Protection

I. Insects

A. Introduction

Insects are one of the greatest destroyers of tree fruits and seeds. They reduce both quality and quantity of seeds and affect angiosperms and gymnosperms equally. Damage is done through all reproductive stages, from developing buds to cleaned seeds in storage. Losses to seed insects are huge, and much is yet to be learned about their complete role in the reproductive cycle of woody plants.

B. Objectives

1. Learn the orders of insects that cause the most damage to tree seeds and the species they attack.
2. Recognize the types of injury that insects cause.
3. Learn some methods of insect control and management.

C. Key Points

The following points are essential in protecting seeds from insects:

1. Insects of the orders Hymenoptera, Diptera, Lepidoptera, Hemiptera, Coleoptera, Homoptera, and Thysanoptera do the most damage to flowers, fruits, and seeds of woody plants.
2. Damage ranges from causing reproductive structures to abort to causing loss of seeds in storage.
3. General types of damage include:
   a. Destroying the seeds only, Hymenoptera (wasps).
   b. Forming galls and mine scales, Diptera (flies).
   c. Free feeding, Lepidoptera (moths).
   d. Consuming endosperm, Hemiptera (true bugs).
   e. Mining cone axes, Coleoptera (beetles).
   f. Causing cone abortion, Homoptera (aphids, etc.) and Thysanoptera (thrips, etc.).
4. Control methods depend on identifying and knowing the insect's life cycle and the host-plant relationship.
5. Some methods for reducing damage are preventive measures, insecticides, natural biological control agents, and proper management techniques.

D. Damage

1. **General concepts**
   a. Insects reduce seed production by infesting buds, flowers, cones, and seeds.
   b. The most damaging insects are largely restricted to six orders: Lepidoptera (moths and butterflies), Diptera (flies), Coleoptera (beetles), Hymenoptera (wasps), Hemiptera (true bugs), and Thysanoptera (thrips).
2. **Specific concepts**
   a. Coleoptera (beetles) are the most damaging group in arid and semiarid zones.
      (1) Bruchidae (bruchid beetles) are the most important by far for Leguminosae; e.g., beetles in the genera: *Amblycorus, Bruchidius,* and *Caryedon.*
      (2) Curculionidae (weevils) lay their eggs on developing fruits:
         (a) Conotrachelus
         (b) Curculio and *Conotrachelus*
         (c) Thysanocnemis
         (d) Nanophyes
         (e) *Apion ghanaense*
   b. Lepidoptera (moths and butterflies) damage stored seeds:
      (1) Pyralidae
      (2) Melissopus and *Valentinia*
      (3) Agathiphaga
      (4) Gelechiidae
   c. Hemiptera (true bugs) feed on seeds with specialized sucking mouth parts:
      (1) Coreidae attack *Erythrina* seeds in India and some *Acacia* species in Africa
      (2) Pentatomidae
   d. Hymenoptera (wasps) feed on seeds:
      (1) Torymidae *(Megastigmus* spp.) larvae feed on *Pinus, Abies,* and *Pseudotsuga*
      (2) Eurytomidae *(Bruchophagus)*
   e. Homoptera (aphids, cicadas, and scales) are not a major threat to seeds.
   f. Thysanoptera (thrips) cause some damage to tree seeds.

E. Controlling insects

Control measures must be guided by the species and ecology of the insect.

1. **Prevention—The** insect may be prevented from reaching the seeds.
2. **Chemical control — Includes** foliar sprays, systemic poisons, light traps, chemical traps, and carbon dioxide.
3. **Natural enemies—** The target insect's life cycle and history should reveal its natural enemies.
4. **Collection practices—Collecting** good seeds is the first step in keeping down losses incurred in storage.

F. Sources

For additional information, see Cibrian-Tovar and others 1986, Johnson 1983, Schopmeyer 1974, Southgate 1983.

II. Pathogens

A. Introduction

Pathogenic organisms (fungi, bacteria, and viruses) cause great economic losses. Not only are seeds the victim of pathogens, but they also are passive carriers (vectors) of pathogens that may not directly affect the seeds but may endanger other organisms. This fact is the basis of plant quarantine regulations that include seeds in the import and export restrictions on plant material.

B. Objectives

1. Learn the major types of seed pathogens and the typical damage that they cause.
2. Identify steps to decrease losses to seed pathogens.
3. Review documented occurrence of micro-organisms associated with tree seeds.

C. Key Points

The following points are essential to preventing seed pathogens:

1. The major disease-causing organisms are fungi, bacteria, and viruses.
2. All tree seeds carry micro-organisms, primarily on the surface of their seedcoats.
3. All seed micro-organisms are not pathogenic; some may even be beneficial.
4. Pathology of tree seeds has not been studied extensively; much work remains to be done.

D. Types of Pathogens

1. **Viruses**
   a. Viruses account for seven kinds of seed damage:
      (1) Abortion of seeds
      (2) Flower sterility
      (3) Seedcoat wrinkling
      (4) Shriveling
      (5) Chalky endosperm
      (6) Staining
      (7) Necrosis
   b. In legumes, embryo-borne viruses reduce viability.
   c. A high incidence of triploidy can result from viral infection.
   d. Market value of seeds can be reduced.
   e. A virus can outlive the seed.
2. **Bacteria—Bacterial** infections account for four kinds of seed damage:
   a. Abortion
   b. Rot
   c. Discoloration
   d. Slime disease
3. **Fungi** are a serious threat to seed health simply because of the great numbers of representative species known as seed pathogens. Fungi account for eight kinds of seed damage:
   a. Abortion
   b. Shrunken seeds and reduced seed size
   c. Rot
   d. Sclerotization and stromatization
   e. Necrosis
   f. Discoloration
   g. Lowered germination capacity
   h. Physiological alterations

E. Control Mechanisms

Seed pathogens can be controlled by reducing infection and by treating seeds in laboratories, storage facilities, and nurseries.

1. **Infection reduction—Infections** in orchards can be reduced by:
   a. Locating seed orchards in areas of low infection risk
   b. Removing alternate host plants
   c. Sanitizing orchards
   d. Applying fungicides
   e. Using good cone- and fruit-handling methods
2. **Seed treatment in laboratories**
   a. Surface sterilization
   b. Fungicides
   c. Hot water soaks
3. **Seed treatment in storage**
4. **Seed treatment in nurseries**
   a. Damping-off
   b. Seedling diseases

F. Micro-organisms Found on Tree Seeds

See the checklist of Anderson (1986a).

G. Sources

For additional information, see Anderson 1986a, International Seed Testing Association 1966, Neergard 1977, Sutherland and others 1987.