Oregon State University Extension Service

Integrated Pest Management for the Cereal Leaf Beetle

Darrin L. Walenta
Extension Agronomist NE OR

Email: darrin.walenta@oregonstate.edu

Phone: 541-963-1010

Klamath Basin Small Grain Winter Meeting
OSU-Klamath Basin Research & Extension Center
February 20, 2014

Objective

Overview of……

- CLB History/Background and Economic Implications
- CLB Biology, Phenology & Injury Symptoms
- IPM Concepts
- CLB IPM Options

CLB History/Background and Economic Implications

Cereal Leaf Beetle

Oulema melanopus (Coleoptera: Chrysomelidae)

- Native to Europe and Asia
- First official record in U.S. = Michigan 1962
- Now widespread across eastern & mid-western states and into Canada
- 1st bio-control efforts 1963-79
- First found in OR, ID & WA in 1999

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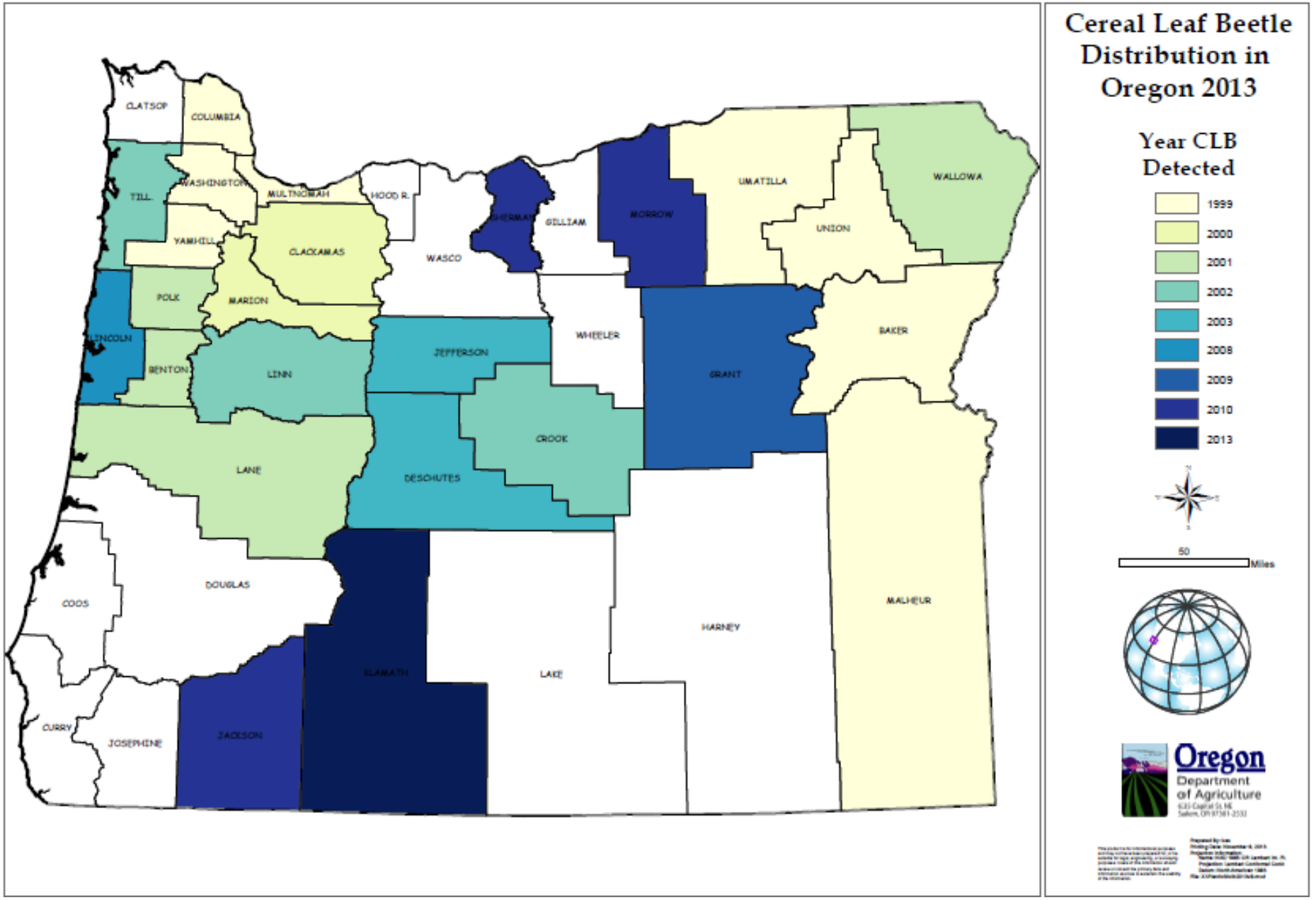
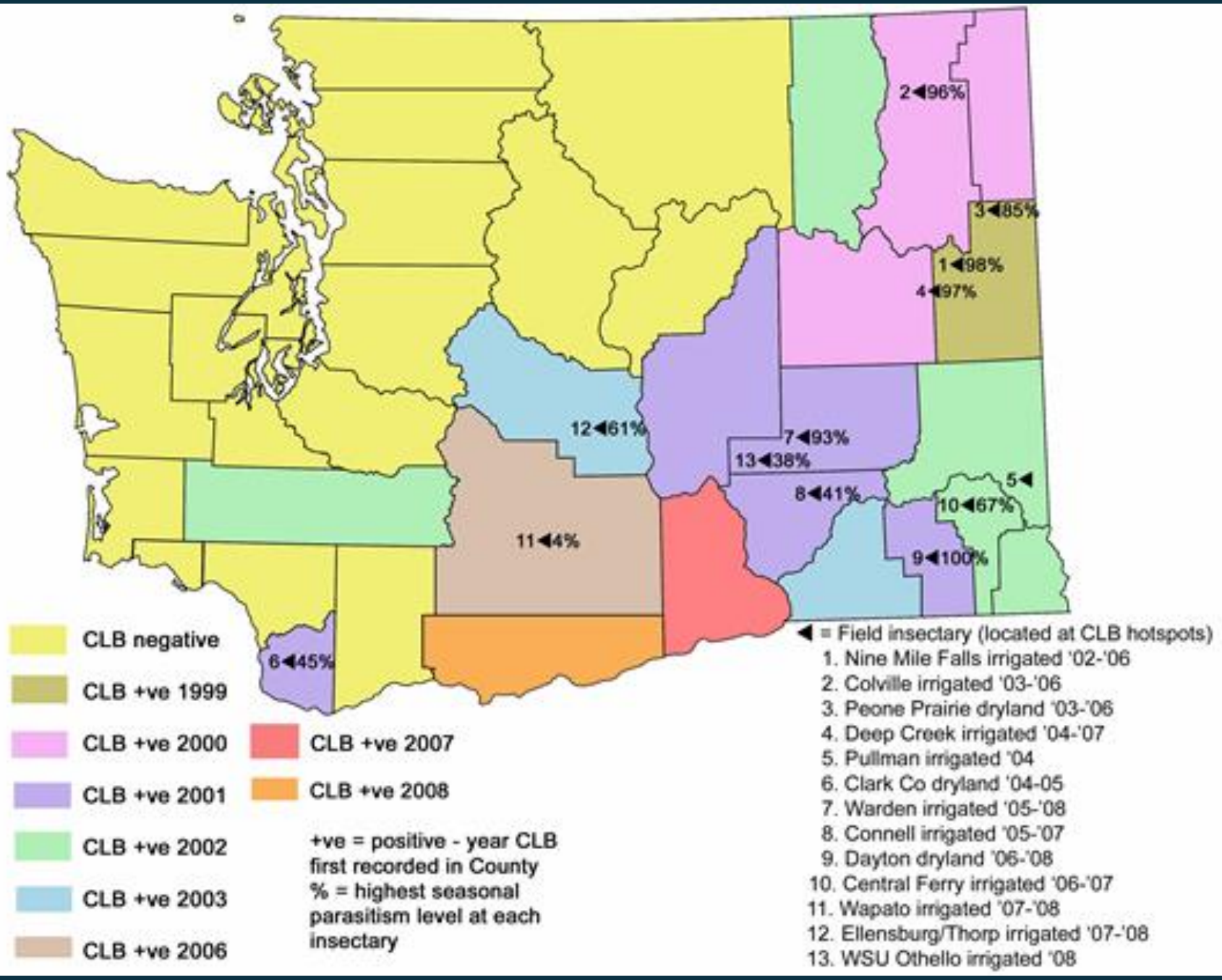


ODA Insect Pest Prevention and Management Annual Surveys
= 25 infested counties as of 2013


2◀96%
3◀85%
1◀98%
4◀97%
12◀61%
7◀93%
13◀38%
8◀41%
5◀
10◀67%
11◀4%
9◀100%
6◀45%
CLB negative
CLB +ve 1999
CLB +ve 2000
CLB +ve 2001
CLB +ve 2002
CLB +ve 2003
CLB +ve 2006
CLB +ve 2007
CLB +ve 2008
+ve = positive - year CLB first recorded in County
% = highest seasonal parasitism level at each insectary
◀ = Field insectary (located at CLB hotspots)
1. Nine Mile Falls irrigated '02-'06
2. Colville irrigated '03-'06
3. Peone Prairie dryland '03-'06
4. Deep Creek irrigated '04-'07
5. Pullman irrigated '04
6. Clark Co dryland '04-05
7. Warden irrigated '05-'08
8. Connell irrigated '05-'07
9. Dayton dryland '06-'08
10. Central Ferry irrigated '06-'07
11. Wapato irrigated '07-'08
12. Ellensburg/Thorp irrigated '07-'08
13. WSU Othello irrigated '08

2009 ISDA CEREAL LEAF BEETLE SURVEY INFESTED COUNTIES

Oulema melanopus

Boundary 1994
Bonner 1998
Kootenai 1998
Shoshone
Benewah 2005
Latah 2004
Clearwater 2007
Nez Perce 2004
Lewis 2004
Idaho 2004
Lemhi 2003
Adams 2000
Valley 2000
Washington 1998
Payette 1998
Gem 1998
Boise 1997
Custer 2003
Clark 2001
Fremont 2001
Canyon 1997
Ada 1996
Elmore 1997
Camas 1998
Blaine 1995
Butte 2002
Jefferson 1998
Madison 1998
Teton 2002
Bonneville 1995
Bingham 1995
Gooding 1997
Lincoln 1997
Minidoka 1996
Jerome 1995
Owyhee 1996
Twin Falls 1996
Cassia 1995
Power 1995
Caribou 1996
Bannock 1994
Oneida 1995
Franklin 1992
Bear Lake 1995

Uninfested County

Infested Counties

Darcy Heckathorne

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Yield Loss Potential – Small Grains

Yield Loss = damage level + crop stage/vigor

dryland –vs- irrigated, low –vs- high vigor

In OR and WA: yield losses up to

25% in spring wheat and 18% in winter wheat

In eastern/mid-western states, yield losses up to 55% in spring wheat and 75% in oats & barley

Low yield impact when damage occurs during late head fill

Significant yield loss (45%) when nearly 100% defoliation during early head fill……

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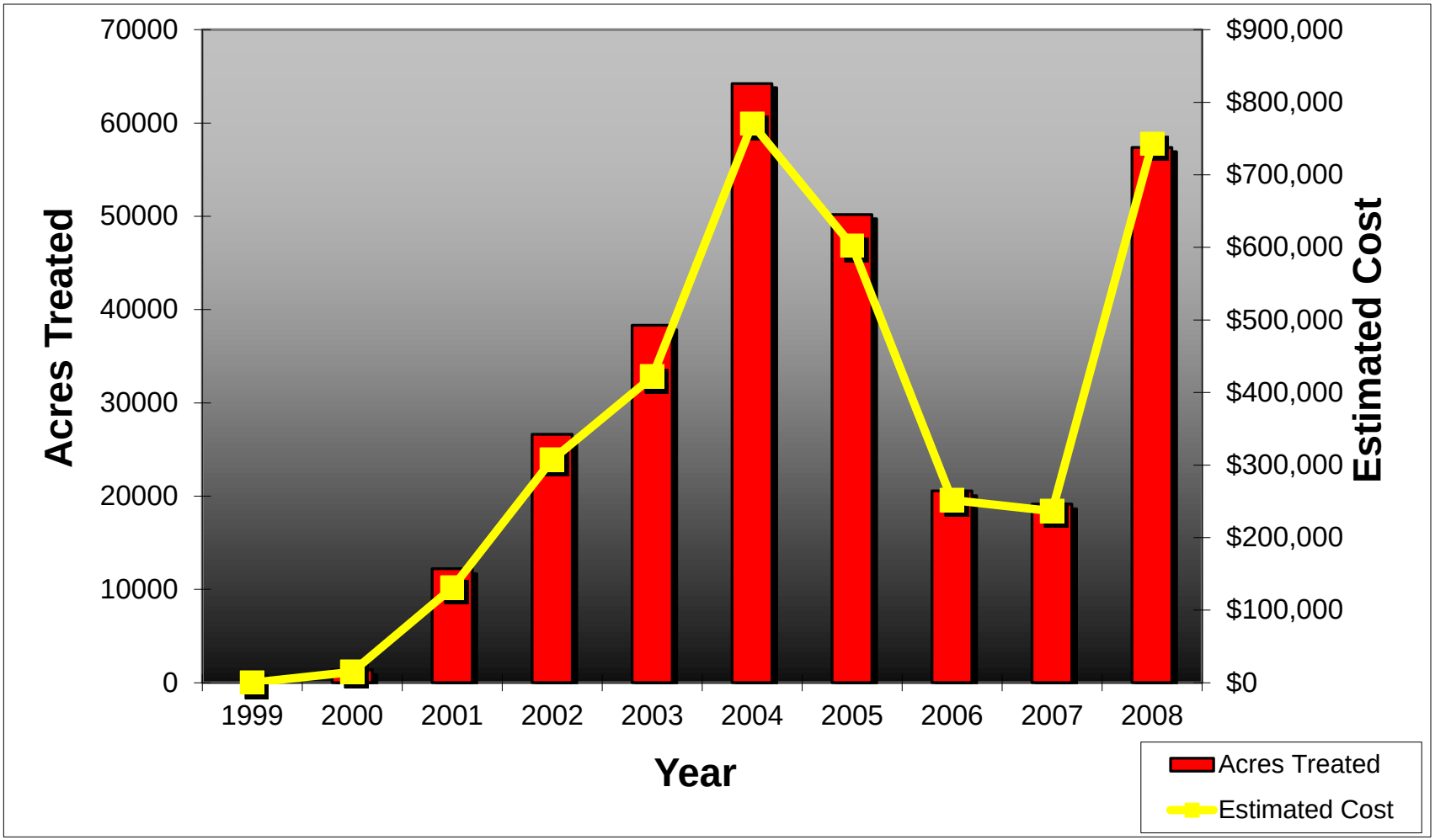
Acreage Treated & Estimated Cost of CLB Control in OR



Compiled by Gary Brown, USDA-APHIS

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CA Exterior Quarantine for CLB

http://pi.cdfa.ca.gov/pqm/manual/htm/pqm_index.htm

Restrictions for certain commodities entering CA from areas under quarantine:

- Small grains
- ear corn
- straw/hay
- grass sod
- grass & forage seed
- fodder/plant liter
- Christmas trees
- used harvesting equipment & machinery

CLB-infested counties

- Covered commodities admitted into CA if certified as “treated” by state department of ag at origin prior to shipment
- “treated” = manner approved by Secretary of CDFA (e.g. fumigation, bulk grain storage period)
- Not exposed to re-infestation after treatment

CA Exterior Quarantine for CLB

Areas Not Known to be CLB - Infested

- Commodities admitted with County of Origin Certificate issued by State Dept. of Ag (ODA)
- Small grains, grass seed, forage need Certificate of Inspection to be free of live or dead CLB

Exemptions do exist…..certificates not needed for:

- Grain sorghum, shelled corn, soybean
- Cleaned and bagged small grain, grass and forage seed ≤ 100 lbs
- Bulk small grains shipped Dec. 1 to April 30 (Master Permit QC 523) but subject to CDFA inspection
- Baled hay/straw but subject to CDFA inspection
- Straw/hay used as bedding during animal shipment

CA Exterior Quarantine for CLB

Implications of recent CLB detection in Klamath Co., OR and Siskiyou & Modoc Co., CA

- CA Exterior Quarantine still in place ***"PENDING……."***
- Agreement between ODA and CDFA
- Jackson & Klamath Co. OR and Siskiyou & Modoc Co. CA considered a *single contiguous production area*
- Enables movement of covered commodities within these counties but not to other CA counties

http://www.oregon.gov/ODA/CID/Pages/cereal_leaf_beetle.aspx

Cereal Leaf Beetle Biology, Phenology and Crop Injury Symptoms

CLB – Host Crops & Weeds

Many grass crop, forage and weedy species

Small grain
- winter –vs- spring
- oats > barley > wheat > triticale

Corn

Sorghum

Rice

Timothy

Orchardgrass

Millet

Brome spp.

Fescue spp.

Ryegrass spp.

Bluegrass

“wild” grasses
- native & introduced

Wild oat

Quackgrass

Jointed goatgrass

Foxtail

Reed canarygrass

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CLB – Damage on wheat

CLB – Damage on corn

CLB – Turf grass seed

Heavy CLB damage on Per. ryegrass in Marion County…

Seedling grass seed fields may serve as over-wintering sites for new adults.

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CLB Life Stages - Adult

- Approx. ¼” to 3/8” long
- Black head
- Orange-red thorax & legs
- Metallic, bluish-black wing covers (elytra)
- Chew completely through the leaf
- ***Drop to the ground when disturbed***

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CLB Life Stages – Adult "Look-alike" spp.

Positive ID is key!!!

- Several other small beetles that may look somewhat similar…….

- Soft-winged flower beetle (Coleoptera: Melyridae)

- Native predator feeds on aphids, alfalfa weevils and immature stages of several other insects.

Look-alike Collops sp. (left) and adult CLB (right). (Photo by G. Clevenger)

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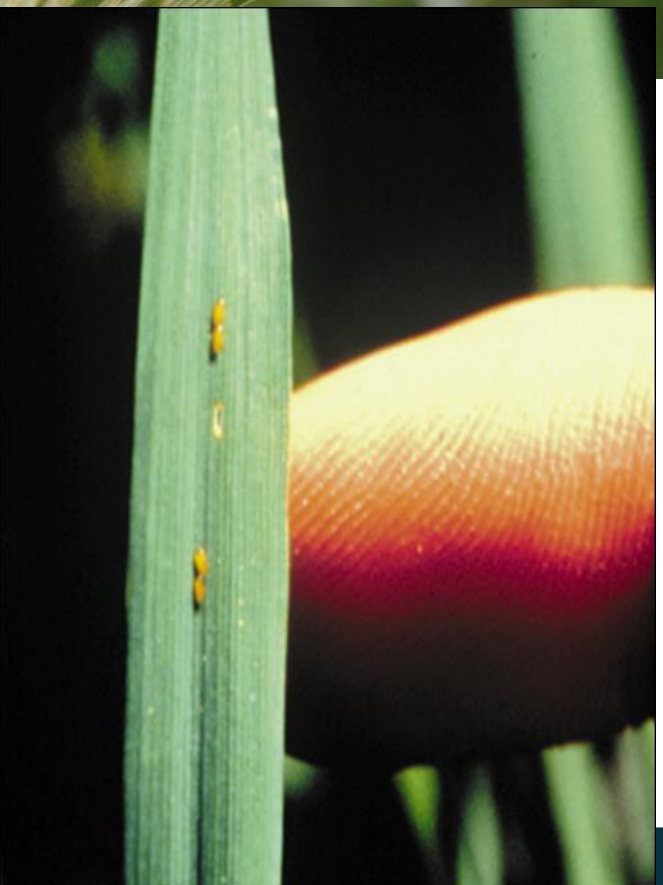

CLB Life Stages – Larva

eggs and 1st instar larva ~ 1/32 to 1/16”

4th Instar larva ~ ¼” to 3/8”

Black head, pale yellow body under black slime (fecal material)

Resemble small slugs

Diana Roberts, WSU Extension

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CLB Life Stages – Larva

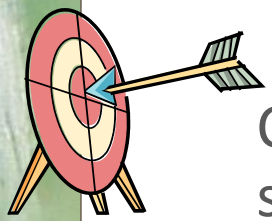
Inter-vienal feeding

Consume mesophyl & upper leaf cuticle

“window-pane” or “frosted” appearance

90% of damage during last 2 instar stages (3rd and 4th)

Active 3 to 4 weeks



Control needed ***prior to*** this stage if infestation at or above threshold

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Extremely isolated case of FROST damage?

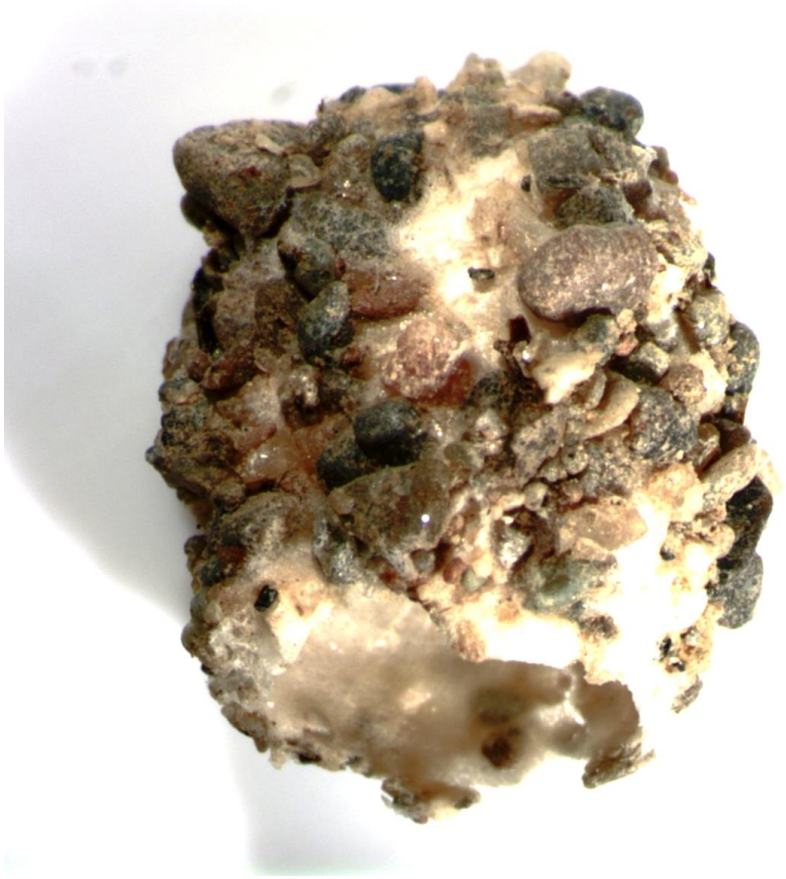
2005 Irrigated Soft White Spring Wheat – Union Co.

1.5 larvae/flag leaf 20% yield loss

91% *T. julis parasitism*


Winter Wheat (anthesis):
70% larvae in 3rd & 4th instar
1.2 larvae / tiller
0.7 larvae / flag leaf
18% yield loss (dryland)

CLB Life Stages – Larva



CLB pupa (Photo by G. Clevenger)

Larva “disappear” mid to late June (few OW adults around)

Drop to ground

Pupate in soil within earthen cells (difficult to find)

*Damage is done at this point, no control in crop needed…….

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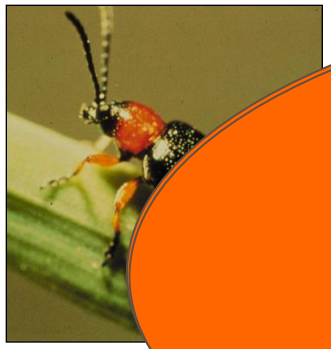
Life Cycle (1 generation/year) - NE Oregon



Cereals

Cool, wet weather slows down all biological processes……egg laying, hatching and larval development…

rasses

OW adults lay eggs for approx. 6 weeks!!!

Adult (over-wintering) Egg Larva Pupa Adults (new summer)

April May June July

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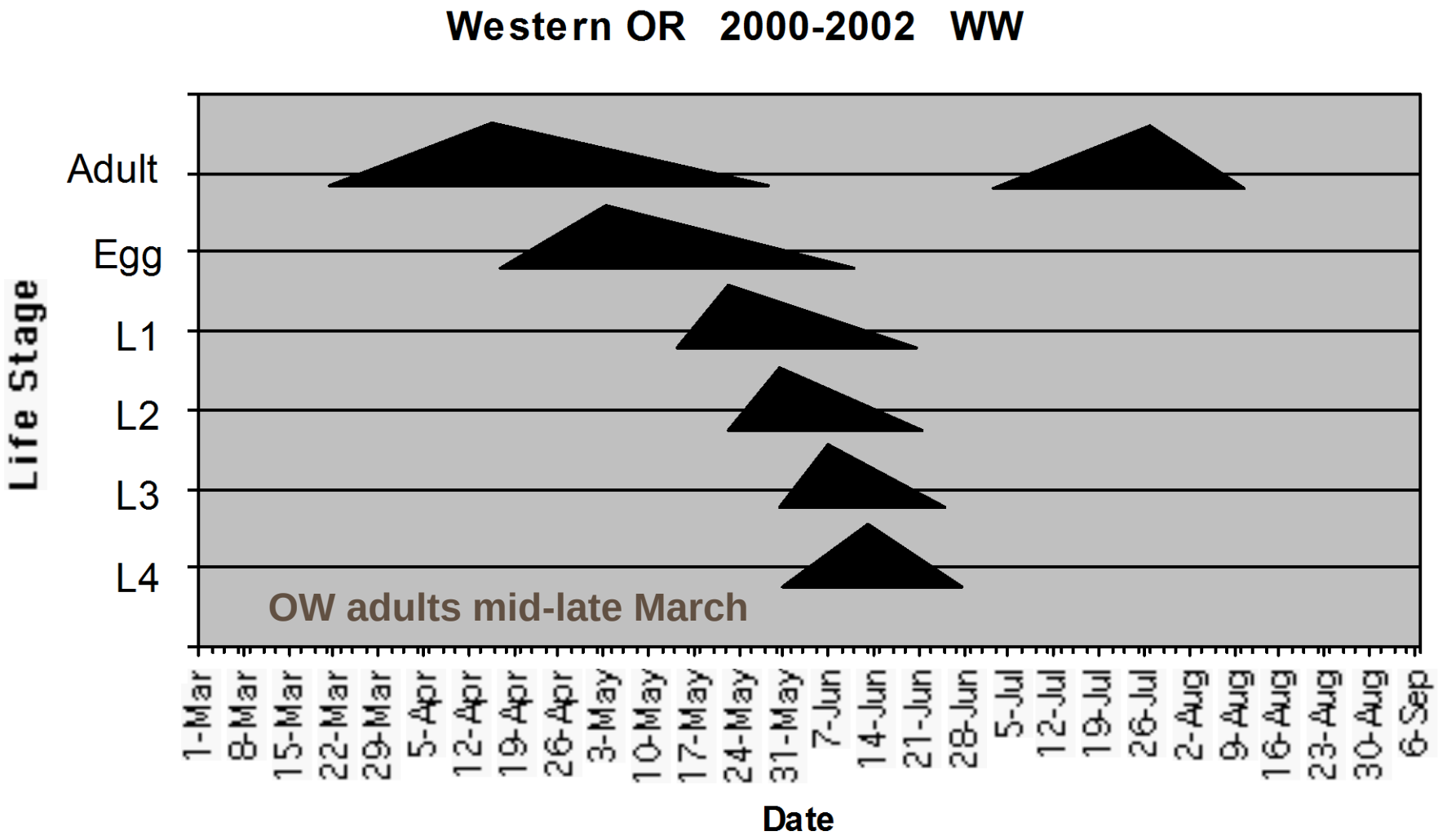
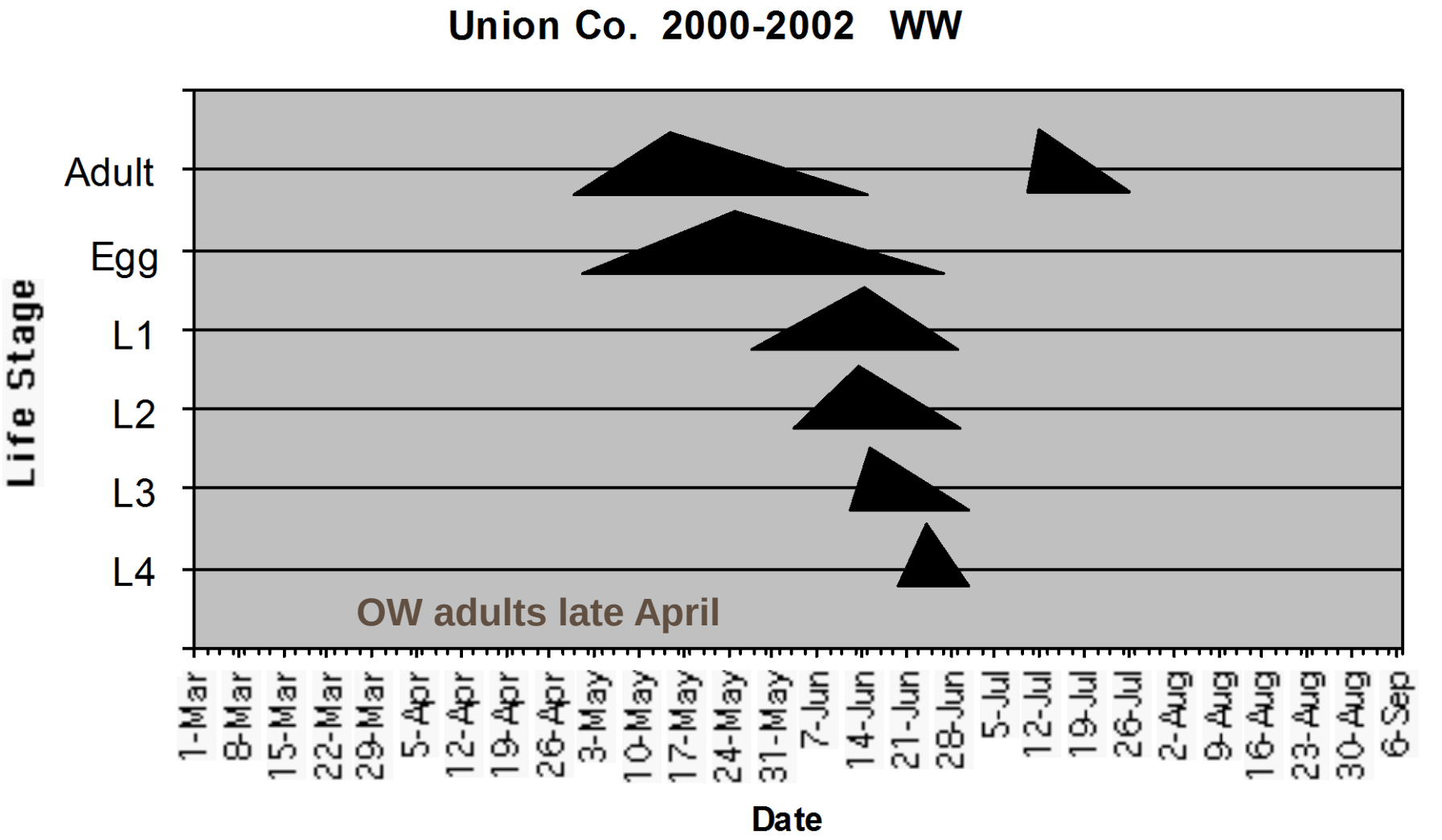
CLB Phenology – Western OR



CLB Phenology – Union Co.



CLB – Habits & Preferences

Adults over-winter in protected sites near grain fields

- Grain stubble, grass crowns, permanent vegetation, riparian areas, etc.
- Disappear in late June!!

Adults very active on calm, sunny days

- Prefer spring planted grains (e.g. oats, barley)
- Can migrate to successively younger stands

Females begin laying eggs ~ 2 weeks after emergence

- can lay up to 300 eggs over 6-week period

Host Crop Preferences in Oregon????

Fall planted grasses

Spring planted grasses

Spring planted cereals

Annual ryegrass

Perennial ryegrass

Orchardgrass

Tall fescue

Kentucky bluegrass

Oats

Over-wintering adults

Late summer adults?

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Susceptibility to Damage - Fall Planted Grasses (2002)

Host plant	6-9-03 Damage	7-14-03 Adults	7-14-03 Damage
Annual ryegrass	low	mowed	--
Perennial rye grass	low	mowed	--
Orchard grass	low	mowed	--
Tall fescue	low	mowed	--
Kentucky bluegrass	none	mowed	--
Fine fescue	none	mowed	--

OW CLB adults attracted to fall-planted AR, PR, OG and TF

Feeding & egg laying did occur but damage was not significant

Susceptibility to Damage - Spring Planted Grasses (2003)

Host plant	OW Adults	6-9-03 Damage	7-14-03 Adults	7-14-03 Damage
Oats		High	5.0	-
Triticale		Medium	24.3	-
Annual ryegrass		low	17.4	High
Perennial rye grass		low	19.7	Medium
Orchard grass		low	29.3	Medium
Tall fescue		low	14.7	Medium
Kentucky bluegrass		none	14.1	Low
Fine fescue		none	1.9	None

Summer Adults

OW adults = not interested when spring grain available
"New" summer adults = can damage spring-planted AR,PR, OG, TF
Fine leaved grasses = not preferred

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CLB – Habits & Preferences

OW adults prefer spring planted grains (oats & triticale) and fall planted grasses (AR, PR, OG, TF).

"New" summer adults appear in July……

- Do not mate
- Dormant during high heat (aestivation period)
- Migrate to any available grass host (corn, grass seed, other) to feed prior to over-wintering (harvest small grains)

Mortality over-winter can range 40-70%

- Extreme temperatures, introduced / natural predators


Photo: D. L. Walenta

IPM Concepts & Resources

Integrated Cereal Leaf Beetle Management

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IPM – Agricultural Definition

Ecologically-based pest control strategy that relies heavily on:

- Natural mortality (e.g. natural enemies, weather, etc.)
- Control tactics that disrupt these factors as little as possible

IPM utilizes pesticides after systematic monitoring of pest populations and natural control indicates a need

IPM considers all control tactics – even no action

IPM – Concepts

Based on biology of……

- Crop
- Pest Complex
- Natural predator(s)

GOAL = maintain pest populations below economically damaging levels by using a combination of control methods such as……..

Biological	Cultural	Chemical
Mechanical	Genetic	

IPM – Key Tactics

Pest ID and Understanding Biology

- Design IPM program to specific pest

Monitoring

- Assess pest and natural enemy populations
- Crop damage levels
- effective management action

Pest Action Thresholds

- Reduce pest levels below economical damage levels

Utilize combination of control tactics

- develop a flexible IPM program (time of year, crop rotation, weather patterns)

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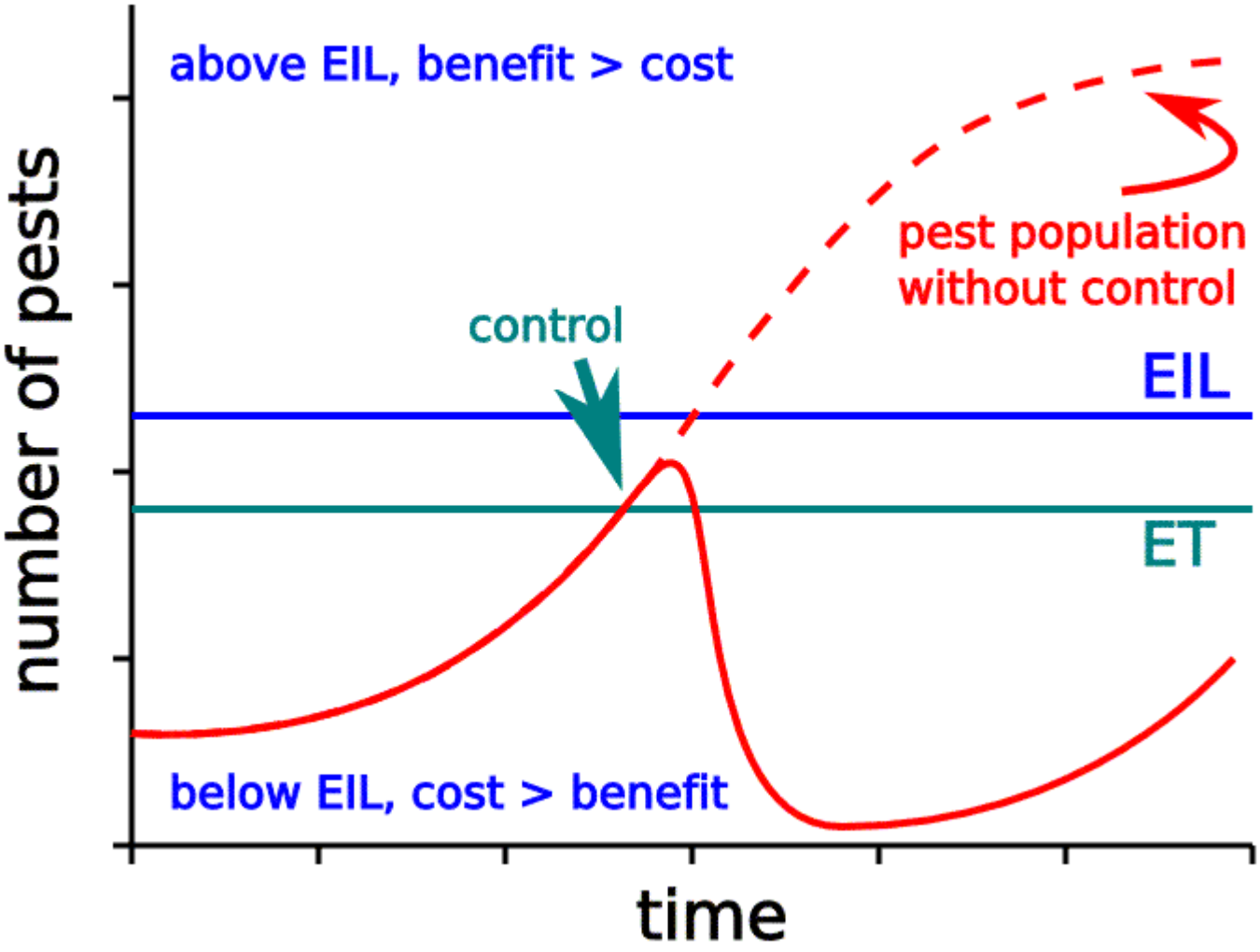
Economic Threshold = pest population levels which require control "action" to prevent unacceptable crop damage / economic loss.



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IPM Resources

OSU – IPPC

PNW Pest Mgmt Handbooks

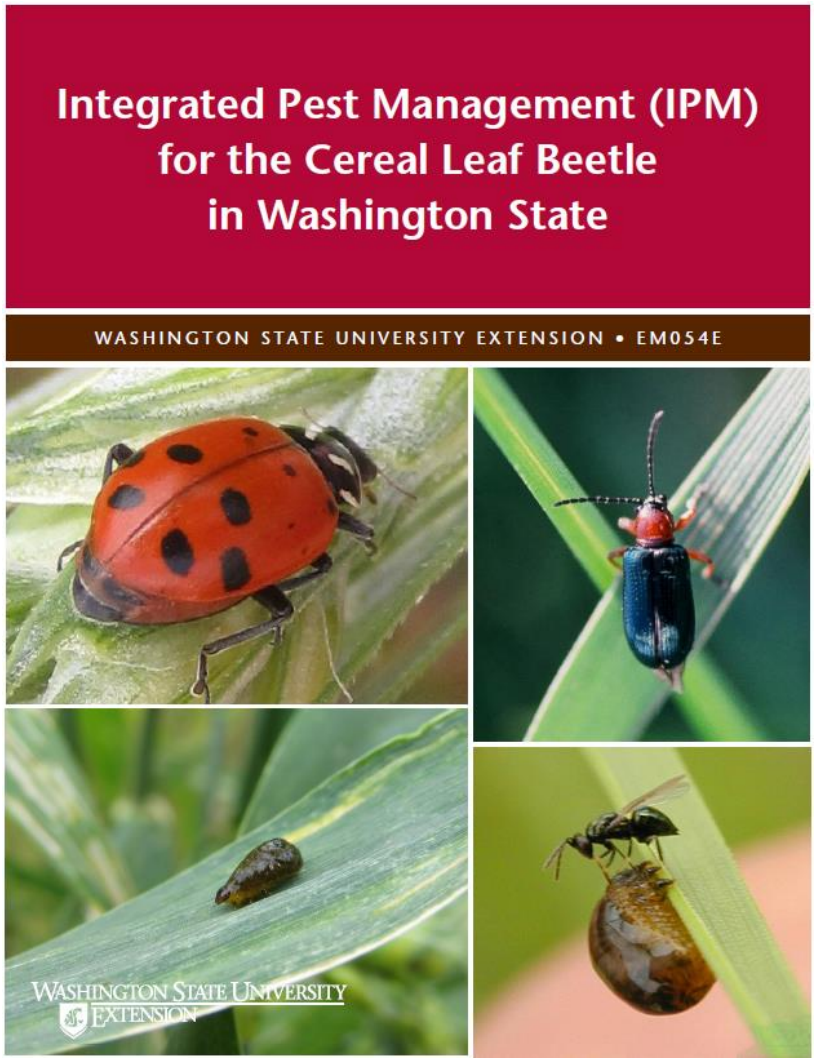
http://www.ipmnet.org/

Insecticide Resistance Action Committee

http://www.irac-online.org/

Western Region IPM Center

www.wripmc.org



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CLB IPM Options

Field Scouting

Economic Thresholds in Small Grains

Management Options

- Insecticides
- Cultural
- ***Biological***

CLB Phenology Model – Online Tool

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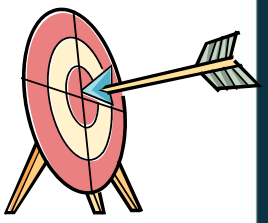
CLB IPM Options – Field Scouting

Primary tool in all IPM programs!

Correct pest ID essential!

Start when temps reach 50 F, continue through early grain fill

- Winter wheat = 2 nodes present
- Spring grain = soon after emergence (1 – 2 leaf, adult damage concern)



Goal = determine when 50% or more eggs have hatched (lots of small **1st & 2nd instar larvae**!)

Monitoring over time helps determine peak levels:

adult infestation - egg laying - larvae development

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CLB IPM Options – Field Scouting

10 X 10 scouting technique

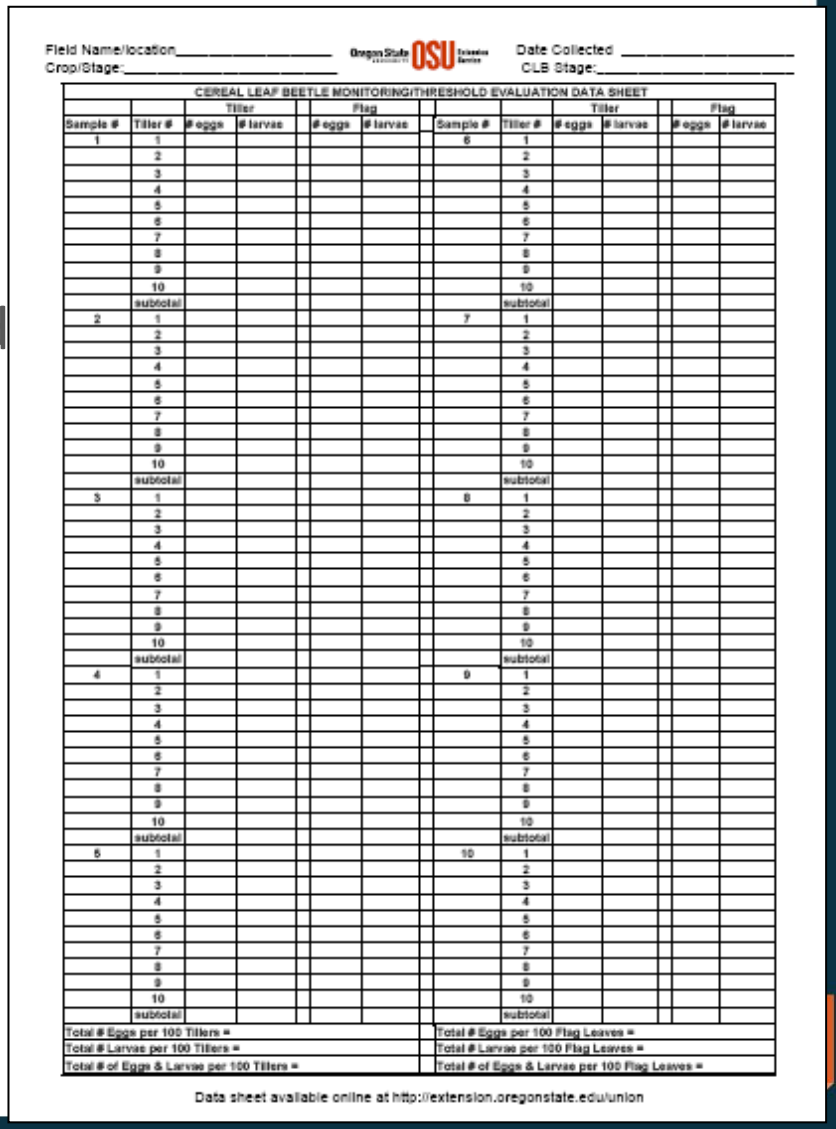
Check 10 tillers every 10 acres

- W pattern across field, check field edges apart

Record # of eggs, larva/tiller and flag leaf (*adults?*)

High % eggs….scout again a few days later

Data sheet available in OR CLB IPM publication later in 2013



Field Name/location_____ Date Collected _____
Crop/Stage:_____ CLB Stage:_____

CEREAL LEAF BEETLE MONITORING/THRESHOLD EVALUATION DATA SHEET

		Tiller		Flag				Tiller		Flag	
Sample #	Tiller #	# eggs	# larvae	# eggs	# larvae	Sample #	Tiller #	# eggs	# larvae	# eggs	# larvae
1	1					6	1				
	2						2				
	3						3				
	4						4				
	5						5				
	6						6				
	7						7				
	8						8				
	9						9				
	10						10				
	subtotal						subtotal				
2	1					7	1				
	2						2				
	3						3				
	4						4				
	5						5				
	6						6				
	7						7				
	8						8				
	9						9				
	10						10				
	subtotal						subtotal				
3	1					8	1				
	2						2				
	3						3				
	4						4				
	5						5				
	6						6				
	7						7				
	8						8				
	9						9				
	10						10				
	subtotal						subtotal				
4	1					9	1				
	2						2				
	3						3				
	4						4				
	5						5				
	6						6				
	7						7				
	8						8				
	9						9				
	10						10				
	subtotal						subtotal				
5	1					10	1				
	2						2				
	3						3				
	4						4				
	5						5				
	6						6				
	7						7				
	8						8				
	9						9				
	10						10				
	subtotal						subtotal				

Total # Eggs per 100 Tillers =	Total # Eggs per 100 Flag Leaves =
Total # Larvae per 100 Tillers =	Total # Larvae per 100 Flag Leaves =
Total # of Eggs & Larvae per 100 Tillers =	Total # of Eggs & Larvae per 100 Flag Leaves =

Data sheet available online at http://extension.oregonstate.edu/union

CLB IPM Options – Economic Thresholds

Current Threshold Levels (adapted): Small Grains

Pre-Boot until Flag Leaf Fully Emerged (Feekes 1-8):

3 larvae and / or eggs per tiller

Boot stage and later (Feekes 9+):

1 larvae per tiller


Photo: D. L. Walenta

Flag leaf contributes ~50% of photo-synthates during early to mid-grain fill (Simmons, 1987)

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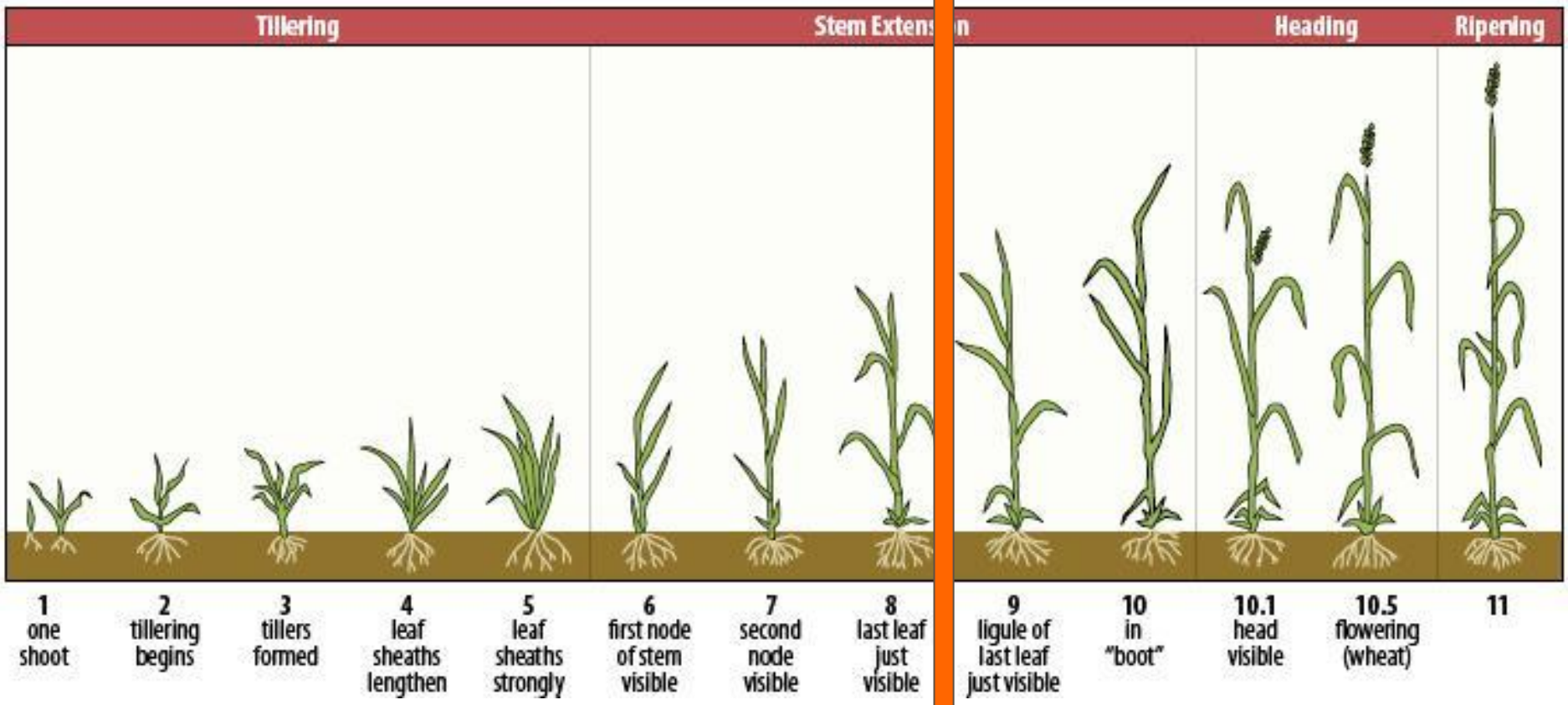
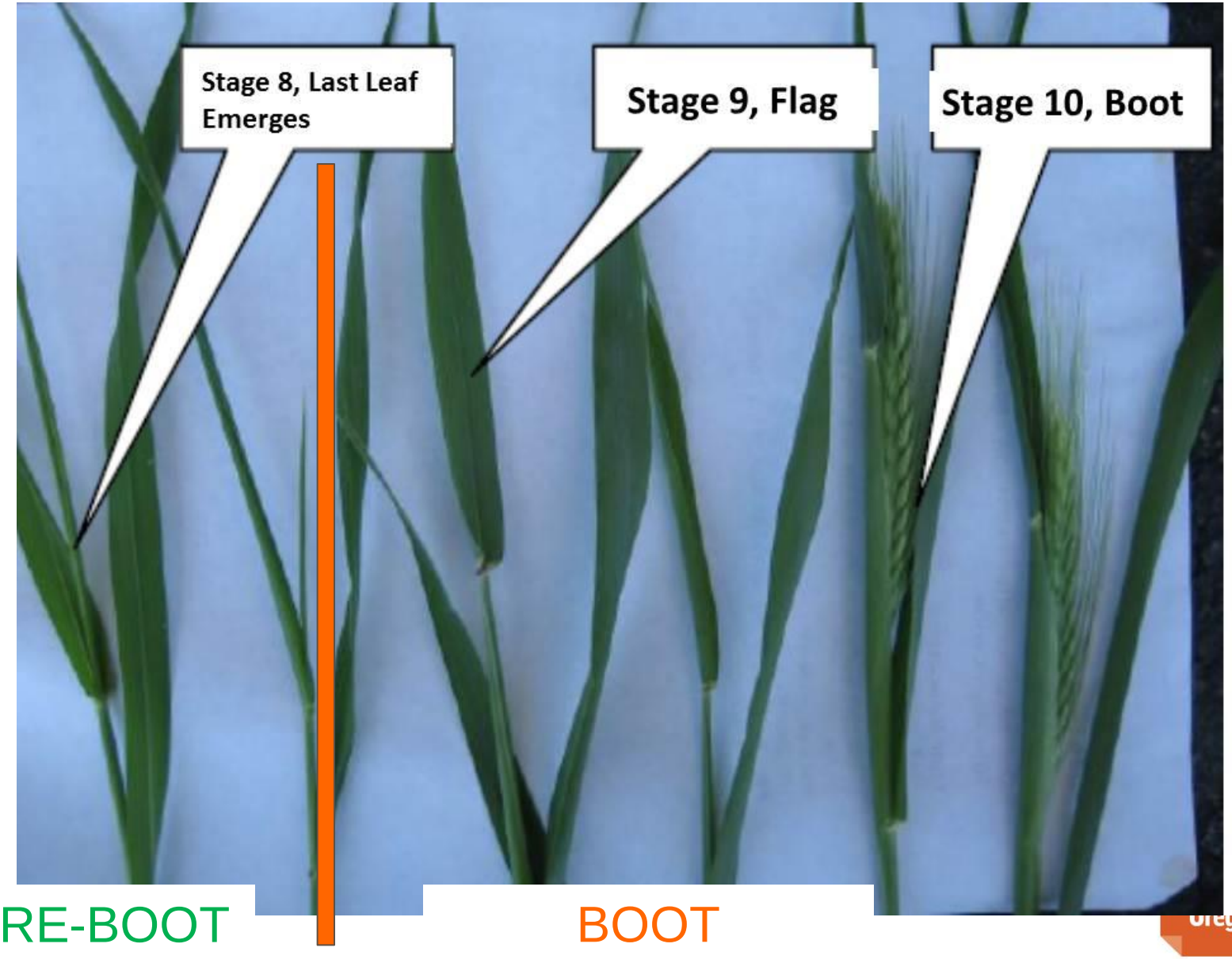
Figure 2-1. The Feekes scale of wheat development.



PRE-BOOT

BOOT


Stage 8, Last Leaf Emerges
Stage 9, Flag
Stage 10, Boot
PRE-BOOT
BOOT

Yield Impact & Economic Threshold Evaluation
Funding: Oregon Wheat Commission

Winter & Spring Wheat

- 4 WW (2 irr)
- 5 SW (2 irr)
- 2 DNS (1 irr)

Treatments (3 reps)

- insecticide
- non-treated

Assessments

- egg/larvae populations
- Flag leaf damage
- Grain yield/loss

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CLB Impact on Soft White Winter Wheat Yield – Union Co.

Treatment	Larvae per Tiller[1]	Larvae per Flag Leaf[1]	Flag Leaf Damage[2]	Average Yield Loss
	#	#	% area	%
2004				
No Insecticide	0.7	**0.4**	22	**-3**
Insecticide	0.1	0	6	0
2005				
No Insecticide	1.5	**0.4**	na	**-14**
Insecticide	0.7	0.2	na	0

[1]Approximately 14 days after insecticide application.
[2]Flag leaf defoliation determined when 90% of CLB larvae initiated pupation.

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CLB Impact on Soft White Spring Wheat Yield – Union Co.

Treatment	Larvae per Tiller[1]	Larvae per Flag Leaf[1]	Flag Leaf Damage[2]	Average Yield Loss
	#	#	% area	%
2004				
No Insecticide	0.7	**0.6**	25	**-13**
Insecticide	0.1	0.1	1	0
2005				
No Insecticide	3.1	**1.0**	na	**-19**
Insecticide	0.1	0.1	na	0

[1]Approximately 14 days after insecticide application.
[2]Flag leaf defoliation determined when 90% of CLB larvae initiated pupation.

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CLB Economic Threshold - Summary


Photo: D. L. Walenta

Spring wheat more susceptible to economic damage

- Yield loss in 7 of 7 study sites
- Ranged from 4 to 21 bu/a loss

Winter wheat = variable response to CLB damage

- Yield loss ranged from 0% to -31% (loss in 2 of 4 sites)
- More advanced growth stage compared to sp. wheat

Irrigated –vs- dryland…….no observed differences

Crop health/vigor influenced damage potential

CLB Economic Threshold - Considerations

PRE-BOOT stage

3 eggs and/or larva per Tiller = **APPLICABLE to SW/WW**

BOOT stage

1 larvae per flag leaf = **DEPENDS…..**

- Observed economic damage at 0.4 to 0.7 larva / flag leaf

ET can be less than 1 larva / flag lead if two conditions are met…..

1. Low crop health and vigor
2. Total # of larva per TILLER > 1

Early detection can help reduce yield loss, improves bio-control and no “slimy”pants!

CLB IPM Options – Insecticides:

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CLB IPM Options – Insecticides:

Several foliar-applied products registered for CLB control in small grains, grass hay & pasture and corn……

- 2013 PNW Insect Management Handbook
  http://www.ipmnet.org/IPM_Handbooks.htm

Be Sure and Follow Label Instructions!

Various restrictions for grazing, forage, fodder, hay, straw & grain (PHI, max amount applied per season, etc.)

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CLB IPM Options – Insecticides: Pasture & Grass Hay

IRAC Site of Action Group #	Product	Active Ingredient
1 A	various	carbaryl
1 B	various	malathion
3 A	Baythroid XL	beta=cyfluthrin
3 A	Silencer, Warrior II	lambda-cyhalothrin
3 A	Mustang Max	zeta-cypermethrin
28 + 3 A	Besiege	chlorantraniliprole + lambda-cyhalothrin

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CLB IPM Options – Insecticides: Small Grains

IRAC Site of Action

Group #	Product	Active Ingredient
1 A	Lannate	methomyl
3 A	Baythroid XL	beta=cyfluthrin
3 A	Silencer, Warrior	lambda-cyhalothrin
3 A	various	pyrethrin
3 A	Declare	gamma-cyhalothrin
5	Radiant SC	spinetoram
15	Dimilin 2L	diflubenzuron
biocide	*Mycotrol O	*Beauveria bassiana*
biocide	*Grandevo	*Chromobacterium subtsugae*

* OMRI listed

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CLB IPM Options – Insecticides: WHEAT only

IRAC Site of Action

Group #	Product	Active Ingredient
1 B	various	chlorpyrifos
3 A	Tombstone	cyfluthrin
3 A	Mustang Max (triticale)	zeta-cypermethrin
1 B + 3 A	Cobalt	chlorpyrifos + gamma-cyhalothrin
1 B + 3 A	Stallion	chlorpyrifos + zeta cypermethrin

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CLB IPM Options – Insecticides: Barley only

IRAC Site of Action Group #	Product	Active Ingredient
3 A + 4 A	Endigo ZC	lambda cyhalothrin + thiamethoxam

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Insecticide Resistance Management - CLB

Rotate site of action groups

- avoid consecutive use of same group
- ***Most products are in Group 1 and 3!!***

Tank mixtures /pre-mixes with different sites of action

- Must be registered for intended use!

Timing is Key!

- only one well-timed application is needed for CLB control!
- Did it work? Monitor efficacy after REI expires.

Using IPM tactics help prevent resistance development

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New Label Requirements for pyrethroid insecticide products

Located in the “Directions for Use” section of label…

- **Buffer Zones**

- **Spray Drift Prevention Requirements**

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PULL HERE TO OPEN

RESTRICTED USE PESTICIDE

DUE TO TOXICITY TO FISH AND AQUATIC ORGANISMS

FOR RETAIL SALE TO AND USE ONLY BY CERTIFIED APPLICATORS, OR PERSONS UNDER THEIR DIRECT SUPERVISION, AND ONLY FOR THOSE USES COVERED BY THE CERTIFIED APPLICATOR'S CERTIFICATION.

GROUP 3 INSECTICIDE

Warrior II with Zeon Technology®

Insecticide

Active Ingredient:	
Lambda-cyhalothrin[1,2]	22.8%
Other Ingredients:	77.2%
Total:	100.0%

Warrior II with Zeon Technology contains 2.08 lbs. of active ingredient per gal. and is a capsule suspension.

[1]*CAS No. 91465-08-6* [2]*Synthetic pyrethroid*

Contains petroleum distillate.

KEEP OUT OF REACH OF CHILDREN.

WARNING / AVISO

Si usted no entiende la etiqueta, busque a alguien para que se la explique a usted en detalle. (If you do not understand the label, find someone to explain it to you in detail.)

See additional precautionary statements and directions for use in booklet.

EPA Reg. No. 100-1295 *EPA Est. 39578-TX-1*

Product of the United Kingdom
Formulated in the USA

SCP 1295A-L2B 0709
304012

1 gallon
Net Contents

syngenta®

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SYNGENTA and Seller offer this product, and Buyer and User accept it, subject to the foregoing Conditions of Sale and Limitation of Warranty and Liability, which may not be modified except by written agreement signed by a duly authorized representative of SYNGENTA.

DIRECTIONS FOR USE

RESTRICTED USE PESTICIDE

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.

SHAKE WELL BEFORE USING.

Do not apply this product in a way that will contact workers or other persons, either directly or through drift. Only protected handlers may be in the area during application. For any requirements specific to your State or Tribe, consult the agency responsible for pesticide regulation.

This labeling must be in the possession of the user at the time of application.

AGRICULTURAL USE REQUIREMENTS

Use this product only in accordance with its labeling and with the Worker Protection Standard, 40 CFR part 170. This Standard contains requirements for the protection of agricultural workers on farms, forests, nurseries, and greenhouses, and handlers of agricultural pesticides. It contains requirements for training, decontamination, notification, and emergency assistance. It also contains specific instructions and exceptions pertaining to the statements on this label about personal protective equipment (PPE) and restricted-entry interval. The requirements in this box only apply to uses of this product that are covered by the Worker Protection Standard.

Do not enter or allow worker entry into treated areas during the restricted-entry interval (REI) of 24 hours.

PPE required for early entry to treated areas that is permitted under the Worker Protection Standard and that involves contact with anything that has been treated, such as plants, soil, or water is:

- Coveralls
- Chemical-resistant gloves, Category G, such as barrier laminate or Viton® ≥ 14 mils
- Shoes plus socks

FAILURE TO FOLLOW THE DIRECTIONS FOR USE AND PRECAUTIONS ON THIS LABEL MAY RESULT IN POOR INSECT CONTROL, CROP INJURY, OR ILLEGAL RESIDUES.

GENERAL DIRECTIONS FOR USE

Initial and residual control are contingent upon thorough crop coverage. Apply with ground or aerial equipment using sufficient water to obtain full coverage of foliage. Apply in a minimum of 2 gals. per acre by air or 10 gals. per acre by ground unless otherwise specified in this label. When foliage is dense or pest pressure is high (heavier insect or egg pressure, larger larval stages), use of higher application volumes and/or higher use rates may improve initial and residual control.

For cutworm control, Warrior II with Zeon Technology may be applied before, during, or after planting. For soil-incorporated applications, use higher rates for improved control.

RESISTANCE MANAGEMENT

Warrior II with Zeon Technology is a Group 3 Insecticide (contains the active ingredient lambda-cyhalothrin). Some insects are known to develop resistance to products used repeatedly for control. Because the development of resistance cannot be predicted, the use of this product should conform to resistance management strategies established for the use area. Consult your local or state agricultural authorities for details.

If resistance to this product develops in your area, this product, or other products with a similar mode of action, may not provide adequate control. If poor performance cannot be attributed to improper application or extreme weather conditions, a resistant strain of insect may be present. If you experience difficulty with control and resistance is a reasonable cause, immediately consult your local company representative or agricultural advisor for the best alternative method of control for your area.

SPRAY DRIFT PRECAUTIONS

BUFFER ZONES

Vegetative Buffer Strip

Construct and maintain a minimum 10-foot-wide vegetative filter strip of grass or other permanent vegetation between the field edge and down gradient aquatic habitat (such as, but not limited to, lakes; reservoirs; rivers; permanent streams; marshes or natural ponds; estuaries; and commercial fish farm ponds).

Only apply products containing Warrior II with Zeon Technology onto fields where a maintained vegetative buffer strip of at least 10 feet exists between the field and down gradient aquatic habitat.

For guidance, refer to the following publication for information on constructing and maintaining effective buffers:
Conservation Buffers to Reduce Pesticide Losses. Natural Resources Conservation Services. USDA, NRCS. 2000. Fort Worth, Texas. 21 pp.
www.in.nrcs.usda.gov/technical/agronomy/newconbuf.pdf

In the State of New York, a 25 ft. vegetated, non-cropped buffer strip untraversed by drainage tiles must be maintained between a treated field and a coastal salt marsh or stream that drains into a coastal salt marsh, for both aerial or ground application. For aerial applications, the 25 ft. vegetated non-cropped buffer strip for runoff protection would be part of the larger 150 ft. buffer strip (or 450 ft. buffer strip for ULV application) required for spray drift.

Buffer Zone for Ground Application (groundboom, overhead chemigation, or airblast)

Do not apply within 25 feet of aquatic habitats (such as, but not limited to, lakes; reservoirs; rivers; permanent streams; marshes; natural ponds; estuaries; and commercial fish ponds).

Buffer Zone for ULV Aerial Application

Do not apply within 450 feet of aquatic habitats (such as, but not limited to, lakes; reservoirs; rivers; permanent streams; marshes; natural ponds; estuaries; and commercial fish ponds).

Buffer Zone for Non-ULV Aerial Application

Do not apply within 150 feet of aquatic habitats (such as, but not limited to, lakes; reservoirs; rivers; permanent streams; marshes; natural ponds; estuaries; and commercial fish ponds).

SPRAY DRIFT REQUIREMENTS

Wind Direction and Speed

Only apply this product if the wind direction favors on-target deposition.

Do not apply when the wind velocity exceeds 15 mph.

Temperature Inversion

Do not make aerial or ground applications into temperature inversions.

Inversions are characterized by stable air and increasing temperatures with height above the ground. Mist or fog may indicate the presence of an inversion in humid areas. The applicator may detect the presence of an inversion by producing smoke and observing a smoke layer near the ground surface.

Droplet Size

Use only medium or coarser spray nozzles (for ground and non-ULV aerial application) according to ASAE (S572) definition for standard nozzles. In conditions of low humidity and high temperatures, applicators should use a coarser droplet size.

Additional Requirements for Ground Applications

Wind speed must be measured adjacent to the application site on the upwind side, immediately prior to application.

For ground boom applications, apply using a nozzle height of no more than 4 feet above the ground or crop canopy.

For airblast applications, turn off outward pointing nozzles at row ends and when spraying the outer two rows. To minimize spray loss over the top in orchard applications, spray must be directed into the canopy.

Pyrethroid labels

Buffer Zones

- 10 ft vegetative filter strip between field edge and down gradient aquatic habitat…….plus…….
- 25 ft no spray buffer zone…..plus……

Spray Drift Prevention Requirements

- Droplet size medium or coarser (ASAE S572 standards)
- Measure wind speed prior to application
  (adjacent to site prior to application, upwind side)
- More on label

CLB IPM Options – Cultural Control

Sound agronomic practices that favor well-established stands

- Vigorous, well-tillered, non-stressed plants
- Tolerate damage from CLB infestations below threshold levels

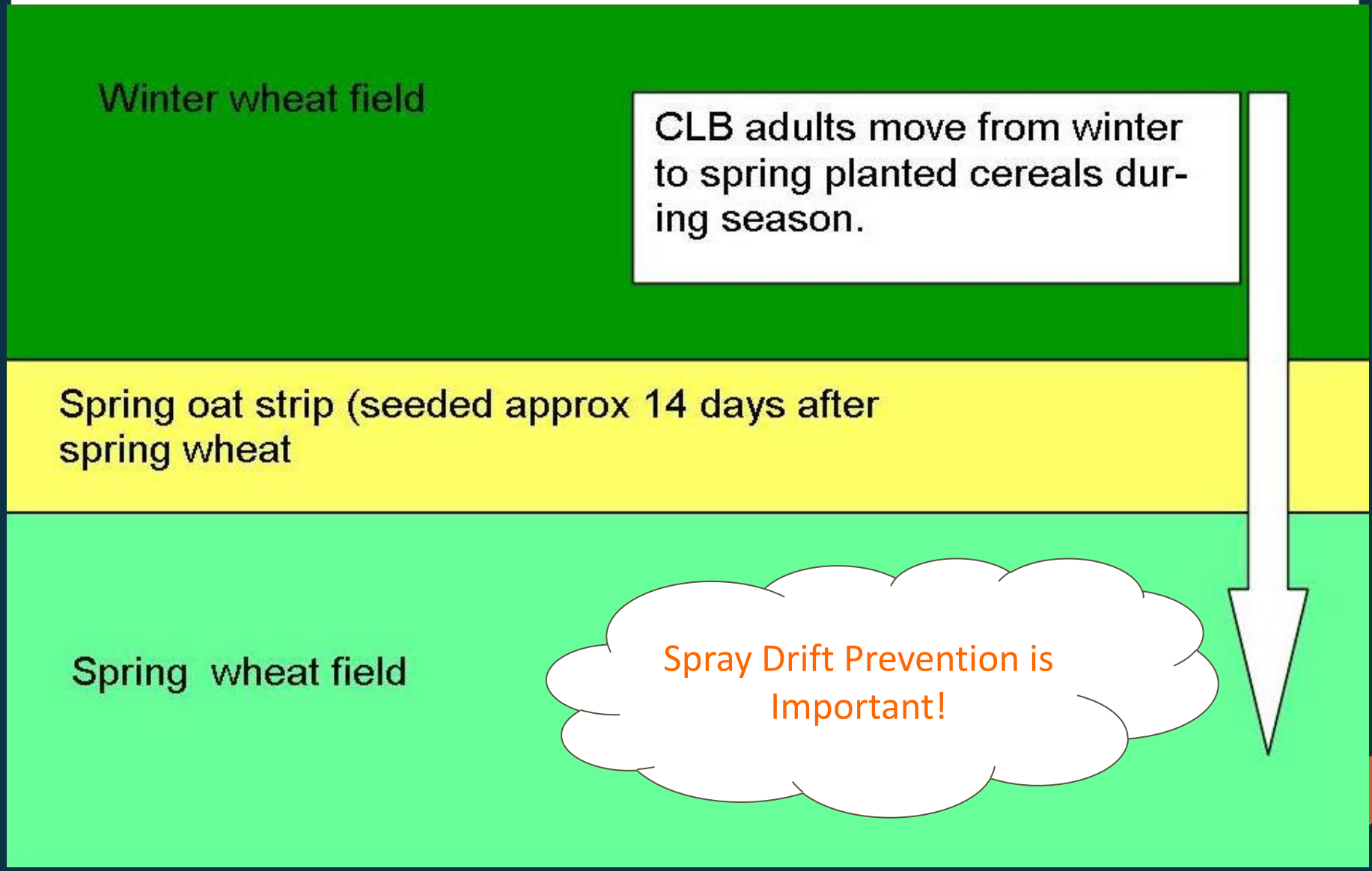
CLB-resistant varieties not identified yet in PNW

- Resistance mechanism = leaf hairiness

Oat trap crop management tactic

- CLB adults prefer small, young oat plants for egg-laying
- Seeding oat border strips 2 weeks after spring wheat effective (Roberts et al. 2010)
- Untreated oats provide refuge for introduced and natural predators

CLB IPM Options – Oat Trap Crop Tactic



CLB IPM Options – Biological Control

No natural predators when CLB first arrived

- Insecticides first line of defense

Introduced CLB-specific parasitoid wasps have been used over the last 40+ years

- Successful example of “classic” biological control
- Natural enemies are imported and released in a new region for permanent establishment

Once established, help maintain CLB populations below economic threshold levels w/o insecticides

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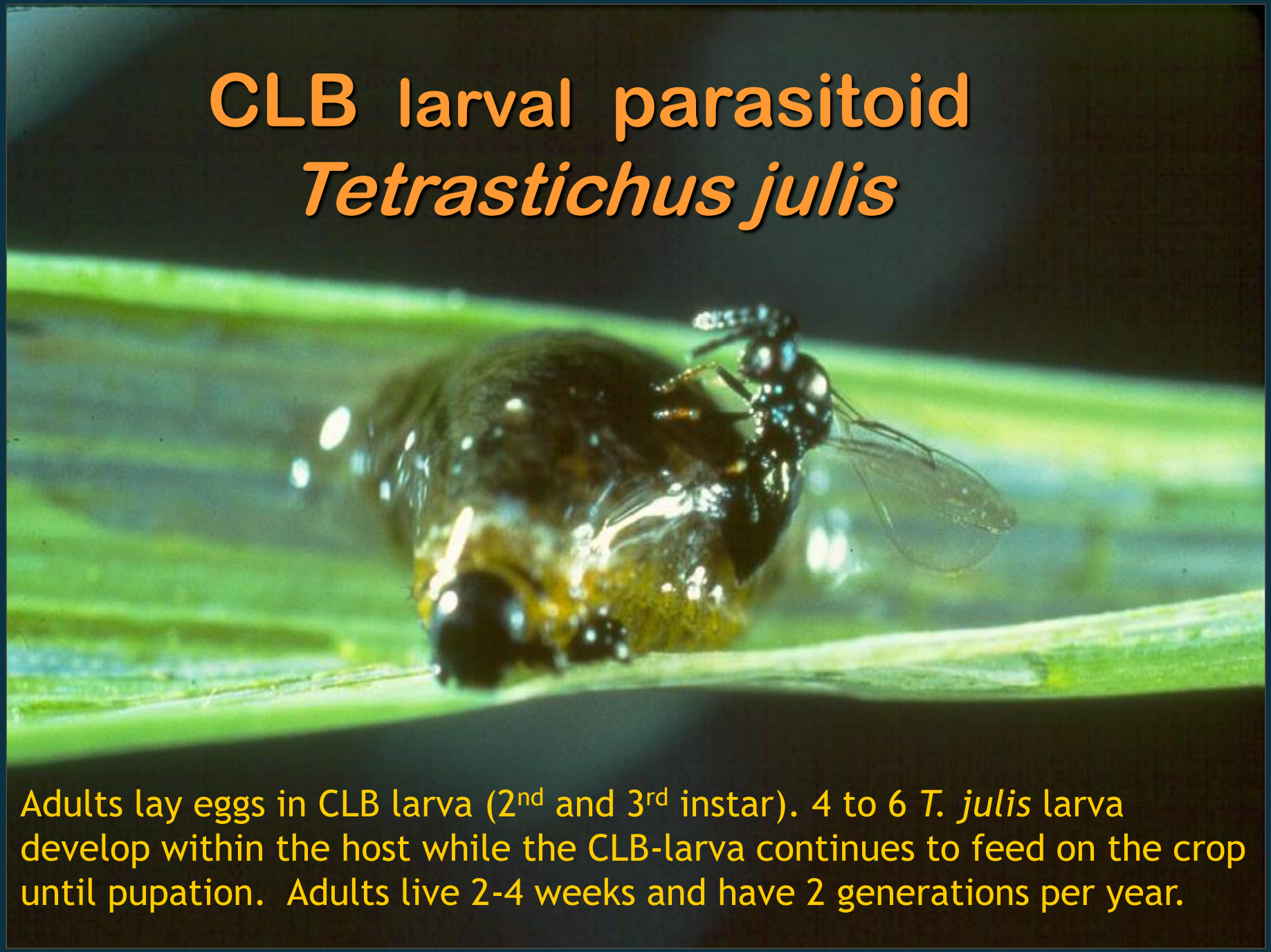
Oregon CLB Bio-control Project

ODA, USDA-APHIS and OSU

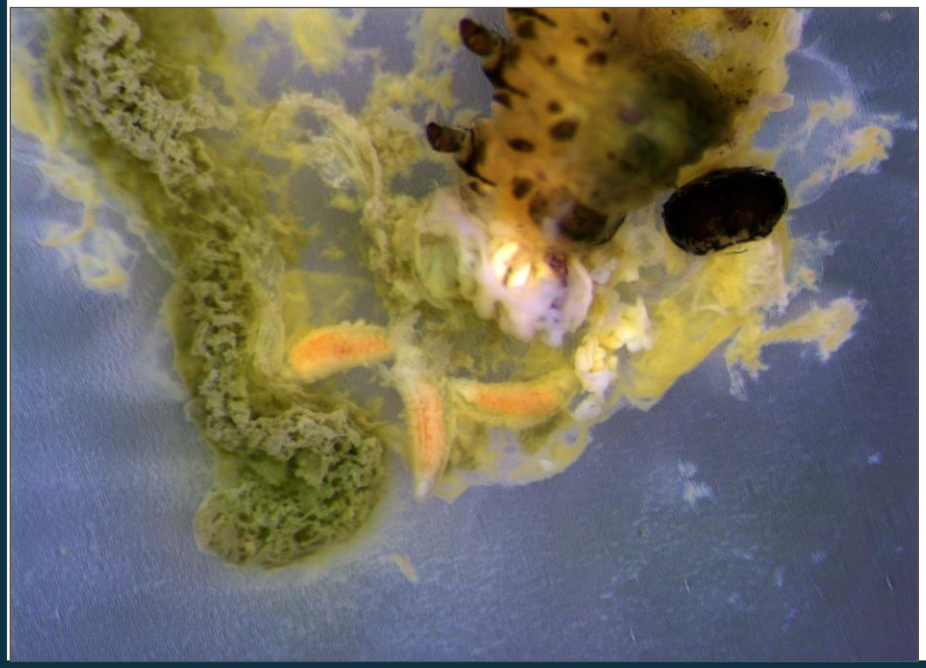
CLB larval parasitoid *Tetrastichus julis*

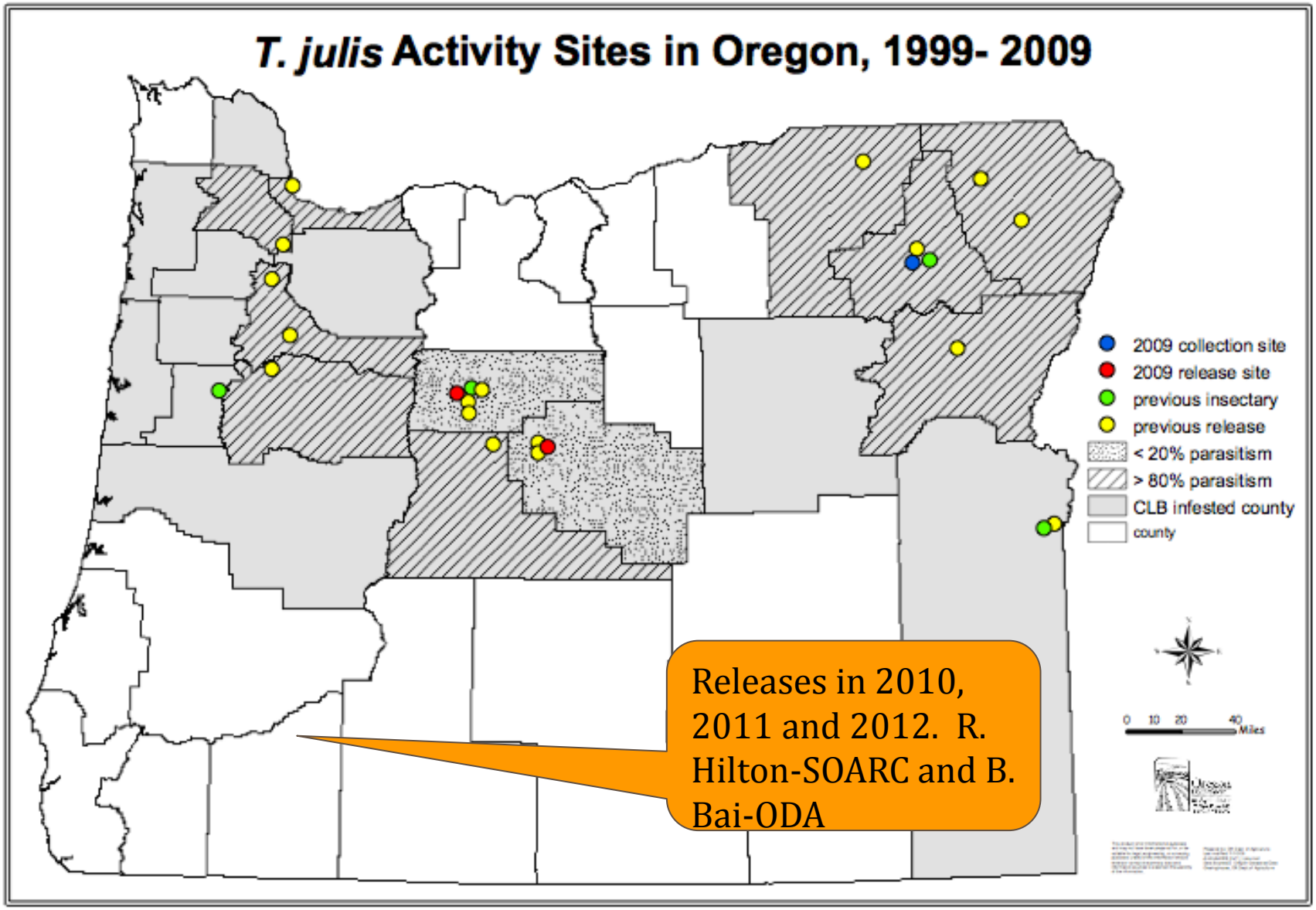


Adults lay eggs in CLB larva (2nd and 3rd instar). 4 to 6 *T. julis* larva develop within the host while the CLB-larva continues to feed on the crop until pupation. Adults live 2-4 weeks and have 2 generations per year.

T. julis larvae recovered from CLB larva

Mike Cooper,
Idaho State Department of Agriculture




T. julis Activity Sites in Oregon, 1999- 2009
2009 collection site
2009 release site
previous insectary
previous release
< 20% parasitism
> 80% parasitism
CLB infested county
county
Releases in 2010, 2011 and 2012. R. Hilton-SOARC and B. Bai-ODA
0 10 20 40
Miles

Statewide biological control release summary (ODA, APHIS)

Year	A. flavipes	T. julis
2000	263	12,310
2001	434	18.905
2002	6,200	107,566
2003	28,111	108,949
2004	26,213	51,000
2005	31,904	23,160
2006	16,750	41,965
2007	4,285	16,207
2008	0	3,564
2009	0	13,870
Total	**114,160**	**397,496**

Recent T. julis Release Activities – R. Hilton, OSU-SOARC

Collection Site	Date	Release Site	# CLB Larva	Parasitism Rate %	# of T. Julis Larva
Multnomah	6-24-10	Jackson-Glass	300	100	1500
Multnomah	6-21-11	Jackson-Glass	200	100	1000
Multnomah	6-22-11	Jackson-Glass	800	100	4000
Multnomah	6-29-11	Jackson-Glass	200	100	1000
Union	6-15-12	Jackson-Table Rock Rd.	600	96	2880
Total			**2100**		**10,380**

Continued release needed until over-winter recovery reaches 50% parasitism levels in the field.

ODA, APHIS & OSU will provide assistance to cooperators willing to leave in-field refuge areas

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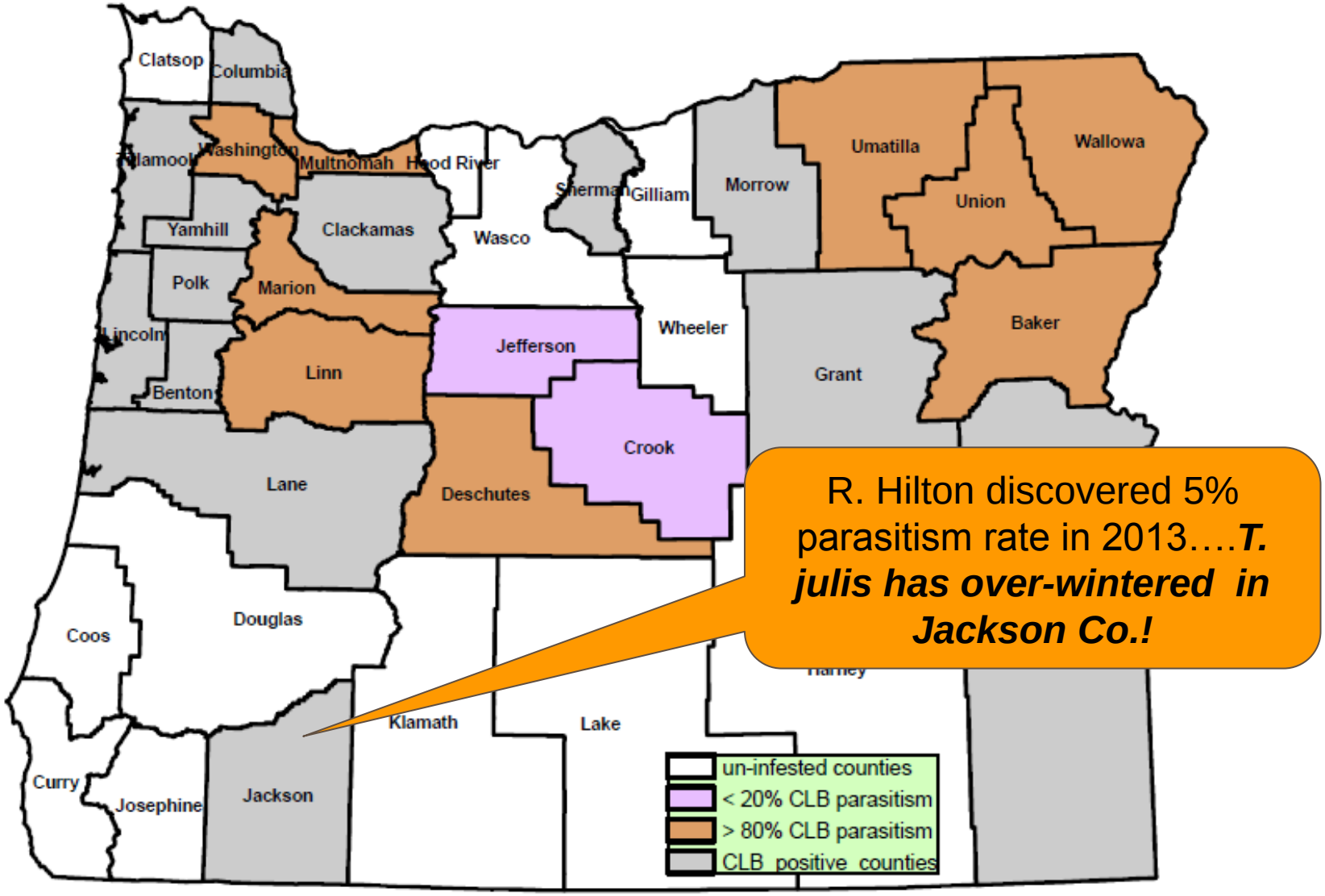
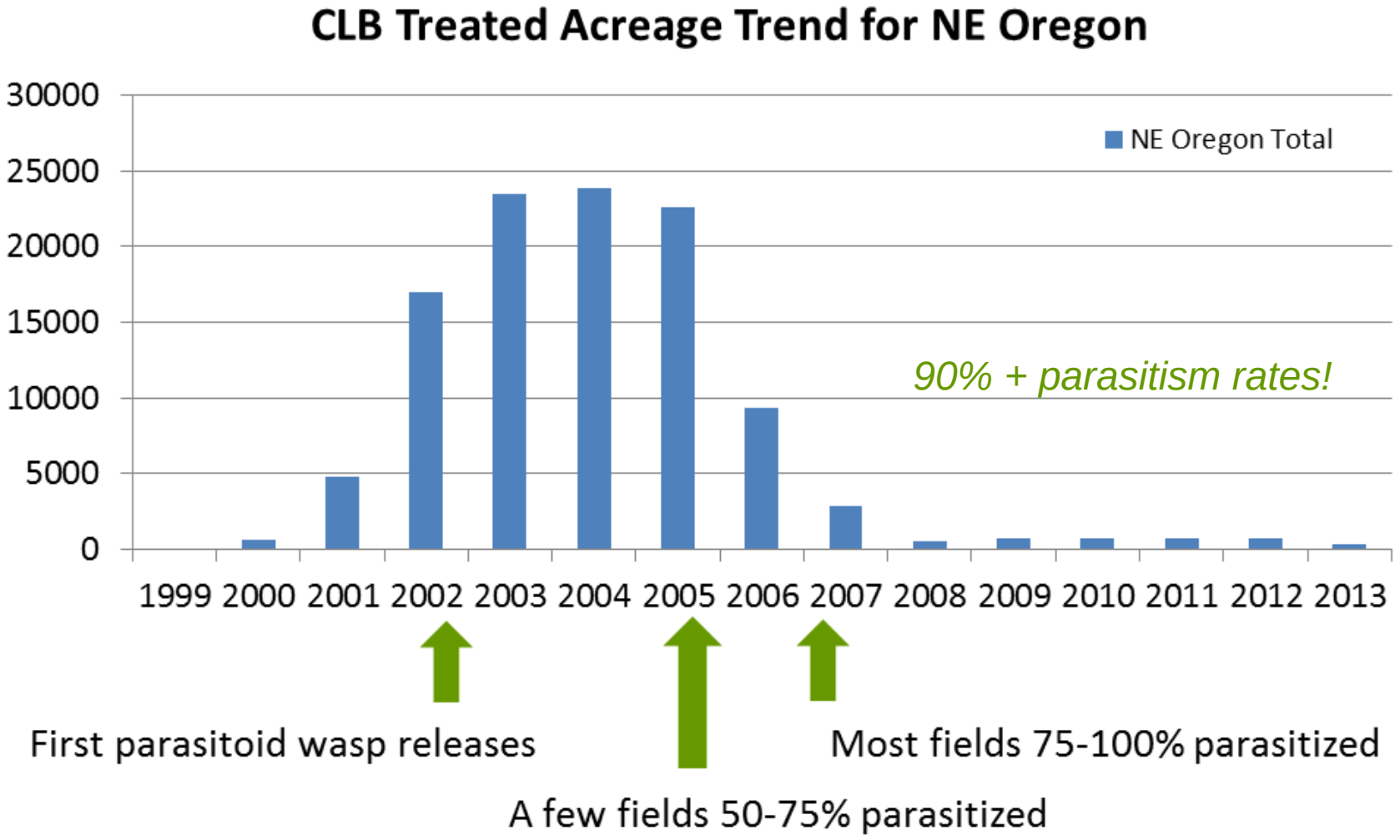
Cereal leaf beetle and larval parasitoid wasp (*T. julis*) distribution in Oregon - 2010



R. Hilton discovered 5% parasitism rate in 2013….***T. julis has over-wintered in Jackson Co.!***



Patience is a virtue!

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T. Julis over-winters in the soil as a larva within the pupal cell of the dead CLB host!

T. julis does not over-winter as an adult so this stage is CRITICAL for its survival

No-till / direct seed systems promote survival

Reduced tillage systems?

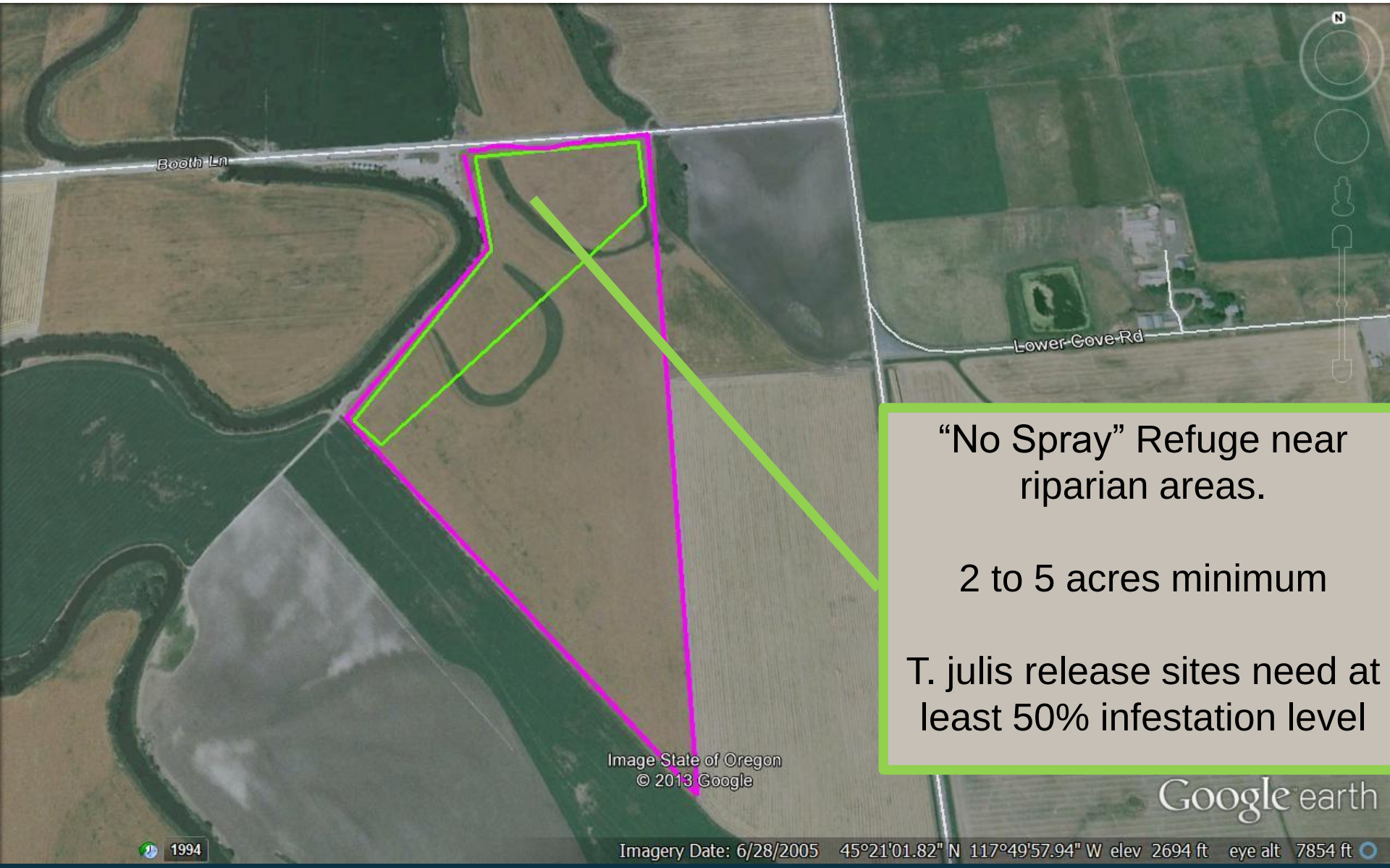
Conventional systems tend to bury/destroy pupal cells

No Spray Refuge Areas within treated fields promote survival of introduced parasitoids and natural predators.

Preferred Sites: large areas near field borders in close proximity to riparian or permanently vegetated areas.

Convergent lady beetle
Hippodamia convergens

Large untreated areas are most effective refuge areas.



"No Spray" Refuge near riparian areas.

2 to 5 acres minimum

T. julis release sites need at least 50% infestation level

Oregon's bio-control program key to CLB management! ODA, USDA-APHIS & OSU greatly appreciate the Oregon Hay & Forage Association for their support that made this program possible!

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Oregon CLB Biological Control Program

T. Julis has gradually spread throughout Oregon

- Managed release efforts and on it's own within local areas

ODA monitors T. julis spread within OR

ODA Commodity Inspection

- certificate of origin for hay shipment to CA

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Oregon CLB Biological Control Program ODA Plans for 2014

Detection surveys in Klamath and adjacent counties

Monitor grain fields for T. julis parasitism rates to locate potential collection sites for re-distribution

Klamath Co. a priority for T. julis release

- Need grain fields with at least 50% CLB infestation level within portion of the field (need 2 – 5 acres, no insecticide)

Continued collaboration between ODA, USDA and OSU

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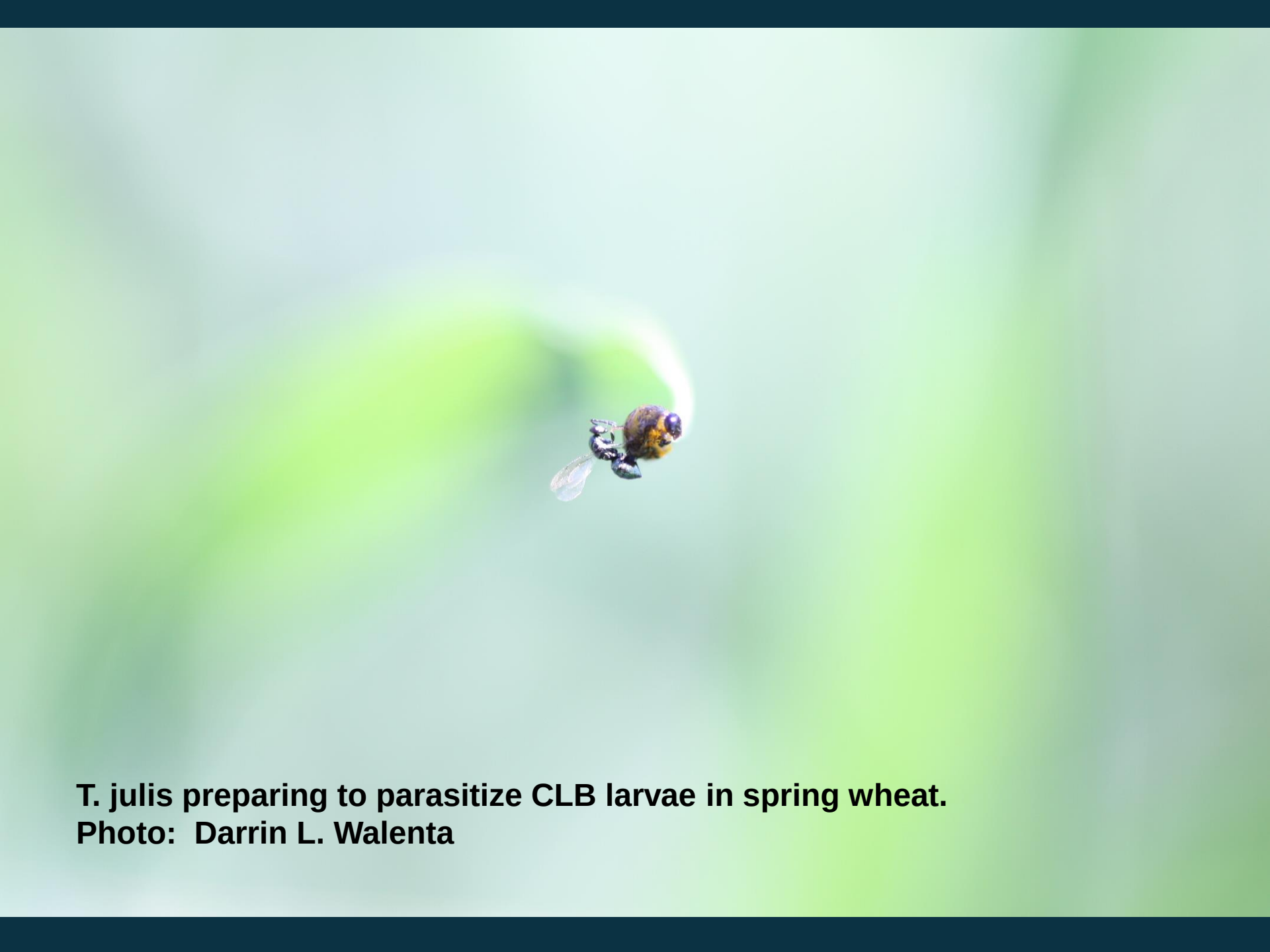
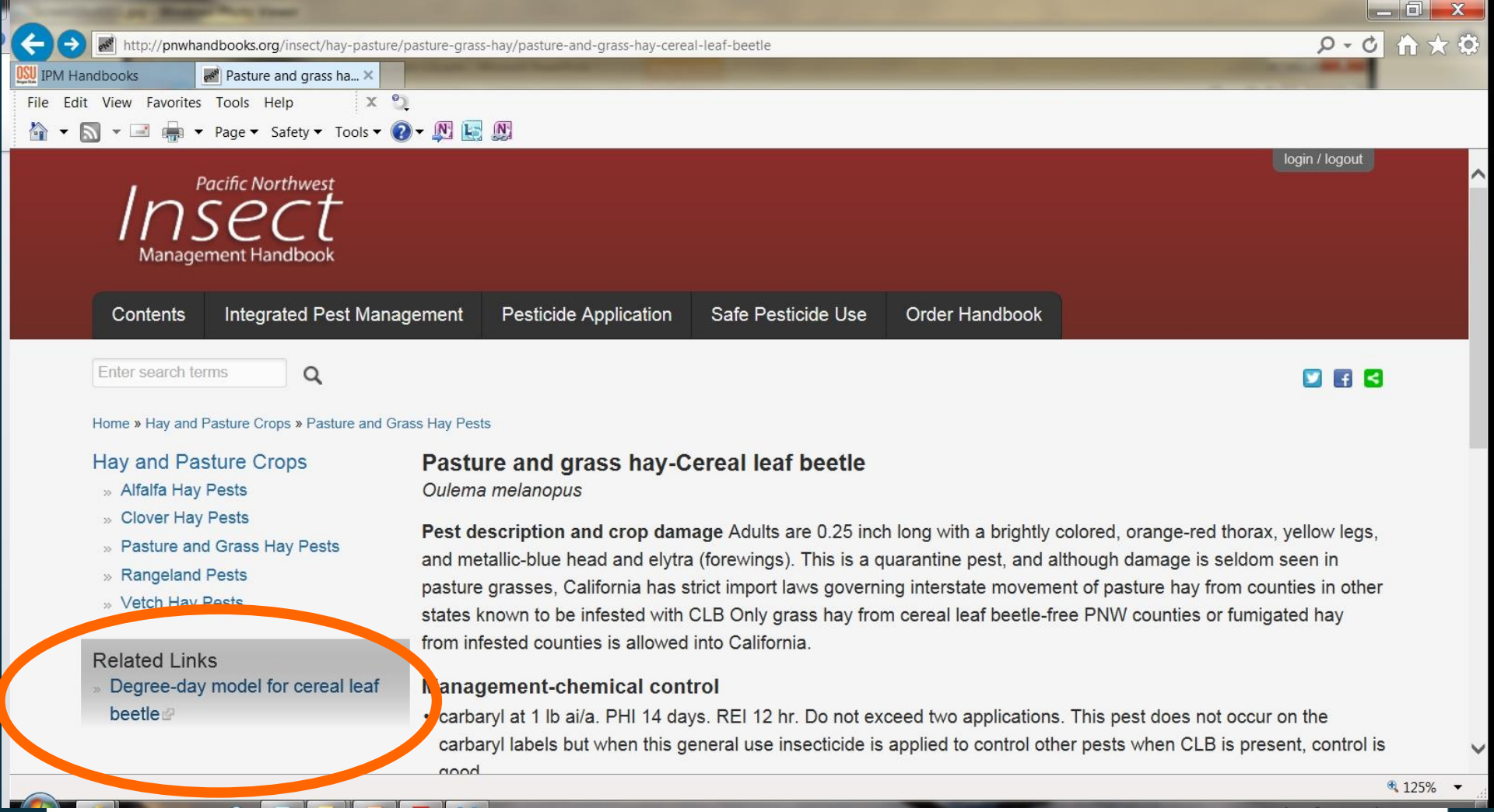
3rd and 4th Instar Larvae

Photo: Darrin L. Walenta



T. julis preparing to parasitize CLB larvae in spring wheat.
Photo: Darrin L. Walenta



http://www.ipmnet.org/IPM_Handbooks.htm

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http://uspest.org/cgi-bin/ddmodel.us?sta=KLMT&mdt=all&spp=clb&cel=1&cal=S1&tlow=48&thi=100&stm=1&std=1&styr=13&enm=9&end=1&spyr=0&

IPM Handbooks | Small grain-Cereal leaf... | Phenology Models f...

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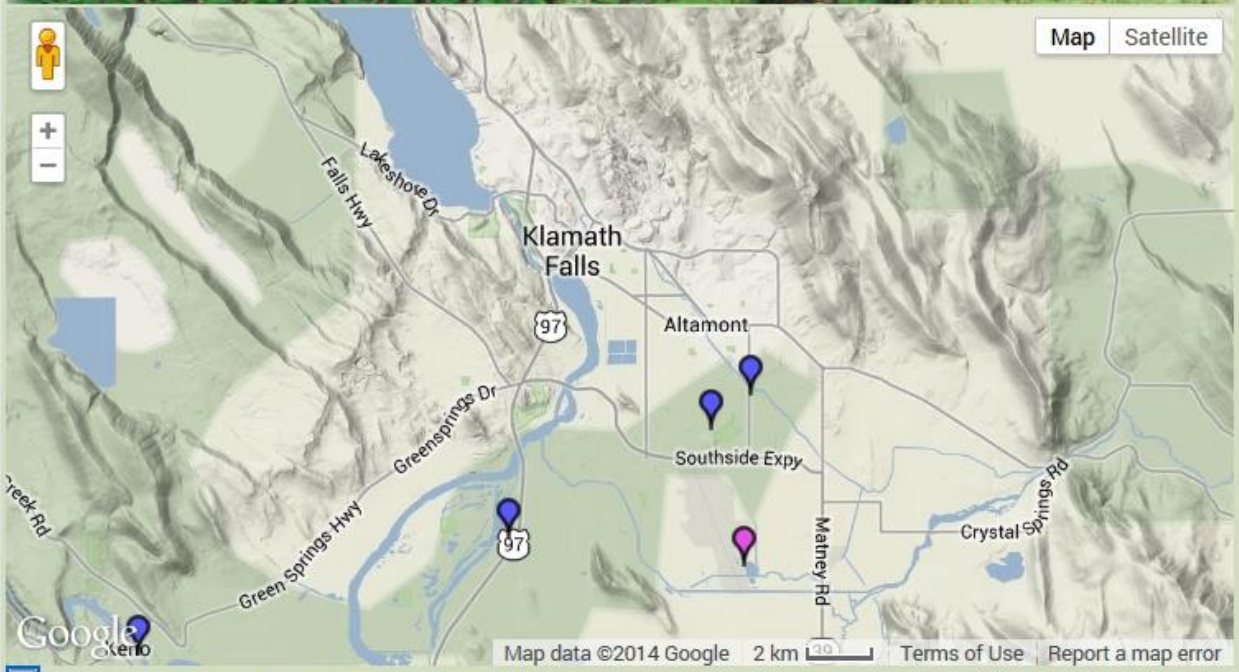
Online Phenology and Degree-day Models

for agricultural and pest management decision making in the US



Klamath Fls Int Apt OR Station: KLMT METAR elev: 4091 ft Lat/Long: 42.1467 -121.7242 **Select location by clicking on pin in Google Map above**

cereal leaf beetle [grasses]
Fulton etal 1975 OSU, OSU synth.

Model category: all models **Select model:** (see list) cereal leaf beetle [grasses] Fulton etal 1975 OSU (model params)

°Celsius: ☐ **Start:** Jan 1 2013 **End:** Sep 1 same yr

```
==============================MODEL INPUTS================================
Model species/general links:        cereal leaf beetle [grasses]
Type:                               insect
Model source/other links:           Fulton etal 1975 OSU, OSU synth.
Calculation method:                 single sine
Lower threshold:                    48 degrees Fahrenheit
Upper threshold:                    100 degrees Fahrenheit
Directions for starting/BIOFIX:     Calendar date
No starting/BIOFIX date, set to:    default date  1 1
Ending date:                        12 1
Model validation status:            requires local validation
Region of known use:                used in USA
==============================EVENTS TABLE================================
 1.   90 DDs after Jan 1: OW gen. ca. 1st adult emerge
 2.  144 DDs after Jan 1: 1st egg laying
 3.  270 DDs after Jan 1: 50%/peak egg laying
 4.  297 DDs after Jan 1: 1st egg hatch
 5.  324 DDs after Jan 1: early/10% larvae
 6.  432 DDs after Jan 1: 50%/peak egg hatch
 7.  612 DDs after Jan 1: 90% egg laying
 8.  648 DDs after Jan 1: peak larvae
 9.  756 DDs after Jan 1: end (90%) egg hatch
10.  900 DDs after Jan 1: 90% larvae/end larvae
11.  936 DDs after Jan 1: end OW adults
12.  990 DDs after Jan 1: 1st summer adult emerge
13. 1314 DDs after Jan 1: 50% summer adult emerge
14. 1530 DDs after Jan 1: 90% summer adult emerge

==============================MODEL OUTPUT================================
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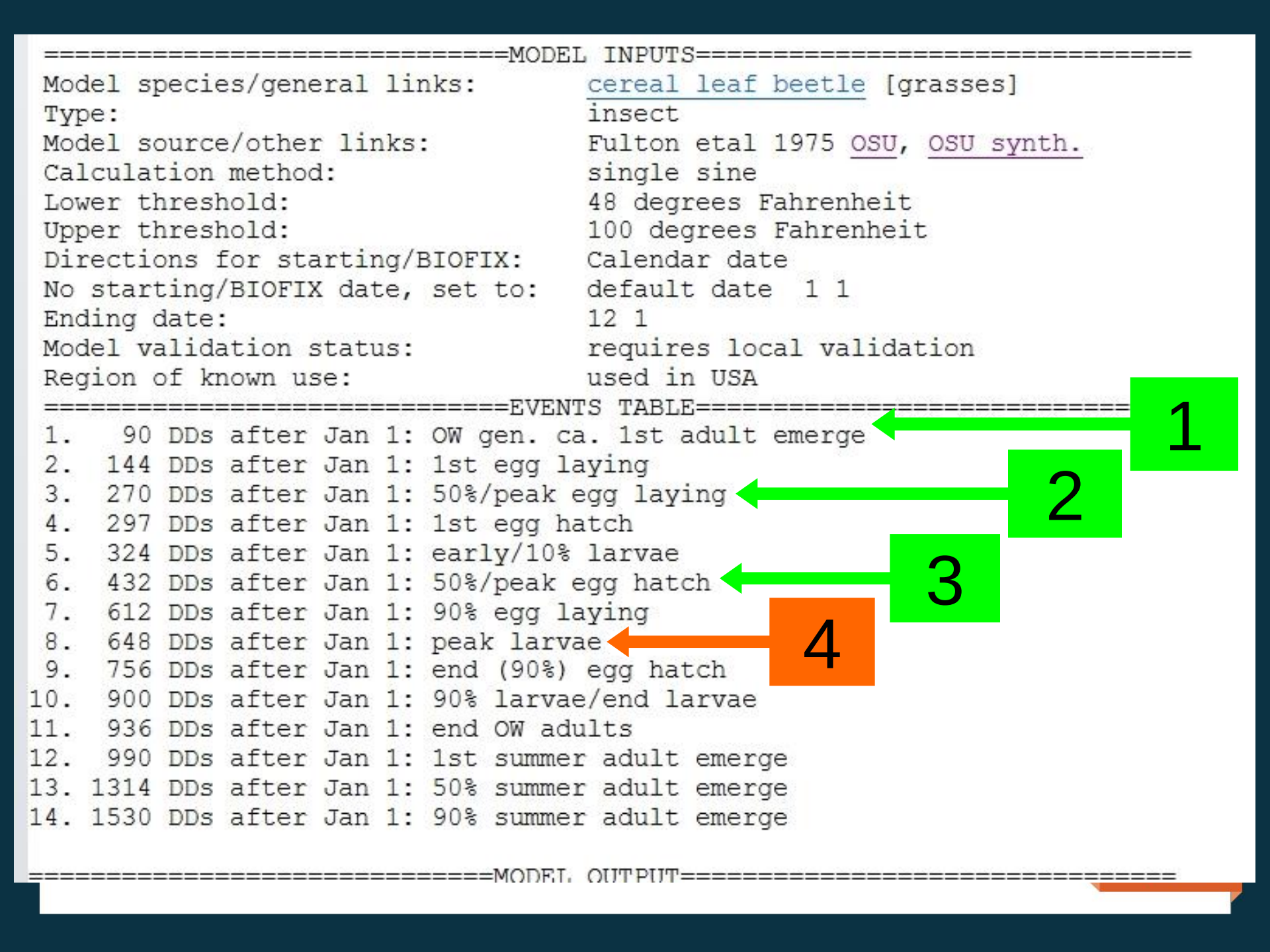

7. 612 DDs after Jan 1: 90% egg laying
8. 648 DDs after Jan 1: peak larvae
9. 756 DDs after Jan 1: end (90%) egg hatch
10. 900 DDs after Jan 1: 90% larvae/end larvae
11. 936 DDs after Jan 1: end OW adults
12. 990 DDs after Jan 1: 1st summer adult emerge
13. 1314 DDs after Jan 1: 50% summer adult emerge
14. 1530 DDs after Jan 1: 90% summer adult emerge

==========MODEL OUTPUT==========

Weather station: 2013 KLMT METAR Klamath Fls Int Apt OR Lat:42.1467 Long:-121.7242 Elev:4091

mn	day	max	min	precip	DD48	CUMDD48	event
1	1	28.04	3.02	0.00	0.00	0.0	* START *
1	2	24.98	-0.04	0.00	0.00	0.0	
1	3	28.94	-0.94	0.00	0.00	0.0	
1	4	28.94	5.00	0.00	0.00	0.0	
1	5	28.40	12.92	0.09	0.00	0.0	
1	6	32.00	24.98	0.01	0.00	0.0	
1	7	35.96	26.06	0.01	0.00	0.0	
1	8	39.92	24.08	0.00	0.00	0.0	
1	9	39.92	17.06	0.03	0.00	0.0	
1	10	30.02	5.00	0.01	0.00	0.0	
1	11	28.04	1.04	0.02	0.00	0.0	
1	12	37.04	-5.08	0.00	0.00	0.0	
1	13	41.00	-4.00	0.00	0.00	0.0	
1	14	21.02	1.00	0.00	0.00	0.0	
1	15	28.04	3.00	0.00	0.00	0.0	
1	16	32.00	1.04	0.00	0.00	0.0	
1	17	33.98	1.04	0.00	0.00	0.0	
1	18	35.06	1.04	0.00	0.00	0.0	
1	19	33.98	-2.02	0.00	0.00	0.0	
1	20	35.06	-0.94	0.00	0.00	0.0	
1	21	35.06	-0.94	0.00	0.00	0.0	
1	22	33.98	3.92	0.00	0.00	0.0	

4	7	48.02	32.00	0.16	0.00	86.0	
4	8	48.02	28.04	0.00	0.00	86.0	
4	9	57.92	21.92	0.00	2.28	88.3	
4	10	62.96	30.02	0.00	4.51	92.8	OW gen. ca. 1st adult emerge
4	11	57.92	24.08	0.00	2.35	95.2	
4	12	64.94	24.98	0.00	4.91	100.1	
4	13	48.92	26.96	0.00	0.08	100.2	
4	14	44.96	19.04	0.05	0.00	100.2	
4	15	44.06	28.04	0.01	0.00	100.2	
4	16	44.96	26.06	0.01	0.00	100.2	
4	17	51.98	21.02	0.00	0.61	100.8	
4	18	62.06	24.98	0.00	3.83	104.6	
4	19	57.92	33.98	0.00	2.84	107.5	
4	20	62.96	21.92	0.00	3.99	111.5	
4	21	64.94	24.98	0.00	4.91	116.4	
4	22	59.00	26.60	0.00	2.82	119.2	
4	23	66.02	30.92	0.00	5.82	125.0	
4	24	66.92	30.02	0.00	6.11	131.1	
4	25	73.94	24.98	0.00	8.54	139.7	
4	26	75.92	30.92	0.00	10.08	149.7	1st egg laying
4	27	75.92	33.08	0.00	10.38	160.1	
4	28	69.08	33.98	0.00	7.46	167.6	
4	29	60.98	33.08	0.00	3.97	171.6	
4	30	59.00	26.06	0.00	2.80	174.4	
5	1	66.02	28.94	0.00	5.64	180.0	
5	2	73.94	33.08	0.00	9.50	189.5	
5	3	77.00	32.00	0.00	10.71	200.2	
5	4	69.08	44.96	0.00	9.48	209.7	
5	5	71.96	44.06	0.00	10.65	220.3	
5	6	73.04	37.04	0.10	9.69	230.0	
5	7	64.94	44.60	0.05	7.37	237.4	
5	8	68.00	37.94	0.14	7.53	244.9	
5	9	75.02	37.04	0.00	10.61	255.6	
5	10	80.96	42.08	0.00	14.52	270.1	50%/peak egg laying
5	11	82.94	46.04	0.00	16.68	286.7	
5	12	82.94	46.04	0.00	16.68	303.4	1st egg hatch
5	13	77.00	41.00	0.00	12.34	315.8	
5	14	73.94	33.80	0.00	9.60	325.4	early/10% larvae
5	15	69.08	39.02	0.00	8.20	333.6	
5	16	60.08	41.00	0.16	4.41	338.0	
5	17	62.06	35.06	0.01	4.58	342.6	
5	18	62.06	30.02	0.00	4.16	346.7	
5	19	66.02	26.96	0.00	5.48	352.2	
5	20	71.96	35.06	0.00	8.89	361.1	
5	21	57.02	28.94	0.01	2.25	363.3	

cereal leaf beetle model - Fulton et al 1975 OSU
Location: 2013 KLMT Klamath Fls Int

Date	DDs	Event
4-10-13	93	OW gen. ca. 1st adult emerge
4-26-13	150	1st egg laying
5-10-13	270	50%/peak egg laying
5-12-13	303	1st egg hatch
5-14-13	325	early/10% larvae
6-2-13	436	50%/peak egg hatch
6-14-13	619	90% egg laying
6-17-13	659	peak larvae
6-28-13	774	end (90%) egg hatch
7-3-13	915	90% larvae/end larvae
7-4-13	938	end OW adults
7-7-13	999	1st summer adult emerge
7-22-13	1321	50% summer adult emerge
8-2-13	1539	90% summer adult emerge

cereal leaf beetle model - Fulton et al 1975 OSU
Location: 2013 IMBO IMBLER OR n

Date	DDs	Event
4-4-13	92	OW gen. ca. 1st adult emerge
4-27-13	151	1st egg laying
5-10-13	277	50%/peak egg laying
5-11-13	298	1st egg hatch
5-13-13	330	early/10% larvae
6-1-13	437	50%/peak egg hatch
6-15-13	613	90% egg laying
6-17-13	652	peak larvae
6-28-13	777	end (90%) egg hatch
7-3-13	921	90% larvae/end larvae
7-4-13	939	end OW adults
7-7-13	992	1st summer adult emerge
7-22-13	1318	50% summer adult emerge
8-1-13	1538	90% summer adult emerge

Closing Comments

CLB IPM has proven very effective in established areas

- Occasional “hot-spots” do occur
- Since 2007, less than 700 acres in NE OR have needed CLB control (refuge!)

Monitor CLB populations levels then consider……

- Does it meet/exceed the economic threshold level?
- What percentage of the population are eggs?
- Do small larvae make up the majority of the population?
- Are the CLB larva parasitized? If so, at what level?

CLB larva samples can be tested by contacting:

Richard Hilton OSU-SOARC (541-772-5165)

If control necessary, leave untreated area within field to serve as refuge for ***T. julis***

OR Cereal Leaf Beetle Bio-Control Program Contacts:

Oregon Department of Agriculture, Plant Division
635 Capitol Street NE
Salem, Oregon 97301-2532
Barry Bai Office: 503-986-4645 Email: bbai@oda.state.or.us

Dr. Helmuth W. Rogg, Oregon Department of Agriculture, IPPM Program Manager
635 Capitol Street NE
Salem, OR 97301-2532
Helmuth Rogg Tel.: 503-986-4662 (of.) Cell: 503-881-7359 Email: hrogg@oda.state.or.us
Richard Worth Tel.: 503-986-6461 Cell: 503-871-7108 Email: rworth@oda.state.or.us

Gary Brown – USDA-APHIS, PPQ
6135 NE 80th Ave., Ste. A-5
Portland, OR 97218
office: 503-326-2814 x239 cell: 503-730-7608 Email: gary.w.brown@aphis.usda.gov

Darrin L. Walenta – OSU Extension Service Union Co.
10507 North McAlister Road
LaGrande, OR
Office: 541-963-1010 Email: darrin.walenta@oregonstate.edu

Oregon State University

Any Questions? Thanks!