Indiana University Sustainability Task Force on Campus Sustainability

Integrated Pest Management

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Executive Summary

The purpose of the Integrated Pest Management (IPM) internship was to evaluate the current pest management situation at Indiana University Bloomington, research pest management programs at other universities, and recommend changes to implement an IPM program at IU. IPM is the recommended method of sustainable pest control because it emphasizes prevention of pest problems through restriction of access to food, water, and shelter in areas of indoor concern and through competition with species in landscaped areas. IPM incorporates education of the community population to recognize and report or remediate conditions that may be conducive to pest problems and also to accept, when appropriate, some low levels of pest presence that do not present health or safety concern or interfere with the designated use of an area. Initially preventing pests reduces the need for future pesticide treatments and saves money that would be spent for such treatments. IU should adopt IPM because it is better for human health and the environment, a better management practice, and cost effective.

Five different entities manage pests at IU: Building Services, Athletics, Residential Program Services, Campus Division, and Indiana Memorial Union. For this study, visits of representative buildings and interviews with managers of each entity were conducted. During the visits, we examined for pests or evidence of pests, conducive conditions, and pesticides. Information gathered from the interviews included what pests were thought to be present, how they were treated, and who treated them.

Results from the study show that currently none of the entities are fully implementing an IPM program, although all entities are observing some aspects of IPM. In the past 10-15 years, pest control practices have been altered to reduce the toxicity of pesticides used and move away from routine applications in the absence of reported or observed problems. During our interviews, we encountered an open ethical response and willingness to achieve better pest management for the campus community. Recommendations were made for each entity to achieve the goal of full IPM implementation. One main recommendation is that better monitoring for pests is needed before pesticide treatments are applied. In addition, it is recommended for the five separate entities to work together and share information regarding pest control.

Definitions of IPM

- "IPM is a cluster of technologies (cultural, mechanical, biological, genetic, and chemical) which is an integrated application (based in biological information) designed to allow humans to compete with other species" (Lame 2005).
- "IPM is an effective and environmentally sensitive approach to pest management that relies on a combination of common-sense practices. IPM programs use current, comprehensive information on the life cycles of pests and their interaction with the environment. This information, in combination with available pest control methods, is used to manage pest damage by the most economical means, and with the least possible hazard to people, property, and the environment" (USEPA 2008).
- "IPM is an alternative pest control technique that manages and suppresses pests by preventing their access to food, water, and shelter" (Centers for Disease Control and Prevention 2007).
- According to entomologist RJ Prokopy, IPM is "a decision-based process involving coordinated use of multiple tactics for optimizing the control of all classes of pests (insects, pathogens, weeds, vertebrates) in an ecologically and economically sound manner" (Ehler 2006).

Introduction

Worldwide, awareness of sustainability is becoming more prevalent. Global issues such as climate change and oil depletion create the need to find more sustainable ways of ensuring our future. The United States Environmental Protection Agency defines sustainability as "meeting the needs of the

present without compromising the ability of future generation to meet their own needs" (USEPA 2008). The Indiana University Task Force on Campus Sustainability was formed to outline a sustainability plan for the university (Indiana University 2008). The Integrated Pest Management internship was created to promote sustainable chemical and pesticide use and develop a pilot IPM program for IU.

IPM is the recommended method of sustainable pest control by organizations such as USEPA and Centers for Disease Control and Prevention (USEPA 2008, Centers for Disease Control and Prevention 2007). Initially preventing pests eliminates the need for future chemical treatments and therefore saves money that would be spent for such treatments. IPM is a proactive holistic approach to preventing pests and addressing pest infestations by eliminating the conditions that allow pests to infest buildings and grounds. This is accomplished by modifying human behavior and habits rather than using pesticides. IPM is sustainable for human health by preventing or eliminating pests of public health significance and pesticides that can be harmful. IPM is economically advisable because it is more cost effective than traditional reactive pest control methods that are pesticide intensive.

The purpose of this paper is to discuss reasons to implement an IPM program, address the current pest management situation at IUB, look at how some other universities are managing pests, and recommend how to implement an IPM program.

Reasons to Implement an IPM Program

Indiana University should implement Integrated Pest Management for three reasons.

1. Human health and environment
2. Good management practices
3. Cost effectiveness

1. Human Health and Environment

Unnecessary exposure to pests and pesticides can have adverse effects on human health. It is important to control pests because many can cause disease, bites and stings, or respiratory problems (National Pesticide Information Center). However, using pesticides for such control can also have adverse health effects. Many pesticides operate as nerve poisons and endocrine disruptors (Baue 2003). This is especially a concern for children. IUB currently provides Campus Children's Center, Campus View Childcare Center, Knee High Day Care Cooperative, Sunflower Day Care Cooperative, and Hoosier Courts Nursery School (Campus Child Care Services IU Bloomington 2003) which offer services to over 200 families annually (IU News Room 2006). IUB also offers housing for students with families. A report from the Federal National Institute of Environmental Health Sciences describes the chronic effects chemicals can have on humans who are exposed during development. The damage to a person exposed to endocrine disrupting chemicals such as 2,4-D is often not seen until the person reaches adulthood or even middle age (Environmental Research Foundation 1993). 2,4-D is an herbicide used at IUB (Barbaris and Nathan 2008). In addition, researchers at Dartmouth College explain that 18 year old college freshman still have development and significant changes in their brain structure, which is part of the nervous system. The Brain of an 18 year old is very different then the brain of a person in their mid twenties (Dartmouth News 2006). In addition to toddlers and young children at IU child care facilities, many IU students may be at risk because nervous and endocrine systems are not fully developed until a person reaches their early twenties. It is important to not expose young college students to unnecessary chemical pesticide risks because they have not fully developed. Human brains do not stop developing until a person reaches their mid-twenties (Sohn 2008).

In addition to posing a hazard for human health, unnecessary pesticide use can also harm the environment. Pesticide residues can be transferred through water runoff and wind deposition, polluting and harming non-target organisms. For example, according to a study by the National Audubon Society, 10 percent of the bird population in the United States is killed each year due to pesticide exposure

(Californians for Alternatives to Toxics). Implementation of IPM would institutionalize the process of identifying and balancing the health and environmental risks and benefits of controlling pests by non chemical means, chemical means, or not controlling them.

2. Good Management Practices

IPM should be adopted because it is a better management practice. IPM is a good management practice because it consists of a measurable plan, includes all stakeholders, requires professional standards, is a proactive approach to problem solving, and documents all costs and actions. It is better for human health and the environment, can be more cost effective, is a better use of resources, involves the community, and enhances public images and relations. Currently at IUB, five different entities, IMU, Residential Program Services, Athletic Facilities, Campus Division, and Building Services, separately manage for pests. IU does not have a uniform centralized pest management system. In adopting IPM, these five entities could be trained together and follow the same written IPM policy, which would improve communication and efficiency.

Implementing IPM at IU is feasible from a management perspective because some of the necessary resources are already on campus. Among the five entities, there are several willing and able people who want to do IPM. These people could be a tremendous asset by utilizing their knowledge and experience. We found that other people who were less familiar with IPM were also interested. IUB should implement IPM to demonstrate through use the types of best management practices it instructs. IUB has several academic programs, such as in the School of Public and Environmental Affairs, which teach and promote environmentally friendly best management practices. It would be advisable for the university to implement and follow the same practices it promotes through its educational programs.

3. Cost Effectiveness

Cost effectiveness could be increased by adopting an IPM plan. Although the cost of implementing IPM may be higher up front due to pest prevention measures such as exclusion, the long term costs would be less. One reason for this is that preventative measures, such as sealing areas where pests can enter, will eliminate future pests and the need for pesticides. Even if IPM is slightly more expensive than traditional pest control, it usually is more efficient, therefore making it cost effective. Cost effectiveness would also be increased due to better management practices of centralizing an IPM policy for the five different entities. In a well managed, centralized system, it is much easier to determine where money is allocated and if there are satisfactory outcomes. Finally, people, especially toddlers and children, who are exposed to pesticides currently thought to be safe, may develop future health problems because the pesticides later prove to not be safe. Many pesticides once thought to be safe, such as DDT, have later proven to be hazardous to human health (Carson, 1962). Unnecessary use of such pesticides could have financially costly future health consequences.

IPM offers achievable and affordable reductions in pesticide use and complaints of pests. A study of IPM implementation in two school systems illustrated an average 71% reduction in pesticide use and 78% reduction in pest complaints over a two to three year time period (Gouge et al. 2006). A study of structural pest control services by competent service providers with an IPM based contract reduced pesticide use by 93% and pest complaints by 89%, with immediate reductions in insecticide sprays (Greene and Breisch 2002).

Current Pest Management

At Indiana University Bloomington, there are five different entities that control pests: Building Services, Athletics, Residential Program Services (RPS), Campus Division, and Indiana Memorial Union (IMU). These groups manage for pests separately and rarely communicate with each other. We visited

several locations to assess what pests were present, how they are managed, and what, if any, IPM practices are already in place.

Currently, there is considerable interest in implementing IPM at IUB. Our interviews revealed that many managers and employees of the five entities would like to implement more IPM practices or learn more about IPM. Student organizations, such as IU Green Campus led by Sarah Combellick-Bidney are also concerned. IU Green Campus was formed to express concerns and raise awareness of chemical use, and is a proponent of IPM practices including educating students about IPM, native landscaping, and creating and labeling habitats. One idea Sarah expressed in an interview is to involve students, particularly those in a science or health related program, in the application of IPM by shadowing IPM experts, researching current pest problems, and working on projects dealing with pest management. Another idea is to promote a native landscaping program. Currently, the biology department conducts indoor projects on native plants. This program could be expanded to accomplish native planting at specific outdoor campus locations. Green spaces could also contain signs with educational information about the habitat and how interested people can become involved in campus sustainability (Combellick-Bidney 2008).

Methods

In order to determine the current pest management situation at IU, we inspected several facilities across campus managed by the five entities. We examined four things: conducive conditions, pest infestations, pesticides, and the professional training of the pest managers. We also interviewed the managers of the facilities to determine what pests they had, how the pests were being treated, and who treated them. Appendix A contains the IPM checklist created for our inspections and interviews.

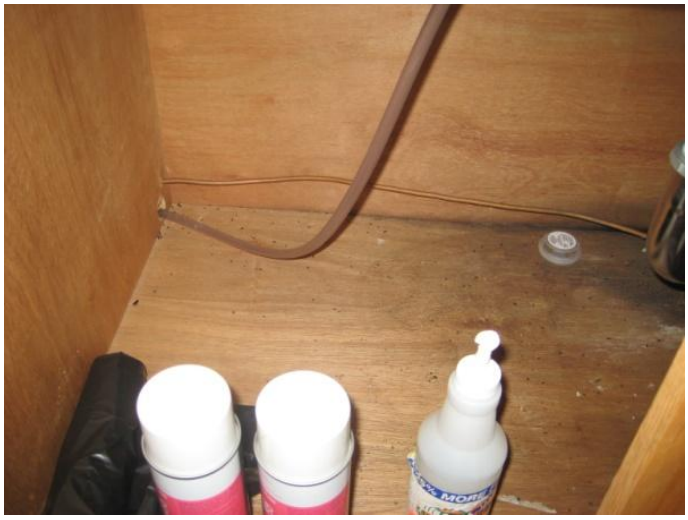
Building Services

SPEA 6/5/08

At SPEA, we visited the faculty lounge, basement, and exterior of the building. In the faculty lounge, we found significant evidence of mice. Large quantities of mouse droppings were found in all of the cabinets and cupboards, as well as near the toaster, in the silverware drawer, and in the corners of the floor. A follow up visit showed that there were more droppings present than the first time. It appears that nobody is responsible for cleaning this area. We found a cockroach ootheca (egg case) buried in the cushions of an upholstered chair. Conducive conditions in the faculty lounge include the outside door, which has gaps near the bottom large enough for a mouse to fit through, crumbs on the kitchen counter near the toaster, and hidden, dark, undisturbed habitat in the cupboards. In the basement, an old monitoring station containing dead mice was found. The mice appeared to have been dead for a very long time. It appears that although a monitoring station was put out, nobody had checked it for a very long time.

We walked around the outside perimeter of SPEA to locate pest entry points. On the east side at the base of the building, there were several small cracks and openings where pests could enter. Also, a bird feeder, attached to an upper story faculty office, is responsible for spilled seeds on the ground, which provides food adjacent to the exterior of the building for pests such as mice. At the SPEA loading dock near the dumpster, we found a few bait stations containing rodenticides. These were not strategically placed, as they were not in locations where a rodent would be most likely to encounter and feel comfortable entering them. Bait stations placed in such locations attract and poison non-target wildlife, such as chipmunks.

Evidence of Mice: The photos below were taken during our visit and show mouse droppings in the faculty lounge.



Further Evidence of Mice: The following photos show mice droppings in the utensil drawer and dead mice in a monitoring station in the basement of SPEA.

Building Services manages for pests in approximately 150 office and classroom buildings. Two state certified staff members allocate 10-15% of their time to pest control. American cockroaches are the most prevalent pests, with Goodbody Hall and several off-campus houses having the most complaints. Basements and machine rooms are the most problematic. Building Services Staff members handle complaints received from building occupants. Pests observed by Building Services include cockroaches, ants, bats, raccoons, mice, and centipedes.

Although regular inspections are not scheduled, custodial staff watch for pests. Some glueboards and monitoring stations are used. Boric acid is a low toxicity pesticide applied for cockroaches. A record log is kept for pest problems requiring treatment.

Athletics

Golf Course 7/17/08

We met Golf Course Superintendent, Brent Emerick, to discuss pest management and chemical use at IU's Golf Course. The Golf Course consists of 28 acres of fairways and tees, 5 acres of greens, 4 acres of driving range, and 2 acres for golf team practice. The major pests at the golf course are fungi such as dollar spot, grey leaf spot, and brown spot, annual grasses such as goose grass and broadleaf weeds, and organisms such as black cut worms. Inspections for these pests are performed daily. In addition to these pests, another problem facing the Golf Course is soil erosion in the surrounding woods. Although there is not a written pest control policy which is followed, chemical treatments for black cut worms are applied every month from mid-May through September. A proactive approach for treating fungi and plant pests is taken. Putting greens are treated weekly and biweekly for these pests. Golf Course applications are performed by IU personnel, and contract treatments are done on other athletic fields. No soil analysis or petiole analysis is done to determine the amount of soil fertilizers and chemicals needed to achieve the desired purpose. In the past, the Golf Course has lost turf when unable to proactively treat for fungus and disease due to lack of budget. In order to reduce conducive conditions at the Golf Course, factors such as 4-6 hours of daily sunlight, aeration, good drainage, and irrigation are essential. While IPM is not formally being implemented, Golf Course Management has knowledge of more environmentally friendly methods and welcomes a more sustainable IPM program.

Golf Course: These photos show the pest dollar spot and goose grass.

Residential Program Services

Halls Food Storage 6/12/08

Halls Food Storage has a contract with ARAB for pest control services. Although no critical problems, such as significant health hazards or pest populations were observed, several concerns exist with how this location monitors and manages for pests. Halls Food Storage and ARAB did not have a pest log to record pest sightings and treatments. We found old glue board monitoring stations and a trap dated from 2006. An outdated monitoring station containing three dead mice was found. These monitoring stations need to be checked more frequently. Rat poison without a date and label was found. Pest evidence observed included mouse feces, dead mice, filth flies, and book lice.

Several conducive conditions were found. In the warehouse, boxes and other storage items were stacked on pallets and shelves. It is important to maintain an 8-10 inch clearance between the shelves and the wall in order to provide ventilation and visibility and reduce conducive conditions where small pests can hide. Not all of the storage stacks and shelves were spaced according to this standard. Condensation was observed in a few locations, which is a conducive condition for termites, carpenter ants, and mold. A few minor conducive conditions were also seen, such as bushes touching the outside of the building and indoor plants which were overgrown with dead vegetation.

Food Storage Findings: The following photos show pests found in monitoring stations and a corner without proper air clearance.

<u>Wright Quad 7/24/08</u>

RPS Health and Safety Manager, John Bruce, met us to discuss pest management at Wright Quad. Currently, German and American cockroaches and mice are the most prevalent pests at Wright Quad. ARAB treats for pests two times a month in the food service area with a pyrethroid flushing agent and gel bait for cockroaches. Records are kept in a binder and there is a clipboard in the kitchen where employees can report pest sightings. Annual inspections of the dorm rooms and quarterly inspections of married housing are conducted, but chemical treatments are applied only when a problem is found.

In the food storage area in the basement of Wright, some mouse droppings and dead rodents in a monitoring station were found. One food storage area did not have any monitoring stations. Outside near a dumpster, a rat trap was present but not operational because of its inaccessible location. One problem noticed is that Arab's service tickets indicate that there is an infestation, yet Wright does not appear to remedy the problem. We saw an ongoing infestation of German cockroaches in the food serving area. Better monitoring, sanitation, and communication are needed.

Wright Quad: The photos below show conducive conditions and a monitoring station in the kitchen, a pesticide in the basement of Wright, cockroaches on the basement storage floor, and three different types of cockroaches in monitoring stations.




<u>Campus View Apartments, Campus View Child Care Center, and Hoosier Courts Nursery School 7/31/08</u>

Campus View Apartments are managed by RPS and contract to ARAB for pest control. American and German cockroaches are the main pests. However, since the recent renovations of the building, no roach sighting have been reported. When residents move in, they are given a booklet and basic move-in information stating that residents are responsible for proactive pest control, such as keeping apartments clean. The Campus View Apartments manager says that there are currently no pests, but, according to ARAB service tickets, pesticides are being used. Pesticide applications are occurring when pests have not been reported, which is an inappropriate use. Although we did not see pest evidence or monitoring stations, conducive conditions, such as food and entry points, do exist. Campus View does not provide formal pest training for staff.

Campus View Child Care Center has a few mice and ants, but overall very few pests. ARAB formerly held their pest management contract, but now pest management is not contracted out to

anyone. Hoosier Courts Nursery School contracts to ARAB, which does monthly pest inspections. Monitoring stations and glueboards were found at Hoosier Courts Nursery School.

Campus Division

Campus Division Interview 8/1/08

We met Mike Girvin, Campus Division Manager. Campus Division is responsible for 2100 acres, and has approximately 30 employees that perform work related to pest management. Of this staff, only 3-4 people do 90% of the pest management duties. Campus Division is divided into the Ballantine Crew, Atwater Garage Crew, North Campus Crew, East Campus Crew, Construction Division, Arborists, and Mechanics. The first four groups have pest management responsibilities. Campus Division staff attends seminars and receives safety and handling procedure information for duties such as spraying chemicals, but do not have any formal pest management training and are not licensed pest control operators, which is necessary for an IPM program.

Campus Division applies pesticides either when a work order is received or for aesthetic reasons. The main pests Campus Division handles are broadleaf weeds, bag worms, and Japanese beetles which are treated with Merit. Wasps and Bees are exterminated by spot treatment with over the counter products. Campus Division has contracts with TruGreen for broadleaf weed control, Nature's Way, and Designscape for roundup application, lawn care, mowing and weed eating. Broadleaf weeds are spot treated with an herbicide as opposed to a general lawn application. TruGreen performs general applications to selected areas. Bag Worms are treated when observed or reported either by spraying or hand removal. Campus Division uses insecticidal soap upon request for outdoor functions. Insecticidal soap is typically sprayed in a 100 yd radius to kill soft bodied insects. Dormant oil (DO) is also frequently used by Campus Division as a mechanical control. Mowers are washed or air cleaned at the Campus Division Garage and maintenance such as blade cleaning is done at satellite shops. Using these designated locations for cleaning and maintenance is a disease prevention strategy. While IPM is not formally being implemented, the arborists apply their knowledge of biology with visual monitoring for plant protection. This group welcomes a more sustainable IPM program.

Indiana Memorial Union

IMU Commons 6/17/08

We met Steve Richards of dining services at the IMU Commons. The IMU has a pest management contract with ECOLAB. We did a tour and inspection of the extensive kitchen behind the Commons. The main issue we encountered was the poor sanitation level, especially underneath the counter tops and kitchen equipment. ECOLAB had an organized pest log containing the dates of inspections and types of treatment for the past year. The service reports indicate that roaches were treated with boric acid and orthene pellets and rodents were managed with weatherblock.

No monitoring stations were being used. The service tickets indicated that pesticides were applied on a regular schedule. These applications were not effective in managing pests based on the pests observed. German cockroaches were the main pest sighted. Numerous baby roaches were seen, which indicates a heavy infestation and recent outbreak. Due to the poor sanitation conditions, roaches in unseen locations, such as in the walls, door jams, or behind equipment, would not have to travel more than a few inches to find food. The sanitation level was low enough to prevent us from detecting pests such as the German cockroach, which would have no need to come out of hiding to travel far and find food. Since our initial visit, IMU and ECOLAB have been making changes based on our verbal recommendations and are working together to improve sanitation and pest control.

Memorial Union: The photos below show roach bait containing the pesticide chlorpyrifos and a potato found underneath kitchen equipment.

Is IPM Being Practiced?

Based on our visits and interviews, none of the entities that control pests are currently implementing a comprehensive IPM program. For example, improved monitoring is needed and pesticides are sometimes applied when pests have not been reported. This is an unnecessary use of chemicals because pesticides are designed to kill pests that are currently present and do not work preventatively. The table below illustrates for each entity which principles of IPM are being done and which are not.

Table 1: Principles of IPM which are and are not being practiced.

Entity	**Building Services**	**Athletics**	**RPS**	**Campus Division**	**IMU**
Contracts to	n/a	Various bidders, such as Turf Grass, Inc.	Arab	TruGreen, Designscape, Nature's Way	Ecolab
Chemicals are applied only when needed (not on a scheduled basis)		no	no	no for broadleaf weeds	no
Regular monitoring/ inspections for pests occurs	No	yes	yes	yes	no
Records are kept of pest sightings and treatments	yes	yes	yes	yes	yes
Staff/employees are educated about IPM practices	somewhat	somewhat at the Golf Course	no	no	no

Building Services

Building Services applies components of IPM such as record keeping and use of monitoring stations. Low toxicity methods, such as mousetraps and bait stations, are used for pest control. Chemicals of higher toxicity are not reported to be used.

IPM is not being practiced because IPM education is not provided for custodial staff and supervisors who inspect and care for the buildings. It appears that buildings are not inspected or monitored on a scheduled basis. The Pest Control Operators for Building Services are licensed, but do not have comprehensive IPM training. We found some inconsistency between what Building Services reports to do and what we observed. Building Services reports to be practicing IPM, partly because they monitor to keep building areas as clean as possible and use glueboards and monitoring stations. However, our visit at SPEA showed that certain areas were not being kept clean and monitoring stations were outdated and had not been checked recently.

Athletics

Although the Golf Course is not practicing comprehensive IPM, some principles of IPM are being followed. Daily inspections are performed for pests such as fungi. Golf Course personnel have knowledge of conducive conditions. In order to be least attractive for pests, a golf course needs 4-6 hrs of sunlight, aeration, drainage, and irrigation. Trees in the wrong location can also cause problems because they retain moisture which can harbor fungi.

The Golf Course is not practicing IPM because it is not implementing a proven host plant resistance strategy. Also, it does not conduct a soil analysis or petiole analysis. Chemical treatments are applied on a scheduled monthly basis from mid-May through September for black cut worms. Also, the Golf Course frequently contracts its pest management service to the lowest bidder, which often indicates that IPM is not being practiced.

Residential Program Services

RPS is practicing components of IPM, such as routine inspections and record keeping. Dorm rooms are inspected annually and married housing is inspected quarterly for pests. In the kitchen at Wright Quad, there is a clipboard to record pest sightings.

RPS is not practicing comprehensive IPM because pesticides are being applied when pests have not been reported. At Wright Quad, ARAB treats the food preparation area twice a month for cockroaches with a pyrethroid flushing agent and gel bait, but the service reports usually indicate that no cockroaches have been seen. In some buildings there is a lack of record keeping. At Halls Food Storage, there is no pest log. For IPM, it is critical to report all pest sightings so that appropriate pest treatment can be done. IPM is not being practiced due to the low level of monitoring. At Wright Quad, one food storage area has no monitoring stations. Also, outside near a dumpster, a rat monitoring box is not operational due to its inaccessible location. For IPM, it is essential that monitoring stations are placed in both strategic and accessible locations. At Halls Food Storage, outdated monitoring stations were found. Glueboards were dated from 2006. Three dead mice were found in a trap that had not been checked recently.

The condition of the pesticides found at Halls Food Storage indicates that IPM is not being observed. Unlabeled rat poison and an outdated over the counter pesticide were found. It is likely that the rat poison was not placed there by ARAB. At Campus View Apartments, it appears that units are occasionally treated with pesticides without documented pest problems. Conducive conditions were present at several facilities. At Halls Food Storage, condensation, which attracts termites and carpenter ants, was observed. The drain in the washing area was clogged and standing water in buckets was found. Also, the air clearance surrounding storage shelves was not adequate in some places. According to IPM standards, it is necessary to maintain an 8-10 inch clearance between the shelves and the wall in order to provide ventilation and visibility.

Campus Division

Campus Division is observing some aspects of IPM. Pests such as bag worms are only sprayed with biological insecticides when observed. Pests such as wasps and bees are spot treated with over the counter pesticides. Insecticidal soap is frequently used in outdoor locations to kill soft bodied insects. All of these treatments have a low environmental impact. Campus Division also keeps a detailed log of pest problems and treatments.

Campus Division is not practicing IPM because many of their pesticide applications are conducted due to political pressure. IU administration prefers a "proactive" pesticide application before a function or outside gathering rather than treatment based on science. Furthermore, there is no staff training for IPM procedures. Staff members attend seminars and new employees are given safety and handling procedures, but IPM education is not included.

Indiana Memorial Union

The main problem with the IMU Commons pest management situation is that pesticide treatments are applied without the use of monitoring stations. For safer, more effective, and sustainable pest management, it is important to monitor first in order to determine exactly what pests need to be treated for in which specific locations. Then, after monitoring, pesticides or other management techniques can be used for target pests at target locations.

At the IMU, IPM was not being practiced because monitoring for pests was not being done and pesticides were being used. ECOLAB has been applying pesticides, mainly boric acid and orthene pellets for cockroaches and weather block for rodents, without first having monitored for these target pests. During our visit, we observed several baby roaches, but no monitoring stations, which indicates a heavy infestation and that IPM is not being practiced.

IPM was not being practiced due to the low sanitation level and resulting conducive conditions. Reducing or eliminating conducive conditions is an essential component of IPM. The area surrounding the dishwasher acts as a sanctuary for cockroaches because it provides heat, moisture, and shelter. An abundance of food debris was preventing the pests from needing to travel far for food. As a result, it would have been difficult to sight pests had they not been abundant. However, since our initial visit, IMU has made a conscious effort to improve its sanitation level and has been working with ECOLAB in order to improve communication and pest management.

Chemicals Used at IU

The following top chemicals for each entity were selected based on danger level and quantity used. The list of pesticides used is from "Indiana University Bloomington: Current and Potential and Green Chemistry Practices," found in Appendix B. Information regarding these pesticides is from the IPM Institute of North America, found in Appendix C.

Athletics

Table 2: Chemicals used by Athletics.

Name	Active Chemicals	EPA toxicity category	USE	Problems	Acres Applied
Arena®	Alachlor	Danger	Insecticide	Toxic to invertebrates, known	6

				groundwater contaminant, carcinogen, endocrine disruptor	
Banol	Chlorothalonil, Propamocarb hydrochloride	Danger	Fungicide	Toxic to aquatic invertebrates and wildlife, carcinogen, potential groundwater contaminant	6
Daconil Ultrex	Chlorothalonil	Danger	Fungicide	Toxic to aquatic invertebrates and wildlife, carcinogen, potential groundwater contaminant	24
Millenium Ultra Selective Herbicide	2,4-D Dimethylamine, Clopyralid, Dicamba	Danger	Herbicide	Toxic to aquatic invertebrates, potential groundwater contaminant	Unknown
Trimec® Classic Brand Broadleaf Herbicide	Dicamba, 2,4-D, Mecoprop-P	Danger	Herbicide	Toxic to aquatic invertebrates, potential groundwater contaminant, possible carcinogen, endocrine disruptor	Unknown

Building Services

Table 3: Chemicals used by Building Services.

Name	Active Chemical	EPA toxicity category	USE	Problems	Ounces used
EcoPCO® AR-X	Phenylethyl propionate, pyrethrins	Caution	Insecticide	Toxic to fish,	280
CyKick® C&C	cyfluthrin	Caution	Insecticide	Neurotoxin, Endocrine disruptor	210
Maxforce®	Hydramethylnon	Caution	Insecticide	Acute aquatic toxicity,	117.6

Professional Insect Control Roach Killer Bait Gel				possible carcinogen, reproductive/ developmental disruptor	
Maxforce® Professional Insect Control Ant Killer Bair Gel; Carpenter Ant Bait Gel	Fipronil	Caution	Insecticide	Possible carcinogen, endocrine disruptor	34.6
Contrac® All-Weather Blox	Bromadiolone	Caution	Rodenticide	Moderate aquatic toxicity	

Golf Course

Table 4: Chemicals used by the Golf Course.

Name	Active Chemical	EPA toxicity category	USE	Problems	Acres Applied
Millenium Ultra Selective Herbicide	2,4-D Dimethylamine, Clopyralid, Dicamba	Danger	Herbicide	Toxic to aquatic invertebrates, potential groundwater contaminant	40
Arena®	Alachlor	Danger	Insecticide	Toxic to invertebrates, known groundwater contaminant, carcinogen, endocrine disruptor	38
Daconil Ultrex	Chlorothalonil	Danger	Fungicide	Toxic to aquatic invertebrates and wildlife, carcinogen, potential groundwater contaminant	68
Proxy	Ethephon	Danger	Growth regulator	Chlorinesterase inhibitor	12
Daconil Zn	Chlorothalonil	Warning	Fungicide, algicide	Toxic to aquatic invertebrates and wildlife,	6

				groundwater contaminant, carncinogen	

Residential Program Services

Table 5: Chemicals used by Residential Program Services.

Name	Active Chemical	EPA toxicity category	USE	Problems
Prescription Treatment® Avert Cockroach Gel Bait Formula 2	Abamectin b1	Caution	Insecticide	Reproductive/ developmental disruptor
Maxforce® Professional Insect Control Roach Killer Bait Gel	Hydramethylnon	Caution	Insecticide	Possible carcinogen, reproductive/ developmental disruptor
Gourmet Ant Bait Gel	Disodium octaborate	Caution	Insecticide	
Borid	Boric acid	Caution	Insecticide	
Contrac® All-Weather Blox	Bromadiolone	Caution	Rodenticide	

Campus Division

Table 6: Chemicals used by Campus Division.

Name	Active Chemical	EPA toxicity category	USE	Problems	Acres applied
Mec Amine-D®	Dicamba, 2,4-D Dimethylamine,	Danger	Herbicide	Toxic to aquatic invertebrates, potential groundwater contaminant, possible carcinogen, reproductive/ developmental disruptor	260
Barricade® 4SC Herbicide	Prodiamine	Caution	Herbicide	Aquatic toxicity, possible carcinogen, endocrine disruptor	130

Dimension™ Herbicide with Plant Food	Dithiopyr	Caution	Herbicide	Potential groundwater contaminant, aquatic toxicity	130

What Other Universities are doing

Research was conducted to observe how other universities manage pests. Components examined were whether or not a university had formal IPM education for their staff and employees who manage for pests, if monitoring for specific pests was done, and if the university had a written IPM policy. No universities in the United States currently have a verifiable IPM program. However, several employ components of IPM, as noted below.

Table 7: Components of IPM that other universities are and are not practicing.

School	Education and training	Monitoring?	IPM policy?
University of Michigan http://www.plantops.umich.edu/grounds/grounds_svcs/trees_forestry/Integrated_Pest_Management.html	Not mentioned	Yes- tree inventory and knowledge of university's landscape	Yes- cultural control for plants
University of Southern Maine http://www.usm.maine.edu/arboretum/ipm.htm	Yes-educational outreach to Facilities Management staff	No, but records kept of pest sightings	Yes- they have a policy statement
University of Montana www.umt.edu/sentinel/UM_campus_**pest_management_plan**_final.doc	*Employee education.* Promote education about pest management through participation in professional societies, meetings, research, and training opportunities. *Campus education*. Remind staff, faculty and students about pest control and turf management efforts, especially during critical times (pesticide applications, wet turf periods, etc). Try to gain compliance with efforts to keep traffic off turf when it is especially susceptible to damage.	Yes- by landscape workers and managers	Sort of- they have a document that includes how pesticides are applied (by a licensed professional) and stored, levels of priority, and how grounds are to be cared for Management plan is to be used as a guiding document
University of Colorado at	Not mentioned	Not mentioned	Not really- but they have a document that assigns

Boulder ecenter.colorado.edu/greening_cu/policies/ipm_policy.pdf			IPM responsibilities to different people/departments
Western Connecticut State University www.wcsu.ctstateu.edu/efs/HS_pdffiles/E112_GPC.pdf	Not mentioned, but they contract out	Yes- of specific areas such as kitchens, glueboards, also have pest sighting logs,	Draft plan
University of Oregon http://oehs.uoregon.edu/policies/ipm/policy.html	Yes- employee training of the specific campus department	No- supposed to develop a monitoring plan	Have a program instead of a policy
Iowa State University http://www.ipm.iastate.edu/ipm/	Yes- lectures and hands on activities for groundskeepers, landscape IPM training	Insect monitoring, keep records, insect and weed identification	Have an IPM coordinator
University of California Berkeley			Environmental Health and Safety Specialist Art Slater asserts that "IPM is a management system, not a list of things that one does, or applies" Landscape IPM- no pesticides, no pesticide risk

Recommendations

It is recommended that Indiana University implement an enforceable IPM policy and develop an IPM committee of the five different entities. IPM involves communication between pest control operators, administration, and the campus community. Marc Lame states that "those responsible for managing pests at IU must co-produce an environmental ethic (IPM policy, implementation plan and oversight) with the campus community. The result of this co-production will develop a partnership with the campus community and the professional pest managers thereby increasing the:

1. Degree of proactive, rather than reactive, pest management strategies
2. Accountability of those that provide conditions conducive for pest infestations (students, administration, faculty and staff)
3. Accountability of those who must act as diagnosticians and educators regarding preventing and remediating those conditions conducive for pest infestations (professional pest managers)
4. Accountability of those that use toxins to control pests such that pesticides are only used when necessary

5. Awareness of the campus community (including alumni) of the efforts and consideration of campus pest management professionals with regard to managing pests

Unless and until the Administration mandates and supports this co-production environmental ethic, pest management will remain costly, dangerous, and unsustainable."

To implement a pilot IPM program at IU, a written policy and procedure are needed. According to principles based on recommendations from the Centers for Disease Control and Prevention, an IPM program should contain the following elements:

1. A pest manager or company to manage and perform or oversee pest management duties. The pest manager should be trained in IPM practices and procedures and can be a hired consultant or a trained employee, such as a custodian or manager. If contracting with an individual or company, it is important to find a pest manager that
    a. Has a written description of their IPM service, including regular inspections, regular service reports, IPM recommendations, and use of least toxic pesticides
    b. Does not promote routine pesticide spraying
    c. Has reasonable expectation of current pest problems, conducive conditions, and management recommendations
    d. Has documentation of pest identification training
    e. Incorporates education into their duties. Education for administrators, staff, employees, and building occupants is part of IPM. Mandatory quarterly training sessions for all employees are recommended
2. The pest management professional monitors for pest problems by routinely inspecting buildings and/or grounds. This is to examine for conducive conditions such as entry points, shelter, and food and water. The pest manager also responds to any pest complaints or reported sightings and is able to identify pests.
3. When conducive conditions or pest activity are found, the pest management professional should eliminate the source of the problem by sealing entry points, removing food, and reducing shelter before pesticide use is considered.
4. If this does not eliminate the problem and pesticide use is necessary, a pesticide with the lowest toxicity should be applied to the target area by a trained pesticide applicator.
5. Detailed records are kept of pest sighting, treatments, and effectiveness (Centers for Disease Control and Prevention 2007).

Specific recommendations for each entity are outlined below.

<u>Building Services</u>

To implement IPM, Building Services will need at least three full time employees trained as pest management professionals to properly inspect and visit their buildings on a monthly basis such that they can act as diagnosticians and educators. An extensive monitoring program needs to be developed. In addition, an educational program for custodians, supervisors, and building inhabitants needs to be developed.

<u>Athletics</u>

Brent Emerick, Golf Course Superintendent, has several management ideas that could feasibly be put into practice. Changing the type of grass in some locations could deter fungi and require less chemical maintenance. For example, the IU soccer fields were replaced with Bermuda grass, and now require no fungicides. Turf grass on the fairways currently consists of bent, rye, and blue grass. Changing turf grass to zoysia or specifically Meyer Z52, a zoysia cultivar, would require less chemical maintenance and be more sustainable. In five years, after a higher upfront expenditure, this type of grass would be more cost effective, offer more playable turf, and be more certifiable.

Audubon International offers the Audubon Cooperative Sanctuary Program for Golf Courses (ACSP), which is designed to protect the environment through education and a certification program. One of many program aspects is chemical use reduction and safety. If IU golf Course became a member of this program, benefits would include better environmental and sustainability ethics, positive publicity, and lower expenditure through improved management practices. The annual fee for this program is $200 (Audubon International 2007).

In order to accomplish these goals, initial financial resources and more administrative support and commitment from the athletic department are necessary. With these resources, implementing strategies such as planting different grass species and becoming a member of the ACSP are feasible. Currently, the Golf Course has little communication with Campus Division. If this were changed, both entities could benefit from sharing landscaping knowledge and reducing costs from ordering common products such as fertilizers in bulk. In addition, communication and sharing of information between entities could improve quality control of contracting services.

Residential Program Services

To implement IPM, RPS should develop and oversee an IPM contract with specific goals. Goals would include preventative measures, monitoring, and treatment procedures. In addition to this contract, a comprehensive IPM education program should be developed for staff and residents.

Pesticides should not be applied without monitoring and considering other options first. At one location we visited, the manager reported that there were no pests, yet pesticides were being used. No monitoring stations were present and very little pest evidence was observed, although some conducive conditions were present. Applying pesticides without monitoring or evidence of pests is ineffective and not IPM. Pesticides kill pests, and do not work preventatively.

Campus Division

Campus Division can work toward IPM by educating the campus community of efforts for better pest management. Increasing the quantity of no mow areas creates wildlife habitat and reduces the need for mowing maintenance and chemical upkeep. Properly managed short prairie grasses would be a superior alternative. Steep banks that are currently mowed regularly could be planted into native grasses, and need to be mowed only once a year. TruGreen currently treats the recreational and athletic fields, Dunn Meadow, and main campus thoroughfares. Although it is necessary to control some of this land for human use, not all of it needs to be mowed and chemically treated. Twenty five percent of it could easily be converted to prairie. This would make a considerable environmental difference and not affect human use. Campus-wide education is important in order for such areas to be viewed as aesthetic and sustainable habitats. Mowed areas could also be allowed to grow to a higher height of 3 ½ inches. This height would not obstruct recreational use or aesthetic value, and would be sustainable by requiring less mowing. Dunn Meadow would be an ideal location to try this. Awareness and demonstration of the practicality of such a plan would promote its further implementation.

Using resources that IU already has can make these ideas feasible. Campus Division already has employees who are experts on this subject. Allowing them to put their ideas and experience into practice would achieve goals toward sustainability. Locations that are currently high maintenance could be converted to environmentally friendly, educational, and sustainable habitats.

Indiana Memorial Union

Improved monitoring for pests is needed at IMU. Pests cannot be properly managed without good quality monitoring. Service tickets indicate that pesticides are regularly being applied for the same pests. IMU and ECOLAB need to work together in order to reduce conducive conditions, monitor for,

and eliminate pests. Cockroaches are the prevalent pest at IMU. Targeted baiting based on monitoring and biology can significantly reduce their populations in just a few weeks.

Reduction of conducive conditions is essential. Improved sanitation in the food preparation area will reduce food sources for pests. Other conducive conditions, such as habitat in door jams and near the dishwasher, can be eliminated or reduced by sealing cracks and pest entrances. After our initial visit, IMU and ECOLAB have made efforts to reduce conducive conditions and improve pest control methods.

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Appendix A: Standards for IPM checklist used during IPM visits at IU.

Standards for IPM: Checklist

Location_____ **Date**_____

Overview

- ☐ Are regular inspections for pests performed?
- ☐ Are pesticides applied as needed or according to a schedule?
- ☐ Is there a written pest control policy which is followed?
- ☐ Are there monitoring stations?
- ☐ Are records kept? (of pest problems or sightings, treatments, pesticide applications, etc.)

Conducive conditions

- ☐ Is there knowledge of what conducive conditions are?
- ☐ Is there awareness of what conducive conditions exist?
- ☐ Is there an effort to reduce conducive conditions, especially when it is simple and inexpensive to do so?

Staff training/duties

- ☐ Does appropriate staff (such as janitors) have duties related to preventing pests?
- ☐ Is there formal education (newsletters, fact sheets, or training for custodians) for people (such as administrators, custodians, teachers, students) in facility? Explain:

  _____

  _____
- ☐ Does staff do treatments? (applying pesticides or cultural controls)
- ☐ Does staff have specific procedures regarding pests that they must follow?

Pesticides

- ☐ Are pesticides applied as needed or according to a schedule?
- ☐ Are pesticides applied by a certified Pest Control Operator?
  - ☐ Does the PCO apply pesticides only as needed based on monitoring observations?
  - ☐ Can the PCO identify the pests?
- ☐ Are other options considered and done before pesticides are used? (such as cultural control options)
- ☐ When pesticides are needed or used, is the option with lowest toxicity used?
- ☐ When pesticides are applied, are they applied only to the infested area, or generally to the broader location?

Appendix B: Chemical use by department information from Indiana University Bloomington: Current and Potential Green Chemistry Practices by Vanessa Barberis and Pearl Nathan, Spring 2008.

Athletics - Integrated Pest Management

Trade Name	Acres Applied	Rate Applied
2,4-D		
26 GT	6	82 oz/acre
26 GT	6	5 oz/acre
8-3-5 Nature Safe	6	1 lb of N/1,000 sq ft
8-3-5 Nature Safe	3	165 lbs/acre
Arena	6	10 oz/acre
Armor Tech 44	16	2 oz/1,000 sq ft
Bandit	12	5 wsp/acre
Banol	6	2 oz/1,000 sq ft
Chipco 26019 Flo	6	1.25 gal/acre
Chlorothalonil	8	7.5 lbs/acre
Chlorothalonil	8	5 lbs/acre
Compass	4	.2 oz/1,000 sq ft
CPR	30	6 oz/1,000 sq ft
Daconil Ultrex	12	7.5 lbs/acre
Daconil Ultrex	24	5 lbs/acre
Daconil Ultrex	6	10 lbs/acre
Daconil Zn	6	2.5 gal/acre
Delta Gard	6	8 oz/acre
Delta Gard	6	8 oz/1,000 sq ft
Dimension	6	15 oz/acre
Dimension	6	2 wsp/acre
Dylox	3	240 lbs
Dylox	3	120 lbs/acre
Fert. 10-18-18	6	130 lbs/acre
Fert. 10-18-18	6	125 lbs/acre
Fert. 13-2-13	6	300 lbs
Fert. 13-2-13	3	11.5 bags
Fert. 13-2-13	3	165 lbs/acre
Fert. 14-2-14	2	2.5 gal/acre
Fert. 17-3-17	12	325 lbs
Fert. 19-1-6	24	3 oz/1,000 sq ft
Fert. 6-12-6	12	3 oz/1,000 sq ft
Fert. 8-4-24	3	200 lbs
Gary's Green	12	1.25 gal/acre
Heritage	12	.5 lb/acre
Instrata	6	1 gal/acre
Iprodione	6	6 oz/1,000 sq ft
Menace	6	8 oz/acre
Millennium		

MgMn	6	3 oz/1,000 sq ft
Nature Safe 8-3-5	6	200 lbs
Nutrol	8	32 lbs
OARS	6	6 oz/1,000 sq ft
Pentathlon	6	10 oz/1,000 sq ft
PK Plus	6	3 oz/1,000 sq ft
PK Plus	12	1.25 gal/acre
Primo Maxx	6	1 oz/1,000 sq ft
Primo Maxx	8	.5 oz/1,000 sq ft
Propiconazole	4	1 oz/1,000 sq ft
Propiconazole	10	.5 oz/1,000 sq ft
Revolver	1	16 oz/1,000 sq ft
Revolver	3	16 oz/acre
Thiophanate Methyl	6	1.25 gal/acre
Trimec		
Ultra Plex	12	1.25 gal/acre

Building Services- Integrated Pest Management

Product	**Quantity**
Products Used Inside	
Maxforce Roach Killer Bait Gel	117.6 ounces
Maxforce Carpenter Ant Bait	3.80 oz.
Maxforce Ant Killer Bait Gel	30.8 oz.
Enforcer Roach Ridd	32 oz.
Premise Foam for Termites	540 oz.
Victor Mouse Traps	120 ea.
LTD Glue Traps	423 ea.
Lo Line Roach Traps	800 ea.
Products Used Outside	
Contract Blocks for Mice & Rats	2 5-gal. pails, 36 pounds
Cy Kick Aerosol	210 oz.
Ecopco Jet X Aerosol-wasps & hornets	280 oz.

Golf Course- Integrated Pest Management

Trade Name	**Acres Applied**	**Rate Applied**
Acclaim Extra	6	20 oz/acre
Arena	38	10 oz/acre
Armor Tech 44	102	2 oz/1,000 sq ft
Armor Tech TM462	6	3 oz/acre
Balan	2	4 oz
Barricade	2	5 wsps
Chipco 26019 Flo	12	1.25 gal/acre

Chipco 26GT	7	2.5 gal/2 acre tank
Chipco 26GT	6	5 oz/1,000 sq ft
Chipco 26GT	6	82 oz/acre
Chipco Signature	7	11 lbs/acre
Chlorothalonil	32	7.5 lbs/acre
Chlorothalonil	64	5 lbs/acre
CPR	6	6 oz/1,000 sq ft
Daconil Ultrex	68	5 lbs/acre
Daconil Ultrex	50	7.5 lbs/acre
Daconil Zn	6	2.5 gal/acre
Daconil Ultrex	6	10 lbs/acre
DeltaGard	13	8 oz/acre
DeltaGard	6	.4 oz/1,000 sq ft
Dimension	32	15 oz/acre
Dimension	32	3 wsp/acre
Dylox	10	2 lbs/1,000 sq ft
Endorse	7	5.5 lbs/acre
Endorse	6	11 lbs/acre
Enhance	6	10 oz
Fairphyte	32	1 gal/acre
Fert. 13-2-13	6	1 lb N/1,000 sq ft
Fert. 14-2-14	96	2.5 gal/acre
Fert. 19-1-6	6	1.25 gal/acre
Fert.10-18-18	12	130 lbs/acre
Fert.10-18-22	6	100 lbs
Fert.17-3-17	9	115 lbs/acre
Gary's Green	42	1.25 gal/acre
Gary's Green	12	3 oz/1,000 sq ft
Gary's Green	6	1 gal/acre
Groundskeeper	6	1.25 oz/acre
Headway	6	1.5 oz/1,000 sq ft
Heritage	19	1 lb/acre
Instrata	32	1 gal/acre
Iprodione	6	6 oz/1,000 sq ft
Menace	12	8 oz/acre
Millenium Ultra	40	2 pts/acre
Nature Safe 15-2-8	33	5,600 lbs
Nature Safe 8-3-5	12	250 lbs/acre
Nutra Green	12	3 oz/1,000 sq ft
Nutra Green	12	1.25 gal/acre
Nutrol	96	16 lbs
Pentathlon	6	10 oz/1,000 sq ft
PK Plus	24	1.25 gal/acre
Primo Maxx	37	.125 oz/1,000 sq ft
Primo Maxx	128	.5 oz/1,000 sq ft
Primo Maxx	98	1 oz/1,000 sq ft

Propiconazole	102	.5 oz/1,000 sq ft
Proxy	7	1.75 gal/2 acre tank
Proxy	12	5 oz/1,000 sq ft
Spotrete	10	2.5 gal
Thiophanate Methyl	12	1.25 gal/acre
Thiophanate Methyl	6	2.5 gal
TirCure	12	6 oz/1,000 sq ft
T-Storm	6	2.2 gal/acre
UltraPlex	42	1.25 gal/acre
UltraPlex	12	3 oz/1,000 sq ft
UltraPlex	6	1 gal/acre

Residential Program Services- Integrated Pest Management

Item	**Quantity**
Catchmaster Glueboard Monitors	
Avert Roach Gel Bait	As needed
Maxforce Roach Gel Bait	As needed
Gourmet Ant Gel Bait	As needed
PI Aerosol Flushing Agent	
Borid Dust (99% boric acid)	
Contrac Blox with locking baitststions (rodenticide)	As needed

Campus Division- Integrated Pest Management

Trade Name	**Acres Applied**	**Rate Applied**
Fert. 18-5-9	130	70% of N/1,000 sq ft
Barricade 4FL	130	20 oz/acre
MecAmine D	260	1.1 oz/1,000 sq ft
Fert. 18-5-9	130	1 lb N/1,000 sq ft
Dimension Ultra Herbicide	130	.375 A.I./acre

Appendix C: Review of chemicals used at IUB by the IPM institute of North America. Available upon request.