IMPACT OF CEREAL LEAF BEETLE ON WINTER/SPRING WHEAT YIELD AND ECONOMIC THRESHOLD ASSESSMENT IN NE OREGON

D.L. Walenta and S. Rao

Introduction

Cereal leaf beetle (CLB), *Oulema melanopus* (Coleoptera, Chrysomelidae), is an invasive pest of economic concern to cereal grains, grass seed/forage crops and other grass-host species in the Pacific Northwest (PNW) region. CLB was first identified in Oregon in 1999 and has since been detected in 24 counties to date. ODA, USDA-APHIS and OSU collaborated and developed an integrated management program for CLB in the Willamette Valley and northeastern Oregon. The team implemented biological control with the introduction of *Tetrastichus julis* (Hymenoptera: Eulophidae), a tiny parasitoid wasp. CLB populations are largely kept in check by *T. julis* in areas with high parasitism rates but occasionally growers encounter CLB hot spots and insecticides are applied. In recent years, a nearly 30% reduction in harvested grass seed acreage in Oregon has occurred in the Willamette Valley while cereal grain acreage, particularly wheat, has increased. This is likely to increase insecticide use for CLB control. However, sustainability of biological control is dependent upon judicious use of insecticides. Hence, it is critical that economic threshold levels are adopted by growers when making decisions to spray their fields.

At the time CLB was first detected in the PNW, region-specific information related to host-crop preference, impact on host-crop yield, population monitoring techniques, economic threshold levels, and pest biology/management was non-existent. As a result, current economic threshold levels were adapted from the eastern U.S. which recommends insecticide application to cereal grain crops when CLB populations reach either: a) three eggs and/or larvae per plant up to the boot stage; or b) one larva per flag leaf during/after the boot stage. Field observations in northeastern Oregon suggest the boot stage threshold level was too high, therefore, prompting a field study to determine if adapted threshold levels were applicable to the area. Although the objectives of this study focused on northeastern Oregon wheat production in the Grand Ronde Valley, the information obtained from this effort could be of use to growers in the Willamette Valley given the increase in wheat production and the continued need to monitor pest populations and *T. julis* parasitism rates in all CLB-infested grass seed production areas.

Objective

The objective of this study was to determine the impact of CLB populations on winter and spring wheat crops grown in northeastern Oregon and to investigate the effectiveness of current economic threshold levels utilized for CLB management.

Methods and Materials

The study was conducted in 2004 and 2005 in established commercial production fields of soft white winter wheat, soft white spring wheat, and dark northern spring wheat located in Union and Wallowa County of northeastern Oregon. The experiment was setup as a randomized block design with 3 replications. Insecticide treatments consisted of: 1) insecticide applied, and 2) no insecticide applied. Replicated treatments were approximately 0.3 to 0.5 acres in size and designed to accommodate the use of commercial-sized equipment. Typical agronomic production practices for each study site were managed by the cooperating grower including the decision to treat CLB populations with an insecticide. Applications were made with either grower-owned or commercial spray equipment with the appropriate registered insecticide of choice for the respective crop.

The 2004 study consisted of a total of 7 sites including 3 winter wheat (2 dryland, 1 irrigated), 3 spring wheat (1 irrigated, 2 dryland), and 1 dark northern spring wheat (dryland) commercial production fields. The 2005 study consisted of a total of 4 sites including 1 soft white winter wheat (irrigated), 2 soft white spring wheat (1 irrigated, 1 dryland), and 1 dark northern spring wheat (irrigated) commercial production fields. Insecticide treatments were not replicated at each site in 2005.

CLB Population Sampling

At each study site, CLB egg and larvae populations were sampled 0 to 7 days prior to insecticide application and again approximately 14 days post-insecticide application. The decision to treat larval populations was determined by the cooperating grower and applied when larval feeding damage was evident and populations were in close proximity to or above current economic threshold levels. In the study, populations were determined by counting the total number of eggs and larvae per tiller from 10 tillers at 5 random locations, thus, yielding a total of 50 tillers sampled per replicated treatment. The number of larvae and eggs on each flag leaf were noted and included in the overall total for each tiller. Average numbers of egg, larvae, and egg + larvae *per tiller* and *per flag leaf* were calculated based on the results from inspecting 150 tillers total per treatment.

Flag Leaf Damage Assessments
Estimates of flag leaf defoliation by CLB larvae were determined by a digital image analysis technique (O'Neal et al, 2002) which utilized a flatbed scanner and imaging software to measure total leaf area and defoliated leaf area. The flag leaf and F-1 leaf were randomly collected from 20 tillers per replicated treatment (60 total tillers sampled per treatment) at each site. Time of leaf sample collection occurred when majority of larvae had moved to the soil to pupate. Leaf samples were prepared for analysis by being rinsed with tap water and blotted dry with paper towels, followed by placement in heat-sealed lamination pouches to preserve the leaves. In 2004, a total of 240 leaves from each site were collected and subjected to image analysis. Leaf defoliation measurements were not collected in 2005.

Grain Yield and Yield Loss Determination
Grain yield was determined by harvesting the center section of each replicated treatment with a commercial combine and the harvested grain was measured with a weigh wagon. Grain yield (bu/acre) and yield loss (for treatments not receiving an insecticide application) were then calculated for each replicated treatment.

Results
Winter Wheat
CLB adults usually emerge in late April to mid-May in NE Oregon and larvae are present when winter wheat crops are in the early boot to anthesis growth stages. Treatment decisions, therefore, were based upon the number of larva infesting the flag leaf. Current economic threshold levels after the boot stage (Feekes 9+) recommend insecticide application when larva populations reach an average of 1 larva/flag leaf.

In this study, CLB larva populations and level of flag leaf defoliation varied from between sites, but resulted in an average grain yield loss of -3 bu/a in 2004 and -14 bu/a in 2005 (Table 1). Winter wheat yield loss ranged from 0 to 18 bu/a, however, grain yield was negatively impacted at only two of the four sites (data not shown). Insecticide treatment at all sites prevented further leaf defoliation and significant yield loss. CLB impact on grain yield did not appear to be influenced by either dryland or irrigated production systems included in this study.

Interestingly, pre-treatment flag leaf populations of CLB larvae met current economic threshold levels at only one winter wheat site which resulted in no yield loss. At all other sites, flag leaf larvae populations collected prior to insecticide application were lower than current threshold levels with an average of 0.4 larvae/flag leaf (Table 1) and range from 0.2 to 0.6 larvae/flag leaf.

Spring Wheat
CLB larvae emerge and begin feeding on NE Oregon spring wheat typically when the crop is in the seedling to early boot growth stages. In this study, all spring wheat sites were in the early boot stage (flag leaf present) when pre-treatment CLB population data was collected. Data in Table 2 indicate flag leaf CLB larvae population averaged 0.6 and 1.0 larvae/flag leaf in 2004 and 2005, respectively, and was higher than in winter wheat. Yield loss occurred at all sites, regardless of irrigated or dryland production system, with an average yield loss of -13 bu/a in 2004 and -19 bu/a in 2005 (Table 2). Compared to winter wheat, these results are indicative of increased susceptibility of spring wheat to CLB damage. Flag leaf defoliation was more severe in spring wheat with damage levels reaching 29% in soft white spring and 36% in dark northern spring (data not shown). Insecticide treatment at these sites prevented further leaf defoliation and significant yield loss.

Discussion and Implications
This study suggests that for both spring and winter wheat, the pre-boot economic threshold of 3 eggs and/or larvae is applicable to northeastern Oregon production systems. However, once the flag leaf emerges (Feekes 9+), the economic threshold level for average # larvae/flag leaf may be less than 1 if two conditions are met: 1) overall health/vigor of the crop is low; and 2) if total # larvae per tiller >1. The overall health and vigor of a particular crop can influence crop tolerance to CLB feeding damage or other pest-related injury. Research from the eastern U.S. indicates effective CLB management techniques include sound cultural production practices that promote early planted, well-tillered wheat crops (Philips et al., 2011). Additional research is needed to further define economic thresholds for all market classes of small grains grown in both dryland and irrigated production systems.

In areas where turf grass and forage seed is produced, the new CLB adults that appear when pupation is complete in the summer and when small grains have matured may migrate to alternate host sites prior to dispersal to overwintering sites (Rao et al., 2004). New stands of annual and perennial ryegrass, orchardgrass and tall fescue (planted the previous spring) are at moderate to high risk for damage by the "summer" adults. It is recommended that seedling grass fields are monitored in late summer especially if in close proximity to small grain production fields.

References

Philips, C.R., Herbert, D.A., Kuhar, T.P., Reisig, D.D., Thomason, W.E., and Malone, S. Fifty years of CLB in the U.S.: an update on its biology, management and current research. J. Integ. Pest Mngmt. 2(2): 2011; DOI: http://dx.doi.org/10.163/IPM11014.

Rao, S., Quebbeman, B. and Walenta D. 2004. Host range of cereal leaf beetle. In Young, W.D., Ed., Seed Production Research, Oregon State University Ext/CrS 123: 50-51.

Table 1. CLB population and impact on commercial soft white winter wheat yield – Union County, Oregon (2004 and 2005, across all study sites).

Treatment	Number of larvae per tiller[1]	Number of larvae per flag leaf[1]	Percent flag leaf defoliation[2]	Percent yield loss
		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 area determined when 90% of CLB larvae entered pupation.

Table 2. CLB population and impact on commercial soft white spring wheat yield – Union County, Oregon (2004 and 2005, across all study sites).

Treatment	Number of larvae per tiller[1]	Number of larvae per flag leaf[1]	Percent flag leaf defoliation[2]	Percent yield loss
		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 area determined when 90% of CLB larvae initiated pupation.