FINAL REPORT
PROJECT NO.: 13C-3343-3123

Project Title: Lygus bug thresholds, cultural and biological control in Washington State apple orchards

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OBJECTIVES:

1. Develop economic thresholds for *Lygus* on apples.
2. Evaluate cover crops/ indigenous plants for their ability to increase survivorship/ effectiveness of Lygus parasitoids.
3. Survey conventional and organic apple orchards for the presence of Lygus parasitoids.
4. Conduct innoculative releases of *Peristenus* spp. into established refugia in apple growing regions where *Peristenus* has not been detected.
5. Conduct orchard floor treatments with formetanate hydrochloride and several candidate synthetic pyrethroid insecticides

SIGNIFICANT FINDINGS- *LYGUS*

1. *Lygus* Economic Thresholds. Branch cage studies were conducted to determine the period of time at which Lygus feeding resulted in the most damage. These studies helped quantify proportional *Lygus* abundance to fruit damage. From these studies we determined that Lygus feeding can result in sub-surface superficial feeding injury at any point between fruit set and harvest, but that early to mid-spring feeding is cosmetically more damaging then summer feeding.

2. Cover Crops/ Indigenous Plants. Replicated plots of 14 cover crop blends were established on the Roza unit at WSU IAREC in May 2003. We have documented significant differences among cover crop blends in their potential to build populations of *Lygus*.

3. Biological Control/ Orchard Surveys for Lygus Parasitoids. A parasite *Peristenus* spp. attacks the nymph stages of *Lygus* and keeps individuals from reaching sexual maturity by emerging in the late instar nymph or early adult stage. Extensive surveys conducted by Walsh in 2002, 2003 and 2004 determined the presence of Lygus parasitism by *Persitenus* spp. in most of the orchards surveyed in Washington State.

4. Inoculative Releases of *Persitenus* into refugia. Populations of *Persitenus* are inconsistent over the sites we surveyed annually and innoculative releases of paraitized will not be effective at establishing populations of *Peristenus*.

5. Orchard Floor Treatments. In 2004 we compared the efficacy of Carzol, Round-up, Asana and mowing as orchard floor treatments. *Lygus* were not detected before the treatments were applied. A week following the treatments, Lygus began to inhabit the orchard. The sweep net samples showed that *Lygus* were significantly less abundant in the mowed plots when compared to the other treatments. The following week showed a reduction in Lygus abundance across all treatments, but the Asana and Roundup treatments hosted fewer *Lygus*.

RESULTS/ DISCUSSION LYGUS-

1. Economic Thresholds- *Lygus* Damage. *Lygus* feeding has been likened to chemical injury. *Lygus* feeding damage in apple orchards is a significant concern after fruit set, however feeding damage can result in fruit disfigurement during the fruit growing season. Branch cage studies in 2001 and 2002 have helped quantify proportional *Lygus* abundance to fruit damage. Three sets of sleeve ages were placed on branches of Fuji trees. Fruit was hand thinned within each cage and specific numbers of adult *Lygus* were added to each cage to produce specific ratios of fruit to *Lygus* bug in each respective cage. Ratios of fruit to *Lygus* per cage included 0, 4, 6, 8, 12, 18, 30, & 60 fruit per Lygus. Cages were left on for 2 weeks at each cycle in April and July 2001 and May 2002 and then removed. Each caged tree branch was then treated with acephate (Orthene) to prevent subsequent feeding injury from occurring. On August 30, 2001 an.d September 10, 2002 ten fruit were removed from each cage site and peeled with a paring knife. *Lygus* damage was noted if necrotic feeding spots were present below the fruit skin surface. Our estimates for fruit damage are much higher then typical consumer standards. A majority of *Lygus* feeding damage was not observable above the fruit skin surface. However, April feeding injury was greater then feeding damage in May or July (Figures 1, 2, & 3) . In 2002 and 2003 we also designed a sequential sample experiment in which we established cages weekly from June through August. One meter sleeve cages were placed over tree branches on which fruit had been thinned to a total of 10. Ten adult Lygus bugs were placed into 3 replicate cages each week. In September ten fruit were removed from each cage site and peeled with a paring knife. Lygus damage was noted if necrotic feeding spots were present below the fruit skin surface. Lygus feeding damage was greatest in May or June in both years (Figures 4 and 5). Damage for every other week appeared to be fairly consistent.

Figure 1. April 2001 Feeding Injury

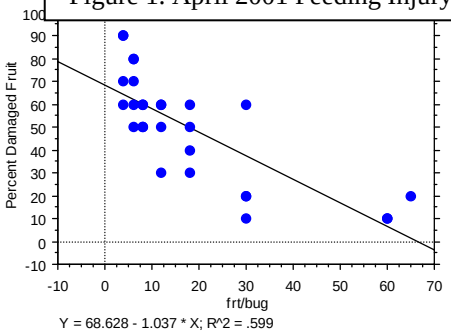


Figure 2. July 2001 Feeding Injury

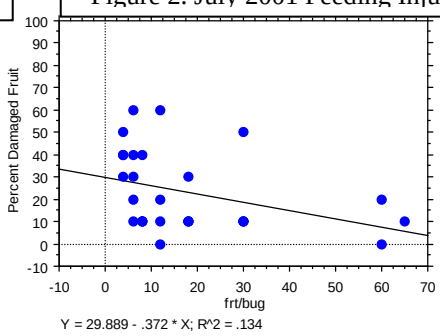


Figure 3. May 2002 Feeding Damage

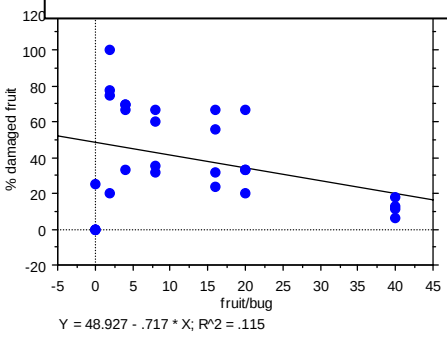


Figure 4. Sequential feeding injury 2002

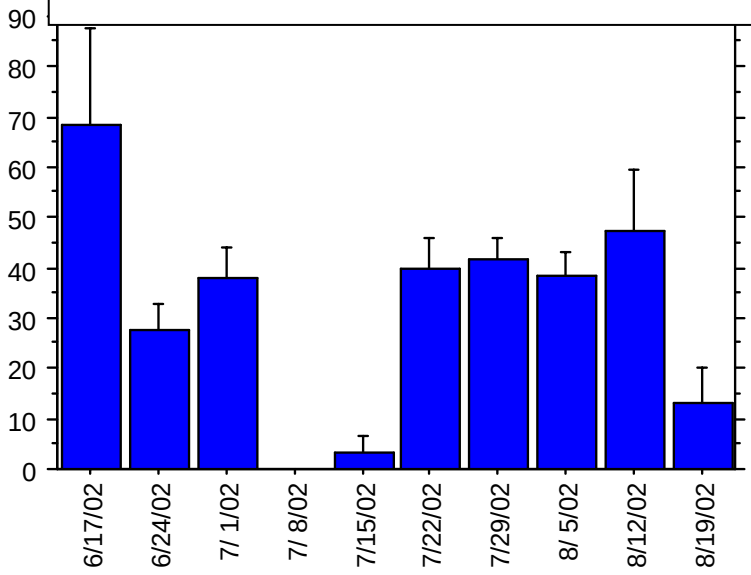
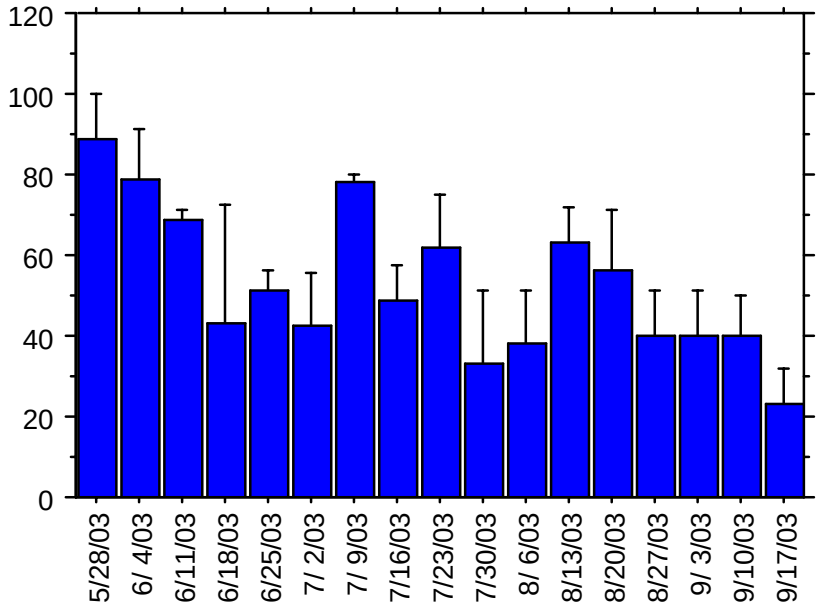
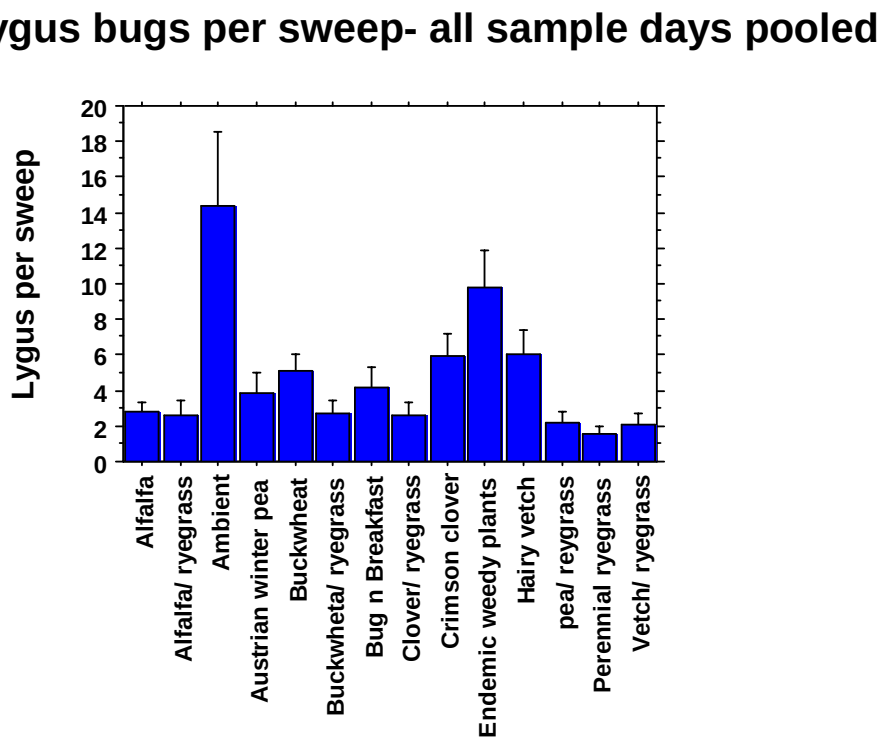


Figure 5. Sequential feeding injury 2003

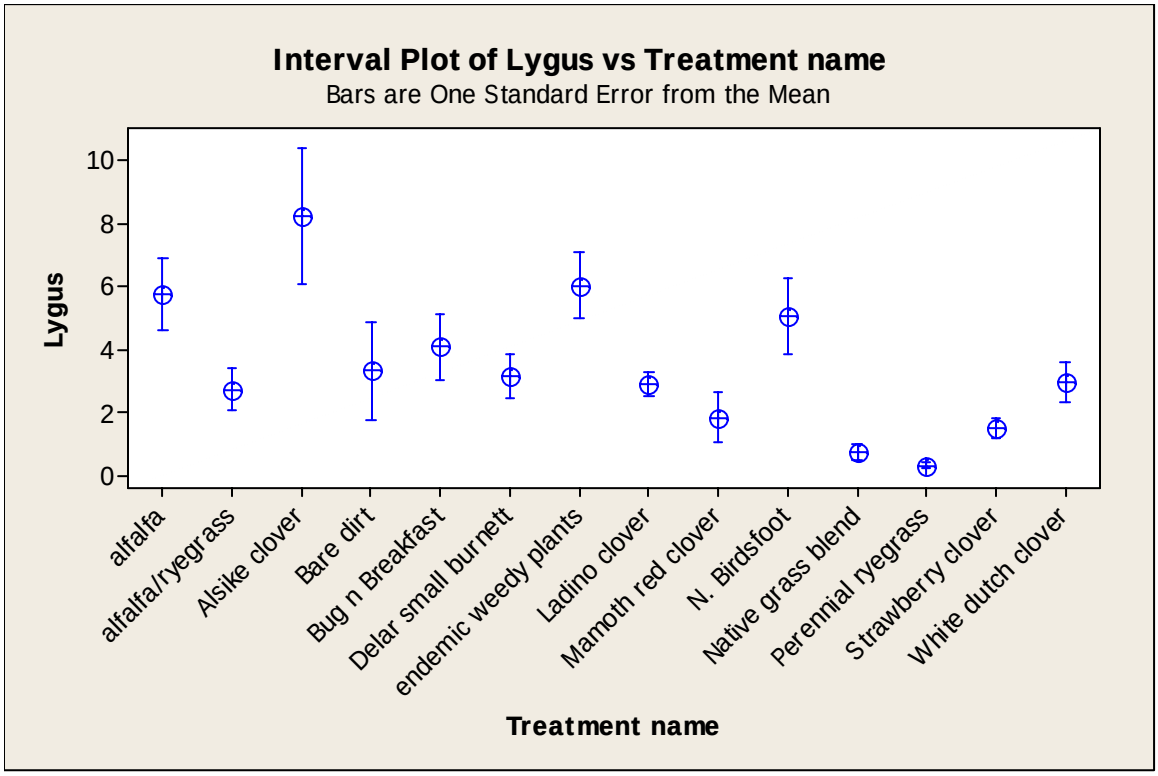


2. Orchard floor cover crops. Replicated plots of 14 cover crop blends were established on the Roza unit at WSU IAREC in May 2003. Cover crop blends included perennial rygrass, buckwheat, buckwheat/ryegrass, alfalfa, crimson clover, hairy vetch, alfalfa/ryegrass, clover/ryegrass, vetch/ryegrass, Austrian winter pea, pea/ryegrass, Bug n Breakfast, and naturalized and endemic weeds. Irrigation was applied by handline sprinklers and irrigation was applied to mimic recommended orchard management practices. Sweep net surveys were conducted every 2 weeks in 2003 and the number of Lygus, thrips and spiders captured was quantified and calculated. In total the cover crop plots were sampled 6 times on 30 June, 14 July, 29 July, 12 August, 9, September and 22 September respectively. Analysis of variance demonstrated that there were no significant differences in Lygus populations among the sample dates so all the dates were pooled.



In 2003, the “Ambient” and “Endemic weedy plants consisted primarily of pigweeds and barnyard grass. These plots are essentially the same but have extra plots will prove helpful in the future as we expand these studies. We can conclude that all of the cover crops were superior to no weed control in reducing populations of Lygus bugs as estimated by sweep net samples.

In 2004 Lygus abundance was greatest in the alfalfa, alsike clover, endemic weedy plants, and birdsfoot trefoil cover crops. Lygus numbers were low in the native grass blend, perennial ryegrass, and strawberry clover treatments. The bare dirt and native grass blends hosted significantly fewer leafhoppers than did the other treatments. This data indicates that the native grass blend and perennial ryegrass were the treatments least likely to host the Lygus.



3 & 4. Biolgical control. A parasite attacking Lygus spp. was discovered in 1995 in Washington State and subsequent collections in Parma, Idaho in 1996 and 1997 showed that the parasite was present (Mayer unpublished data). The parasite has been described as *Peristenus howardi* Shaw (Hymenoptera: Braconidae), a new species . Previously, *Peristenus pallipes* Curtis was reported from Idaho. However, recent taxonomic work on the genus indicates that these may have been misidentified. *Peristenus* spp. attacks the nymph stages of *Lygus* and keeps individuals from reaching sexual maturity by emerging in the late instar nymph or early adult stage.

Collections made in 2000 (Mayer, unpublished data) did not document the parasite's presence beyond the Touchet, Washington and Parma, ID regions. Extensive surveys conducted by Walsh (AE News 2003) in 2002, 2003 and 2004 determined the presence of *Lygus* parasitism by *Persitenus* spp. in several important fruit production regions in Washington State. However, the results of the survey were disappointing in that levels of parasitism were low or not detected in several important fruit growing areas Extensive surveys in 2002 and 2003 determined the presence of Lygus parasitism by *Persitenus* spp. In total over 150 sites were surveyed over 3 years and over 11,000 Lygus were dissected to determine if *Peristenus* spp were present. In 2002, 38 sites were surveyed and 4,724 nymphs collected of which 190 nymphs were parasitized. In 2003, 67 sites were surveyed and 4,468 nymphs were collected of which 48 nymphs were parasitized. In 2004, 79 sites were surveyed and 3,450 nymphs were collected of which 173 were parasitized. Parasitism never exceeded 30%. And unfortunately was not detected in the majority

of orchards that were surveyed over 3 years. Parasitism of Lygus by *Peristenus* was greatest in areas that were less disturbed by human activity.

5. Orchard Floor Treatments:
Replicated 5,000 square foot blocks were established in a commercial c.v. 'Granny Smith' orchard on the Roza Unit near WSU Prosser. Carzol, Asana, and Roundup were applied at recommended field rates with an ATV mounted boom sprayer. Controls were left unaltered while in the mowing treatment vegetation was cut to four to five inches. Pesticide treatments and mowing were conducted on April 26, 2004 in an attempt to assess how thrips and Lygus would respond. For each sample date, four yellow sticky cards were placed on the orchard floor and canopy in each plot to assess thrips abundance. Lygus were surveyed by sweeping the orchard floor with a sweep net five times per plot.

Lygus were not detected before the treatments were applied. A week following the treatments, Lygus began to inhabit the orchard. The sweep net samples showed that Lygus were significantly less abundant in the mowed plots when compared to the other treatments. The following week showed a reduction in Lygus abundance across all treatments, but the Asana and Roundup treatments hosted fewer Lygus. By this time, the vegetation in the Roundup treatments was dead and subsequently unlikely to host Lygus. This data indicates that frequent mowing of the orchard floor may help to reduce Lygus abundance.

Orchard Floor treatments 2004.