

FHP TECHNOLOGY DEVELOPMENT PROPOSAL

Project Status: New, not previously funded

Project Number: R8-2000-02

Project Title: Control of the Nantucket Pine Tip Moth With Augmentative Releases Of A Native *Trichogramma* sp. Egg Parasite

Subject: Biological control, pine tip moth, *Rhyacionia frustrana* egg parasites, *Trichogramma exiguum*

Project Objective: To determine if Nantucket pine tip moth populations can be reduced to below damaging levels by augmentative releases of the native egg parasite, *Trichogramma exiguum* under operational conditions.

Brief Description Of Project: This project is designed to determine if egg parasites can be effectively used on an operational basis to control the pine tip moth.

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Principal Investigators: C. Wayne Berisford, Department of Entomology, University of Georgia, Athens, GA 30602; David L. Orr and Fred P. Hain, Department of Entomology, North Carolina State University, Raleigh, NC

Cooperators: The Pine Tip Moth Research Consortium
North Carolina Eastern Christmas Tree Growers Association

Justification: The Nantucket pine tip moth, *Rhyacionia frustrana* (Comstock) (Lepidoptera- Tortricidae) has become an important pest associated with intensively managed loblolly pine plantations and Virginia pine Christmas tree plantations throughout the South. Although conventional pesticides can provide effective control, they are detrimental to existing natural enemies and there is no demonstrated benefit beyond the current generation, By supplementing existing natural enemies via augmentative releases of native egg parasites, adequate control may be possible with no adverse environmental impact.

Urgency: This is not a crisis situation. However, substantial growth losses from tip moth attacks are occurring on a regular basis.

Link To National FHP Technology development priorities: This project addresses the national program priority to develop a biological control method for an established native pest.

Scope of Application: Successful development of this biocontrol technique will be applicable to pine stands and Christmas tree plantations throughout the South where the

tip moth is a problem. It could be used in several states and would also provide a model for biological control of other lepidopterous forest pests.

Research Basis: A preliminary experiment conducted in 1997 showed that it is feasible to control the tip moth by releasing large numbers of reared native *Trichogramma*. Previous research from our labs has shown that egg parasites are a major source of tip moth mortality and the only natural enemy which kills tip moths before any damage occurs.

Methods: *Trichogramma exiguum* is a major native egg parasite of the tip moth (McCravy and Berisford 1998). Natural populations of the parasite colonize young pine plantations and are an important mortality factor of the tip moth, but do not suppress the pest on their own. A successful pilot test has been conducted which demonstrated the feasibility of mass-releasing (augmenting) *T. exiguum* in one acre plots within plantations for tip moth control (Orr et al. 1999). In that study the efficacy of released *T. exiguum* was demonstrated, as well as the suitability of pine plantations as habitat for *T. exiguum*, in terms of microclimate and predation.

In the proposed project, two sets of paired 10 acre plots will be set up at three locations (N. C., Ga., La.). One plot in each pair will be treated with a single *Trichogramma* release and the other designated as a check (total of six replications/treatment). Plot layout and analysis of data will be conducted using a complete block design, with systematic placement of treatments.

Trichogramma will be deployed within the eggs of a factitious host (Mediterranean flour moth, *Ephestia kuehniella*) contained in small cardboard capsules (approx. 2.5 cm³). Flour moth eggs are killed with UV radiation prior to parasitism to ensure that no pest insects are introduced into the environment. Parasitized eggs will contain *Trichogramma* in three different stages of development (cohorts) to insure emergence of adults over much of the tip moth oviposition period. Cardboard capsules will be dispensed from a helicopter with a modified fertilizer spreader to provide a *Trichogramma* density of ca. 400,000 females/acre from each of the three cohorts. The quality of released *Trichogramma* will be monitored through standard quality control procedures (Orr, et al. 1999).

A new culture of *Trichogramma exiguum* has already been collected from field locations in North Carolina, purified, and established as 41 separate isolines in the Biological Control Laboratory at NC State University (NCSU SCL). If this proposal is successful, the isolines will be sent to a commercial lab to be combined (for improved vigor), mass reared, and formulated into cardboard capsules for use in field studies. This system has been employed by the NCSU BCL for 5 years with consistently high success.

Christmas tree plots will be established in North Carolina as four sets of paired one acre plots. One plot in each pair will be treated with *Trichogramma* release and the other designated as a check. The cardboard capsules containing the *Trichogramma* will be deployed by hand at the base of the trees at densities similar to above- Of the four check plots, half of each plot will receive no treatment, while the other half will receive normal chemical treatment for tip moth control.

Density of *R. frustrana* eggs in pine and christmas tree plantations will be estimated from biweekly sampling of shoots from 30 trees located within the central 50 % of plots (to avoid edge effects). This sampling will allow us to determine if pest density is the same in both treatment and check plots. Parasitism will be estimated by holding eggs (25°C, 80% RH, 14:10 L:D photoperiod) collected during biweekly egg density sampling to determine the percentage of that are parasitized. To ensure that increases in parasitism are the result of our releases, identification of *Trichogramma* reared from eggs will be made by D. Orr (NCSU) and confirmed by J. Pinto (University of California, Riverside).

Finally, the percentage tip moth-infested shoots on trees in treatment and check plots will be estimated by sampling 100 trees from the central 50% of each plot. Additionally, the mean numbers of tip moth larvae per infested shoot will be determined. Assessments will also be made during subsequent tip moth generations to determine if there is any carryover in tip moth control due to the increased egg parasitism.

Measure Of Success: Efficacy of *Trichogramma* will be assessed from damage data, but only if population levels are similar in treated and check plots, and if there is a direct correlation between parasitism levels and pest suppression. This will allow us to ensure that observed control of *R. frustrana* populations is actually the result of *T. exiguum* releases. The ultimate determination of success will be the relative tree heights and diameters in treated and control plots during the second year of the study

Cooperators: Members of the Pine Tip Moth Research Consortium and North Carolina Christmas Tree Growers will provide research sites. Selection of cooperators will be made on the basis of available sites so the exact people cannot be identified at this time.

Products: A publication will be prepared which describes the detailed methodology and results from the project.

Technology Transfer: The methodology will be distributed through the Pine Tip Moth Research Consortium and the North Carolina Christmas Tree Growers initially to introduce the concept and technology to growers. These groups will provide a basis for extension of the technology to other interested growers.

Project Duration: 24 months; project will be completed in FY 2001.

Long Term Budget: \$45,600.00 (breakdown attached; some matching funds provided by the Pine Tip Moth Research Consortium and North Carolina Eastern Christmas Tree Growers).

References Cited:

Orr, D. B., C. P. Suh, K. W. McCravy, C. W. Berisford and G. L. DeBarr. 1999, Evaluation of inundative releases of *Trichogramma exiguum* (Hymenoptera: Trichogrammatidae) for suppression of Nantucket pine tip moth (Lepidoptera: Tortricidae) in loblolly pine plantations. Canad- Entomol. In review.

McCravy, K. W. and C. W. Berisford. 1998. Parasitism by *Trichogramma* spp. (Hymenoptera: Trichogrammatidae) in relation to Nantucket pine tip moth (Lepidoptera: Tortricidae) egg density and location. Environ. Entomol. 27: 356-59.

BUDGET

| | STDP | UGA | FY-2000 | | | TOTAL |
|------------------------------|-----------------|-----------------|-----------------|-----------------|----------------|------------------|
| | | | NCSU | TMC | NCCTG | |
| Salaries | | | | | | |
| Co-PI – W. Berisford | -- | \$5,800 | -- | -- | -- | \$5,800 |
| Co-PI - D. Orr | -- | -- | \$4,648 | -- | -- | 4,648 |
| Co-PI - F. Hain | -- | -- | 4,148 | -- | -- | 4,418 |
| Labor | -- | -- | -- | \$5,000 | -- | 5,000 |
| Staff Benefits | -- | 1,506 | 2,287 | 500 | -- | 4,293 |
| Student Labor | 10,000 | -- | -- | -- | -- | 10,000 |
| Supplies | 3,000 | -- | -- | -- | \$1,000 | 4,000 |
| Trichogramma | 12,000 | -- | -- | -- | -- | 12,000 |
| <u>Travel</u> | 4,000 | -- | -- | -- | -- | 4,000 |
| Total Direct Costs | \$29,000 | \$7,306 | \$11,083 | \$5,500 | \$1,000 | \$53,889 |
| Indirect Costs | -- | \$18,686 | -- | -- | -- | 18,861 |
| Grand Total | \$29,000 | \$26,167 | \$11,083 | \$5,500 | \$1,000 | \$72,750 |
| | | | | | | |
| | STDP | UGA | FY-2001 | | | TOTAL |
| | | | NCSU | TMC | NCCTG | |
| Salaries | | | | | | |
| Co-PI – W. Berisford | -- | \$2,900 | -- | -- | -- | \$2,900 |
| Co-PI - D. Orr | -- | -- | \$2,343 | -- | -- | 2,343 |
| Co-PI - F. Hain | -- | -- | 2,074 | -- | -- | 2,074 |
| Labor | \$6,000 | -- | -- | -- | -- | 6,000 |
| Staff Benefits | 600 | 754 | 1,148 | -- | -- | 2,502 |
| Student Labor | 4,000 | -- | -- | -- | -- | 4,000 |
| Supplies | 2,000 | -- | -- | \$5,000 | -- | 7,000 |
| <u>Travel</u> | 4,000 | -- | -- | -- | -- | 4,000 |
| Total Direct Costs | \$16,600 | \$3,654 | \$5,565 | \$5,000 | -- | \$30,819 |
| Indirect Costs | -- | \$10,786 | -- | -- | -- | 10,786 |
| Grand Total | \$16,600 | \$14,440 | \$5,565 | \$5,000 | -- | \$41,6050 |
| Project Total (2 yrs) | \$45,600 | \$40,607 | \$16,648 | \$10,500 | -- | \$114,355 |

TMC = Pine Tip Moth Research Consortium
 NCCTG = North Carolina Christmas Tree Growers Association

Benefit and Cost

Production Function:

The objective of this project is to expand a previous successful feasibility study to determine if Nantucket pine tip moth populations can be reduced to acceptable levels by augmentative release of the native egg parasite *Trichogramma exiguum* under operational conditions. The egg parasites are expected to decrease tip moth damage by ca. 80 percent and increase tree biomass by 20 percent and stem volume by 10 percent in the treated tip moth generation. Stands without augmentative releases will suffer ca. A 30 percent reduction in average tree biomass during the first year. The primary benefit from the treatments is a significant increase in average tree volume expressed as tons of fiber per acre. We do not know if increased egg parasitism due to the releases will carry over into the second year. Therefore, no proposed benefit can be calculated. However, our long-term studies show that volume gains for the first year will extend through rotation, which is projected to be 18 years. In Christmas trees, *Trichogramma* releases can reduce the need for chemical control and improve the form of Virginia pine. Although they cannot be quantified, additional benefits will be derived from the reduction in pesticide use and site contamination. Reduced pesticide uses can also prevent the buildup of secondary pests such as scale insects and aphids.

Assumptions:

Trichogramma releases will significantly reduce tip moth attacks for at least one generation.

There will be no treatment costs without this project

Benefits from this project will accrue for 18 years (rotation age)

Background Data:

Stem volume of trees will increase significantly (5%) which is ca. 0.5 additional tons of fiber/acre/year.

The annual increase in stem volume will be maintained through rotation (18 years).

Trichogramma release will incur a one-time cost of \$50/acre.

There are ca. 900,000 acres of 1 and 2 year old loblolly pine plantations in the South annually under intensive management.

Two percent of available acreage will be treated with *Trichogramma* (18,000 acres).

Expenditure and Output Values (EOV) Without Project:

EOV without project = \$0 from increased fiber production

Expenditure and Output Values With Project:

EOV with project = 0.5 additional tons/ae/yr. X \$15/ton x 18,000 ac = \$2,430,000

discounted to \$1,777,365 - \$900,000 (1 time *Trichogramma* cost) = \$877,365

Benefit Attributable To Project = \$877,365 - 0 = \$877,365

Benefit/Cost Ratio = 877,365/114,355 = 7.67

Benefit Attributable To STDP Funds = $7.67 \times \$45,600 = \$349,752$

PNV of Project = $\$877,365 - \$114,355 = \$763,010$

PNV of STDP = $\$877,365 - \$349,752 = \$527,613$