Nursery Integrated Pest Management in Wisconsin

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Summary. A Nursery Integrated Pest Management program was initiated in Wisconsin in 1991. From 1991 to 1993, the educational and monitoring program enhanced grower familiarity with the IPM concept, as well as provided detailed information on the pest problems common to woody landscape plants in Wisconsin. Educational features of the program include twilight seminars and winter workshops, a pest control guide that described the management strategies available for pests of woody landscape plants, and also statewide pest reporting and pest predictions.

Widespread concern over pesticide residues on various commodities and contamination of the environment has precipitated a change in traditional pest management practices. A response to such concerns has resulted in a variety of programs, frequently referred to as Integrated Pest Management (IPM) or Best Management Practices (BMP). Regardless of nomenclature, significant program objectives are aimed at creating greater efficiencies in the control and/or management of pest species. A majority of the IPM programs to date have targeted agronomic and edible horticultural crops. However, considerable pesticide use occurs on non-edible commodities. One such area includes the nurseries that produce landscape plants. Historically, preventative pesticide applications 'in nurseries were made to ensure production of high-quality, saleable stock. Through the implementation of IPM principles, Wisconsin nursery operators have eliminated unnecessary preventative pesticide applications without sacrificing product quality.

The nursery industry in Wisconsin is large and diverse. There are >700 licensed nurseries, ranging in size from < 5 acres to >1000 acres. The greatest concentration of nurseries is in the southeastern section of the state, where major metropolitan areas are located. Coincidentally, the locations including a number of major Wisconsin watersheds. As a result, concerns for improving environmental quality are paramount.

Through the cooperation of the Wisconsin Dept. of Agriculture, Trade and Consumer Protection (WDATCP), the Wisconsin Nurserymen's Assn. (WNA), the Univ. of Wisconsin-Extension (UWEX), and the Univ. of Wisconsin Integrated Pest Management Program, a Nursery IPM Program was launched in May 1991. Program development

involved nursery growers and county horticulture agents from the beginning through meetings with representatives from the Wisconsin Nurserymen's Assn. Through their response at the planning meetings, as well as the response of participants through surveys distributed at the end of each season, the program coordinator was able to incorporate the nursery industry's needs and interests.

A survey of pest management practices was conducted during the first year of the program as a joint effort between the UWEX Nursery IPM Program and the Wisconsin Agricultural Statistics Service. Partial finding was made available through a grant from the National Agricultural Pesticide Impact Assessment Program. The survey was mailed to 100 nursery operators selected at random from throughout the state. Questions ranged from which pesticides were used commonly in the nursery to what the nursery operator believed were the most serious pests—from an economic standpoint as well as pest abundance. In addition, the survey asked which non-chemical pest management measures were used and what factors played a role in the selection of non-chemical alternatives. Finally, survey recipients were asked what information sources were used in helping them make pest management decisions.

The grower survey resulted in an interesting contrast between their perceptions and the actual scouting findings. Growers indicated their primary pest problems were, in decreasing order of importance, weeds, white-tailed deer, rabbits, aphids, the eastern tent caterpillar (*Malacosoma americanum*), and mice. These six pests represented the majority of pest problems reported. All other pests were reported by < 10% of the total population surveyed. When the top six pests were compared with the observations made by the scout and the cooperator during the first field season, different sets of significant pests were identified. Plant bugs, aphids, leafhoppers, leafminers, verticillium wilt, anthracnose, and scab were determined to be the top pest problems in Wisconsin nurseries. The inconsistency between the two lists is attributed largely to improper pest identification. Most nursery operators were able to identify weeds positively as a problem, and they knew the characteristic damage caused by deer, mice, and rabbits. However, symptoms of verticillium wilt in ash and maple were attributed to drought stress and not associated with a vascular pathogen. Similarly, leafhopper injury, which results in the resetting of the terminal shoots of various species, particularly in maple, was not associated with the causal insect because the perpetrator was rarely present when the damage was noted. These are just two examples of misdiagnosis of pest problems; it is suspected there may be more. Proper diagnosis is the first important step in implementing a proper management strategy. Through the educational aspect of the Nursery IPM Program, growers are made more aware of the different types of pest damage.

The Nursery IPM Program consisted of two primary components: Monitoring and education. Initially the program included a five-county demonstration area in southeastern Wisconsin. Five nurseries responded to a request mailed to all licensed nurseries within the demonstration area, indicating that they wished to participate in the scouting program during the pilot year. The total area included in the five participating nurseries was 58 acres. In 1992, a mailing was made again to all licensed nurseries within the five-county demonstration area. Comments from first-year

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participants were favorable, and were believed to play a role in the doubling of enrollment the second season. Over a 2-year period, program involvement increased to include statewide participation.

Nurseries enrolled in the Full IPM Program (whereby a trained program scout was enlisted to regularly monitor nursery stock) were assessed a \$24/acre charge during the first 2 years to cover the cost of scouting. This charge was increased to \$26 during the third season to cover increased costs in transportation and wages. The program scout hired for the 2nd and 3rd years of the project was an undergraduate student in horticulture and landscape architecture. He was provided with hands-on training by the coordinator, as well as university faculty and staff. Despite the scout's initial lack of formal education in basic entomology and plant pathology, he was quick to learn the common pests associated with the trees and shrubs of Wisconsin. His interest in learning more about the problems associated with the culture of woody landscape plants motivated him to investigate further any unknown problems he encountered. The scout's salary started at \$5/h the first year, but was increased to \$6/h the second season as he became more experienced and independent. The cost of scouting generally was recovered through a reduction in pesticide applications, proper timing, or the elimination of unnecessary treatments on pest populations that did not approach the threshold level.

The Wisconsin Nursery IPM Program was supported through supplemental funding in addition to the per-acre charge assessed growers participating in the Full IPM Program. It is believed that private industry would not be able to offer a similar low-cost monitoring service, because a private consultant would not have free access to all of the resources available in a university-based program. Growers indicated that they would pay as much as \$30/acre for the services provided; however, this figure still may not provide sufficient financial resources necessary for a private consultant to become successful.

The scout visited each nursery on a weekly basis in the first year to assess the stock. During the 2nd and 3rd years, monitoring frequency was decreased to biweekly based on observations of pest population dynamics during the first year. It was observed by the coordinator that annual insect pests such as leafminers, plant bugs, potato leafhoppers, and sawflies developed at a rate that did not change population levels significantly from one visit to another. Disease development also was not rapid enough to warrant monitoring on a weekly basis. Because of the larger plant size and length of establishment of most of the stock scouted, root-rot problems were of little concern. Other diseases, such as foliar pathogens like scab, rust, powdery mildew, or anthracnose, in most situations did not pose a life-threatening condition on the host. Once a disease was reported, progression and continued infection of healthy tissue continued at a slow to moderate rate. In situations where a potential for rapid development was present, such as the case with an aphid infestation, the nursery manager was alerted to the affected plants and was recommended to monitor these plants between scouting visits.

Inspection was primarily visual and relied on the "key plant-key pest" concept to narrow the amount of plant material inspected at each visit. Under this concept, only those species of plants with known susceptibility to injurious disease and insect pests at the time of the visit were in-

spected. For example, early in the season, during the month of May, the scout would concentrate on monitoring pine for the early instar larvae of the European pine sawfly (*Neodiprion sertifer*), and pine needle scale (*Chionopsis piniifoliae*) crawlers if a scale infestation was present. In addition, ash and honeylocust were monitored for plant bug presence and lifestage and birch leaves were examined for early evidence of birth leaf miner (*Fenusa pusilla*) activity. As the season progressed into July, it was no longer necessary to continue monitoring for the early season pests previously described. At this time, mites and foliar pathogens became a problem. Primarily, an aesthetic threshold level was used whereby the pest population density represented the amount of damage that reduced the saleable quality of the plant. Because this concept is quite subjective, actual pest population levels were reported to provide some consistency to the evaluation. Trees that were not for sale the year of inspection were allowed a higher level of damage by foliar-feeding insects and foliar pathogens. A comparison was made between the number of insects or amount of disease present and the amount of cosmetic damage to the plant. This value may then be applied in future years as trees approach marketability, when less aesthetic damage is tolerated. With the comparison of cosmetic damage to population levels, the grower is better able to decide whether or not to treat a particular plant to prevent excessive damage.

Through phenology and degree-day accumulations, pest development was tracked and management practices were implemented before populations exceeded threshold levels. The method of degree-day calculation used was that of a modification of the rectangular method described by Arnold (1959). A developmental minimum temperature of 50F and maximum temperature of 86F were used in calculating daily heat accumulations. Degree-days were calculated beginning 1 Mar. and continued through 31 Oct. of each year. The dates were chosen because, in Wisconsin, temperatures outside of this period are typically too cold to support significant insect or disease development. In addition, during the period from 31 Oct. through 1 Mar., most deciduous plants are defoliated and in a state of dormancy. The use of degree-day accumulations was particularly beneficial in timing pesticide applications to manage oystershell (*Lepidosaphes ulmi*) and pine needle scales. Pest population densities and distributions were recorded during each visit; this record was consulted prior to subsequent visits to determine the progression of the infestation.

In addition to visual monitoring, the use of pheromone traps to determine the emergence of specific indigenous insect pests aided the nursery operator in the timing of chemical pesticide applications when necessary. Some insects monitored through the use of pheromone traps included the Japanese beetle (*Popillia japonica*) and gypsy moth (*Lymantria dispar*), two pests that currently are regulated in the state by the WDATCP. At this point, Wisconsin has only isolated outbreaks of gypsy moth, primarily located on forested sites—widespread defoliation has not occurred. At present, the WDATCP is working closely with the Dept. of Natural Resources to monitor for gypsy moth throughout the state in an attempt to prevent further spread of this potentially serious pest. Although several outbreaks of Japanese beetle have been observed, these instances have been contained successfully and eventually eradicated. Because the Japanese beetle has not become

established in Wisconsin. It is the goal of the WDATCP to prevent establishment from occurring in the future. An extensive trapping network is in place within nurseries throughout the state. This trapping network is designed to detect isolated infestations that may result from a shipment of infested material to Wisconsin. Through this effort, widespread establishment of the Japanese beetle may be prevented.

Another group of insects frequently monitored are the clearwing borers. Nurseries growing ash were recommended to place pheromone traps in their ash plantings to monitor for the presence of the lilac borer (*Podosesia syringae*), which commonly attacks ash in Wisconsin. Often this insect can go undetected in a nursery until evidence of damage is apparent. At this point, it may be too late to implement successful management practices. One of the nurseries participating in the scouting program had been plagued by a problem with lilac borers. Traps were placed in ash plantings in late May and were monitored daily by the nursery manager. During the 2nd week of June, a significant increase in adult borers, from < 10 to > 30, was noticed in the trap over a 4-day period. Three days following the increase, all ash in the block were treated with chlorpyrifos. Follow-up trapping during 1993 indicated that the population of borer adults was reduced significantly, from > 40 trapped during 1992 to < 10 the following year.

After each visit, the scout submitted a report to the nursery operator relating information on pests identified, host species, and severity of the infestation. Pest management recommendations were not made by the scout. Such recommendations were provided in a timely fashion by either faculty at the Univ. of Wisconsin or the County Cooperative Extension Horticulture Agent. Because the Nursery IPM Program operated out of the College of Agricultural and Life Sciences at the Univ. of Wisconsin-Madison, the project coordinator was able to keep in close contact with faculty and specialists in the Depts. of Horticulture, Entomology, and Plant Pathology. As problems arose, the coordinator was able to contact appropriate faculty or staff for diagnostic assistance or recommendations for management. The coordinator then contacted the nursery operator, usually within 24 h of the last visit, and provided the suggested recommendations. It was the nursery operator's decision whether or not to implement the recommendations.

The Full IPM Monitoring Program was designed to target nurseries between 5 and 50 acres in size. Larger or smaller nurseries were invited to become cooperators and provide pest-sighting information to the WDATCP's weekly *Cooperative Pest Survey Bulletin*. The bulletin is a publication that provides information collected from state survey entomologists and plant pathologists, as well as various cooperators within the state for a wide variety of crops. Cooperators differed from the participants in the Full IPM Program in that they only provided information to the bulletin staff that included the pest sighted, host species, relative severity, and the county in which the nursery was located. Growers participating in the cooperator program were not given recommendations for management, nor were they required to submit regular scouting reports. The benefit gained was a greatly expanded section covering the pests of woody landscape plants in the bulletin. Migration of exotic insect pests, such as leafhoppers, could be tracked

from the southwestern section of the state eastward and then northerly along Lake Michigan. In addition, indigenous insects followed the same pattern of development because degree-day accumulations occurred at a faster rate in the southern sections of the state. Nurseries in east-central Wisconsin could watch the migration of leafhoppers or other insects in counties south and west of their location and determine from historical experience when they first could expect to notice the pest in their nursery. More than 30 cooperators from throughout the state participated in this program during the first 2 years of the project. As a result of the increased coverage of woody landscape plants, subscriptions to the bulletin increased by $\approx 10\%$.

In addition to the monitoring programs, an extensive weather network was used with the cooperation of the extension agricultural meteorologist to provide degree-day information for locations statewide. A network of 185 weather stations throughout the state collects information such as maximum and minimum temperatures, precipitation, evapotranspiration rate, and wind speed on a daily basis. This information is relayed to the main weather office in Madison. The entire process is computerized, and information is automatically updated. For insect pest predictions, only temperature information is necessary. By tracking maximum and minimum temperatures throughout the growing season, degree-day information was updated daily and made available to subscribers of the Univ. of Wisconsin's WISPLAN computer network the following day. WISPLAN is available in all of the County Cooperative Extension offices, as well as to growers who wish to subscribe for a monthly fee. Growers not subscribing to this network may receive degree-day accumulations on a weekly basis in the *Cooperative Pest Survey Bulletin*. All licensed nurseries in the state received a subscription to the bulletin, as a benefit of licensing. The *Cooperative Pest Survey Bulletin* was published first in 1956. This was to fulfill a requirement for the receipt of federal funding to conduct pest surveys throughout the state. Additionally, Wisconsin has a state statute that indicates that endemic as well as exotic pest outbreaks must be reported to any concerned growers within the state. Growers were encouraged to purchase their own maximum-minimum thermometers and calculate degree-days to provide a more-accurate estimate of degree-day accumulation for their particular location. Those growers who preferred to use indicator plants to aid in pest prediction were referred to *Coincide* by Orton and Green (1989). Information included descriptions of the common insect pests of the upper midwest. It also provides information on the insects' life cycles and correlations of critical life stages to indicator plants. Plant species chosen as indicator plants must be common to a wide geographic range and must possess succinct phenological features such as period of flowering or fruit-ripening. Common indicator plants used in this book include *Magnolia x soulangiana*, *Syringa vulgaris*, and *Spirea x Vanhouttei*, to name a few.

Educational programs offered by the Nursery IPM project were well-received. Monthly twilight seminars were held throughout the growing season at host nurseries within the demonstration area. A 2-day pest management seminar was held annually during the winter. Exhibits at the Wisconsin Nurserymen's Assn. Summer Field Day, as well as at the Mid-Am Exposition in Chicago, provided an opportunity for nursery operators to test their pest identification knowl-

edge. Collections of insects were preserved to be used as teaching aids at various events. In addition, Riker mounts of plant damage as a result of disease or insect activity were available. Nursery operators were encouraged to examine unlabeled samples and attempt to determine the pest or cause of damage. Because proper pest identification is critical to successful pest management, the improvement of pest identification skills is important. Regular informative articles on various pests or other IPM-related topics appeared in the Wisconsin Landscape Federation's monthly publication, *Green Side Up*.

In June 1991, the first twilight seminar was held. The seminars were informal; there was no preregistration necessary and no fee was charged. Participants were encouraged to bring samples of perplexing pest problems to share with the group. Some of the topics discussed included insect and disease identification and management, non-chemical alternatives for weed control, plant nutrition, new cultivars, pesticide regulations, and regulated pests. The seminars were designed to be interactive between the speaker and the participants, as well as among the participants themselves. During the 2-h seminars, the first hour included a discussion by the evening speaker. Following this presentation, the host nursery conducted a tour of the facility and demonstrated practices that may be unique to the operation. The twilight seminars were well-received by the nursery industry and by arborists, grounds maintenance personnel, landscape contractors, and others concerned with the culture of woody landscape plants. Average attendance at each seminar was ≈ 35 to 40.

A 2-day, in-depth Nursery Pest Management Seminar was offered in Feb. 1992 and 1993. These seminars examined cultural and pest management issues concerning woody landscape plants. Basic insect taxonomy and plant pathology, as well as more-advanced insect identification and disease diagnosis, were presented. Nutrient management, weed management, and environmental disorders also were discussed. During both program offerings, attendance surpassed the upper limit of 75. As a result of the overwhelming response, this educational seminar is expected to become an annual training session.

Two publications were created as a result of the Nursery IPM Program. The first, *Woody Ornamentals Pest Control Guide*, was designed to provide both chemical and non-chemical pest management information and a listing of all disease and insect pests specific to Wisconsin' cultivated woody hosts. Phonological information also was provided to assist growers regarding proper pesticide timing. About 1500 copies of the *Woody Ornamentals Pest Control Guide* were printed and distributed each year. At present, the publication is being adapted to become a UWEX Cooperative Extension publication. It will be available for sale through the UWEX Cooperative Extension publication office in May 1994.

The second publication was a scout training manual designed to aid the program scout, as well as nursery operators, in disease and insect identification. Unlike other resource materials, this manual addresses only those pests common to Wisconsin. Descriptions of each disease or insect are given. Pest photographs are included when available. In addition, a description of the pests' characteristic damage and life cycles are included. A list of host plants and scouting tips also are provided to assist scouts in locating infestations.

Overall, the Wisconsin Nursery IPM Program has been well-received. As the project is turned over to various agencies and individuals outside of the university for continuation, IPM enjoys strong support by the Wisconsin Nurserymen's Assn. and the Wisconsin Dept. of Agriculture, Trade and Consumer Protection. Although the program is viewed as a success, there are nurseries in the state that maintain their traditional pest management practices. However, with strong interest by their organization, state agencies, and public demands, more of these individuals are likely to adopt IPM programs.

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