Mechanical approaches to perennial weed suppression in organically established no-till cover crops

Final Report for FNE12-741

Project Type: Farmer
Funds awarded in 2012: $8,879.00
Projected End Date: 12/31/2014
Region: Northeast
State: New Hampshire
Project Leader:

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Project Information

Summary:

This project proposed to use a yeoman's plow with large and adjustable swept undercut bars fitted with a heavy coulter to test two main approaches. The first approach was to set the undercut bar just below the top sod root layer to further weaken or kill the sod before organic no-till drilling of spring and winter covercrops, and later no till planting of corn, sunflowers, or soybeans. The second approach was to set the coulter to make one slice through the rolled mulch layer and undercut perennial weeds just below the mulch while leaving the mulch layer largely in place. This project trialed several dates, sod and mulch conditions and different depths and plow/cultivator setups.

The results of the trial are mixed. Quantitative data from 2013 Corn plots in comparison with conventional tillage, no-till, and strip till methods is included with this report. Although one year's data is not particularly helpful, because the desired outcome has much more to do with longer term soil health than annual corn yield, but it was interesting to note that the yeoman's treatments were grouped with the other no-till and strip till treatments. Quantitative data from 2012 trials was not feasable because of either low yield and/or deer damage to plots.

Initial observations of the equipment functioning in the field indicate that there are some conditions where the technique may be made more effective in the pre-planting strip till type treatment, and that undermulch "sweeps" could be effective with some changes to the equipment design and tractor setup to improve accuracy durring cultivation. Recomended changes and associated 3D sketchup drawings are provided as part of this report. The proposed improved tool design, which is essentially a sweep plow design, is posted to http://farmhack.net/node/1255 as part of ongoing project dissemination.

Although just one year's data, the data bellow shows that the no-till treatments had the lowest soil moisture levels, but the yeoman's treatment was not significantly different than any other treatments. Weed levels were not significantly different from other treatments exept for the full tillage and glyphosate no-till treatment with

interseeding. Corn yield using the yeoman’s undercut method was not significantly differant than the organic no-till or strip till methods or no-till with glyphosate only (without legume interseeding). In conclusion, it is clear that more refinement of methods and equipement is needed, but that results are promising enough to try again with those adjustiments.

- Corn Yield Standard Deviation
- Corn plots weed standard deviation
- kingman_corn_plots_moisture_ SD.JPG
- Corn Plot Data Kingman

Introduction:

Project Objectives:

The objectives and operational performance targets of this trial as laid out in the proposal were as follows:
Stage 1) Planning and procurement of appropriate varieties and amendments
Stage 2) Plot layout, planting and treatments
Stage 3) Observation and data collection
Stage 4) Analysis reporting and outreach

Stage one and stage two proceeded well for the objective of sod preparation with some delay in plot layout due to substantial rain in late May. Initial first stage trials in the preparation of sod with the yeoman's plow started on June 9th 2012 at site 1 and continued on the 11th on site two and then ultimately on an alternate site 3 on the 14th of June.

In 2013 a randmoized complete block design trial was designed and planted at UNH's Kingman research farm. Yield data from strip till, yeoman's undercut passes, convential tillage and conventional no-till plantings was compared. Overhead aerial imagery was taken after planting, mid season and prior to harvest in October. Those images were prepared and diseminated in the form of a KMZ file which is viewable using Google Earth.

Cooperators

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Research

Materials and methods:

In 2012 the first site was attempted on June 9th in a rocky Hollis Charlton soil dominated by timothy and orchard grass and some red clover. Depth control and draft requirements were effectively adjusted. Technique for implement steering and control was also documented. Accurate guidance though adjustments to tractor steering was one of the great challenges in following previous rows in a plot or staying within a row during cultivation during the second stage trials in July.

The second first stage site was primarily timothy and orchard grass in a Buxton sandy loam with a heavy three inch sod mat that resisted cutting and had lots of horizontal rooting that bound together tightly. The third site was the most effective and compatible with the technique. It was a sandier well drained soil and primarily an alfalfa clover mixed plant population. This was the one plot that yielded data. The four replications on June 14th included conventional tillage, yeoman’s tillage with and without undercut bars, and an unverferth ripper stripper, and a no-tillage. All treatments were seeded with silage corn (biomass data attached in table format) No yield data was collected on the sunflower treatments due to heavy deer damange on all the plots.

Photo documentation of setup and immediate effects in various sod and mulch conditions will provided the basis for an annotated handbook on approaches to undercutting roots for strip tillage and under mulch cultivation which is published on www.farmhack.net and in a google earth plugin included in this report.

in 2013 the yeoman's setup with undercut bars was incorporated into a larger field trial at Kingman Reasearch Farm. Corn and biomass data from representative samples of those plots was tabulated and will be included in this report. Aerial images of the plots is also included in this report. The images were taken by a low cost unmanned aerial system based on free open source technology. The airframe was a stock Bixler2, with a Cannon A2200 12Megapixel camera mounted in the nose running a CHDK(cannon hacker development kit) intervelometer at ISO 800 and fixed focus at infinity. The images were imported into ArcMap 10.2 as rasters and each plot image was associated with the shape file for each plot. Each plot shape file also had the associated data imported. The resulting layers were then exported to a KMZ file to enable data visualization, access to the data by treatment and plot and to enable clear imaged of the plot cover prior to harvesting.

Research results and discussion:

The impact of these trials has already positively affected approaches to reduced tillage and maintenance of cover and future crop planning on the land managed by the farm. Even before the statistical analysis is done, the importance of soil health and of describing the physical root structure beyond species composition has become very clear. Based on observations from this trial our farm will continue to work towards a higher legume mix with a less matted sod and more species with deeper roots that are more vulnerable to undercutting and not as matted in the first few inches. This type of sod stand fits with a more regular rotation with grains oil seeds and high legume forage and grazing rotations. Another possible outcome is the development of a purpose built implement that is closer to a dryland sweep plow to reduce the draft requirement. Additional anticipated outcome of this work are as follows:

A basic guide to setup and operation of a yeoman’s plow with undercut bars in

various conditions (including moisture level, species composition, time of year, and root structure and above ground growth description) has been started at farmhack.net as a wiki post and can be found here http://farmhack.net/node/1255.

This includes recommended improvements to the equipment to improve effectiveness in various conditions and to improve steerability, and reduce power requirements. There is an ongoing challange in the development of a descriptive vocabulary and approach to describe the above and below ground conditions of the soil and plant community, both living and dead, to classify conditions where the technique has been tried. This will be critical to determine when and in what condition undercutting may be effective and how those conditions and equipment setups are best communicated.

The aerial imagery used to document the different treatment effects is also a significant contribution that has provided a low cost method for analysis of field trials that will likely have implications well beyond the scope of this individual project.

Research conclusions:

The most significant accomplishment is a much greater understanding in the classification and description of the conditions of the cover and root community that is being affected by the type of technique used in this project. For example, an established sod that is primarily shallow rooted and vegitatedly reproductive through rhizomes is more likely to have a highly matted structure and would not be a good candidate for applying this technique. A sod that is largely deeper rooted and less matted and composed primarily of legumes like clover and alfalfa,with a mix of grasses like tomothy and orchard grass would be more appropraite cantidates.

Further research is needed, but it also seems likely that with predominatly cool season forages common in the North East that a late season treatment in July or August might be a better fit. Later in the season the growth cycle is slowing down in and the forage may be more suseptable to water stress then in the type of conditions that this trial encountered. In this scenario the practice might be used for establishing winter crops or even winter kill cover crops with minimal disturbance.

The annotated photographic documentation illustrates many of the particular technical aspects that were discovered. The project resulted in a better understanding of the equipment's function in different field conditions and the importance of tractor and equipment setup. (please see annotated images posted earlier and on Farm Hack for more detail).

In addition to the project specific acomplishments the project also created a clear pathway for next steps and future work both to refine both the tools and biological systems and timing of planting and and other practices. The work also resulted in the unnanticipated but related discoveries of the effectivness of killing hairy vetch with a no-till drill and an improved approach to seeding into standing winter rye and crimping after seeding rather than before.

- Sweep plow recomendation and Yeoman’s plow illustration

Participation Summary

Education & Outreach Activities and Participation Summary

PARTICIPATION SUMMARY:

Education/outreach description:

Dorn Cox presented his work at multiple conferences around the region including Vermont NOFA, NH NOFA and at Univeristy of Maine Grain conferences. The field trials were also shown at on-farm field days in June 2012, August 2012, and August 2013. The material was also shared throughout the University of New Hampshire Agroecology laboratory field days, meetings and presentations and diseminated through soil health workshops in conjunction with joint conservation district and USDA/NRCS events. The documentation is also published in a wiki format at http://farmhack.net/node/1255 with broader discussion about the tool and tool bar design included below.

A Google Earth File with clickable images showing data from each plot - also posted to www.farmhack.net and embeded there.

Project Outcomes

Assessment of Project Approach and Areas of Further Study:

Potential Contributions

The project resulted in the refinement of the plow setup and design for undercutting as well as further developing methods for communicating and sharing equipment design elements, and use in the field. The project also provides a road map for developing more indepth trials to improve understanfing of plant populations and soil health in relationhsip to undercutting as a transition method.

In addition this project helped develop and refine new data collection methods for field trials for analysis and communication of the results using aerial imagery.

This project is also providing a template to use forums and wikis on Farm Hack to facilitate ongoing communication of case studies and tool use that can be ongoing and cumulative and insights and comments from a wider community.

Future Recommendations

This project opened many areas which will require more work, but which are also very promising.
The following are some examples of future trials which could further explore:

- sweep designs - size, angles, coulter setup, rollers
- further analysis of plant populations variations and combinations
- further timings in plant growth stageand treatments
- effects of weather and soil conditions in relationship to the above variables

Future work would likely focus less on the yeoman's shank as the base tool and

more on a more dedicated sweep plow design in conjunction with the other refinements outlined in the annotated photos and above areas of interest.

US Department of Agriculture

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