FOREST NURSERY PEST MANAGEMENT IN CUBA

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Abstract

A systematic survey of methods to detect pests in forest nurseries before they damage plants was done. These surveys recorded the most important forest nursery pests during 18 years (from 1980 to 1998) and their geographical and temporal distribution in the principal enterprises in Cuba. Approximately a dozen insect species and three fungi species responsible for the major problems in forest nurseries in Cuba were studied.

The principal insect pests are: *Anomis illita* (Guer) (Lep. Noctuidae), a defoliator of *Hibiscus elatus* (blue mahoe); *Anurogrillus* spp. (Orthoptera, Gryllidae) a defoliator of *Tabebuia angustata* (white wood), *Samanea saman* (raintree), *Cordia gerascanthus* (cordia wood), *Cedrela odorata* (cigar box cedar); *Atta insularis* (Guer) (Hym. Formicidae) a defoliator of *Hibiscus elatus* (blue mahoe), *Pinus caribaea* (Caribbean pine), *Swietenia macrophylla* (Honduras mahogany), *Casuarina equisetifolia* (horsetail beefwood); *Draeculocephala cubana* (Hom. Cicadellidae) a defoliator of *Eucalyptus* sp. (Eucalyptus), *Hibiscus elatus* (blue mahoe), *Tectona grandis* (teakwood) and *Samanea saman* (raintree). The principal fungi are *Fusarium* sp. (damping off) for broadleaf spp., and *Lecanosticta acicola* (*Mycosphaerella dearnessii*) and *Sphaeropsis sapinea* (Diploid blight) in forest pine nurseries.

The integrated management of forest pests in nurseries in Cuba is discussed. Biological control is utilized but, with few exceptions, the current management of pests relies on chemical products. Finally, the status of pest management in forest nurseries and prospects for the future are discussed.

Key Words

Seedling, reforestation, disease, insects, fungi, cultural control, IPM

Insects and diseases and the importance of their control are a global problem in both agriculture and forestry. These pests are responsible for a 30% loss in annual crop production (Gramberg 1981). By comparison, it has been estimated that 11.7% of losses nationally are caused by pests in forest nurseries in Cuba (Forestry Direction 1992). The forest sector has a great environmental, social and economic importance in Cuba, where 21% of the surface is covered with forests (1,980,720 hectares of natural forests; 352,900 hectares of established plantations and 124,200 hectares of new plantations). To maintain this industry, there are currently 60 standard nurseries (from 100,000 to 1,000,000 seedlings) and 100 smaller nurseries (10,000 to 100,000 production), and the trend is for an increase in the latter. The Institute of Forest Research of Cuba (IIF) was created in 1969 as a FAO (Food and Agriculture Organization of the United Nations) project, and since then it has overseen the research in the forested areas in the country. The Institute has devoted much time towards the investigation of proper procedures for the healthy development of the plants in forest nurseries, having determined that this aspect is essential to obtain plantations with good quality. The country forest patrimony took over in 32 Integral Forest Enterprises (EFI) and 24 Establishments of the National Enterprise for the Protection of Flora and Fauna. Also, with the collaboration of the Vegetal Sanitary Research Institute (INISAV) (Department of the Agriculture), the programs for studying diseases and insects have been established and new technologies developed. During almost 30 years the IIF worked in the detection and the

determination of the most harmful forest pests, with the help of a structure that goes from the base (EFI) to the headquarters (IIF) (Hochmut 1984). As a result of this work, they identified more than 100 species of forest nursery pests, with additional information about their biology and potential for causing damage. Vázquez and others (1999) described the management of forest insect pests of Cuba. This paper discusses diseases and their effects in forest nurseries, as well as preliminary strategies and future perspectives for management of these nursery pests.

Methods

The methods, in essence, are the same as those presented by López and others (1999), involving a systematic sampling of various forest nursery types, including conifer, broadleaf, caesarian, eucalyptus, and mixed nurseries. The specialists from each unit take samples of the affected parts of the plants or of the harmful agent, register the information in terms of locality, soil type, age of the plant, and treatments applied. Finally, they make a preliminary diagnosis of the sample. The specialists from the Forest Experiment Stations (EEF) produce the Sanitary Control Cards, which include all the information on the affected plant as well as the source and preliminary diagnosis. They send the cards to the headquarters (IIF). If it is necessary to verify the diagnosis they also send samples of the harmful agents. In the laboratories of the IIF, the identity of the harmful agent is determined with the help of other institutions. Later, an analysis is carried out using all information, and treatments are recommended. It is possible that damage from mechanical or environmental causes can be confused with symptoms caused by insects or fungal diseases (Landis 1989). For this reason, it is important to inspect the seedbed systematically and to collect the samples as soon as possible. The final identification of harmful agents was a result of collaboration with specialists from the United States and Europe for both insects (Hochmut 1984) and microorganisms (Leontovic 1992).

General Pest Control Strategies

The intensive work in the control of forest pests in Cuba began in the 1980s. From the 1980s to the present, two general strategies of work were developed to achieve the most integrated pest management possible: 1) prevention, which is based mainly on cultural practices to achieve strong and healthy seedlings; and 2) control, which includes the identification of the harmful agents, the evaluation of the damages, and direct treatment. It was in the 1990s, during the development of organic agriculture and biological control, that a third strategy emerged—in other words, conservation. It should be clarified that these strategies are not mutually exclusive, but rather inter-related, and are not contradictory with those outlined by Cordel and others (1989).

Main cultural practices

- Seed collection: Collection varies according to the species, but most are gathered during the months of April to June.
- Timing of sowing: Sowing depends on the species, but generally starts from September and runs through March. However, blue mahoe (*Hibiscus elatus*) is sown from June to August.
- Soil mixes: Brown soil can be used with carbonate or arena-loamy soil, blended with 10% organic matter. In Cuba, for the traditional production of conifer seedlings, pinegrove soil is added, containing natural mycorrhizas, with triple superphosphate (chemical fertilizer) added. In the case of broadleaf spp., no chemical fertilizers are added; but natural fertilizers in the form of organic matter (compost, green manure, etc.) are used.
- Sowing depth: The seeds are generally sown to a depth of 6 to 8 mm.
- Irrigation: Irrigation occurs twice a day during the first 20 days, then once a day if one observes that the substrate is dry. Excess humidity should be avoided.
- Weeding: Weeding should occur whenever necessary.
- Length of growing season: The growing season generally lasts 3 to 4 months. However the meliaceous should remain in the nursery from 10 to 12 months.
- Lifting and packing: Plants should be transferred from the nursery to the field in boxes to avoid damage.
- Plantation establishment: Planting should occur at the beginning of the rainy season after rainfall has moderated.

Preventive practices

Preventive practices play an important role in controlling disease outbreaks. These practices include:

- Preliminary inventories of the nursery areas to identify potential disease problems.
- Plant less vulnerable forest species in problem areas and note the environmental conditions which may contribute to disease problems.
- Use seeds of good quality with certificate of agreement.
- Reproduce clones with tolerance or genetic resistance to diseases.
- Prohibit the transplanting of infected seedlings.
- The entire nursery is fenced to impede the entrance of animals or people that can introduce pests in immature stages (eggs, nymphs, etc.).
- Pesticides should be stored at least 200 m from housing and dining rooms, and be well protected from environmental factors.
- Seedling and seedbed surveys are carried out every 7 days (once per week) with the purpose of detecting damage or infection.

Problems observed with prevention

Occasionally, even with a system of intensive management, sanitary practices have not resulted in the elimination of weeds or infected seedlings. Seeds have also been planted without the Certificate by the National System for Certification of Seeds to guarantee their quality and purity. For such reasons, pests have continued to cause economic losses.

Results of the nursery pest survey

Several species of insect and disease pests have been detected in forest nurseries in Cuba, but among these, 9 species of insects and 3 species of diseases are found with greater frequency and have the capacity for greater damage to the seedlings. Information is also presented on the identification of these pests and their control.

The main insect pests are as follows:

1) *Anomis illita* (Lepidoptera: Noctuidae) Common name: Green worm of the blue mahoe.

It is a monophagous species that affects *Hibiscus elatus* (Majagua). The adults are grizzly brown colored moths, about 3 cm in size, that lay their eggs of clear green color on the underside of leaves or on the stem. The larvae that actually cause the damage are yellowish green in color and can reach up to 3 cm in length. During the larval stage, they live on the back of leaves and are usually hard to detect—in other words, it is difficult to distinguish them at first sight. The pupae stage occurs in the bottom of containers or in the seedbed at a depth of 2 to 3 cm. The pupae are reddish brown in color and measure up to 15 mm. The insect attack begins on the new leaves and will continue onto the old leaves. During the investigation period (1980 to 1998), this insect affected 500,000 seedlings of blue mahoe. Their presence was registered between May and August —in other words, practically during the entire nursery season. It is a nursery pest with national distribution. The largest incidence was during the years 1982 and 1984 in the EFI Cienaga de Zapata and Bayamo.

2) *Atta insularis* Guer. (Hymenoptera: Formicidae) Common name: bibijagua.

This is our largest ant and the most harmful. They vary in size, from 6 mm (working) to 18 mm (queens), and are of reddish dark brown color. It is a poliphagous pest of forest nurseries, but the most vulnerable species appear to be the Caribbean pine (*P. caribaea*) Pine of Mayarí (*P. cubensis*) and the Pine of the Master Saw (Sierra Maestra) (*P. maestrensis*). This pest is distributed throughout the country. The greatest damage has been observed in the nurseries of the Saw Crystal, Mayarí, and Nipe in the eastern zone. These ants are social insects that live in large nests built under ground. They transport and cultivate certain species of fungi on which they feed. The defoliation by these ants is observed generally in isolated seedlings, but from time to time they devastate large areas of the seedbed. The ants prefer well drained red soils. The damages are observed during the entire year, but the largest activity is immediately after the first rains of May and June, during the building period of the new nests. The symptoms of damage are easily seen because seedlings of any age can be defoliated, and both the old and new needles are cut to the base of the stem.

3) *Anurogrillus* sp. (Orthoptera: Grillidae)

They are seedling cutting crickets of typical form for the Orthopteros, with a thick body, and their jumping legs very developed. They are brown in color and measure approximately 3 cm in length. They are ground-dwelling insects and are hidden under stones, boards, or other objects during the day. During the night, they leave in search of food, cutting the seedlings in the nursery. They eat only portions of the seedling, especially the stem, and leave the remaining material abandoned. This is what characterizes its attack. They are present mainly during March and May, and mainly in the eastern zone of the country.

4) *Draeculocephala cubana* (Metc. & Brun.) (Homoptera: Cicadellidae)

Its body is triangular and green in color. The yellow-greenish head is planate and ends in the form of a spear. It measures approximately 6 to 9 mm. This insect is found in large numbers in Euclypts, blue mahoe, teak, *Samanea saman* and *Cordia gerascanthus* nurseries. Symptoms include seedlings which are twisted and chlorotic, ending in death. Prevention includes weeding and sanitation of the seedbeds and the surrounding areas. The insect has national distribution and is found during the entire nursery growing season, but is more harmful in the drought time, from April to November.

5) *Hypsipyla grandella* (Zeller) (Lepidoptera: Pyralidae)

The adult is a gray butterfly, from 25 to 38 mm in length. Its common name is the meliaceous shoot borer. It attacks the species of this family, mainly the cedar (*Cedrela odorata*).They also attack the mahogany of Cuban (*Swietenia mahagoni*) and the mahogany of Honduran (*Swietenia macrophylla*). It is distributed throughout the country, but is found mainly in the nurseries of the central region, especially in the Marsh of Zapata. It is more abundant in the months of April to July.

The principal diseases were as follows:

1) Damping off or fall of the seedling

This disease affects all species of pine and several broadleaf species. The disease is generally caused by *Fusarium* spp. that are endemic to the soil and normally do not cause damage, that is to say a saprophitic microorganism. However, under specific conditions of humidity and temperature, the fungus becomes a parasitic agent to the seedling. It is an especially aggressive fungi for the plants cultivated as bareroot. It is present during the entire year, but causes less damage from the end of November to the beginning of January. It causes the most damage during the 8 weeks following germination of the seedling. The symptoms of the damage are characterized by constriction at the root collar, which results in the wilting and the falling down of the seedling. It is an explosive disease that can result in the death of thousands of plants in 24 hours. This same agent can also cause root rot. But in this case, the plants become chlorotic and die without falling down. It is found throughout the country, but is most prevalent in the eastern region.

2) Brown Spot—*Lecanosticta acicola* (Thüm.) Syd

This disease is presently found only in the eastern zone of the Island—in other words, Baracoa, Guantánamo, Plateau of Mayarí and Master Saw. Its presence has not been confirmed in the central and western zones. Its host plants include Pine of the Master Saw (*Pinus maestrensis*), Caribbean pine (*P. caribaea*) and pine of Mayarí (*P. cubensis*). The fungi develop in the tissue of the needles, and development can occur throughout the growing season. Various symptoms are indicators of the disease. Symptoms include spots of different coloring on the needles with the most common symptom, called brown stains, appearing as small brown spots from 1 to 3 mm. In the center of these spots are the fruiting bodies appearing as rounded points of black. At the beginning of the infection, the needles maintain their green color among the brown spots. Later, when the spots grow and converge, the needles become reddish brown and eventually die back to the base. The needles desiccate and fall, producing defoliation and eventually death of the seedling. This disease is known as one of the most dangerous for the pines, since it can spread throughout extensive areas and destroy the majority of the seedlings in the nursery. Therefore, it is necessary to survey the area to locate possible sources of infection and avoid disease outbreaks.

3) Die back of conifer seedlings—*Diplodia pinea*

Plant hosts include *Pinus tropicalis* and *P. cubensis*. The distribution includes Havana and the eastern region. The pathology of this fungus is widely debated. Some authors consider this fungus to be a facultative parasite, without physiological effects in the plants, while others report it as a pathogen, capable of penetrating young tissue. Symptoms of

the damage include invasion of needles of nursery pines, reduction in the germination of the seeds, root rots, and damping off. It is most prevalent during the months of May through July. It is frequently associated with scolyids of *Ips* and *Hypothenemus* genera.

Damping-off and brown spot comprise approximately 50% of the total forest nursery pests recorded in Cuba. Although insects in general showed a greater diversity in species, they had less impact and caused less mortality in seedlings. This was mainly due to the fact that insects are easier to identify and chemical treatment is more effective. Brown spot was the most dangerous diseases in this survey, with the highest frequency in the eastern mountainous region where the resources are scarcer and treatment is more difficult due to the topographical characteristics of the localities. In general, the forest species most affected were *Pinus maestrensis* (34%), *Hibiscus elatus* (24%), and *Pinus caribaea* (19%).

Estimation of Damage

To determine the magnitude of damage, the intensity of the symptoms on the seedlings from the corresponding pest, as well as its dispersal throughout the seedbeds, were measured. The intensity of the attack was measured by the number of parts of the plant affected (leaves, bud, and so on) divided by the total biomass. An attack was considered light if the plants were less than 30% damaged. An attack was considered strong if greater than 30% of the plant was affected.

Dispersal of the attack

The number of plants attacked in the seedbed was counted and was divided among the total of plants of the species in question. An infection/ infestation was considered light if 10% or less of the plants were affected. An infestation was considered strong if the number of affected plants was over the 10%. Subsequently attacks were classified into categories for treatment application. If the intensity and the dispersal are light, then it is placed in the light classification for damage. If the intensity is light and the dispersal is strong, then is placed in moderate damage. And if the intensity and dispersal are strong, then we classify it as strong damage and therefore utilize the stronger treatment. If the attack is light, we can choose mechanical control. The above shows the importance of systematic surveys, since, generally, nursery pests can be controlled when their incidence is observed before they reach large magnitudes.

Methods of Controlling Pests

Control of insects

The use of biological pesticides is not yet common practice. The application of synthetic insecticides such as carbaryl, diazinon, dimethoate and malathion still predominate. Nevertheless, at the beginning of the decade of the 1990's, we introduced the possibility of biopesticide treatments. When the evaluation of the damage was light, the use of biological products was recommended. However, in the majority of the cases, chemical application was necessary to obtain an effective control. In the case of the ants of the genus *Atta,* BIBISAV-2 50 to 100 g a.i. /m^2 has recently been used. But the results were always more effective when 15g Myrex was used at the mouth of each nest. Additional effective chemical control occurred when Formifol and Saubex (15 g a.i.) were used by mouth of each nest. Good control of cricket cutting of seedlings was obtained with the use of the pesticide Malathion 1000 CE 88.7 at 0.2% a.i./has. When these attacks were increased, the application of Dipterex PS 50 at 0.5 to 1.6 kg/has was effective. For the control of *Draeculocephala cubana* and other sucking insects, we applied Clorpirifos CE-48 at 0.72 to 0.96 kg. a.i./ha when the attacks were light and DimethoateCE-40 at 0.4 to 1.0 kg./ha when attacks were strong. For the control of *H. grandella,* biological products such as the *Bacillus thuringiensis* (Bt 32 PH) at 4.0 L/ha have been used. When these products did not work, Dipterex was applied in similar concentrations.

Control of diseases

For the control of the diseases we do not use biological treatments. To control damping-off, an analysis of the soil is carried out. If pathogenic fungi is found in the soil, the seedbed is disinfected before sowing (at least 10 days before sowing). It is, however, more convenient to seek soils free of pathogenic fungi. Chemical treatment against diseases should be applied immediately following appearance of the first symptoms. The use of Zineb 75% PH at 500 gr in 100 liters of

water is recommended, applying it at a rate of 7 liters per square meter. The applications should be done at intervals of 5 to 7 days, depending on the circumstances. Zineb 75% can also be applied in form of dust, depending on the target pest, on the affected seedlings.

Brown spot: Lecanosticta acicola

Seedlings should not be grown next to plantations that currently have or have had this disease. Chemical treatment should take place if areas display a 5% infection rate in the regions in which the disease has been observed (province of Granma, Santiago of Cuba, Guantánamo, and Holguín). Applications will occur using copper oxicloro 50% PH at 300 gr in 100 liters of water. In nurseries where the disease exists, the affected seedlings should be burned, with the seedlings within 50 m around the epicenter also destroyed. In these cases, treatment will be carried out every 7 to 10 days, maintaining the fungicide on the foliage for the longest possible time.

Diplodia blight: Diplodia pinea

The utilization of the systemic fungicide benomyl is recommended for control. The product should be applied as soon as symptoms of the disease appear. Elimination of the affected seedlings should also occur. If possible, resistant pines should be grown in these areas.

Future Perspectives

The new strategy of forest nursery pest management includes intensive and integrated management, keeping in mind the ecological focus of using biological pesticides and entomophagous insects. The production of mycorrhizal fungus in the laboratories of the IIF should also be considered in order to conserve the beneficial fauna and to protect the natural environment. In Cuba, the conditions for the implementation of such intensive integrated management programs exist in conifer and broadleaf nurseries. The network of 7 Forest Experimental Stations, with 2 sub-stations in Pinar del Río, help to carry out the expansion of technology and to contribute to the training of personnel in forest enterprises. There are 30 Territorial Stations of Plant Protection, as well as 48 centers of entomophagous and entomopathogen breeding in the Vegetal Sanitary National Center that offer biological products for the control of insect pests.

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