Integrating Benefits of Organic Apple and Pork Production. Jim Koan Almar Orchard, Flushing, MI and David Epstein Dept of Entomology, Michigan State University

A pilot project answered several fundamental scientific questions regarding the integration of livestock and organic apple production and potential benefits for pest management. Six one-acre plots, three grazed and three non-grazed were established in an eight-acre orchard, 15'X22' spacing. Hogs were rotated among three 1ac grazed plots, spending 2-3 days in each grazed plot per week for three weeks from mid-June-mid-July. Three 1ac ungrazed plots were monitored as a control.

"June Drop" Apples: Mean drops over a three-week period of approximately 123 apples per tree were measured in each of the 2007 and 2008 growing seasons. Field collected apples in 2008 were brought back to the lab, and the number of apples with PC oviposition scars was quantified. Apples were then placed in containers over vermiculite to allow PC larvae to exit. Forty-seven percent of field-collected, aborted apples had at least one PC oviposition scar, and 15.7 percent of drops contained viable PC larvae. Twenty-seven and 24 two-month old Berkshire hogs (20-30kg), grazed prior to predicted emergence of PC larvae, consumed over 99 percent of dropped apples in 2007 and 2008 respectively.

PC Larval Survivability: The ability of PC larvae to survive the hogs' digestive tracts was tested by mixing a total of 264 PC larvae into apple pulp, feeding the mixture to six growing pigs in 27 meals over a five-day period, collecting all feces, and examining the feces for the presence of living PC larvae. Total fecal collections were completed each day. No live PC larvae were collected from feces. This controlled PC larval feeding experiment demonstrated that ingestion by pigs was 100 percent lethal to PC larvae.

PC Oviposition and Feeding: Plum curculio damage to fruit was evaluated by sampling 600 fruit per plot in June and again in August for oviposition and feeding injury, respectively. Spring egg-laying injury from PC in 2007, prior to start of grazing, was 11% in grazed plots, 8% in non-grazed plots. Summer PC feeding injury, following the start of grazing in 2007, was 4.9 fold higher in non-grazed control plots ($p<0.0001$). Spring PC oviposition injury in 2008 was 8.7% in non-grazed plots and 4.1% in grazed plots. Summer PC feeding injury was 3.4 fold higher in non-grazed plots in 2008 ($p<0.0001$). Rooting of young hogs (under 60 lbs) in the tree row soil as they foraged through the orchard averaged 4-6 inches in depth. Rooting by hogs larger than 100 lbs resulted in some exposure of tree roots and some destruction of sod in the drive rows.

Codling Moth: Preliminary 2008 results suggest that rotational grazing with hogs may have a significant impact on CM damage. Codling moths were monitored in all six experimental blocks. Three pheromone-baited traps were placed in each block and checked weekly. A damage evaluation consisting of 20 fruit from 10 randomly selected trees within each block was conducted pre-harvest. Codling moth catch was slightly less in the three rotationally grazed plots compared to the ungrazed plots. However, total capture or total capture for either the first or second flight was not significantly different. Damage differed significantly between the grazed and ungrazed treatments with 2.7% and 7.5% damage observed in the grazed vs. ungrazed plots respectively. The fact that trap captures were not significantly different was not surprising

as the plots were narrow (2-3 rows wide) and in close proximity. Thus, the origin of moths caught in traps may not correlate well to how the hogs were deployed in the orchard. Expansion of plot size to 2 ac in the proposed project will allow for a proper evaluation of hog grazing on highly mobile insect and disease pests, such as codling moth and apple scab, that could not be well evaluated using the 2007-2008 plot design.

Weed Management: The impact of rotational grazing of hogs on orchard floor vegetation was monitored through the use of transects, biomass samples, and plant identification. Three 24 m permanent transects were established within each of the six blocks and percentage coverage data was collected beginning on May 8 and continuing through September 18, 2008 on at 21 day intervals. A standard Daubenmire frame (20cm x 50cm) was used as a quadrat with a reading taken at 1 m intervals. Percentage coverage of grass, forbs, shrub, tree, and bare ground were estimated at each sample date and reference photographs taken on the first sampling date (May 8, 2008). At the last sampling date (September 18 2008) a biomass sample consisting of total above ground biomass was collected from every third quadrant. Samples were placed in marked paper bags and dried in a soil-drying oven for 96+ h and then weighed. Prior to drying, plant diversity was estimated through the random selection of two of the samples with plants identified to species with separate biomass measurements taken for each.

Hogs did not appear to change the species of weeds present in the grazed orchards, but had a significant impact on weed cover and biomass. In grazed plots there was between 17% and 34% more bare ground throughout the 2008-growing season. Weed biomass at the end of the season was reduced by approximately 70%. Forthcoming data on species diversity and total above ground biomass may provide additional insights into how hogs may be utilized in place of cultivation or herbicides.

Reproduction and Health of Swine: Three Berkshire gilts and a boar were purchased in late 2006 and organic certification received in 2007. Two liters are produced per year to synchronize with planned dates for grazing in the orchard. Pigs in 2008 achieved a harvest weight of 250 pounds in nine months of age vs. 11 months in 2007. This is attributed to supplemental feeding of ground corn and wheat-milling by-product when not grazing.

Overall, the health status of the swine at AlMar Orchards is currently acceptable and not in need of pharmaceutical intervention. Fecal samples collected biweekly over 20-weeks were screened for internal parasites at MSU. *Balantidium coli*, a common, non-health threatening parasite was found in adults and offspring. *Blastocystis sp*. cysts were found in moderate amounts in over 60% of the fecal samples collected in 2008. Fecal samples contained a few *Ascaris suum* and *Strongyloids sp.* eggs, and *Coccidial* oocytes in both 2007 and 2008. About 15% of pig feces contained *Trichuris sp*. eggs in 2008.

Pigs, reindeer and turkeys at AlMar Orchards consistently excrete non-pathogenic *E. coli*. All samples collected from April to September of 2008 tested negative for salmonella. Less than 10% of pig feces tested positive for pathogenic *E. coli*. Aged fecal samples were tested for *E. coli* and salmonella in orchards 6, 10, and 19 weeks after grazing. Over 80% of aged-fecal

samples were positive for non-pathogenic *E. coli,* 5.4% tested positive for pathogenic *E. coli,* with one sample containing antibiotic resistant *E. coli*.

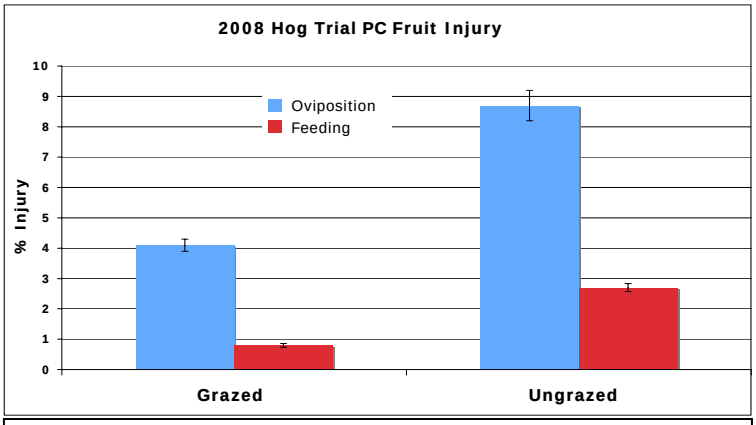
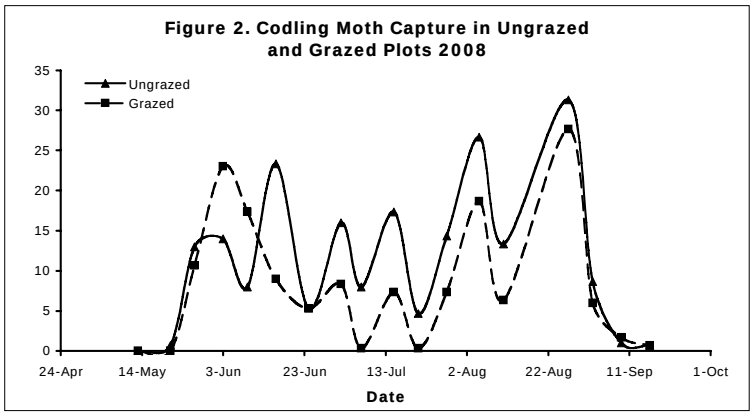
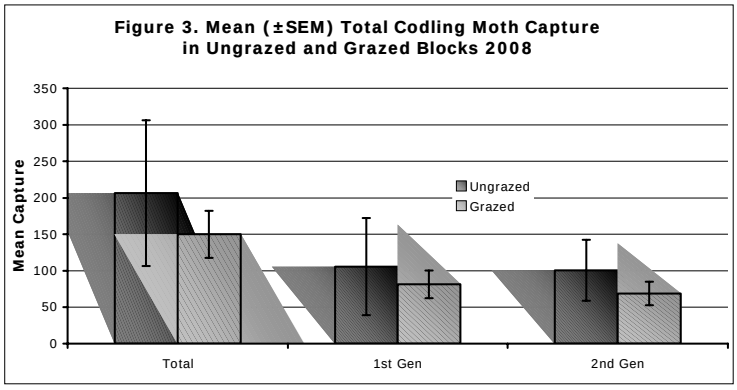


Figure 1. Plots flash-grazed with hogs had significantly less egg-laying (*p<0.001) and summer feeding injury (*p<0.001) to apples from plum curculio then occurred in ungrazed plots in 2008.





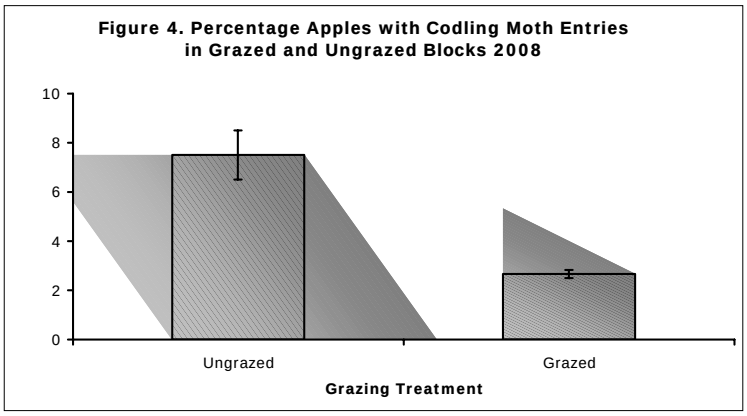


Figure 4. Percentage Apples with Codling Moth Entries in Grazed and Ungrazed Blocks 2008
10
8
6
4
2
0
Ungrazed
Grazed
Grazing Treatment

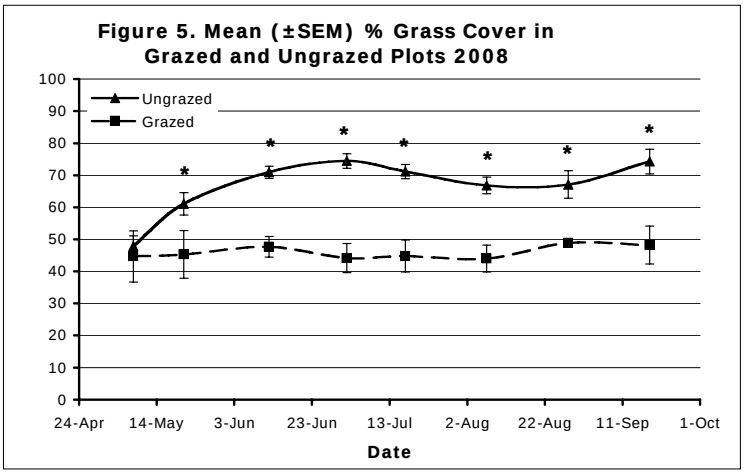


Figure 5. Mean (±SEM) % Grass Cover in Grazed and Ungrazed Plots 2008
100
90
80
70
60
50
40
30
20
10
0
Ungrazed
Grazed
24-Apr
14-May
3-Jun
23-Jun
13-Jul
2-Aug
22-Aug
11-Sep
1-Oct
Date