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Economic Analysis of Two-Spotted Spider Mite Management on Greenhouse-Grown Poplars

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The two-spotted spider mite- Tetranychus uriticae *Koch-is a perennial pest problem on greenhouse-grown poplar (*Populus *spp.). Although weekly applications of miticide effectively managed this pest, other issues such as manage-meat costs and worker safety prompted an effort to test another approach. An integrated pest management (IPM) program for spider mite suppression was developed using pest monitoring, release of predatory mites-*Phytoseiulus *persimilis Athias-Henriot and* Amblyseius californicus *(McGregor)-and spot-treating with a miticide when neces sary. One year after implementation of this IPM program, mite populations have been suppressed to acceptable levels, pest management costs have been reduced by 81%, and concerns regarding miticide exposure by personnel sharing the greenhouse facilities have been eliminated.* Tree Planters' Notes 44(4): 154-156; 1993

At Iowa State University in Ames, research is being conducted by the Department of Entomology on the insect-plant interaction of the cottonwood leaf beetle (*Chrysomela scripta* F) and poplar (*Populus* spp.) selections. The laboratory colony of beetles requires a continual food source. Selected tree clones are grown in a greenhouse.

The two-spotted spider mite (*Tetranychus uriticae* Koch) is a common pest in greenhouse environments. This mite has been a perennial problem associated with the cultivation of *Populus* in our greenhouses but is not a problem in field plantings. In the past we have managed this pest effectively with weekly applications of a miticide, usually dienochlor (Pentac®) or propargite (Ornamite®). However, economic considerations, environmental concerns raised by non-project personnel sharing the greenhouse space, and the need to use pesticide-free plant materials as insect colony food prompted a reconsideration of our program.

We decided to attempt implementation of an rote-grated pest management (IPM) program. The IPM strategy utilizes more than one pest control method to increase the performance of a pest management program so that it is both economically and ecologically sound (Pedigo 1989).

One common tactic employed in greenhouse IPM programs is the release of natural enemies (predators, parasitoids, and diseases) of pests (Hussey and Scopes 1985, Parrella 1990). In this paper, we describe how we used predatory mites- *Phytoseiulus persimilis* Athia-Henriot and *Ambyseius californicus* (McGregor) for the suppression of the two-spotted spider mite *Tetranychus urticae* on *Populus,* and the benefits that accrued from using IPM.

Methods

We implemented our IPM program in two completely enclosed greenhouse bays. Each bay was 6.15 m (20 feet) long and 3.69 m (12 feet) wide, with a total floor area of 22.3 m^2 (240 square feet). About 70 trees are grown to a height of 1 m (39.37 inches) in each bay. Populations of spider mites reached extremely damaging levels as evidenced by the wide spread chlorosis and the webbing covering the leaves. On March 28, 1991, prior to the beginning of the program, dienochlor (Pentac® Aqua Flow) was applied at label rate to suppress *T. urticae* populations (½ tea spoon AI per gallon). This was done to provide a more favorable predator-to-prey ratio and increase the probability that the released predators might manage pest populations (Hussey and Scopes 1985, Weinzerl and Henn 1991).

It has been reported that for proper control of the two-spotted spider mite, 10 to 50 predators were needed per plant (Hussey and Scopes 1985, Weinerl and Henn 1991). Because there are no published recommended release rates for Populus spp., we estimated what our release needs would be, based on pest infestation and tree size. On April 6, 1991, 1,000 of each of two predator mites----*Phytoseiulus persimilis*-Athias-Henriot and *Amblyseius californicus* (McGregor)-were released on 150 trees (Weinzierl and Henn 1991), a ratio of 13.3 mites per tree (Pest Management Supply, Amherst, MA). Because of high temperatures in the greenhouse (> 32.2 °C), the predators died, making this release a failure. When the

temperature was more moderate (< 26.5 /C), the same number of mites was released on April 11, 1991. An additional 1,000 *A.californicus* were released .on September 26, 1991, to increase the numbers of mites and provide added control of the pest during the hottest part of the summer. Trees were monitored daily for symptoms of pest mite population increases. Leaves were sampled randomly every week to determine the continued presence of predators. No additional labor costs were added to the program as both these surveys were conducted while watering the trees.

Results and Discussion

Suppression of spider mite. Before we began the IPM program, we had to use a weekly application of a miticide to ensure that our trees had low levels of damage. Whenever we reduced the frequency of application to a biweekly schedule in an attempt to reduce pesticide use and cost, spider mite populations consistently reached outbreak levels and the majority of leaves on our trees were heavily damaged. This damage compromised the quality and quantity of the food supply for our insect colony and reduced growth of the trees.

Over the 1-year period since we began the IPM program, predators have provided good levels of spider mite suppression. Only four additional spot applications of dienochlor (¼ teaspoon AI in ½ gallon water) were required to suppress minor outbreaks on some of the trees.

The qualitative measures of effectiveness of this IPM program were (1) the lack of damaged, chlorotic leaves and mite webbing, (2) the lack of a need to spray miticide to ensure food quality for the insect colony, and (3) the continued presence of predator populations on the trees throughout the entire year period, as evident on weekly randomly sampled leaves.

Economic benefits. The key to success for an IPM program is vigilant monitoring of the plants for symptoms of insect activity or damage. In our project, personnel needed no additional training as they are entomology or pest management students (figure 1). However, other organizations that implement an IPM program will probably need to train their personnel to scout for pest problems, preferably while performing other tasks such as watering. This will ensure that outbreaks are stopped before they become damaging.

Because of the rapid reproduction rate of the pest, miticide had to be applied weekly to ensure healthy trees. In addition to the cost of the miticide, there are many extra costs associated with weekly spraying:

Figure 1 -*Entomology student monitoring greenhouse-grown poplars for pest and predator activity.*

Someone from the project had to spray the miticide, which took about 2.5 hours each week to mix and apply. At a base pay of $5.00/hr for student labor, spraying costs $650.00/year in wages. The sprayers need to wear protective clothing (table 1). The filters for protective masks (changed monthly, at $4.39/pair) cost $52.68 annually, gloves (replaced monthly at $1.21/ pair) cost $14.52, and coveralls (replaced every other week at $4.70 each) cost $122.20 annually. (These are 1991 prices obtained from the Iowa State University's Central Stores Catalog.)

Table 1 -*Economic comparison between two methods for management of the two-spotted spider mite* (Tetranychus urticae) *on greenhouse-grown Populus, Ames, Iowa (March 1991-March 1992)*

	Integrated pest management*	Pesticide application†
Predator release 1	$ 37.20	$ 0.00
Predator release 2	37.20	0.00
Predator release 3	13.00	0.00
Pesticide‡	0.90	15.60
Labor	20.00	650.00
Protective coveralls	9.40	122.20
Filters	0.00	52.68
Gloves	0.00	14.52
Total	$117.70	$855.00
Estimated savings	$737.30	

*Three releases of predator mites (Phytoseiulus persimilus and Amblyseius californicus) plus 1 initial and 4 spot applications per year of dienochlor (Pentac®), ¼ tsp. AI, ½ gallon solution per application.
†Weekly application of dienochlor (Pentac®) ½ teaspoon AI per gallon of water, 2 gallon solution per application
‡Pentac® Aqua Flow price is $57.50 per quart. Actual cost of annual applications, based on amount of pesticide applied in IPM program
(one initial application and four spot program.treatments), and weekly miticide applications in non-IPM

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Conclusion

The use of an IPM program involving the release of two species of predators was determined by us to be effective in controlling two-spotted spider mite in our greenhouse environment. Although this was not a quantitative, controlled experiment, it does illustrate the practical applications of an IPM program in a greenhouse environment. The purpose of this program was to reduce our pesticide use while maintaining healthy food trees for our insect colony. We reached this goal 1 year after we began this program, on March 28, 1991, and as an added benefit we saved $737.30 in wages and protective clothing. This, along with freeing time for other purposes and alleviating concerns by non-project personnel, is seen as a positive attribute for the IPM program. We believe that this program has made a substantial contribution to our project and will have many long-term benefits.

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