Special Technology Development Program
Final Report

PROJECT NUMBER: R1-1999-01

PROJECT TITLE: A Demonstration and Evaluation of the Effects of Interactions between Biological Control Agents and Chemical, or Fire Treatments for Managing Spotted Knapweed

PROJECT STATUS: Continuing

EXPECTED PROJECT DURATION: 3 years

EXPECTED COMPLETION DATE OF THE PROJECT: 3 years

ACTUAL COMPLETION (FISCAL) YEAR: 2001

SUBJECT : Noxious Weed Biological Control

STATUS OF SUBJECT SPECIES : noxious

PROJECT OBJECTIVE(S) :

1. Evaluate the effects of chemical applications (Tordon and Transline) on the survival over time of two root-feeding biological control agents, *Agapeta zoegana* and *Cyphocleonus achates.*
2. Determine whether different densities of knapweed, achieved through different chemical treatments, affect the ability of biological control agents to establish and increase in population size.
3. Determine whether fire has an effect on population size of root-feeding biological control insects and the knapweed seedbank.
4. Develop a set of recommendations to assist land managers in determining the best treatment or combination of treatments, for spotted knapweed based upon our findings from biological, chemical and prescribed fire trials.

BRIEF DESCRIPTION OF PROJECT : This project consists of two interlinked studies. In the first study, we will test two hypotheses: the first is that biological control insects can survive in areas treated with low concentrations of herbicides. The assumption is that at low concentrations, not all knapweed plants are killed, thus leaving refugia for the insects. A preliminary study found strong evidence of the ability of *A. zoegana* to survive in knapweed plants remaining in skips (areas missed by the herbicide) and surrounding untreated areas following an aerial application of a herbicide (Sturdevant, Six, Vander Meer, unpublished data). The second hypothesis is that lowering densities of knapweed in areas where it is well established will help optimize conditions for biological control insect establishment and efficacy. Our experiments are designed to assess which densities of knapweed might be optimal for the biological control insects and determine what herbicide concentrations will be necessary to achieve these densities. We will focus our efforts of two herbicides, Tordon a commonly utilized herbicide in management of knapweed, and Transline, which unlike Tordon can be used in forested areas because it has no or little effect on trees. By assessing both herbicides, we will be able to develop data supporting weed management programs in a wide range of situations.

In the second study, we will also test two hypotheses: the first is that biological control agents feeding in the roots can survive the direct effects of burning. The effects of a low versus a high intensity burn will be evaluated on the root-feeding insects. The second hypothesis is that fire has a negative effect on the knapweed seedbank and therefore an indirect effect on insects over time. The burning project will be done in a forested area that has been recently logged and is infested with spotted knapweed. Some logging slash must remain on the ground to facilitate the fire and therefore have an effect of the spotted knapweed seedbank, otherwise without some slash, fire in knapweed acts like a crown fire and never results in high enough temperatures to affect the seedbank. Woody debris will be added or removed to simulate the two treatments of a low and high intensity fires.

Both studies are conducive to use as demonstration projects for displaying the effects of an integrated management approach in managing spotted knapweed.

CHANGES TO PROJECT SCOPE OR OBJECTIVES : Instead of conducting all phases of the fire studies in the field, we are currently conducting several studies in the lab. This will enable us to determine the temperature at which a given percent of the *Agapeta* expire. The biggest difficulty with the original proposal is heating the soil evenly in the field and subsequently the insect population inside knapweed roots. The objective of the study is to determine the lethal temperature required to kill *Agapeta* feeding inside a knapweed root. Many insects have a critical upper temperature limit between 40 and 45 degrees C. The first step is to determine the percent mortality of *Agapeta* at predetermined durations of temperatures. This will be done using thermocouples, placed in knapweed roots containing *Agapeta*, then heated in drying ovens at the USFS Fire Science Laboratory, Missoula, MT. During FY2001, we will conduct a similar study in the field. We will evaluate the effects of several planned prescribed fires on *Agapeta* feeding in roots of knapweed plants. Knapweed plants infested with *Agapeta* will be randomly placed in the soil prior to the fire. Thermocouples will be placed at several depths along the knapweed root to measure the temperature near the point where the insects typically feed. Shortly after the fire, survival of larvae in roots will be evaluated. Data characterizing the fire such as fuel types and load, moisture content of fuel and flame length, will be obtained from the National Forest system or other agency.

ADDITIONS TO PROJECT SCOPE OR OBJECTIVES: We also expect several lab studies to stem from this project. Currently we are conducting lab studies to support the field studies. These studies look more in depth at the effects of herbicides and soil heating on *Agapeta* survival. Dow AgroSciences is also interested in working on several related projects with us in the future.

FHP LEAD CONTACT (FHP person submitting proposal):

Name	Affiliation (Office or Dept.)	Phone, E-mail, Fax
Nancy J. Sturdevant	Northern Region, Missoula Field Office	(406) 329-3281, nsturdevant@fs.fed.us (406) 329-3347

PRINCIPAL INVESTIGATOR(S):

Name	Affiliation (Office or Dept.)	Phone, E-mail, Fax
Diana Six	University of Montana, School of Forestry	(406) 243-5573
Dennis Vander Meer	University of Montana, School of Forestry	(406) 243-5573

COOPERATORS (contributing to, but not leading, the project) (add lines as necessary):

Name	Affiliation (Office or Dept.)	Phone, E-mail, Fax
Mary Halstvedt	Dow AgroSciences	(406) 665-9558 mbhalstvedt@dowagro.com

COOPERATOR INVOLVEMENT :

Name	Role	Time Commitment
George Markin	Reviewed proposal	2 days
Jim Oliverez	Reviewed proposal and on-going progress	3 days
Jim Story	Provided technical guidance and insects	1 week
Alan Knudsen	Provided field assistance	1 week

PRODUCTS AND DUE DATES

1. Develop a set of recommendations to assist land managers in determining the best treatment or combination of treatments, for spotted knapweed based upon our findings from biological, chemical and prescribed fire trials.

2. A demonstration area to display and educate interested parties on the effects and benefits of integrated weed management.

3. FHP technical report and several journal articles.

STATUS OF PRODUCTS/PRESENTATIONS: The project has been used as a demonstration area as part of several field days focusing on integrated weed management. Preliminary results of this project were presented at the ESA meeting and at the WFIWC in 1999. The publications and recommendations will be developed after the FY2001 field season.

ACCOMPLISHMENTS TO DATE:

Products: Recommendation brochure- Fall 2001.

Publications: Fall 2002.

BRIEF DESCRIPTION OF ACCOMPLISHMENTS AND RESULTS:

In May of 1999, 21 plots were established at each of 2 sites. In June, the baseline insect population density was measured for larvae of each species. The plots where then augmented to insure an insect population was present in each plot. In late August, when the knapweed was mature, vegetation characteristics including height and seedhead productions were recorded to evaluate changes in the vegetation after the herbicides were applied.

In May of 2000, all treatments were applied to randomly selected plots. The herbicides were administered by a licensed pesticide applicator. In June, larval populations were evaluated. Initial results indicated that the herbicides had little effects on the insect populations.

In August of 2000, vegetation characteristics were measured to establish the post-treatment effect of herbicides on knapweed and all other vegetation on plots. Larval and vegetation surveys will be conducted again in 2001.

During Fall of 2000, lab studies will be conducted to determine the effects of fire on the survival of *A. zoegana* larvae. The field trial of the effects of prescribed fire on the survival of *A. zoegana* will be conducted in the spring summer of 2001. In July of 2000, preliminary testing of the soil heating apparatus was assembled and tested.

FIRST FISCAL YEAR FUNDED: FY1998

FUNDS OBLIGATED FROM BEGINNING OF PROJECT THROUGH FINAL FISCAL YEAR (extend table as needed):

Fiscal Year	STDP Funding	Other-Source funding	Source
1998	$53,339	$65,469	University of Montana Dow AgrSciences
1999	$40,979	$40,979	University of Montana Dow AgroSciences
2000			University of Montana

FUNDS NOT USED FROM PREVIOUS FISCAL YEAR: 0

POST-PROJECT TECHNOLOGY SUPPORT: NA

Some projects result in products or information that do not inherently require sustained investment for continued support after the conclusion of a project. However, other projects may result in products that are not usable without a continuing commitment to sustained investment for support (sustained access, user support, training, or through continued funding from a source committed to the use of the product). Frequently, project leaders develop a deeper understanding and appreciation for this type of sustained support as the project progresses: in this case, please provide your best estimates based on current understanding of the products being developed. If either item 1 or 2 are irrelevant to this project, explain why.

1. Estimated annual funding needed to support the product(s) or continued use of technology after the completion of the project when FHP STDP funding is no longer available:

2. Indicate what sponsor/decision-maker (by name and/or by title) or what organization has committed to being responsible for future support and/or to provide this funding for continued support. If no commitment has been made, describe what steps are being taken to secure this commitment.

_____

_____

_____

LOOK TO THE FUTURE:

The STDP project evaluates the survival of biological control agents and changes in densities following herbicide applications of varying rates over the short-term (2 years). Longer- term studies are needed to more adequately assess the effects of varying knapweed densities (resulting from the herbicide applications) on insect population growth and dispersal (3-5 years). Longer- term studies would provide very useful information on how biological control agents respond to changing knapweed densities and their environment.

For many weeds species and biological control agents, long-term impact studies need to be conducted. The sooner these studies can be initiated, the sooner we can assess the benefit of our efforts in biological control of weeds.

In addition to achieving the original objectives of the STDP, we also developed augmentation techniques for the two root-feeding insects of knapweed. These techniques may be applicable to other biological control agents as well. We also developed an efficient and effective vegetation sampling technique that also may be applicable to other weed species.