FINAL PROJECT REPORT
WTFRC Project Number: AE-06-603/ARS No.5853 52-7-368

Project Title: Sprayable foam for trapping and killing codling moth larvae

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Cooperators: Lerry Lacey, Gary Judd
Other funding Sources: None
Agency Name:
Amount awarded:
Notes:

Total Project Funding: $62,300

Budget History:

Item	**Year 1:** 2006	**Year 2: 2007**	**Year 3: 2008**
Salaries	$21,000		$21,700
Benefits	6,400		6,600
Wages			
Benefits			
Equipment			
Supplies	3,000		3,000
Travel	600		600
Miscellaneous	0		
Total	$31,000	No-cost extension	**$31,300**

Budget Notes: We requested that the WTFRC 2006 funding be used by us in 2007, and that additional funding be postponed one year. This requested change is reflected in the budget table.

Salary requests are for partial support of a biological technician at Wapato (½ time), and partial support for a chemistry technician at Albany, CA (½ time). Travel request is to cover Dr. Glenn's travel from California to participate in WTFRC meetings.

Supplies include materials for preparation of foams, a foamer applicator, olfactometer and arena assay supplies, banding, pesticides and other chemicals, codling moth rearing materials, and nematodes.

Project Objectives:
1. Develop, test, and select a biodegradable replacement, to be applied as a liquid or semi-solid to a tree trunk.

2. Evaluate pesticides and pathogenic nematodes in a candidate foam material to determine both larval recruitment, mortality and duration of effectiveness.

3. Compare cardboard banding and a biodegradable foam in apple orchards for efficacy and cost assessments.

Significant Findings:
1. Comparisons of polyurethane foam and cardboard banding showed a superiority of the foam in recruiting greater numbers of larvae that are seeking spin up sites.

2. Laboratory evaluations of several additional materials showed a clear connection between foam cell (bubble) size and efficacy, and superiority of a starch based material over others.

3. An industrial foamer (texture sprayer) has been modified and shown to be useful for both mixing of experimental materials and application to tree trunks in an orchard.

4. Candidate materials have been selected and tested that meet the criteria of low cost, biodegradable,

Methods:

Polyurethane foam (commercial Great Stuff ®) was applied to tree trunks in a two inch wide band. Other trees were banded with 2 inch wide cardboard banding. The materials were removed in late September and numbers of codling moth cocoons counted.

A series of materials were manufactured in the Albany laboratory to provide candidates for testing. These materials were both natural and synthetic, but were all designed to be light weight, porous, and inexpensive. Base materials were cardboard, wood fibers, starches, straw, polystyrene, polyurethane, and concretes. A range of densities of materials were also tested. .

Candidate materials were tested in the laboratory to rank types of materials and material consistencies for their acceptance by mature codling moth larvae. Larvae from the USDA laboratory colony were removed from cocoons and placed individually in 16 oz plastic cups with pieces of test materials. Materials were scored at 1 and 24 hours for larval contact with and entry into the material. Great Stuff polyurethane foam and cardboard bands were used for comparison, as positive controls. A series of materials were tested using this arena assay. These comparisons provided candidate types of

materials for use in more advance testing and formulations.

Preliminary field testing was conducted using foaming formulations of milled wheat straw and a combination of milled wheat straw and softwood fiber. At material costs of $0.22 to $0.25 per tree, bands of these materials were applied to sets of 5 trees, in swaths of 5 to 8 inches, about 6 inches above the soil. The foams were applied using a commercial "texture" air gun sprayer. Applied materials were evaluated for weathering over a 6 week period.

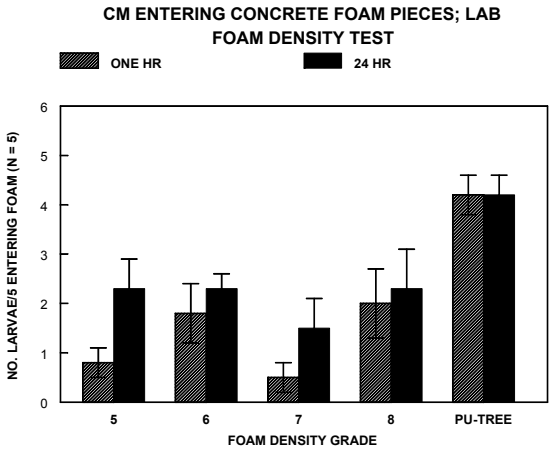
Results and Discussion:

Best results in laboratory assays were with polyurethane foams, a fiber reinforced foam, a fiber roll, a straw/starch formulation, and cardboard. These results supported the hypotheses that efficacious materials facilitated codling moth entry by chewing through the material and by the presence and size of air pockets or cells. All materials that strongly recruited larvae were "chewable" and open in consistency.

Table 1. Percent of mature codling moth larvae entering piece of test material held in 16 oz plastic cup in laboratory. N = 10 to 20.

Material	% Larvae Entering Test Material	
	30 min	24 hours
Rice Straw/Starch Foam	20	100
Concrete Foam	0	60
Fiber Reinforced Concrete Foam	20	90
Mearl 10 Cement Foam	0	20
Mearl 5 Cement Foam	0	0
Pressed Cork	0	25
Starch Fiber Foam	0	15
Pressed Board	0	10
Fiber Foam	20	70
Foam Freeze Starch	0	0
Polyethylene foam	0	50
Polyurethane Foam	10	90
Polystyrene Foam	10	65
Large Pore Starch Foam	90	90
Fiber Roll	100	100
Great Stuff®	50	100
Card Board	85	85

Comparisons of densities of ultra-light concrete did not show an improvement in efficacy with decreasing density and all densities were inferior to cardboard banding. The lack of acceptance by some larvae may have been due to the toughness of the concrete, despite the presence of numerous small air pockets. It was surprising nonetheless to see codling moth larvae bore into soft forms of concrete and spin up cocoons within the concrete.



Assessments of formulations of milled wheat straw were efficacious in laboratory assays, and the series of alterations made in the formulation were intended to improve water repellency, stickiness and maintenance of depth, and ease of application to the tree trunk.

A milled wheat straw sprayable foam applied to apple tree trunks in autumn of 2007 was successfully applied through a texture applicator air gun, to a depth of about ½ inch. This material remained intact on the trees through December, but was readily knocked off at that time.

Plans and Time Line for 2008.
January to April. Additional foams will be laboratory-tested for acceptability to codling moth larvae, in Wapato. These assays will further evaluate the milled wheat straw mixtures, altered to provide greater foaming action after application to the tree.

May/June. One or more candidate materials will be evaluated in the field, using the commercial foamer applicator, to determine the acceptability of such applications to codling moth larvae when applied to tree trunks. These treatments will be directly compared to cardboard banding. Applications to apple tree trunks will be made in early June, and counts made of cocoons in early July.

May to August. Formulation alterations will be made in Albany to provide better foaming action and larger cell sizes within the material applied to trunks. A second generation milled wheat starch foam will then be tested in the laboratory in Wapato to determine if changes in the formulation impacted acceptability to larvae. In addition, preliminary attempts will be made in the laboratory to test a pesticide and nematodes in the foam formulation. These materials will be evaluated in the laboratory, using the arena bioassay, in comparison to foam without pesticide or nematodes. Data will be obtained on recruitment of larvae into the foam (to test the hypothesis of no repellency of the treatments) and on mortality and survival of larvae within the foam.

August /September. Field trials will evaluate the second generation foam, in comparison to cardboard banding , to evaluate efficacy in recruiting larvae in the field, but also to durability when exposed to irrigation sprinklers.

September 2007 into January 2008. It is anticipated that a series of laboratory assays will need to be done to evaluate and compare several pesticides at different dosages, and different dosages of nematodes, to select dosages that provide optimum results in anticipation for field testing in 2008. In addition, information obtained from the two field trials may indicate the need for additional fine tuning of the foam formulation to provide durability and rain fastness. Any changes to the

formulation would necessitate additional laboratory testing before the next field season.