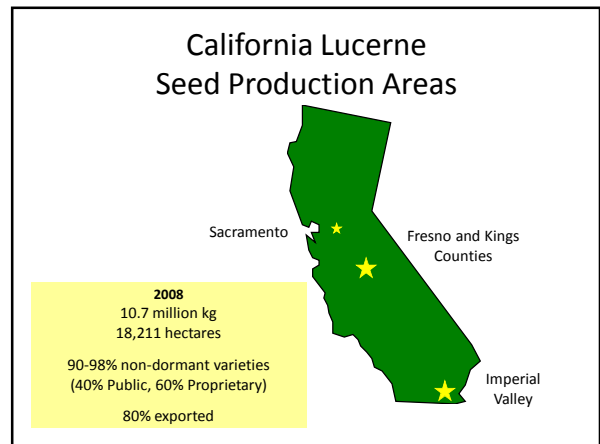
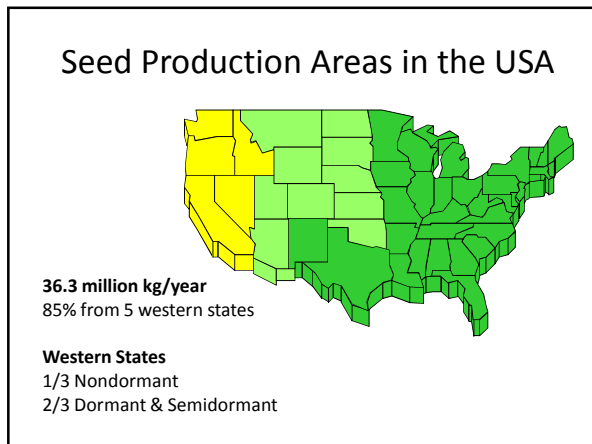
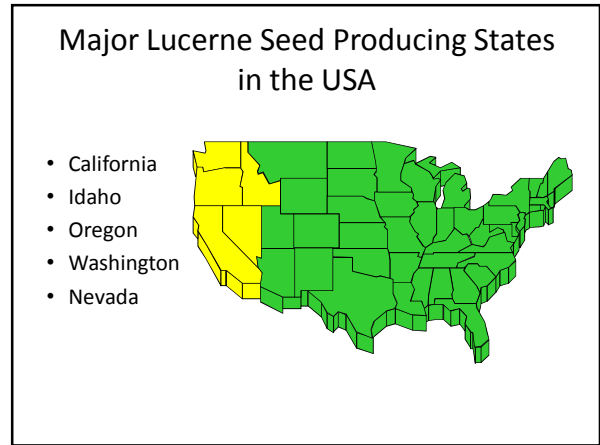
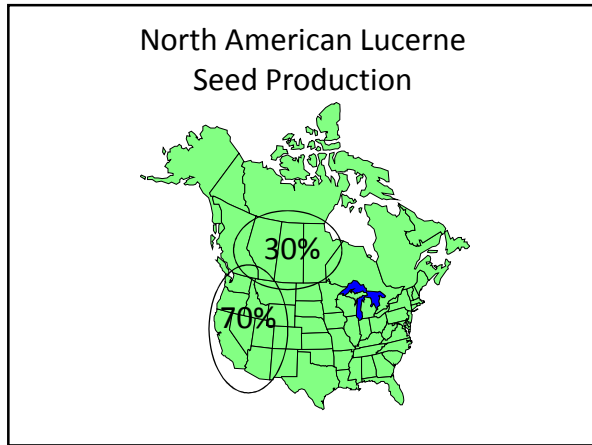




Outline

- US Production Areas, Statistics, and Markets
- Lucerne Pollination by Honey Bees
 - History
 - Contracts
 - Impact of Selected Seed Production Practices on Pollination
- Research to Improve Pollination
- Alternate Pollinators for Lucerne Seed Production



Major Markets for Lucerne Seed

- Forage
 - Dairy
 - Beef
 - Horses
 - Sheep
- Sprouts

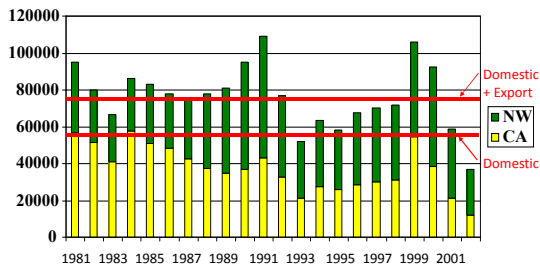


Lucerne Seed Markets



- **Domestic**
 - 22.7-24.9 million kg/year
- **Export (1° nondormant)**
 - 6.8-9.1 million kg
 - South America
 - Mexico
 - Middle East
 - Europe

Production (X 1000 pounds)



Sources: Alfalfa Production Research Board Statistics, USDA Various States



Pollination

Pollination

Use of bees for pollinating crop plants is based on the bees' dependence on nectar and pollen as food sources.




Attraction of Bees to Flowers




- **Visual** response to amount, size, & color of bloom
- **Olfactory** response to aromatic compounds produced by the plant
- **Reward** response to factors such as the amount of pollen and the amount and quality (sugar content) of the nectar.

Lucerne Pollination

- Plentiful bloom and fragrance are assets.
- Honey bees and other pollinators are attracted by the nectar. 
- Lucerne is not an abundant pollen producer and its pollen is *least attractive* to honey bees when compared to most crops and weeds.

Lucerne Pollination

Lucerne flowers require *tripping* and *cross pollination* for maximum seed and forage yields.




- Self pollination results in fewer seeds and inferior quality of the resulting forage plants.
- In the field, less than 1% of the self-tripped flowers produce seed and most non-tripped flowers fail to do so.

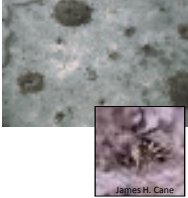
Maximum tripping and cross pollination result from pollinator activity.

Major Pollinators of Lucerne in the Western US


Honey bees
(*Apis mellifera*)



Alkali bees
(*Nomia melanderi*)




Leafcutting bees
(*Megachile rotundata*)



Honey Bees (*Apis mellifera*)

- Inexpensive (\$35)
- Readily Available
Pollinate 42 different fruit, nut, vegetable, forage and seed crops in CA
- Inefficient Pollinators
Only a small percentage of the foraging bees are active pollen collectors.
Prefer other crops to lucerne.
Learn to avoid tripping mechanism.
- Require Long Production Season (8-10 weeks)




Honey Bees & Lucerne Seed *Pollination History*

- Before 1946, honey bees were not valued for their role in seed production.
- Then, it was shown that honey bees increased yields upwards of 560 kg/ha.
- Early 1950's: Use of honey bees for pollination of seed was an accepted practice
 - 2 colonies per acre (4.9 colonies/ha) initially
 - Peaked at 4 colonies per acre (9.9 colonies/ha) in 1977
 - Dropped back to ~3 colonies per acre (7.4 colonies/ha) to benefit bee health

Honey Bees & Lucerne Seed Pollination

- Bees are introduced into seed fields at approximately 30-50% bloom.
- Growers use 2-3+ strong colonies/acre (4.9-7.4+ colonies/ha).
- Enhance pollination by placing a second group of bees in the field 3-4 weeks later.



Honey Bees & Lucerne Seed Pollination

Seed production relies on clear and continuous communication between

- Seed growers
- Beekeepers
- Pest control advisors
- Pesticide applicators
- Irrigators

A Team Effort!



Pollination Contracts

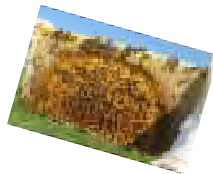
Specify number & strength of colonies required

Minimum of **3 colonies per acre**, each with at least **1000 square inches of brood** covered with **adult bees** and an **actively laying queen** in a **two-story colony** with room to grow.

(7.4 colonies/ha with 6450 square cm of brood)

May also specify colony strength in terms of "frames of bees".

Colony Strength Definitions



- A frame of bees
 - A frame of bees has 4-5 bees per square inch (0.6-0.8 bees per square cm) on ¾ of the surface on both sides of the frame
 - Recommended minimum 8-10 frames of bees (12 better)
- Square inches of brood (~1000 square cm of surface area per side of each frame)
 - 6450 square cm of brood *minimum* (3+ frames)

Pollination Contracts

Maintenance of bee colonies in proper condition for pollination

- Bees gather pollen to feed brood. Need actively laying queen for the entire pollination season.
- During heavy nectar flow, beekeepers must add/replace superss to maintain space for egg laying or the colony becomes honey bound and field activity of the bees will suffer
- Provide a source of fresh water
 - In-field water reduces flight distances during hot periods
 - Fields with water yielded 50-106 kg/ha more than fields without

Pollination Contracts

When bees are to be moved into and out of fields



Remove bees 30 days prior to projected harvest date. Blossoms pollinated beyond that point would not reach maturity by harvest.

- First colonies should be moved in when the lucerne is between 30 and 50% bloom
- Full compliment of colonies should be moved into the field within 7 days after reaching 50% bloom
- If the field begins to look like a flower garden, there are not enough bees per acre.

Pollination Contracts

Description of distribution pattern in or around the fields

Most effective pollination activity occurs within a 100-meter radius of the colony.


Colony Distribution

- Colonies placed at the edge of the field provide twice as many bee visits to blossoms as colonies placed at some distance from the field.
- Colonies located systematically within a field will have about twice as many bees visiting blossoms as there would be if the same number of colonies were located at the field's periphery (Atkins et al, 1979)

Pollination Contracts

Procedures to be followed when pesticides are to be applied

- Proper notice (48 hours) to beekeepers before pesticides harmful to bees will be used
- Compensate for extra movement into and out of fields



Pollination Contracts

Rental fee and payment procedure



Keys to
Successful Lucerne Pollination
in the USA




Production Practices that Influence
Pollination

Stand Establishment
Clipback
Irrigation
Pest Management

Competitive Bloom

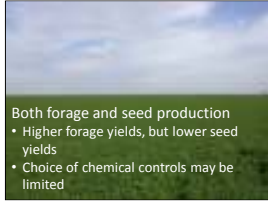
Within 3.2 km of a seed field, competition for pollinators and insect control programs may affect yield.

Major competitors for honey bee visitation in seed growing areas are safflower, milo, corn, cotton, mustard, melons, clover, morning glory, sunflower, and asparagus.



Stand Establishment

Solid vs. Row Planting



Both forage and seed production

- Higher forage yields, but lower seed yields
- Choice of chemical controls may be limited



Low Density Plantings

- Higher yield potential
- Easier detection and control of weeds & volunteers
- Pollination access
- Efficiency of pesticide applications & desiccation

Plant Population

- Plant density has a direct effect on seed yield.
 - Thinner stands may have improved water use efficiency, pest control, and pollination; often resulting in higher yields
- Minimum Seeding Rates
 - 0.56-0.84 kg/ha for row plantings
 - 6.7-11.2 kg/ha for broadcast seedings

Clipback

Spring clipback removes winter growth and encourages uniform bloom, timed to coincide with peak pollinator activity.

Options:

- Forage harvest
- Chopping
- Chemical clipping
- Grazing



Of all the production practices employed by seed producers, **Irrigation Management & Pest Control** have major effects on the pollination activities of honey bees in seed fields.

Irrigation Management

Lucerne seed requires 4.3-4.9 meg/ha of water per year as irrigation or effective rainfall.

Fall, Winter, Early Spring
Fill soil profile with water

Summer

Time irrigations to promote slow, continuous growth, bloom, and seed set without stressing plants.

Timing and the amount of water applied affect the condition of the field and subsequent seed production.



Irrigation Management

- In 24-48 hours following the beginning of an irrigation, bee visitation drops dramatically (from 25% to 95%) for 7-10 days.
- The field then becomes highly attractive to foragers again.
- Attractiveness tapers off in 7-10 days and/or until the next irrigation.



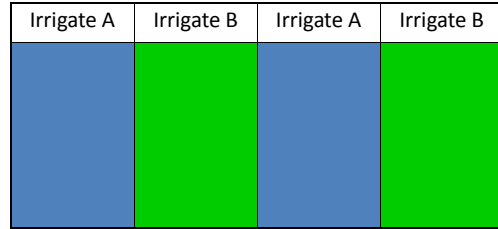
Irrigation Effects on Pollination

- When the moisture content of the soil and plants is high
 - **Sugar content** of the nectar is normally low. (Honey bees prefer plants in moderately dry soil due to the **higher sugar concentration** in the nectar.)
 - Lucerne flowers are **more difficult to trip**.

Consider alternate block irrigation to maintain bee visitation in irrigated fields.

Alternate Block Irrigation

Stagger bloom/stress condition in each field, maintains bee visitation, and increases yield



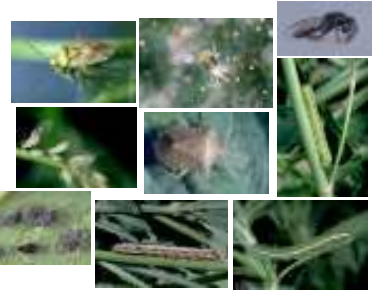
Alternate Block Irrigation

Field Acreage	Prior Year (kg/ha)	Alt Block (kg/ha)	% Yield Increase	Age of Stand
157	782	1299	66	2
144	860	1060	23	6
74	1465	1636	11	2
150	414	647	56	2
200	336	655	95	2
170	476	756	58	3

Pest Management

Key Pests in Western US Seed Production

- Lygus Bugs
- Spider Mites
 - Two spotted
 - Pacific
 - Strawberry
- Seed Chalcid
 - Seed wasp
- Stink Bugs
- Aphids
- Worms (grubs)



Monitoring Pest Populations

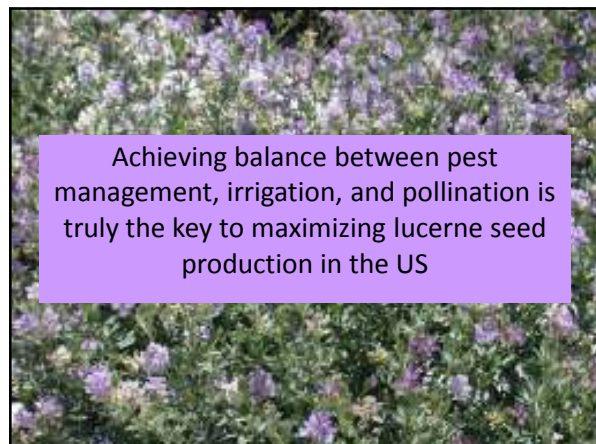
- Growers monitor most pest and beneficial insect populations once or twice each week throughout the season.
- Population counts and stage of insect development are used to determine management strategies.



Chemical Control



- Most effective and widely used strategy
- Chemicals must be applied carefully to kill target pests without harming pollinators
 - Apply at night
 - Move bees out of field if necessary
- Direct and residual pollinator effects
- Bee repellency
 - Pesticide applications reduce bee foraging levels 40-97% for 2.5 to 7 days
 - Piggyback pesticide applications with an irrigation to limit the amount of time bee visitation is impacted.



Achieving balance between pest management, irrigation, and pollination is truly the key to maximizing lucerne seed production in the US