Conservation tillage for organic cabbage: Yield, weed growth, and management costs

Final Report for FNE12-736

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Region: Northeast
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Project Leader:

Janna Berger
Adamah/Isabella Freedman Jewish Retreat Center

Co-Leaders:

Arthur Schwab
Adamah / Isabella Freedman Jewish Retreat Center

Project Information

Summary:

Soil erosion caused by agriculture can cause reduced productivity and environmental problems. Minimizing tillage can reduce erosion but is difficult to manage in organic vegetable production systems. Our experiment tested the viability of organic cabbage production in untilled hairy vetch. We measured yield, head size, and weeding time for tilled and no-till plots for three cabbage varieties (Chinese, green, and red). We found no significant differences in total yield (avg 60 kg / 100 sq ft) or number of heads (avg 23 heads / 100 sq ft) between any treatments. Weeding took somewhat longer ($p<0.1$) for tilled plots (avg 260 min / 100 sq ft, vs. 144 min for no-till plots) and tilled plots of red cabbage (4.0 kg / head) and no-till plots of green cabbage (3.4 kg / head) had significantly higher ($p<0.05$) head sizes than other treatments (avg 2.1 kg / head). These results show that organic no-till cabbage might be effectively produced without increases in labor costs or decreases in yield. We recommend larger scale production of this experiment that incorporate mechanized cultivation to test these results.

Introduction:

Soil erosion is a widespread problem in agriculture, both on sloped upland fields and in flood prone areas. Annual, organic vegetable production is among the most vulnerable cropping systems because the frequent tillage used for cover crop and vegetable incorporation as well as mechanical weed control damage the soil structure and leave it exposed to direct raindrop impacts, further exacerbating the movement of soil particles.

This issue is one of the reasons that cover crops are so widely used on diversified

organic vegetable farms. By protecting the soil when vegetables are not in the fields, especially during spring snow melt, cover crops prevent a great deal of soil damage and add organic matter to the soil, improving the structure. However, there remain periods when the soil is almost entirely bare of plants: primarily before and after planting as well as following harvest of some crops.

There are a number of agricultural practices which can further mitigate the risk of soil erosion, some of which are in fairly widespread use of organic vegetable farms. Straw and black plastic mulch are often used to control weeds and warm the soil for hot weather crops and cover crops may be inter-seeded into existing crop stands eliminating the bare period following harvest and field clean up. Reduced and no-till practices are widely used on conventional grain farms but are not commonly used on organic vegetable farms due to the difficulty of controlling weeds without herbicides and the complexity of their management in diversified fields and rotations.

Plastic and straw mulch have the disadvantage of being labor intensive to install, and remove in the case of plastic mulch, while inter seeded cover crops do not protect the soil before planting and during establishment of the cash crops. Reduced tillage of winter cover crops has the potential to protect the soil during these vulnerable times and possibly reduce weed pressure and provide beneficial insect habitat. That said, weeds that do establish will be more difficult to remove and the matt of vegetation may prove to harbor fungal pathogens in moist conditions.

The diversity of field conditions and of vegetable crop needs mean that relatively simple cover crop mulch management, like that seen in larger fields of agronomic crops, may prove difficult on smaller organic vegetable farms. That said, general guidelines, incorporation factors like crop species, weed control, and management time, would be indispensable for farmers making a wide range of unique decisions. We hope that this experiment serves as one piece of this developing system.

Project Objectives:

This project will help other farmers by assessing the feasibility of zone tilled and no-tilled organic cabbage in terms of their effect on yield and management costs relative to conventionally tilled organic cabbage. Many farms in the Northeast are located on sloped land or in floodplains and it is easy to see soil loss in eroded channels on tilled hillsides or after overland floods. While the costs of soil loss are high in the long run and motivate many farmers to employ conservation practices already, the short term cost of these practices, such as reducing tillage, must maintain the farms year-to-year financial viability. If we find that zone tilled or no-tilled organic cabbage out-yield the conventionally tilled control and require less labor during production then the choice is an easy one for us, and other farmers, to make going forward. However, it could also be that we see a reduction in yield or increase in management cost in the conservation tillage treatments. If this were to be the case, it will be essential for farmers to know the short-term cost of their long-term conservation practices. By measuring these effects, this research will allow farmers to compare the costs and benefits of conservation tillage for organic cabbage both to conventional tillage and to other conservation practices they might undertake or already implement.

Outreach will be accomplished both by educating the participants in Adamah's sustainable agriculture fellowship and other visitors on-site and reaching the greater farming community through conference presentations or poster (at the NOFA summer conference and state specific NOFA winter conferences) and the dissemination of a short summary bulletin. By educating our fellows in research

methods and conservation tillage practices, they will be able to take this knowledge into the larger world after they leave the program. The summary bulletin will be available on our website, as a hard copy when we present the results and on-site at Adamah, and be submitted to the CT-NOFA newsletter as an article. We will also share the results of this experiment with our email network of alumni, many of whom work at other farms, and with other researchers, whether farmers or professionals, who are working in the area of conservation tillage in organic agriculture. We will share our raw data and analysis thereof with anyone who would like to use it.

Research

Materials and methods:

We planted three varieties of cabbage (green, red, and Chinese) in two locations this spring. Each location was planted with hairy vetch cover crop the previous fall and had three replications with two tillage treatments (no-till and full tillage) for each variety arranged in a randomized complete block. Unfortunately, we lost one entire location to deer damage in the summer and ended up with only one viable location as a result. We recorded the time it took to weed all plots and the final harvest weight for each cabbage variety and treatment as well as the number of harvestable heads. We had originally wanted to do a more complicated experiment than we ended up doing in several ways. We wanted to have an additional tillage treatment (strip tillage) but the tiller we had planned to use for strip tillage pulled all of the cover crop off of the entire plots so we decided to only do two treatments. We had also originally proposed to measure weed density and soil nitrogen but found the logistics too dificult to do during the season.

In the last week of June, 2015, we transplanted planted red, green, and Chinese cabbage - three rows, 18 inches apart in row. In the no-till plots, we used a trowel to dig a small hole for the transplants. The plots were 5 feet wide and each plot was 20 ft long. Each plot was weeded as necessary throughout the season (between 7/29/2015 and 9/5/2015) with each blocks fully weeded on the same or consecutive days. We harvested the cabbage on 9/15/2015, 10/6/2015, and 10/23/2015 as the heads were ready. At harvest, we measured the number of heads and their weight.

Total yield (kg), head count, and weeding time (minutes) were analyzed using two factor ANOVA (analysis of variance). See attached summary data with analysis (outcomes and impacts section).

Research results and discussion:

During the growing season, our general impression of the experiment was that cabbage in the tilled plots grew more quickly and looked larger than in the untilled. Our yeild data supports this observation but the statistical results show very few significant differences between treatments (see figures in attached "summary data with analysis" spreadsheet).

Overall weight and head counts were not significantly different between any treatments (avg 60 kg and 23 heads / 100 sq ft). Head counts were very similar for all treatments but overall yield was higher in tilled plots for Chinese cabbage (45 kg / 100 sq ft vs. 38 kg untilled) and red cabbage (90 kg / 100 sq ft vs. 47 kg untilled) but lower in green cabbage (53 kg / 100 sq ft vs. 84 kg in untilled). While yield differences were not significant, they do fit with our in-season impression that the

cabbage in the tilled plots looked better overall.

Although tilled red cabbage (4.0 kg / head) had larger heads ($p<0.05$) than no-till (2.1 kg / head), the opposite was true in green cabbage (2.3 kg / head vs. 3.4 kg / head in no-till plots). We also found that the tilled plots took longer to weed (260 min vs. 144 min in no-till plots) but the difference was only somewhat significant ($p<0.1$). We did all of our weeding using hand tools (hoes and hands) and with tractor cultivation (difficult in no-till plantings) it is possible that this difference would disappear or invert.

Experimental data and summary with statistical analysis are attached.

- summary data with analysis
- weeding data
- yield data

Participation Summary

Education & Outreach Activities and Participation Summary

PARTICIPATION SUMMARY:

Education/outreach description:

We produced at poster presentation which we displayed in the CT NOFA winter conference exhibit hall. We will display the poster in our farm kitchen. We host other Connecticut farmers for farm tours once a year through the Western Connecticut CRAFT program. We have shared our research process in past years and will discuss our results at this session. Many non-farmers (e.g. ecology students and other school groups) also visit our farm and by keeping the poster up we will be able to share our research results and process with with people who may work with farmers or go into farming in the future.

Attached is a pdf of our poster which is freely available for others to use in whole or in part.

- cabbage poster

Project Outcomes

Assessment of Project Approach and Areas of Further Study:

Future Recommendations

The results of this experiment provide us with optimism. The fact that we did not find many significant treatment differences supports the possibility that organic cabbage could be profitably produced in reduced tillage systems. However, one of the difficulties of doing research on a small farm is that despite cabbage being an important crop for us (we make sauerkraut and sell fresh cabbage) it does not take

up enough of our land to have each of eighteen plots as a full bed. In designing a similar experiment in the future, we would recommend reducing the number of treatments (one or two cabbage varieties instead of three) and locating it in a field section with short beds so that each plot would be a complete bed. This would allow the treatment of each tilled bed normally (possibly including a small ammount of tractor cultvation) and increase the size of each plot to accentuate treatment differences.

We hope to try growing no-till cabbage in the 2015 season, using one variety (likely green cabbage, which performed best in this experiment) to see if we see similar result to what we saw in 2014.