CONTINUING EDUCATION UNIT

Integrated Pest Management
IPM Concepts

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This two-part series is excerpted from ISA's Best Management Practices: Integrated Pest Management. *This article discusses the background and purpose of IPM, provides an overview of IPM terms, and introduces the concepts of action thresholds and monitoring. Part 2, to be published in our February 2008 issue, will discuss pest management tactics.*

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LEARNING OBJECTIVES

The arborist will be able to

- define a landscape pest and recall the major pest groups.
- explain the relationship between plant health care (PHC) and integrated pest management (IPM).
- explain the purpose and application of an action threshold in IPM.
- name pest monitoring tools and techniques.
- summarize the key pest/key plant concept.

Background

Arboriculture is founded on the principles of plant health care (PHC), which is defined as a comprehensive system for managing the appearance, structure, and vitality of ornamental landscapes within client expectations. PHC is a proactive, holistic management system that encompasses all aspects of landscape stewardship: site evaluation and preparation; plant selection, establishment, and cultivation; pest management; and plant utilization and removal.

PHC recognizes that trees and woody plants are part of a greater landscape ecosystem that includes turfgrasses as well as annual and perennial herbaceous plants. These vegetative components interact with one another on multiple ecological levels through competition, allelopathy, nutrient cycling, microclimate alteration, and pest dynamics. To create sustainable landscapes, arborists and landscape managers must understand these interactions and adopt a landscape ecosystem approach in their PHC practices. Woody plants should not be managed in isolation from other vegetative components; the impact of management actions on the entire landscape ecosystem should always be considered.

An essential component of PHC is pest management. Pests frequently threaten the health, structure, appearance, or value of landscape plants. For most of the 20th century, landscape pest management had a single dimension: chemical control. Beginning in the 1970s, a multidimensional approach to landscape pest management, called integrated pest management (IPM), evolved to address the ecological, social, and economic implications of overreliance on chemical pest control. Today, PHC embraces IPM as the preferred approach to managing landscape pests.

Purpose

The purpose of this two-part series, based on ISA's newly released *Best Management Practices: Integrated Pest Management*, is to provide a succinct overview of the basic definitions, concepts, and practices that pertain to landscape IPM. The articles are intended to aid arborists and landscape professionals in designing, planning, and implementing an IPM program as part of a comprehensive PHC management system. While many PHC concepts are reinforced by this publication, the primary focus is landscape IPM. Readers are encouraged to learn more about IPM and the PHC management system through additional, comprehensive resources.

Definitions

Landscape Pest

A landscape pest is any organism that
- competes with desirable plants for resources
- threatens the health, structure, appearance, or value of desirable plants
- diminishes personal enjoyment, comfort, or safety in the landscape

Landscape pests belong to several major groups of organisms (Figure 1):
- insects and other arthropods (mites, ticks, and spiders)
- microorganisms (fungi, bacteria, viruses, mycoplasma-like organisms, and nematodes)
- mollusks (snails and slugs)
- vertebrates (rodents, rabbits, deer, birds, reptiles, and amphibians)
- weeds, vines, parasitic plants (mistletoes and dodder), and epiphytic plants (ball and Spanish moss)

Most organisms found in the landscape are not pests. In fact, many organisms make positive contributions to the landscape by suppressing pest populations, facilitating organic matter cycling, and enhancing personal enjoyment. To uninformed clients and professionals, all insects and mites are harmful to landscape plants. Because of misguided beliefs, many landscapes are managed with routine applications of broad-spectrum insecticides that eradicate all insects and mites. This approach is harmful because beneficial organisms are destroyed along with pests, which disrupts the landscape ecosystem.

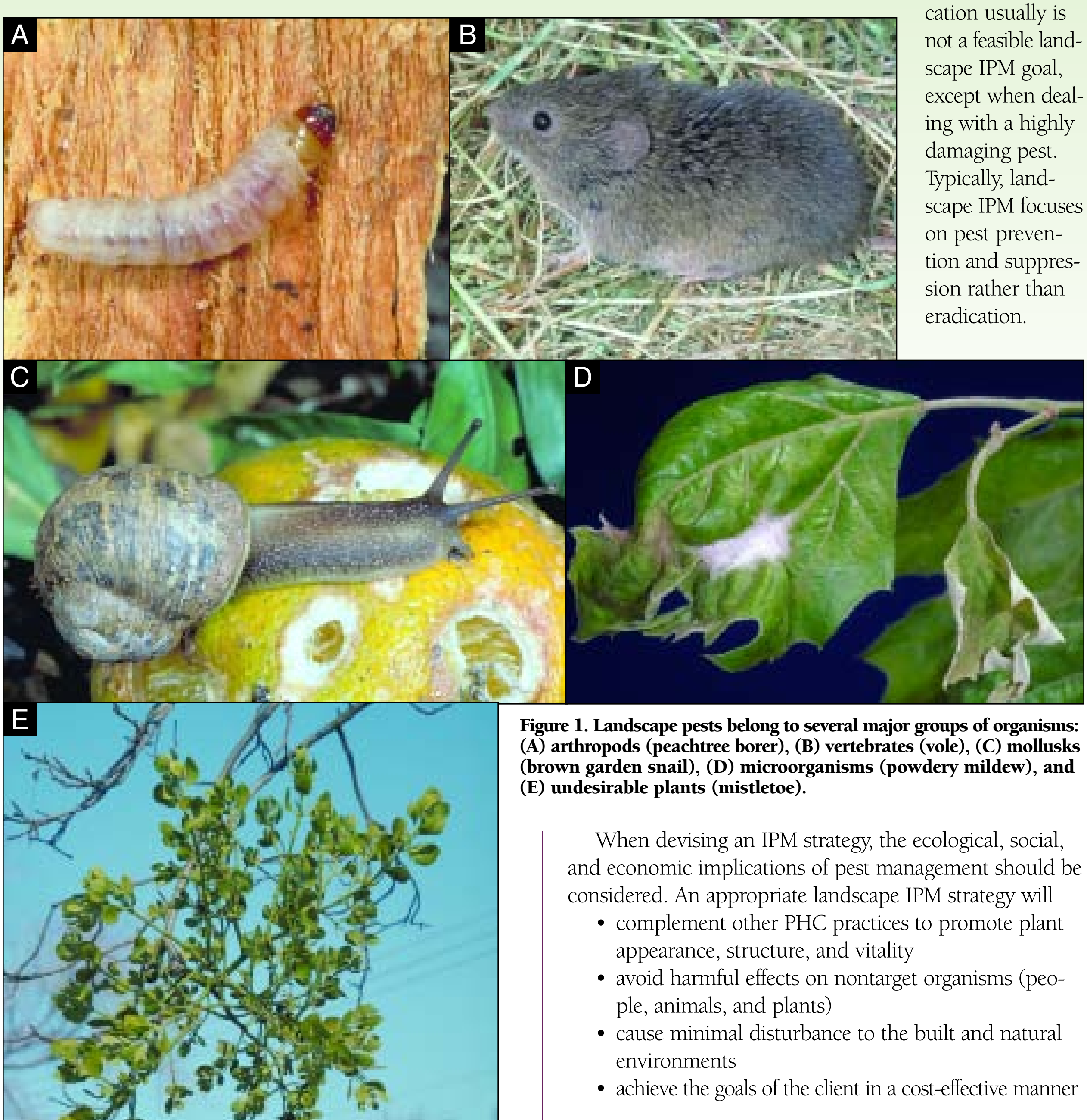

Figure 1. Landscape pests belong to several major groups of organisms: (A) arthropods (peachtree borer), (B) vertebrates (vole), (C) mollusks (brown garden snail), (D) microorganisms (powdery mildew), and (E) undesirable plants (mistletoe).

An organism may be a pest in some circumstances while not in others. In addition, the mere presence of a pest may not necessarily warrant control. The task of the landscape manager is to determine whether an organism is a pest and, if so, whether management is warranted.

Integrated Pest Management (IPM)

It is important to recognize that landscape IPM is not equivalent to PHC, but rather an essential component of the PHC management system. More specifically, landscape IPM is a method for managing pests that combines appropriate preventive and control tactics into a single management strategy. Depending on the circumstances, a single tactic or combination of tactics may be appropriate for a specific pest problem. The goal of IPM is to manage pests and their damage at levels tolerable to the client. Pest eradication usually is not a feasible landscape IPM goal, except when dealing with a highly damaging pest. Typically, landscape IPM focuses on pest prevention and suppression rather than eradication.

When devising an IPM strategy, the ecological, social, and economic implications of pest management should be considered. An appropriate landscape IPM strategy will

- complement other PHC practices to promote plant appearance, structure, and vitality
- avoid harmful effects on nontarget organisms (people, animals, and plants)
- cause minimal disturbance to the built and natural environments
- achieve the goals of the client in a cost-effective manner

Action Thresholds

Pest presence does not necessarily constitute a pest problem. A pest becomes a problem when its population or the injury it causes exceeds a tolerable level known as an action threshold (Figure 2). IPM practitioners use three types of action thresholds in managing pests. They are population action, physiological action, and aesthetic action thresholds.

Some organisms (such as biting insects, ticks, certain vertebrates, and weeds) are considered pests because they

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Figure 2. A pest becomes a problem when its population or the injury it causes exceeds a tolerable level known as an action threshold (ash plant bug adults, nymphs, and fecal drops pictured).

diminish personal enjoyment, comfort, or safety in the landscape. Such pests are managed using a population action threshold, the population level above which personal comfort or landscape quality is diminished. When the pest population exceeds this action threshold, control measures are considered.

Most landscape pest problems result from organisms eating or inhabiting desirable plants, which can cause both physiological and aesthetic plant injury. A physiological action threshold is the injury level above which the health or structure of desirable plants is compromised. An aesthetic action threshold is the injury level above which the appearance of desirable plants is diminished. In both cases, control measures are considered when the injury level exceeds the action threshold.

A population action threshold can also be used to manage physiological or aesthetic plant injury. For example, a dramatic increase in spider mite population can often be detected prior to visible signs of plant injury. By establishing a population action threshold and routinely assessing the mite population, control measures can be quickly implemented, should the mites become excessive, and thus prevent plant injury.

Many landscape pests can cause unacceptable aesthetic injury without adversely affecting plant health or structure. In addition, most nonprofessionals have limited tolerance for aesthetic plant injury. As a result, aesthetic action thresholds are often lower than physiological action thresholds. IPM practitioners must determine the most appropriate action threshold for each plant–pest–client scenario.

Determining an appropriate action threshold for landscape pests requires knowledge, experience, and foresight. Some of the factors to consider when establishing an action threshold include

- client tolerances and expectations
- plant value, condition, and susceptibility
- pest damage potential
- time of year
- site conditions
- prevailing weather conditions
- inspection frequency
- potential for natural pest control

Based on these factors, action thresholds for landscape pests may vary from zero tolerance to considerable tolerance. It is possible for a single pest to have multiple action thresholds across different properties and even within a property. While efforts have been made to develop standard action thresholds for specific pests, individual clients will differ in their pest tolerance and landscape management expectations. Therefore, communication is important for educating clients about IPM, identifying their management goals, and establishing appropriate action thresholds. In particular, clients should be informed that pest presence does not necessarily constitute a pest problem and that pest management decisions are based on action thresholds.

Monitoring

Monitoring is a critical component of landscape IPM. Monitoring is a program of regular landscape inspections to make observations and collect information required for pest management decision making (Figure 3). Three types of information should be collected during routine IPM inspections:

- site information
- plant information
- pest information

Figure 3. Monitoring is a program of regular landscape inspections, which is a critical component of landscape IPM.

Site information is valuable for the diagnosis and treatment of landscape pest problems. Valuable site information includes recent weather patterns, landscape cultural practices (including management of other vegetative components), additions/ removals of neighboring plant material, and hardscape construction/ repair. These events can influence plant vitality and pest activity both positively and negatively. In many instances, the predisposing factor for pest-related plant stress is an adverse site condition such as drought or excessive irrigation. Identifying and correcting adverse site conditions are crucial to an effective IPM strategy.

Collecting plant information such as condition, developmental stage, and phenological stage is another important aspect of an IPM inspection. A plant's condition and developmental stage can influence its pest susceptibility as well as its injury tolerance. Plants in poor health because of adverse site conditions or overmaturity can be particularly susceptible to certain pests and intolerant of the injury that they cause. In such cases, it may be appropriate to lower the action threshold for a pest to reduce the risk of infestation and injury. The plant's phenological stage can also influence injury tolerance and, therefore, impact pest control decisions. For instance, a late-season, defoliating pest on a deciduous tree may not warrant control because the canopy is near senescence and thus the impact on overall plant health is minimal.

Several types of pest information should be collected during an IPM inspection, including

- pest identification
- pest population level
- life stage(s) present
- potential for natural control of the pest

The presence of an organism on an injured plant does not imply that it is the causal agent. Improper identification of an organism can lead to misdiagnosis of the plant problem or improper prescription of a pest management tactic. For example, the primary cause of a plant problem may be an abiotic factor, such as weather or soil, that has predisposed the plant to a pest. Treating the pest certainly helps address the problem but does not fully correct it. Most management tactics (particularly pesticides) are pest specific. Misidentification of the pest may lead to the wrong choice of pesticide, which can fail to treat or even exacerbate the pest problem. Once an organism is properly identified as a pest, its population level can be assessed for plant injury potential and then routinely monitored according to an action threshold.

When a pest is causing intolerable plant damage, the life stage of the pest must be properly identified so that an appropriate management tactic can be chosen. Many landscape pests can be effectively managed only during a vulnerable life stage. For example, many scale insects cannot be controlled with pesticides once they reach adulthood and develop their protective waxy covering. In addition, many fungal diseases cannot be controlled with therapeutic fungicides, thus limiting disease management to nonchemical tactics. Employing management tactics inappropriate for the pest life stage is a waste of resources and may exacerbate the pest problem.

Pest management may not be necessary when there is high potential for natural control of the pest. IPM practitioners should acquaint themselves with the numerous types of organisms that can naturally control pest populations through predation and parasitism. Certain weather conditions can also naturally suppress pest activity. While conducting IPM inspections, the practitioner should note not only pest populations but also the presence of natural enemies and suppressive conditions. When natural control is high, the appropriate response may be to continue monitoring the pest and use chemical control tactics only as a last resort.

Monitoring Tools and Techniques

Numerous tools and techniques are available to facilitate landscape inspection and monitoring. A few of the most important ones are discussed here. A hand lens and field guide are valuable for on-site identification of both plants and pests. If field identification is not possible, a specimen should be collected for identification by a colleague or diagnostic clinic.

Sometimes it is difficult to evaluate a pest problem based solely on visual inspection of the landscape. The pest may only be active at certain times (such as the black vine weevil at night), or current damage levels may provide insufficient information to guide management decisions. In addition, some pests can only be controlled during a specific life stage that is difficult to detect (as with clearwing moths). In these circumstances, trapping devices should be used to monitor pest abundance and life stage, to evaluate action thresholds, and to properly time control tactics (Figure 4). Trapping devices are commercially available for various insect pests.

Figure 4. Pheromone-baited insect traps are used to monitor pest abundance and life stage, evaluate action thresholds, and properly time control tactics.

Phenology calendars and degree-day models are knowledge-based tools that IPM practitioners can use for monitoring pest development and properly timing control tactics. Both of these tools help account for the annual variability in pest development, which can vary two to three weeks from year to year depending on emergent weather conditions. The life cycle and development of many landscape pests (particularly insects and mites) are highly dependent on the temperature of the surrounding environment. These organisms develop rapidly at warm temperatures and slowly at cool temperatures. As a result, the calendar timing of their development can vary substantially from year to year, making preventive pest control difficult.

A simple method for tracking the seasonal development of pests is a phenology calendar. Phenology is the study of relationships between periodic biological events and seasonal climate changes. Annual natural events such as animal behavior and plant development are often better correlated with seasonal, climate changes than specific calendar dates. As a result, the development of insect and mite pests can be reasonably predicted by observing the budding, flowering, or fruiting of common native or landscape plants. For

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example, emergence of adult boxwood leafminer has been observed to coincide with the first flowering of common lilac (*Syringa vulgaris*), and spring cankerworms are active when saucer magnolias (*Magnolia ¥ soulangiana*) bloom.

With a few years of astute observation and record keeping, an IPM practitioner can develop a reliable phenology calendar. In addition, a number of state extension agencies across the United States have developed phenology calendars for common landscape pests. These calendars can be used to schedule IPM inspections and better target pest management tactics.

A degree-day model is a more scientific approach to predicting the effect of seasonal warming on pest development. There is a lower threshold temperature below which insect and mite development slows dramatically or ceases. For insect and mite pests of woody plants, the commonly accepted lower threshold is 50°F. A simple degree-day model uses this lower threshold temperature and the daily average temperature (the average of the recorded high and low temperatures for a given day) to predict pest development stages.

To calculate degree-days, the threshold value (50°F) is subtracted from the daily average temperature. The difference equals the degree-day units for that day (negative values are recorded as zero). A running total of the cumulative degree-days is maintained throughout the growing season. In temperate portions of the United States, degree-days usually begin accumulating in late February or early March. When the cumulative degree-days reach a known target for a specific pest, intensive monitoring or preventive control tactics can be implemented.

Degree-day targets have been established for the life cycles of numerous pests and are commonly available through state cooperative extension agencies (Table 1). Phenology calendars and degree-day models may vary across regions, so use outside sources of these tools carefully. They are intended only to supplement IPM decision making. Additional landscape observations should be used to direct management actions.

Key Pests and Key Plants

To facilitate landscape IPM, practitioners should become familiar with the key pests and key plants in a particular region or on a specific property. Key pests are organisms that are frequently encountered in landscapes and predictably cause injury to landscape plants. Examples include aphids, mites, powdery mildew, and Phytophthora root rot. Key pests may also include particularly noxious pests such as Dutch elm disease and emerald ash borer. IPM practitioners can improve their effectiveness by learning the life history of key pests, signs and symptoms of the injury they cause, and appropriate management tactics.

Key plants are defined in two ways. First, a key plant can be a species that has a high incidence of pest problems due to inherent susceptibility or common mismanagement. For example, many *Prunus* species are inherently susceptible to a wide range of pests. Flowering dogwood (*Cornus florida*) is often plagued with pest problems when inappropriately planted in degraded soils on hot, sunny sites. Second, a key plant can be a specimen that has significant value in a landscape. A specimen plant may be highly valuable due to its location, function, size, appearance, or cultural significance. Because value is often subjective, the IPM practitioner may not readily distinguish key plants in the landscape and should consult with the client to identify his or her key plants.

By identifying key pests and key plants and understanding client expectations, the IPM practitioner can better estimate the frequency and duration of IPM inspections necessary to meet management objectives. This information is particularly important for pricing commercial IPM services, forecasting workloads, recruiting personnel, and procuring pesticide control supplies.

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Table 1. Growth degree-day (GDD) estimates for the life stages of common landscape pests and the corresponding phenological events observed at Secrest Arboretum in Wooster, Ohio, from 1997–2001.

Pest	Life Stage	GDD	Phenological Event
Eastern tent caterpillar	Egg hatch	92	Manchu cherry (first bloom)
Spruce spider mite	Egg hatch	162	Bradford pear (full bloom)
Boxwood psyllid	Egg hatch	179	Weeping Higan cherry (full bloom)
Gypsy moth	Egg hatch	192	Eastern redbud (first bloom)
Azalea lace bug	Egg hatch	206	Koreanspice viburnum (full bloom)
Honeylocust plant bug	Egg hatch	230	Sargent crabapple (first bloom)
Pine needle scale	Egg hatch	305	Red horsechestnut (first bloom)
Lilac borer	Adult emergence	330	Winter King hawthorn (first bloom)
Lesser peach tree borer	Adult emergence	372	Black cherry (first bloom)
Bronze birch borer	Adult emergence	547	American yellowwood (first bloom)

Source: "Chapter 11: Using Degree-Days and Plant Phenology to Predict Pest Activity" by Daniel A. Herms, in *IPM of Midwest Landscapes*, University of Minnesota, 2003.

CEU TEST QUESTIONS

To receive continuing education unit (CEU) credit (1.0 CEU) for home study of this article, after you have read it, darken the appropriate circles on the answer form of the insert card in this issue of *Arborist News*. (A photocopy of the answer form is ***not*** acceptable.) A passing score for this test is 16 correct answers.

Next, complete the registration information, ***including your certification number***, on the answer form and send it to ISA, P.O. Box 3129, Champaign, IL 61826-3129. Answer forms for this test, **Integrated Pest Management: IPM Concepts**, may be sent for the next 12 months.

You will be notified only if you do not pass. If you do not pass, ISA gives you the option of re-taking the quiz until you do achieve a passing score.

1. Plant health care (PHC) is defined as a comprehensive system that manages
   a. plant appearance
   b. plant structure
   c. plant vitality
   d. all of the above
2. Most of the organisms found in the landscape are not pests.
   a. true
   b. false
3. Plant health care (PHC) differs from integrated pest management (IPM) in that
   a. PHC is just one part of a more inclusive IPM management system
   b. PHC focuses mainly on managing pests to acceptable levels while IPM is a more holistic approach to managing plants and their environment
   c. IPM is only one component of the holistic PHC management system
   d. PHC is proactive while IPM is almost always reactive
4. A landscape pest is any organism that
   a. is found on a plant with compromised health, structure, or appearance
   b. threatens the health, structure, appearance, or value of desirable plants
   c. diminishes personal enjoyment, comfort, or safety in the landscape
   d. both b and c
5. An appropriate landscape IPM strategy will
   a. be costly but effective
   b. avoid harmful effects on nontarget organisms
   c. eliminate any need for additional PHC practices
   d. all of the above
6. The injury level above which the health or structure of a desirable plant is compromised is known as a(n)
   a. physiological action threshold
   b. population action threshold
   c. aesthetic action threshold
   d. time to take some action threshold
7. When determining an appropriate action threshold for a landscape pest, it is important to
   a. determine the level of aesthetic damage a particular client is willing to tolerate
   b. factor in the value of the plant within the landscape and its current condition
   c. determine the impact of a pest given the time of year, severity of the pest, and pest population
   d. all of the above
8. A key plant can be defined as
   a. a plant that has significant value in a landscape
   b. a plant species that is often prone to disease, infestation, or structural defect
   c. any plant native to the chain of islands found at the southern tip of Florida
   d. both a and b
9. Which of the following would not be considered a key pest?
   a. an extremely noxious (damaging) pest
   b. a pest that predictably reduces the aesthetic value of a landscape plant
   c. an insect that is a parasite of a common landscape pest
   d. an insect pest that is frequently encountered in a specific region
10. Landscape monitoring
    a. is a program of regular landscape inspections
    b. entails collecting site, plant, and pest information
    c. is facilitated by tools and techniques such as pheromone traps and phenology calendars
    d. all of the above
11. It is inappropriate to manage a landscape pest that causes unacceptable aesthetic injury if it does not adversely affect plant health or structure.
    a. true
    b. false

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12. IPM strategies typically focus on pest prevention and
    a. subordination
    b. eradication
    c. suppression
    d. elimination
13. Managing a secondary pest on an ailing plant while neglecting to treat the primary stress factor (for example, poor site conditions)
    a. will have no impact on plant health
    b. helps to address the problem but does not fully correct it
    c. usually allows the plant to adapt to the primary stressor and fully recover
    d. will actually decrease plant health
14. The growth and development of many landscape pests are dependent both on the passage of time and climatic conditions. What units have been developed to take both of these factors into consideration?
    a. kilowatt hours
    b. calorie hours
    c. degree-days
    d. development days
15. The study of the relationships between periodic biological events and seasonal climate changes is called
    a. phenology
    b. pomology
    c. physiology
    d. phrenology
16. It is irresponsible to use annual applications of broad-spectrum pesticides to eradicate all possible landscape pests because
    a. beneficial and nontarget organisms are destroyed along with pests
    b. it often takes at least two years for most pests to reach problematic levels again
    c. mixing many narrow-spectrum pesticides together is more effective
    d. all of the above
17. Biting insects, ticks, and other pests that diminish personal enjoyment, comfort, or safety in the landscape are often managed using a(n)
    a. physiological action threshold
    b. population action threshold
    c. aesthetic action threshold
    d. DEET application threshold
18. What key information should be collected during routine IPM inspections?
    a. client, plant, and pest information
    b. site, client, and pest information
    c. site, plant, and client information
    d. site, plant, and pest information
19. Standard action thresholds may be used because individual clients rarely differ in their pest tolerance and management expectations.
    a. true
    b. false
20. When establishing an action threshold, it's important to consider
    a. client tolerances and expectations
    b. plant value, condition, and susceptibility
    c. pest damage potential
    d. all of the above AN