Undergraduate Research Academy (URA)

Cover Sheet

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MENTOR Kurt Schulz

PROJECT TITLE Strategies for Efficient Control of Euonymus fortunei
Based on Physiological Status

ABSTRACT: The abstract is a brief, comprehensive summary of the content of the proposal in about 150 words in plain language. Reviewers receive their first impression from this abstract. The information needs to be concise, well organized, self contained, and understandable to persons outside your academic discipline.

The native plant communities of Illinois are being threatened by plant species introduced from other places. These species were under control in their native habitats due to pressures from competing plants, herbivores and diseases. However, when introduced into the Illinois, these exotic species had no natural controls. The exotic species have begun to colonize the landscape, harming native species in the process. There are several evergreen vines that have been introduced into Illinois as ground covers and have begun to cause damage. One such species is the purple wintercreeper (Euonymus fortunei). This species is a very aggressive evergreen vine which not only creeps over the ground but also climbs up trees and buildings. Very little coordinated research has been done on control methods for this invasive plant. However, it is a problem for the Watershed Nature Center in Edwardsville, IL as well as in most of Southern Illinois and the eastern United States. The objective of this project is to test different control methods for Euonymus fortunei at the Watershed Nature Center and the Southern Illinois University- Edwardsville Campus.

Upon submitting this proposal, I verify that this writing is my own and pledge to fulfill all of the expectations of the Undergraduate Research Academy to the best of my abilities. I understand that failure to do so may result in return of fellowship money to the University and forfeiture of academic credit and honors recognition.

Signature of the Student

I am able, willing, and committed to providing the necessary facilities and to take the time to mentor this student during this project. I verify that this student is capable of undertaking this proposed project.

Signature of the Faculty Mentor

This project is within the mission and scope of this department, and the department fully supports the faculty mentor and student during this venture.

Signature of the Department Chairperson

03/16/2004 12:01 PM
Introduction:

Invasive plant species have become a problem in Illinois. They are rapidly changing Illinois' natural communities by taking over habitats and excluding native plants. Robert Devine (1994) describes the devastating effects of invasive species in his article, “Botanical Barbarians.” He found that invasive plants cost US farmers $3.6 to $5.4 billion a year in crop loss and comprise 50 to 75 percent of the major crop weeds in the United States, according to the congressional Office of Technology Assessment. However, he also suggested that the cost of invasive species in natural habitats, although not determined in percent or cash value, is far greater (Devine, 1994).

Illinois is host to a substantial number of invasive species. In southwestern Illinois these include the tree-of-heaven (*Ailanthus altissima*), Japanese honeysuckle (*Lonicera japonica*), Asian shrub honeysuckles (*Lonicera maackii, L. tartarica, L. X bella*), and periwinkle (*Vinca minor*). Notably, there are a number of species of exotic invasive evergreen vines which have been introduced to Illinois as ground covers. These include periwinkle (*Vinca minor*), wintercreeper (*Euonymus fortunei*), Japanese honeysuckle (*Lonicera japonica*), pachysandra (*Pachysandra terminalis*), and English ivy (*Hedra helix*). These plants are capable of quickly spreading over the ground by vegetative reproduction. Several climb trees, shrubs and buildings, making them a broad scale threat to the natural environment. It is widely believed that evergreens pose a unique threat because they may be able to photosynthesize in forest understories during spring and fall when the leafy canopy is gone, but temperatures are moderate.

Some successful control techniques for evergreens include biological control, cutting, spraying, and combinations of cutting and spraying. Biological control methods include introducing weevils, moths or other pests to a population of invasive plants. This introduces the plant's natural control from its original ecosystem into its new ecosystem. However, this type of treatment can have unpredictable effects on the environment and the ecology of other native plants. Therefore, many scientists (myself included) see it as too risky to attempt (Langeland and Stocker, 2000). Cutting is a technique used to damage the plant by robbing it of its leaves and stored energy. Spraying is the use of an herbicide to poison the plant. Cutting and spraying is usually the most effective control. Cutting a plant before it is sprayed allows the herbicide to enter the plant more easily through the wound (e.g. Schulz and Thelen 2000). However, herbicides can be extremely harmful to surrounding plants and may persist in the environment. In nature reserves herbicide use is restricted to the dormant season for deciduous species. Roundup® (glyphosate) is the only herbicide considered for this experiment due to its limited toxicity, minimal ecological effects, and ease of use (Johnson, 1998).

Literature Review:

*Euonymus fortunei* (Fig. 1), an invasive evergreen in the family Celastraceae, introduced from China to the United States in 1907 as an ornamental ground cover. Its common name is the purple wintercreeper. Purple wintercreeper can form a dense ground cover or climb 12-21 meters along vertical surfaces using aerial roots. Flowers form during June and July followed by pink to red capsules containing seeds in autumn. It also reproduces vegetatively by lateral shoots along the main vine. It is easily spread by birds and other animals feeding on the fruits produced in the fall. *Euonymus fortunei* is a threat to native species because of its rapid, dense growth, evergreen nature and...
tolerance of harsh conditions. It apparently outcompetes native vegetation by depleting soil moisture and nutrients, blocking sunlight and densely populating an area to prevent other growth (Hutchinson, 1990).

Very little research has been done to develop control methods for purple wintercreeper. There have been several proposals of seemingly effective methods. Johnson (1998), working in Great Smoky Mountain National Park, found that 25% Roundup® applied to the freshly cut plant proved the most effective method of control. Johnson does not mention the best time to apply this treatment. However, he does say that the treatment is effective at temperatures as low as 4 °C (Johnson, 1998).

Another project conducted by the Illinois Nature Preserves Commission (INPC) also suggested that a cut and spray method would be the most effective. The INPC also found that a concentration of 25% was effective in controlling *Euonymus fortunei*. The application period suggested for this treatment was late autumn while other non target vegetation is dormant. Because of this concern, the treatments were only performed in late autumn and no other times were tested (Hutchinson, 1990).

The INPC found after reviewing the literature that no effective biological controls for wintercreeper would be feasible in natural areas (Hutchinson, 1990).

**Objectives and Hypothesis:**

The purpose of this study will be to develop a simple and effective method of controlling the spread of *Euonymus fortunei*. The studies that have been previously performed found the cut and spray method using a 25% concentration of Roundup to be the most successful. However, they did not agree on time of treatment. Treatments in the field are most conveniently performed in the summer, which is not always the most ecologically effective time frame. Therefore, my objective is to determine the most effective time to treat the invasive species.

Several physiological and ecological features dictate preferred times for treatment. Glyphosate generally enters plants through the stomates and inhibits the synthesis of certain amino acids. In general the conductance (openness) of stomates is
highest during early spring, when demands for CO₂ are greatest and water stress is least. Spraying in late fall to prevent damage to spring flowering species generally limits the penetration and toxicity of the herbicide because conductances are low, metabolic rates are reduced by lower temperature, and plant growth has largely ceased.

A common problem in all studies (e.g., Schulz and Thelen 2000) is that treated plants regrow. Regrowth is supported by stored carbohydrates in stems and underground parts. Elimination of the stored carbohydrates by mowing or pruning potentially has a strong effect on regrowth. Vaughn et al. (2004) observed this vividly in Amur honeysuckle.

This study will evaluate the effect of cutting and cutting plus herbicide at several different times in the growth cycle of *Euonymus*. A separate cutting treatment is used to test the addition effect of herbicide. Vaughn et al. (2004) have shown that cutting dramatically damaged invasive Amur honeysuckle (*Lonicera maackii*), and gave statistically equivalent results to cutting plus herbicide.

Some aspects of plant physiology need to be considered when developing a control strategy for *Euonymus*. The most important of these is that *Euonymus* probably takes advantage of warm days in early winter and early spring to photosynthesize rapidly while the tree canopy is still absent. By the time the tree canopy leaves out and the understory becomes dark, it may have accumulated much of its stored energy. This stored energy can be used for regrowth after treatment.

I believe that the most effective time to treat the species will be in the early spring, as the canopy closes in early May. The plants have been freely photosynthesizing all winter and spring while the tree canopy has been absent. Carbohydrates have been stored in the plant to be used for growth and seed making. If the plants were cut and sprayed just after the canopy closes, they would be robbed of stored energy useful for regrowth. I expect that much of the stored energy will be in above ground storage parenchyma; it is a widespread misconception that roots are the dominant storage organs in woody plants (Kramer and Kozlowski 1979). Regrowth will be further limited by deep shade during the summer and fall.

Late autumn is also a widely recommended time for treatment. Unfortunately the tree canopy will still be dormant for several months after treatment, allowing the damaged plants to photosynthesize freely. This gives the plant a time period of recovery before the canopy closes in spring. Therefore, I do not feel this is the most effective time of treatment, as Hutchinson’s (1990) research suggests.

Summer is the most common time of treatment in the field. This is simply due to convenience for volunteers and staff. However, by summer, the plants are stronger, larger and harder. Therefore, they would be less likely to be harmed by cutting and spraying and more likely to recover.

**Procedure:**

Twenty 3m x 2m plots infested with *Euonymus fortunei* will be placed at randomly chosen locations at the Watershed Nature center and on the Southern Illinois University Edwardsville campus (10 plots each location). Each plot would then be divided into 6-1m x 1m squares. Each square will be randomly assigned a treatment combination (Fig. 2): cutting in spring (May 15), summer (August 20), fall (October 30); no application of herbicide and application of 25% Roundup®. The locations under
study are so badly infested with *Euonymus* that I am unconcerned that many non-target plants remain to be damaged by the spring and summer herbicide treatments.

<table>
<thead>
<tr>
<th>Spring Cut</th>
<th>Summer Cut</th>
<th>Autumn Cut</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Roundup</td>
<td>No Roundup</td>
<td>No Roundup</td>
</tr>
<tr>
<td>Spring Cut</td>
<td>Summer Cut</td>
<td>Autumn Cut</td>
</tr>
<tr>
<td>25% Roundup</td>
<td>25% Roundup</td>
<td>25% Roundup</td>
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</table>

**Figure 2.** Schematic diagram of treatment combinations. Actual distribution of treatments will be randomized across the squares.

Each square will be photographed in spring to record the cover of *Euonymus*, and will be photographed 30 days after treatment, and again in spring the following year. Vaughn et al. (2004) effectively used photography to record data in another project. The percent of *Euonymus* cover and regrowth will be estimated from digital copies of the photographs using image analysis software (Image J, public domain software version of NIH Image).

One complicating factor is the varying availability of light (400-700 nm wavelength) to support the regrowth of plants. I will measure light availability using a Canopy Ceptometer® (Decagon Devices, Pullman, WA). This device can be used to sample light intensity over a large area. These intensities can be standardized against unobstructed light in an open area and used to compare light availability. Light will be measured at all study sites at the time each treatment is applied, allowing estimates of spring, summer, and fall light availability.

Analysis of covariance is a statistical technique that can be used to test for treatment effects (Zar 1997) and the role of light. This approach has the advantage of allowing us to test the effects of both time of cut, herbicide treatment, light, and any unique responses to treatment at certain times of year or under certain light conditions ("interactions"). The data will be analyzed as a randomized complete block design.

**Timeline:**

(N.B. This experiment must begin before URA funds are dispersed. I have made arrangements to "borrow" funds from my mentor’s research grant to cover initial costs. His grant can be reimbursed in goods at a later date.)

**April 2004** - All plots will be selected and surveyed at the Watershed Nature Center and SIUE campus.

**May 2004** - Initial photographs of squares to be treated in spring. The spring treatment will be applied. Light measurements.

**June 2004** - Photography of treated squares and data analysis.
August 2004- Initial photographs of squares to be treated in summer. The summer treatment will be applied. Light measurements.
September 2004- Photography of treated squares and data analysis.
October 2004- Initial photographs of squares to be treated in fall. The fall treatment will be applied. Light measurements.
November 2004- Photography of treated squares and data analysis.
March 2005- Photography of all treated squares and data analysis. Light measurements.

References:

Budget Justification

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