Pest Management

Insects and diseases claim more timber each year than any other forest menace. Some of this loss is a natural part of the forest's natural cycle; however, forest health can decline if this natural cycle is thrown out of balance. We value and rely on forests for a wide variety of resources that can be threatened by forest pests, and therefore it is important to monitor forest health and intervene when those resources are at risk. Proper forest management, early detection, and protective measures can prevent or reduce the effects of insect and disease problems; while more intensive management and control options are available when required.

Forest pest management can be difficult for a number of reasons. Trees are generally a low-value crop per acre; to make a forest profitable one cannot afford the cost-intensive control options that are frequently utilized for other agricultural crops. In fact, complete control or eradication of forest pests is, with few exceptions, difficult or impossible to achieve. Trees are grown on vast acreages making monitoring difficult, access problematic, and management/control of pests very expensive. Unlike an annual crop that matures within a single growing season and may only be exposed to a few pests or environmental stressors, trees are long-lived and exposed to many stress agents over the course of their lifetime. They are also very large organisms, so close examination of an entire tree including its leaves, branches, roots, and internal structures, is impossible. Chemical applications that require thorough coverage over the entire plant are limited to young trees or small cultivars. Trees do not heal; rather they compartmentalize their wounds. Compartmentalization is an effective way to contain injured, diseased, or dead tissues, but these "walled-off" pockets of wood and decay can lead to tree health problems years after the initial damage occurred. Trees are the largest organisms in forest communities, and any treatments or control options may adversely affect other organisms in the vicinity. Injury to non-target organisms is a major concern in forest health management. Finally, there are relatively fewer chemical control options available for forestry use than in agriculture or landscape management. Because of these difficulties, forest managers must use an Integrated Pest Management approach when dealing with forest pests and other stress agents.

Integrated Pest Management (IPM) is an environmentally friendly and cost effective approach that utilizes a variety of preventative measures, cultural controls, and direct control measures to promote plant health. No single activity in an IPM program is effective on its own; rather, all of the components of the program contribute to plant health and when used together, effectively keep pest problems below a tolerable threshold. The first and most important step in establishing and maintaining a healthy forest is proper forest management. Planting the appropriate tree species for the site, managing competing vegetation, maintaining appropriate stocking, minimizing injury and stress, and adhering to sound silvicultural methods is the first step in preventing disease and insect problems, and minimizing the impacts of stress agents. In urban forests, proper tree care including water, fertilization, pruning, mulching, and correct species selection will promote long-lived trees that provide many benefits.

An important component of proper forest management and tree care is monitoring the health of the forest and trees within it. Because of the difficulties encountered when managing forest health problems (as discussed above), it is best to detect and mitigate problems early and when they occur at small, localized levels. When an outbreak or epidemic occurs, foresters are often left with very few effective control options. An awareness of the health of your forest, the health of trees in the surrounding area, past predisposing factors, and any changes in the forest community that could throw the natural cycle out of balance is critical to prevent widespread and severe damage by pests.

Foresters have a variety of methods at their disposal to prevent, manage, and control pest problems. The following approaches can all be used as part of an integrated pest management program:

1) ***Exclusion***, otherwise known as quarantine, targets the introduction of forest pests. Quarantines may be difficult to establish, but are usually the cheapest method of pest control. Quarantines are only effective when the pest is not already present in an area, and when natural or artificial boundaries can be established that can effectively prevent introductions. Internal quarantines are utilized to keep a pest inside of the area where the pest is already established. Laws and regulations forbid the export of potentially infested material out of the quarantine zone without certification. External quarantines are enacted in areas free of a certain pest and prevent the importation of potentially infested materials into the pest-free zone. Quarantines can be enacted at city, state, regional, and international levels, but can also be utilized on much smaller scales. For instance, growers can inspect seedlings at the time of planting for disease or insect problems carried in on nursery stock, and effectively exclude those pests from becoming introduced into the stand. Use of soil-less planting media in containerized nursery stock may prevent the introduction of soil-borne pathogens, and use of only local seeds and plant materials can avoid the establishment of non-native pests.

2) ***Eradication*** is utilized when a quarantine has failed. The ultimate goal of eradication is to completely eliminate the pest from an area so that an external quarantine can be established. But complete eradication is only possible when pest populations are small, or when the pest is highly sensitive to control measures. In forestry, this is rarely the case, so eradication is also referred to as ***sanitation***. Sanitation seeks to reduce the pest population below acceptable levels, but usually does not result in complete elimination of the pest. Sanitation and eradication can be achieved through fumigation, crop rotation, destruction of infested/infected plants or plant parts, and destruction of potential hosts.

3) ***Protection*** is utilized to protect susceptible plants from attack, injury, or disease when a pest is present. Also known as prophylactic treatments, protective measures must be in place before the tree is attacked by the pathogen or insect. Typically, prophylactic treatments consist of a ***protectant pesticide*** that is sprayed onto the surface of the plant to prevent an infestation/infection from occurring. Protectant pesticides, because they reside on the plant surface, tend to wash off over time and must therefore be applied periodically while the pest is present. However, some protectant pesticides have systemic properties that allow the chemical to be taken up into the plants vascular system where it may provide long-lasting protection. Protectant pesticides tend to be very effective, but are also among the most expensive control measures because of the need to constantly apply them, and the most likely to cause environmental damage or harm to non-target organisms. Because protectant pesticides need to be applied often and in large quantities, there is also an increased risk that the pest population will develop resistance to the chemical.

4) ***Cures***, or therapeutic treatments, are available in certain cases that limit the damage to a tree that has become infected/infested by a pest, and may potentially eradicate that pest from the plant so further damage does not result. Cures cannot heal the tree, but they may allow recovery if the pest population is incapacitated, reduced, or eliminated. Therapeutic treatments usually come in the form of systemic pesticides that are injected into or taken up by the plant; translocation of the pesticide throughout the infested/infected plant is necessary for adequate control. The benefit of cures is that they can be applied only when needed (after the plant has been attacked), as opposed to prophylactic measures which must be continually applied to prevent an attack from occurring in the first place. This makes them more environmentally friendly, potentially more cost effective (over the long term), and reduces the risk of resistance development in the pest population. However, there are relatively few therapeutic options available in forestry, and they tend to be reserved for high-value trees (landscape trees and ornamentals) because of their high cost per plant.

5) ***Incomplete Resistance***, also known as horizontal resistance or polygenic resistance, is a type of resistance that does not prevent infection/infestation from occurring, but limits the number of attacks or the extent of damage that occurs to the host. Trees with incomplete resistance may not be attacked by beetles as frequently as highly susceptible tree species, may have fewer infections by pathogens, or may have less severe symptoms/signs resulting from those attacks. Incomplete resistance is controlled by many plant genes; each gene partially contributes to plant defenses, but alone they provide little protection. Overall, incomplete resistance is the best possible control option available if it is sufficient to keep damage below acceptable thresholds. The protection it provides is inexpensive, long-lasting, and durable. However, it does permit some damage to occur, and it is difficult to develop this type of resistance. Because many genes are involved, it can take many years (or generations) of plant breeding to achieve desirable results.

6) ***Complete resistance***, also known as vertical resistance or monogenic resistance, is a type of resistance that either prevents infection/infestation completely, or prevents any damage from occurring after an attack occurs. Complete resistance is controlled by a single plant gene that confers 100 percent protection to the plant from a specific pest. Obviously this type of resistance is highly desirable, and can actually be developed quickly through genetic engineering. Occasionally, completely resistant individuals can be found in nature, and used to develop resistant plant varieties. However, initial development of a completely resistant plant variety can be very expensive. In addition, because complete resistance is only controlled by one gene, there is an increased risk that the pest population will evolve mechanisms to overcome that resistance, in which case the variety would become completely susceptible.

7) ***Avoidance*** is perhaps the cheapest and most effective option available to control pest problems, but there are few applications of avoidance available in forestry. The key to avoidance is to make the host unavailable or the environment unsuitable for pest attacks. For instance, plants can be planted earlier/later in the growing season to avoid the time of year when spores from a pathogen are produced. But because trees are long lived organisms, this type of avoidance is difficult to achieve in forestry. However, examples of avoidance include planting trees in microclimates where the environment is not suitable for infections to occur, or delayed planting of seedlings to allow pest populations to dissipate from a stand.