

## Experimentation to Monitor and Control Grape Root Borer

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Grape root borer, *Vitacea polistiformis* (Harris), is one of the most serious insect pests of grapes in the eastern United States. It is a clear winged moth, whose larval stage feeds exclusively on the roots of grape vines, both cultivated and wild species. Unfortunately it is rarely recognized as a destructive pest of grapes, except in the southern portion of its range. The moth has been captured from central Ontario at the northern limits of *Vitis riparia* to Miami, Florida and its currently known western boundary extends from Texas to Minnesota. Many areas of the Mid-Atlantic and New England states have never been checked for the presence of grape root borer in commercial vineyards. Grape root borer is definitely a major factor and possibly the main reason for premature vine decline in most areas. At our own vineyard located in Landisville, Pennsylvania it is the number one reason for the decline and death of grapevines. The only area of the East where grape root borer has never been found during testing is the grape belt along the south shore of Lake Erie.

In 1980 through 1982, Gerald Jubb, Jr. of Pennsylvania State University did a pioneering survey on the occurrence of grape root borer in Pennsylvania (Jubb, 1982). Previous to this survey only four known specimens of grape root borer had been found in Pennsylvania, all in the southeast. Our vineyard was one of 44 surveyed by Jubb and one of 11 with grape root borer present. In 1981, wine grapes had been grown in our vineyard for eight years and the area surveyed had been in grapes for only six years. A total of 60 vines were examined. Three pupal cases were found under two vines for an infestation rate of 3.3%. Two vineyards were found with high infestation rates, one in Adams County with 37.5% of the vines infested and one in Lancaster with 32.7%. Vineyards with grape root borer were found in Lancaster, Lebanon, York, Adams, Cumberland, and Northumberland Counties. Subsequent surveys have also found grape root borers present in Centre, Chester, Northampton, and Delaware Counties.

A large national survey in 1985 through 1987, using pheromone traps, found the moth in Pennsylvania, New Jersey, Maryland, Virginia, North Carolina, South Carolina, Georgia, Florida, Mississippi, Arkansas, Missouri, Ohio, and Michigan (Snow et al., 1991). In New Jersey moths were captured in Warren, Gloucester, Atlantic, and Burlington Counties. Only Washington County in Maryland was sampled and root borers were present. A survey of grape root borer was also done in New Jersey in the 1960's (Coniglio, 1965). Old reports have also found the moth in New York State, Vermont, and Minnesota.

The damage done by grape root borer larvae can be extensive. One larva in the root system can reduce the yield by 30%, while three larvae reduces the yield 50%. If one larva is feeding at the trunk base, the vine is usually girdled by about 6%, but the yield will decrease 47% (Dutcher and All, 1979). Two larvae feeding at the trunk base will

girdle the vine 12% and reduce the yield 73%. The lifespan of the grape root borer is one, two or three years, with the vast majority of time spent in the larval stage. In our own vineyard, chambourcin production decreased 69% in four years due to grape root borer.

The grape root borer is a clear winged moth that mimics the paper wasps of the genus *Polistes* both in appearance and habits. In our area adults emerge anytime from mid-June until the end of August, with the greatest numbers appearing from mid-July to early August. After emerging, the adults live about one week and are active only during the day. The males are most often seen flying about from 12:00 PM until 4:00 PM, with the greatest activity from 1:00 PM to 3:00 PM. The females are rarely seen flying in the vineyard. Both the males and females emerge from the pupa in the mid-morning. Females tend to remain in the immediate area and about noon begin to call the males with a pheromone. Release of the pheromone is responsible for the heightened activity of the males in the early afternoon. The morning after mating, the female begins to lay eggs. Each female lays an average of 350 eggs, with about half laid the first day. The remaining eggs are laid each day for the next week until death. Eggs are usually laid singly as the female walks about or flies short distances to leaves and shoots of the vine or any plants or weeds in the vineyard. Eggs are also laid on the bare soil.

The first indication of grape root borer in our 3 acre vineyard was the discovery of three pupal cases in 1981. Adult male grape root borer moths were first observed in the mid or late 1980's. Other observations of adult moths were made sporadically through the 1990's. In 1999 a few adults were observed but no mention was made in the vineyard journal. By 2000 the number of adult moths increased dramatically. Sightings of male moths were made on July 13, 14, 18, and 20. By the time adult male grape root borers were easily visible in the vineyard extensive damage had already been done. The production of chambourcin had decreased by 69% from 1996 to 2000.

In 2001 our vineyard was included in a study of grape root borer by Dr. Michael Saunders and Ms. Carrie McManaman of Penn State University. One white paper Pherocon 1C wing trap with a pheromone lure was placed in the middle of the vineyard. This type of trap is the standard used in almost all trapping studies for grape root borer. Unfortunately this type of trap proved to be totally ineffective. Large numbers of male moths were observed flying within a few feet of the trap but not entering. Moths were even seen entering the trap, landing on the sticky surface and then being able to fly away. With the failure of the trap to catch most of the moths, an inexpensive child's insect net, 1 foot in diameter, was used. During the summer of 2001 a total of 190 male moths were captured, 78 in the wing trap and 112 with the small insect net. In 2001 the first moth was caught on June 8<sup>th</sup> and the last on August 18<sup>th</sup>. The highest catch was on July 24<sup>th</sup> with 71 moths caught in the trap and by netting.

With the failure of the white wing trap in 2001, a different style of trap was utilized in 2002. Two universal moth traps or unitraps (also known as bucket traps) were placed in the center of the vineyard about 12 feet apart. One trap was all green, while the other trap had a white bucket, yellow funnel section, and green top. The trap with the yellow funnel section is identified in our work as a yellow-mixed trap. Each trap contained a

pheromone lure in the basket and a 10% DVPP toxicant insecticide PVC tape in the bucket to kill any moth that entered the trap. In 2002 a total of 239 moths were captured, with only 15 being caught with a net. Surprisingly, the yellow-mixed trap consistently caught more moths than the green trap. A total of 150 moths were caught in the yellow-mixed trap while only 74 were caught in the green. The pheromone lures were switched in the traps to check if one lure was defective, but the result was the same. The first moths were captured June 22<sup>nd</sup> and the last on August 23<sup>rd</sup>. The greatest catch was on July 17<sup>th</sup> with 106 moths in the traps and only 8 with the net.

With the apparent difference between the yellow-mixed and green traps, coupled with a continuing decline in chambourcin production, a much larger experiment was devised. The goals were to maximize the capture rate by determining the best color and placement of traps and to ascertain if mating disruption is possible using a high number of pheromone traps. The experiment was designed to attempt capture of all male moths with sufficient replicates for statistical analysis. Three different trap colors, green, white and yellow-mixed were used. A total of 27 traps of each color (81 traps total) were placed in the vineyard in a randomized complete block design. Each plot measured 18' by 72', containing a total of 24 vines and each block measured 54' by 72'. The color for each plot was selected using a ten thousand random digit table. A totally white universal moth trap was unavailable. Using a yellow-mixed color trap, the green top and yellow funnel section were sprayed white with a semi-gloss paint.

The placement of traps within the vineyard is also addressed by this experiment. Our vineyard has a standard three wire trellis system. Wires are located at 36", 54", and 72" above the ground. Vines are trained to a vertical shoot positioned bilateral or unilateral cordon depending on the variety. Traps were placed hanging from the wires so the pheromone lure was either 18" (low), 44" (medium), or 70" (high) above the ground. The low traps were well below the foliage and very visible, while the medium traps were placed in the fruiting zone and could be hidden by foliage. The high traps were initially visible, although by mid-July they could be hidden by foliage. A total of 27 traps at each height (81 traps total) were placed in the vineyard in a randomized complete block design. Each plot measured 54' by 72' and three traps of the same height treatment were placed in each plot. The height for each plot was selected using a ten thousand random digit table. Each height and color combination had a total of nine replicates. The experimental area covered 80% of the 3 acre vineyard. Twice a week or every three of four days, each trap was checked. In 2004 the color and placement of each trap was reassigned from the previous year using a ten thousand random digit table.

The first moths were captured June 28<sup>th</sup> (2 moths) and the last on August 30<sup>th</sup> (1 moth) in 2003. The highest catch was on August 2<sup>nd</sup> with 96 moths. In 2004, the first moth was captured June 29<sup>th</sup> and the last August 7<sup>th</sup>, with the highest catch on July 13<sup>th</sup> with 33 moths. A total of 224 moths were captured in 2003. In 2004 the total number of moths captured decreased 36% to 144.

The data collected in 2003 and 2004 was subjected to statistical analysis with two different programs. The first was the on line agricultural statistics analysis program

(AgStats02) provided by the Pacific Northwest Conservation Tillage Systems Information Source at <http://yolo.usda-ars.orst/steep/AgStatsweb/>. This program allows up to 16 treatments and 16 replicates and performs an analysis of variance. The level of significance can be selected at 1%, 5%, 10% or 20%. All data entered with this program utilized the randomized complete block design option. The other statistical program was SAS/STAT from the SAS Institute performing an analysis of variance and Tukey's studentized range (hsd) test.

Height treatment data in the statistical programs has been entered as low (18 inches above ground level), medium (44 inches above ground level), and high (70 inches above ground level).

Table 1 Height Treatments		2003	2004
high	70"	98 moths	66 moths
medium	44"	75 moths	40 moths
low	18"	51 moths	38 moths

Using the AgStats02 with nine replicates, no significant difference was found between the three treatments in 2003. When the data from 2004 was analyzed with AgStats02, the high placement at 70" was significantly better than the medium or low with a 5% level of significance.

Table 2 AgStats02 Height Treatment 2004

LSD (least significant difference) 2

Treatment Name	Mean	
high	7	A
medium	4	B
low	4	B

5% level of significance

No significant differences were found in the 2003 and 2004 height treatments using 27 replicates with Tukey's studentized range (hsd) test.

Color treatments are entered in the statistical programs as yellow (trap with yellow, green, and white components), green and white for 2003 and 2004.

Table 3 Color Treatments	2003	2004
yellow	101 moths	77 moths
green	88 moths	42 moths
white	35 moths	25 moths

Significant differences were found between the three colors each year. In 2003, using the

AgStats02 with nine replicates, the yellow-mixed and green traps were significantly better than the white traps at capturing moths and in 2004, the yellow-mixed traps were significantly better than the green or white traps.

Table 4 AgStats02 Color Treatments 2003 and 2004

2003	LSD	5		2004	LSD	3
Treatment Name	Mean			Treatment Name	Mean	
white	4	A		white	3	A
green	10	B		green	5	A
yellow	11	B		yellow	9	B
5% level of significance				5% level of significance		

With the Tukey's studentized range (hsd) test using 27 replicates, significant differences were found in the color treatments. In 2003, the yellow-mixed traps were significantly better than the white and in 2004 the yellow-mixed traps were significantly better than the green or white traps.

Table 5 SAS/STAT Tukey's studentized range (hsd) test Color Treatments

2003	LSD	2.0991		2004	LSD	1.1797
Treatment Name	Mean			Treatment Name	Mean	
white	1.2963	A		white	0.9259	A
green	3.2593	AB		green	1.5556	A
yellow	3.7407	B		yellow	2.8519	B
5% level of significance				5% level of significance		

Based on statistical analysis, the height treatments do not appear to be significant. Only the AgStats02 program in 2004, showed any significance with the high better than the medium or low. Testing will continue in coming years on the possible significance of placement. Each year the high traps have caught the greatest number of moths, but not in significant numbers.

The color treatments have shown a statistical significance each year. Yellow-mixed traps have captured the greatest number of moths each year and statistically are better than the white or the green and white traps depending on the year. The white traps have consistently caught the lowest number of moths and have been the poorest statistically. Although white paper wing traps have been used extensively in grape root borer research, their use should be limited to general survey work. Other colors of traps will be tested in the future.

Distribution of the grape root borer in a small area is very random. In the experimental

test area of 2.41 acres, there were plots with no root borers and other areas with high concentrations. Each year 25 traps or 31% caught no root borers during the 2.5 months of trapping. In 2003, 4 traps or 5% captured 25% of the total moths with the highest single trap catch of 17, followed by 15, 14, and 10. In 2004, 4 traps or 5% captured 20% of the total moths and the two highest trap counts were 8, followed by 7 and 6. A random reassignment of the traps is done each year because of this variability.

The total number of moths captured each year is decreasing. In 2002 with two universal moth traps, a total of 239 moths were captured. With the introduction of 81 traps to the vineyard in 2003, 224 male moths were caught. The following year in 2004, 144 moths were captured, a 36% decrease in one year. During the same time period production has increased, chambourcin went from 1.4 tons in 2002 to 4.0 tons in 2004. If the current trends continue in future years of testing, the mating disruption and control of grape root borer appears possible with the proper placement and color of traps.

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