ANNOTATED BIBLIOGRAPHY OF THE GRAPE ROOT BORER (LEPIDOPTERA: SESIIDAE)

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ABSTRACT

An annotated bibliography of the grape root borer, Vitacea polistiformis (Harris) is presented. The entries include information on the biology, control, damage impact, distribution, and importance of the species in the eastern United States. This pest is of growing importance to the commercial grape industry.

RESUMEN

Se presenta una bibliografía del barrenador de la uva Vitacea polistiformis. La bibliografía incluye información sobre la biología, control, daño, distribución, e importancia de las especies en el Este de los Estados Unidos. Esta plaga está aumentando en importancia para la industria comercial vitícola.

The grape root borer, Vitacea polistiformis (Harris) (Lepidoptera: Sesiidae) is an important pest on grapes in the eastern United States. The species has an obligate diapause and attacks the roots of grape vines. The life cycle requires two years, approximately twenty three months of which are spent as larvae feeding within and under the cambium of the root tissue. Pupation begins in early summer of the second year, and depending on geographic location, adults fly from mid-June through October.

The most recent information on distribution shows that the species occurs as far south in the United States as central Florida and as far north as southwestern Michigan (Snow et al. 1989). This area includes all of the Atlantic Coast states south of Connecticut and east of Kansas. Populations are greatest in the southern states, with incidence gradually decreasing the further north one goes. The species has been recorded in significant numbers in southern Pennsylvania (Jubb 1982) and Ohio (Alm et al. 1989), but it does not occur in the northern areas of these states around Lake Erie, where there is a concentration of commercial grape production. However, it is reported from southwestern Michigan along Lake Michigan.

Damage caused by the grape root borer has resulted in enormous losses to the commercial grape industry. It has been blamed for the destruction of entire vineyards in Florida (Adler 1982), and in South Carolina, it is cited as the cause of the total cessation of bunch grape production (Pollet 1975). Dutcher & All (1979) determined that a single larva is capable of causing a 6% girdling of the vine trunk which is associated
with a 47% reduction in yield. Those authors also indicate that two or three larvae are capable of killing an entire vine if they are feeding in an essential part of the root system.

All varieties of grapes, both cultivated and wild are subject to attack by the grape root borer. For many years, 'Scuppernong', a variety of muscadine, was thought to be resistant to attack (Brooks 1907), but this later proved incorrect (Wylie 1972).

Several natural enemies have been documented over the years. Among these are the barn swallow Hirundo rustica erythrogaster Boddaert, the mockingbird Mimus polyglottos polyglottos (L.), the crested flycatcher Myiarchus crinitus (L.), the braconid wasp parasite Bracon caucicola (Gahan), the lightning bug larva Photuris pennsylvanica De Gress, the nematode Neocaprecta cariopcivae Weiser, and two insect pathogenic fungi, Beauvaria bassiana (Balsamo) and Metarrhizium anisopliae (Metchnikoff) (lark & Enns 1964, Sarai 1972, Dutcher & All 1977, Brooks 1907, and Sorensen 1975).

Many methods of cultural control have been attempted. Some of the earliest methods involved techniques such as pouring hot water on the exposed roots to scald the larvae (Saunders 1889), or simply replanting vineyards away from old, infested ones (Ritcher 1989). Today, the best cultural method appears to be mounding of soil under the vines to prevent emergence of adults. Dutcher & All (1985) reported this technique results in an 83% reduction in adult emergence. This method is also successful in preventing new larvae from penetrating the soil (All & Dutcher 1978). Attwood (1963) and Wylie (1972) reported polyethylene strips placed under grape trellises were effective as a control.

The best method of control at the present time is with insecticides. All et al. (1982) reported chlorpyrifos (Loraben) effective in killing newly hatched larvae. Ethylene dibromide and ethylene dichloride are also effective against larvae if applied correctly. All & Dutcher (1977) demonstrated that a pressure-flow injection device is the most practical method of injecting toxicants into the soil. Other methods of application, such as soil surface applications, foliar sprays, and systemics, gave less than satisfactory results.

The discovery by Schwarz et al. (1983) of the grape root borer pheromone, (E,Z)-2,13 octadecadien-1-ol acetate and its later improvement by Snow et al. (1987) provided researchers with a reliable tool for monitoring the adult seasonal activity of the species. As a result, the timing of control measures can now be scheduled more efficiently than in the past, when exuviae counts were the only means of detecting the pest. Future expansion of this technology may lead to improved methods of control.

It has been our attempt in this publication to provide researchers and other interested persons with all the published information available on the grape root borer, including biology, distribution, economic importance, and control. The bibliography provides the literature citations necessary for obtaining the articles, and the annotations summarize the contents of the articles. The subject index is designed to lead the reader to articles that deal with particular subjects. A few publications that we were unable to obtain are not annotated, but most of them are old and outdated.

This paper was written because of increased grape production in the eastern United States and an increased interest in V. politiformis due to its growing economic importance.

Annotated Bibliography


3. All, J. N., and J. D. Dutcher. 1977. Subsurface and surface insecticide applications to control subterranean larvac of the grape root borer. J. Econ. Entomol. 70:649-652. Twenty five insecticides evaluated at various rates for larval control. Tests included contact, systemic, and fumigant insecticides. Several application methods tested. Only injection of fumigants among infested roots close to the vine collar or in lateral roots under the trellis effectively controlled larvae. Ethylene dibromide and ethylene dichloride most effective. Pressure-flow injection device most practical method of injection.

4. All, J. N., U. E. Brady, and J. D. Dutcher. 1978. Persistence and bioactivity of encapsulated and emulsified formulations of methyl parathion in soil infested with the grape root borer. J. Econ. Entomol. 71:236-238. Encapsulated and emulsifiable concentrate formulations of methyl parathion did not control larvae in subsurface and surface applications of 2.2 and 4.4 kg Al/1000 ml, respectively. Low efficiency due to lack of penetration into the soil.

5. All, J. N., and J. D. Dutcher. 1978. Current status of grape root borer infestations in Georgia: promising control methods. Georgia Agric. Res. 19(4):17-20. Contact and systemic insecticides hold little promise of controlling larvae that have established on the roots. However, certain fumigants highly effective in controlling larvae if injected into soil within 6-8 inches of infested roots. Injection of ethylene dichloride with a pressure flow injection device most effective and practical technique evaluated to date for controlling larvae.

6. All, J. N., M. C. Saunders, J. D. Dutcher, and A. M. Javid. 1981. Susceptibility of grape root borer larvae, Vitacea palistiformis (Lepidoptera: Sesiidae) to Nippolecta carpopusae (Nematoda: Rhabditida): potential of host kairomones for enhancement of nematode activity in grape vineyards. In Misc. Publ E/SA-J2:9-14. Strain of N. (=Steinerrena) carpopusae infecting larvae found in 1974. Studies in vineyards revealed low mortality at two sites, 1.5% for larvae and 0.8% for adults. Laboratory bioassays demonstrated high levels of nematode required to insure high infection of newly-eclosed, 1-, and 2-year-old larvae. Inundative application of N. carpopusae, adequately applied to soil around grape vines failed to infect resident larvae. Suggested that borer has evolved tolerance to this nematode.

7. All, J. N., M. C. Saunders, and J. D. Dutcher. 1982. Soil treatment with chlorpyrifos for control of first instar grape root borers. Insecticide and Acaricide Tests. 7:37. Chlorpyrifos residues in treated soil toxic to 1st instar larvae for up to 14 days. Greatest mortality at the highest rate tested, 4.4 kg Al/acre.

8. All, J. N., M. C. Saunders, and J. P. Dutcher. 1982. Control of the grape root borer. Eastern Grape Grower and Winery News. 8(2):42-43. Reported "barrier" type applications for control of young larvae with chlorpyrifos successful by providing a toxic residue in the soil for at least 3 weeks. (This was before chlorpyrifos was registered.) Weed control and close cutting of cover crops under vines mentioned as useful cultural practices. Also, mounding of soil or use of plastic mulches under trellis mentioned as mechanical barriers. Injection of fumigants found most effective when done in late fall after harvest or in early spring.

methods for control. Chlorpyrifos lethal to newly-hatched larvae for at least four weeks. Granular and emulsifiable concentrate treatments equally effective at rate of 2.3 kg Al/1000 linear m. Soil treatments of chlorpyrifos, methyl parathion and carbaryl inhibited egg hatch; lindane ineffective. Chlorpyrifos and several other insecticides not lethal to pupae and did not inhibit adult emergence in treated soil. Mounding of soil under vines reduced adult emergence by 83%.

10. All, J. N., J. D. Dutcher, and M. C. Saunders. 1987. Control program for the grape root borer in grape vineyards of the eastern United States. Down to Earth. 43(2), Aug:10-12. General review article on grape root borer. Chemical control with chlorpyrifos covered in detail. Recommends 2.25 pints of Lorsban 4E/100 gallons of water applied to 200 vines. Coarse spray of 0.5 gallons total volume/vine should be applied on 15 ft² area around base of each vine.


15. Attwood, V. G., W. D. Wylie, and W. P. Boyer. 1963. Survey method for grape root borer (Vitacea polistiformis polistiformis) as used in Arkansas. CfTR (7-12-63) 13(28):808. Successful survey method: count empty pupal cases in vineyards. When pupae come to soil surface, about one third of the pupal cases extend above ground. Adults emerge when in this position. After adult emerges, empty pupal case remains intact. Ninety percent or more of the adults emerge within a 1 ft radius of the trunk of the vine. Searching under the vine for empty pupal cases during last half of July and all of August will reveal presence of grape root borer.


Lists grape root borer (Sciapteron polistiformis) larvae collected in stems of grape vines within 50 miles of New York City. Accuracy of report questionable.


25. Clark G. N., and W. R. Enns. 1964. Life history studies of the grape root borer (Lepidoptera: Sesidiidae) in Missouri. J. Kansas Entomol. Soc. 37:57-63. Excellent paper on the biology and economic importance in Missouri. Reported as serious pest. Some vineyards completely destroyed. Adults reported to emerge from July to September in single or bimodal peaks. Observations on mating and number of eggs laid also reported. Most ovipositions on weeds beneath the vines or on low hanging leaves of grapevine. No larval preference reported for age or size of roots attacked. As many as 25 larvae reported within 1 ft radius of crowns. Beauvaria bassiana and Metarrhizium anisopliae reported as fungal pathogens. Birds reported as predators of adults.


30. Dutcher, J. D., and J. N. All. 1977. The summer activity, damage impact, and

31. Dutcher, J. D., and J. N. All. 1978. Predictive models for the summer activity of *Vitacea polistiformis* in Concord grape vineyards. Environ. Entomol. 7(3):456-460. Summer activity in three northern Georgia 'Concord' vineyards presented as set of regression models of pupal development and grape berry sugar accumulation as state variables forced by degree-day input. Significant correlation between these two phenological regressions. Useful pest management tool which can predict pupal development state from accumulated berry sugar content.

32. Dutcher, J. D., and J. N. All. 1978. Survivorship of the grape root borer in commercial grape vineyards with contrasting cultural practices. J. Econ. Entomol. 72:751-754. Life tables constructed for single two year generations of grape root borer in two 'Concord' grape vineyards with contrasting cultural systems. With scheduled insecticide treatments, annual intertrelis tillage, and 4-arm Kniffin training system, egg mortality from predation 11.6% and egg hatchability of eggs not killed by predators 25.3%. With no insecticide treatment, no annual tillage, and Modified Munson training system, egg mortality by predation 61.7% and egg hatchability 76.8%. No significant differences for survival of subterranean life stages. Lowest survival in larval period from eclosion from egg to establishment of first feeding site; highest survival in larval period spent in feeding site and during pupal stage.

33. Dutcher, J. D., and J. N. All. 1978. Reproductive behavior of *Vitacea polistiformis* (Harris). J. Georgia Entomol. Soc. 13(1):59-63. Mating, calling behavior, and oviposition cycle presented in excellent detail. Mating occurs between 1300 and 1800 hours and is completed in one to four hours. Male moths attracted to a calling female exhibit characteristic mating sequence. Male briefly contacts female antennae, then hovers over the female abdomen, thrusting with genitalia, then couples. Oviposition begins between 8.00 and 9.00 on morning following mating and continues during day for up to eight days. Moths oviposit 51% of eggs within 24 hours of mating. Mean fecundity 354 eggs/female. Mean incubation period 14 days at 20 degrees C. Squash vine borer males attracted to calling grape root borer females, but repelled when flying within 1-2 cm of the female.

34. Dutcher, J. D., and J. N. All. 1979. Biology and control of the grape root borer in Concord grape vineyards. Fruit South. 24(5):6-8, 11-15. Very good overview. Includes literature overview and own research over five year period. Data presented deal with reproductive behavior, bionomics, and control, and pest management strategy proposed. Control achieved by combining subsurface applications of fumigants against subterranean larvae and pupae, accurate timing of foliar insecticides against moths, and soil mounding to prevent adult emergence from soil and neonate larva from reaching grapevine roots. Natural enemies of subterranean stages, particularly *M. anisopliae*, *B. bassiana*, and N. (=Steinernema) *carpocapsae*, enhanced by increasing soil moisture through irrigation.


37. Dutcher, J. D., and J. N. All. 1979. Damage impact of larval feeding of the grape root borer in a commercial Concord grape vineyard. J. Econ. Entomol. 72:159-161. Relationship between root injury by grape root borer and vine vigor parameters in a commercial vineyard. Single larva can cause a 6% girdling of the trunk base, associated with 47% reduction in yield. Feeding on trunk base much more detrimental than feeding in peripheral roots. Low economic injury level of grape root borer suggests an even lower economic threshold level. Conclude that insecticidal control measures should be used as soon as presence of grape root borer is detected in vineyard.


Agric. Res. & Dev. Ctr., Hort. Series 59(2):25-30. At present, grape root borer found only in southern half of Ohio. Monitoring northern half of state will continue to see if range extends. Current research activities aimed at control include cultural control (plastic mulch), chemical control (chlorpyrifos), and use of confusion/disruption technique.


62. Kron, F. J. 1854. To all cultivators of the grape vine in the south. In E. Mitchell, The Grape Vine. Raleigh Register Semi-Weekly, 5 April:2. According to Bambara 1977, this was first report of grape root borer attacking cultivated grapes in North Carolina. Adult activity reported from 8:00 AM to 6:00 PM with peak activity about 1:00 PM.


65. MacKay, M. R. 1968. The North American Aegeriidae (Lepidoptera). A revision based on late instar larvae. Mcm. Entomol. Soc. Canada, 58:112. Contains revision of family based on larval characteristics of about 60 species. Discusses and illustrates larval characteristics for most species. Larvae of grape root borer collected from French Creek, West Virginia; Atlanta, Georgia; and Tifton, Georgia.


to parasitize grape root borer. They carry bacterium, *Pseudomonas aeruginosa* or *P. septica*, which is fatal to insect (septicemia). Field tests with nematode against peach tree borer were conducted in Arkansas. Nematodes sprayed onto vine trunks with low pressure sprayer. Adequate moisture critical to infestation.


76. Pollet, D. K. 1975. The grape root borer in South Carolina. Clemson Univ. Ext. Ser. Cire. 550-7. Extension-type paper that first reports grape root borer in South Carolina in 1967. Since that time, 300-350 acres of bunch grapes have been destroyed, and yields greatly reduced. As a result, some counties have ceased bunch grape production. Reported in 22 counties. No chemical control cited, but mounding with grape hoc reported as providing good control. Time of activity in South Carolina cited as early as June 27 and as late as Sep. 20. Peak activity reported about August 15. Two year life cycle reported.


81. Sarai, D. S. 1969. Effect of burial of grape root borer pupae on adult emergence. J. Econ. Entomol. 62:1507-1508. Soil hoed out from vineyard, then thrown back on grapevine roots with grape hoe when most of mature larva had pupated. Data showed ridge about 7.5 inches high and two feet wide gave effective control of pupae. Considered practical by author and also helped to control weeds. Seasonal adult cycle also given for both control and treated plots.

82. Sarai, D. S. 1972. Seasonal history and effect of soil moisture on mortality of newly hatched larvae of the grape root borer in southern Missouri. J. Econ. Entomol. 65:182-184. General paper on seasonality of grape root borer. Details of
head capsule measurements, oviposition, seasonal pattern of emergence, survival in roots with different moisture levels, etc., covered. Concludes three year life cycle probable, based on presence of three different sizes of larvae in roots. Peak adult emergence on Aug. 10, 1987, and July 25, 1968. Larvae and some pupae attacked by Beauveria bassiana and Metarrhizium anisopliae.

83. Saunders, M. C., and J. N. All. 1985. Association of entomophilic rhabditoid nematode populations with natural control of first-instar larvae of the grape root borer, Vitacea polistiformis, in Concord grape vineyards. J. Invert. Path. 45(2):147-151. Laboratory and field bioassays determined susceptibility of 1st instar larvae to entomophilic rhabditoid nematode, Neoaplectana (=Steinernema) carpocapsae. Augmentation of nema population during critical period of oviposition and eclosion suggested as control technique.


89. Snow, J. W., M. Schwarz, and J. A. Klun. 1987. The attraction of the grape root borer, Vitacea polistiformis (Lepidoptera: Sesidiidae) to (E,Z)-2,13 octadecadien-1-ol acetate and the effects of related isomers on attraction. J. Entomol. Sci. 22(4):371-374. The addition of one (1) percent (Z,Z)-3,13 octadecadien-1-ol acetate to the grape root borer pheromone. (E,Z)-2,13 octadecadien-1-ol acetate, greatly increased capture of males in sticky traps. Numbers collected increased from three to seven times, depending on test, location, and time of season. New blend sufficiently attractive to provide effective monitoring system.


rearing. Air and soil temperature at surface and 3 inches below surface monitored during adult emergence period. Vines with no grape root borer emergence average yield were 4.97 kg per vine; vines from which 6 grape root borer emerged averaged only 2.41 kg per vine. Yield increased as distance from old vineyard increased.

102. Townsend, H. C., and S. Micinski. 1981. Grape root borer research. Proc. Arkansas State Hort. Soc. 102:154-157. When adult emerges from pupal case in soil, case left protruding from soil. Cases found and used as indicator of adult emergence. Soil surface under each vine examined weekly for pupal cases from July 15th to September 15th. Peak emergence week ending August 11. Pupal cases found in all directions from trunk of vine, at distances up to 136 cm (54 in) from trunk. Previous research indicated 90% emerged within 35 cm (13.5 in) of trunk. In this study radius of 94 cm (37 in) needed to include 90% emergence. Average distance 47 cm (19 in).


112. Wylie, W. D. 1972. Grape root borer research. Proc. Arkansas State Hort. Soc. 86:94-95. Provides brief look at the various control measures tried in Arkansas. Incorporating insecticides into soil to kill larvae leaving roots to form cocoons ineffective. Using plastic cover around vine stalk to decrease adult emergence effective when properly done. Application of some insecticides to soil surface appeared to be highly effective in preventing larval entry into soil. Emulsified ethylene dichloride injected into soil around base of grape vine gave control without damaging vines. Ethylene dichloride used as spray ineffective. Two natural enemies, the green muscadine fungus and a nematode, appear successful in reducing natural populations. Reports in the literature that ‘Scuppernong’ grape immune to grape root borer attack are erroneous.


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ENDNOTES

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