Entomopathogenic Nematodes Are Effective at Killing Plum Curculio Larvae in the Soil

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Current recommendations to control plum curculio (PC) rely on insecticide applications targeting adults. Due to various environmental and regulatory concerns, there is a need to develop alternative and more sustainable management strategies for this pest. Entomopathogenic nematodes (EPNs) have been identified as being promising biological control agents of key insect pests. EPNs are very small, soft bodied, non-segmented roundworms that are parasites of insects. The nematodes are obligate parasites of insects in nature. EPNs occur naturally in soil environments. They locate their prey in response to carbon dioxide, vibration, and other chemical cues.

When an EPN is used against a pest insect, it is critical to match the right nematode species against the target pest. About a dozen nematode species are produced commercially as biological control agents of economically important insect pests including the larvae of several weevil species. Results from previous research conducted by USDA ARS scientists indicate that, relative to the untreated check, the EPN species *Steinernema riobrave* caused 85.0% and 97.3% control in 2011 and 2012, respectively, in Belchertown, Massachusetts, and 100% control in West Virginia on both years. Another nematode species, *Steinernema feltiae*, caused 0% and 84.6% control in 2011 and 2012, respectively, in Belchertown, and 78.2% and 69.7% control in West Virginia. These results are highly encouraging because this is the first time that biological control of

Pyramidal emergence trap used for the quantification of PC adult emergence after the application of either, the EPN *Steinernema riobrave,* or water (control). Trap dimensions: 1.1 x 1.1 yards at the base.

PC shows high potential for controlling immature stages of PC. Here, we present results of on-farm research that aimed at demonstrating the level to which EPN *Steinernema riobrave* applied to the soil underneath the canopies of perimeter-row apple trees is effective at killing PC larvae.

Materials & Methods

Study sites and experimental cages. This study was conducted in seven orchard blocks located in Massachusetts (five blocks) and New Hampshire (two blocks). Within each block, individual perimeter-row trees and their understory were used. Two pyramidal emergence traps (1.1 x 1.1 yards at the base) made of PVC and steel screen were placed underneath the canopy of each tree. Within each tree, the assignation of cages for treatment (EPN application, see below) or control (water only) was done at random. A plastic conical device that topped each cage permitted the capture of adult PCs that, upon adult emergence from the immature stages, walked upward on the interior surface of the capturing device. Thirty-two cages (16 were assigned to EPNs, 16 served as controls) were deployed in all across all seven blocks. Each orchard block received 4-8 cages.

Experimental approach. Prior to the placement of the emergence cages, 75 apple fruitlets that were suspected to have PC larvae were placed on the ground, underneath tree canopies. The fruit was spread out to cover about 50% of the area under the emergence cages. All fruitlets were collected from unsprayed trees in Belchertown, Massachusetts. EPNs were obtained from BASF Corporation. EPN application rate was 4 million of infective juvenile nematodes per square meter (1.1 yards) and were applied in 3.78 L of water. For each tree, one cage received EPNs and the other cage received water (3.78 L) alone. Afterwards, the cages were buried and flagged with treatment information and application date (July 16-20, 2018). Starting on 15 August 2018, the number of adult PCs collected in the capturing device were recorded and removed on a weekly basis. Other than the amount of water that was applied during treatment application, no additional

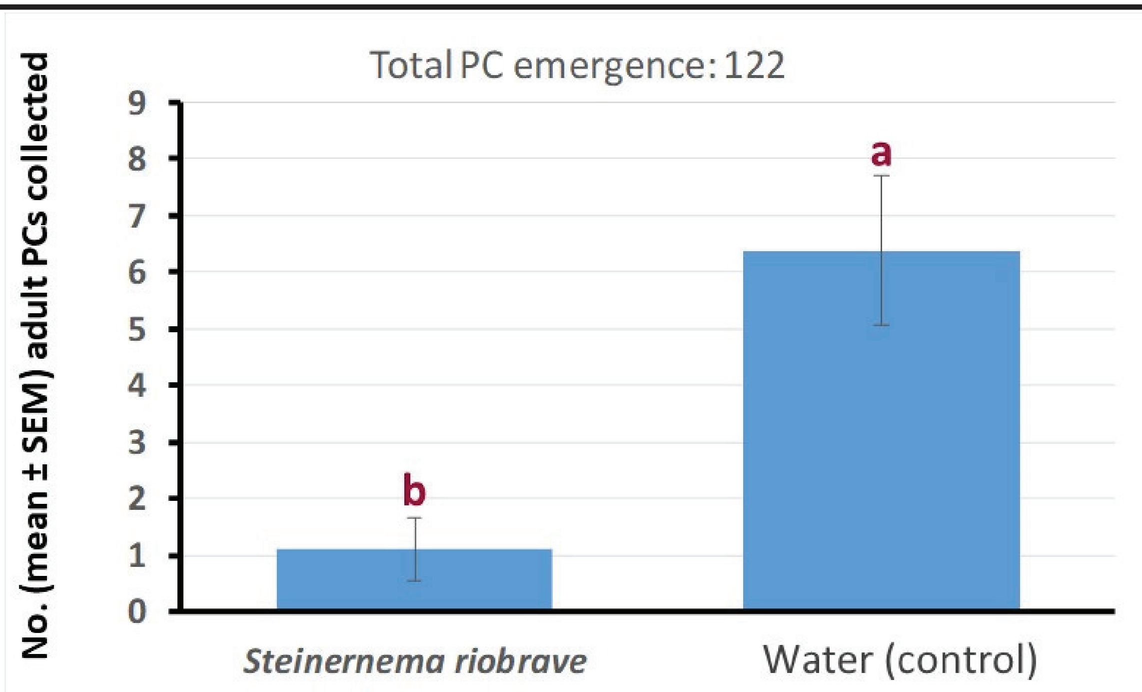
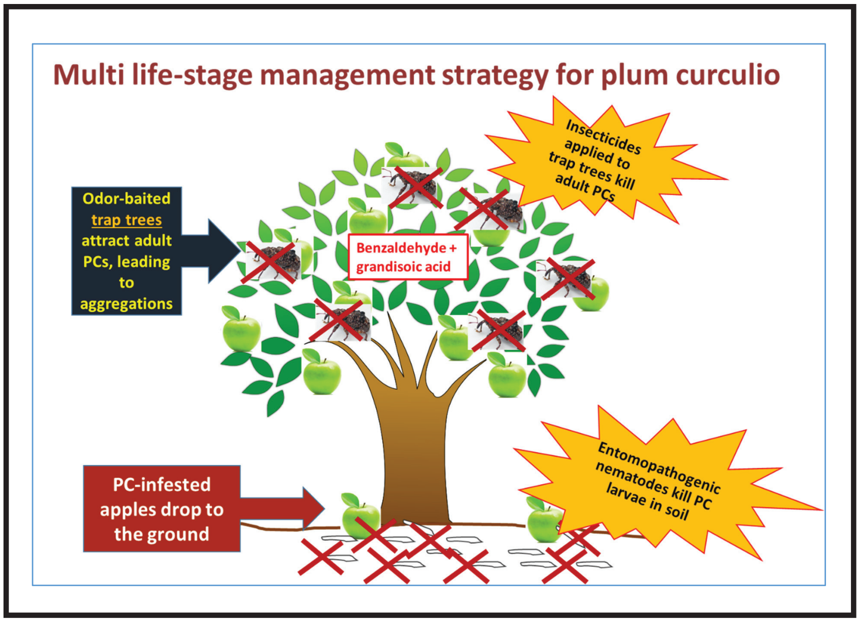


Figure 1. Number (mean ± standard error of the mean [= SEM], *a measure of how precise the estimate is*) of adult plum curculios (PCs) that were recovered from emergence cages following application of either, the EPN *Steinernema riobrave,* or water (control). Different letters above bars denote statistically significant differences between treatments at odds of 19:1.



irrigation took place. Treatment effects were assessed by comparing the number of adult PCs emerging from cages subject to EPN application versus control cages.

Results

Overall, 122 adult PCs were recovered from the 32 emergence cages (103 weevils from control cages, and 19 weevils from EPN-treated cages), a result that indicates that only a low number of fruit that was placed inside the cages (2,475 fruits) was actually infested with PC. On average, 1.1 adult PCs were recovered from EPN-treated cages while 6.4 adult PCs were recovered from control cages (Figure 1). Thus, the application of EPNs led to a 5.5-fold decrease in the number of adult PCs emerging relative to the untreated check.

Conclusions

Our results indicate that the EPN *Steinernema riobrave* is effective at killing PC larvae in the soil. The overall goal of this research is to use EPNs as a biologically-based component of an IPM program that targets multiple stages of PC. This approach makes use of attractive lures to pull adult PCs to selected perimeter-row trees. The canopies of odor-baited trees are then sprayed with adult-killing insecticides while the other trees in the block do not receive insecticides to control PC (see preceding *Fruit Notes* article). By only spraying odor-baited trees the total number of trees that receive insecticide treatment can be reduced by more than 90%. As a result of adult PC aggregations, there is also aggregation of fruit injury by PC in odor-baited trees. As shown here and also from previous research, EPNs can then be applied to the soil of those trees to kill PC larvae, which will also be concentrated in those areas compared to any other trees in the orchard.

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Literature Cited

Leskey, T.C., Piñero, J.C., and Prokopy, R.J. 2008. Odor-baited trap trees: a novel management tool for the plum curculio, *Conotrachelus nenuphar* (Herbst) (Coleoptera: Curculionidae). Journal of Economic Entomology 101: 1302-1309

Shapiro-Ilan, D.I., Leskey, T.C., and Wright, S.E. 2011. Virulence of entomopathogenic nematodes to plum curculio, *Conotrachelus nenuphar*: Effects of strain, temperature, and soil type. Journal of Nematology 43: 187–195.

Shapiro-Ilan, D.I., Wright, S.E., Tuttle, A.F., Cooley, D.R. and Leskey, T.C. 2013. Using entomopathogenic nematodes for biological control of plum curculio, *Conotrachelus nenuphar*: Effects of irrigation and species in apple orchards. Biological Control 67: 123-129.

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