Wheat Research Progress Report - Final

Project #: 4168-1202

Title: Establishing Cereal Leaf Beetle Biocontrols in Washington State

Researchers: Diana Roberts (WSU Extension, Spokane), Terry Miller (Northwest Biological Control Insectary/Quarantine [NWBIQ], Pullman), Keith Pike (WSU Entomology, Prosser), Steve Miller (USDA-APHIS, Spokane), **),** and Mike Klaus (WSDA).

Progress Report Year: 2008

Goal: *Establish a proactive, effective biocontrol program for cereal leaf beetle (Oulema melanopus) in Washington State.*

1999

Cereal leaf beetle was first found in Washington state in a routine survey in the Spokane Valley in June 1999 (Mike Klaus, WSDA). In response to a subsequent newsrelease by WSU Extension, Kit Cutler reported CLB on his irrigated farm at Nine Mile Falls. He had seen CLB in his fields at low levels the previous season but in 1999 they were obvious in the field.

A group of scientists representing several agencies and states met in Spokane to discuss the new findings and plan for CLB management.

2000 – 2002

More details on this period of the project are in the document *Washington State CLB Activity Report 2002.*

In 2000, Mark Hitchcox (WSDA) initiated release of the parasitoid wasp, *Tetrastichus julis*, at the Kit and Rob Cutler Farm at Nine Mile Falls. The parasitized CLB larvae were imported from Montana and Pennsylvania, and were processed through the Northwest Biological Control Insectary and Quarantine (NWBIQ) at Pullman where they were transferred to locally grown wheat leaves to ensure they were not importing other pests and diseases.

Hitchcox made the first releases in mesh tents at the edge of grain fields. He made subsequent releases along the perimeter of open fields. In 2002, Kit Cutler established a managed insectary (see document *WA CLB Insectary Management Plan*) on a 5-acre plot with 2 replications. The first overwintering *T. julis* was recovered only following the establishment of this managed insectary

2003

Diana Roberts (WSU Extension) assumed coordination of the Washington state CLB project after Mark Hitchcox left the WSDA. Mike Gould, a WSU entomology graduate student, continued the survey and release work.

The first overwintering *T. julis* was recorded at the Nine Mile Falls insectary – 1 out of 130 larvae collected in mid-June was parasitized. Release of *T. julis* (as parasitized CLB larvae) continued at Nine Mile Falls (Spokane County) and at insectaries established in the spring of 2003 at Peone Prairie (Spokane County; Wally Knapp) and Colville (Stevens County; Richard, Rick and Gary Seitters).

These 3 insectaries were 5 acres each, also with 2 replications of the insectary design and with half the area in crop in any one season. The farmers were paid $500 per acre per year through funds from USDA-APHIS. See the document *CLB Insectary Gentleman's Agreement* for further details on management of the insectaries.

We also began release of the egg parasitoid, *Anaphes flavipes*, at these 3 insectaries. The parasitized CLB eggs were shipped overnight in coolers from the USDA lab in Niles, MI. The eggs arrived in Petri dishes, which we transferred to 1 pint milk cartons with mesh-covered holes in them so the emerging wasps could leave the carton. The cartons were attached (duct tape) to lath stakes within the crop canopy.

The recommendation of the Niles lab was to release the larval and egg parasitoids at separate insectaries so each species could establish without competition for the host. However, none of the farmer cooperators wanted to risk having a potential "dud" parasitoid in their area. As this was a cooperative project, we respected their wishes and decided to operate on a real life, survival of the fittest approach.

Another recommendation was to concentrate all our resources and the parasitoid releases at 2 field insectaries for the whole state. (This original recommendation meant we would have only one egg parasitoid insectary and one larval parasitoid insectary for the whole state). We decided that approach was too risky and all our efforts could be wasted if, for example, spray drift or some other event took out an insectary. We decided to locate as many insectaries as we could afford wherever there were a CLB hotspot. Our intention was to close down insectaries as the parasitoids decreased the CLB populations and to open up new ones in successive hotspots, in a type of leapfrog pattern.

2004

We won funding for the CLB Biocontrol Project from the Washington Wheat Commission through the Wheat Review process. Laurie Stone, who had just completed a BS in Entomology from WSU, worked as the project summer field technician. She collected CLB eggs and larvae early in the season for pre-release monitoring (by dissection and/or rearing) for overwintering of parasitoids. She continued the release of the egg and larval parasitoids at the previous 3 insectaries and at a new one at Deep Creek in Spokane County, managed by the Spokane Hutterian Brethren. From 2004 onwards the new insectaries were about 3 acres in size with 1 replication of the basic crop and fallow planting sequence. Farmer cooperators were still paid $500/acre/year.

Pre-release levels of larval parasitoids at field insectaries are presented in Table 1 and Figure 1. Percentage parasitism data were not available for the sites where the *T. julis* was reared out of the CLB larvae at the NWBIQ. We recovered the egg parasitoid (*A. flavipes)* overwintering at very low levels at Colville and Nine Mile Falls insectaries. One (1) *A. flavipes* adult was reared from eggs collected at each of these two sites. Laurie Stone also found a *T. julis* wasp (but no CLB) in a wheat field at Wilbur, WA – about 60 miles west of the Nine Mile Falls insectary!

Diana Roberts revived and facilitated a post season meeting of the Western CLB group of scientists at Spokane, WA. More about this group is in the document *The Western CLB Biological Control Group*.

2005

Lacey Jones and Kathlene Peck worked on the project as summer technicians. They continued the monitoring and release of parasitoids at the 4 established insectaries. We also made releases of both parasitoids at new insectaries at Warden (Grant County, Dennis Treat) and Connell (Franklin County, Jonathan Chase).

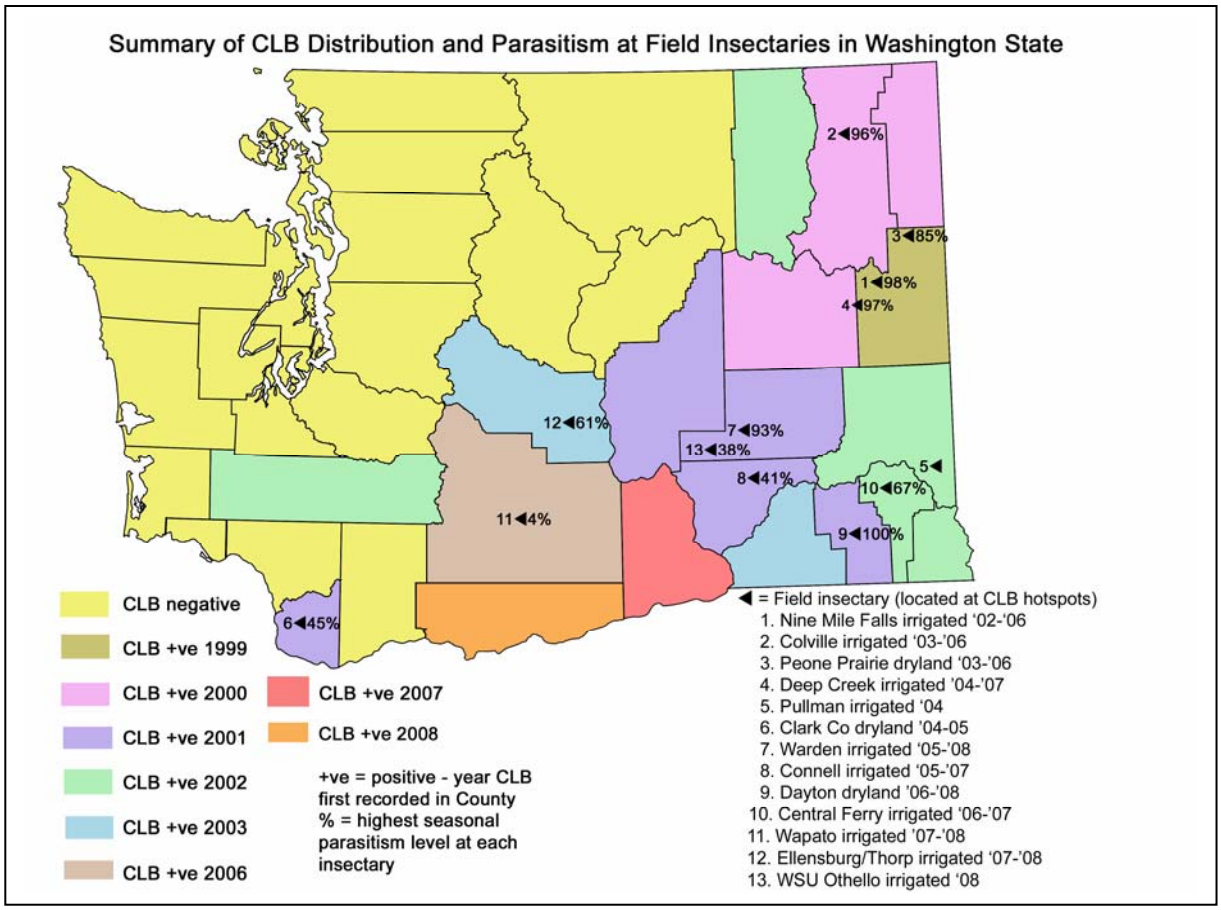
The *A. flavipes* colony had been moved from Niles, MI to a Colorado Department of Agriculture lab at Grand Junction. The cooperating states sent the Colorado lab live CLB adults for egg-laying production. The lab sent back parasitized CLB eggs on clipped oat leaves where they had been laid. We put these eggs out in the field in the milk cartons described earlier. See more details on this production process in the document *WA CLB Field and Laboratory Protocol*.

Table 1. *T. julis* parasitism levels in CLB larvae at Washington state field insectaries 2003 to 2008.

Field Insectary	Year	Collection dates	Total # CLB larvae collected	Average Parasitism (%)
1. NINE MILE FALLS (Irrigated) 2002-2006	2003		130	<1
	2004			No data
	2005	5/7 - 6/14	257	11
	2006 ¶	6/1 - 7/24	310	79
	2007 ¶‡	6/18 - 7/9	215	95
	2008 ¶‡	7/10	50	98
2. COLVILLE (Irrigated) 2003-2006	2005	6/16 - 6/28	370	10
	2006	6/7 - 7/13	270	87
	2007‡	5/23 - 7/19	291	96
3. PEONE PRAIRIE (Dryland) 2003-2006	2004			46 §
	2005	6/16 - 6/21	598	78
	2006	6/7 - 7/24	145	77
	2007 ‡	6/19	39	85
4. DEEP CREEK (Irrigated) 2004-2007	2005	6/14 - 6/28	810	47
	2006	6/23 - 7/28	214	86
	2007	6/18 - 7/23	231	97
5. Pullman (Irrigated) 2004	2004			No data
6. Clark County (Dryland) 2004-2005	2006‡	6/15	100	45
7.WARDEN (Irrigated) 2005-2008	2006	6/1 - 7/18 Ω	136	17
	2007	5/22 - 7/15	129	9
	2008	6/23 - 7/16 Ω	137	93
8. CONNELL (Irrigated) 2005-2007	2006	6/1 - 6/27 Ω	147	33
	2007	5/29 - 7/9	200	41
9. DAYTON (Dryland) 2006-2008	2007	5/24 - 7/18	329	83
	2008	6/27	50	100
10. WSU CENTRAL FERRY (Irrigated) 2006-2008	2006			67
	2007	6/4 - 6/14	99	54
	2008	5/20 - 6/12	230	31
11. WAPATO (Irrigated) 2007-2008	2008	5/21 - 7/8	334	4
12. ELLENSBURG & THORP (Irrigated) 2007-2008	2007	7/6 - 7/13 Ω	63	24 ¥
	2008	6/6 - 7/15 Ω	352	61 ¥
13. WSU Othello (Irrigated) 2008	2008	5/29 - 7/18 Ω	359	38

¶ 2006 collections were about 30 larvae per week, 2007 & 2008 collections were about 50 larvae per week thro'out season. ‡ Sampled in vicinity of discontinued insectaries. § Colors show significant differences between years within sites, 95% confidence level. Ω *T. julis* release began 6/9/06 at Warden, Connell; 6/15/07 at Ellensburg; 6/13/08 at Warden, Thorp and 6/16/08 at Wapato, WSU Othello. ¥ Data from Ellensburg insectary.

Figure 1. Summary of CLB distribution and parasitism (by the larval parasitoid *T. julis*) at field insectaries in Washington state, 1999 to 2008. Solid triangles indicate approximate locations of field insectaries and the highest level of seasonal parasitism recorded within them. Insectaries were discontinued as the larval parasitoid caused the CLB population within them to crash, and new insectaries were started at hotspots as the CLB moved across the state.



Recovery and parasitism levels of the larval parasitoid were excellent, and *T. julis* also showed up in commercial fields several miles beyond the insectaries (Figure 2). We had limited recovery of *A. flavipes* at 3 insectary locations. At the Nine Mile Falls insectary, 1 out of 503 CLB eggs examined under a microscope were parasitized, and at Deep Creek Insectary 3 out of 363 eggs were parasitized. From 2005 onwards we used only dissection of larvae and microscope examination of CLB eggs for this purpose. We did not use the rearing methods to determine parasitism recovery as they did not enable us to get percentage data. See the document *WA CLB Field and Laboratory Protocol* for details on checking CLB eggs for parasitism by *A. flavipes*.

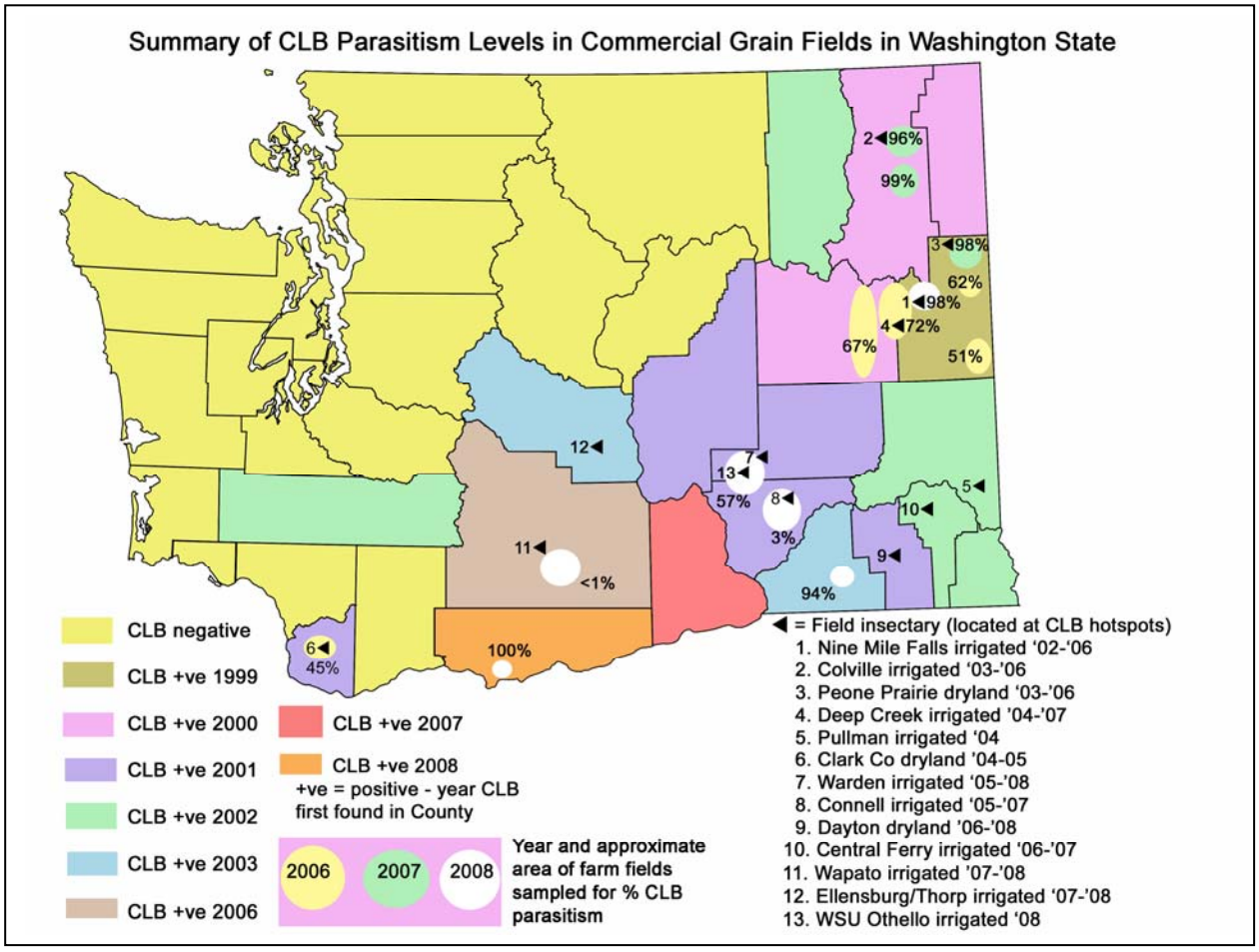
This was the last year (2003 – 2005) that the larval parasitoid was imported, as parasitized CLB larvae, from Montana. All these larvae were processed through the NWBIQ. Parasitoid release data are shown in Table 2.

Funding from the WWC and USDA-APHIS continued. The summary of project funding is in Table 3.

2006

Lacey Jones and Moose Sanders worked on the project as summer technicians. Prior to this season, CLB infestations had occurred primarily in irrigated areas. However in the 2006 season, CLB became obvious in the wetter, dryland areas of Stevens, Spokane, Whitman, Columbia, and Walla Walla Counties.

Figure 2. Summary of CLB parasitism levels (by the larval parasitoid *T. julis*) in commercial grain fields in Washington state, 2006 to 2008. Colored ellipses show the year and the approximate areas from which CLB larvae were collected from farm fields and dissected. Percentages were the average level of parasitism from that area. Sample sizes were often small due to low incidence of CLB, especially in dryland areas.



We added a new insectary at Dayton (Columbia County, Jay Takemura). The older insectaries established prior to 2004 had imploded; CLB was hard to find in them due to high parasitism levels by *T. julis*, so we
discontinued them at the end of the 2006 season. Parasitism levels are shown in Table 1 and Figure 1. The sample size collected weekly from each insectary was 30 CLB larvae or eggs. See the document *WA CLB Field and Laboratory Protocol* for details on checking CLB eggs for parasitism by *A. flavipes* and CLB larvae for parasitism by *T. julis*.

In 2006 we did not recover any egg parasitoids (*A. flavipes*), and neither did colleagues in Oregon where they had previously recorded good establishment. However in Montana the egg parasitoid was not recovered at all for several years after release, but there it has established solidly.

Also in 2006, we transferred parasitized CLB larvae (*T. julis*) from our own insectaries to new insectaries, without needing to import them from other states. We did not process them through the NWBIQ, assuming the plant material would not be carrying pests foreign to the state. We also recorded excellent spread of the larval parasitoid from insectaries to commercial farms in the region (Figure 2). The samples collected from farm fields were small, but they did show the movement of *T. julis* beyond the insectaries.

Table 2. CLB parasitoid releases at Washington state field insectaries, 2000 to 2008.

Year	***Tetrastichus julis*** **(as parasitized CLB larvae)**	***Anaphes flavipes*** **(as parasitized CLB eggs)**	***Lemophagus curtus*** **as parasitized CLB larvae**
2000	No data	0	0
2001	No data	0	0
2002	No data	0	0
2003	No data	No data	0
2004	7,028	10,038	125
2005	6,900	5,599	0
2006	3,087	9,994	0
2007	4,956	0	0
2008	2,460	0	0

Table 3. Summary of funding for biological control of CLB in Washington state, 2003 to 2008. Figures for USDA-APHIS and WSU are best estimates only.

Agency Partner	**Funding total 2003 to 2008**
USDA-APHIS	$53,800 for Washington state ± $50,000 Colorado lab
WSCPR	$9,960
WWC	$112,992
WSU	±$180,000 for faculty salaries, etc

2007
Lacey Jones, Bill Fish, and Nancy Miller worked on the project as summer technicians. WSU entomologist Keith Pike made a first recording of CLB in Benton County in 2007. USDA-APHIS had not conducted formal surveys for CLB in uninfested counties since 2005.

We added a new insectary at Wapato (Yakima County, Bob St. Hilaire) and made releases in an oat field immediately west of Ellensburg (Kittitas County, Jeff Brunson). This meant we had 5 active insectaries and the project was focused more on the Columbia Basin with the closure of several of the older insectaries.

There were very few reports of CLB infestations from the dryland farming areas. We obtained no CLB larvae samples from dryland areas of eastern Washington and received no reports of economically damaging CLB infestations from these areas. A sample from a commercial oat field near Princeton, Latah County, ID, - a considerable distance from the nearest insectary in Washington - showed 72% parasitism! Across dryland eastern Washington the levels of parasitism by *T. julis* were 83% to 99% - (Table 1 and Figure 1) this is a seasonal average, not a sample high!

In our experience, parasitism levels greater than 75% are sufficient to keep CLB below economic thresholds. Once CLB parasitism levels reached around 70% we recommended that farmers not spray their fields. Parasitism levels of 50% - in fields that had a CLB population above the economic threshold - were trickier. Spraying in this situation would kill large numbers of beneficial insects but not spraying would leave the field vulnerable to CLB. We recommended that farmers spray heavily infested areas (usually field borders adjacent to winter wheat) and leave the rest of the field untreated but monitor it closely. More about the success of this technique is in the document *The Effect of CLB Damage and Parasitism at Nine Mile Falls.*

A very high population of ladybird beetles (*Hippodamia convergens*) across the region in 2007 contributed to the low numbers of CLB. They consumed up to 40% of CLB eggs and larvae (David Bragg, WSU Extension, personal communication). These ladybird populations may have increased following an aphid infestation on spring wheat in 2006.

In the irrigated areas of Grant and Franklin Counties, recovery of the larval parasitoid beyond the insectaries was low. This was due possibly to wasp mortality from the high pesticide inputs in potato fields, which provide a tougher environment for *T. julis* survival than the dryland areas where insecticides are seldom used in cereal crops. Also noted in the area around Connell, WA, were several wheat fields that were sprayed for CLB when the incidence of the pest was way below the economic threshold. Continuation of this practice will also create challenges for the successful multiplication of the larval parasitoid in the irrigated area.

Unfortunately the *A. flavipes* colony, which was maintained by the Colorado State Dept Agriculture, crashed in the spring of 2007. We made no field releases of *A. flavipes* in 2007. This parasitoid has been challenging to rear and maintain. Neither did we recover any overwintering *A .flavipes* from insectaries. In September 2007, the Western CLB workers group received new information about the relative lack of impact that *A. flavipes* made on CLB populations in the

Midwest, and we decided consequently to cease rearing and release of this parasitoid. *T. julis* is doing an excellent job on its own, contrary to conventional wisdom about biological controls.

The Western CLB Group did pursue releasing a related species from China, *Anaphes nipponicus that* team members Barry Bai and Keith Pike had identified as a possible parasitoid. However, Terry Miller of the NWBIQ concluded that it was unlikely to be successful in the PNW but some potential for southern states like California. More about this parasitoid may be found in the document on *Anaphes nipponicus.*

In 2007 we also tested using an oat strip planted between winter and spring wheat fields to function as a trap crop or modified insectary for farmers who wanted to avoid spraying and build parasitoid populations. See the document *2007 WA Oat Strip Trap Crops for CLB Management* for further details on this project.

2008

Bill Fish (Field Technician) and Sally Yoshida (Lab Technician) worked on the project.

Bill Fish officially confirmed CLB in Klickitat County (Kelly Kreps farm) though we had reports of it being there since 2005.

We had no reports of damaging CLB infestations in the dryland areas of eastern Washington. Spraying did occur in the Wapato and Connell areas. *T. julis* is established at low levels in these areas (Figure 1 and Figure 2) and farmer management practices from here on will dictate the parasitoid's ultimate success. Parasitism levels in Grant County (57%) demonstrated the potential success of the wasp in irrigated areas. Kittitas County also showed huge potential as the farm field (not a managed insectary) at Ellensburg had seasonal parasitism of 61% only one year after the first wasp releases. CLB larvae from Walla Walla County were 94% parasitized, although there was no field insectary in that county.

T. julis has been established at WSU Central Ferry since 2006 (Table 1) but parasitism levels have appeared to drop off since 2006. The first record was one larvae sample from spring wheat taken later in the season when parasitism levels are usually higher, and subsequent samples were from winter wheat. There was not an insectary at Central Ferry managed according to the USDA plan, but *T. julis* releases were made in existing spring wheat plots. Also, the research farm is managed with intensive tillage which can be damaging to *T .julis* survival. David Bragg (WSU Extension) also attributed the low parasitism levels in 2008 to a cold spring – however similar conditions existed at other locations in eastern Washington and the *T. julis* was active at many locations.

The Connell insectary was discontinued due to a change in the farmer's management practice - he won an EQIP Contract from NRCS on that field. We had discontinued all insectaries along the eastern border of Washington, except for Dayton.

We established new insectaries at Thorp (Kittitas County; Craig George) and at WSU Othello (about 10 miles from the Connell insectary). We had hoped to use the Dayton insectary as a

source of parasitized CLB, but it had imploded and had 100% parasitism. We distributed larvae from the insectary field at Ellensburg (Jeff Brunson farm) to insectaries at Thorp, Wapato, Warden, WSU Othello, and to a farm field in Klickitat County. However, the WSU Othello and Klickitat County sites were already parasitized at viable levels before we made any releases there.

We did not collect CLB larvae from previously affected sites in the far east part of the state, except for Kit Cutler's farm where there was 98% parasitism in an oat strip trap crop he planted adjacent to spring wheat. He made the quote, "Two years ago who would have thought it would take 2 people one hour to collect 50 CLB larvae in this field!"

As all affected counties, except for Yakima and Franklin, had high levels of CLB parasitism we decided to conclude the CLB biocontrol project with the 2008 season. The larval parasitoid is established in these counties and should increase if farming practices will allow it. The farmer cooperator at Wapato plans to continue a modified insectary for a while to increase the wasp populations.

Acknowledgments
We appreciate the interagency collaboration and funding on this project, especially USDA-APHIS and WSDA. We also thank the Washington Wheat Commission and the Washington State Commission on Pesticide Registration for their generous support for the project.

We appreciate the contributions of the cooperating farmers; Richard, Rick, and Gary Seitters from Colville, Ed Talbott from Chewelah, Jack Herres from Peone Prairie, Kit and Rob Cutler from Nine Mile Falls, Paul Gross and the Hutterian Brethren from Deep Creek, Jay Takemura from Dayton, Dennis Treat from Warden, Jon Chase from Connell, Bob, St Hilaire from Wapato, Jeff Brunson from Ellensburg, and Craig George from Thorp. We appreciate the support of John Steinbock and Kurt Tetrick, the farm managers at WSU Othello and WSU Central Ferry

This project would not have been possible without the dedicated work and long hours from technicians Mike Gould, Laurie Stone, Lacey Jones, Kathlene Peck, Moose Sanders, Bill Fish, Nancy Miller, and Sally Yoshida – thank you!

The Effect of CLB Damage and Parasitism at Nine Mile Falls, WA, 1998 to 2008
Diana Roberts (WSU Extension)

A question from the Western CLB Group was, "What damage to cereal crops has CLB caused in Washington, and how has the larval parasitoid contributed to preventing this damage." Kit Cutler compiled a summary (Table 1) of the effects of CLB and the parasitoid on winter and spring wheat crops on his irrigated farm at Nine Mile Falls.

Table 1. Progression of CLB infestations and *T. julis* parasitism levels at the Cutler Farm, Nine Mile Falls, WA, from 1998 to 2008. Yields are for Alpowa spring wheat from 1998 to 2006, and for Tara and Louise for 2007 and 2008.

Year	Alpowa Spring Wheat Yield (bu/A)	Insecticide Applied for CLB (Warrior 3 oz.A)	Madsen Winter Wheat Yield (bu/A)	Insecticide Applied for CLB (Warrior 3 oz.A)	T. julis in insectary/ commercial fields (% parasitism)	Notes
1998	85	NO	85	NO	NA	K. Cutler saw CLB but didn't identify/report it
1999	119	NO	119	NO	NA	CLB reported in WA by WSDA (M. Klaus) and K. Cutler
2000	114	NO	114	NO	NA	Lots of CLB - ate bluegrass to whiteness. Even neighbors reported flights of CLB. WSDA began release of *T. julis* in field borders
2001	68	NO	121	NO	0/0	Release of *T. julis* in field borders continued.
2002	**36**	NO	**88**	NO	0/0	**WSU spring wheat replicated trial yielded 60 bu/A in sprayed plots and 44 bu/A in untreated plots (27% loss).** Established first managed insectary.
2003	97	Whole Field	122	Whole Field	**0.8**/0	First recovery of overwintering *T. julis*. First release of *Anaphes flavipes*
2004	97	NO	121	NO		18 *T julis* wasps reared - method did not provide percentage. One (1) overwintering *A. flavipes* reared.
2005	96	Whole Field w/ Herbicide	124	NO	6/NA	Drift occurred to insectary from aerial application. One (1) overwintering *A. flavipes* seen under microscope.
2006	90	Borders only	102	NO	79/60	No *A. flavipes* recorded
2007	79 (Tara & Louise)	NO	123	NO	NA/95	Insectary discontinued. No *A. flavipes* recorded
2008	101 (Tara & Louise)	NO	127	NO	NA/98	Parasitism recorded in strip of oats adjacent to spring and winter wheat

Kit Cutler's greatest losses from CLB were in 2001 and 2002, when he didn't spray and although the parasitoid had been released it had not yet established in detectable numbers. In 2002, not all the yield loss was due to CLB – frost and a plant disease also contributed to the loss. WSU replicated spring wheat trials on the farm that year yielded 60 bu/A in insecticide-treated (Warrior) plots and non-treated plots yielded 44 bu/A (27% yield loss). Similarly, in 2007 the yield depression was not attributed to CLB

In 2006 the parasitoid was effective enough that he sprayed only field borders and in 2007 and 2008 he did not need to spray his crops at all and the level of parasitism in his spring wheat was 95% and 98% respectively. In 2007 and 2008 he seeded a strip of oats adjacent to his spring wheat and winter wheat (see document *2007 WA Oat Strip Trap Crops for CLB Management* for further details).

The impact of CLB and the larval parasitoid are shown in Figure 1. These data demonstrate how a farmer can move from depending on insecticides to utilizing T. julis parasitism for CLB management.

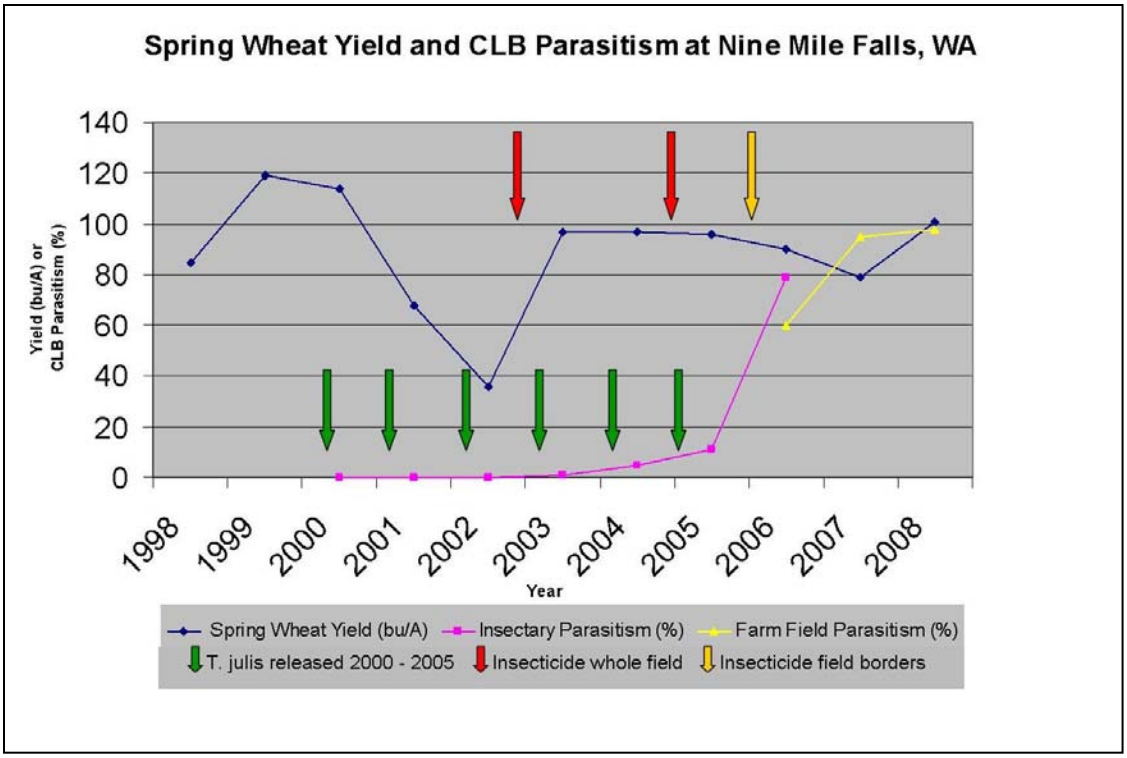


Figure 1. The impact of CLB infestations and T. julis parasitism on irrigated spring wheat yields at Nine Mile Falls, WA, from 1998 to 2008. Yields are for Alpowa spring wheat from 1998 to 2006, and for Tara and Louise for 2007 and 2008. Yield loss in 2002 was about 27% due to CLB, and in 2006 yield depression was not attributed to CLB.

Using Oat Strips as a Trap Crop and/or Modified Insectary in Commercial Farm Fields

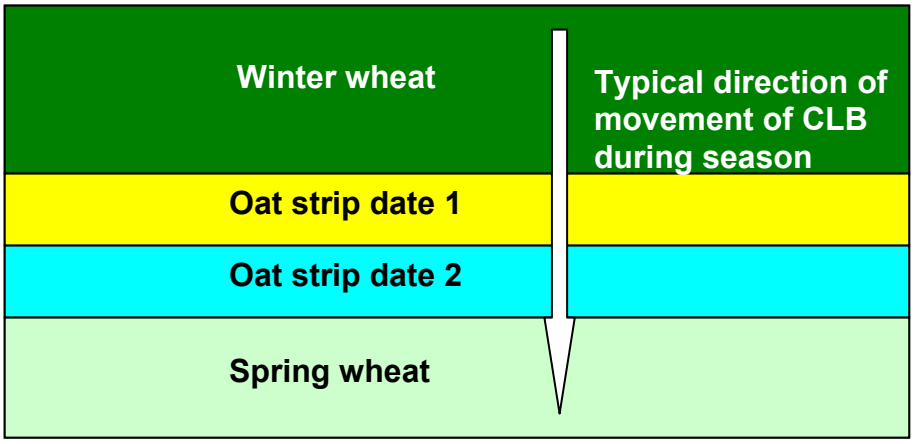
Diana Roberts, WSU Extension

Farmers in eastern Washington wanted to know how they could build the populations of the larval parasitoid (*Tetrastichus julis*) of the cereal leaf beetle (*Oulema melanopus*) and avoid destroying them if they needed to spray spring crops in their own fields. In 2007 we set up demonstration oat trap crops at 4 sites: Nine Mile Falls (Kit and Rob Cutler, irrigated), Colville (Richard Seitters, irrigated), Chewelah (Ed Talbott, dryland) and Peone Prairie (Jack Herres, dryland).

Each farmer seeded 2 strips of spring oats between winter wheat and spring wheat (Figure 1). They used their own drills and seeding/tillage systems. The first strip of oats was seeded just prior to or at the same time as the spring wheat, and the second strip was seeded 2 weeks later. Details are shown in Table 1.

The idea tested was that as the CLB moved from the larger winter wheat into the young, fresh spring wheat, they would remain preferentially in the oats strips as this crop is their favorite food. Hopefully, the oats would "trap" enough CLB that the spring wheat would not need spraying and the parasitoid would multiply freely. However, if the spring wheat were highly infested, the oats would still not be sprayed and would function as a modified insectary for the parasitoid so its population would be able to increase for the next season.

Figure 1. Diagrammatic representation of oat strip/trap crops (not to scale)



Field technicians sampled each site, including the 2 oat strips and the adjacent spring wheat once per week through the season. They counted the numbers of CLB eggs and larvae on each of 10 plants each week, and determined the parasitism level in the CLB larvae.

The infestation pressure from CLB at all sites was low in 2007, so we were unable to see dramatic results from the trap crops (Table 1). Also, parasitism of CLB was already >95% at all the sites. Over all sites and collection dates there were not statistically different infestation levels between the crops. However, at the peak of the period when larvae were feeding (June 18 to July

5), across all sites there were higher numbers of CLB larvae per plant in the second seeding of oats than in the spring wheat (Table 2).

Location	Crop Being Sampled	Seeding Date	Oat Strip Width (ft)	Mean # Eggs/plant *	Mean # Larvae/plant *	T. julis parasitism level (%)
Nine Mile Falls	Oats 1	8-Apr-07	20 ft	1.5	0.5	96%
Spokane County	Oats 2	22-Apr-07	20 ft	5.5	1.1	
Kit & Rob Cutler	Spring Wheat	6-Apr-07		0.7	0.2	
Peone Prairie	Oats 1	12-Apr-07	36 ft	0.4	0.1	98%
Spokane County	Oats 2	26-Apr-07	36 ft	0.7	0.3	
Jack Herres	Spring Wheat	13-Apr-07		0.2	0.1	
Chewelah	Oats 1	11-May-07	30 ft	0.4	0.0	99%
Stevens County	Oats 2	11-May-07	30 ft	0.4	0.0	
Ed Talbott	Spring Wheat	4-May-07		0.2	0.0	
Colville	Oats 1	16-May-07	60 ft	0.9	0.4	96%
Stevens County	Oats 2	30-May-07		Data not collected		
Richard, Rick, & Gary Seitters	Spring Wheat	18-May-07		0.6	0.2	

*** Sample size: eggs and larvae counted on 10 random plants per strip - removed weekly from Jun 5 through maturity.**
High numbers of ladybird beetles were seen across eastern WA & contributed 40% to egg and larvae mortality at WSU Central Ferry - Dave Bragg, WSU Extension

Table 1. Seeding details for CLB oat trap crops, average numbers of eggs and larvae per plant, plus CLB parasitism numbers at 4 farm sites in eastern Washington in 2007.

Crop	Sample Date		
	June 18 - 20	June 25 - 28	July 2- 5
Oats 1	0.4 ab*	0.2 b	0.1 b
Oats 2	0.9 a	0.9 a	0.6 a
Spring Wheat	0.2 b	0.2 b	0.1 b

* Means followed by different letters are significantly different at 95% level of probability

Table 2. Mean number larvae/plant in oats and spring wheat at peak sampling dates across 4 locations

Conclusions

- This oat strip system has potential for reducing infestation levels in spring wheat adjacent to winter wheat and providing a simple insectary design for farm situations.
- It is important to note that intense tillage is supposed to bury CLB pupae containing overwintering wasp pupae and thus reduce the wasp survival rate. However, although none of these farmers used direct seeding systems, the parasitism level of CLB was >95% at all these sites.