Agroecosystem Approach to Managing Imported Cabbage Worm (Peris rapae)

Final Report for FW06-025

Project Type: Farmer/Rancher
Funds awarded in 2006: $6,356.00
Projected End Date: 12/31/2006
Region: Western
State: Montana
Principal Investigator:

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Biodesign Farm

Project Information

Abstract:

Imported cabbage worm (ICM) is a pest of broccoli, cabbage, Brussels sprouts and related plants in the mustard family typically managed with insecticides. Research has shown, however, that several naturally occurring predators and parasites can reduce ICW infestations.

Biodesign Farm has designed a high-plant-diversity, reduced-tillage production system to enhance beneficial insect habitat. The farm has used living mulches between vegetable rows since 1995. In 2004, it began to experiment with greater in-field vegetation diversity and reduced tillage, moving to a new field and setting up organic minimum- and no-till plots. In 2006, it designed an experiment to answer these questions:

• Can ICW be managed without the use of pesticides?
• Can ICW be managed by increasing habitat for predators and parasites?
• What are the most effective predators and parasites for ICW?

The experiment evaluated three treatments: unsprayed control, sprayed bimonthly with a pyrethrum/rotenone mix (chosen to impact predators and parasites while not targeting ICW), and sprayed with Bt when ICW larvae reached a threshold level (chosen to target ICW and have little effect on predators and parasites).

Based on crop yields and ICW damage evaluations, management was possible without spraying chemicals. Broccoli and cabbage yields were high and none was deemed unmarketable because of insect injury. Brussels sprouts in unsprayed plots yielded an 88% marketable crop. Where predator populations were disturbed by spraying rotenone-pyrethrum, ICW damage to Brussels sprouts was highest; where predators were not disturbed, damage was lower.

Introduction

Imported cabbage worm (ICM), a pest of broccoli, cabbage, Brussels sprouts and related plants in the mustard family, is the most common and destructive of the

cabbage worms found in the Intermountain West and High Plains regions. Most vegetable producers use insecticides to manage the pest, and even certified organic producers use repeated applications of Bt. Whitney Cranshaw, extension entomologist at Colorado State University, suggests that several naturally occurring predators and parasites, including ground beetles, paper wasps, spiders and parasitic wasps such as Apateles glomeratus, can reduce ICW infestations.

Project Objectives:

- Can ICW be managed without the use of pesticides?
- Can ICW be managed by increasing habitat for predators and parasites?
- What are the most effective predators and parasites for ICW?
- Does the ICW predator/parasite complex change over the season?
- What is the seasonal variation of ICW in Western Montana?

Cooperators

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Research

Materials and methods:

In 1995 and 1996, Biodesign Farm received a Western SARE grant to study methods of managing living mulches to enhance weed, insect and disease management without sacrificing yield. More predators were found in plots where living mulches were mowed compared with bare soil or lightly tilled plots. That led in 1997 to experiments with minimum tillage, and crop yields remained high. In 2000, the farm stopped spraying for Colorado potato beetle and imported cabbage worm. Over the next five years, economic injury from Colorado potato beetle occurred in only one year, and there was no injury from ICW.

In 2004, the farm decided to experiment with more in-field vegetation diversity and reduced tillage in a new location, a 6-acre field designed to enhance beneficial insect and wildlife habitat while still allowing for efficient high-yield vegetable production. The field, in pasture for 50 years, was pastured with 600 sheep (sheep tillage) in 2004. In April 2005, the field was undercut and turned over 4-6 inches deep, disked twice and allowed to dry. The field was disked twice again in May and seeded to a cover crop of triticale and red clover, then mowed to 3 inches in September. The field is virtually weed free with a 600 by 30 foot untilled permanent pasture center separating two 2.5-acre cover-cropped sections. A 600-foot native plant hedgerow consists of Montana native fruiting shrubs, small trees and forbs

(perennial sunflower). The field is surrounded by a 15-foot-wide pasture maintained as a wildlife corridor just outside an 8-foot woven border fence. The new field has been managed organically for 12 years and was certified in 2004.

The experiment was a completely randomized design with three treatments and six replications for a total of 18 3-foot by 50-foot plots, with 10-foot sections between each treatment replication. The three treatments were:

1. Unsprayed control.
2. Sprayed bi-monthly with pyrethrum/rotenone mix. The mix was chosen to comply with organic certification and to have maximum negative effect on predators and parasites and minimum effect on ICW. These plots were sprayed 10 times.
3. Sprayed with Bt (Bacillus thuringensis) when ICW larvae reached a threshold level. These plots were sprayed eight times.

ICW populations were monitored to make sure numbers were high enough to affect the crop, and the amount of ICW damage was measured to determine salable and unsalable parts of the crop. Predator and parasite populations were monitored to see if beneficial insects were present and, if so, whether their presence could be correlated with biological control of ICW.

Research results and discussion:

Based on crop yields and evaluation of damage from imported cabbage worm, the study indicates that acceptable levels of cabbage worm management are possible without spraying chemicals in reduced-tillage vegetable production systems with diverse vegetation. Despite high ICW population pressure in July and August, marketable yields of unsprayed broccoli and cabbage were quite high (broccoli yielded 1,449 pounds from 1,300 plants and cabbage yielded 931 plants from 256 plants). No broccoli or cabbage was deemed unmarketable because of insect damage.

Brussels sprouts in unsprayed plots produced an 88% marketable crop. Brussels sprouts in rotenone-pyrethrum sprayed plots produced fewer marketable sprouts (80%). Fewer predators and fewer predator species were found in these sprayed plots. The plots also showed a decreased predator population after each rotenone-pyrethrum spray. Thus, where predator populations were disturbed with the spray, ICW damage to Brussels sprouts was highest, but where predator populations were not disturbed, the crop damage was lower. Plots sprayed eight times with Bt had the least ICW injury – marketable yield was 97%.

Cabbage aphids, another pest of Brussels sprouts, were also conspicuously absent, resulting in no damage to the crop in 2006, no surprise as the there were high numbers of predators that prey on aphids caught in weekly sweeps.

Broccoli may have escaped ICW injury because of early harvest, which began on June 28 and ended on July 28. Adult cabbage worms did not reach high numbers until July 19, and larval numbers were not high until July 26.
Seasonal population dynamics of pests and predators may be important. Had the first generation population of ICW been as high as the second, marketable yields may have fallen to uneconomical levels. In this system where living mulch between rows is not tilled, predators and other prey, like aphids and thrips, may interact differently from year to year. Many of the generalist predators were preferentially feeding on thrips in the red clover living mulch rather than on ICW, which may account for the higher level of injury to Brussels sprouts in no-till plots compared with cabbage in minimum-till plots.

Yields were very good in minimum-till plots, but were reduced in no-till plots, probably because of cooler soil temperatures, slowly available nitrate-nitrogen and

general plant competition. More work is needed to understand the complex interactions in production systems that increase plant diversity and reduce tillage. This study indicates great potential for pest management using a systems approach.

Participation Summary

Educational & Outreach Activities

PARTICIPATION SUMMARY:

Education/outreach description:

Study data were presented at the Montana Organic Association annual meeting in Missoula Dec. 3, 2006 and the Montana State University Vegetable Pest Management School in Bozeman January 2007. The findings were also scheduled to be presented to the 13-member vegetable producers group, Homegrown, during a February 2007 potluck.

A farm tour was held June 10, 2006, in Bozeman, Gardening with Nature, attended by 30 people, including five farmers and ranchers. A second tour was held September 3, 2006, Conservation Farming Research, attended by 26 people, including 8 farmers and ranchers.

A DVD on the farm’s living mulch, reduced-tillage system was produced with a grant from the local access television station. It was shown in Missoula and sent to the Organic Farming Research Foundation in California.

Project Outcomes

Project outcomes:

Several growers have contacted the project coordinator at the Montana State University extension office to ask for help in integrating predator enhancement into their vegetable production systems. And two farmers have asked for help in developing a living mulch system for their operations.

Recommendations:

Potential Contributions

The study demonstrated that a reduced-tillage increased-diversity system could be designed to provide an economically acceptable biological control for the main pest of cabbage, broccoli and Brussels sprouts, precluding the use of pesticides. In a system designed to enhance biological control, broad-spectrum insecticides like rotenone-pyrethrum provided less pest control than doing nothing at all. This may be because the broad-spectrum insecticide diminished predator populations and was not particularly effective on ICW. In this study, ICW was managed by enhanced habitat for predators and parasites.

The study found a seasonal variation of ICW in western Montana, with populations peaking during the second generation in July. Brassica crops, like early broccoli, harvested before mid July are likely to be less affected by ICW and should require no

spraying in Montana if predators are enhanced by habitat diversification. This could save labor and material for Bt applications (the study participants applied seven Bt sprays based on IPM threshold models, while most local producers make two to five applications).

Future Recommendations

The ICW predator/parasite complex was observed to change over the season, which may have important control implications that merit further study. The main biological control had been expected to come from a specialist parasitic wasp, but parasitism did not seem to be a significant biological control in the study. It may be that designing systems to enhance generalist predators may provide better biological control, even with a specialist type of pest like imported cabbage worm.