogenous phytohormone concentrations of a nitrogen-fixing *Anabaena* sp. cyanobacterium culture in open raceways for use as fertilizer for horticultural crops. Journal of Applied Phycology, 31:3371-3384. https://doi.org/10.1007/s10811-019-01856-z.

Wickham, A., and J.G. Davis. 2023. Optimizing organic carrot (*Daucus carota* var. sativus) yield and quality using fish emulsions, cyanobacterial fertilizer, and seaweed extracts. Agronomy, 13:1329. https://doi.org/10.3390/agronomy13051329.

Woodard, A.J., J.R. Schultheis, K.M. Jennings, A.L. Woodley, and D.H. Suchoff. 2024. Horizontal planting orientation can improve yield in organically grown sweetpotato. Hort Science, 59:36-42. https://doi.org/10.21273/HORTSCI17352-23.

Yeh, D.A., B. Dai, M.I. Gómez, and V.M. Walton. 2024. Does monitoring pests pay off? a bioeconomic assessment of *Drosophila suzukii* controls. Pest Management Science, 80:708723. https://doi.org/10.1002/ps.7801.

Yoder, N., and J.G. Davis. 2020. Organic fertilizer comparison on growth and nutrient content of three kale cultivars. HortTechnology, 30:176-184. https://doi.org/10.21273/HORTTECH04483-19.