Effect of grape variety on grape berry moth development

Final report

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Research priority: This proposal addresses the following research priority:
Disease and Pest Management: Development of effective, efficient and sustainable disease and pest management materials.

New Research (X)
Continued Research ( )

Amount Funded: $5,358

Project summary
This study determined differences in development, survival and fecundity of grape berry moth grown in Concord, Niagara, Riesling, Vidal and Chambourcin. We found differences in survival, egg and larvae development when gown on these cultivars in laboratory conditions. The results of this study have potential to improve the existing grape berry moth degree-day model after their validation in field conditions. This should translate into an ability to better time pest management strategies according to the grape cultivars grown in different vineyards.

Objective
To determine differences in development, survival and fecundity of grape berry moth grown on different grape varieties.

Materials and methods

Insect colony: Grape berry moth larvae were collected between Jun and August of 2021 from vineyards in the Lake Erie Region. These larvae were reared in laboratory conditions on the grapes they were initially collected. GBM larvae were allowed to pupate on sheets of paper inside plastic containers. Male and female pupa were transferred to plastic rearing cages (30 X 60 X 30 cm) containing a feeding substrate (cotton balls soaked in 1:1 honey-water solution) and an oviposition substrate (grape clusters) for the emerging moths. The rearing conditions were 26^{o}C, 50% RH and 16h photo phase.

Grape varieties: The development of GBM was tested in 5 different grape cultivars: Concord and Niagara (*Vitis labrusca*), Riesling (*Vitis vinifera*), and the French American hybrids Vidal and Chambourcin.

Insect development and survivorship: For each grape cultivar, 20 mated female moths were placed in a rearing cage (30 X 60 X 30 cm) containing a grape cluster hanging from the top and a honey/water-soaked cotton ball. Grape clusters were replaced with new ones every day until obtaining more than 50 GBM eggs per cultivar. These eggs were allowed to hatch and develop inside those berries with constant provision of fresh berries as needed. Sheets of paper tissue were placed inside the plastic containers as pupation substrate. Once the adults emerged from pupae, they were paired (male and female) and isolated in small plastic enclosures with grape clusters from the same grape cultivar in which they had developed. New grape clusters were provided every day for oviposition until death of the female moths.

Data collection: We collected the following information of GBM grown on each grape cultivar:

- Time of egg development (Number of days from egg laid to larvae hatch)
- Time of larvae development (number of days from neonate hatch to pupation)
- Duration of pupal stage (days)
- Egg hatch, larvae survival, pupa survival, and adult emergence (percentage of GBM stages that successfully developed)
- Fresh weight of pupa
- Moth pre-oviposition period (days)
- Number of eggs produced by each GBM couple
- Longevity of female moths (days)

Data analysis:

We calculated the average number of days it took for the different GBM stages to develop on each grape cultivar. Statistical differences among grape cultivars were calculated using the non-parametric test of Kruskal-Wallis for non -normally distributed data. Egg hatch, larvae survival, pupa survival, and adult emergence were calculated as percentages.

Results

Time of egg development. In our laboratory conditions, GBM embryos took 3-5 days to develop with an average of 4.6. We found significant differences in egg development on different grape cultivars (Kruskal-Wallis rank sum test, chi-squared = 39.309, df = 4, p-value = 6.014e-08). We found faster egg development on Niagara compared with vidal; and slower development in Chambourcin compared with those laid on Niagara and Riesling (Figure 1).

Time of larvae development. GBM larvae took between 9 to 26 days to develop, with an average of 16 days. There were significant differences in egg development on different

grape cultivars (Kruskal-Wallis chi-squared = 91.679, df = 4, p-value < 2.2e-16). GBM larvae feeding on Niagara grew faster than those grown in Concord, Riesling and Vidal, but were not different from those fed on Chambourcin (Figure 2). Similarly, GBM larvae grown in Chambourcin grew faster than those fed on Concord, Riesling and vidal (Figure 2). GBM larvae grew faster when fed on Concord than when fed on Riesling (Figure 2).

Duration of pupal stage. GBM pupa took between 7-10 days to develop with an average of 9.3. We did not find significant differences in the development of GBM pupa coming from larvae fed on different grape cultivars (Figure 3).

Survival. The survival of grape berry moth embryos (egg hatch), larvae, pupa, and adult emergence was calculated for individuals growing on different grape cultivars. Egg hatch was above 96% in all grape cultivars; however, for most cultivars only 80% of neonate larvae were able to bore into the grapefruits, this percentage was much lower in Vidal (52%) (Table 1). From the number of larvae that successfully bored into grapefruits, only 40% on average became pupae. From those that pupated, an average of 32% became adults. These percentages varied with the grape cultivars in which the insects grew (Table 1). Larvae fed on Riesling and Vidal had higher mortality at the larval and pupae stages than those fed on Chambourcin and Niagara. Larvae fed on Concord had slightly higher mortality than those fed on Niagara (Table 1).

Fresh weight of pupa. GBM pupa weighs on average 4.8 mg. We did not find differences in pupa weight among the grape cultivars tested.

Moth pre-oviposition period. Moths took between 3-7 days to lay eggs after their emergence as adults. We did not find differences in pupa weight among the grape cultivars tested.

Female oviposition and longevity. On average each grape berry moth female laid 6.2 eggs in 11 days. We did not find differences in oviposition and adult longevity among the grape cultivars tested.

Technology Transfer Plan

The results of this study will be disseminated to growers by the PI of the project through extension meetings and through online publications at the Penn State Extension Wine and Grapes blog (https://psuwineandgrapes.wordpress.com/). Results of this project will also be presented at the regional Mid-Atlantic Fruit and Vegetable convention in January of 2023; this meeting brings together educators, growers and industry partners from Pennsylvania, New York, Maryland, New Jersey, Virginia and Delaware, among others. The results of this work will also be disseminated through the general public and scientific community through a publication in a peer-reviewed journal that is currently in preparation.

Attachments

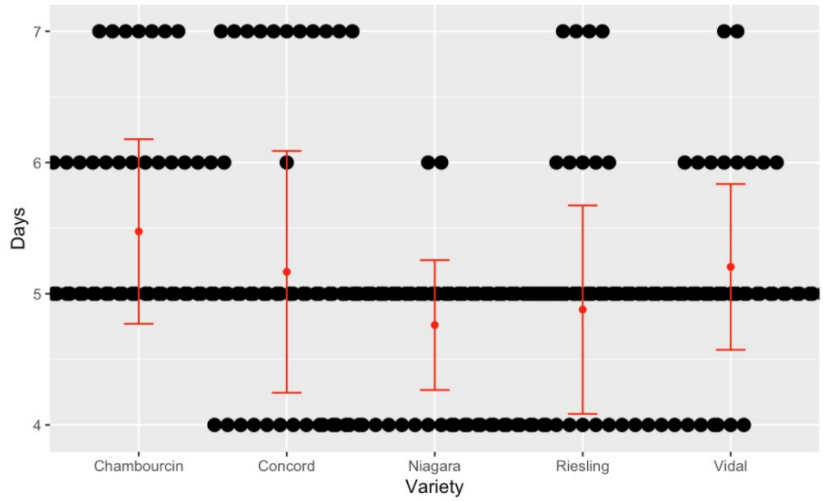

Figure 1. GBM egg development on various grape cultivars. Bars represent means and standard errors. Black dots illustrate the dispersion of the data.

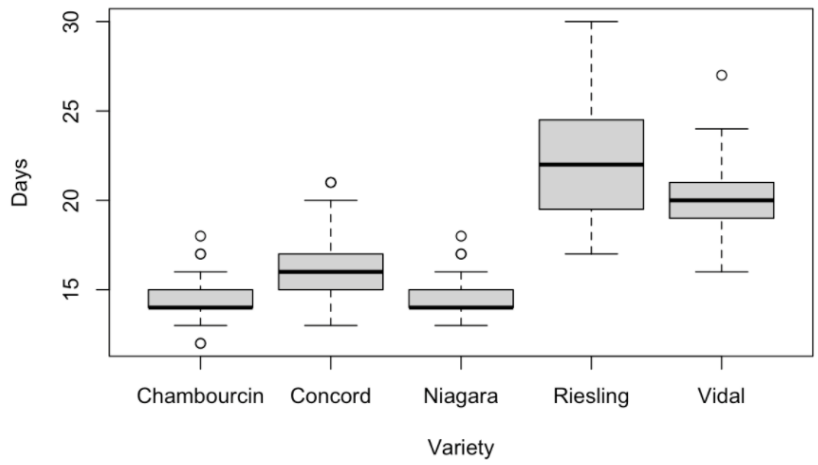

Figure 2. Development of GBM larvae in various grape cultivars. Bars represent means and standard errors. White dots illustrate the dispersion of the data.

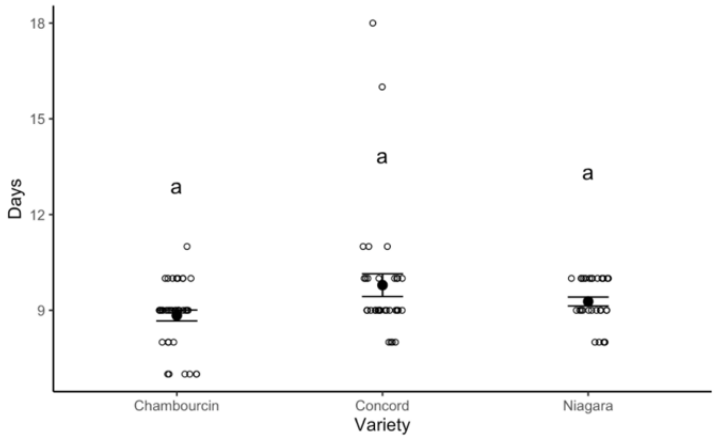

Figure 3. Development of GBM pupae coming from larvae fed on various grape cultivars. Bars represent means and standard errors. White dots illustrate the dispersion of the data.

Table 1. Survival of grape berry moth stages on various grape cultivars

Cultivar	n	% hatched eggs	% larvae that bored into the fruit	% pupae developed	% emerged adults
Concord	84	96.43	79.76	45.24	35.71
Niagara	91	100.00	81.32	54.95	50.55
Riesling	85	100.00	80.00	23.53	14.12
Chambourcin	68	97.06	86.76	61.76	47.06
Vidal	84	100.00	52.38	15.48	10.71

Conclusions

The results of this study show differences in life history traits of grape berry moth growing in different grape cultivars in controlled conditions. These results will need to be validated in the field to determine the interactions of the host plant and the environmental on grape berry moth populations. This information has potential to improve the existing grape berry moth degree-day model by including the grapevine cultivar as an additional variable. This should translate into an ability to better time pest management strategies according to the grape cultivars grown in different vineyards.