Building on Organic Knowledge: On-Farm Transfer of a Trap Cropping Method to Control Lygus Bug in Conventional Strawberry Production

Final Report for FW07-311

Project Type: Professional + Producer
Funds awarded in 2007: $14,864.00
Projected End Date: 12/31/2009
Region: Western
State: California
Principal Investigator:

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Project Information

Abstract:

An on-farm experiment conducted in 2007 at a conventional strawberry ranch in Monterey County under direct management by the farmer cooperator tested the efficacy of insecticide-treated alfalfa trap crops for the reduction of lygus bug (Lygus hesperus Knight) damage in associated, untreated strawberries. This method of lygus bug control was transferred from an earlier successful demonstration of the technique in organic strawberries under management with tractor-mounted vacuums by the same farmer cooperator (Swezey et. al. 2007). Lygus bug abundance was significantly reduced in insecticide-treated trap crops when compared with untreated control trap crops, and damage in adjacent untreated strawberry rows was only slightly increased. Cutting the trap crops for height control and spray penetration was also tested. Cutting for height control was associated with significantly greater lygus bug control in the trap crop and reduction of damage in neighboring strawberries in 2007.

Introduction

California produced over 86% of all strawberries grown in the United States in 2007. California strawberry production is a major state industry, ranking 8th among all state agricultural commodities in 2007 with an estimated farm gate sales value of over $1.3 billion on 34,600 planted acres (CDFA 2008). However, the California strawberry industry faces potential environmental, economic, and social sustainability problems with the use of insecticides in local watersheds of Santa Cruz and Monterey Counties, where over 40% of the strawberries are grown. In 2007, over 120,000 lbs of active ingredient neurotoxic organophosphate (malathion, dibrom, chlorpyrifos, diazinon) and carbamate (methomyl, naled, carbaryl) insecticides (in addition to nearly 2,000 lbs of active ingredient of the synthetic pyrethroid insecticides bifenthrin and fenpropathrin) were applied for insect control, principally to control the damage of one insect: the western tarnished plant bug

(WTPB) or lygus bug, Lygus hesperus Knight, the key economic fruit pest of strawberries in the central coast counties. To attain high production volume, California strawberry growers are responsible for disproportionately high pesticide use rates. California strawberry production used an average of 282 lbs. of active ingredient (AI) pesticides per acre of production in 2007, far exceeding averages for any other California crop (CDPR 2008). In the Pest Management Strategic Plan for Strawberry Production in California (CMCC/CSC 2003), new materials and techniques for controlling lygus bugs were explicitly identified as one of the most critical research needs “to sustain the viability of the California strawberry industry.” Lygus bugs are also explicitly mentioned as a primary pest in the Crop Profile for Strawberries in California (NSF-CIPM 1999).

The feeding of lygus bug nymphs and adults causes distortion of strawberry fruit, which renders the berries unacceptable for fresh market sale. During feeding, lygus bugs destroy developing embryos in achenes (seeds) during early fruit development, thereby preventing growth of fruit tissue beneath and surrounding the damaged achene (Handley and Pollard 1993). Economic thresholds are exceeded at very low lygus bug densities. Unacceptable levels of damage occur at densities of one or two lygus bugs per 20 strawberry plants sampled (Strand 1994). The damage caused by lygus bug feeding on the strawberry fruit is often referred to as “cat-facing” and results in an undersized, cosmetically degraded fruit unacceptable in fresh marketing. Typical control programs can entail 6-8 applications of insecticide per season, often at biweekly calendar intervals (June-September). The cholinesterase-inhibiting OP and carbamate neurotoxins represent a known direct human health hazard to applicators and workers exposed in the fields. Detectable residues of some of these water-soluble insecticides, including diazinon and chlorpyrifos, have been implicated as causes of toxicity to freshwater aquatic organisms in ambient tests of agricultural drainage water in Monterey County.

To protect environmental and human health and reduce or eliminate the use and cost of toxic pest control materials, alternative approaches, such as certified organic production, must be validated and information about these approaches disseminated. For example, in 2007, California organic strawberry growers declared a farm gate sales value of $43.5 million on over 1700 acres. This comprised 5% of California’s total strawberry acreage. From 1999 to 2007, the declared value of California organic strawberries has increased 500% (from $8.7 million declared in 1999), and registered planted acres increased by over 120% (http://www.cdfa.ca.gov/is/i_&_c/organic.html.). This growth has been in response to increasing demand for organic strawberries in California. During this time, we have worked closely with a cooperating organic strawberry farmer, Larry Eddings, Grower/President of Pacific Gold Farms, to develop organically compliant methods of lygus bug control. With a 2002 Western SARE-funded research project entitled : “Control of western tarnished plant bug (WTPB) Lygus hesperus Knight in organic strawberry production systems using trap crops and tractor-mounted vacuums” (SW02-035), our research team demonstrated that lygus bugs were attracted to in-field alfalfa trap crops more than to adjacent strawberry rows, and that a tractor-mounted vacuum treated trap crop significantly reduced damage due to lygus bug feeding in associated strawberry rows compared with a whole field vacuuming program and an untreated control (no trap crop). This was a unique and economically important result for the cooperating grower, because trap crop vacuuming constitutes a 75% reduction in machine energy/effort usually expended by organic strawberry growers in whole-field vacuuming programs (Swezey et al. 2007). Larry Eddings now profitably uses the trap crop technique on over 80 organic acres at Pacific Gold Farms, with ranches located in the drainages of the Monterey Bay National Marine Sanctuary. While these organic farms represent low pesticide residue environments for workers and the environment, there has been a tremendous regional effort on the part of NRCS to reduce agricultural runoff from conventional strawberries by integrating alternative methods of pest control. As a professional + strawberry producer team, we were motivated to demonstrate the efficacy of trap crops on Pacific Gold's remaining 800 conventional acres. The economic and environmental benefits that could be achieved by reducing the use of lygus-directed insecticides are far-reaching: improved environmental health of the slough and sanctuary, improved water quality, savings to farmers by cutting chemical, energy and labor costs, and increased protection of worker health and safety.

Project Objectives:

Based on our previous collaboration, our research team composed of entomologist Sean L. Swezey and staff research associates Janet Bryer and Diego Nieto conducted research on a conventional strawberry ranch managed by Larry Eddings to test if using trap crop-directed insecticide applications on managed trap crops could decrease the need for insecticides in associated strawberries for lygus bug control. This project was distinctive in that it was attempting to inform the conventional industry (95% of CA acreage) as to the broad applicability of observations first made with a previous Western SARE research grant on organic acreage. This was a creative joining of the two production approaches for potential industry-wide benefit.

Cooperators

- Larry Eddings

  Producer

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  Watsonville, CA 95076

  (831) 728-0153 (office)

Research

Materials and methods:

On a 44-acre conventional strawberry ranch in the Salinas Valley, where Larry Eddings grows strawberries conventionally, we set up the entire ranch in an intercropped pattern by planting one alfalfa row for every 40 rows of strawberries. This was the single largest conventionally trap-cropped strawberry ranch in the state, devoting 2-3% of the overall acreage to trap crops. Four alfalfa trap crop rows (150 ft. in length) and fifteen adjacent downwind strawberry rows were randomly assigned as experimental plots to each of two treatments: 1) insecticide treated alfalfa trap crop (no associated strawberry treatment until necessary) and 2) no alfalfa trap crop (conventional chemical control in adjacent strawberries. Untreated controls with no trap crop were also included to determine the efficacy of insecticide applications. "Trimmed" (periodically cut to a height of 24") and un-trimmed sub-plots were added to treatments 1 and 2. Larry Eddings made all pest control decisions based on monitoring of associated strawberries in the plots. Each week during the harvest season, lygus bug adult and nymph abundance was sampled using a hand-held vacuum suction device (modified reversed leaf blower). Each week, a sample consisting of 50 one-second suction points aimed at either alfalfa or strawberry flowers was taken from a continuous line walked along a trap crop row or row of strawberries. Samples were frozen, sorted, and counted at the end of the experiment. Each week, we randomly selected 75 plants in the fifteen adjacent rows and counted all harvestable berries and WTPB-damaged berries, in order to calculate percent crop damage due to treatment. We statistically evaluated the differences in WTPB abundance in the trap crops and strawberries and differences in fruit damage due to treatment. Treatments were replicated four times and were sampled for insect abundance and damage percentage as detailed above. All treatment differences were analyzed using an ANOVA model with SPSS 11.5 software.

At the outset of this experiment, field conditions were superb and grower understanding of treatment protocols was ideal. The only early obstacle was a small, late-arriving lygus population. This was problematic because economic thresholds for pest density were not being exceeded in June or much of July. Consequently, the grower was reluctant to apply insecticides, which meant we couldn't initiate certain elements of our experiment.

When our experiment finally commenced, the lygus bug population was surging. This surge, coupled with very low prices for conventional strawberries, didn't provide the grower with much of an incentive to maintain critical untreated control plots, where strawberries would be "unprotected" from lygus bug feeding. Hence, all unsprayed control plots of this experiment were removed by mid-August.

Research results and discussion:

The participating grower was optimistic that appropriate alfalfa trap crop management strategies could enhance lygus bug suppression with limited, directed insecticide applications. In particular, timed alfalfa trap crop cuttings could prevent the trap crops from growing too tall and wide for spray applications to successfully penetrate the foliage. Trap crop spraying and cutting techniques were compared with comparable uncut and unsprayed trap crops.

Results indicate that Dibrom, a registered lygus insecticide, can reduce lygus nymph abundance in alfalfa trap crops (Fig. 1). Brigade, another insecticide, is also capable of reducing lygus nymph abundance in trap crops (Fig. 2).

Figure 3 shows the timing of insecticide sprays and lygus control results of the replicated applications. Insecticide application to cut alfalfa generally resulted in lower post-spray lygus bug density, indicating that these treatments can reduce lygus bug populations in the trap crop. Cutting/trimming of alfalfa significantly reduces lygus nymph abundance (P 0.05). However, strawberry damage adjacent to uncut alfalfa was significantly greater when compared with damage next to cut alfalfa on 30 July and 3 September (Fig. 7). These results indicate that insecticide-treated trap crops can reduce damage in neighboring strawberries on certain dates, thereby minimizing required insecticide applications in the strawberry rows.

Lygus bug abundance was reduced with insecticide sprays directed at alfalfa trap crops. Both Dibrom and Brigade significantly reduced pest densities in the trap crops. This is a new finding that opens the door for further research inquires: how can early season (June) applications impact growing lygus populations? Which lygus bug insecticide is best suited to reduce lygus densities? What is the optimum application frequency?

Trimming alfalfa trap crops improves insecticide application efficacy. There were roughly half as many nymphs in cut alfalfa as in uncut alfalfa. There was only one major peak of nymphs in cut alfalfa in mid-July, which may be attributable to similarity in height between cut and uncut alfalfa. During this time, the protocol for trap crop cutting frequency was still being refined, and it became apparent that trimmings needed to be made more frequently.

In general, it is still difficult to determine the effect of cutting on the function of trap crops. Clearly, there are more nymphs in the uncut sections of alfalfa, but is this attributable to a decreased attraction (pull) of lygus into a cut trap crop, possibly due to a lack of flowers? Or alternatively, does cut alfalfa reduce lygus reproduction/growth rates? By sub-dividing future insect sampling in adjacent strawberry rows between cut and uncut alfalfa, we may be better able to determine how managing alfalfa affects insect dynamics within the strawberry rows.

Mean percent strawberry damage from unsprayed strawberries adjacent to a sprayed trap crop was significantly greater than damage rates from sprayed berries without a trap crop. However, this difference was less than 1% (sprayed trap crop 3.85%; sprayed berries 3.05%). In practical terms, there was a reduction in whole-field insecticide use of approximately 97%, with strawberry damage rates that were acceptable to the grower. With additional research to separate the influences of certain variables (such as trap crop management and the timing of insecticide applications), our approach can develop into a viable conventional lygus bug management program with trap crops in strawberries.

Participation Summary

Educational & Outreach Activities

PARTICIPATION SUMMARY:

Education/outreach description:

To provide educational outreach to other strawberry growers, researchers, agricultural extensionists, PCAs, and any other interested members of the farming community in the area, we held an extension field day in 2009. The field day provided an opportunity to educate and discuss our results. In the field, the PI discussed what we continue to learn about the management of alfalfa trap crops to limit lygus bug damage.

The principal investigator gave the following presentations of data analyzed in this report:

Integrated Pest Management Workshop - Salinas (5/20/09)
Agricultural Land-based Training Association
Rural Development Center Farm

“Alfalfa Trap Crops for Lygus Control” (classroom)
“Insect Scouting and Alfalfa Trap Crop Management for Lygus Control” (field demonstration)

Entomological Society of America, National Meeting – Reno (11/18/08)
“Management of alfalfa trap crops for control of Lygus hesperus Knight in California conventional and organic strawberries”

Project Outcomes

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Recommendations:

Potential Contributions

Lygus bug abundance was reduced with insecticide sprays directed at alfalfa trap crops. Both Dibrom and Brigade significantly reduced pest densities in the trap crops. This is a new finding that opens the door for further research inquires: how can early season (June) applications impact growing lygus populations? Which lygus bug insecticide is best suited to reduce lygus densities? What is the optimum application frequency? In general, it is still difficult to determine the effect of cutting on the function of trap crops. Clearly, there are more nymphs in the uncut sections of alfalfa, but is this attributable to a decreased attraction (pull) of lygus into a cut trap crop, possibly due to a lack of flowers? Or alternatively, does cut alfalfa reduce lygus reproduction/growth rates? By sub-dividing future insect sampling in adjacent strawberry rows between cut and uncut alfalfa, we may be better able to determine how managing alfalfa affects insect dynamics within the strawberry rows.

With additional research to separate the influences of certain variables (such as trap crop management and the timing of insecticide applications), our approach can develop into a viable conventional lygus bug management program with trap crops in strawberries.

Future Recommendations

We will continue to extend our results concerning conventional and organic trap crop management to the strawberry production community. We have encountered increasing interest in methodology and implementation on the part of many new growers. We believe any strawberry grower in the region can adopt these practices profitably with proper understanding of pest dynamics and the appropriate field techniques.

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This site is maintained by SARE Outreach for the SARE program and is based upon work supported by the National Institute of Food and Agriculture, U.S. Department of Agriculture, under award No. 2019-38640-29881. SARE Outreach operates under cooperative agreements with the University of Maryland to develop and disseminate information about sustainable agriculture. USDA is an equal opportunity provider and employer.
