Ongoing Research at DREC
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Winter 2017 Update

1) Major activities completed: Experiments conducted: Field experiments were established to investigate impacts of hay mulch and arbuscular mycorrhizal fungi (AMF) inoculant on onion, table beet, winter squash, and sugar snap pea yield in an organic vegetable production system. These experiments were located in Dickinson and Absaraka, ND. 'Mycogrow' AMF inoculant (Fungi Perfecti, LLC, Olympia, WA) was applied in a water solution at a rate of 7.4 g L-1 to half the plots after planting crops. This inoculant contained AMF species Glomus intraradices, Glomus mosseae, Glomus aggregatum, and Glomus etunicatum. Hay mulch from square bales was applied after crop emergence in a layer that was approximately 15 cm deep. Weeds were removed from all plots on a timely basis, so yield differences among treatments were due to factors other than crop-weed competition.

2) Data collected: Weed density and weed seedbank density were quantified. Time required for weed removal was recorded. Neither site was irrigated but rainfall was fairly frequent at both sites. Both sites were fertilized with chicken (Absaraka) or cow (Dickinson) manure to prior to planting. Soil from each plot was tested for N-P-K and although variation across plots was great, nutrients were present in adequate amounts for vegetable production. Peas were harvested every two to three days during July. Beets were harvested mid-August. Onions were harvested in mid-September and squash were harvested in mid-October. Soil cores were collected from each plots and sent to Cornell for soil health analysis that included assessment of wet aggregate stability, active carbon, and soil respiration.

3) Summary statistics and discussion of results: The hay mulch almost completely suppressed weed emergence whereas weed pressure in the bare plots was considerable. Bare plots required substantially more weeding time than the mulched plots. Over time (from 2015 to 2017) weed seedbank density decreased at the Absaraka site for both mulched and tilled plots, but the effect was much more pronounced among the mulched plots. At the Dickinson site, from 2015 to 2017, weed seedbank density remained the same for mulched plots, but increased substantially for tilled plots. At the Absaraka site, crop grown in mulched plots produced greater yield than crop grown without mulch under conventional tillage. At Dickinson, most crops failed due to a combination of drought and damage caused by rodents. Only the onion crop at Dickinson was harvested for yield, and similar to the Absaraka site, mulched onions produced greater yield than onions grown without mulch under conventional tillage. At Absaraka, wet aggregate stability increased over time (from 2015 to 2017) for mulched plots, but remained the same for tilled plots. At Dickinson, wet aggregate stability increased over time for both mulched and tilled plots, but the effect was much more pronounced for mulched plots. At Absaraka, active carbon increased over time in mulched plots only. At Dickinson, active carbon decreased over time regardless of tillage/mulch. At both sites, soil respiration was greater for mulched plots than for tilled plots. AMF inoculation did not impact any measures of crop yield, weed community extent, or soil health indicators.

4) Key outcomes or other accomplishments realized: Via presentations of research results at scientific meetings, researchers learned about the key results produced by this research. Via talks at field days, farmers, gardeners, and extension personnel learned about the results of this research.

Project 1. Reintegration of Sheep Grazing Into Dryland Organic Farms

This is a USDA-OREI funding project that is being conducted in collaboration with Montana State University. As part of a larger project, we are assessing the effect of no-till management with sheep grazing on weed management, in comparison to a conventionally tilled system. We began data collection during the summer of 2013 and 2016 was the last year of data collection. Treatment effects on weed management are assessing by quantifying both weed seed bank and realized above-ground weed communities. Peer-reviewed publications from this research will forthcoming following the completion of the project, but initial results suggest that no-till with sheep grazing is not an effective weed management approach in this region where short growing seasons prevent establishment of highly productive cover crops.

Project 2. Tillage and AMF Inoculant Impacts on Organic Vegetable Production in the Upper Great Plains

This is a project funded by The Ceres Trust. Two critical issues in organic vegetable crop production are weed management and soil health (or quality). Typically, organic farmers rely heavily on tillage to manage weeds. However, excessive tillage can damage soil physical properties and the microbiological community. This community (including arbuscular mycorrhizal fungi, or AMF) provides critical ecosystem functions that enhance nutrient and water uptake by crop plants. Previous research has demonstrated that reductions in tillage enhance diverse communities of AMF and other soil microbiota, while other research has indicated that the use of inoculants can increase crop growth and yield. Few, if any, studies have specifically asked what the value of AMF inoculation is under different tillage regimes in the Upper Great Plains. We will determine the impact of inoculating vegetable plants with an organically certified blend of AMF species on weed community dynamics, soil health, plant health, and overall profitability in two contrasting organic production environments: a tilled system vs. a no-till system that relies on legume hay mulch for weed suppression.

Initial work began during the summer of 2015. During the summer of 2015, numerous measurements and samples were taken from these experiments. A graduate student and a summer worker supported by the Ceres Trust grant were involved in all aspects of the field work. We sampled the soil to measure the soil weed seed bank. We quantified the weed populations at emergence and later at the peak of the growing

season. We sampled crop roots to analyze for AMF colonization. We sampled soil to be analyzed for phospholipid fatty acid (PLFA) analysis. This analysis will show the composition of the soil microbial community. We sampled soil to determine soil respiration. We also collected crop leaf tissue for plant nutrition analysis. Finally, we determined final yield for all crops.

Soil samples taken for PLFA analysis were sent to Ward Laboratories in NE for analysis. We have received the results of this analysis, which showed great variability in the soil microbial community across the field. Plots in Absaraka where onions were grown were affected by a soil borne fungal pathogen called fusarium basal rot. The disease especially affected onions in the non-mulched plots. Some of these plots suffered near-total yield loss. The mulch likely stopped splashing rain drops from spreading the disease and so far fewer onion bulbs were lost in the mulched plots. The mulch harbored small rodents that chewed on the winter squash fruits. Some fruits in all plots were damaged, but the damage was greater for squash growing in mulched plots. In general, yields were much greater at the Absaraka site than the Dickinson site. This is probably due to soil and rainfall differences between these two sites. Preliminary results indicate that the no-till system is beneficial for some vegetable crop types (beets and onions) but detrimental because of rodent damage for winter squash and largely neutral for snap peas. Peer-reviewed publications from this research will forthcoming following the completion of the project.

Project 3. Mulch and Biochar Impacts on Organic Strawberry Establishment

This project is funded with NDSU Agricultural Experiment Station research appropriated funds. Strawberries grown in organic systems are commonly mulched with hay/straw or plastic. Although hay/straw mulches add organic matter to the soil, they are unstable in windy conditions, harbor weed seeds, and encourage pests such as slugs. Plastic mulches efficiently suppress weeds; however, plastic does not biodegrade, thus presenting a disposal problem. Effective weed management is crucial for perennial strawberry production and the common mulching products pose weaknesses; therefore, introducing novel mulch materials would benefit producers. Diseases also pose a threat to strawberry production. Biochar has been shown to increase resistance to some diseases and improve growth and yield of strawberry plants.

Field trials were conducted at the NDSU Horticulture Research Farm in Absaraka, ND and at the Dickinson Research Extension Center in Dickinson, ND, to examine the ability of three organic mulch materials and pine-derived biochar to aid in perennial strawberry production. In early June 2015, Cavendish variety bare root strawberries were transplanted into prepared beds at both sites. The experimental design was a 2

(biochar vs. no biochar) x 4 (alfalfa hay, paper, hemp hurd, or no mulch) factorial arranged in a randomized complete block. To establish a perennial matted row system, flowers were removed to encourage runner production and vegetative growth. Weed biomass, flower production, leaf number, runner production, and soil water content were measured throughout the growing season. Because weeds were removed, crop-weed competition did not occur, therefore, differences between mulch treatments were due to other factors.

Soil temperature and volumetric water content did not differ among any treatments, indicating that mulch and biochar treatments indirectly impacted strawberry growth via some other factor. At Absaraka, hay-mulched strawberry plants produced fewer flowers than plants grown in bare soil or with paper or hemp mulch. At Dickinson, strawberry plants grown with hay mulch and in bare soil produced fewer flowers than plants grown with paper or hemp mulch. Biochar was associated with decreased flower counts at Dickinson, but did not impact other measures of strawberry growth. Hay mulch was associated with fewer strawberry leaves compared to bare soil or paper or hemp mulch. Strawberry plants mulched with paper or hemp produced greater numbers of runners than plants grown in bare soil or mulched with hay. All mulches suppressed weeds equally well compared to bare soil. Peer-reviewed publications from this research will forthcoming following the completion of the project.

2016 Publications

Hogstad S, Gramig G, Carr P. 2016. Mulch and biochar impacts on organic strawberry establishment. Proceedings of the 69th Annual Meeting of the Western Society of Weed Science (22).

Gramig G, Carr P. 2016. Investigating the potential of hay mulch and AMF inoculant for small-scale organic vegetable production. Proceedings of the 69th Annual Meeting of the Western Society of Weed Science (21).

Gramig G, Carr P. 2016. Hay mulch and mycorrhizae inoculation impacts on organic onion performance. MOSES Organic Farming Conference Research Forum.

2017 Publications

Beamer KP, Gramig GG, Carr PM. 2017. Arbuscular mycorrhizae inoculation and tillage impacts on organic vegetable production. MOSES Organic Farming Conference. February 23-25, La Crosse, WI.

Hogstad SK, Gramig GG, Carr PM. 2017. Weed communities shift in response to organic no-till integrated with grazing. Weed Science Society of America Annual Meeting, March 6-9, Tucson, AZ. 57:143.

Hogstad SK, Gramig GG. 2017. Mulch and biochar impacts on organic strawberry yield. Weed Science Society of America Annual Meeting, March 6-9, Tucson, AZ. 57:68.