FINAL REPORT

WTFRC Project # **WSU Project # 6531**

Project title: Integrated control of grape mealybug

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Objectives:

- Develop new IPM strategies and tactics for control of grape mealybug (GMB)
- Determine the feasibility of biological control of GMB in pear
- Examine the effects of generalist predators on GMB
  - Earwigs and lacewings
- Enhance the knowledge base of GMB biology in pear
  - Distribution, sampling
- Determine the levels of resistance in GMB
- Identify factors influencing the emergence of GMB as a pest

Significant findings from 2001:

1. **Identify and evaluate new pesticide chemistries for GMB control**

   a. Summary of effectiveness of new insecticides:
   Applaud > Assail >= Provado = Actara > Calypso
   b. Provado
      a. Baseline tolerances were established
         i. Provado had the highest LC50 of the chloronicotinyls (least toxic to GMB)
      b. Field trials demonstrated that there was no difference in control between clusterbud and petalfall applications
      c. Summer applications controlled GMB, but residual effect was reduced relative to the first generation
   c. Actara
      a. Baseline tolerances were developed
      b. Clusterbud applications were the most effective
      c. Petal fall and summer applications also controlled GMB
   d. Assail
      a. Baseline tolerances were developed
         i. Assail has the lowest LC50 of the chloronicotinyls
      b. Clusterbud applications were the most effective
      c. Petal fall and summer applications also controlled GMB
      d. Using a codling moth timing for the first generation does not provide control of GMB
   e. Calypso
      a. Baseline tolerances were developed
      b. Clusterbud and petal fall applications were the most effective
      c. Summer applications also controlled GMB
         i. Least effective of chloronicotinyls in the summer

d. Using a codling moth timing for the first generation does not provide control of GMB

f. Applaud
   a. Baseline tolerances were established
   b. Applaud was the most effective material at clusterbud
   c. Applaud was also the most effective in the summer
   d. Applaud appears to be dose-sensitive, with reduced rates providing little control

Methods:

Several new insecticides were evaluated in the laboratory and in the field for efficacy against GMB. Bioassays were conducted in the laboratory to both determine baseline tolerance levels and examine relative efficacy of products. A modified glass vial technique was used to conduct the lab bioassays, with the insecticide coating the inside of a vial into which 20 GMB nymphs are placed. Baseline tolerances will be used in the future to monitor for the first occurrences of resistance evolution.

Field trials were conducted using single-tree plots and small airblast sprayer plots (9-16 tree replicates). Population evaluations were made using timed visual inspections, which turned out to be the least variable sampling method.

Results and Discussion:

Baseline data were established for the chloronicotinyls and Applaud (Table 1). These data will be useful in the future in monitoring for the first occurrence of resistance to these materials.

Table 1. Baseline tolerances of GMB to chloronicotinyls and Applaud using a glass vial bioassay

Compound	Time	n	Slope (std err)	LD 10	LD 50	LD 90
Provado	48	262	1.93 (.32)	0.09 (.02-.20)	0.43 (.2-.72)	2.01 (1.18-5.40)
Provado	96	262	2.38 (.40)	0.04 (.01-0.06)	0.12 (.08-.17)	0.43 (.30-.75)
Assail	48	326	1.32 (.16)	0.00 (.00-.00)	0.002 (.00-.00)	0.02 (.01-.08)
Assail	96	326	1.34 (.29)	0.00 (.00-.00)	0.00 (.00-.00)	0.01 (.01-.04)
Calypso	48	240	0.82 (.16)	0.00 (.00-.002)	0.013 (.004-.025)	0.468 (.22-1.93)
Calypso	96	240	0.547 (.18)	0.00 (.00-.00)	0.001 (.000-.005)	0.189 (.07-2.33)
Actara	48	230	0.81 (.13)	0.00 (.00-.002)	0.010 (.001-.027)	0.372 (.118-4.47)
Actara	96	230	0.65 (.15)	0.00 (.00-.00)	0.003 (0.0-0.011)	0.256 (.065-8.15)
Applaud	48	296	0.96 (.16)	3.18 (.46-6.6)	68.45 (42.3-199.0)	1472.6 (380-60091)

All chloronicotinyls controlled GMB well when used at clusterbud. Summarized results are presented in Figures 1,2. In all trials, Calypso had the shortest residual control of GMB. Also, the effects of Calypso were effected more by rate than the compounds (reducing the rate had a more dramatic effect on reducing control). Applaud was the most effective product, followed by Assail, Provado, and Actara. While Calypso was the least effective of the chloronicotinyls, it still provided a level of control comparable to current field standards.

I expect that the chloronicotinyls, as well as Applaud, will greatly reduce the problematic nature of GMB control in Washington for several years to come. These materials are more effective than materials that were available in the past, and with the addition of prebloom registrations they can be used at the most effective timings. However, it is important that Applaud receive registration to provide an alternate chemistry with which to practice chloronicotinyl resistance management.

The development of GMB was slower in the spring of 2001 than would be typical (although the same phenomenon occurred in both 1999 and 2000). In a more typical year, GMB would be expected to emerge 2-3 weeks earlier, and optimal control would more likely be achieved by clusterbud applications. This phenomenon could lead to poor control if clusterbud applications are made prior to GMB emergence. Recommendations for clusterbud applications should be made in conjunction with field observation / sampling to determine that first and second instar crawlers have emerged from egg masses under bark scales.

Figure 1. Relative effectiveness of several new insecticides for prebloom control of GMB, in accumulated GMB days

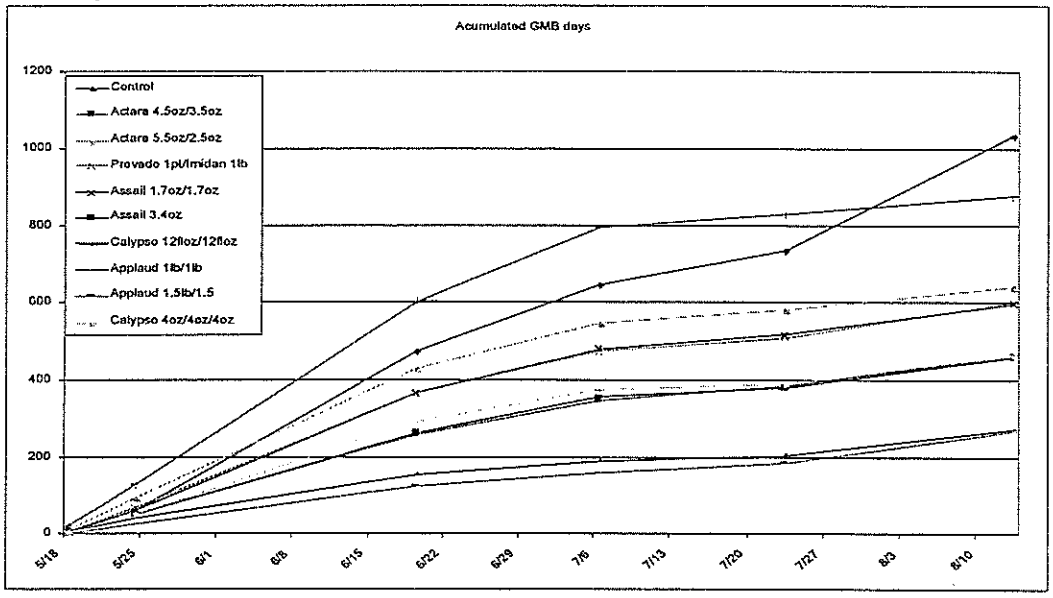
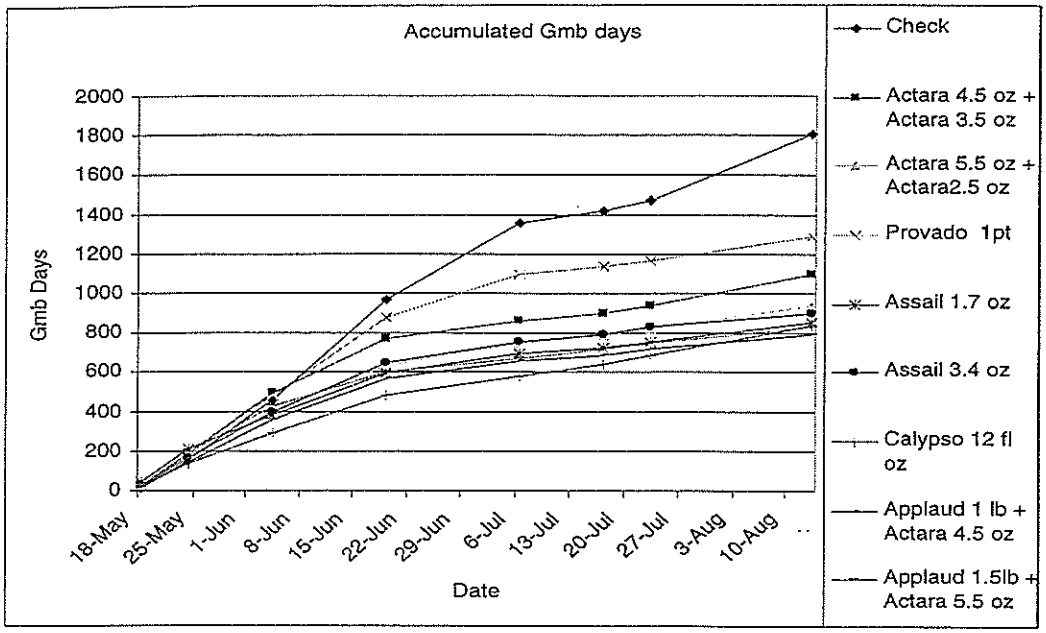


Figure 2. Relative effectiveness of several new insecticides for summer control of GMB, in accumulated GMB days



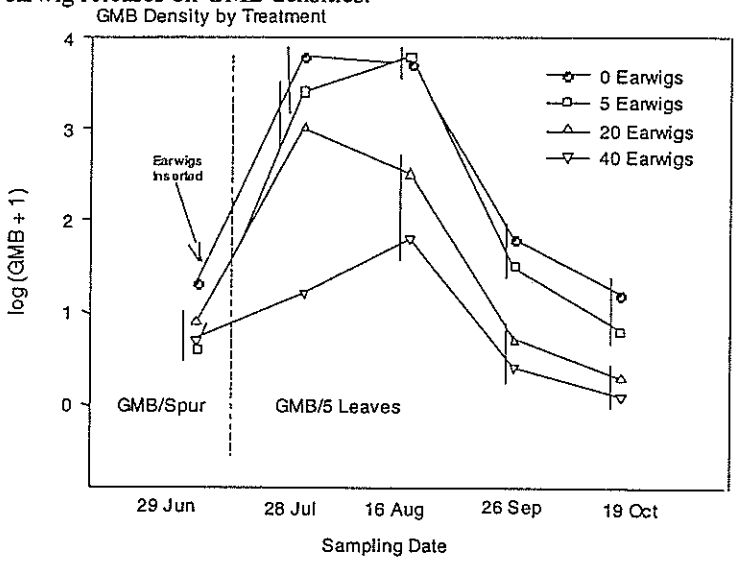
2. Evaluate populations of endemic natural enemies in unsprayed orchards, and cooperate in classical biocontrol programs for GMB

Unsprayed pear orchards were sampled for GMB natural enemies. In 2001, no parasitized GMB were identified. Populations of other natural enemies were moderate, with *Campylomma* and *Dereaocoris* occurring the most frequently. Earwigs were not sampled. Green lacewing only occurred during 2 of the 10 sampling periods.

Summary of Previous Results for this Project:

1. Biological Control
    a. Earwigs
        i. Lab studies caging earwigs on GMB infested small trees demonstrated that earwigs feed on GMB. Earwigs typically removed all GMB from caged shoots.
        ii. Earwigs established in limb cages also significantly reduced GMB populations. However, unlike in the lab, earwigs in field limb cages did not eliminate GMB.
        iii. Earwigs were demonstrated to have an effect on GMB populations in the field. Earwigs did not control high populations of GMB, but low populations of GMB did not increase in trees into which 200 or more earwigs were introduced.
        iv. Multiple releases of earwigs into GMB-infested pear orchards showed some reduction of GMB. However, variation in GMB sampling prevented conclusive results in large plot trials.

Figure 3. Effect of earwig releases on GMB densities.



b. Green lacewings

i. Lab studies caging green lace on GM- infested small trees demonstrated that lacewings feed on GMB. Lacewings typically removed all GMB from caged shoots.

1. release of lacewing nymphs was most effective
2. release of loose lacewing eggs was less effective than eggs stuck on cards

ii. Lacewings released into limb cages also reduced GMB

1. release of nymphs was again most effective
2. release of eggs demonstrated an effect, but significantly less effect than nymphs

iii. Multiple releases of lacewings into GMB-infested pear orchards had little effect on GMB populations

1. most effective treatment was spraying 10,000 eggs per tree ($12 / tree)
2. GMB populations were not significantly reduced by release of nymphs

Figure 4. Effect of lacewing releases on GMB densities

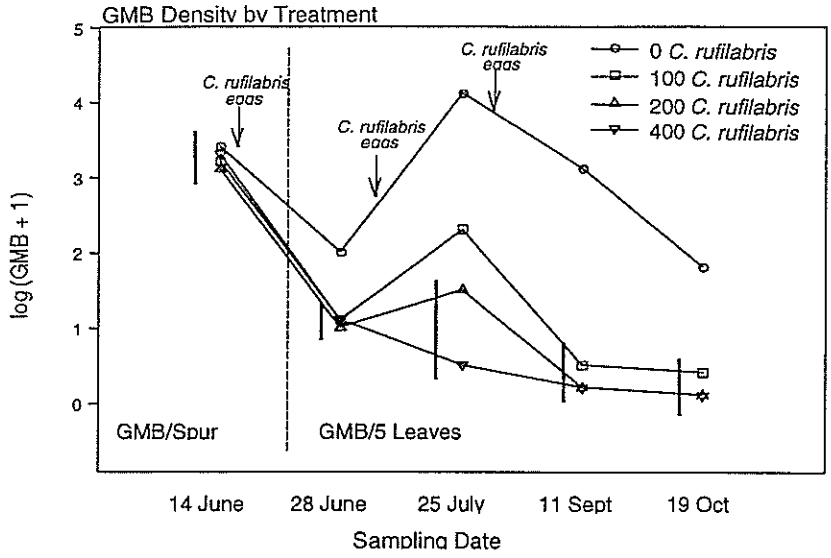
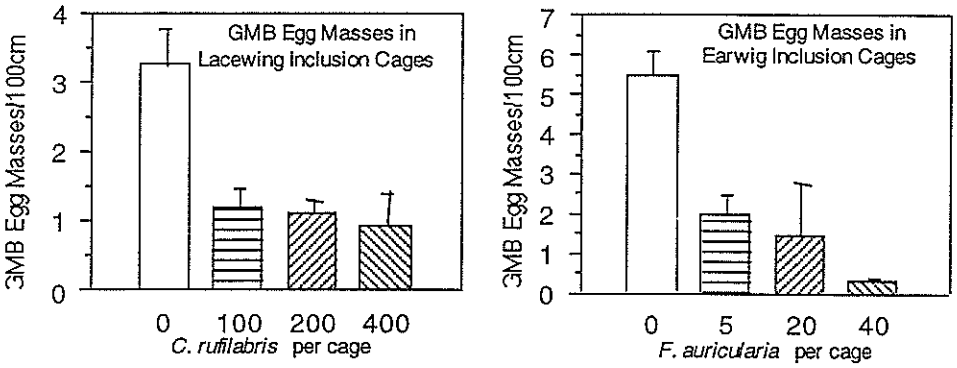


Figure 5. Effect of lacewings and earwigs on GMB egg mass densities



c. Other predators / parasites
    i. Surveys of unsprayed GMB-infested orchards found several species of parasitoids
        1. 3 encyrtid species
        2. no parasitoids of GMB have been found in commercial orchards
    ii. No unique predators (that aren't found frequently in commercial orchards) have been found in unsprayed GMB orchards
    iii. It appears that biological control of GMB will be very difficult

2. Basic biology
    a. Sampling
        i. The distribution of GMB within trees was described
            1. uniform in unmanaged orchards
            2. higher densities in the upper portion of the tree in the late season in sprayed trees
            3. overwintering generation makes the distribution more uniform in sprayed trees
        ii. Several sampling methods were investigated
            1. leaf sampling

a. too costly
2. shoot sampling
a. too costly
3. beat tray sampling
a. unreliable for sample small populations
4. timed visual inspection
a. best in-season field method, also fairly costly
5. egg mass counts
a. best method for predicting future infestation
6. fruit infestation
a. best method for determining efficacy of control
b. does not correlate with field population density

iii. Gene flow
1. preliminary studies have found variation in the esterases and malate dehydrogenase
2. PCR primers have not been identified yet

3. Chemical control
a. OP resistance
i. Occurs throughout the Wenatchee Valley
ii. Yakima populations are less sensitive
iii. High rates of Guthion and Imidan still control OP-resistant populations
b. Alternative materials
i. Chloronicotinyls are the best alternatives to OPs
1. 2 are registered
2. Newest materials listed in 2001 results
ii. Applaud is as good or better than the chloronicotinyls
1. registration is several years away
iii. Surround does not control GMB
iv. Amitraz provides a low level of control
v. Carzol provides a moderate level of control
c. Timing
i. Prebloom control of GMB is necessary
ii. Control of the summer generation is more difficult
1. reduction in GMB population is limited from all the materials
2. however, fruit infestation is low when an effective material is applied

Budget:

Proposed project duration: 3 years and this represents a final report
Current year request: 0

Year	Year 1 (1999)	Year 2 (2000)	Year 3 (2001)	Total 1999-2001
Total	52,400	29,200	35,000	116,600

Item	Year 1 (1999)	Year 2 (2000)	Year 3 (2001)	Totals 1999-2000
Salaries[1]	32,400	16,200	21,000	69,600
Benefits (32%)	10,380	5,190	6,720	22,272
Wages	7,000	6,000	5,500	18,500
Benefits (16%)	1,120	960	880	2,960
Equipment	0	0	0	0
Supplies	1000	350	400	1700
Travel	500	500	500	1500
Miscellaneous	0	0	0	0
Total	52,400	29,200	35,000	116,600