

The background of the slide is a dark green color with a pattern of lighter green, stylized leaves. The leaves are scattered across the page, with some overlapping. The text is centered and written in a white, serif font with a slight shadow effect.

Relationships between Forest Nutrition and Insects

Intermountain Forest Tree Nutrition Conference

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Tree Resistance Mechanisms

- Preformed = Constitutive
 - Present prior to attack
- Induced
 - ‘Turned on’ by attack

Tree resistance mechanisms of conifers: A three-step sequence

- Step 1 – wound cleansing (resin flow)
- Step 2 – infection containment (induced response)
- Step 3 – wound healing (isolate the invader)

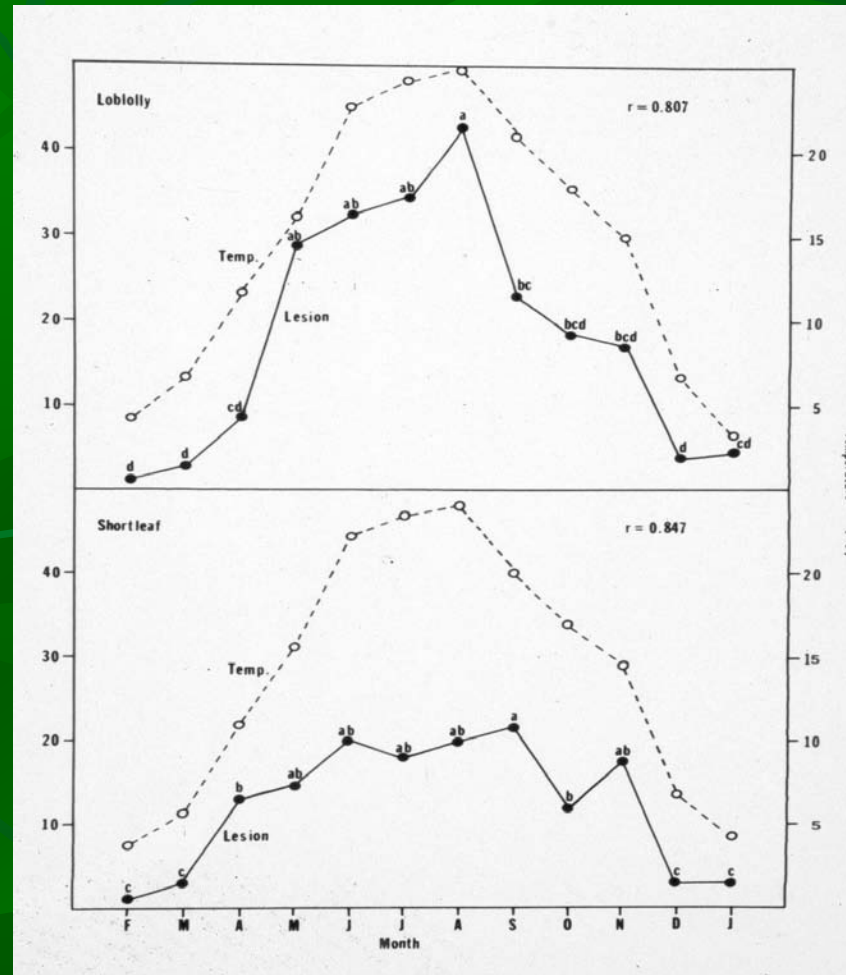
Constitutive defense – resin flow



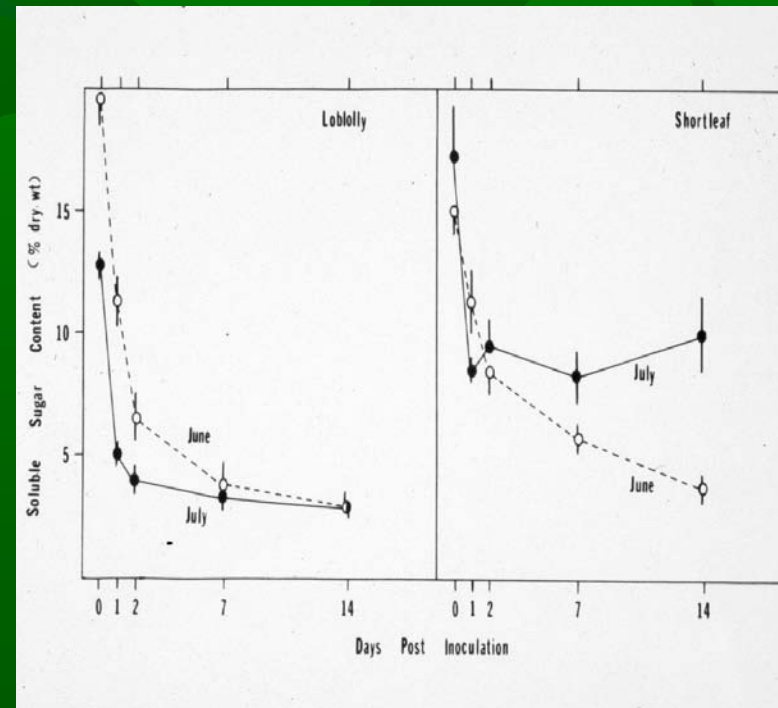
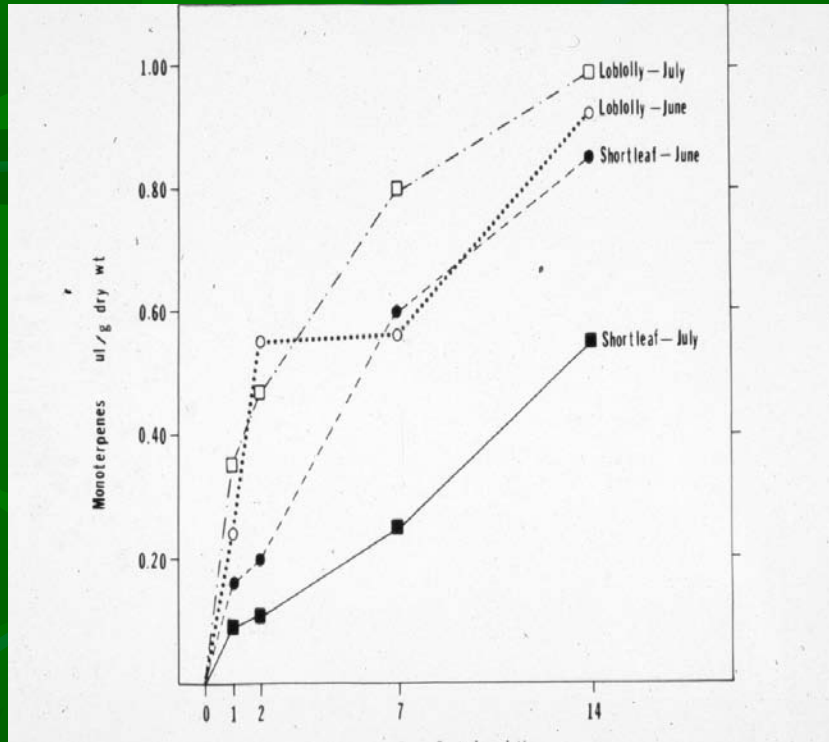
Induced defense – hypersensitive lesion



Seasonal response of southern pines to fungal inoculation



Biochemical changes within the lesion tissue



Tree resistance mechanisms of conifers: A three-step sequence

- This is an energy-intensive process



Managing for Bark Beetles: Stand Density Species Composition

We frequently think of thinning stands for bark beetle management.

- Pre-commercial Thinning
- Commercial Thinning

- Prevention Tactic
- Suppression Tactic

Thinning Studies with bark beetles

- Have concentrated on suppression aspect
- Have provided mixed results
- Thinning does appear to improve tree vigor indices that are important in bark beetle resistance
 - Resin production and flow
 - Inducible mechanisms
- What would happen if you combined thinning with fertilization?

Tree nutrition (N) and mountain pine beetle



- Project being conducted in collaboration with John Marshall, Brian Shirley and the Intermountain Tree Nutrition Cooperative
- Project involves fertilization of lodgepole pine and assessing nitrogen assimilation across several trophic levels

MPB infesting lodgepole pine in BC

Too late for prevention

- Stand density too high
- Stand composition not appropriate
- Tree species –
- Lodgepole pine is built to live fast and die young (it is well adapted to utilize MPB and fire)



Tree nutrition and mountain pine beetle: Basic biology

- Preferred host of MPB is lodgepole pine
- MPB prefers mature to over-mature hosts in relatively high density stands
- MPB has several fungal associates that may benefit the beetle nutritionally and/or by aiding in overcoming host resistance
- MPB has a rich component of natural enemies that attack it



Tree nutrition and mountain pine beetle: Rationale

- Induced resistance mechanisms of the tree are energy intensive
- Trees respond with a 3-step response to either the beetle or its associated fungi
- Carbon-nutrient balance theory predicts that the release from nutrient stress can result in trees that are not as well defended



Tree nutrition and mountain pine beetle:

Methods

- Two sites have been utilized – Craig Mountain (Idaho Department of Fish and Game) and the UI Experimental Forest
- Nitrogen fertilization treatments applied in spring (urea applied to individual trees at rates equivalent to 0, 300 or 600 lbs per acre) in a completely randomized design
- Craig Mtn – trees baited with aggregation pheromone for ‘natural’ attack
- UIEF – trees cut and ‘manually’ infested

Tree nutrition and mountain pine beetle: Measurements

- Tree
 - Inner bark nitrogen content
- Beetle
 - Adult beetles captured emerging from trees
 - N content measured
 - Beetle size measured
- Fungi
 - Scraped from pupal cell and N content measured
- Natural Enemies
 - Captured emerging from trees
 - Community measured
 - N content measured

Tree nutrition and mountain pine beetle: Why examine the fungi



- The fungi are intimately associated with bark beetle species
- Fungi probably have 2 roles that benefit the beetle
 - Overcoming host resistance
 - Nutritional
- Fungal ‘nutritional ecology’ may impact overwintering success

Tree nutrition and mountain pine beetle: Natural enemies

- Common natural enemies such as these clerids can be intimately associated with the bark beetle prey
- The immature predators feed exclusively on the immature prey items under the bark of the attacked trees
- Does tree nutritional status impact natural enemy success and survival?
- Photos from:

www.insectimages.org



Tree nutrition and mountain pine beetle: Very preliminary results

- More nitrogen (% of tissue) in fertilized trees versus controls
- Larger mountain pine beetles from fertilized trees versus controls
- More natural enemies from trees receiving the low fertilization treatment
- Cannot comment on host attraction/resistance (yet)

Tree nutrition and mountain pine beetle: Future Directions:

- Thinning may slow infestation enlargement, what about low-level fertilization.
- What about combining thinning with fertilization to improve tree vigor (submitted proposal with Han-Sup Han and Leonard Johnson)?
- What does fertilization do to the overwintering success and survival of mountain pine beetle? of the fungal associates?

Relationships between Forest Nutrition and Insects

Anything and everything that we do in forest management impacts insects in the forest. The question becomes one of understanding the impacts and the implications not just on any ‘pest’ species, but on the general community of insects present on the sites.

The end – any questions?

