Insect Pest Management in Alfalfa Seed:

Sampling and Thresholds

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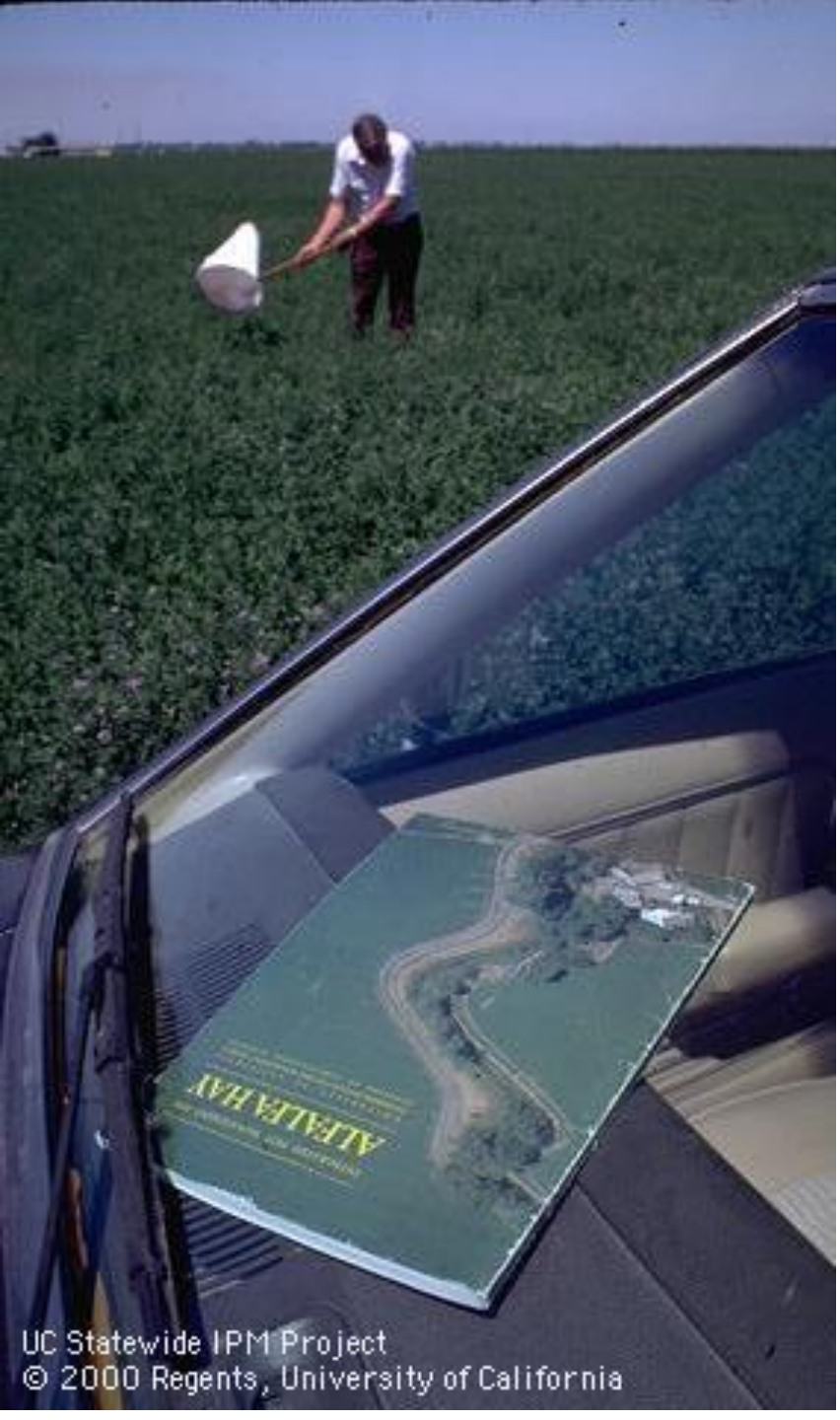
University of Idaho
Tradition. Change. Excellence.

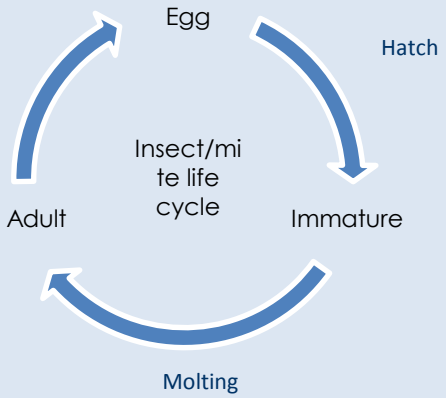


Sample to:

Make effective, economically/ environmentally sound insect management decisions

- When (if) to apply control measures
- Apply the right control
- Avoid pest outbreaks/ yield loss
- Avoid unnecessary treatments
- Resistance management
- Determine population trends
- Determine effect of treatments

Key IPM Concepts



- Knowledge of the pest:
  - Identification, life cycle
  - Crop and non-crop hosts
  - Injury to crop

- Decision making tools
  - Sampling/ monitoring
  - Action/ economic thresholds)

- One or more management tactics
  - Cultural
  - Chemical
  - Biological control, HPR, etc.)

Economic injury levels and action thresholds

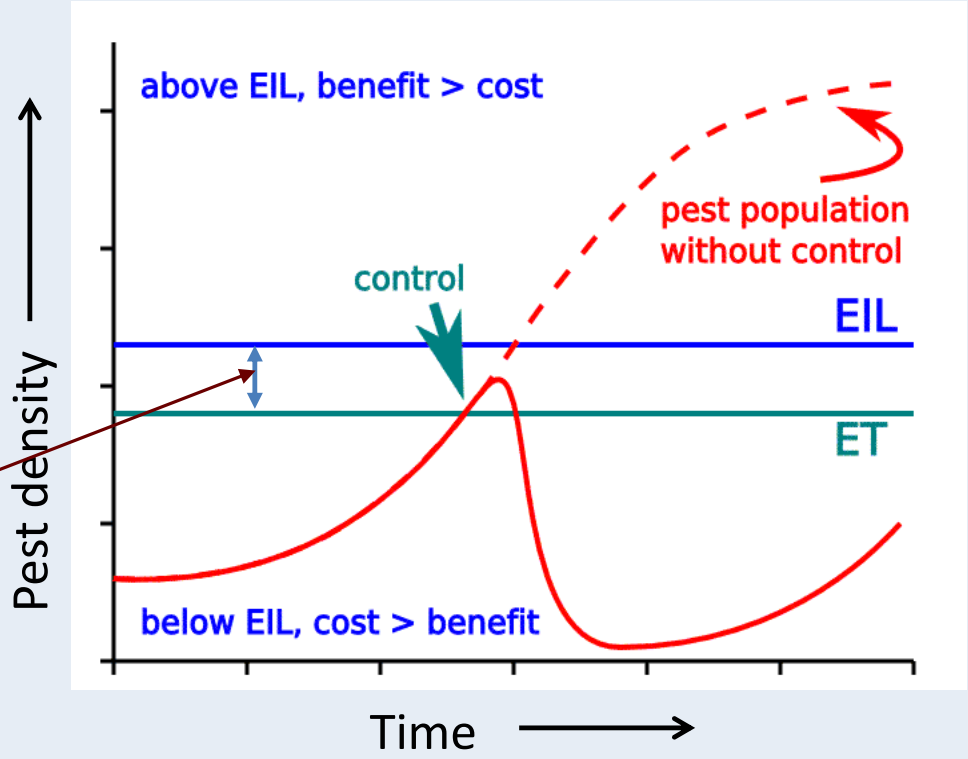
When to apply treatments

Economic injury level: pest density that causes economically significant crop loss, or when:

Cost of yield loss = cost of control efforts

Economic (action) threshold: level at which pest should be treated to prevent it exceeding the EIL

Lag time

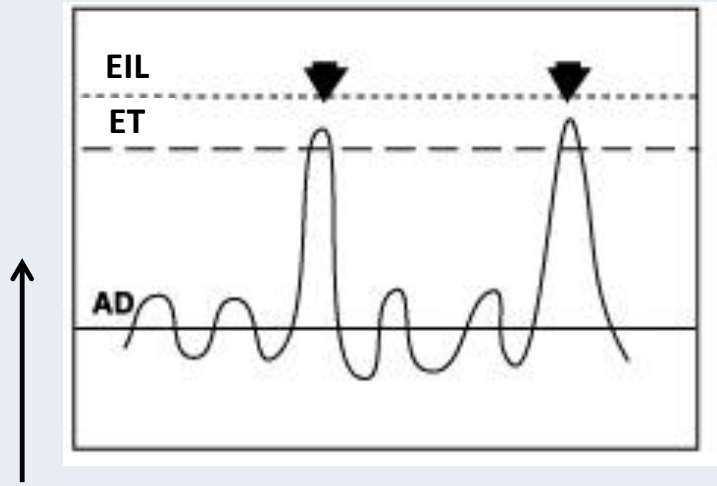


Action thresholds

Indirect vs. direct pests

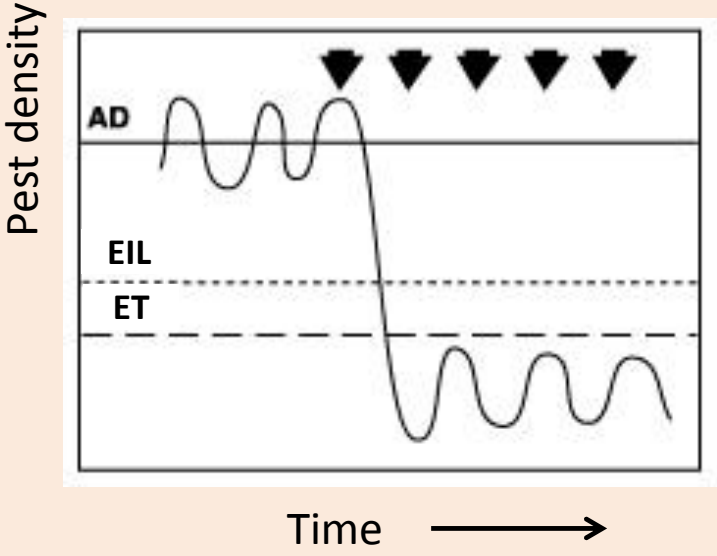
Indirect pests: attack non-harvested plant parts (roots , shoots, leaves…)

- Higher tolerance level
- Density often below ET
- More response time



Direct pests: attack harvestable commodity (fruit, fruit buds…)

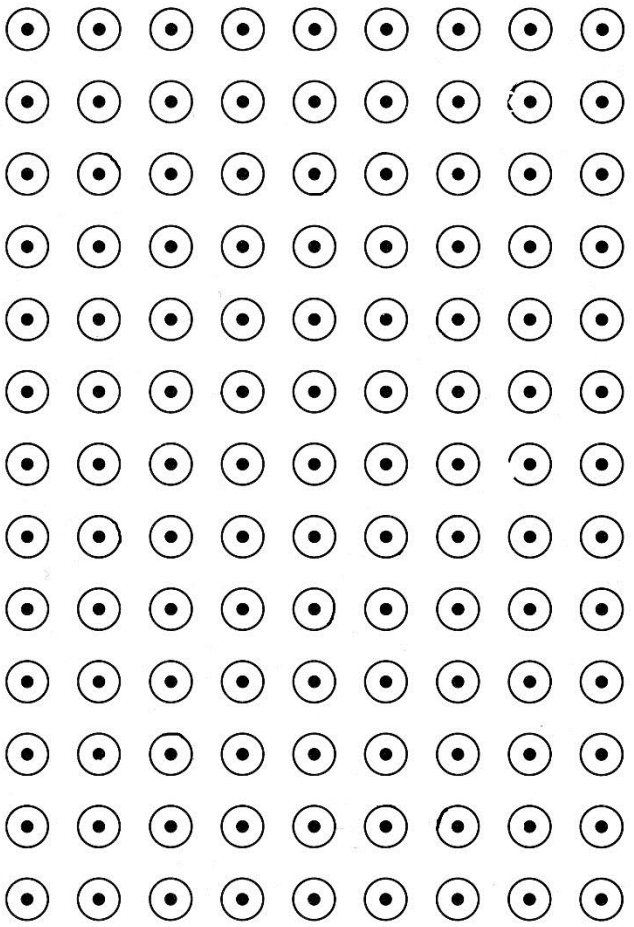
- Lower tolerance level
- Density often above ET
- Less response time



From Metcalf and Luckmann 1994

Representative samples

We need to reliably estimate the actual mean density (e.g. pests per leaf)



Samples should be unbiased

- Representative of the area (field/block) being sampled
  - Sampling only from areas showing damage gives estimates higher than actual mean
  - Sampling only from undamaged areas gives estimates lower than actual mean
- Each sample unit should have an equal chance of being selected

How to sample

Walk a predetermined route that covers the entire field

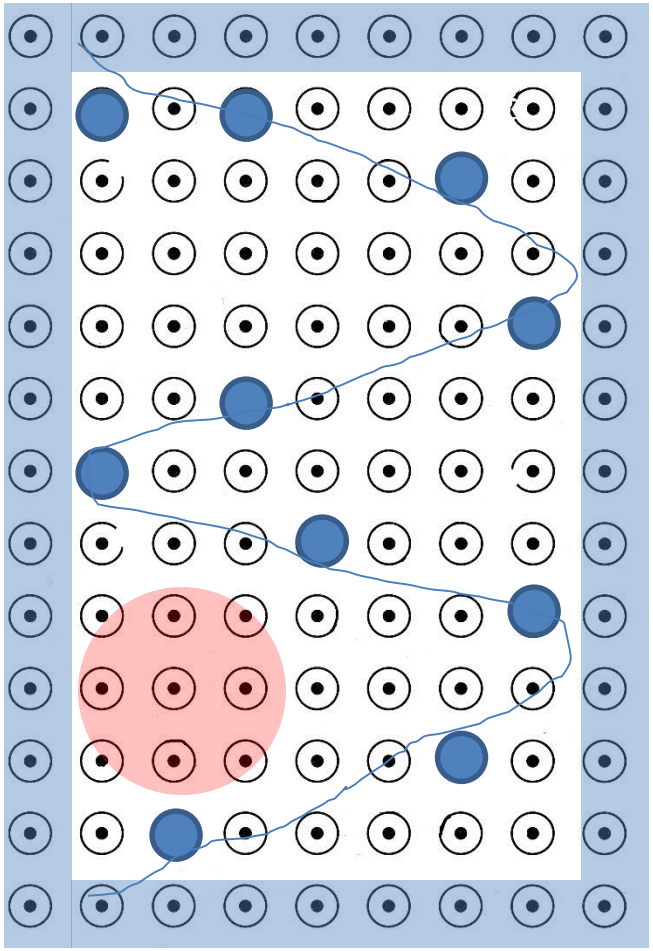
Zig-zag or “W” shaped routes are good

Make observations about field conditions while scouting

Don’t sample from plants that are obviously more or less healthy than the field generally

Don’t consistently sample from leaves/areas within easy reach

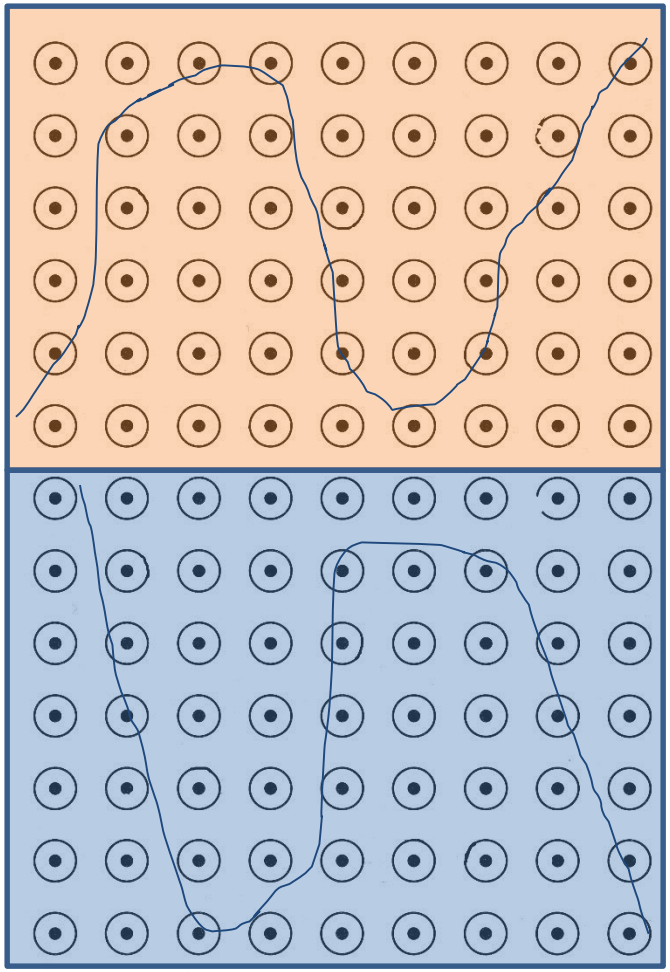
Consider separate samples from field edges and “hot spots”



How to sample

Take separate samples for units (fields/blocks) managed differently

- Different varieties
- Different fertilization
- Different irrigation
- Different ages
- Different previous crop

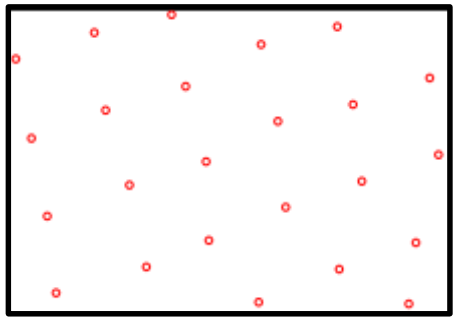


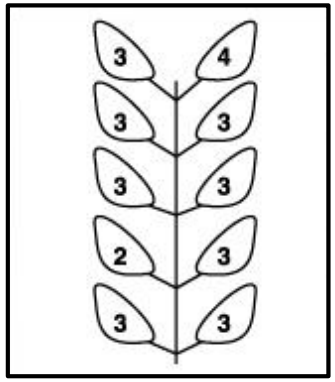
How many samples are required?
Depends on insect distribution

Possible Insect distributions in fields or on plants

Uniform

Mean>> variance





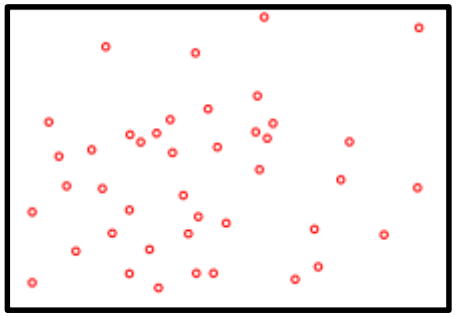
Mean=3

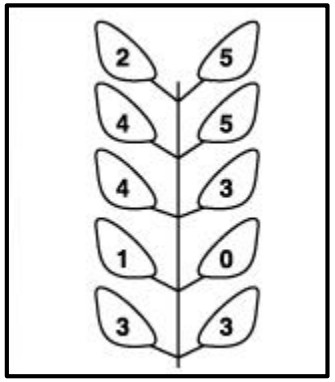
Variance=0.2

Few samples needed: rare

Random

Mean≈variance





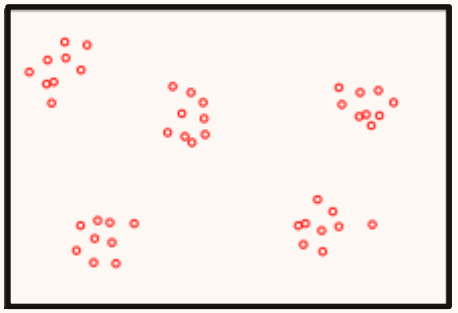
Mean=3

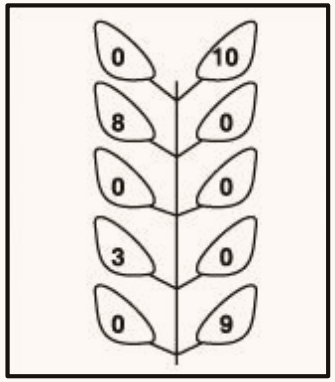
Variance=2.6

Many samples needed: uncommon

Clumped

Mean<< variance





Mean=3

Variance=18.2

Very many samples needed: common

From Orchard Pest Management: A Resource Book for the Pacific Northwest

Determining the number of samples needed requires detailed information about the mean to variance relationship

- Changes with each pest and crop combination
- Changes as density increases for each pest
- Changes for different stages of same pest

Most sampling plans are developed using insect distribution data so that a fixed number of samples is used to provide a conservative estimate of the mean, e.g.

- Number of insects
  - Per sweep
  - Per leaf or stem

Sampling methods

Sweep net samples

- Collects many insects quickly
- Useful for sampling field crops, ground cover and field edges
- Not as useful when crop less than 6-8 inches tall
- Counts on site or in shop/lab
- Hand lens/ aspirator useful

Standard sweep net sample

- Most thresholds calibrated for a “standard sweep”
- Used for: lygus, alfalfa weevil, caterpillars, aphids

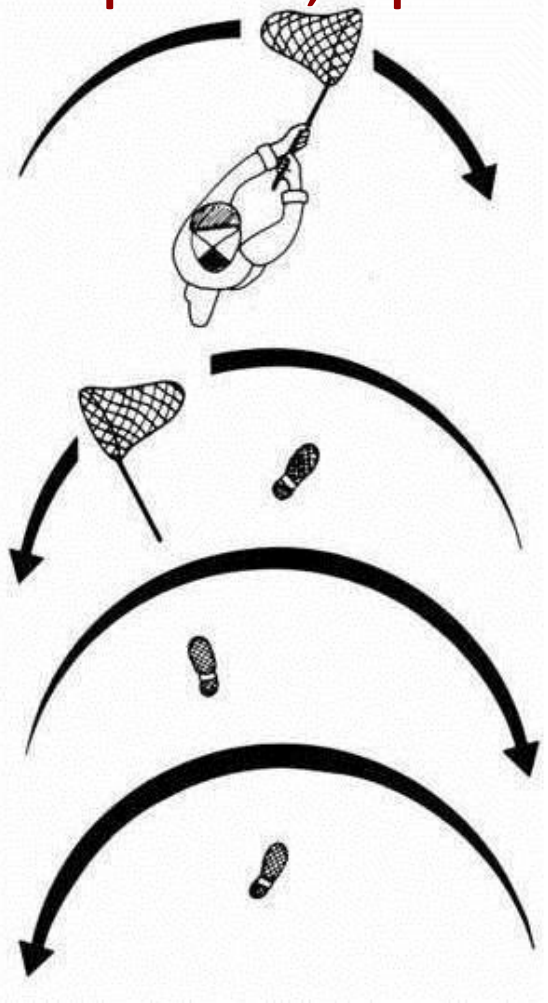
Standard Sweep

- 15 inch dia. sweep net
- Short, stiff handle handle
- Canvas bag

4-5, 5 sweep samples

4-5 different areas

- Representative of field



Factors affecting sweep sample results

- Weather, particularly wind speed, air temperature, and solar radiation intensity. Different weather conditions may affect the number of insects in the area you are sweeping.
- Different habitats, especially the height of the plants
- Time of day, reflecting different cycles of behavior of the species.
- Different styles of sweeping and different sweepers

Stem/ Leaf counts

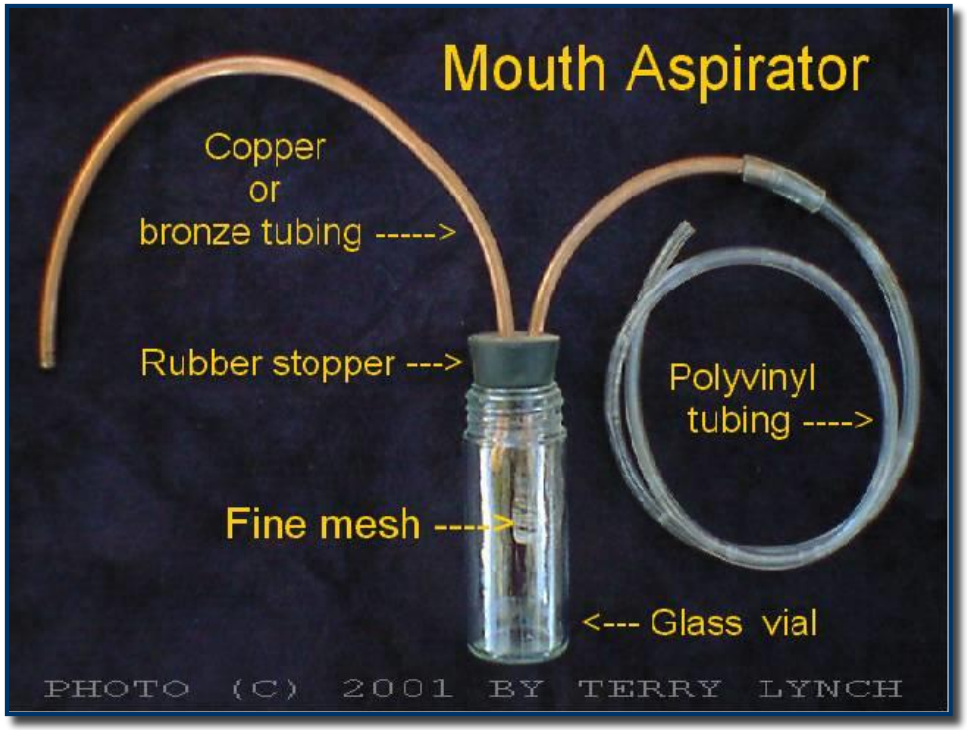
Aphids/ Spider mites

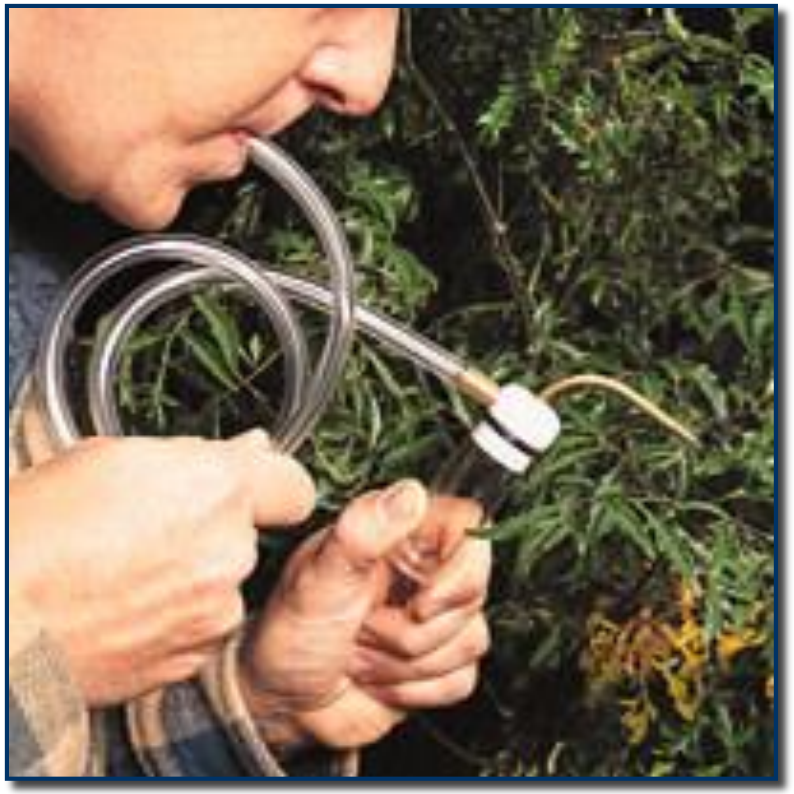
- Counts of insect/mites or damage directly from stems or leaves
  - 4-5 stems
  - 4-5 different areas
  - Representative of field
- Shake into net or white pan for counting
- Counts on site or in shop/lab

10x-20x hand lens useful

Sampling methods

Insect aspirator





Major/Primary Insect Pests of Alfalfa Seed

- Alfalfa weevil, *Hypera postica*
- Alfalfa seed chalcid, *Bruchophagus roddi*
- Aphids
  - Pea aphid, *Acyrthosiphon pisum*
  - Spotted alfalfa aphid, *Therioaphis maculata*
  - Blue alfalfa aphid, *Acyrthosiphon kondoi*
  - Cowpea aphid, *Aphis craccivora*
- Lygus bugs, *Lygus hesperus, L. elisus*
- Twospotted spider mite, *Tetranycus urticae*

Aphids

- Pea aphid, *Acyrthosiphon pisum*
- *Prefer stems to leaves*
- *Widely distributed on plants*
- *Heat intolerant: spring and fall pest*
- *Mild toxin producer*

- Blue alfalfa aphid, *Acyrthosiphon kondoi*
- *Prefer stems to leaves*
- *Prefers plant terminals*
- *Heat intolerant: spring and fall pest*
- *Moderately toxic saliva*

Pea Aphid vs….

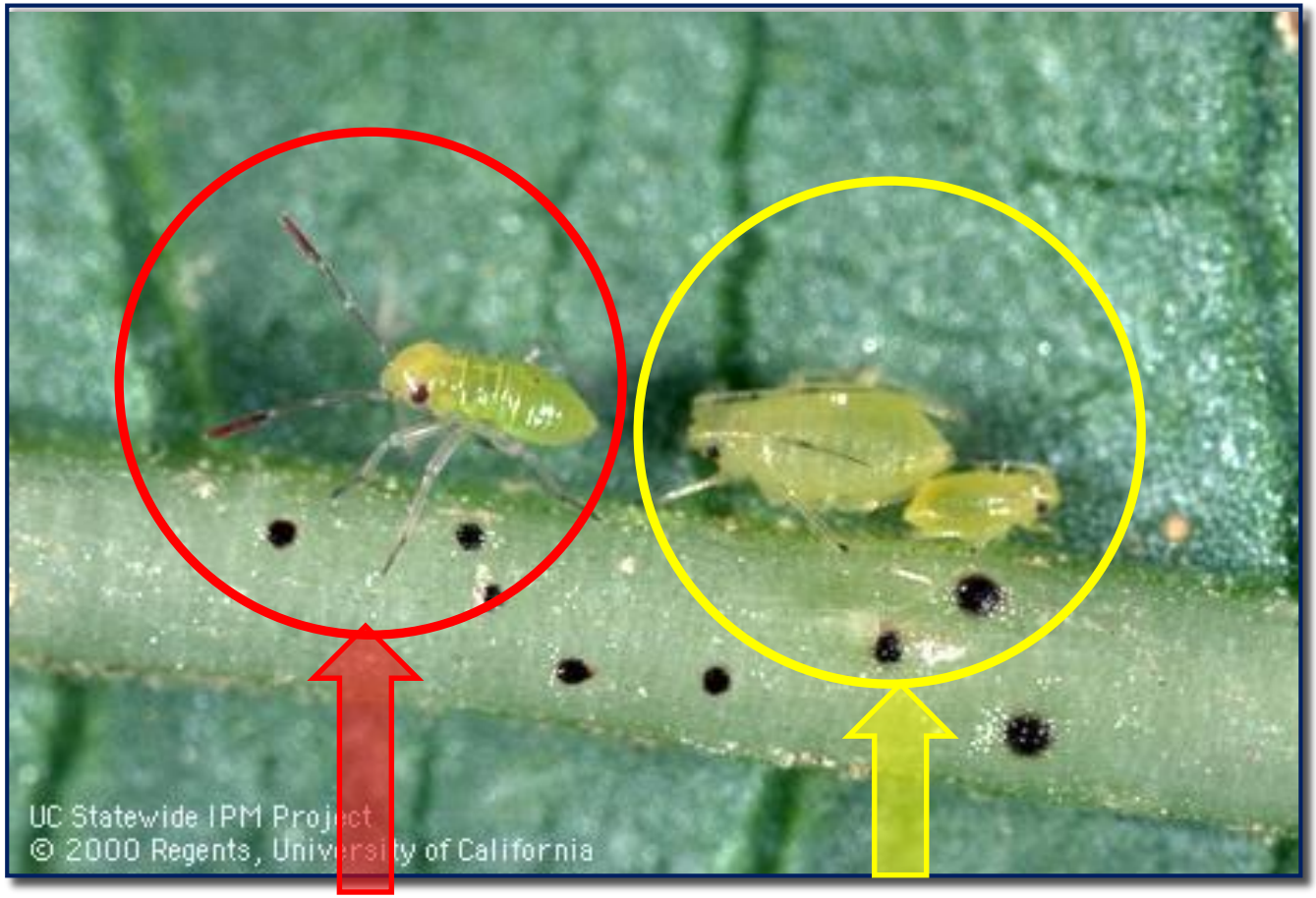
…Blue Alfalfa Aphid

Aphids

- Spotted alfalfa aphid, *Therioaphis maculata*
  - *Prefer lower leaves/ stems*
  - *Widely distributed on plants*
  - *Heat tolerant: summer pest*
  - *Prolific honeydew producer*
  - *Highly toxic*

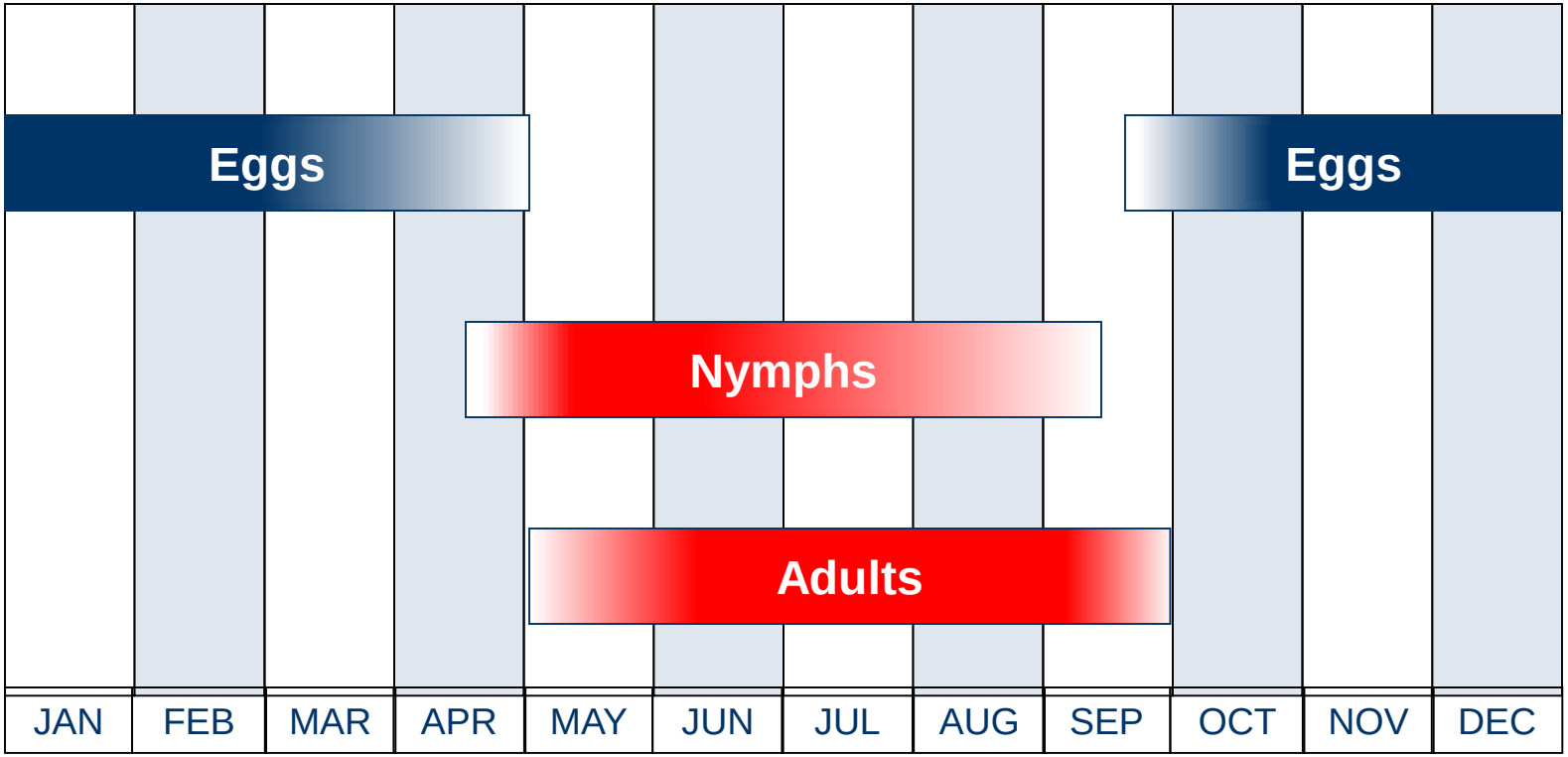
- Cowpea aphid, *Aphis craccivora*
  - *Prefer leaves*
  - *Widely distributed on plants*
  - *Heat tolerant: summer pest*
  - *Prolific honeydew producer*
  - *Moderately toxic*

Aphids vs. early instar lygus nymphs



- Lygus nymphs
  - Antennae forward
  - Move quickly
- Aphids
  - Antennae laid back
  - Move slowly

Aphid Seasonal Distribution in Alfalfa Seed



Aphids: Action thresholds for sweep samples*

Plant stage	Pea/ alfalfa aphids	Blue alfalfa/ cowpea aphids	Spotted alfalfa aphids
Pre-bloom	150 per sweep	10 -12 per sweep	20-30 per sweep
Bloom	150 per sweep	40 - 50 per sweep	20 - 30 per sweep
Post-bloom	> 100 sweep	40 - 50 per sweep	20 – 30 per sweep

* Natural enemies not present

Aphids: Action thresholds for stem samples*

Plant height	Pea/ alfalfa aphids	Blue alfalfa/ cowpea aphids	Spotted alfalfa aphids
Seedling	-	-	1-3 per stem
≤ 10 inches	40 - 50 per stem	10 - 12 per stem	10-12 per stem
> 10 inches Bloom ≤ 20	70 - 80 per stem	40 - 50 per stem	20 - 30 per stem
> 20 inches	> 100 stem	40 - 50 per stem	20 – 30 per stem

* Natural enemies not present

Aphids: Impact of natural enemies on action thresholds

- Low numbers (< ET) are usually beneficial
  - Attract and maintain natural enemies
  - Hemipteran predators (aphids, lygus, etc.)
  - Lady beetles (aphids, spider mites, etc.)
  - Parasitic wasps (aphids only)
- High numbers (> ET)
  - Injure/ kill plants
  - Yield loss
  - Reduce predator effectiveness (prevent predator switching, to other pests

Aphid Management[1]

Chemical control[2]

- bifenthrin (**Brigade 2EC or Discipline 2EC**) at 0.06 to 0.1 lb ai/a
- **dimethoate 4EC** at 0.25 to 0.5 lb ai/a.
- endosulfan (**Thionex 3EC**) at 1 lb ai/a. (spotted alfalfa aphid)
- gamma-cyhalothrin (**Proaxis, Declare**) at 0.01 to 0.015 lb ai/a
- flonicamid (**Beleaf**) 0.089 lb ai/a
- lambda-cyhalothrin (**Warrior**) at 0.02 to 0.03 lb ai/a
- **malathion 8EC** at 0.75 to 1 lb ai/a. PHI 0 days
- methidathion (**Supracide 2E**) at 0.5 to 1 lb ai/a.
- N-methyl carbamate (Pirimor 50-DF) at 0.0625 to 0.19 lb ai/a
- permethrin at 0.05 to 0.2 lb ai/a.
- pymetrozine (**Fulfill**) at 0.086 lb ai/a
- zeta-cypermethrin (**Mustang**) at 0.014 to 0.25 lb ai/a.

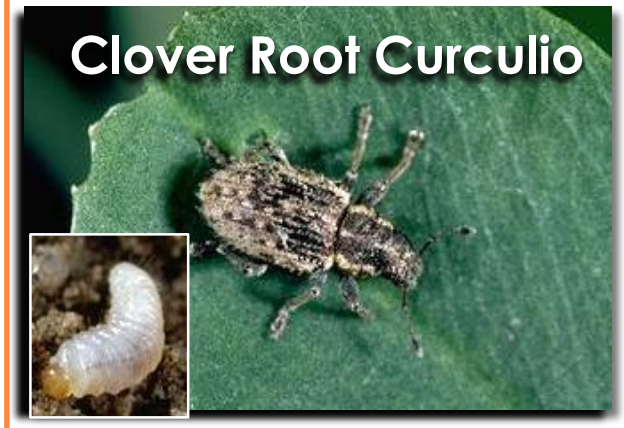
Resistant varieties: available for, spotted, blue, pea, alfalfa, and cowpea aphids

[1]See **Pacific Northwest Insect Management Handbook :** http://uspest.org/pnw/insects, for application details

[2] Most of these insecticides are hazardous to bees and should not be applied if bees are actively foraging in alfalfa

Weevils in alfalfa

Sitona spp: short snout, root feeding larvae



Sampling approaches and management options differ

Hypera spp: longer snout, leaf feeding larvae

Alfalfa Weevil, *Hypera postica*

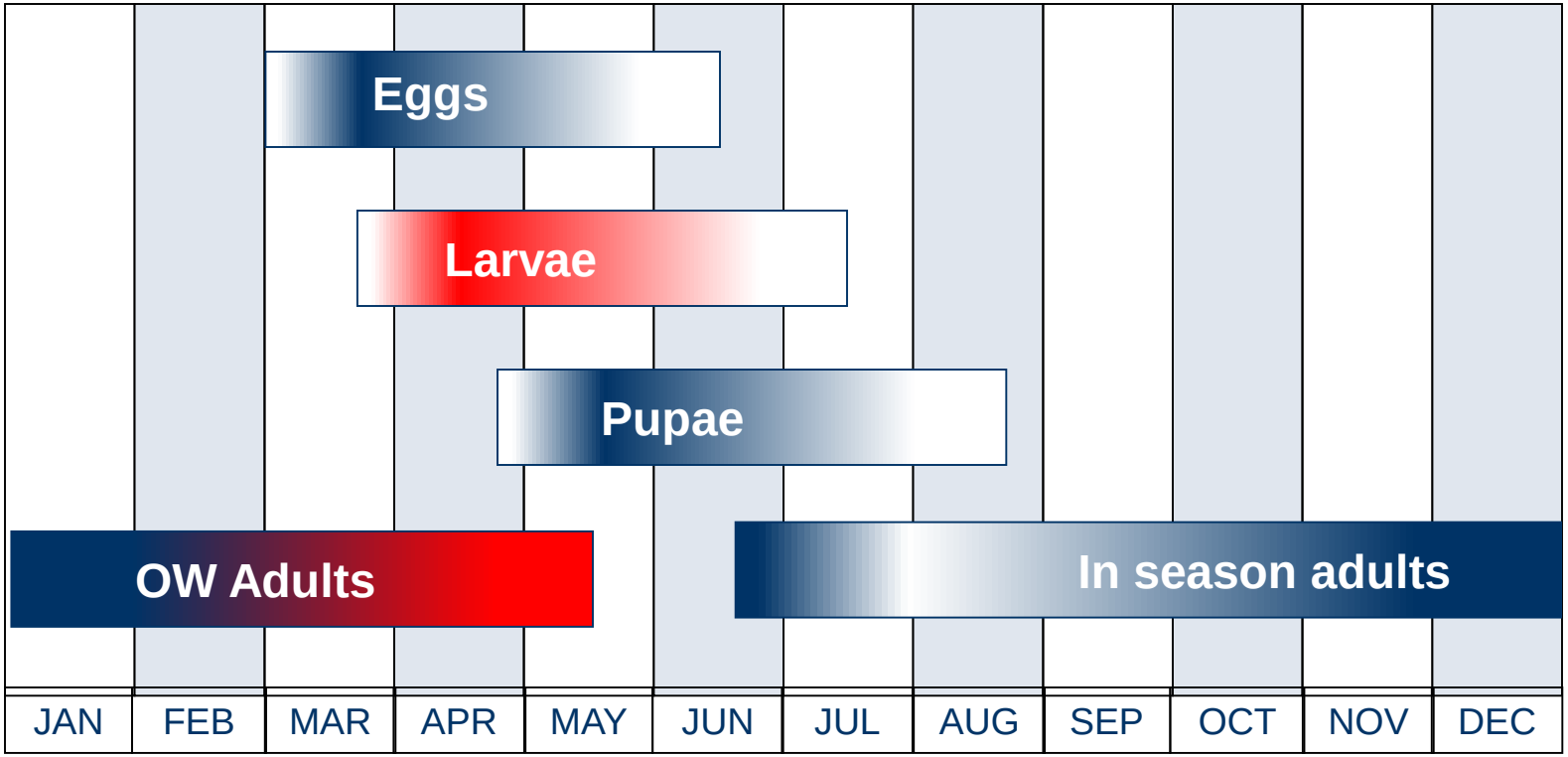
- Snout nosed beetles, ¼ inch long
- Gray brown, with dark stripe on back
- Early season pest

Alfalfa Weevil, *Hypera postica*

- Mature larvae ~ 3/8 inch long
- Black head, white stripe on back
- Often feed in terminals, stunt growth
- Cause most damage

Alfalfa Weevil Damage

Alfalfa Weevil Seasonal Distribution in Alfalfa Seed



Alfalfa Weevil, *Hypera postica*, Management[1]

Sampling and thresholds

- ✓ 15-20 larve per 180 degree sweep, or
- ✓ 30% of terminals show feeding damage
- ✓ Usually controlled by pre-bloom lygus sprays

Chemical control[2]

- bifenthrin (**Brigade 2ECor Discipline 2EC**) at 0.06 to 0.1 lb ai/a
- **dimethoate 4EC** at 0.25 to 0.5 lb ai/a
- gamma-cyhalothrin (**Proaxis, Declare**) at 0.01 to 0.015 lb ai/a
- indoxacarb (**Steward EC**) at 0.065 to 0.11 lb ai/a
- lambda-cyhalothrin (**Warrior**) at 0.02 to 0.03 lb ai/a
- **permethrin** at 0.1 to 0.2 lb ai/a
- zeta-cypermethrin (**Mustang Max**) at 0.014 to 0.025 lb ai/acre

No resistant varieties available

[1]See **Pacific Northwest Insect Management Handbook :** http://uspest.org/pnw/insects, for application details

[2] Most of these insecticides are hazardous to bees and should not be applied if bees are actively foraging in alfalfa

Lygus bugs, *Lygus hesperus, L. elisus*

- Species of *Lygus* are important pests of alfalfa seed and other seed crops in most US regions.
- Historically, losses to lygus in alfalfa seed average about 10% annually

Lygus damage to alfalfa seed

Adults and nymphs

- Adults & nymphs feed on developing flower buds, flowers, & immature pods
  - Drying (blasting) of flower buds
  - Flower, seed pod drop
  - High numbers can reduce number of seeds
  - Generally doesn't result in economic loss

Lygus damage to alfalfa seed

Adults and late instar nymphs

- Feed on immature seeds in developing pods
  - Damages or kills developing seeds
  - Reduce quality and quantity of yield
  - Most damage caused by
    - Late (4 and 5) instar nymphs
    - Adults

Lygus Seasonal Distribution in Alfalfa Seed

Eggs

Nymphs

Adults

JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

Lygus Action Thresholds

Plant stage	Lygus per sweep
Pre-bloom (clean-up)[1]	2 - 6 per sweep
Bloom	8 - 10 per sweep
Post-bloom[2]	12 – 15 per sweep

[1] Use lygus degree day model to time sampling

- Don't allow build up of late instar nymphs

[2] Probably don't need to treat late season

- If combined number of bigeyed bugs and nabids are twice the number of Lygus

Lygus bugs, Lygus spp., Management[1]

Chemical control[2]

acetomiprid (**Assail 70 WP**) at 0.05 to 0.075 lb ai/a
bifenthrin (**Brigade 2ECor Discipline 2EC**) at 0.06 to 0.1 lb ai/a
dimethoate 4EC at 0.25 to 0.5 lb ai/a
endosulfan (**Thionex 3EC**) at 1 lb ai/a
flonicamid (**Beleaf**) at 0.0875 lb ai/a
formetanate hydrochloride (**Carzol SP**) at 0.46 to 0.92 lb ai/a
gamma-cyhalothrin (**Proaxis, Declare**) at 0.01 to 0.015 lb ai/a
lambda-cyhalothrin (**Warrior**) at 0.02 to 0.03 lb ai/a
malathion 8EC at 0.75 to 1.25 lb ai/a
methidathion (**Supracide 2E**) at 0.5 to 1 lb ai/a
naled (**Dibrom 8E**) 1.0 to 1.5 lb ai/a
Novaluraon (**Rimon 0.83 EC**) at 0.058 to 0.077 lb ai/a
permethrin at 0.1 to 0.2 lb ai/a
zeta-cypermethrin (**Mustang**) at 0.035 to 0.05 lb ai/a

No resistant varieties available

[1]See **Pacific Northwest Insect Management Handbook :** http://uspest.org/pnw/insects, for application details

[2] Most of these insecticides are hazardous to bees and should not be applied if bees are actively foraging in alfalfa

Sampling methods

Monitoring degree days

- Insects don't grow or grow very slowly below some lower temperature threshold
- Insects don't grow or grow very slowly above some upper temperature threshold
- Between the lower and upper thresholds insect growth increases with temperature
- Predicts insect development by accumulating heat units (degree days)
- Determine best time for monitoring/ sampling or control efforts

Sampling methods

Monitoring degree days

- Biofix: When to begin accumulating degree days
  - Calendar date or
  - Biological event (1st or peak nos. of insect/ stage)
- Threshold temperatures
  - Lower threshold: no development below this
  - Upper threshold: no development above this
- Mean daily temperature= $\left(\frac{T_{max}-T_{min}}{2} \right)$

Sampling methods

Accumlating degree days: for each day

$$\text{Degree days} = \left(\frac{T_{max} - T_{min}}{2} \right) - T_{low}$$

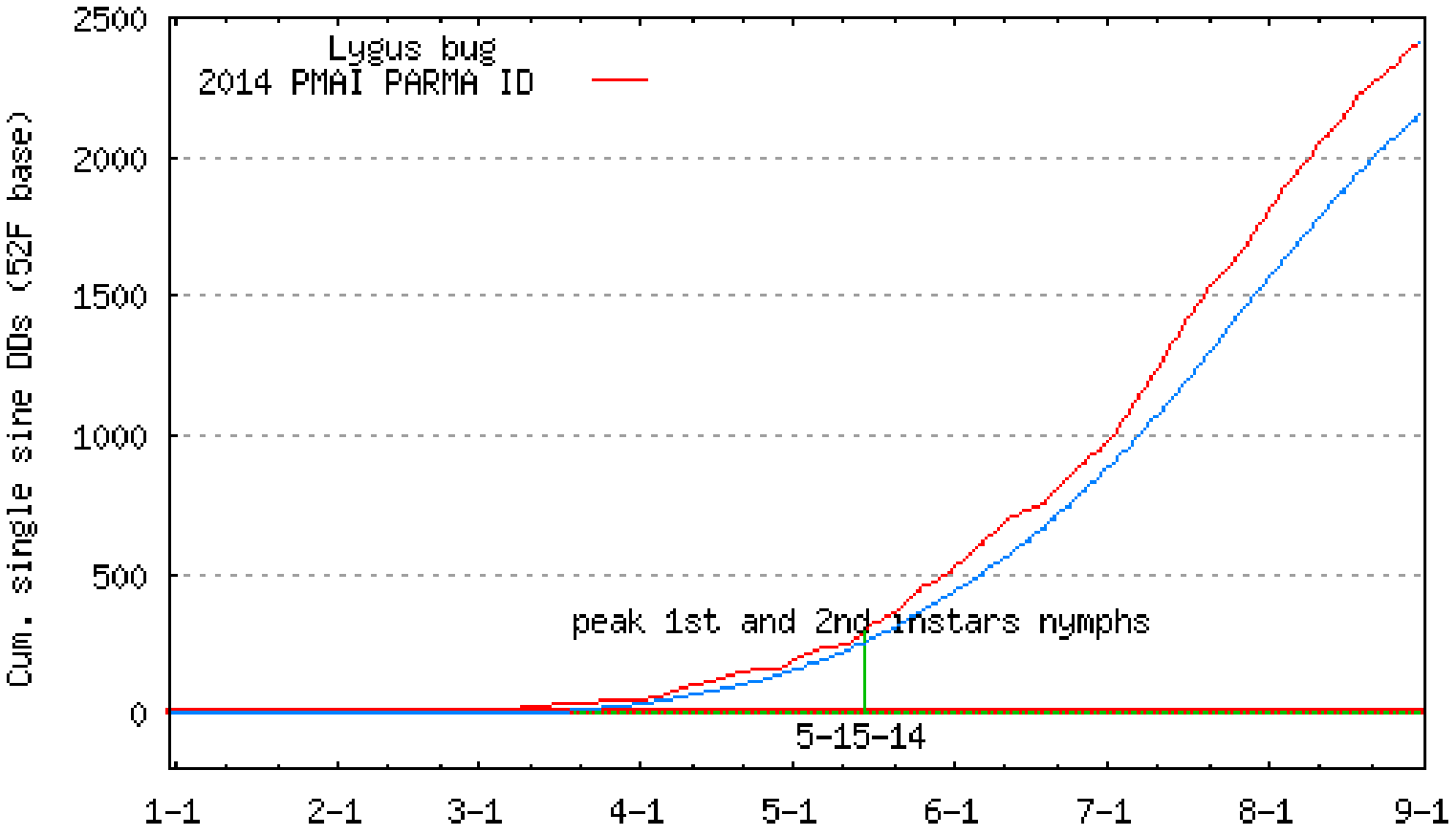
Mean daily temp. ≤ Lower threshold: No DD accumulation

Mean daily temp. > Lower threshold: DD accumulation

Maximum daily temp never exceeds the upper development threshold

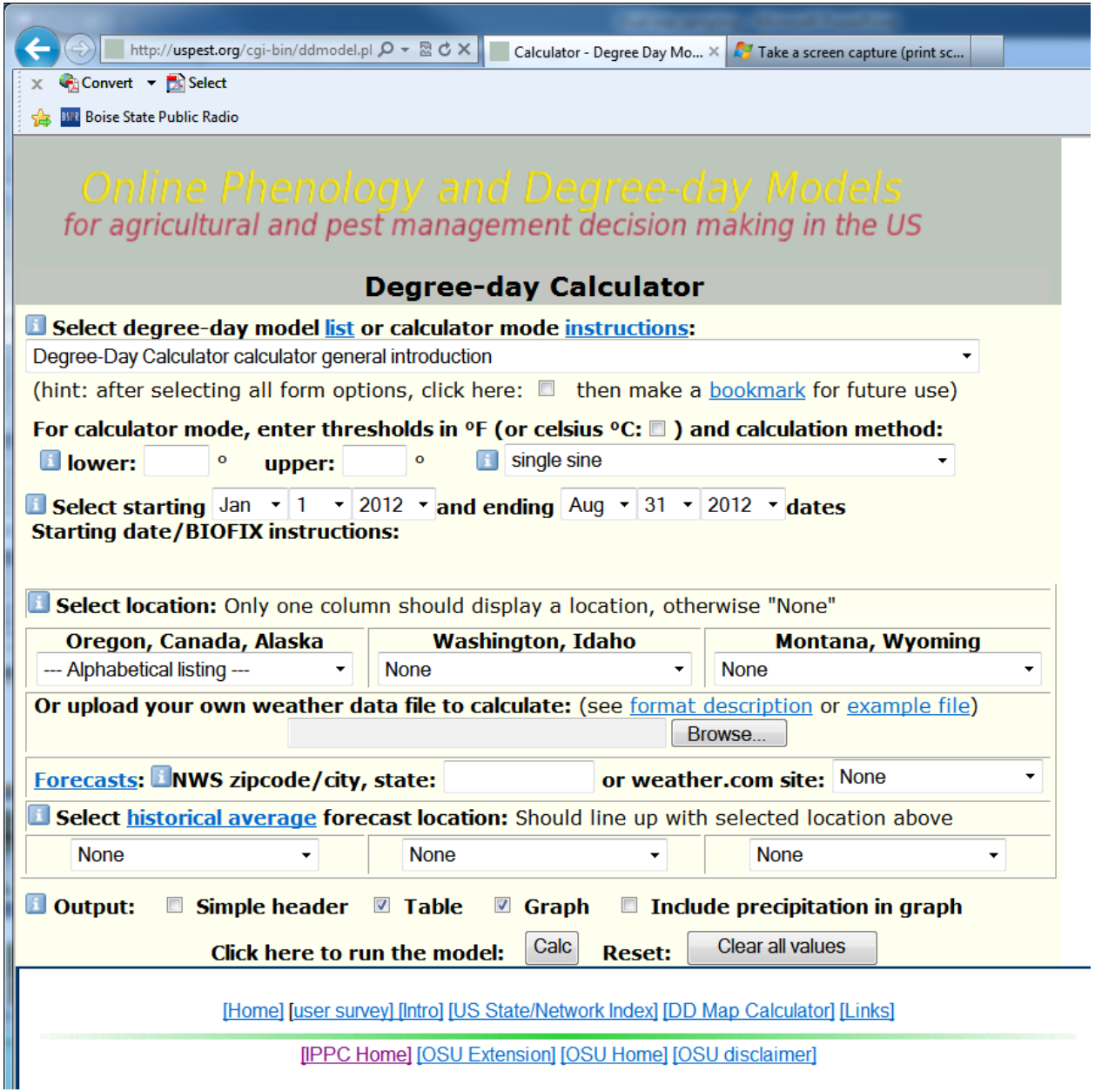
- Thermal constant: no. of DD required to reach a development stage
- **(272 DD from Jan. 1 to peak 1st and 2nd instar lygus from OW adults)**

Lygus Degree day model output for Parma, ID 2014



http://ippc2.orst.edu/cgi-bin/ddmodel.pl?spp=lyg

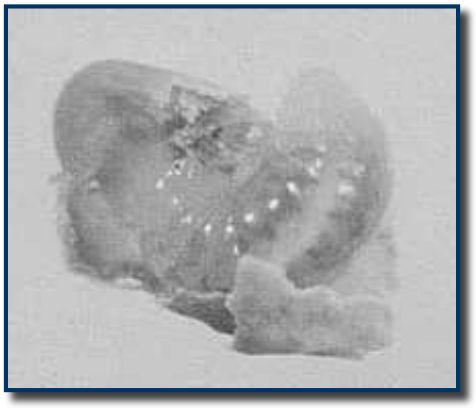
http://uspest.org/cgi-bin/ddmodel.pl



Alfalfa Seed Chalcid, *Bruchophagus roddi*

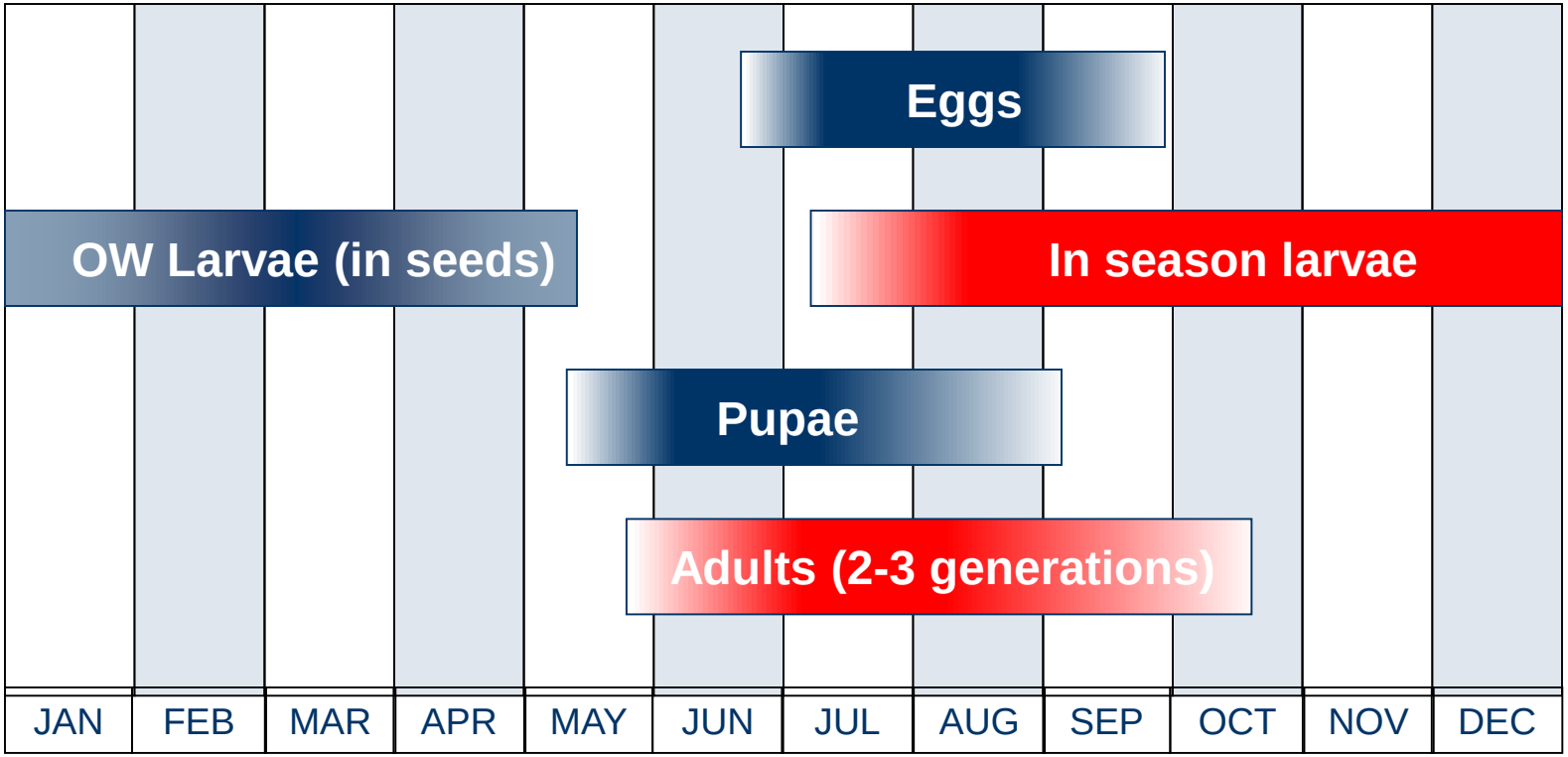
Alfalfa Seed Chalcid

- Adults lay eggs in developing seed
- One larvae per seed



- Overwinter as a mature larva inside seed
- Pupate in early spring
- Adults emerge in early June

Alfalfa Seed Chalcid Seasonal Distribution in Alfalfa Seed



Alfalfa Seed Chalcid

Action threshold

- No established threshold

Chemical control

- Pesticides not effective for seed chalcid control

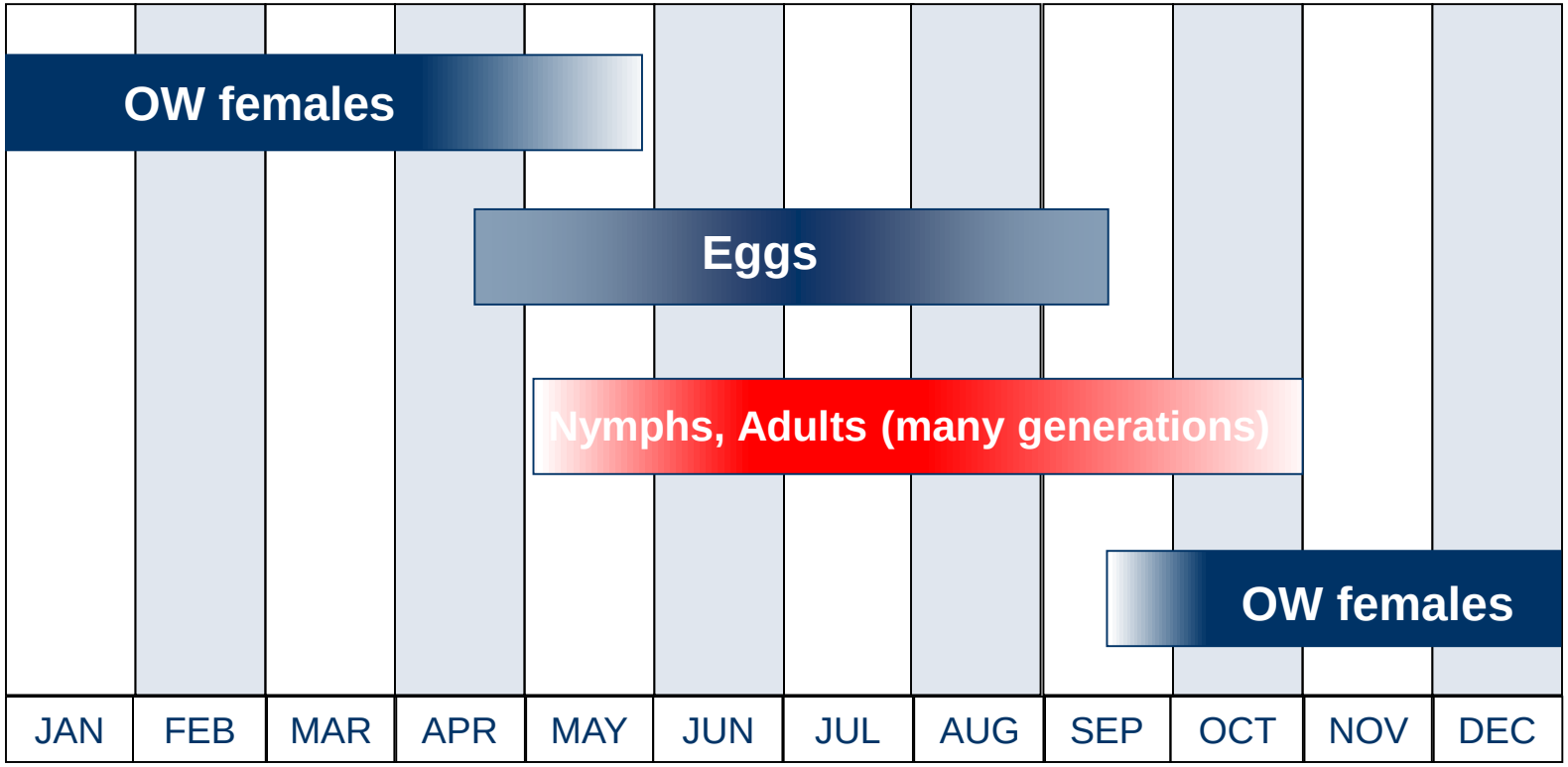
Cultural control

- Cultivate 1” deep in fall to bury infested seed; irrigate
- Destroy chaff and screenings by April
- Destroy escaped alfalfa on field edges etc.

Spider mites, *Tetranychus urticae, etc.*

- Adults are 0.65mm (1/32in), oval, two dark spots
- Immature (nymphs) yellow to green
- Eggs are 0.1mm (1/256in), spherical, translucent
- Feeding by adults and immatures stipples and browns foliage

Spider Mite Seasonal Distribution in Alfalfa Seed



Spidermites, *Tetranychus* spp., Management[1]

Sampling and thresholds

- ✓ Early summer treat when 25% of leaves infested
- ✓ Mid summer treat when 50% of leaves infested
- ✓ Late summer treat when 75% of leaves infested
- ✓ After mid-August 100% infested leaves may not justify treatment

Chemical control[2]

- abamectin (**Agri-Mek, ABBA 0.15EC**) at 0.01 to 0.02 lb ai/a
- bifenazate (**Acramite 4 SC**) at 0.5 to 0.75 lb ai/a
- bifenthrin (**Brigade 2ECor Discipline 2EC**) at 0.06 to 0.1 lb ai/a
- **dicofol** at 1 to 1.5 lb ai/a
- etoxazole (**Zeal**) at 0.035 to0.525 lb ai/a
- gamma-cyhalothrin (**Proaxis, Declare**) at 0.015 lb ai/a
- hexythiazox (**Onager**) at 0.09 to 0.13 lb ai/a
- lambda-cyhalothrin (**Warrior**) at 0.03 lb ai/a
- **malathion** 8EC at 0.75 to 1.25 lb ai/a.
- propargite (**Comite**) at 1.23 to 2.05 lb ai/a
- **Sulfur DF** at 2.4 to 4 lb ai/a.

[1]See **Pacific Northwest Insect Management Handbook :** http://uspest.org/pnw/insects, for application details

[2] Most of these insecticides are hazardous to bees and should not be applied if bees are actively foraging in alfalfa

Minor/Secondary Pests of Alfalfa Seed

- Armyworms
  - Yellowstriped armyworm, *Spodoptera praefica*
  - Bertha armyworm, *Mamestra configurata*
- Cutworms
  - Variegated, *Peridoma saucia*
  - Army cutworm, *Euxoa auxiliaris*
  - Redbacked, *Euxoa ochrogaster*
- Pea leaf weevil, *Sitona lineata*
- Loopers
  - Alfalfa looper, *Autographa californica*
  - Cabbage looper, *Trichoplusia ni*
- Grasshoppers

Armyworms

Order: Lepidoptera (Moths and butterflies)

Family: Noctuidae (Armyworms, cutworms, etc.)

Western yellow striped armyworm, *Spodoptera praefica*

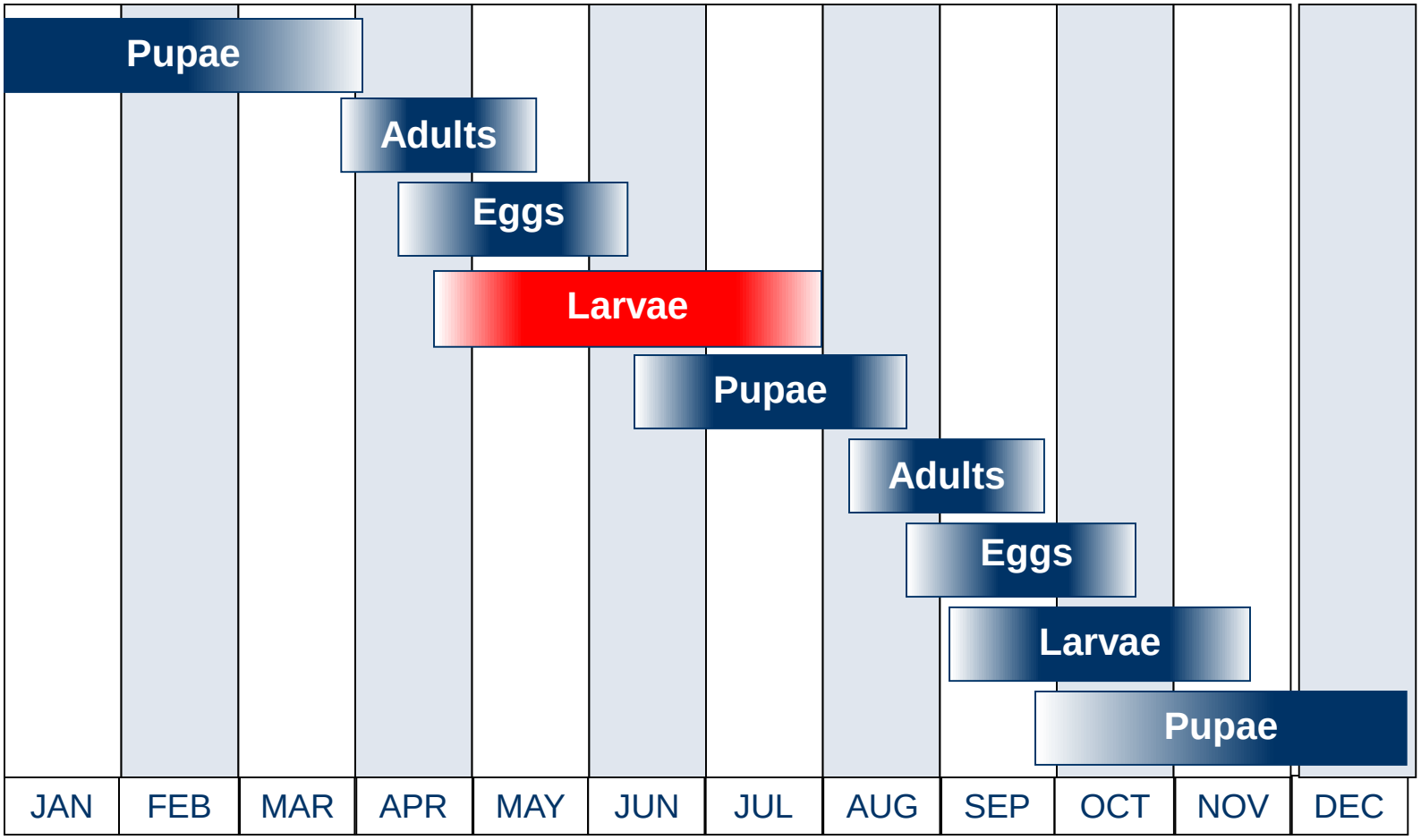
Bertha armyworm, *Mamestra configurata*

Western yellow striped armyworm, *Spodoptera praefica*

Order: Lepidoptera (Moths and butterflies)

Family: Noctuidae (armyworms, Cutworms, etc.)

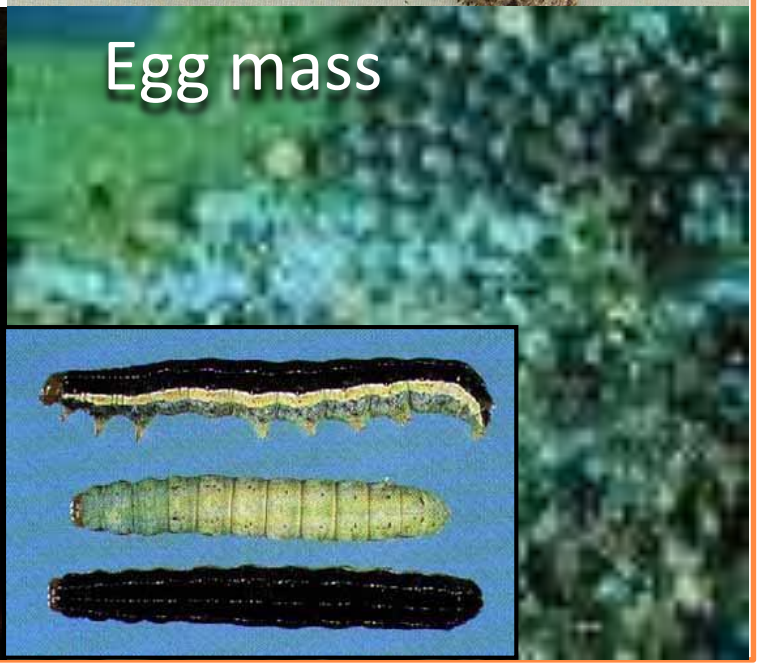
Western Yellowstriped Armyworm Seasonal Occurrence



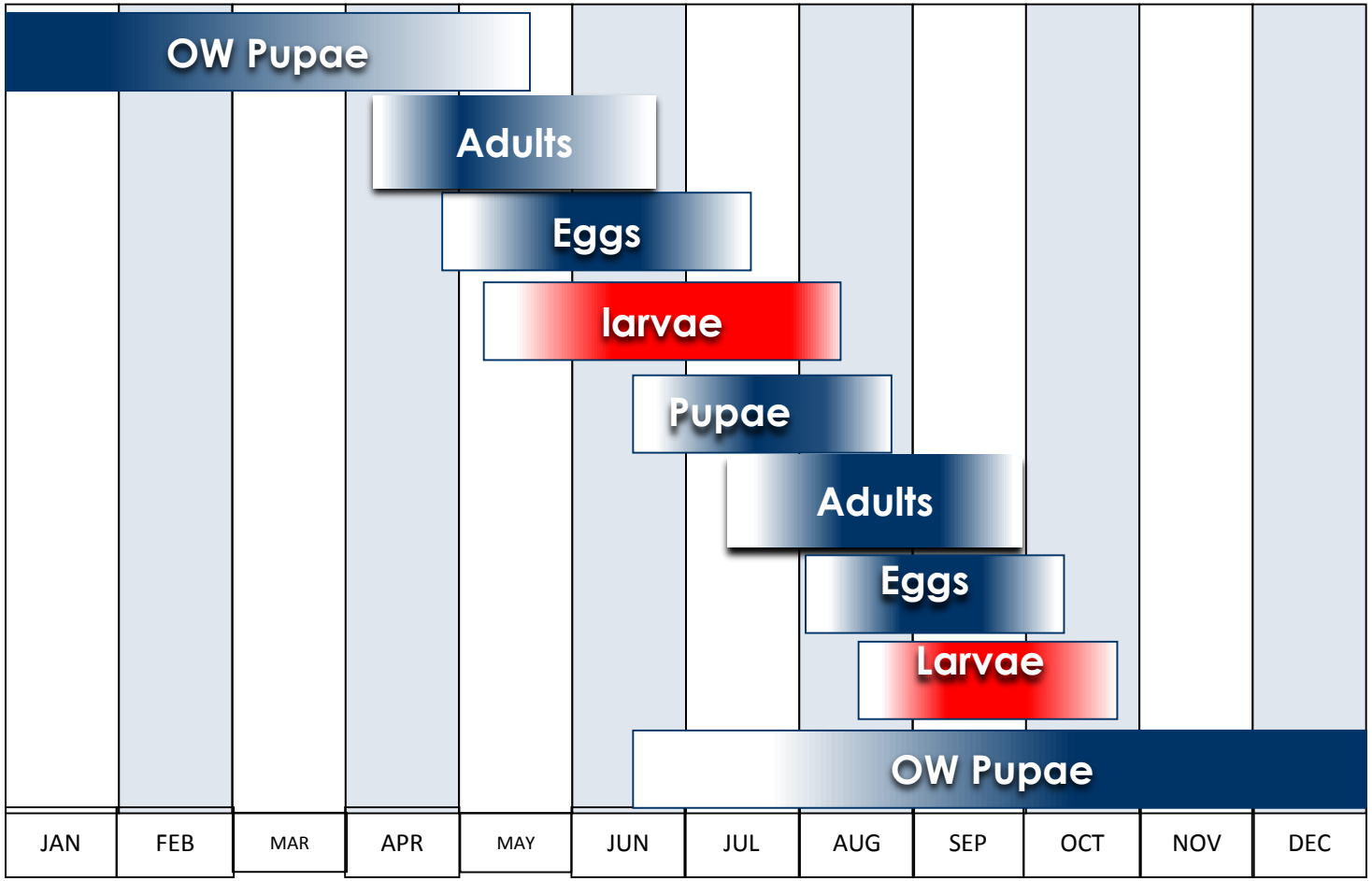
Bertha armyworm, *Mamestra configurata*

Order: Lepidoptera (Moths and butterflies)

Family: Noctuidae (Cutworms, armyworms, etc.)



Seasonal occurrence of bertha armyworm, *Mamestra configuata*



Armyworm Management[1]

Sampling and thresholds

- ✓ No established thresholds
- ✓ Treat when number of non-parasitized larvae < 15
- ✓ Larvae are active during the day and nights

Chemical control[2]

- *Bacillus thuringiensis* (**Deliver**) at 0.25 to 1.5 lb product/a.
- chlorantraniliprole (**Coragen**) at 0.045 to 0.065 lb ai/a.
- chlorantraniliprole/lambda-cyhalothrin (**Voliam Xpress**) at 0.059 to 0.088 lb ai/a.
- gamma-cyhalothrin (**Proaxis, Declare**) at 0.01 to 0.015 lb ai/a.
- indoxacarb (**Steward**) at 0.065 to 0.11 lb ai/a for beet armyworm and 0.09 to 0.11 lb ai/a for western yellowstriped armyworm.
- lambda-cyhalothrin (**Warrior**) at 0.02 to 0.03 lb ai/a.
- **malathion** at 1 to 2 lb ai/a.
- permethrin (**Ambush, Pounce**) at 0.05 to 0.2 lb ai/a.
- zeta-cypermethrin (**Mustang**) at 0.0175 to 0.025 lb ai/a

[1]See **Pacific Northwest Insect Management Handbook :** http://uspest.org/pnw/insects, for application details

[2] Most of these insecticides are hazardous to bees and should not be applied if bees are actively foraging in alfalfa

Cutworms

Order: Lepidoptera (Moths and butterflies)

Family: Noctuidae (Cutworms, armyworms, etc.)

Variegated cutworm, *Peridoma saucia*

Redbacked cutworm, *Euxoa ochrogaster*

Army cutworm, *Euxoa auxiliaris*

Clover cutworm, *Scotogramma trifolii*

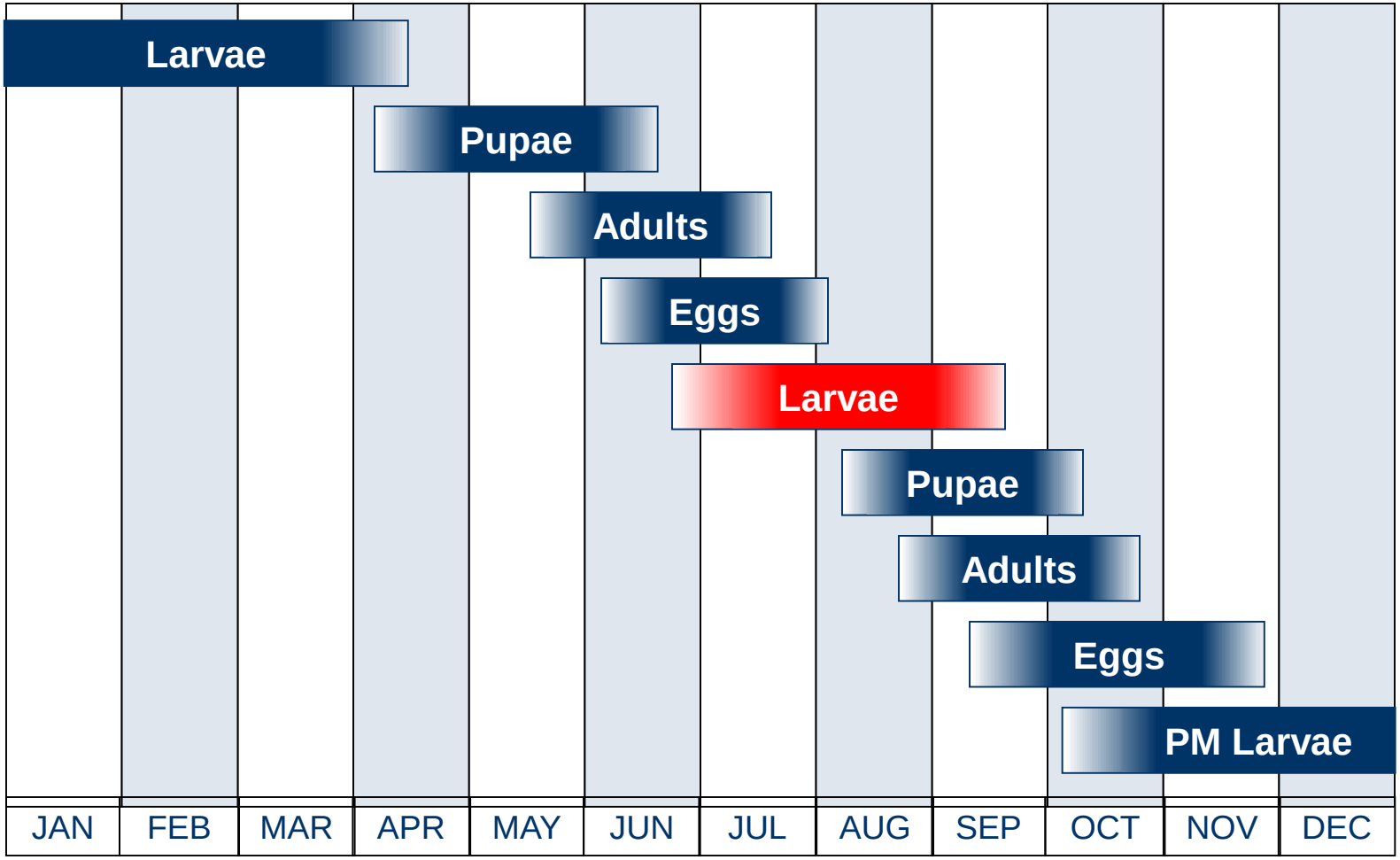
Granulate cutworm, *Feltia (Agrotis) subterranea*

Variegated cutworm, *Peridoma saucia*

Order: Lepidoptera (Moths and butterflies)

Family: Noctuidae (Cutworms, armyworms, etc.)

Variegated Cutworm Seasonal Occurrence

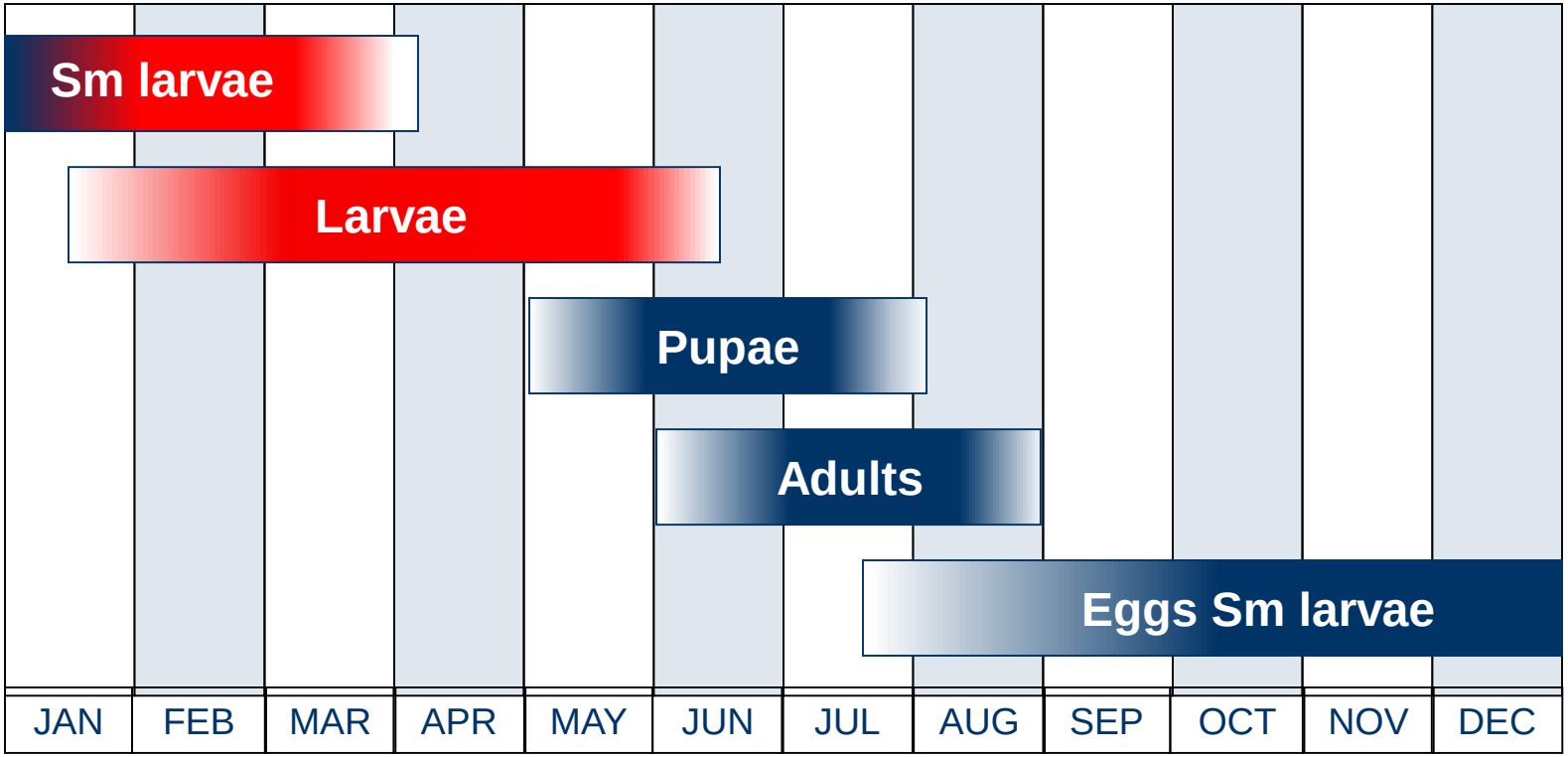


Redbacked cutworm, *Euxoa ochrogaster*

Order: Lepidoptera (Moths and butterflies)

Family: Noctuidae (Cutworms, armyworms, etc.)

Redbacked Cutworm Seasonal Occurrence

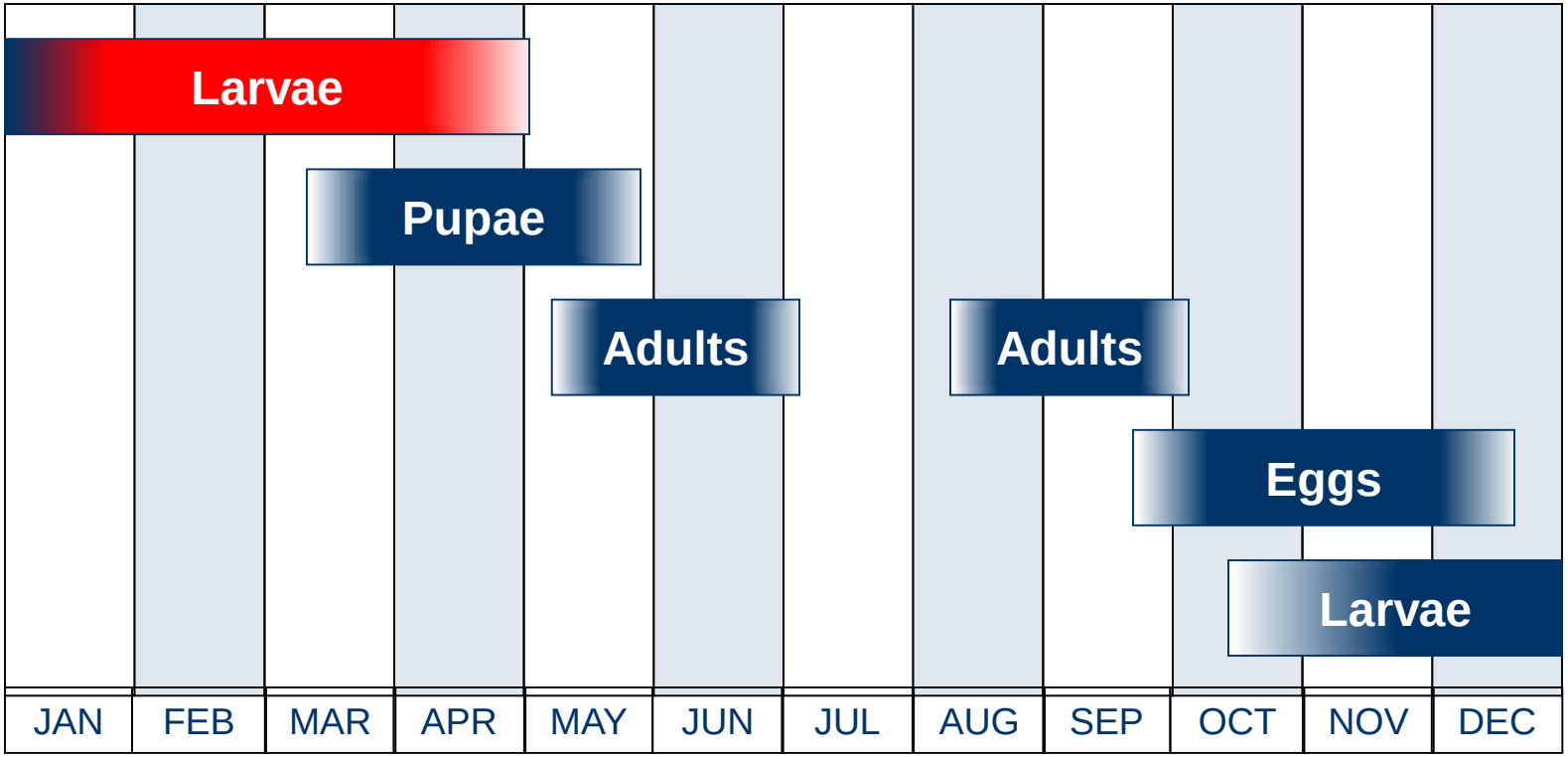


Army cutworm, *Euxoa auxiliaris*

Order: Lepidoptera (Moths and butterflies)

Family: Noctuidae (Cutworms, armyworms, etc.)

Army Cutworm Cutworm Seasonal Occurrence



Cutworm Management[1]

Sampling and thresholds

- ✓ No established thresholds
- ✓ 2 larvae per square foot or when damage is apparent
- ✓ Damage can be extreme in new seedings
- ✓ Treat evenings or after irrigation

Chemical control[2]

- *Bacillus thuringiensis* (**Deliver**) at 0.25 to 1.5 lb product/a.
- chlorantraniliprole (**Coragen**) at 0.045 to 0.065 lb ai/a.
- chlorantraniliprole/lambda-cyhalothrin (**Voliam Xpress**) at 0.059 to 0.088 lb ai/a.
- gamma-cyhalothrin (**Proaxis, Declare**) at 0.01 to 0.015 lb ai/a.
- indoxacarb (**Steward**) at 0.065 to 0.11 lb ai/a for beet armyworm and 0.09 to 0.11 lb ai/a for western yellowstriped armyworm.
- lambda-cyhalothrin (**Warrior**) at 0.02 to 0.03 lb ai/a.
- permethrin (**Ambush, Pounce**) at 0.05 to 0.2 lb ai/a.
- zeta-cypermethrin (**Mustang**) at 0.0175 to 0.025 lb ai/a

[1]See **Pacific Northwest Insect Management Handbook :** http://uspest.org/pnw/insects, for application details

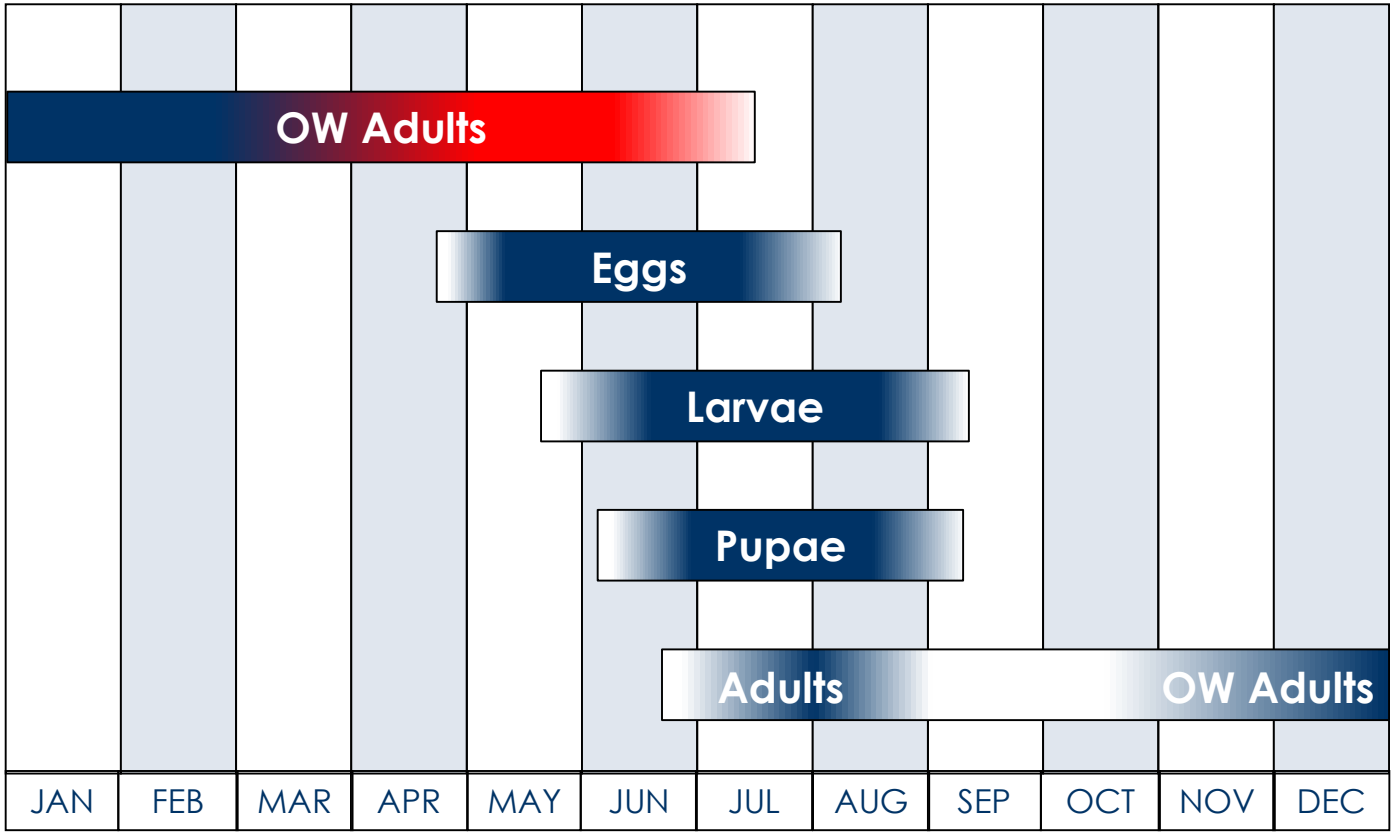
[2] Most of these insecticides are hazardous to bees and should not be applied if bees are actively foraging in alfalfa

Pea leaf weevil, *Sitona lineata*

Order: Coleoptera (beetles)

Family: Curculionidae (weevils)

Seasonal occurrence of pea leaf weevil, *Sitona lineata*



Pea Leaf Weevil Management[1]

Sampling and thresholds

- ✓ No established thresholds (>25% injury on terminal leaves of seedling plants
- ✓ No pesticides registered for pea leaf weevil control
- ✓ Not usually an economic pest
- ✓ Adult leaf feeding in new seedings can cause serious stand loss
- ✓ Larvae feeding in root nodules not economic with adequate nutrients

Chemical control[2]

(adult control only)

- Most pesticides applied for alfalfa weevil, cutworms and armyworms will control pea leaf weevil

[1]See **Pacific Northwest Insect Management Handbook :** http://uspest.org/pnw/insects, for application details

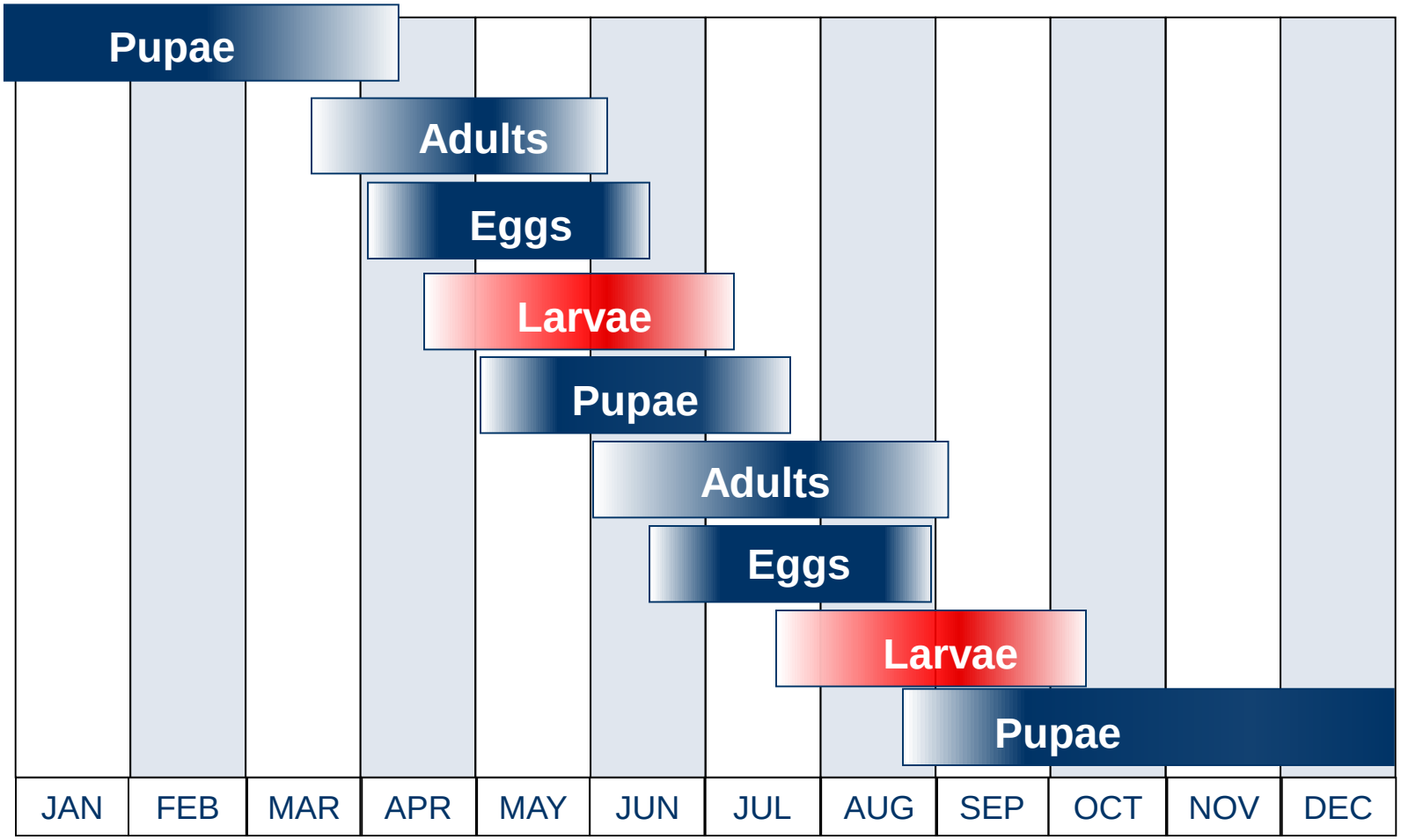
[2] Most of these insecticides are hazardous to bees and should not be applied if bees are actively foraging in alfalfa

Alfalfa looper, *Autographa californica*

Order: Lepidoptera (butterflies and moths)

Family: Noctuidae (armyworms, cutworms, loopers)

Alfalfa Looper Seasonal Distribution in Alfalfa Seed



Parasitized alfalfa looper

Alfalfa Looper Management

Sampling and thresholds

- ✓ Occasional pest Idaho
- ✓ Similar to cabbage looper uncommon
- ✓ Treat if you have 10 or more non-parasitized larvae per 180° sweep

Chemical control[2]

- *Bacillus thuringiensis* (**Deliver**) at 0.25 to 1.5 lb product/a.
- chlorantraniliprole (**Coragen**) at 0.045 to 0.065 lb ai/a.
- chlorantraniliprole/lambda-cyhalothrin (**Voliam Xpress**) at 0.059 to 0.088 lb ai/a.
- gamma-cyhalothrin (**Proaxis, Declare**) at 0.01 to 0.015 lb ai/a.
- indoxacarb (**Steward**) at 0.065 to 0.11 lb ai/a for beet armyworm and 0.09 to 0.11 lb ai/a for western yellowstriped armyworm.
- lambda-cyhalothrin (**Warrior**) at 0.02 to 0.03 lb ai/a.
- permethrin (**Ambush, Pounce**) at 0.05 to 0.2 lb ai/a.
- zeta-cypermethrin (**Mustang**) at 0.0175 to 0.025 lb ai/a

[1]See **Pacific Northwest Insect Management Handbook :** http://uspest.org/pnw/insects, for application details

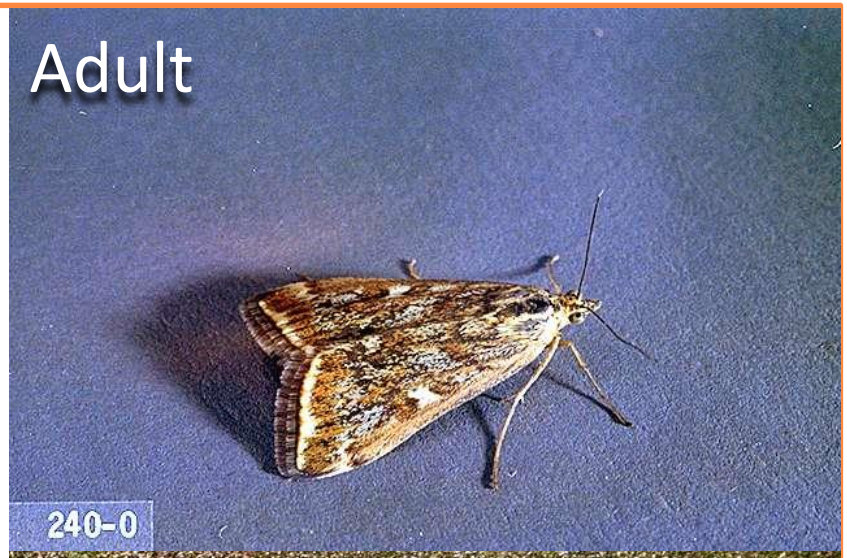
[2] Most of these insecticides are hazardous to bees and should not be applied if bees are actively foraging in alfalfa

Webworm

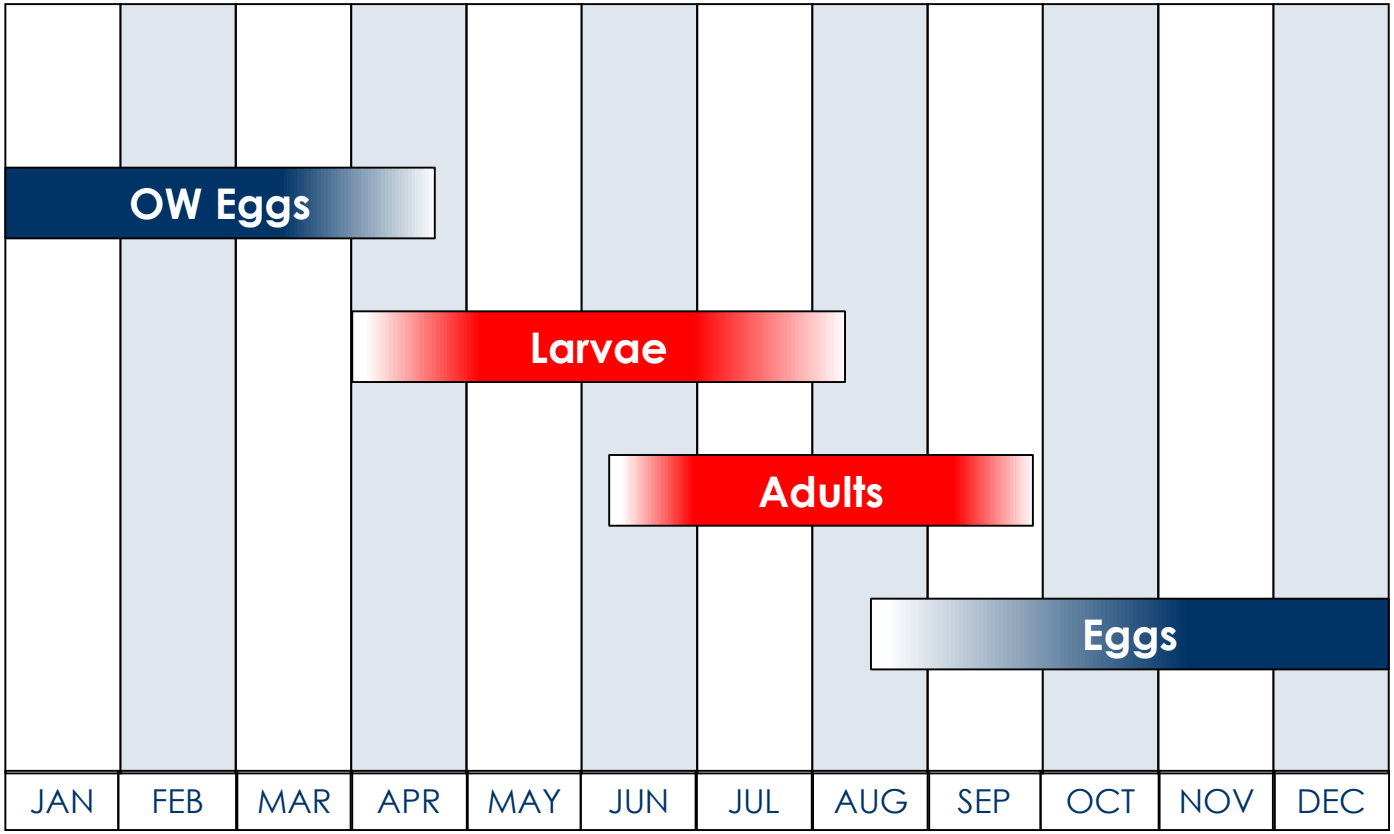
Order: Lepidoptera (moths and butterflies)

Family: Pyralidae (snout moths)

Beet webworm, *Loxostege sticticalis*



Seasonal occurrence of beet webworm



Beet Webworm Management

Sampling and thresholds

- ✓ Rarely requires treatment, but can be serious problem in alfalfa produced for seed
- ✓ Five larvae per sweep, or 10% of terminals covered with webs

Chemical control[2]

- chlorantraniliprole (**Coragen**) at 0.045 to 0.065 lb ai/a.
- gamma-cyhalothrin (**Proaxis, Declare**) at 0.01 to 0.015 lb ai/a.
- indoxacarb (**Steward**) at 0.065 to 0.11 lb ai/a for beet armyworm and 0.09 to 0.11 lb ai/a
- lambda-cyhalothrin (**Warrior**) at 0.02 to 0.03 lb ai/a.
- permethrin (**Ambush, Pounce**) at 0.05 to 0.2 lb ai/a.
- zeta-cypermethrin (**Mustang**) at 0.0175 to 0.025 lb ai/a

[1]See **Pacific Northwest Insect Management Handbook :** http://uspest.org/pnw/insects, for application details

[2] Most of these insecticides are hazardous to bees and should not be applied if bees are actively foraging in alfalfa

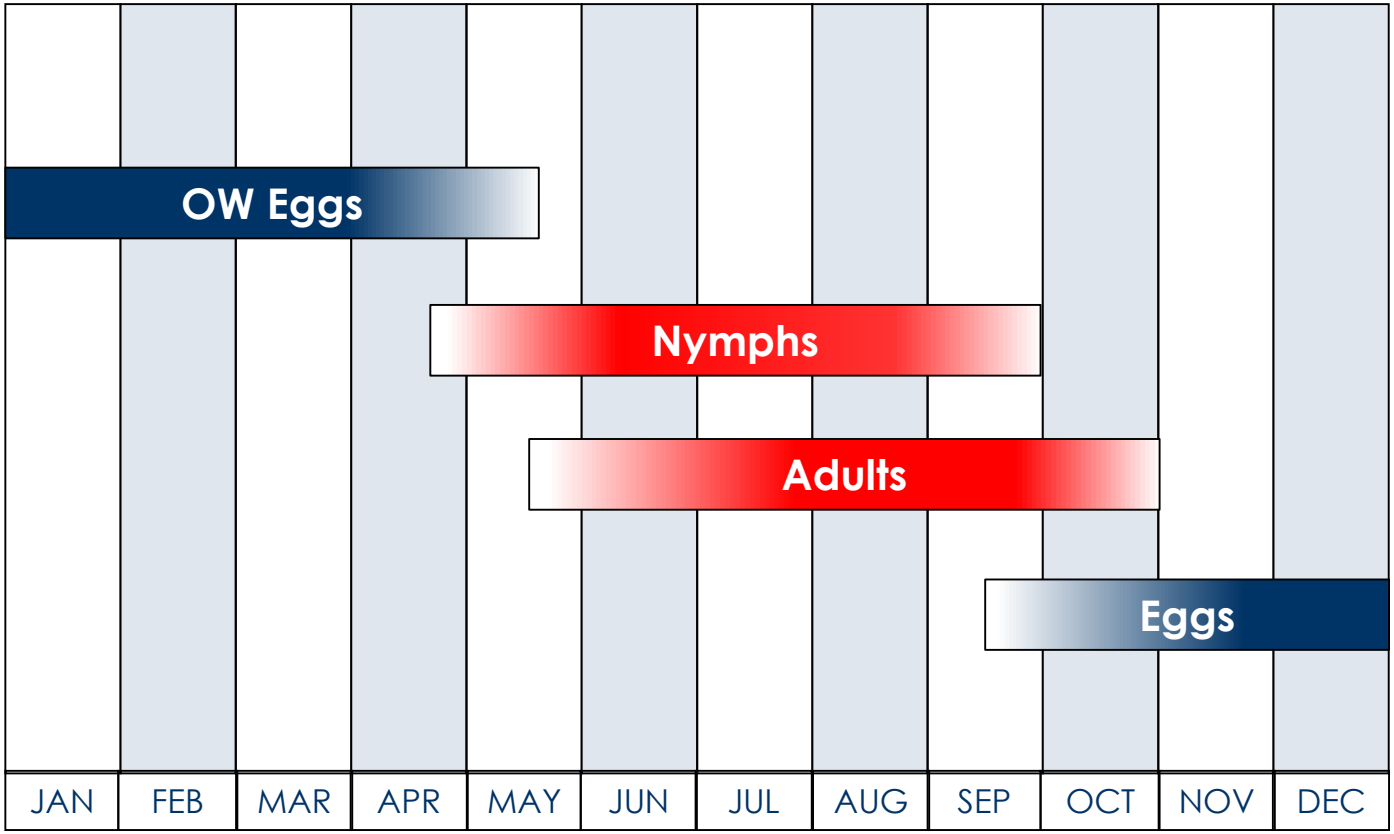
Grasshoppers, *Melanoplus spp*. and others

Order: Orthoptera (beetles)

Family: Acrididae (grasshoppers)

Migratory grasshopper, *Melanoplus sanguinipes*
Redlegged grasshoper, *M. femurrubrum*
Twostriped grasshopper, *M. Bivittatus*

Seasonal occurrence of grasshoppers



Grasshopper Management

Sampling and thresholds

- ✓ 8-15 nymphs/adults per square foot
- ✓ Nymphs easier to control than adults
- ✓ Early season pest
- ✓ Occurs with and often confused with alfalfa weevil (adults and larvae)

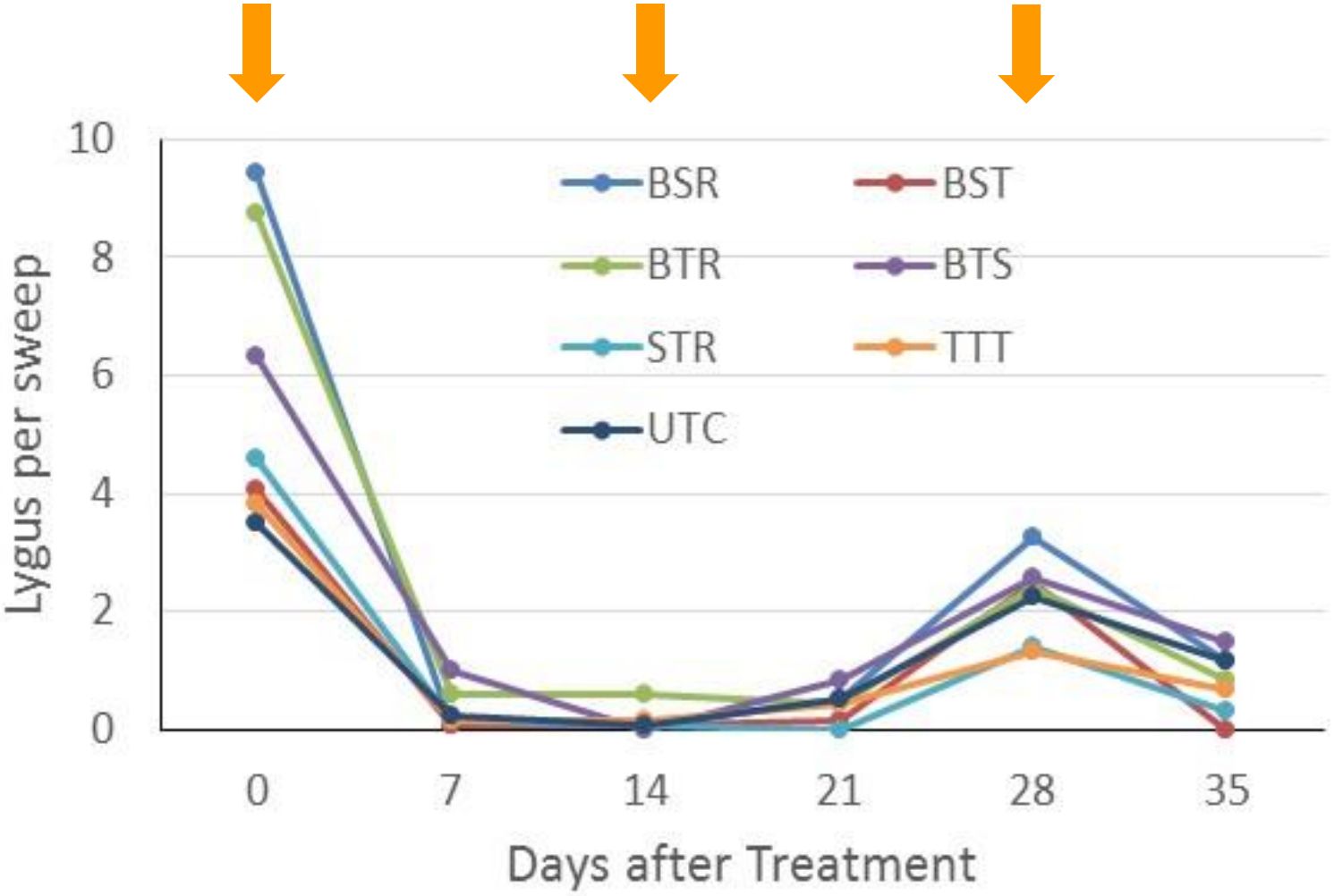
Chemical control[2]

- diflubenzuron (Dimilin 2L) at 0.031 lb ai/a.
- dimethoate 4EC at 0.25 to 0.5 lb ai/a. gamma-cyhalothrin (Proaxis, Declare) at 0.01 to 0.015 lb ai/a.
- lambda-cyhalothrin (Warrior) at 0.02 to 0.03 lb ai/a.
- malathion 8EC at 0.75 to 1.25 lb ai/a.
- *(Nosema locustae)* (Nolo Bait. Use as manufacturer directs.
- zeta-cypermethrin (Mustang) at 0.035 to 0.05 lb ai/a.

[1]See **Pacific Northwest Insect Management Handbook :** http://uspest.org/pnw/insects, for application details

[2] Most of these insecticides are hazardous to bees and should not be applied if bees are actively foraging in alfalfa

Mean no. of small lygus bug nymphs per sweep before and after treatment with the indicated insecticides in a two-week rotation; B=Beleaf, T=Transform, S=Sivanto rotations. Each insecticide

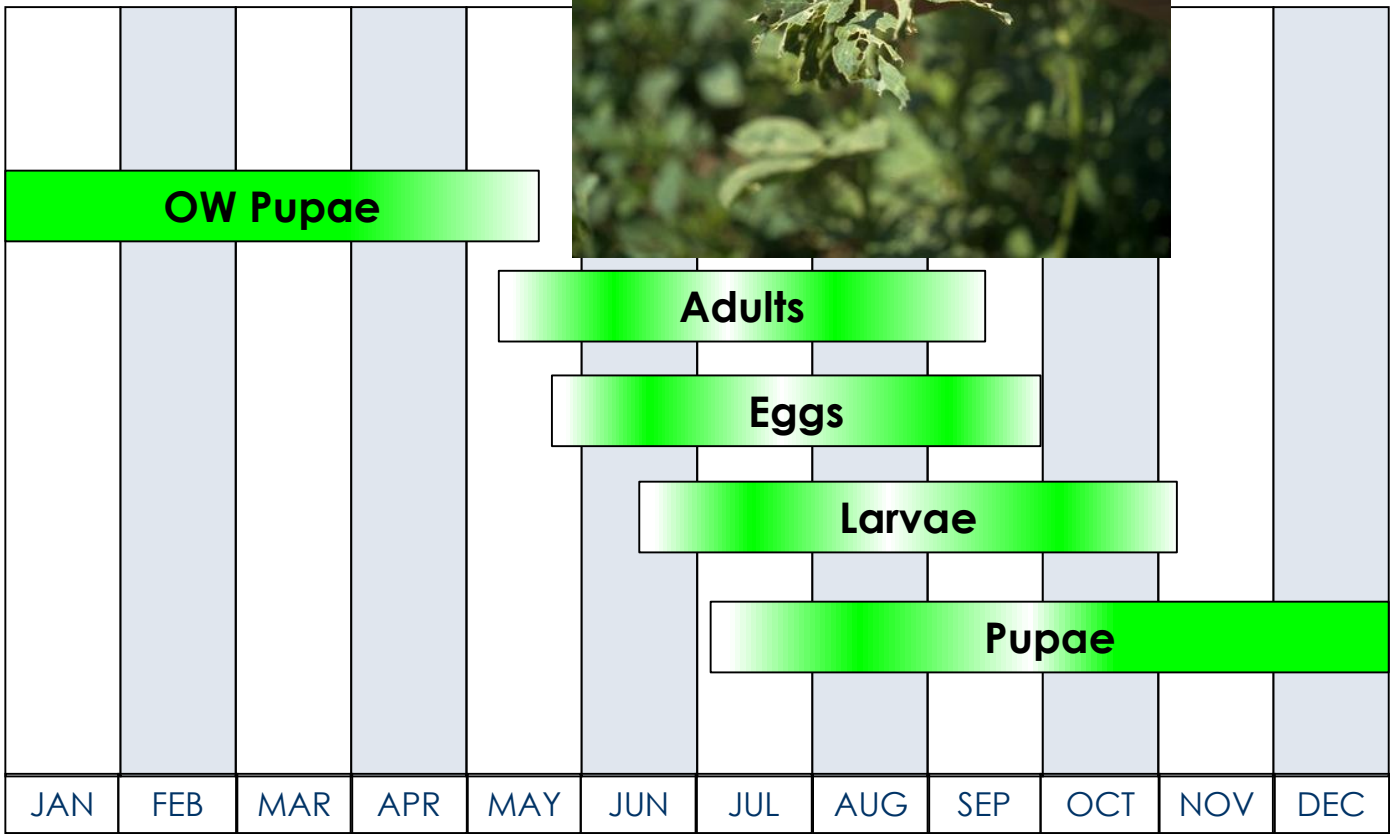


Alfalfa caterpillar, *Colias eurytheme*

Order: Lepidoptera (butterflies and moths)

Family: Pieridae (cabbage, sulfur and white butterflies)

Seasonal occurrence of alfalfa butterfly



Alfalfa Caterpillar Management

Sampling and thresholds

- ✓ Seldom a pest Idaho
- ✓ Treat if you have 10 or more non-parasitized larvae per 90° sweep

Chemical control[2]

- *Bacillus thuringiensis kurstaki* (Many products) at 0.25 to 1.5 lb product/a.
- beta-cyfluthrin (Baythroid XL) at 0.0125 to 0.022 lb ai/a.
- carbaryl at 1 lb ai/a.
- chlorantraniliprole/lambda-cyhalothrin (Voliam Xpress) at 0.049 to 0.078 lb ai/a.
- chlorpyrifos (Lorsban 4E, Lorsban Advanced) at 0.5 to 1 lb ai/a.
- chlorpyrifos + gamma cyhalothrin (Cobalt) at 0.23 to 0.52 lb ai (11 to 26 fluid oz formulation)/a.
- cyfluthrin (Tombstone) at 0.025 to 0.044 lb ai/a.
- gamma-cyhalothrin (Declare) at 0.0075 to 0.0125 lb ai/a.
- indoxacarb (Steward) at 0.065 to 0.11 lb ai/a.
- lambda-cyhalothrin (Warrior) at 0.015 to 0.025 lb ai/a.
- malathion at 0.62 lb ai/a. PHI 0 days. REI 12 hr. ULV formulations are the only ones labeled for this pest. Not effective below 65°F.
- methomyl (Lannate LV) at 0.45 to 0.9 lb ai/a.
- methoxyfenozide at 0.06 to 0.12 lb ai/a.
- methyl parathion at 0.5 lb ai/a.
- permethrin (Ambush, Pounce) at 0.05 to 0.2 lb ai/a.
- zeta-cypermethrin (Mustang, Mustang Max) at 0.028 to 0.05 lb ai/a.

[1]See **Pacific Northwest Insect Management Handbook :** http://uspest.org/pnw/insects, for application details

[2] Most of these insecticides are hazardous to bees and should not be applied if bees are actively foraging in alfalfa