Horticultural News

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HorticulturalNews

Editors: Winfred P. Cowgill, Jr. & Jaime C. Piñero

The New Jersey State Horticultural Society was organized on August 17, 1875 at Geological Hall, Rutgers College, New Brunswick, NJ. It remains the oldest Horticultural organization in New Jersey.

Horticultural News began as the *The New Jersey State Horticultural Society News*, in October of 1920. The Society began "collecting paid membership in order to obtain funds to promote new features of the society and extend the usefulness of the society. The Horticultural Society News was started to be the official society publication." Published M. A. Blake, Professor at Rutgers College was the first president and chair of the publication committee.

Editors served as follows:

MA Blake	1920 - 1947
Norman F Childers	1948 - 1980
Win Cowgill	1981 - 1988
Emily Brown Rosen	1988 - 1990
Linda Butenis Vorsa	1991 - 1995
Jerry Frecon	1995 - 2010
Win Cowgill & Wes Autio	2010 - 2021
Win Cowgill & Jaime Piñero	2021-

June 2010: Horticultural News has moved to an online web-based format. The New Jersey State Horticultural Society has partnered with the University of Massachusetts Fruit Notes.

October 2021: Jaime Piñero became the editor from UMass upon the reitrement of Wes Autio. Cowgill and Piñero are the new editors of Horticultural News and Fruit Notes.

Horticultural News is distributed to growers, extension personnel and researchers and libraries across North America. Horticultural News focuses primarily on tree-fruit culture, but addresses small-fruit cultural issues as well. Most reports are from current research at Rutgers University, University of Massachusetts, and other universities.

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Cover: Featured speakers at New Hampshire Fruit Growers' Association education and dinner meeting at Brookdale Fruit Farm, Hollis, NH. August 20, 2025. Pictured left to right are: Win Cowgill (Win Enterprises International, LLC); Trevor Hardy (Brookdale Fruit Farm and host); Jon Clements (University of Massachusetts Extension); and Bill Pitts (Bill Pitts Consulting and Midwest Apple Improvement Association). Photo: Win Cowgill

Using Degree-Day Models and Camera Traps to Manage Codling Moth in 2025

Ajay Giri[1], Jaime C. Piñero[1], Jeremy Delisle[2]
[1]Stockbridge School of Agriculture, University of Massachusetts Amherst
[2]University of New Hampshire Cooperative Extension

The codling moth (*Cydia pomonella*) is a major pest affecting apples, pears, and other pome fruits. Native to Europe, it has become a global concern for fruit growers. The insect undergoes a complete life cycle (egg, larva, pupa, and adult) (Fig. 1) and can produce up to three generations per year, depending on climate. Damage is caused by larvae that tunnel into the fruit and feed on the seeds, often causing the fruit to drop prematurely.

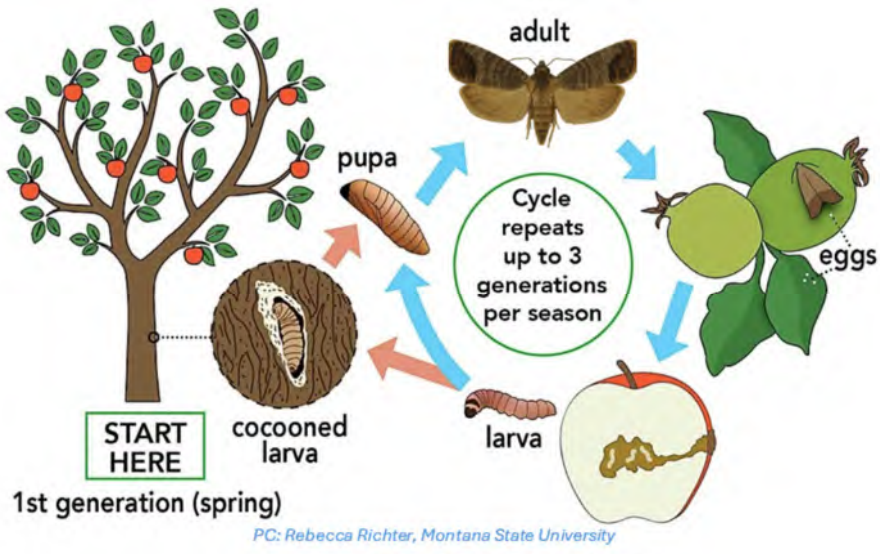

Figure 1. Codling moth life cycle. Eggs hatch into larvae that tunnel into fruit, then pupate under bark or debris before emerging as adults. Two to three generations occur each year.

Camera Trap Technology.

To improve monitoring, a specialized camera trap was developed by Barn Owl Technologies. This trap features a trapezoid-shaped design with a top-mounted camera, and a sticky liner and CM sex pheromone to attract and capture moths (Fig. 2A). It is powered by a rechargeable battery that lasts up to 12 weeks. The camera system uploads three high-definition images daily through an iOS mobile app called *FarmBugReport* (Fig. 2B). While identification of captured moths is currently done manually (Fig. 2C), automated identification using custom-designed image analysis tools is under development.

Advantages of Camera Trap Monitoring.

Using camera traps offers several practical benefits. It enables remote monitoring, reducing the need for frequent field visits. The system provides accurate, daily records of moth captures, giving insights into their temporal activity. This helps growers determine biofix (the date of the first consistent moth capture) which is crucial for synchronizing pest management activities with the biological development of the CM. Currently, camera traps are deployed at 15 locations across three New England states (Fig. 2D).

Biofix and Degree Days (DD).

Establishing a biofix helps predict critical stages in the CM's development, such as egg-laying and larval emergence. This can be further refined by tracking degree day (DD) accumulation, a measure of heat units above a base temperature (50°F base for CM) required for insect development. DD can be calcu-

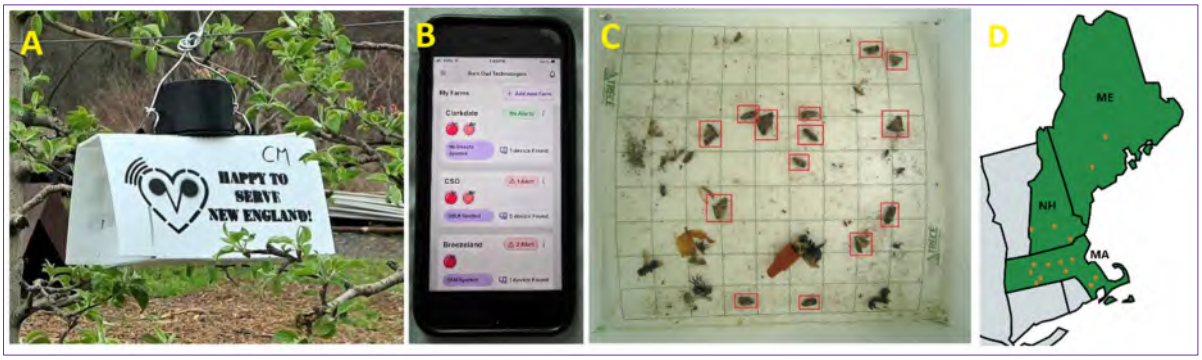

Figure 2. Camera trap (A), mobile app interface (B), and an uploaded image from the camera trap (C). In 2025, camera traps were deployed across three New England states (D).

lated using the formula: *(MaxTemp+MinTemp)/2 – 50°F*, or by using online tools such as the Network for Environment and Weather Applications (NEWA) website, which offers location-specific pest models.

Application in CM Management.

Tracking biofix and DD enables growers to forecast the optimal timing for pest monitoring and intervention. For instance, CM egg hatch typically begins around 100 DD after biofix. Larval activity peaks in between 220 to 250 DD. This window is often recommended for the first insecticide spray (Table 1), especially after petal fall. A second spray may be needed at 500 to 600 DD, if the CM pressure is high around the peak of the first generation's egg hatch. Later in the season, a third spray may be required when the second generation begins egg hatch at 1000 to 1260 DD, with a possible fourth spray during the 1320 to 1720 DD range if pest pressure remains high.

Case study: CM monitoring and management decisions - 2025 season.

During the 2025 season, CM activity was tracked in orchards across Massachusetts (Easthampton, Warren, Phillipston, Leominster, and Stow) and New Hampshire (Hollis). The first sustained moth captures, or biofix, occurred between May 13 and May 16. Shortly afterward, a cold spell from May 18 to May 25 brought temperatures below the developmental threshold of 50°F, temporarily slowing moth development (Fig. 3). Once conditions warmed, trap counts rose sharply, signaling a second wave of adult activity. By early June, degree-day accumulation reached the critical 220–250 DD window (June 6–8), when the first insecticide spray was recommended to target newly hatching larvae. A follow-up spray was advised at 500–600 DD to protect against larvae from the later wave of moths. While the first generation typically ends around 700–800 DD, consistent trap captures throughout June indicated a prolonged flight this year due to the cold spell and naturally staggered emergence.

The second-generation flight began in mid-July, though timing varied by location. For example, cooler conditions in Phillipston delayed development by

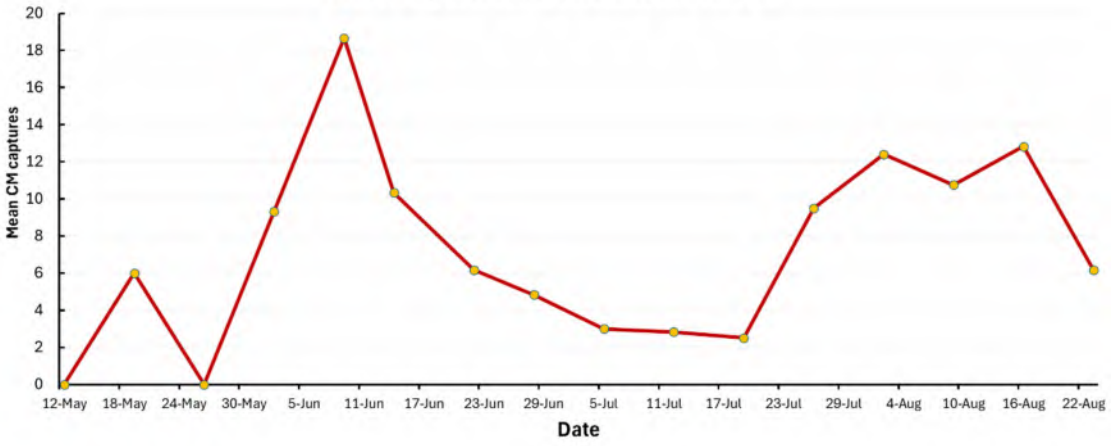

Figure 3. Mean codling moth (CM) captures across six orchards in Massachusetts and New Hampshire in 2025.

roughly 150 DD compared to other orchards. To manage this generation, sprays were recommended between 1000 and 1260 DD, with an additional application in the 1320–1720 DD window if trap captures and fruit pressure remained high.

Looking ahead, although New England usually experiences two complete generations of codling moth, the warmer late summer in 2025 increases the likelihood of a partial third generation. Controlling these later larvae is especially important, since they are more likely to damage fruit close to harvest.

Acknowledgements

We thank all participating apple growers for allowing us to conduct this study in their orchards. We used camera trap prototypes developed by Owl Barn Technologies (Richard Chen, owner). We are also grateful to Xavier Nishikawa and Vishnu Eskew for technical assistance, and to Soonhong Min, Heriberto Godoy, and Chris Gates for their help in the field and laboratory. This project was supported by the Massachusetts Fruit Growers Association and the New England Tree Fruit Research Committee.

Ajay is a Ph.D. student at the UMass Stockbridge School of Agriculture.

IFTA visits neighbors to the North

Jon Clements
University of Massachusetts Extension

July 21- 23, 2025, one hundred International Fruit Tree Association members visited neighboring orchards to the north, in Ontario, Canada during their annual Summer Study Tour. Bed and breakfast was at the Doubletree in London, Ontario from where we headed west on Day 1 to the Leamington area on the northern shore of Lake Erie, and then on Day 2 east to the Niagara Frontier on the south shore of of Lake Ontario. Followed by a quick morning trip on Day 3 to an orchard and garden center closer to London. What follows are some pics and brief highlights from the Study Tour.

Day 1, Westward Ho!

Thompson's Orchards hosted by Don Thompson. 110 acres of apples, peaches and pears. Don says "My tree planting awakening came during an IFTA Tour in Nova Scotia, where I met Terence Robinson for the first time and was exposed to new ideas about high density planting." Guess what? Current row spacing has stabilized at 2 feet by 10 feet.

AAFC (Agriculture and Agri-Food Canada) Harrow Research & Development Center. Mostly a bus tour of their many projects including their clonal gene bank consisting of about 800 apple and 200 pear accessions amongst many other Canadian fruit crops (think berries). Security was tight for obvious reasons I guess, we had to present our passports prior to the tour and did not get off the bus out in their plantings. The Fruit Wagon! hosted by Leslie Huffman and Doug "Fruit Wagon" Balsillie, both long-time IFTA participants. Canada's "Most Southerly Orchard" in Harrow. Many looked forward to this stop where we saw the real Fruit Wagon, and Doug and Leslie toured their fresh-market apple and pear orchards intermingled with cider apples for their daughter-operated fledgling Carolinia Cider Co.

Figure 1. Surround(ed) apples (Honeycrisp?) at Thompson's Orchards. Surround application(s) seemed to be a common practice in Ontario.

Figure 2. Bus shot of apple accessions at AFC Harrow Research & Development Center. Note hail/sunburn net. Why?

Figure 3. The actual famous Fruit Wagon

Day 2, Isn't the Niagara Frontier famous for wine?

Vineland Research & Innovation Center <https://www.vinelandresearch.com/>. Formerly solely a Agriculture-Canada/University of Guelph government research station, now a rather re-born public-private partnership whose mission is "Improving the economic viability, sustainability and competitiveness of horticulture in Canada." Impressive collaboration with several "education" stops including soil health and apple variety breeding and evaluation. They are pretty serious about the latter, that is bringing the next great (best thing) new apple variety to Canada (and beyond) growers.

Figure 4. Giving a tour of The Fruit Wagon orchard, Leslie and Doug as always are entertaining. Especially Doug. Note the "crop and flop."

Figure 6. One of the well-orchestrated education stops at Vineland, this one hands-on soil health.

Figure 5. Red Heart apple trees at The Fruit Wagon. Used exclusively for making cider.

Figure 7. One of the apple test variety plantings at Vineland.

Thwaites Farms wholly a pear stop. (Ho-hum.) But 500 acres growing asparagus, peaches, nectarines, seedless grapes, and oh those pears. Climate-wise the Niagara Frontier is nearly perfect for growing all kinds of fruits.

Figure 8. Sensory/taste evaluation of new/test apple varieties an important part of new apple variety testing at Vineland. Impressive research.

And, when in the Niagara Frontier, must check out a winery. In this case Sue Ann Staff Winery, Sue-Ann being a fifth-generation grape grower and award-winning Canadian winemaker. I have to say it was not the typical majestic winery on the hill experience, more "homey," but it was well executed and the wines were very good. Too busy drinking wine to take pics? Likely.

Figure 9. Nice looking pear crop at Thwaites. Surround(ed) of course!

(Half) Day 3, not too far from London

Versteegh Farm/Orchards, hosted by Michael Versteegh. Not much to say here other than how could it be done any better? One interesting note, M.9 is the rootstock of choice, trees largely looked uniform and healthy. When asked about RATD (Rapid Apple-Tree Decline), Michaels comment was "oh yes, we see some of that, it's just winter injury." Humph. Should also mention some tech was highlighted here, including the H.S.S. AgBot sprayer and crop load visioning by home-grown Vivid Machines.

Heeman's Greenhouse. Strawberries and Cider. Top notch garden center where customer service and welcoming via "Daymakers" was top priority.

Figure 10. Nice Honeycrisp/M.9 block at Versteegh.

Amazing signage and plants. Wish I lived closer.

Figure 11. Will Heeman shows us their strawberries, still being harvested and sold at their "drive-up" strawberry sales trailer.

Be sure to visit the IFTA Facebook page for more pictures and info. And as always, thanks very much to our Canadian hosts. It was a good and informative time had by all.

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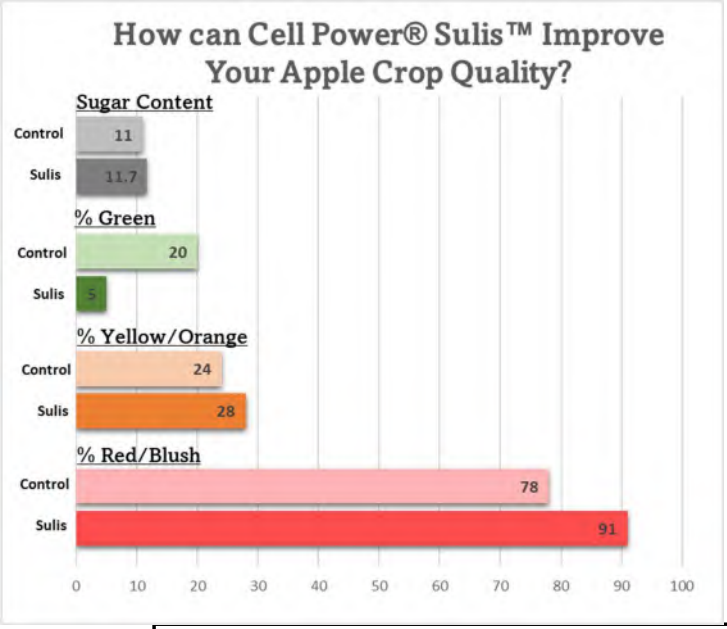

2024 NC140 NJ Hard Cider/Rootstock Trial Update with 'Porters Perfection' Cultivar

Megan Muehlbauer[1, 2], Rebecca Magron[2]

[1]Rutgers, The State University of New Jersey, New Jersey Agricultural Experiment Station

[2]Rutgers Cooperative Extension of Hunterdon County

In 2023 an apple rootstock trial with the scion 'Porters Perfection' was established as part of the NC-140 Regional Rootstock Research Project. This trial is replicated at 16 sites throughout the United States, and one site in Canada, including at the Rutgers University, Snyder Research and Extension Farm in Pittstown, New Jersey.

The variety 'Porters Perfection' is an apple utilized primarily for pressed juice and hard cider production and is characterized as a bittersharp variety. It is the first hard cider variety to be included in an NC-140 rootstock trial.

In 2023, NC140 'Porters Perfection' rootstock/Hard Cider trial was planted at the Snyder Research Farm in Pittstown, NJ. The trial was planted at a spacing of 645 trees per acre in a modified tall spindle system. The trial consists of 7 rootstock genotypes which include G.969, G.890, G.41, G.213, G.210, G.202 and G.11. http://nc140.org/plantings/2023applerootstock.html.

Data was collected from the trial in the fall of both 2023 and 2024 on trunk cross sectional area (cm^2). Additional data was collected on yield per tree(kg) for the first time in 2024. Trunk cross sectional area and 2024 yield were used to calculate the yield efficiency of each rootstock (kg/cm^2).

By the end of the 2024 growing season the 2023 Porters Perfection trial was thriving and differences in rootstock TCSA are already evident (see Table 1). The rootstock G.890 had the largest TCSA at 7.8 cm^2 and G.213 had the smallest TCSA at 4.3 cm^2. The growth in TCSA was also calculated between the 2023 and 2024 growing season. The greatest growth in TCSA occurred in the G.210 rootstocks (~1 cm), while the smallest change in growth occurred in the G.41 rootstocks (~0.6 cm).

A small amount of fruit was left on the trees in 2024 and hand thinned down to 3 fruits/cm^2 TCSA. The fruit set was far more significant than expected Table 1 and Figure 1. The largest yield (0.57 kg) was collected from

Table 1: Average Trunk Cross Sectional Area for 2023 and 2024 growing seasons, Average yield and Average Yield Efficiency 2024 of trees in the 2023 Porters Perfection Rootstock Trial.

Rootstock	Average TCSA cm^2 (2023)	Average TCSA cm^2 (2024)	Average Yield kg (2024)	Average Yield Efficiency kg/cm^2 (2024)
G.11	2.39	4.9	0.2	0.04
G.202	3.3	7.0	0.8	0.04
G.210	2.8	6.8	0.1	0.02
G.213	1.9	4.3	0.2	0.04
G.41	3.3	5.7	0.6	0.13
G.890	3.7	7.8	0.4	0.05
G.969	2.8	5.5	0.5	0.11

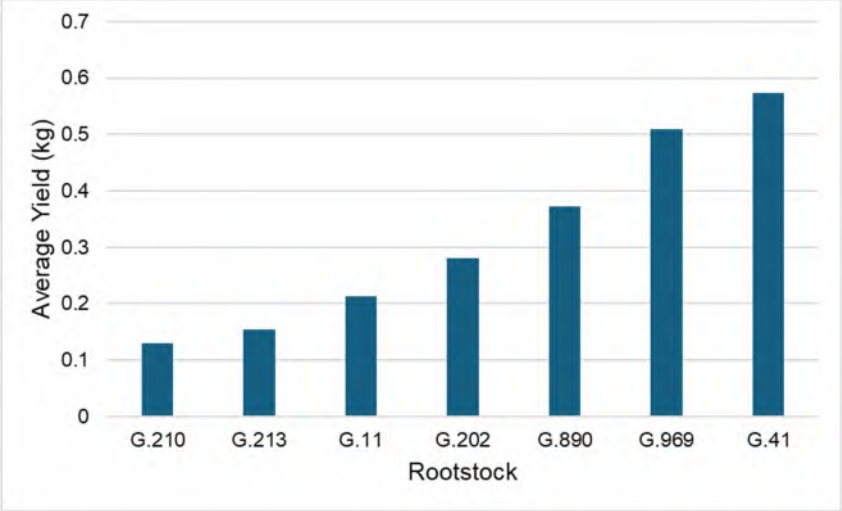

Figure 1. Average fruit yield (kg) in 2024 for each of seven rootstocks included in the study.

G.41, while the smallest yield was collected from G.210 (0.1 kg).

Although there was not a significant amount of fruit harvested in 2024 there was a nearly 10-fold difference in yield efficiency between the lowest yield efficient rootstock (G.210 with 0.02 kg/cm^2) and the most yield efficient rootstock (G.41 with 0.12 kg/cm^2).

The results are still preliminary regarding the TCSA and yield efficiency. However, to date all rootstocks have resulted in vigorous, precocious well adapted trees and appear to have the potential to yield significant fruit yields for 'Porters Perfection' (Figures 2, 3, 4).

For additional information on NC140 Rootstock Trials, locations of other trials and annual state reports of trials, and hundreds of final publications, see our official NC140 Website: http://nc140.org/

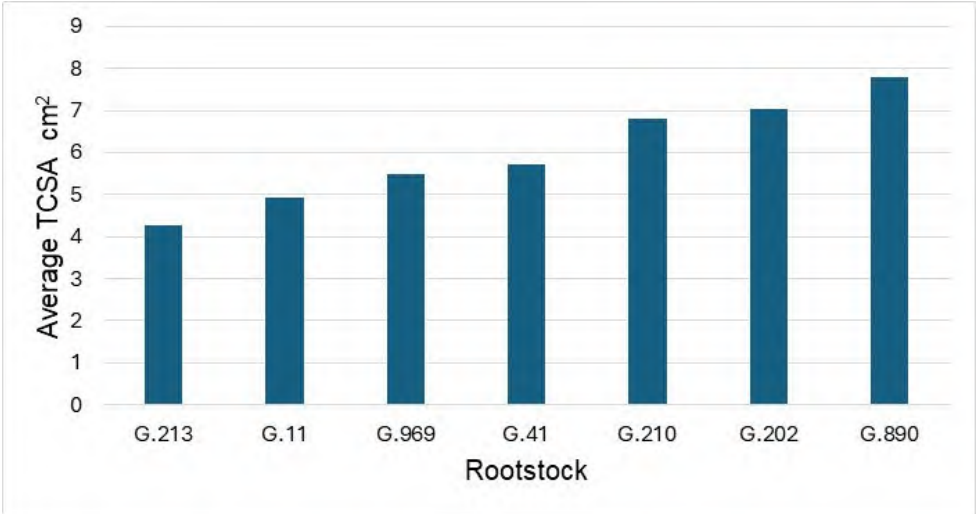

Figure 2. Average Trunk Cross -Sectional Area (TCSA) (cm^2) in 2024 for each of seven rootstocks included in the study.

Support

Thank you to the NJ State Society for research grant support to enable this long term project, to the NJ Agricultural Experiment Station, to the Hunterdon County Board of Chosen Freeholders and to the staff at the Rutgers Snyder Research and Extension Farm.

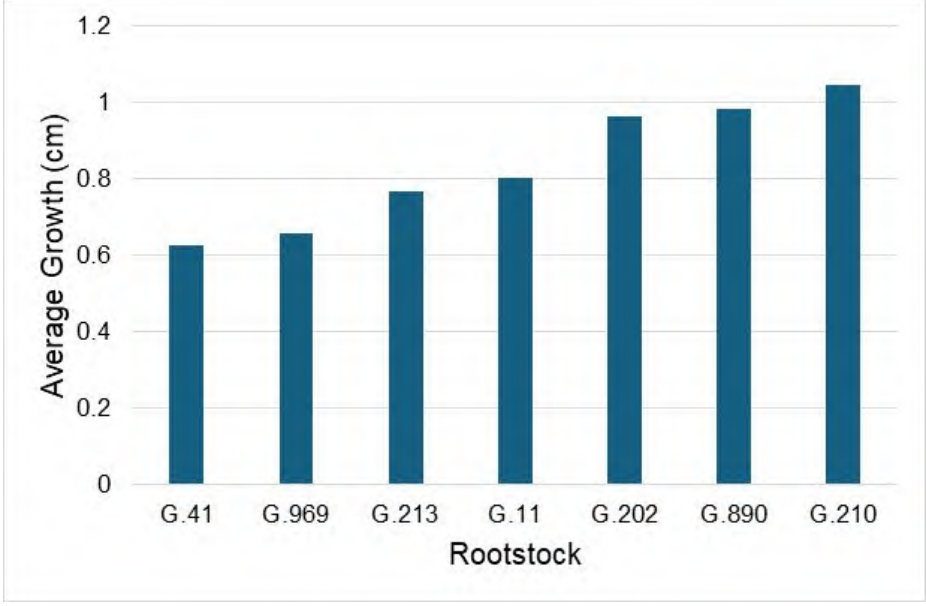

Figure 3. Average Growth (cm) of rootstocks between 2023 and 2024 growing seasons.

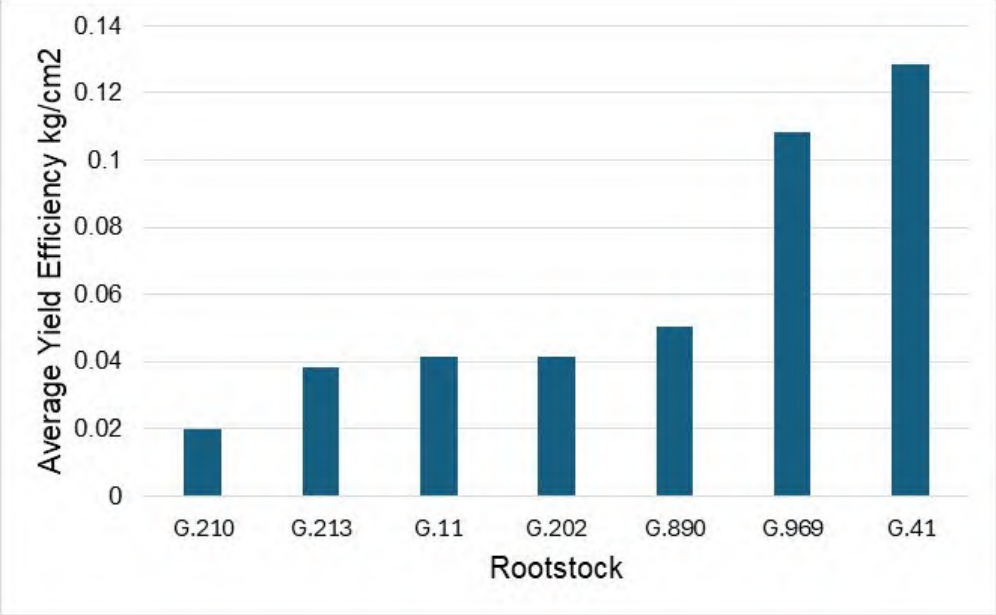

Figure 4. Average Yield Efficiency (yield (kg)/ trunk cross sectional area (cm^2) of all seven rootstocks included in the study.

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Maturity Standards for Asian Pear Harvest?

Win Cowgill[1,2], Rebecca Magron[2], Jon Clements[3]
[1]Professor Emeritus, Win Enterprises International, LLC
[2]New Jersey Agricultural Experiment Station
[3]University of Massachusetts Extension

Abstract

Increased demand for Asian Pears (*Pyrus pyrifolia*) in Northern New Jersey and the New York City Metro Area farmer's markets provides new opportunity for fruit growers. Contrary to horticultural practices used in growing European pears, Asian pears are more labor-intensive to thin, harvest and transport, therefore commanding increased commitment and learning curve for the grower, but setting a premium market price. Nine varieties of Asian pears are being evaluated at the Rutgers NJAES Snyder Research and Extension Farm as part of a 2010 Northeast Asian pear trial. The objective is to evaluate Asian pear cultivars for suitability in Northern New Jersey fruit orchards as a new crop. In 2012, third-leaf Shinko had the highest yield efficiency, 11.8kg/cm^2 with Shinsui and Isiiwase the lowest 0.16kg/cm^2. Housi was the largest tree as measured by trunk cross sectional area (TCSA) 28.2 cm^2, as contrasted to Shinko having the smallest TCSA at 15.4 cm^2. One challenge in evaluating variety suitability is in determining the optimum fruit harvest date for each cultivar. Asian pears are harvested tree-ripe for optimal maturity and marketability, and trees often have to be harvested multiple times. Maturity standards have not been systematically established and vary greatly by cultivar. While there were differences between varieties in traditional maturity indices, flesh pressure and brix, they did not correlate well to harvest maturity. Skin color was highly correlated to taste, which is a subjective measurement. Visual color rating values from Asian pear Color Chart, by Adel Kader, between 4 and 6 were found to be optimum for most cultivars. Under-ripe fruit have less desirable eating quality and do not ripen in storage. Over-ripe fruit are more prone to bruising and can begin internal breakdown not easily visible with intact fruit.

Introduction

As part of a Northeast Regional Asian Pear Variety Trial, established in New Jersey in 2010 at the Rutgers Snyder Farm, Pittstown, NJ, much has been learned to date. Over the past two growing seasons in NJ part of our work has focused on determining how to know when to harvest Asian pears.

Background

Asian pears are becoming an important commodity for selected growers in NJ. New Jersey has over 200 acres planted to date with more acreage planned. Contrary to horticultural practices used in growing European pears, Asian pears are more labor-intensive to thin, harvest and transport, therefore commanding increased commitment and learning curve for the grower, but setting a premium market price. Growers utilizing tailgate markets and Pick Your own marketing have done well marketing to the large Asian population in New Jersey as well as educating other consumers about Asian pears to increase their market

penetration. Asians make up 8.25% of NJ's population of 8.9 million people.

Our variety trial consisted of 10 cultivars of Asian pear as well as two European cultivars to attract fireblight so we can evaluate the Asian pears for fireblight tolerance under NJ growing conditions. **Figure 1** lays out the harvest dates of our varieties begging the end of August with Kosui and ending with Nitaka the end of October.

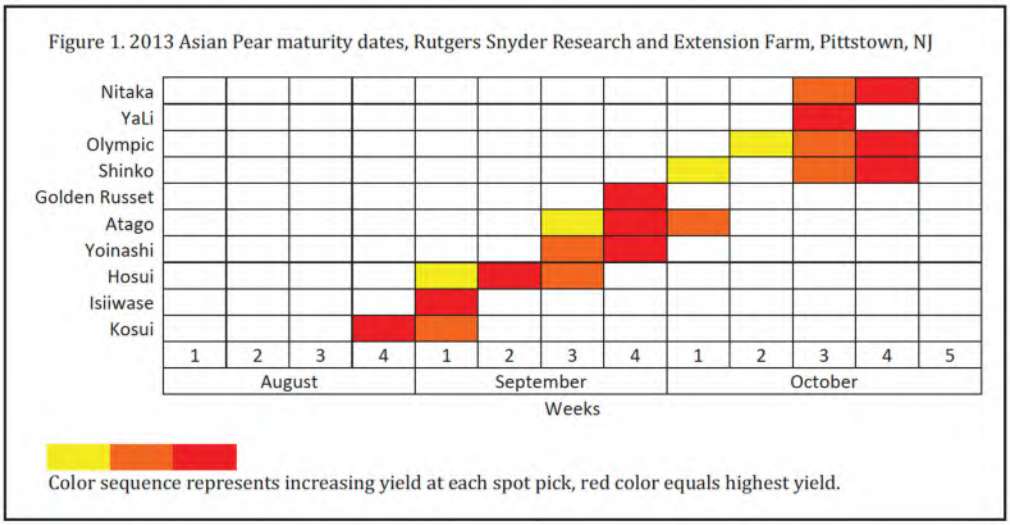

Figure 1. 2013 Asian Pear Maturity Dates.

Note that small fruited Asian pears will not develop the sugars and flavors. Asian pears must be thinned to a single fruit per spur and maybe one every other spur. If crop load is excessive fruit quality will suffer. See the citations below for how to chemically thin Asian pears to remove 50% of the fruit. The rest of thinning must be done by hand clipping.

What we have learned is that you must begin sampling each variety two weeks before anticipated harvest. While each variety will have its own parameters, specifically to color both the back ground color and the over color. It does help if you know what a specific variety and is meant to look like and taste like. The true secret is starting early and then sampling the fruit every 4-5 days. You will start to see the back ground color change and the sugars come up as the fruit ripens and gets sweeter. You have to sample fruit for each cultivar from multiple trees to make sure you have a random sample.

Every grower that produces Asian pears struggles to pick them at the correct maturity.

What we have learned is that you cannot use conventional apple maturity testing on Asian pears. The Starch Iodine test does not work, Brix testing for Soluble solids is not reliable and pressure testing is not very helpful either. Unlike apples, Asian pears do not ripen up in storage so they have to be harvested and stored pretty much tree-ripe. All too often this is not the case and fruit being sold is less than optimal.

Maturity Standards

Harvesting tree ripe Asian pears depends on the following factors, both ground and over color, flesh texture and of course taste! One of our goals of this trial is too develop maturity standards for the best cultivars we identify for NJ and develop simple protocols for growers to determine when to harvest their Asian pears for optimum flavor and marketability.

In 2012 we started evaluation maturity using the UC Davis Color Chart **(Figure 2)** as a starting point. We and attempted to match the ripening pear's background color to the chart. This is an older chart and not all the orange colors

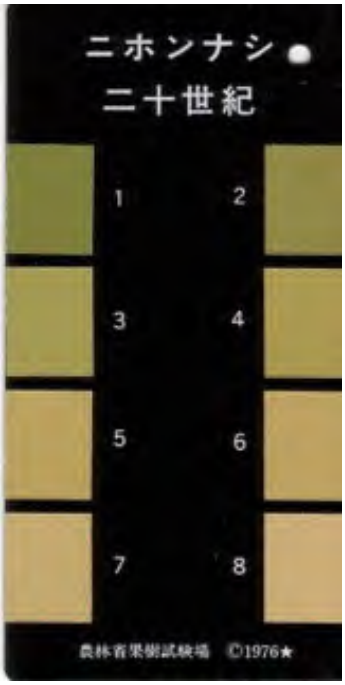

Figure 2. UC Davis Asian Pear Harvest Ground Color Chart.

were on the chart.

What I found in 2013 was that by starting well ahead of ripening, if you walked the blocks every few days, you could start to see the background color change. As it changed from green to brown or green to yellow (Ya Li) it was easy to see the change.

Individual fruits also ripen on the sunny side of the tree first (south and southwest) and individual fruits will not ripen uniformly; the sunny side can be more mature than the back shaded side. The entire fruit has to begin to change color to be ripe enough to harvest.

For texture and eating quality, you also had to sample the fruit with and eat a slice to check for sugar/flavor. Immature fruit will not taste good and be hard. You have to sample the green side as well to make sure its ready. Fruit that has not sufficiently ripened will not have the varietal flavors associated with that pear. It will also be hard and crunchy vs sweet and melting.

We learned one trick/tool for evaluating Asian Pear maturity from an old friend and outstanding Asian Pear Grower, Mr. Ging Lee, Pittstown Fruit Farm, Pittstown, NJ.

Use a sharp knife to slice the flesh of the pear. Bite into a ripe Asian pears and then slice those same pear with a knife (same sharpness) to get the "feel" of what a ripe pear should slice like. When tasting Asian pears only taste the flesh not the skin to make sure your evaluating the maturity of the flesh for taste and texture. You will begin to relate maturity and good taste with the flesh texture as measured by the slicing knife. When the Asian pear fruit is totally green (immature), the knife will barely slice the fruit, you have to pull it through. As you try it on a riper fruit the knife moves easier. When fully ripe it glides right through the fruit easily. Continue to use the same knife each time you assess field fruit maturity throughout the season. I used this extensively in 2013 with great success. The more you use it, the more it relates. You can get to the point where you just slice, and you know where you are at.

One of our biggest take aways from doing detailed maturity sampling was that almost all Asian pear varieties must be harvest multiple times to have mature fruit fit to eat. Most required 3-4 harvests and some 5.

See figure 3 – Demonstrating the knife technique- Four pears' photos- 2 sunny side and 2 green side.

In summary- for harvesting Asian pears at optimum maturity you do the following:
Begin tracking background color 2 weeks before anticipated harvest.

As background color changes color, slice with knife for texture rating and taste the fruit

Both green shaded side of fruit and sunny side must be sampled.

Utilize as many harvests as necessary to only pick mature fruit, 3-5 picks.

Stop Drop

Note that some Asian pear cultivars can drop prematurely. Retain is labeled on pears, single or double application, 7 day PHI, for stop drop or harvest management timing.

Citations

Asian Pear Cultivar Trial in New Jersey and Massachusetts, 2012. Winfred P. Cowgill, Jr., Suzanne Sollner-Figler, Rebecca Magron, Jon M. Clements, Wesley R. Autio
http://www.horticulturalnews.org/92-1/a4.pdf.

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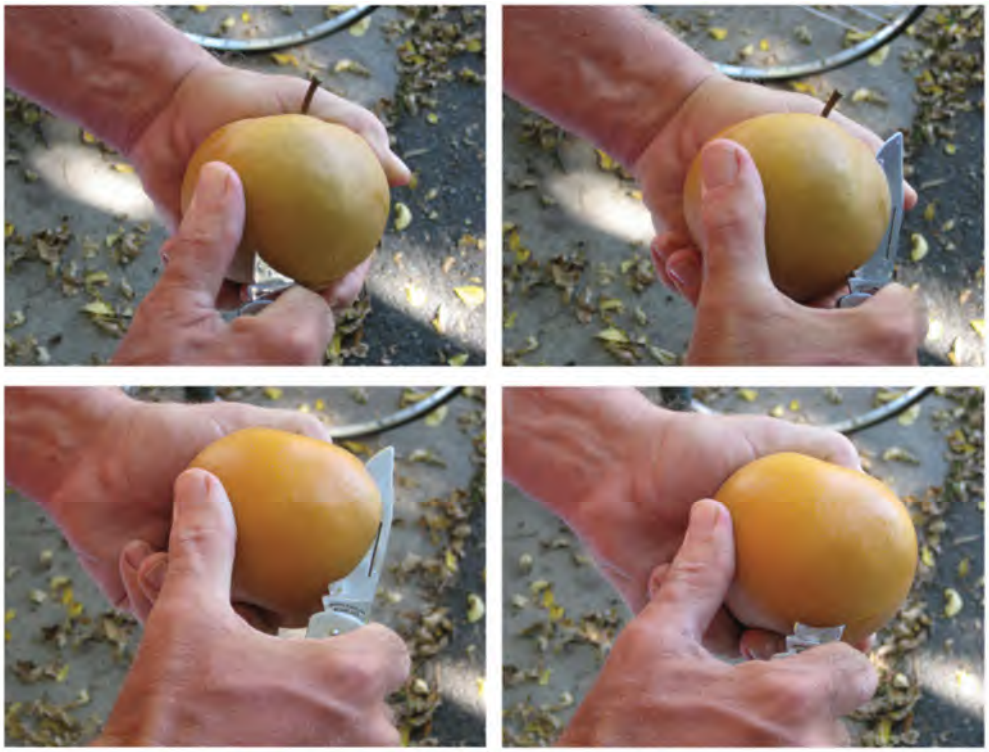

Figure 3. Knife Technique.

Beneficial Nematodes vs. Fungi: Commercial Biocontrol Options for Managing Plum Curculio

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In the northeastern United States, the plum curculio (*Conotrachelus nenuphar*) completes only one generation per year. Overwintered adults emerge from wooded areas in late April to early May and begin oviposition shortly after petal fall. Eggs are deposited in young fruit, and the developing larvae cause premature fruit drop by June and July. Mature larvae exit dropped fruit to pupate in the soil, and new adults emerge in mid-July through August. These summer-generation adults feed on apples until September, and as day length shortens in early fall, they migrate to overwintering sites where they remain until the following spring.

Generally, management of overwintered adults with insecticide sprays during the petal-fall and early summer period is sufficient to prevent economic injury/ Summer-generation damage is considered to be minimal. However, in years of high population pressure or in orchards with severe injury, supplemental mid-season control may be warranted. Recent research has highlighted biological control agents such as entomopathogenic nematodes (EPNs) and entomopathogenic fungi (EPF) as promising alternatives. These organisms naturally occur in soil and can infect plum curculio larvae as they enter the ground to pupate, thereby reducing the emergence of summer adults. While the efficacy of EPNs in orchard soils has been repeatedly validated in field trials, results with EPF have been more variable.

This study was conducted to evaluate two commercially available products, the EPN *Steinernema carpocapsae* (BioSC) and he EPF *Beauveria bassiana* (BotaniGard ES), against plum curculio larvae. In Study 1, the objective was to determine larval mortality over time following treatment with each product at the label rate. In Study 2, the objective was to compare the rate of adult plum curculio emergence from treated soil when the products were applied at half-label, label, and double-label rates., relative to the recommended rate.

Materials & Methods

Experimental procedures. Field-collected soil was sterilized twice (to eliminate any existing pathogenic organisms) by autoclaving at 121 °C and 15 psi for 1 h on two consecutive days. After sterilization, the soil was air-dried completely for two days and then placed into 10.5-cm diameter plastic cups (100 g per cup).

In Study 1, treatments were applied at the label rate, whereas in Study 2, treatments were applied at the label rate, half-label rate, and double-label rate.For BioSC, the recommended field application rate is 250,000 infective juveniles (IJ) per m^2. Based on this rate, the corresponding rates were 2,200 IJ (label rate), 1,100 IJ (half-label rate), and 4,400 IJ (double-label rate) for the experimental units (cups) that were used for the experiment. For BotaniGard ES, the recommended field rate is 8 fl oz per 1,000 ft^2. Given that the product contains 1×10^9 viable conidia per mL, the calculated cup rates were 4.7×10^8 conidia (label rate), 2.4×10^8 conidia (half-label rate), and 9.4×10^8 conidia (double-label rate). All Treatments were applied by pipetting 2 mL of the prepared suspension evenly onto the soil surface in each cup.

Plum curculio larvae were obtained from prematurely dropped apples collected on June 19 from an unsprayed apple orchard in Belchertown, MA. The apples were placed on moist sand, and beginning one week after collection, the sand was rinsed daily to recover emerging larvae. Larval recovery continued until no additional larvae were obtained for three consecutive days. Recov-

ered larvae were maintained on moist paper towels in plastic boxes and held in an environmental chamber at 25 °C with a 16:8 h (light:dark) photoperiod until used in the experiment. For the experiments, ten larvae were introduced into each prepared cup before the application of the treatments.

Data collection. In Study 1, soil from each cup was examined at 3, 7, and 10 days post-inoculation by emptying the contents onto a tray and recording larval mortality. All dead larvae were removed at each inspection. In Study 2, the soil was left undisturbed; cups were maintained until adult emergence, and the total number of emerging adults was recorded.

Results

Study 1. For the first question, regarding how long it took to kill plum curculio larvae following treatment with each product at the label rate, we found that the EPN BioSC killed about half of the larvae within 3 days, nearly 90% by day 7, and achieved complete mortality by day 10. In contrast, the EPF BotaniGard ES showed no difference compared with the untreated control (Figure 1).

Study 2. For the second question, comparing adult plum curculio emergence rates when the products were applied against the larvae at half-label, label, label rates, and double-label rates, we observed that the EPN BioSC completely suppressed adult emergence at all application rates, even at the half-label rate. In contrast, the EPF BotaniGard ES failed to suppress adult emergence, even when applied at double the label rate (Figure 2).

Conclusions

Our results clearly demonstrate that the commercial entomopathogenic nematode (EPN) *Steinernema carpocapsae* (BioSC) provides highly effective control of plum curculio, with the majority of adults killed within one week. In contrast, the entomopathogenic fungus (EPF) *Beauveria bassiana* (BotaniGard ES) failed to reduce plum curculio survival under our experimental conditions. Based on these findings, BioSC can be recommended as a promising biological tool for managing plum curculio when applied to the larval stage, whereas

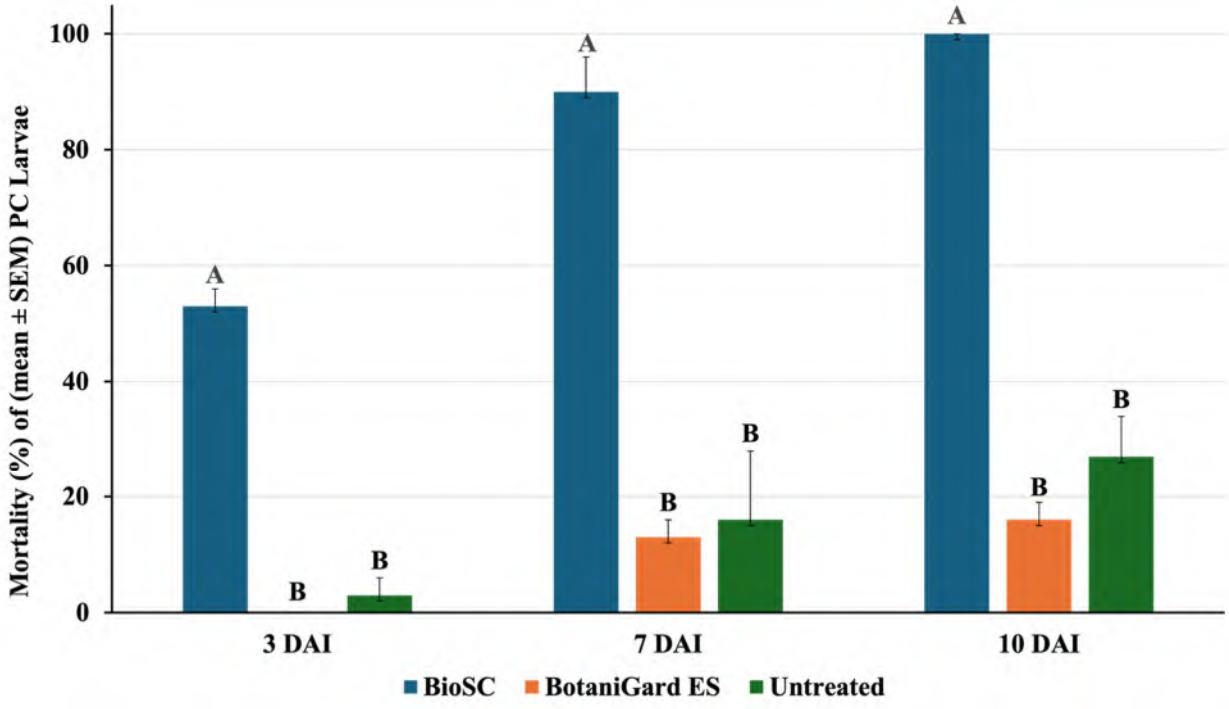

Figure 1. Mean (± SEM) mortality of plum curculio larvae (n = 10 per cup) at 3, 7, and 10 days after inoculation (DAI) with the entomopathogenic nematode *Steinernema carpocapsae* (BioSC), the entomopathogenic fungus *Beauveria bassiana* (BotaniGard ES), or water (untreated control). Within each DAI, bars with different lowercase letters (a, b) differ significantly ($P < 0.05$ means the odds are 1:19).

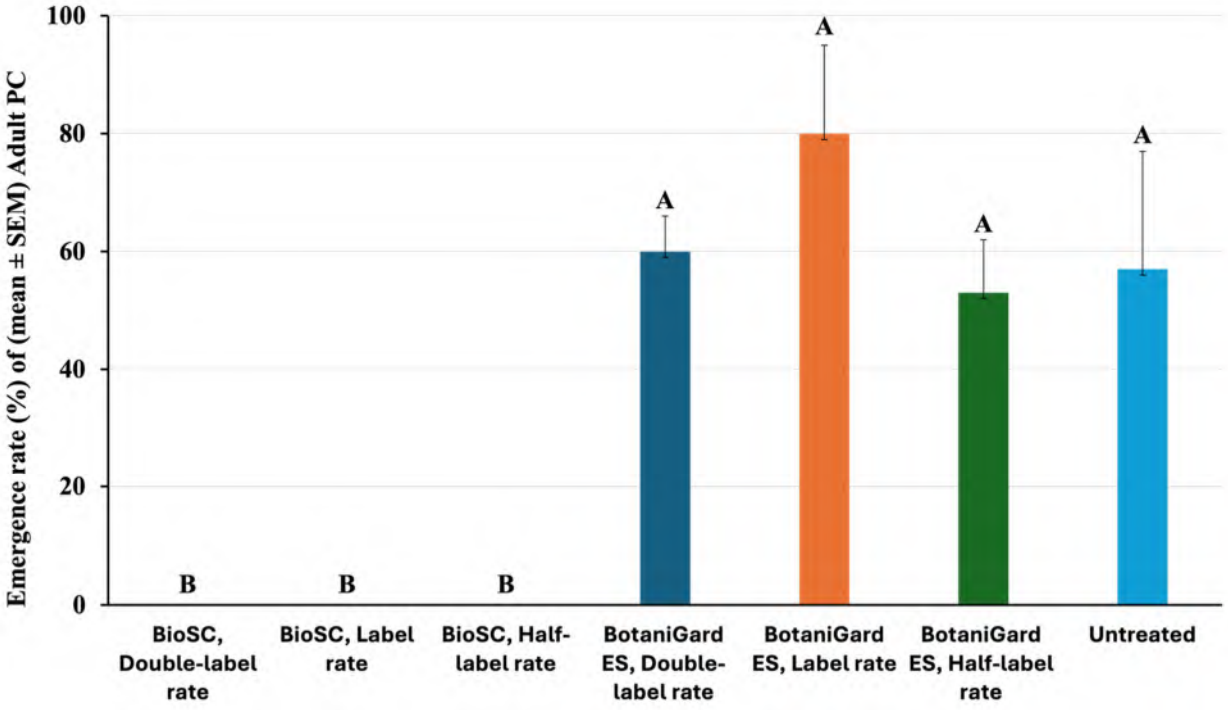

Figure 2. Mean (± SEM) adult emergence of plum curculio (PC) (n = 10 larvae per cup) after treatment with the entomopathogenic nematode *Steinernema carpocapsae* (BioSC), the entomopathogenic fungus *Beauveria bassiana* (BotaniGard ES) applied at half-, label-, or double-label rates, or water (untreated control). Bars with different letters differ significantly ($P < 0.05$).

BotaniGard ES should not be considered for this purpose until further research demonstrates efficacy. These results emphasize the need for research-based validation and Extension recommendations before new biological control products are adopted by growers.

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