L-5069

Texas Agricultural Extension Service
The Texas A&M University System

The Pepper Weevil and Its Management

David G. Riley and Alton N. Sparks, Jr.*

The pepper weevil, *Anthonomus eugenii* Cano (Figure 1), is a severe insect pest of sweet and hot varieties of pepper, *Capsicum* spp., in the southern United States, Mexico, Central America, Hawaii and several Caribbean islands. Adult pepper weevils feed on fruit and leaf buds and lay eggs on flowers, buds and fruit. Larvae (grubs) feed inside pepper pods. This causes premature fruit drop and can result in significant crop losses of up to 50 percent (Figure 2). Often, entire pepper fields must be plowed under because too few fruit are left to harvest, and the infestation poses a threat to later pepper plantings. Up to 90 percent fruit loss has been measured in experimental plots infested early in the season and left untreated. Additionally, even moderate infestations late in the season can cause complete loss of fields. Larger fruit do not immediately drop when they become infested, and entire fields are often abandoned because of concern in shipping infested fruit to markets.

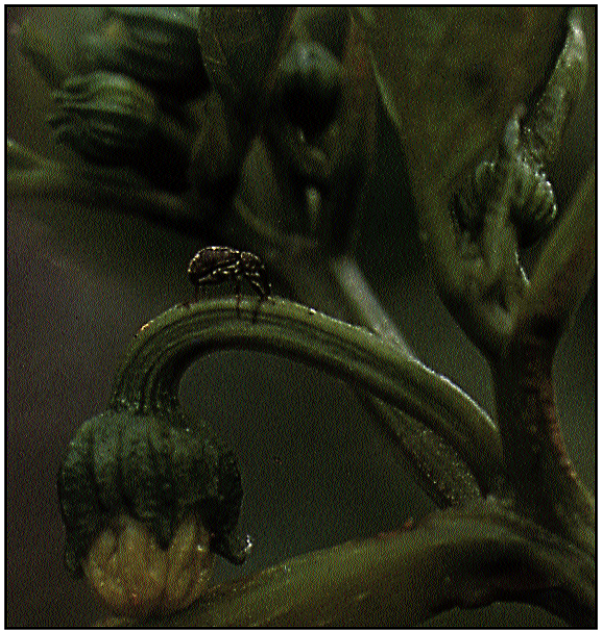

Figure 1. Pepper weevil adult on bell pepper.

Figure 2. Pepper weevil grubs in pepper fruit and fallen bud.

*Assistant Professor, Texas Agricultural Experiment Station, and Associate Professor and Extension Entomologist, Texas Agricultural Extension Service.

Pepper Weevil Biology

The pepper weevil shares many of the characteristics of other members of the genus *Anthonomus*. The weevil feeds on relatively few plant species, and females oviposit (lay eggs) on flower buds or fruit. Pepper weevil grubs develop inside the bud or fruit, and like the cotton boll weevil, *Anthonomus grandis*, the pepper weevil has three larval instars and multiple generations per year. Diapause has not been detected in the pepper weevil, which means that its northern range is limited to areas that can support pepper weevil host plants throughout the winter.

Management should begin with an understanding of the pepper weevil's life cycle (Figure 3) and the factors that influence its population growth. Information on the biology of the pepper weevil is summarized in Table 1. Generation time and the number of generations per year are determined primarily by host availability and temperature. The pepper weevil can complete its larval development in the fruit and/or flowers of most pepper varieties and on several species of nightshade. Investigators report varying generation times for the pepper weevil, with the largest differences occurring between summer and fall when temperatures vary most. In hot weather the generation time is shortest, about 13 days.

Newly emerged adults are light brown and darken to a grayish-black in 2 to 3 days. The mating and egg laying begins about 2 to 3 days after emergence. In one season it is possible to have three or four generations of weevils, and if

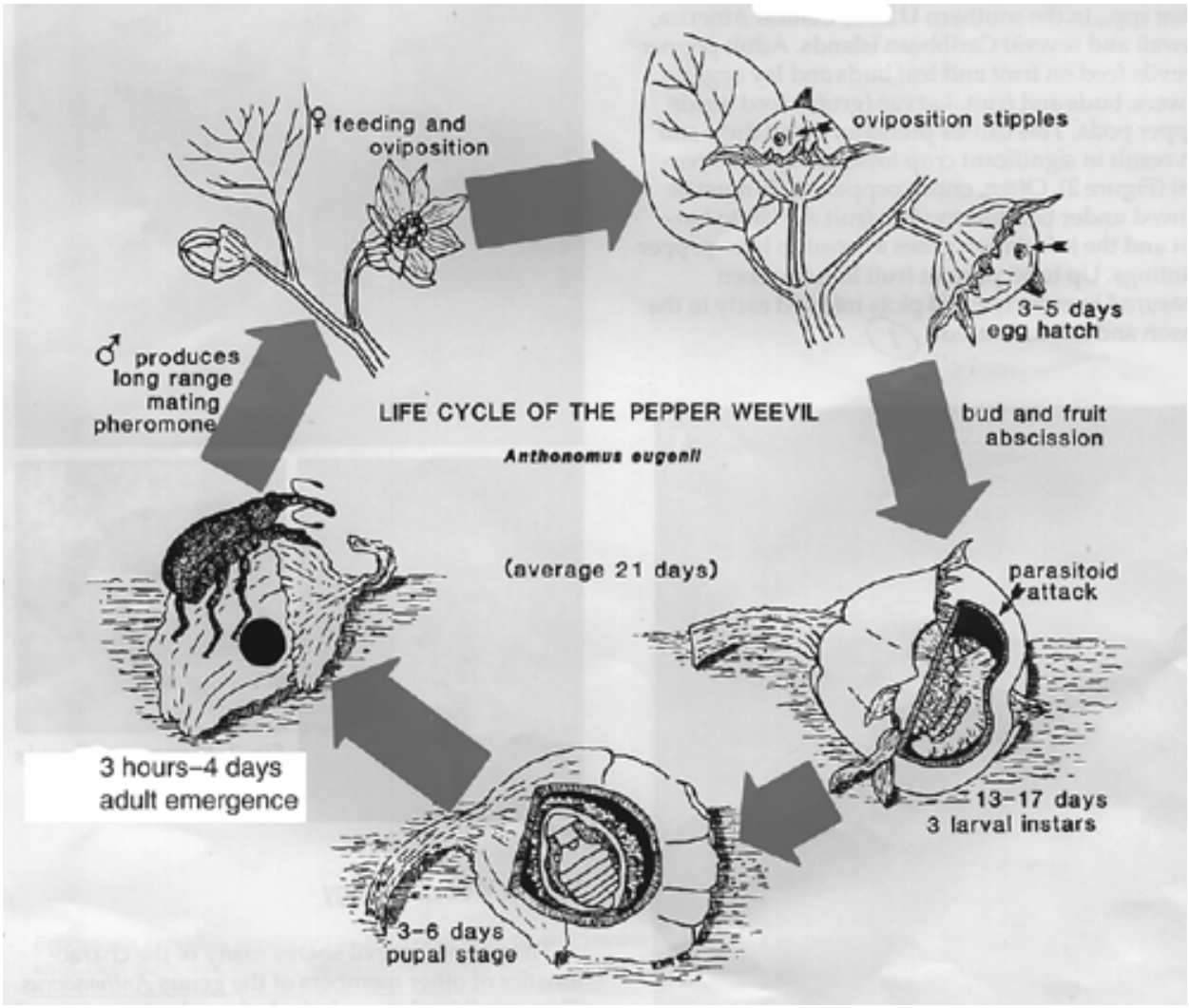

Figure 3. Life cycle of the pepper weevil. Illustration by E. Vasquez.

Table 1. The biology of the pepper weevil, *Anthonomus eugenii* Cano.

Generation time	2 weeks in hot weather 3 weeks in mild weather 6 weeks in cold weather
Generations/year	5 to 8
Longevity of adults	3 months average with food 1 to 3 weeks without food
Oviposition period	more than 1 month average
Fecundity	average 340 eggs/adult
Oviposition rate	average six eggs/day
Natural enemies	**Predators** Solenopsis geminata (fire ant) Strunella magna (meadow lark) Tetramorium guineese (ant)
	Parasitic wasps Pyometes venticosis Catolaccus incertus Pediculoides ventricosus Bracon mellitor Habrocytus piercei Zatropis incertus Catolaccus hunteri
Natural controls	freezing temperatures overheating of fallen fruit destruction of fallen fruit lack of host material
Host plants	peppers and nightshades

the spring and fall crops overlap, problems with pepper weevil can be much greater in the second crop. In South Texas, survival of adults between cropping seasons is greater between the fall and spring crops because of lower temperatures.

The size of the fruit, previous pepper weevil oviposition or feeding, and the availability of sufficient host plants are important factors in the selection of egg-laying sites. The plant species that sustain higher weevil populations are typically the more preferred. Developing fruit 1.3 to 5.0 centimeters in diameter are preferred over smaller or larger fruit for egg laying. Pepper weevil females probably lay most of their eggs during the day, and avoid fruit buds with eggs already present. Varietal differences in peppers may affect host preference somewhat, but are not sufficient to be utilized in control programs.

More research is needed to determine the effects of varietal differences. Recent tests suggest that pepper varieties which produce large numbers of small fruit (unlike bell pepper, for example) have more fruit that escape damage.

Sampling for Pepper Weevils

Weevils are likely to re-infest fields as they move to and from secondary host plants and cull sites. Little data regarding pepper weevil movement is available, but they may be able to move long distances. Most field observations suggest that pepper weevils disperse slowly through pepper fields early in the season, which can result in localized clumps of weevils and their damage. Peppers planted next to infested nightshade, peppers or pepper culls are likely to be attacked first.

The clumped pattern of pepper weevil infestation in the field makes scouting more difficult. There is a great tendency to underestimate pepper weevil numbers unless sufficient samples are taken. More pepper weevils are found along field margins than in the interior of the field, so sampling along the margins will give a better idea of infestation and reduce scouting time. Pepper weevil adults are often found in the same sample locations from week to week. It is important to locate these “hot spots” of pepper weevil activity to determine if they need extra chemical controls and to discover possible causes of weevil re-occurrence that might be avoided in the future.

Methods of detecting pepper weevil activity include 1) inspecting terminal buds or bud clusters for pepper weevil adults, 2) using yellow sticky traps for adults, 3) making direct weevil counts using whole plant inspections, 4) scouting for feeding damage or egg laying in terminal bud clusters, and 5) using boll weevil traps baited with pepper weevil males or pheromone extracts. The presence of medium-size fallen fruit should not be used as the first indication of pepper weevil activity, because at this point it is far too late to prevent significant yield loss (Figure 4). For each day that a mature adult goes uncontrolled, six new weevils are produced. Thus, if a fruit takes 3 days to abort and another 2 days pass before the problem is detected, each adult female would have laid an additional 30 eggs prior to detection of the fallen fruit. Also, weevils inside

Figure 4. Fallen fruit in an infested pepper field.

fallen fruit cannot be controlled with insecticides. Only the adults that come in contact with the insecticide are controlled with sprays, so it is important to determine adult activity in the field.

The lack of frequent scouting and accurate monitoring of pepper weevil populations are major limitations to the implementation of action thresholds (using scouting data to decide whether or not to spray). Where pepper weevils are known to be a problem, fields should be sprayed periodically from before first bloom to harvest. This is the recommended practice if a reliable sampling method is not used, but this practice uses excessive insecticides if weevils are not present and can lead to other pest problems. Studies of the relationship between damage and weevil infestation levels suggest that the following levels can be used to prevent economic loss in bell peppers: 1) 5 percent damaged terminals or 2) one pepper weevil per 200 plants, inspecting two terminal buds per plant. With the terminal bud inspection method, at least 800 plants (approximately one-half hour of scouting) must be inspected without finding a single weevil before a decision not to treat a pepper field can be made with a high level of confidence (Table 2). If weevils are found in less time, then insecticide applications are justified.

Table 2. Sampling for pepper weevil adults or damage in bell pepper.

Sampling method	Minimum sample (time)*	Comments
Whole plant inspection	25 plants (1 hour)	Approximately 2 minutes per plant, less time on seedlings.
Terminal bud inspection	1,600 terminals (1/2 hour)	1 second per terminal; search for adults only.
Damage to terminal buds	200 terminals (1/2 hour)	10 seconds per terminal; must inspect closely for egg laying.

*Only if no weevils at all are found within these minimum times should a decision be made not to treat.

Control of the Pepper Weevil

To economically control weevils once they become established, it is best to implement a spray program based on frequent, accurate scouting. Plants should be checked in many locations within the field to properly assess the level of pepper weevil activity. Insecticides registered for pepper weevil are listed in Table 3. These organic insecticides do not cause excessive residues on harvested fruit. The availability and relatively low cost of effective insecticides make regular applications an attractive option for reducing risk. Even so, an intensive scouting program and the use of action thresholds for weevils and other pepper pests should be used to reduce the possibility of insecticide resistance; avoid outbreaks of secondary pests such as mites, whiteflies and thrips; reduce insecticide costs; better target limited-use insecticides; and monitor efficacy of control practices. The two recommended thresholds for pepper weevil, as stated earlier, are 5 percent damaged terminal clusters or one adult

Table 3. Insecticides registered for the pepper weevil on bell pepper.

	Lbs AI/acre	Pre-harvest interval	Comments
Permethrin	0.1-0.2	3 days	No more than 1.6 lbs AI/acre/season.
Oxamyl	0.5-1.0	7 days	Best in calendar sprays or in combinations[1].
Esfenvalerate	0.025-0.05	7 days	No more than 0.35 lb AI/acre/season, suppression.
Cryolite	25-50	0 if washed	Wash off residues or apply before fruit formation.

[1]Other products used in combination: azinphos-methyl, methomyl.

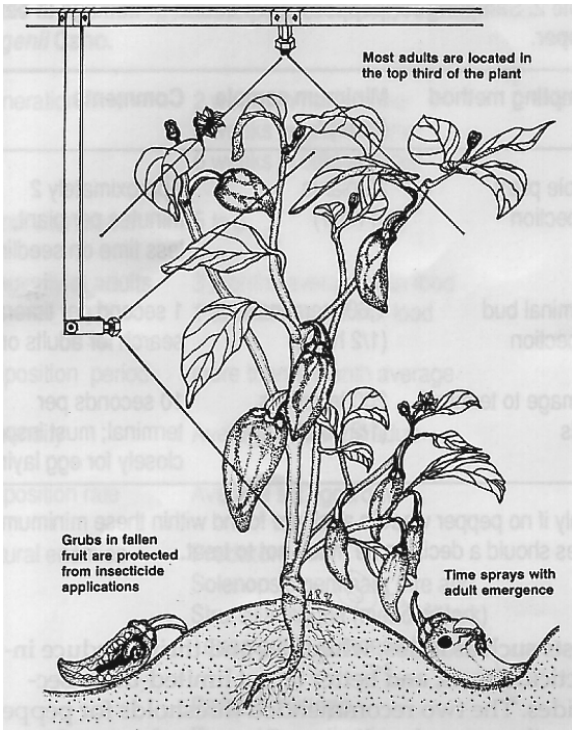

Figure 5. Timing and placement of sprays are important for pepper weevil control. Illustration by A. Riley.

per 200 plants with two terminal buds inspected per plant. In the Lower Rio Grande Valley these levels are best used after an early-season preventive spray at first bloom.

Immature weevil stages cannot be controlled with insecticides, even systemics. However, as many as 30 percent of the weevil grubs in fallen fruit may be killed as sunscald heats and dries the fruit.

Recommended cultural controls include the destruction of pepper residue immediately after the last harvest, removal of pepper culls which can harbor weevils inside, making sure transplants aren't infested, and the removal of nightshade from pepper fields and field margins. If new peppers are planted next to old peppers then the old peppers should be sprayed before plowing because destruction of the old host material can trigger a migration of weevils to the new pepper planting. Because host plant availability largely determines weevil population level, the most effective control methods, other than pesticides, are eliminating pepper culls and secondary host plants such as nightshade. The only biological control known at this time is the feeding of certain hymenopterous parasites on pepper weevil grubs; however, their impact appears to be minimal. Parasites have been found in oxamyl-treated plots where an action threshold for insecticide application was used, so parasitism can complement insecticide controls.

Recommended Management Practices for Pepper Weevil

1. Avoid locations with pepper weevil infestations when selecting sites for a new pepper crop.

2. Scout fields weekly beginning at transplanting or before first bloom. Also scout nightshade plants and old pepper residue in the area before planting to determine if a preplant cleanup is needed.

3. Avoid carry-over of weevils from one season to the next. This is a problem where peppers are cut back to produce a second crop or crop residue is left standing after harvest.

4. If weevils infest early, begin controls at first bloom to prevent an early build-up of pepper weevil.

5. Target insecticide sprays at the adults by getting good spray coverage and timing applications with the presence of adults or their emergence from fallen fruit.

Issued in furtherance of Cooperative Extension Work in Agriculture and Home Economics, Acts of Congress of May 8, 1914, as amended, and June 30, 1914, in cooperation with the United States Department of Agriculture. Zerle L. Carpenter, Director, Texas Agricultural Extension Service, The Texas A&M University System.

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