# Evaluating Damage to Nursery Crops

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In spite of the best efforts at prevention and control, all nurseries experience crop damage due to pests. But the question arises: does the damage in a particular nursery justify additional expenditures for prevention or control? To answer that question, managers must identify the damage and evaluate costs and benefits of prevention and treatment and impacts on outplanting success. Production of seedlings in the nursery is an integral part of forest regeneration and restoration programs. Damage to seedlings in the nursery may result in crop losses or poor field performance after outplanting in the field. Poor performance after outplanting may also be caused by damage occurring after seedlings leave the nursery. Diligent recordkeeping and evaluation and reporting of seedling performance is critical to correctly identify the cause of damage and when, where, and why it occurred, so the most effective and least costly treatments can be applied and future damage prevented.

## Evaluating Damage in the Nursery

Damage caused by pests in forest nurseries can affect crops in several ways. Outright seedling mortality is the most obvious impact. Physical damage and growth loss may be less obvious, but are no less important. Seedlings that have been killed or are otherwise unsuitable for planting are usually a total loss. Occasionally, seedlings that are too small or have minor physical damage can be transplanted. Other seedlings may meet specifications and be shippable in spite of damage. The objective of evaluating crops for damage is to identify whether seedlings are suitable for outplanting or transplanting or should be culled. The information can also be used to make decisions about the efficacy of control treatments in the current crop and to plan preventive actions in future crops. To determine the impact of damage, and appropriate treatment and prevention methods, correct diagnosis of causal agents is critical.

A program for identifying and evaluating pest damage should be a routine part of nursery operations. Such evaluations may be designed either for general pest occurrence or for specific problems. The intensity of an evaluation may range from informal seedbed scouting to intensive sampling procedures that permit statistical analyses. Preliminary sampling data may be needed to determine the distribution and variation of the damage to select the most effective and efficient evaluation. Causal agents may include biotic factors such as insects, pathogens, and animals, and abiotic factors such as the nursery environment, mechanical damage, and chemical agents. A person knowledgeable in identification of damaging agents should supervise or conduct the evaluations. It is important to conduct evaluations when symptoms of damage are readily visible. This step may require surveys several times during the crop production cycle. Proper timing of evaluations requires understanding of local nursery insect and disease problems. Insects that cause damage, such as lygus bugs, often appear in early summer. Root diseases, stem rusts, and foliage blights are easiest to see late in the growing season. Fungal diseases, especially root diseases, can manifest subtly with chlorosis or stunting. Fungal diseases may be difficult to diagnose in the field and may require whole plant testing in a laboratory. Some belowground damage, including that caused by root diseases, root weevils, and cranberry girdlers, may not be visible until seedlings are lifted or packed.

Keeping a thorough and accurate record of evaluations is very important. Information to record includes the date, seedbed location, seedling species, seedlot, family, stock type, signs and symptoms observed, causal agent, age of the affected seedlings, portion of seedlings affected, and the size and distribution of the affected area. Background information that is helpful both for planning evaluations and diagnosing damage includes soil type and drainage, irrigation records, cultural practices, pesticide and fertilizer use, and weather data.

After a diagnosis is made, consideration of costs and benefits and analysis of environmental impacts is needed to select treatments that are the most economical and safest for nursery field workers and the environment. The loss in crop value resulting from seedling damage and mortality is affected by the extent of the damage, the value of the seed and seedlings, and the costs associated with transplanting and treatments to control pests. Seed value, seedling age, and stock type are significant factors because they represent the level of investment that has already been made in a crop. The cost of control treatments and transplanting represent additional investments that may be needed before a damaged crop can be outplanted.

Use of economic criteria when making decisions about treatments is an important component of integrated pest management. Economic damage is the point when the loss in value caused by damage to a crop equals the cost of control. The economic injury level is the population at which a pest begins

causing economic damage to a crop. The goal of integrated pest management is to use all available methods to keep pest populations below this level, but not to completely eradicate them. The action threshold is the point at which treatment should be applied to prevent the economic injury level from being reached. In forest nurseries the action threshold for many pests is low because the potential for economic damage is high. Treatment is worthwhile because large numbers of seedlings are often involved, or because seed values are high. In some cases, the action threshold may be set at zero, in other words, treatments are applied before any damage is observed. Generally, an action threshold of zero is used when dealing with pests whose populations increase rapidly, so that by the time damage is observable the economic injury level has been reached. Such treatments include fumigation, seed treatments, pre-emergent herbicides, and protectant systemic insecticides and fungicides.

## Evaluating Damage After Outplanting

Damage to seedlings caused by pests or abiotic factors, such as freeze injury or anaerobic conditions in the nursery may carry over to affect outplanting success. If seedlings are not available for planting, investments in site preparation may be lost. The site may have to be prepared again when seedlings become available in subsequent years. Insects and diseases originating in the nursery are frequently transported to outplanting sites on infested or infected seedlings. Many of these insects and pathogens do not survive well in the natural environment. However, some are capable of surviving and may continue to damage planted seedlings. Insects and pathogens may also be spread from one nursery to another on seedlings that are shipped between facilities.

Not all outplanting problems are the result of problems that may have occurred in the nursery. Determining whether damage to seedlings observed after outplanting originated in the nursery requires careful examination of signs and symptoms, and often involves retracing the history of the stock from lifting through storage and planting to find clues. Successful diagnosis may be difficult if adequate records have not been kept. Information that is helpful in evaluating outplanting problems includes signs and symptoms observed on damaged seedlings; records from lifting, packing, storage, and transportation (date, duration, location, temperature, and type of container); outplanting site conditions (site index, soil type, site preparation methods including any chemical applications, and competition); planting records (seedling quality, planting methods, planting quality, and weather); and records of subsequent events such as unusual weather, fertilization, and herbicide or other release treatments.

The most serious consequence of outplanting insect-infested or diseased seedlings is the potential for introduction of invasive pests and their subsequent spread to native forests. White pine blister rust and Port-Orford cedar root disease are two examples of diseases that were introduced on nursery stock early in the twentieth century and spread into native forests, causing widespread mortality. More recently, the introduction and spread of *Phytophthora ramorum*, the causal agent of sudden oak death and Ramorum blight, has highlighted the potential for spread of diseases between nurseries, and from nurseries to native forests. It emphasizes the importance of careful evaluation and identification of diseases and insects in nursery stock. Most States have regulations for inspection and certification of nursery stock to protect against interstate movement of *Phytophthora ramorum* and other invasive pests.

Cooperation between nursery managers and landowners or managers in evaluation of damage after outplanting can improve both nursery production and outplanting success. The success of these evaluations depends upon accurate records being kept from sowing to outplanting by the nursery manager and those responsible for outplanting and seedling establishment. Participation in such evaluations can enhance a nursery manager's reputation as a professional with an interest in providing the highest quality seedlings to ensure reforestation and restoration success.

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