

# Final Project Report - NYS IPM Program, Agricultural IPM 2003-2004

## **Title:**

Development of a Risk Assessment Model for Mirid Bug Damage on Apples

## **Project Leader(s):**

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**Type of grant:** Monitoring, forecasting and economic thresholds

**Project location(s):** Findings may be applicable in apple-growing regions of New York, New England, Washington, Canada, Europe. Findings may be more broadly applicable to research into other pest/host systems in which synchronous phenology plays a key role in crop damage.

**Abstract:** Mullein plant bug damage is unpredictable. Sometimes, even when there are high nymph numbers, there is no damage. This is probably due to asynchrony between mullein bug egg hatch and apple bloom; apples are only susceptible from bloom through when fruit are about 0.5 inch diameter. Insecticides must be applied at the pink bud stage to prevent all economic damage. To avoid using insecticides unnecessarily at the pink stage, we need to be able to predict whether mullein bug egg hatch will occur when the crop is susceptible. To accomplish this we are comparing simulation models of MPB development and apple development for their ability to predict pest/crop synchrony under different winter and spring temperature scenarios. Results of model runs will be compared to historical data on pest/crop development and damage incidence. At this point in this multi-year project, models are being constructed. In addition, Red Delicious trees will be planted in pots, infested with mullein bugs by placing them in infested orchards, then subjected to various temperature scenarios, similar to those used in the model runs. Supplies have been ordered for planting in spring 2004.

**Background and justification:** Mullein plant bug (MPB) feeding causes scarring of the fruit, appearing as dark, raised pimples that result in downgrading and, when numerous, deformation and cullage. It is a sporadic but sometimes a potentially devastating pest in New York and New England, eastern Canada, British Columbia and the Pacific northwest. While it is generally considered a beneficial predator of pest aphids and mites in Europe, it is beginning to cause economic damage there, as well. MPB overwinters as eggs laid behind apple bark that, in most years, hatch around the time of Red Delicious full bloom. We have determined, as has another investigator (Reding et al. 2001) that the crop is most susceptible to damage during the period from bloom through petal fall and that the best insecticide strategy against this pest is to apply an effective material (there are several) at the pink stage, because by petal fall much of the damage has already been done. We have also determined a preemptive threshold for pink insecticide application (preemptive because nymphs do not usually hatch, and therefore cannot be detected, until full bloom) using pheromone-baited traps to monitor adult activity the preceding fall. However, in some seasons, even though numerous nymphs are present, no damage is observed even where insecticides have not been applied at pink. It is our belief that in seasons when apple blossom development is advanced in relation to MPB development the crop reaches a less susceptible stage before the bulk of the nymphs have hatched out. (This is probably why McIntosh usually do not suffer detectable damage — in most seasons MPB eggs have not hatched until McIntosh phenology is beyond the susceptible bloom–petal fall stage.) Insecticides directed at this insect at the pink stage will, therefore, be applied unnecessarily in

those seasons. Developing a method to predict when this asynchrony between bloom and MPB egg hatch results in no, or less than economic damage to the fruit, so that an insecticide will not be applied unnecessarily, is the final step in formulating a complete MPB risk assessment program. Predicting the degree of synchrony will require a temperature-driven model of apple tree development that can be compared with a model of MPB development. Normally, such models are based on degree-day accumulations from observed bud break to bloom. However, the accuracy of this approach is not very good. We have found preliminary evidence from experiments that development after bud break is affected significantly by late winter temperatures. Trees held at warmer winter temperatures (but not causing growth) bloomed earlier than trees held in colder winter temperatures. We plan to develop models that take these periods into account separately, and test the models against historical weather and phenology data from Geneva. If the models are validated in this test, they can then be compared to historical data on tree and MPB development and MPB damage.

## **Objectives:**

OBJECTIVE 1: Model apple tree phenological development and compare to MPB developmental model(s), and historical weather, tree development, MPB development and MPB damage data.

OBJECTIVE 2: Empirically determine the effect of varying late-winter and spring temperatures on spring development of apple and MPB on apple

OBJECTIVE 3: Determine whether fruit damage is different under different scenarios of late-winter and spring temperatures affecting synchrony between MPB hatch and apple bloom.

## **Procedures:**

### **1 - Model apple tree phenological development and compare to historical weather, tree development, MPB model predicted and historical development and MPB damage data.**

A temperature-driven model of apple tree development will be constructed and compared to historical weather and tree phenology data for validation. Output from the model under various winter and spring temperature scenarios will be compared to output from a model of MPB development to determine whether there are indications of asynchrony under the various scenarios. Finally, the models will be compared to historical Red Delicious and MPB hatch phenology and damage data from 1994–present for indications of correlation between weather patterns hypothesized to result in asynchrony in MPB hatch and Red Delicious bloom, and amount of fruit damage.

### **2 - Determine effect of late-winter and spring temperatures on spring development of MPB on apple**

1) In the fall, we will allow potted Red Delicious apple trees to become infested with MPB by placing them in orchards where MPB adults are caught in numbers above our current threshold

2) Examine trees for eggs to ensure that they are infested

3) In late fall, place infested potted trees in growth chambers set up to approximate temperature conditions experienced in a) a late winter with warmer than normal temperatures, followed by normal spring conditions, b) a late winter with warmer than normal temperatures, followed by cooler than normal spring conditions, c) a late winter with normal temperatures, followed by normal spring conditions, and d) a late winter with normal temperatures, followed by cooler than normal spring conditions. Monitor temperatures and calculate degree day accumulation.

4) Tap tree limbs each day during the egg hatch period to determine the number of MPB small and large nymphs present. Record tree growth stage each day.

**3 - Determine whether fruit damage is different under different scenarios of MPB hatch in relation to bloom.**

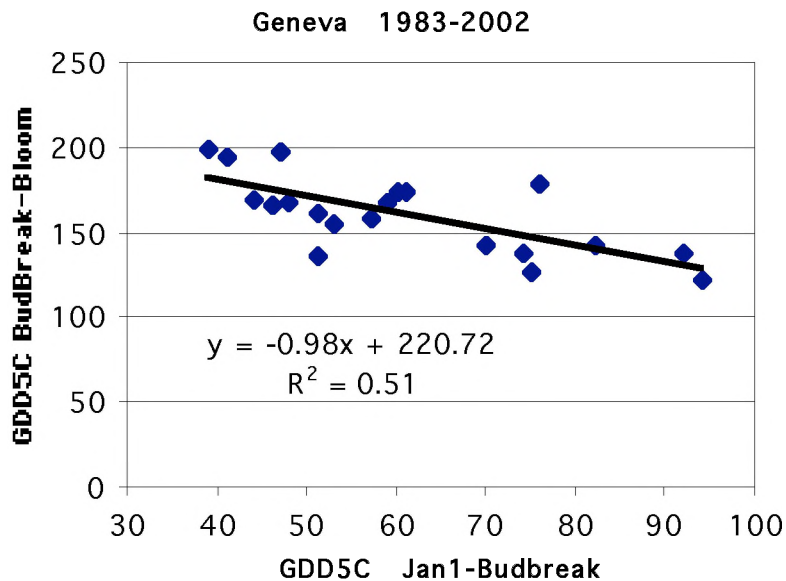
5) Pollinate flowers. (on trees used in Objective 2)

6) Examine fruit in each of the growth chamber scenarios for damage and record a) total number of fruit per tree, b) number of fruit/tree that are free of MPB damage, c) number of fruit/tree that have one or two minor blemishes (USDA Fancy), d) number of fruit/tree that have more than two minor blemishes or 1–2 major blemishes (USDA #1) and, e) number of fruit/tree that have greater than 2 major blemishes or are deformed (USDA Cull).

**Results and discussion:** This was the initial year of a multi-year project. Because funding was received mid-season an adequate number of appropriate trees was not available. Trees and planting supplies have been ordered for 2004. Modeling efforts are under way but the major portion of the work — running, validating and refining models — will be carried out in Winter 2003-04.

Generally apple bloom predictions are based on degree day accumulations starting at budbreak in the spring. Historically a 50°F base was used for the degree-day calculations. Based on limited experimental treatments and statistical analyses of over 20 years of observations at Geneva we have found several results that may relate to the apparent asynchrony of tree vs bug development. First, the number of days from budbreak to bloom at different base temperatures was tested. We found that the  $R^2$  of the relationship was 1% with 50°F base, 5% with 41°F base, and 74% with 32°F base. This indicates that the tree development can occur at temperatures much lower than at the commonly used base temperature of 50°F. 50°F has also been used as the base for MPB development although Judd and McBrien have shown a sigmoid form fits MPB development better. Nonetheless, MPB development is very slow below 50°F

Second, we have found that the number of degree days required for tree development from budbreak to bloom decreases with greater degree day accumulations from January 1 to budbreak (i.e. the warmer the winter-early spring, the less heat needed to get from budbreak to bloom) (Fig. 1). There is also a less clear but statistical suggestion that warmer falls in the previous years also reduces the heat needed to get from budbreak to bloom.



**Figure 1.** Heat required to move apples from budbreak to bloom decreases if the winter period up to budbreak is warmer as expressed by degree day accumulations above 5°C (41°F).

In four years (1994-1997), observed 50% MPB hatch ranged from 2 days before full bloom to 10 days after bloom. The statistical modeling has suggested that the observation of apparent asynchrony of the MPB hatch from the tree bloom may result from a difference of temperature sensitivity. The observation that there was relatively little damage in 2002 and 2003 as the MPB hatch was too late may be hypothesized to be due to a lower tree development temperature threshold. In 2002 and 2003 the last few weeks until bloom were cooler than normal, probably allowing more tree development than MPB development. Of course, these relations must be tested with controlled temperature studies with potted trees as we plan.

### References:

- Judd, G.J.R. and H.L. McBrien. 1994. Modeling temperature-dependent development and hatch of overwintered eggs of *Campylomma vebasci* (Heteroptera:Miridae). Environ. Entomol. 23 : 1224-1234.
- Reding, M.E., E.H. Beers, J.F. Brunner and J.E. Dunley. 2001. Influence of timing and prey availability on fruit damage to apple by *Campylomma vebasci* (Hemiptera: Miridae). J. Econ. Entomol. 94 : 33-38.