ECOLOGICAL CHEMISTRY OF FOREST PEST CONTROL

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Contents

Summary

This chapter represents a brief discussion of the major types of forest insect pests found in North America today. For each group a discussion of the general life cycle and potential detrimental forest related effects caused by species within the group is presented. The major groups of forest pest control agents are then discussed. Specifically, the mode of action and ecological chemistry of each group is presented with several examples of chemicals with each group. Finally, a detailed case study of chloropyrifos is discussed that evaluates the movement of the pesticide through the environment and the potential risks that it poses to non-target organisms that may come into contact with it either through direct ingestion or through bioaccumulation through the foodchain.

1. Introduction and Historical Pesticide Use

The use of pesticides may have begun as early as the Roman times. However, the widespread use of synthetic organic pesticides began in the 1930's. The early uses of

organic pesticides were primarily focused on agriculture, although forestry based usage became popular shortly thereafter.

Pesticide usage has increased worldwide throughout since the 1930's, although the use of chemical pesticides has diminished in the 1990s due to the advancement of biological and genetic controls. The U.S. Environmental Protection Agency (USEPA), Office of Pesticide Programs (OPP) estimates that the total usage of pesticides in the United States had not significantly increased in the latter part of the twentieth century. An estimated 1.2 billion pounds of pesticides were used in the United States in 1997, and an estimated 5.7 billion pounds were used worldwide. This represents a worldwide market of approximately 37 billion dollars annually. The pesticides included in this estimate include herbicides, fungicides, insecticides, and other various categories of insecticide. The estimates also included the use of non-conventional pesticides such as wood preservatives and biocides (biological control agents). The 1997 estimates of conventional chemical pesticide use are down from recent years where total pesticide usage peaked in 1994.

Historically, chemical pesticide usage was greatest in the late 1970's and the early 1980's where chemical pesticide usage was estimated at nearly 800 million pounds in the United States alone.

2. Forest Pests

Pesticide use for forestry and other applications (including home lawn applications) typically make up approximately 20 percent of the total US annual pesticide consumption, with agriculture making up the remaining 80 percent. These pesticides are used to control a variety of classes of pests. The following sections provide a brief introduction to each of the major classes of forest pests and provide information regarding species and general effects of each class on forestry resources. Most classes of forest pests are widely distributed throughout forested regions of the world; however, for the purposes of this chapter, they will primarily be discussed as they are found in North American forests.

2.1. Defoliators

Defoliating insects represent a group of forests pests commonly found in both deciduous and coniferous forests. Effects on host species are manifested in a variety of ways by defoliators, ranging from minor effects and individual mortality in an area to widespread population level mortalities in some outbreaks.

The defoliators represent a large and diverse assemblage of species. Species are typically associated with a single host species or within a group of similar species. In general, effects are seen in the tree due to a reduction in photosynthetic potential. Since defoliators generally consume the green leafy portions of their host species, changes in transpiration rates and the associated changes in the translocation of food within the tree also affect the responses of individual trees during and following defoliation.

In cases where insect defoliation has caused widespread mortality among the host

species, large economic effects may occur. In smaller scale infestations, defoliators may cause a range of effects from loss of property value, wildlife habitat, and to aesthetic values of parks or other public lands.

Common defoliators include gypsy moth (*Lymantria dispar*), forest tent catipillar (*Malacosoma disstria*), western spruce budworm (*Choristoneura occidentalis),* eastern spruce budworm (*Choristoneura occidentalis*), douglas-fir tussock moth *(Orgyia pseudotsugat*), and cypress tip moth (*Argyresthia cupressella*).

The gypsy moth has been the focus of a considerable degree of study in the eastern portions of North America where damage caused by their presence has been severe. Gypsy moth larvae feed on a variety of tree species, including oaks and several species of ash in both the over- and under-stories of the forest. In areas where large percentages of the tree species are among the preferred hosts by the gypsy moth, defoliation can be both extreme and lethal.

The western spruce budworm is an example of a highly important and widespread defoliator in the western portions of North America. As their name implies, western spruce budworms feed on coniferous species, primarily Douglas and white fir. Spruce budworms, as opposed to gypsy moth, consume the new growth in the adult form while the larvae do not feed. Recent outbreaks of western spruce budworms in Colorado have led to defoliation and more severe effects over areas as large as two million acres.

In general, the large group of defoliating insects represents the most diverse and destructive group of forest pests in North America. Insects included in this group each year affect large tracts of land. Pesticide application is a commonly used method for control of defoliator populations.

2.2. Sapsucking Insects and Mites

Sapsucking insects also represent a large and diverse assemblage of forest pest species, causing widespread damages in many areas of North America. Sapsucking insects (from the family Homoptera and Hemiptera) generally use piercing and sucking mouthparts to feed on sap from their host species. Although most species only cause minimal damage, several species such as the balsam wooly adelgid (*Adelges piceae*) and red pine scale (*Matsucoccus resinosae*) can cause more widespread mortality.

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Biographical Sketch

Mr. J.M. Allen has 10 years of experience in the fields of risk assessment, wildlife biology, and forest/ecosystem biology. Mr. Allen provides technical expertise and project management experience in a number of disciplines, including ecological risk assessment, field investigation design and data interpretation, geographic information systems, database programming, data management and statistical analysis.