Moth Mania 2

Select lepidopteran pests in red raspberry and blueberry

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Problem Background

- OBLR can cause both direct damage to blueberries.
- Increasing grower reports of OBLR contaminants 2017 - 2019.
- Reports of difficulty or inability to control leafrollers 2019.

Leafrollers and Fruitworms Export Concern

- Quarantine pests for S. Korea
- EU is changing quidelines on fruitworm with possible further restrictions.

Leafrollers and Other Direct Pests and Harvest Contaminants of Red Raspberry and Blueberry

Tortricidae

Orange Tortrix (*Argyrotaenia franciscana*) – caneberries, blueberry

Obliquebanded Leafroller (*Choristoneura rosaceana*) - caneberries, blueberry

Cherry Fruitworm (*Grapholita packardi*) - blueberry

Noctuidae

Spotted Cutworm (*Xestia c-nigrum*) – caneberries (occasionally blueberry)

Winter cutworm (*Noctua pronuba*) – caneberries (occasionally blueberry)

Primary Leafrollers
Skagit and Whatcom Counties

Obliquebanded Leafroller

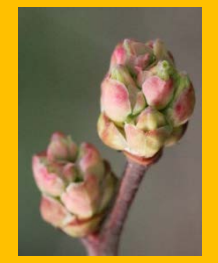
Choristoneura rosaceana

Orange Tortrix

Argyrotaenia franciscana

Leafroller Life Cycle

Eggs hatch and larvae overwinter in cracks, crevices and debris.



Overwintering larvae emerge & feed on buds and new leaves.

Fall & Winter

Spring & Summer

Larvae pupate in the leaves and adults emerge ~late April – May

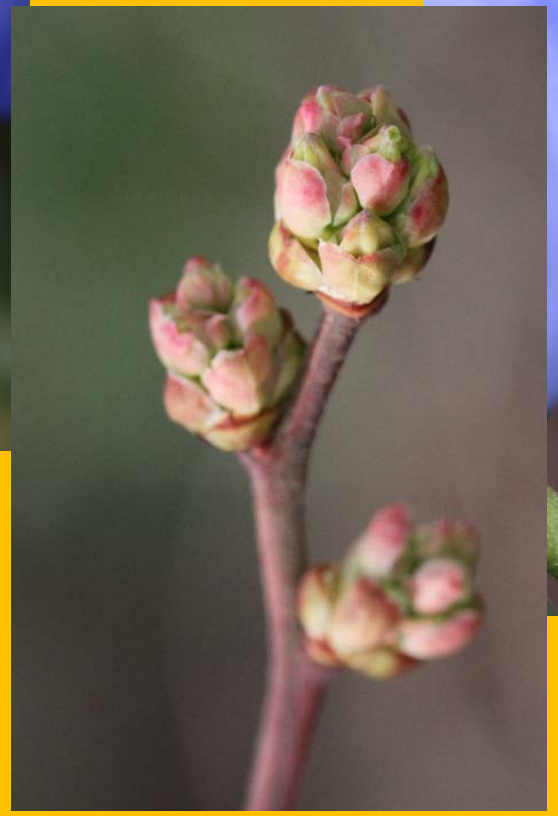
Adults lay overlapping greenish eggs on upper surface of leaves.

Summer generation pupates and lays eggs.

Summer generation can directly damage berries and are harvest contaminants.

Tortricid Damage to Blueberries

Monitoring – visual damage
Use OT and OBLR pheromone traps



Scout for worms at bud break
~Mid-March 'Duke'

Tortricid Harvest Contaminants

Leafrollers in Red Raspberry

Most larvae emerged 2-3 weeks after first bud swell

April

Prebloom spray protects pollinators.

OT and OBLR in raspberry

- Direct berry damage possible
- Harvest contaminant

Monitor new growth for web nests

Utilize pheromone traps

Leafroller Management

OBLR

OT

Eggs and Larvae

Treated with IGR (e.g. Confirm, Esteem, Intrepid) *check registrations and MRLs*

Affect larvae feeding on eggshells

Larvae

Spinosad shows similar results to pre-bloom OP

Bt - ~3 applications in a very specific window.

Daily max temps above 60 - 65F

Newer reduced risk insecticides show good efficacy against larvae (e.g. Delegate, Altacor) *check registrations and MRLs*

Obliquebanded Leafroller Insecticide Resistance Potential

Ops- azinphos-methyl, chlorpyrifos

Pyrethroids – cypermethrin, deltamethrin, esfenvalerate

indoxacarb, IGRs - methoxyfenozide, tebufenozide, phosalone

INSECTICIDE RESISTANCE AND RESISTANCE MANAGEMENT

Susceptibility of *Choristoneura rosaceana* (Lepidoptera: Tortricidae) to Two New Reduced-Risk Insecticides

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J. Econ. Entomol. 103(1): 140-146 (...

ABSTRACT The response of field-collected p... *neura rosaceana* (Harris) (Lepidoptera: Tort... and azinphosmethyl was assessed using a ... obliquebanded leafroller were collected from nine ... counties of Washington. The neonates of t... parameters of probit regression lines were est... ured for all populations compared with a sus... was detected in response to all four insecticid... hich had never been used in the field. lethal ... oyl, 0.5–3.6 for spinosad, 1.2–5.3 for chlorant... analysis indicated possibility of cross-res... both members of spinosyn class. The occur... chlorantraniliprole and spinetoram in field-... field application indicates that the risk of ... insecticides exist. However, it is likely that ... insecticides are used judiciously in conjunction ... plications of these results for developing and im... are discussed.

... roller, field-collected populations, chlorantraniliprole, spineto-

... leafroller, *Choristoneura rosa-* ... is), is a tortricid moth native to North A... a (Weires and Riedl 1991). It is a major pest of pome fruits, second only to codling moth, *Cydia pomonella* (L.), in Washington (Brunner 1999). In apple, obliquebanded leafroller larvae feed on flower buds, leaves, and developing fruits (Howitt 1993, Ohlendorf 1999). Fruit damage from larval feeding can occur in the spring, during midsummer (the most significant), or just before harvest (Beers et al. 1993). Leafrollers, and the key apple pest, *C. pomonella* (L.), have been controlled using the organophosphate (OP) insecticides for over four decades. However, reports of decreasing efficacy of OP insecticides against leafrollers have been attributed to the development of insecticide resistance (Brunner 1996). Insecticide resistance to OPs and cross-resistance to other groups of chemicals have been documented in obliquebanded leafroller (Beissig et al. 1986, Lawson et al. 1997, Waldstein et al. 1999, Ahmad et al. 2002, Smirle et al. 2002, Dunley et al. 2006), in some cases even before the new insecticides had been used in the field (Sauphanor et al. 1998, Dunley and Welter 2000). In addition, the implementation of Food Quality Protection Act of 1996 (FQPA) (U.S. Environmental Protection Agency [USEPA] 1996) has increased restrictions on the use of broad-spectrum insecticides, especially the OPs.

The development of insecticide resistance as well as regulatory actions such as FQPA have led to a greater priority in the development of reduced-risk insecticides as OP alternatives (USEPA 1997). Chlorantraniliprole and spinetoram are the reduced-risk insecticides recently registered as OP alternatives. Chlorantraniliprole is an anthranilic diamide, which belongs to insecticide resistance action committee (IRAC) mode of action class 28 (Insecticide Resistance Action Committee [IRAC] 2009). Anthranilic diamides selectively bind to the ryanodine receptors (RyR) in insect muscles resulting in an uncontrolled release of calcium from internal stores in the sarcoplasmic reticulum (Lahm et al. 2005, Cordova et al. 2006), causing impaired regulation of muscle contraction leading to feeding cessation, lethargy, paralysis, and death of target organisms. Anthranilic diamides have very low vertebrate toxicity because of a >500-

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Occurrence of significant levels of resistance against chlorantraniliprole and spinetoram in field-collected *C. rosaceana* before their first field application.

Journal of Insect Science | www.insectscience.org ISSN: 1536-2442

Resistance and cross-resistance in populations of the leafrollers, *Choristoneura rosaceana* and *Pandemis pyrusana*, in Washington apples

John E. Dunley, Jay F. Brunner, Michael D. Doerr and E. H...

Washington State University, Tree Fruit Research and Extension Center, ... Wenatchee, WA 98801

Abstract

Insecticide bioassays of the leafrollers, *Choristone... emis pyrusana* Kearfott (Lepidoptera: Tortricidae), were use... -resistance between azinphosmethyl and other insecticides. C... ations with susceptible laboratory colonies of both leafroll... rior to registration and field introduction of several of inse... 5–2001 following several years of use in the field. Insecticides te... os, methyl parathion, tebufenozide, methoxyfenozide, s... uringiensis, and azadirachtin. Azinphosmeth... comparison to field populations. Resistance to azinp... (5.2–26.8 fold) and *P. pyrusana* (8.4–24.9 fold)... e between azinphosmethyl and the insect growth ... and in all but one population of the two leafroller ... pyrifos. Some of the populations tested were cross-resistant ... nses to these materials were more variable.

...phosphate, insect growth regulator, benzoylhydrazine

...stration ratio, LC_{50}, Lethal concentration (50% of the population)

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Journal of Insect Science: Vol. 2006 | Article 14 1

Cross resistance between azinphosmethyl and IGR's tebufenozide and methoxyfenozide were found in populations.

Research Article

SCI

(wileyonlinelibrary.com) DOI 10.1002/ps.2294

Selection for resistance, reversion towards susceptibility and synergism of chlorantraniliprole and spinetoram in obliquebanded leafroller, *Choristoneura rosaceana* (Lepidoptera: Tortricidae)

Ashfaq A Sial* and Jay F Brunner

Abstract

BACKGROUND: Obliquebanded leafroller, *Choristoneura rosaceana* (Harris), is ... America. Repeated applications of broad-spectrum insecticides have resu... and multiple resistance in this pest. Studies were conducted to dete... resistance and the effect of metabolic synergists on toxicity of new ... in *C. rosaceana*.

RESULTS: Larvae of *C. rosaceana* were selected for resist... levels of resistance to each insecticide were obser... susceptibility of a subset of larvae from both ch... levels after five and six generations respec... unstable in *C. rosaceana*. In synergist bio... (DEF) and piperonyl butoxide (PBO)... the involvement of esterases in ... resistance.

CONCLUSION: These f... management pro... could be incorporated into *C. rosaceana* resistance

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Keywords: ...oxypyr; spinetoram; resistance; selection; reversion; synergism

1 INTRO...

Obliquebanded ... *rosaceana* (Harris) (Lepidoptera: Tort... phagous insect with a broad host range including ... of Rosaceae and Cornaceae.[1] It is native to North America ... and is an economic pest of deciduous tree fruits throughout major tree-fruit-growing regions in the United States and Canada.[2–4] Broad-spectrum insecticides such as organophosphates (OPs) have been widely used to control major pests of tree fruits, including *C. rosaceana*. The reliance on repeated applications of conventional neurotoxic insecticides has resulted in the development of resistance to these insecticides and cross-resistance to other insecticides in *C. rosaceana*,[5–15] and in some cases to new classes of insecticides prior to them being applied in the field.[13–17]

The occurrence of resistance, cross-resistance and multiole resistance in *C.rosaceana* necessitates the introduction of resistance management strategies in order to ensure adequate control and conserve chemical control options,[18,19] which are scarce resources indeed. Additionally, the implementation of the Food Quality Protection Act of 1996 has placed restrictions on the use of conventional broad-spectrum insecticides and expedited the registration of reduced-risk insecticides.[20] Chlorantraniliprole and spinetoram are two of the reduced-risk insecticides recently registered for use in tree fruit production. Chlorantraniliprole [Rynaxypyr™] is a member of a new class of insecticides, the anthranilic diamides, which selectively bind to the ryanodine receptors in insect muscles, resulting in an uncontrolled release of internal calcium stores from the sarcoplasmic reticulum, causing impaired regulation of muscle contraction leading to feeding cessation, lethargy, paralysis and death of the target insect.[21,22] Spinetoram is a recently developed spinosyn that primarily

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462

Pest Manag Sci 2012; 68: 462–468 www.soci.org © 2011 Society of Chemical Industry

Significant levels of resistance developed after 12 generations but after 5-6 generations without selection pressure, pretreatment levels returned.

Requesting funding in 2020 to mass rear OBLR and perform Resistance Bioassays

2019 OBLR Mating Disruption Field Trial in Blueberry

Pheromones twist-tied to blueberry branches.

Treatment

- Lures – 200/acre for 26 acres
- Traps – perimeter and interior
- 2 Controls

ISOMATE® OBLR/PLR PLUS

A MATING DISRUPTION FORMULATION FOR OBLIQUEBANDED LEAFROLLER (*Choristoneura rosaceana*), PANDEMIS LEAFROLLER (*Pandemis pyrusana*)

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OBLR Mating Disruption in Blueberry - Evaluation

Visual Observations

- Count leafrolls
- leaf feeding damage
- Egg masses
- Pupae/pupal cases

Pheromone Traps

- Treated - 10 interior, 10 perimeter
- UTC - 5 interior, 5 perimeter

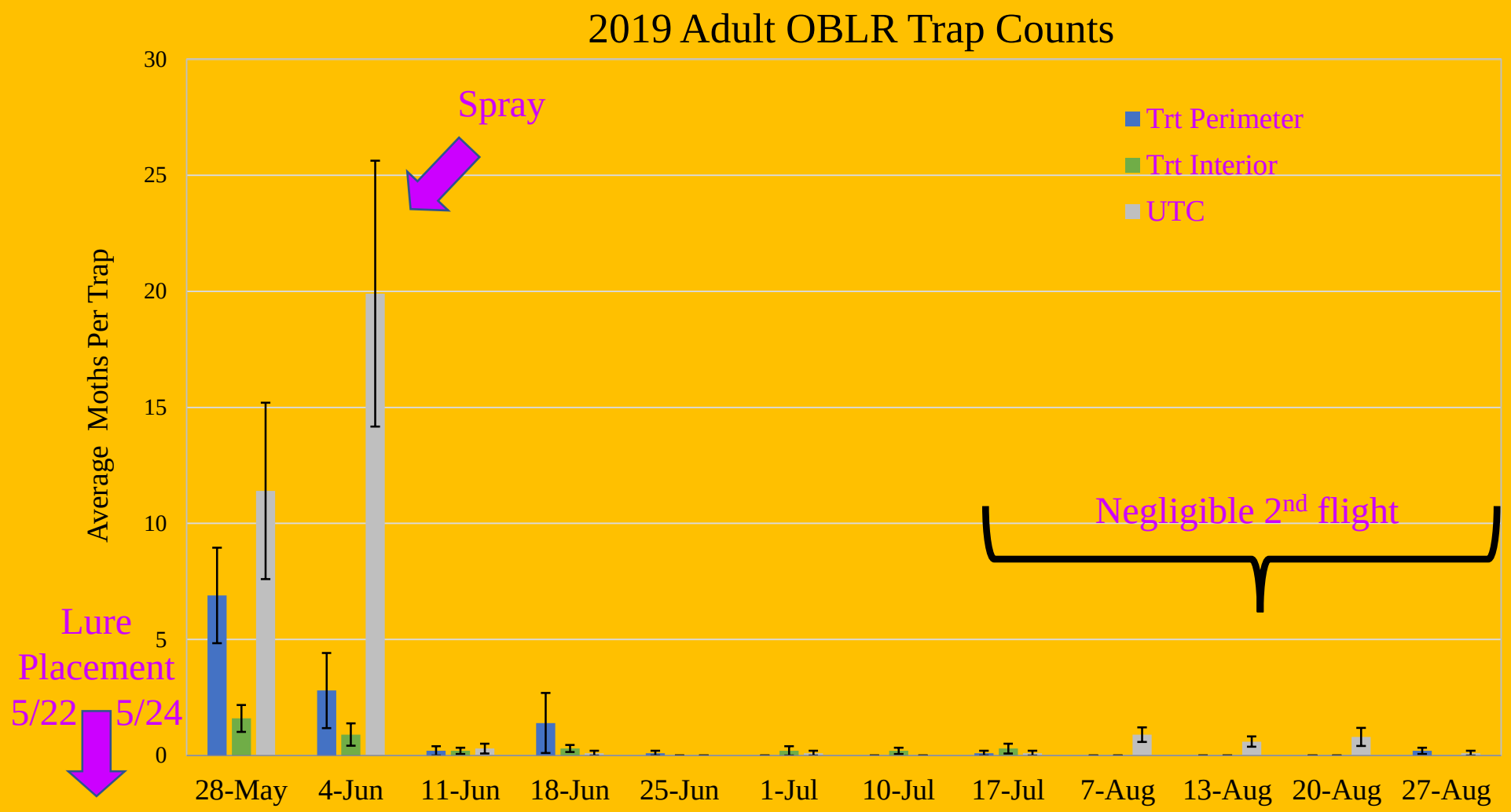
Virgin Moths

- Set out virgin moths reared from field-collected pupae.
- Collect moths 3 days later and dissect for presence of spermatophore in females.

Harvest

- Ride the harvester
- Observe worms/pupae/webbed berries on the belt

OBLR Mating Disruption in Blueberry - Results



Summary - 2019
Mating Disruption

- Achieved trap shut down in the interior traps.
- Moths in the perimeter traps were higher (statistically significant) than interior.
- No worms found in treated field or on harvester following lure application unlike UTC
- Second generation flight negligible.

OBLR Mating Disruption - PROS

1. Compatible with beneficials
2. One-time application, Season-long treatment (200/acre)
3. Could add an additional IPM tactic for managing OBLR
4. No Resistance
5. Acceptable management tool for leafrollers in other crops

Mating Disruption – CONS

1. Hand applied
2. Costly?
3. Supplemental - not stand-alone management tool
4. OBLR strong flier
5. OBLR – high fecundity

OBLR Mating Disruption Future Direction

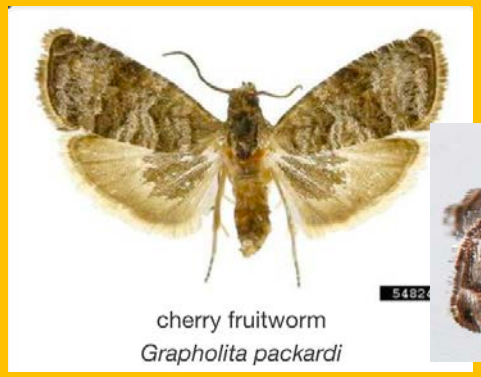
1. Pacific Biocontrol has provided prototype puffers at rate 1/acre
2. Straight chain pheromones are EUP exempt up to 250 acres.
3. Release pheromone puffs at 15 minute intervals 5pm - 4am.

Mating Disruption – Questions

1. Puffers - not a machine harvest concern in tree fruit.
2. Require removal prior to harvesting and replaced afterwards?
3. With industry commitment, prototypes anticipated for trial in 2021.

Cherry Fruitworm Life Cycle – only pest of Blueberry

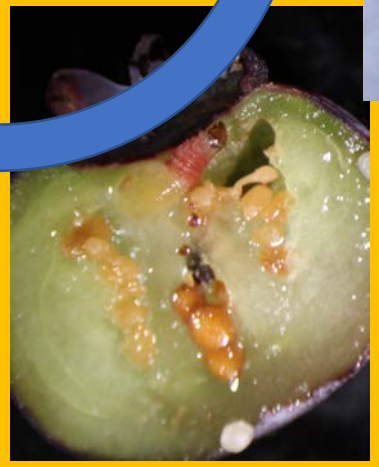
Single eggs laid in/near calyx.
Mid-May to early June
Bc Ministry of Ag



Pupation – following May. Adults emerge late May - early June. Peak mid-June. Remain until mid-late July

Single CFW generation in blueberry

Young larvae
white with black head
bore into fruit – 3 weeks



Mid – late July – mature larvae exit hole and search for overwintering site.

Overwinter on host bushes. In cherry bore into pruning stubs and plug entrance with silk.

Mature larvae - pink with brown head

Cherry Fruitworm Damage

Premature ripening

Berries fill with frass – doesn't web berries unlike cranberry fruitwworm

Larvae travel between touching berries

Managing and Monitoring Cherry Fruitworm

Weedy, un-kept fields – prone to CFW

Search for CFW larvae at petal fall

Use - False codling moth, *Thaumatotibia leucotreta* lures not CFW lures.

In BC – sprays recommended around June 10.

Cranberry Fruitworm – so far only damage to cranberries in BC

Cutworms

Xestia c-nigrum

Noctuidae

Xestia c-nigrum – Spotted cutworm

Noctua pronuba – Winter cutworm

Primarily – harvest contaminant

Reports for red raspberry only

Noctua pronuba

Cutworm damage

Look for Foliar feeding damage low to ground

Spotted Cutworm - *Xestia c-nigrum*

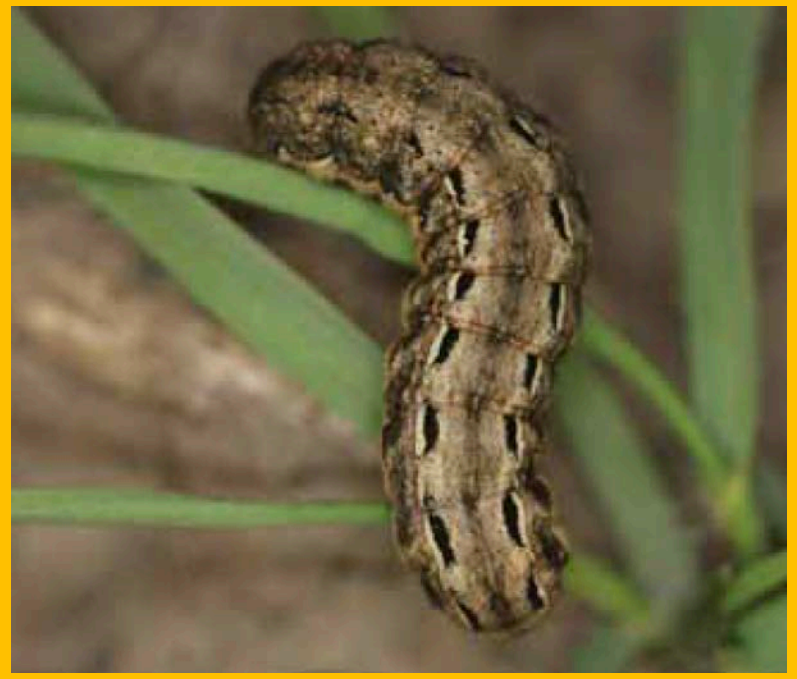
Cutworms – greater problem in fields with sod or mulch than clean culture

Overwinter – eggs, larvae*, pupae, adults

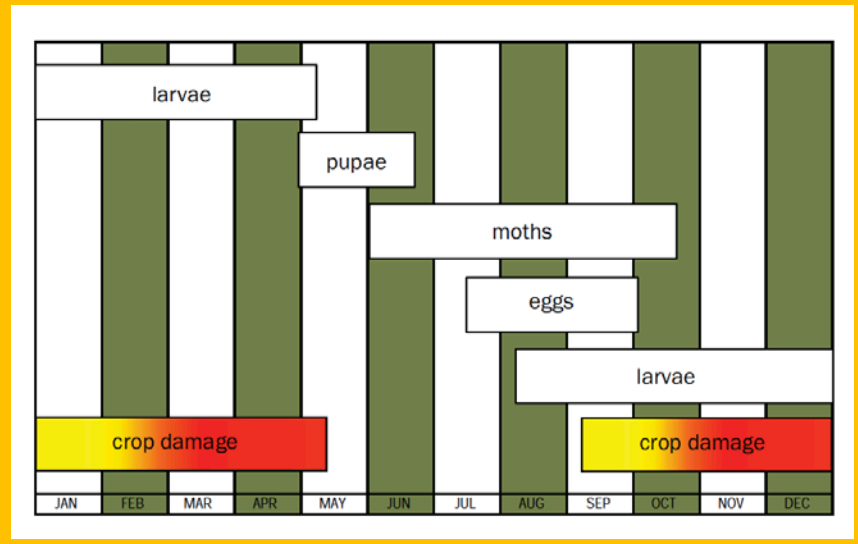
* Most destructive – feed and damage buds

© Dick Wilson

Winter cutworm – *Noctua pronuba*



Dashed black lines on dorsum



Red and yellow
peak larval damage

U. Idaho - extension

Possess bright yellow underwings

Larvae actively feed during winter months – can damage spring buds

Thank You

This work is/was supported by the USDA National Institute of Food and Agriculture Project WNP00543
Washington Blueberry Commission
Washington State Commission on Pesticide Registration
Don Thomson and Pacific Biocontrol

Application of a pesticide to a crop or site that is not on the label is a violation of pesticide law and may subject the applicator to civil penalties up to $ 7,500. In addition, such an application may also result in illegal residues that could subject the crop to seizure or embargo action by WSDA and/or the U.S. Food and Drug Administration. It is your responsibility to check the label before using the product to ensure lawful use and obtain all necessary permits in advance.