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An Integrated Pest Management Success Story: Orangestriped Oakworm Control in Norfolk, Virginia, U.S.

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Abstract. Pesticide applications directed against the orangestriped oakworm declined by over 80% the first year after implementation of an aesthetic injury threshold into an Integrated Pest Management program. After a moderate resurgence 2 years later, pesticide use further declined with no pesticides applied against this pest in the past 7 years. Cost and pesticide use decreased from $6,795 and 55,000 L (14,300 gal) in 1986 to $877 and 7,800 L (2,028 gal) in 1988 and no cost since 1999.

Key Words. Aesthetic injury level; *Anisota senatoria*; Integrated Pest Management.

This study reports the long term impact of a key component of the municipal shade tree Integrated Pest Management (IPM) program in Norfolk, Virginia, U.S.—the suppression of orangestriped oakworm, *Anisota senatoria* (J.E. Smith) (OSO). Initial objectives in 1986 were to determine whether a monitoring program coupled with establishing an aesthetic injury level could be used to suppress OSO with reduced pesticide input. The objective was to revisit this study site and evaluate the long-term results and impacts 20 years after implementation.

The OSO is a native insect and an occasional pest of forest trees and urban plantings from eastern Canada to Georgia, westward to Minnesota, Kansas, and Texas (Felt 1905; Houser 1918; Becker 1938; Drooz 1985). Major outbreaks of this insect have occurred in Connecticut, Michigan, New Jersey, New York, Pennsylvania (Johnson and Lyon 1988), and Maryland (Smith and Raupp 1986). Adults appear from late June to early August and lay golden yellow clusters of 200 to 500 eggs on foliage of lower branches. Oaks (*Quercus* spp.) are preferred hosts, but birch (*Betula* spp.), hickory (*Carya* spp.), filbert (*Corylus* spp.), and maple (*Acer* spp.) are also attacked. Early instars are gregarious and skeletonize foliage, whereas later instars consume entire leaves leaving only the main vein. During September, larvae migrate from the trees and pupate in the soil.

Approximately 10,000 oaks, primarily willow oak (*Quercus phellos* L.) and pin oak (*Quercus palustris* Muenchhausen), have been planted along municipal streets and in parks in Norfolk, Virginia, over the last 70 years. Management of trees planted on public property is the responsibility of the Bureau of Parks and Urban Forestry (BPUF), a division of the Norfolk Department of Recreation, Parks and Open Space. Severe defoliation of municipal trees by OSO was first noted in 1981, and citizen complaints to BPUF and elected officials subsequently increased each year. Based in part on the economic value of urban oaks (Diamond et al. 1987), public outcry about the tree defoliation, and OSO frass on city sidewalks, large amounts of pesticides were applied to infested trees in the 1980s. Pesticide applications for OSO control were focused in neighborhoods where citizen complaints originated. The policy for OSO control was to treat on municipal property at specific addresses where infested trees occurred in response to citizen requests. This policy was controlling OSO; however, it added significant pesticide load to the urban environment and was not cost-effective. Treating entire city blocks achieved better suppression but increased the pesticide volume. Pesticide use for OSO suppression increased for 6 consecutive years reaching a peak in 1986 when 55,172 L (14,345 gal) were applied (48% of all pesticides applied to municipal trees).

METHODS

A research study was initiated in 1987 to identify the impact of OSO defoliation, the pest with the greatest pesticide input, on both the urban street trees and on citizen tolerance for insect injury with the objective of reducing pesticide load and municipal costs without alienating citizens (Coffelt and Schultz 1990). Establishment of an aesthetic injury level (AIL) was conducted by university and BPUF staff presenting photographs of trees with quantified defoliation to citizens residing in the infested Norfolk neighborhoods. Citizens were shown photographs of five defoliation levels (15%, 25%, 50%, 75%, and 100%) and were asked what level of damage they were willing to accept (0% was provided verbally as a choice). In addition, the effect of different levels of defoliation on tree vigor was measured by measuring root starch content. Survey data showed that 70% of the respondents were willing to tolerate some defoliation (Coffelt and Schultz 1990) with 28% of the citizens considering 25% defoliation aesthetically acceptable. In addition, analysis of the effect of defoliation on root starch content indicated that 25% defoliation or less would not affect tree vigor (Coffelt and Schultz 1990). Use of 25% defoliation as the threshold provided BPUF employees with guidelines of monitoring oak trees on municipal property and making treatment decisions based on the results of their monitoring. Beginning in 1988, only trees on municipal properties that exceeded 25% damage were treated with pesticides to suppress OSO. Pesticide application records from 1981 to 2005 were obtained from BPUF, and quantity and selection of pesticides directed to OSO suppression were identified.

RESULTS AND DISCUSSION

In 1988, the results of implementation of IPM practices were immediate and impressive (Figure 1). Monitoring infested trees and using the 25% AIL resulted in a decrease in pesticide use from 39,860 L (10,364 gal) to 7,866 L (2,045 gal), an 80.3% decrease. There was resurgence in OSO populations in 1989 and 1990 that resulted in pesticide applications of 18,000 L (4,680 gal) and 32,399 L (8,424 gal), respectively. A steep decline in pesticide use began in 1991. From 1991 to 1998, pesticide applications ranged from 0 (in 1992 and 1994) to 1,573 L (409 gal) (in 1991) with a mean of 250 L (65 gal). From 1999 to 2005, no pesticides were applied for OSO suppression.

The sharp decline in pesticide use is attributed to the implementation of several IPM strategies. We feel that the use of the 25% AIL was the key component of the control strategy. It was supplemented by early season monitoring and physical removal of egg masses with pole pruners. The city also changed from synthetic to microbial pesticides. Before 1989, all applications for OSO were full-coverage hydraulic sprays with either organophosphate or carbamate insecticides. Beginning in 1989, *Bacillus thuringiensis* was the primary method of control; it was applied by backpack sprayers to the lower tree limbs where most oviposition occurs (Coffelt and Schultz 1994).

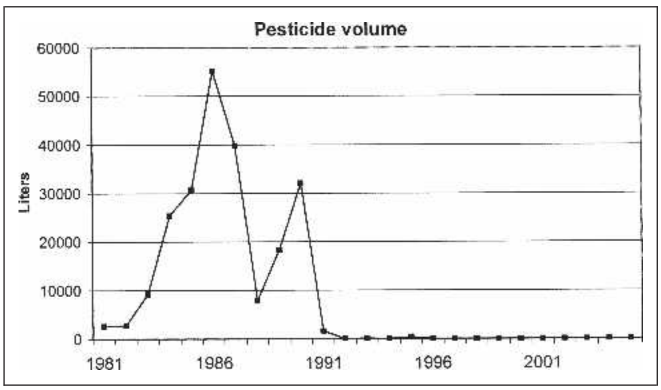

Figure 1. Pesticide volume for suppression of orangestriped oakworm in Norfolk, Virginia, 1981 to 2005.

By using the AIL as a decision-making tool, Norfolk could apply a uniform intervention standard to the entire city while practicing IPM. Despite the initial success of the program, citizen requests for pesticide application continued for a few years after implementation, no doubt resulting from citizen expectation of "spray on demand" service from prior years. Calls to BPUF and demands for treatment decreased as citizens became informed about the IPM strategies in use by BPUF through educational programs delivered by Cooperative Extension. Benefits to the city from the implementation of IPM were reducing insecticide costs for OSO suppression to nearly zero (1991 to 1998) and eliminating them entirely (1999 to 2005). As pesticide applications decreased, labor expenses shifted from pesticide application to monitoring of the trees. Even with the additional duties, the total annual cost of OSO management remained below that of the previous 4 years (1984 to 1987) when spraying without monitoring was the standard (Coffelt and Schultz 1990). By 1995, with OSO populations reduced to barely detectable levels, Norfolk eliminated its "spray unit" and reassigned personnel to other roles. With Norfolk's location bordering portions of the Chesapeake Bay and several of its tributaries, a reduction of the amount of pesticides applied to municipal street trees generates a positive environmental impact. Intangible benefits include increased citizen awareness and recognition of the municipality being proactive in environmental stewardship.

IMPLICATIONS FOR ARBORICULTURE

The long-term benefits of using IPM to lead from the pesticide-first strategy to monitoring and scouting with management decisions based on aesthetic injury levels were demonstrated. Scouting when oviposition is expected, mechanically removing egg masses, using a 25% aesthetic injury threshold, and selecting *Bacillus thuringiensis* as the control agent were the elements in the successful control strategy. The results show that after IPM implementation, pest populations can remain below aesthetic injury levels for extended periods, currently at 14 years.

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Résumé. Les applications de pesticides contre l'anisote à ligne orangée ont diminué de 80% durant la première année suivant l'implantation d'un programme de lutte intégré comportant un seuil de dommages esthétiques. Après une résurgence modérée deux ans plus tard, l'emploi des pesticides a par la suite décliné pour finir avec aucun emploi au cours des sept dernières années. Le coût et la quantité de pesticides ont diminué de 6795$ et 55000 litres en 1986 à 877$ et 7800 litres en 1988, et à finalement aucun coût depuis 1999.

Zusammenfassung. Die Pestizidapplikationen gegen den orangegestreiften Eichenwickler gingen in dem ersten Jahr der Einführung eines ästhetischen Schwellenwertes in ein Integriertes Pflanzenschutzprogramms um 80% zurück. Nach einer Wiederauflebung zwei Jahre später sank der Pestizideinsatz noch weiter bis hin zu keinem Einsatz in den vergangenen 8 Jahren. Die Kosten und Pestizideinsatz sanken von $6795 und 55.000 l in 1986 auf $877 und 7,800 l und seit 1999 auf keine Kosten mehr.

Resumen. Las aplicaciones de pesticidas directas contra el gusano rayado naranja del encino declinaron arriba del 80% después del primer año de implementación, como un protector estético contra el daño, dentro de un programa de manejo de plagas. Siguiendo a un resurgimiento moderado dos años después, el uso del pesticida declinó más allá de la no aplicación de pesticidas contra esta plaga en los pasados siete años. El costo y uso del pesticida desminuyó de $6795 y 55,000 litros en 1986 a $877 y 7,800 litros en 1988 y sin costos desde 1999.