COLLEGE OF AGRICULTURE & NATURAL RESOURCES

MAES | MARYLAND AGRICULTURAL EXPERIMENT STATION

LESREC Poplar Hill and Salisbury Facilities

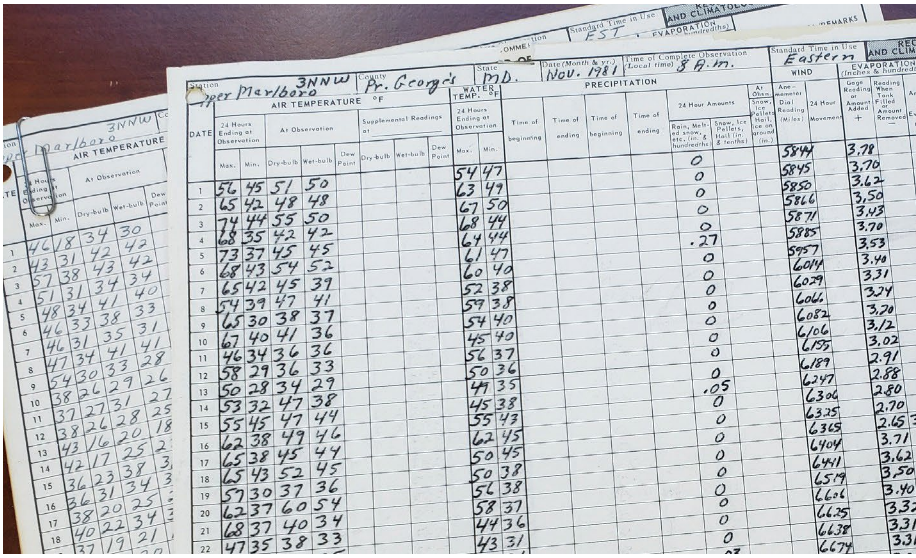
ROOTS IN RESEARCH

Yield of 2022

We are proud to present you with the first edition of a series of annual newsletters showcasing the diversity of applied research and hands-on educational programming that happen at the University of Maryland Research and Education Centers across the state. These facilities provide a living-laboratory space to carry out research addressing the real-world problems facing our farmers from issues like invasive species, climate change, economics, and environmental conservation. The information produced from these research projects is shared with the scientific community and directly to the public through journal articles, extension newsletters, and many other formats, but compiling summaries of all of the work done at each facility in one publication here gives a snapshot of how many projects are carried out at each research farm every year.

Here, we have compiled reports on the 2022 projects at the Lower Eastern Shore Research and Education Center (LESREC) facilities at Salisbury and Poplar Hill. Maryland's Eastern Shore supports the highest density of farmland in the state, and LESREC represents the unique growing conditions of the area: sandy soils, flat topography, and high water tables with poor drainage. The Salisbury facility was historically the vegetable research facility, and still supports research on vegetable disease and insect pest management, cultural practices, and variety trials among other work. The facility at Poplar Hill is dedicated to agronomic research, and supports work on grain crop variety trials, wheat breeding, cover crops, and alternative crop rotations, among other experiments. We hope you enjoy reading about the breadth of different projects, and gain some insight on the value of the work carried out at the RECs each year.

In This Issue:



Poplar Hill and Salisbury Weather Station

Weather data for Poplar Hill and Salisbury are displayed on our website. The information can be displayed by month, or by the year in a printable format. To compare weather data averages by the month or year, check out our website. If your research requires this data in a different format, please contact Sheila Oscar and she will help to get the information you are requesting.

Pollinator / Vegetative Buffers Demo Day Was a Success!

Jonathan Moyle

Put on by the Nanticoke Watershed Alliance, Delmarva Poultry Association, University of Delaware Cooperative Extension, and University of Maryland Extension, poultry growers and others came out to learn how these buffers can capture dust, shade houses, deter Canada geese and other wild fowl (preventing spread of disease), absorb excess nutrients before they reach local waterways, and reduce maintenance costs and time on their properties.

Held here at the Lower Eastern Shore Research & Education Center (LESREC) in Salisbury, participants enjoyed a beautiful day, where they heard from experts and shared a meal generously provided DCA and the Nanticoke Watershed Alliance.

Roots in Research
CMREC Beltsville, Clarksville, Turfgrass and Upper Marlboro, LESREC Poplar Hill and Salisbury, and WMREC Keedysville are published by the University of Maryland Extension

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Front Cover photo: Marylee Ross spraying a squash plot. Photo by Megan James Hickman.

Disease and Nematode Management Field Day

held Tuesday, August 2, 2022, 8:30 – 10:30 am

Educational Speakers at LESREC included: Dr. Sarah Hirsh, Dr. Haley Sater, and Dr. Alyssa Koehler.
Outreach topics:

- Nematode Management
- Updates on herbicide resistant weeds
- Watermelon Spacing and grafting
- Management approaches of Fusarium

Vegetative Buffers Field Day- Poultry Farmers Educational Speakers at LESREC included : Dr. Jon Moyle, Dr. Haley Sater and Dr. Emily Zobel.
Outreach topics:

- Miscanthus education
- Avian influenza
- Vegetative buffer benefits

Dairy Field Day Activities Included:

- Vet demonstrations
- How to handle scours
- Compost barn education
- Soil fertility and forage education by Dr. Amanda Grev and Dr. Nicole Fiorellino

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2022 Annual Report

Click here to read more…

Overview of the Northeast Region IR-4 Program

The Northeast Region of The IR-4 Project is a collaboration between the University of Maryland College Park (UMCP), University of Maryland Eastern Shore (UMES) and North Carolina State University (NC State).

The IR-4 Project Headquarters (HQ) is located at NC State in Raleigh, NC. The Regional Director's office is located at UMES in Princess Anne, MD. The Regional Field Coordinator's (RFC) office is at the University of Maryland's Lower Eastern Shore Research and Education Center (LESREC) in Salisbury, MD. This facility houses the Regional Field Coordinator (RFC) office as well as a Field Research Center in Food Use. Attached is a summary of the activities of the IR-4 Northeast Region (NER) Field Coordinator's Office and Field Research Center in 2022.

Objectives and Mission Statement

The objective of the IR-4 Project, "to facilitate regulatory approval of sustainable pest management technology for specialty crops and specialty uses to promote public wellbeing," falls perfectly under the University of Maryland's College of Agriculture and Natural Resources (AGNR) Roof-top Statement, to "embody the University's land-grant mission with a commitment to eliminate hunger, preserve our natural resources, improve quality of life, and empower the next generation."

Evaluation of Grafted Watermelon for Fusarium Wilt Management

Ben Beale-Extension Agent, St. Mary's County
Alan Leslie-Extension Agent, Charles County
Haley Sater-Extension Agent, Wicomico County

Fusarium Wilt, caused by the soil borne pathogen *Fusarium oxysporum* f. sp. *niveum* is becoming more problematic in seedless watermelon production in Southern Maryland. Unfortunately, there are few effective management options for this soil borne disease. New races of fusarium wilt are now present in the area that can overcome traditional cultivar resistance. Effective fungicides are limited and do not provide season long control at labeled rates. In many cases, once a field is infested with fusarium wilt, watermelon production is no longer a viable option. A technique that has been effective in other areas is grafting of susceptible cultivars onto fusarium resistant rootstocks of interspecific hybrid squash or citron species. Watermelon grafting is more difficult than tomato grafting and is normally done by outside companies who specialize in the technique. During the 2020 and 2021 growing season, a field research and demonstration trial was conducted at several farms with a history of fusarium wilt to evaluate the efficacy of grafting for fusarium management. A second study was undertaken in the 2022 growing season to evaluate the optimum plant population for grafted watermelon.

During the 2022 season, a population study was conducted at two locations-one at a private farm in St. Mary's County and the other at the UMD Lower Eastern Shore Research and Education Center (LESREC). Both sites had a history of watermelon fusarium wilt. Seedless Fascination watermelon plants grafted to Carolina Strongback (CSB) citron rootstock were planted at each location with plant spacing of 4ft, 6ft and 8ft between plants and row spacing of 54 to 60 inches. Plots were intensively managed utilizing black plastic mulch, drip tape, fertigation and crop protectants as needed. Each site utilized a complete block randomized design with four replications. The study utilized SP-6 pollenizer plants grafted to CSB rootstock. Tri-Hishtil (25 School House Rd, Mills River, NC 28759 (P) 828-620-5020), a commercial firm in North Carolina specializing in grafting donated the plants for the trial. Data on yield, fruit size, fruit quality and canopy cover was collected.

Summary of Results: The six foot spacing resulted in the highest yields and the highest fruit count at both sites. While this is only one year's worth of data and yields were below average due to the growing season, it appears that the 6 foot spacing is ideal for grafted watermelon. This spacing requires considerably less plants than conventional watermelon spacing. The study also found that fruit size also increased with greater plant spacing, as was expected.

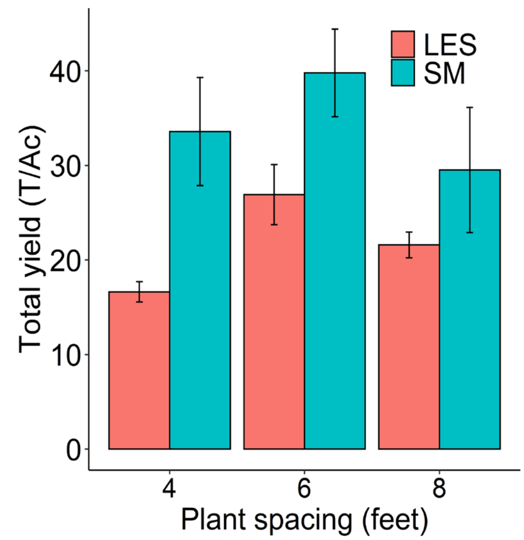

Figure 1. Mass of watermelons harvested for each of the three plant spacings for both the St. Mary's site and the LESREC site.

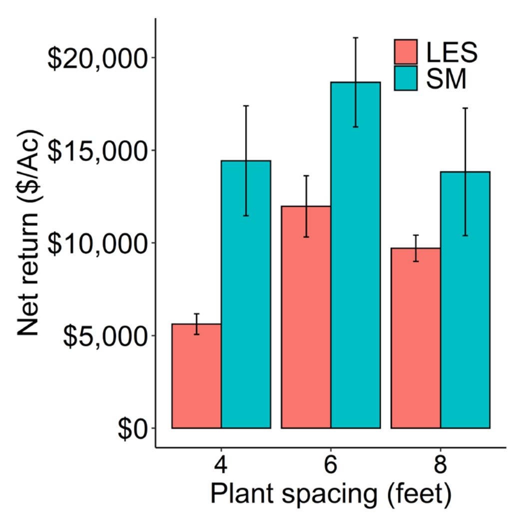

Figure 2. Price received for melons produced at each of the three plant spacings at each site. Prices were calculated as the average per pound price of watermelons at the local produce auction at the time of harvest, minus the differential costs of the number of grafted plants per acre. Other inputs (fertilizer, plastic mulch, etc.) were not considered.

LESREC Cucumber Beetle Pest Management Trials 2022

David Owens
University of Delaware Extension Specialist, Agricultural Entomology
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Cucumber beetles are one of the key insect pests affecting watermelon, cantaloupe, cucumber, squash, and pumpkins throughout the country. They transmit diseases such as bacterial wilt to many (watermelons are resistant to wilt), and they feed on rinds which can render the fruit unmarketable. Insect pest management for cucumber beetles involves regular early season scouting and early to mid-summer scouting. Usually around Memorial Day, cucumber beetles migrate into fields. Early colonizing males release aggregation pheromones which act as a beacon to bring a greater population into the field. Females lay eggs in the soil and by mid-July, first generation adults emerge out of the soil to feed on flowers, leaves, and fruit. Cucumber beetle management relies heavily upon neonicotinoid insecticides in drip lines (ex. Admire Pro, Platinum) or broadcast insecticides (ex. the neonicotinoid Assail, pyrethroids, and the diamide Harvanta). A trial performed at LESREC in 2021 indicated reduced susceptibility to the pyrethroid class of chemistry, severely limiting pest management options. In 2022, a follow-up watermelon trial was planted at LESREC to evaluate these insecticides. Plots consisted of 3 rows, 10 plants each of 'Fascination' seedless melons transplanted May 25. Overwintered beetles were treated on June 24 with Admire Pro and Platinum in the driplines and foliar Brigade and Azera. Treatments were replicated three times. We produced a video discussing the proper way to calculate product rates when chemigating fields with insecticides and that was posted to YouTube:

Overall beetle numbers were low in 2022 and no significant treatment differences were observed for applications targeting the overwintered generation. A second application was made in August, with treatments applied August 2, 9, and 19, testing an experimental product from Syngenta and comparing it with another insecticide Besiege. (Besiege is a pyrethroid/ diamide premix sometimes used for rindworm management). Summer beetle pressure was also low, and no significant treatment differences could be detected in terms of live or dead beetle counts and incidence of flower feeding. While it was disappointing not be able to follow up on interesting findings from the 2021 trial year, there were multiple trials conducted in Maryland and Delaware in which beetle pressure was unusually low. More trial work is being conducted in 2023 at LESREC and at the University of Delaware Carvel REC. We are grateful to the University of Maryland experiment station for supporting work to understand how beetle susceptibility to commonly used insecticides may be changing as well as gathering data on potential new products. We also are grateful to David Armentrout for his support and assistance with this project.

Severe rind feeding caused by cucumber beetles

Implementing growing trials to better the practice of growing popular grown crops of the region

David Armentrout - Facility Manager, Salisbury and Poplar Hill (LESREC)

As the Facility Manager for the Lower Eastern Shore Research and Education Center located in Salisbury, MD and in Quantico, MD I believe it is important to implement growing trials to better the practice of growing popular grown crops of the region. In doing so, I as the Facility Manager, can increase my knowledge and experience in successfully perfecting the cultural practices needed for such crops. In 2022, I specifically looked at demonstrating Pumpkins ('Pumpkin Variety Trial'), Sweetcorn ('Sweetcorn Comparison and Insecticide Timing Trial') and Cantaloupe/Watermelon ('Cantaloupe and Watermelon on White vs. Black Plastic Culture Comparisons'). In 2022, I also worked with Dr. Jeff Pettis looking at 'Strategies and Evaluation of Honeybee Survival at LESREC'. The experience and knowledge gained in implementing such demo-trials allows myself to better suit researchers in growing similar or related crops in future trials. In addition, such demo-trials are an added bonus during Facility tours.

Role of Rhizobial Diversity for Drought and Herbivory Tolerance in Soybean

Authors: Brendan Randall (PhD student), Kelsey McGurrin (Faculty Specialist), and Karin Burghardt (Assistant Professor)

Research team: Burghardt lab members from the Department of Entomology in collaboration with Smithsonian Environmental Research Center and UNC-Greensboro researchers, and Dr. Nicole Fiorellino (Director of the UMD soybean variety trial).

Increasing the diversity of soil bacteria interacting with a plant may help decrease insect herbivory, especially during droughts (link). To follow up on this work, our team collected data within the University of Maryland Soybean Variety Trial from 2019-2022 at four UMD RECs (Fig 1. Poplar Hill, Clarksville, Wye, and Keedysville). We are interested in measuring traits and yield of soybean plants from the same varieties growing across a wide range of environmental conditions (Fig 2. drought, flooding, insect herbivory) and determining how that relates to the diversity of the nitrogen-fixing bacterial partners (rhizobia) associated with the plant (Project BeanDIP).

Fig 1. Soybean plants growing in plots at the LESREC Poplar Hill facility. Photo credit: K. McGurrin

As an additional question in this field study, we investigated whether commonly applied soybean seed treatments that include fungicides, insecticides, and often a rhizobial inoculum decrease herbivore damage on soybeans or increase yield. While we occasionally see early season decreases in piercing-sucking insect damage, we found no evidence that seed treatments lead to higher bean yield across three years of the replicated study for the soybean varieties tested (Fig. 3) across the REC farms.

Fig 2. Silver-spotted skipper (Epargyreus clarus) caterpillar, a common defoliating insect on soybean in Maryland. Photo credit: K. McGurrin

Data from the field trial on rhizobial diversity, herbivory, plant traits, and yield will be paired with ongoing experiments at the UMD greenhouse, manipulating the strain identity and diversity of rhizobial partners to determine if this can help soybean plants be resilient to the multiple stressors likely to increase with climate change in MD. Preliminary results indicate that the strain identity of the rhizobial partner can differentially alter the level of chewing insect herbivory and trait expression related to growth and drought resistance depending on the watering conditions (drought or ambient). Therefore, some rhizobia strains are more effective at enhancing resistance traits in soybean plants than others. Harnessing rhizobia partners that fix large amounts of nitrogen as well as partners that may enhance resistance traits in the plant through seed inoculums or liquid culture spraying, may improve grower outcomes while also contributing to higher levels of soil diversity. Future work in the field will examine the role of targeted rhizobia partner diversity in driving resistance to herbivory and drought stress through rainfall manipulation experiments in experimental soybean plots at UMD REC facilities.

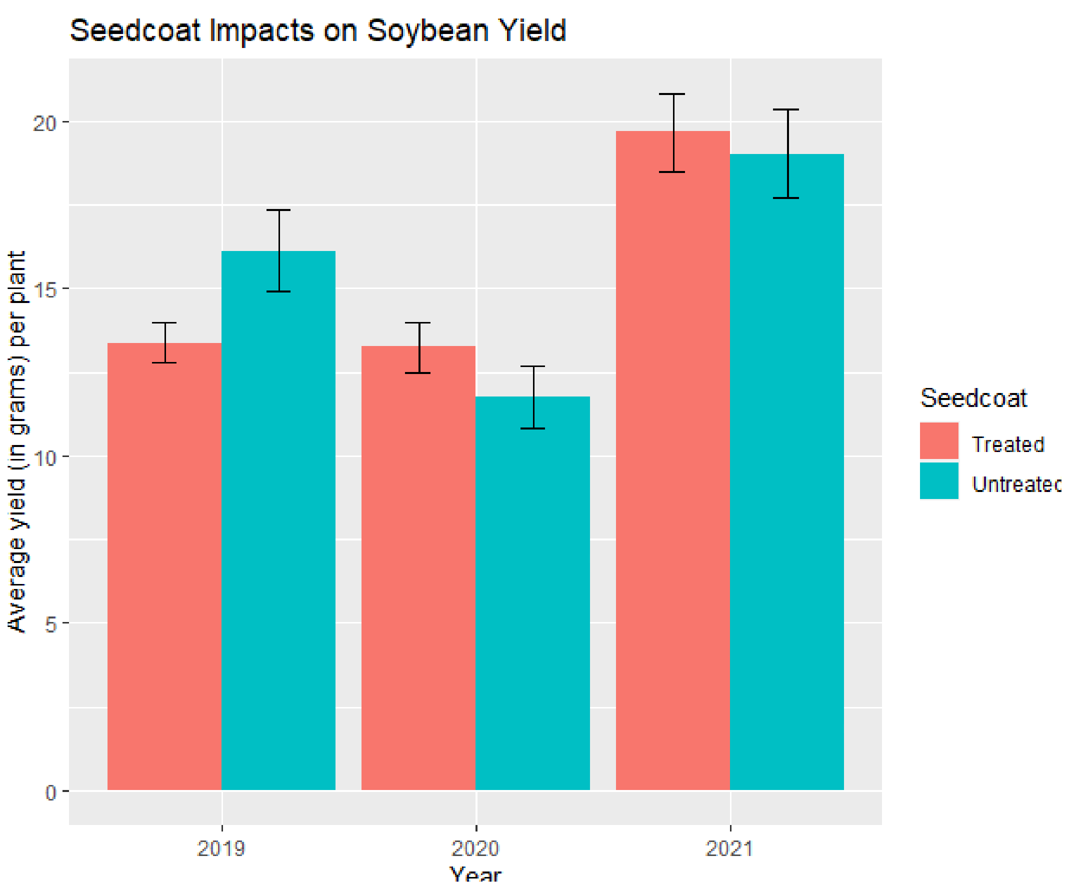


Fig 3. Preliminary results indicate no difference in yield between soybean plants treated with a seed coat seed treatment vs. untreated seeds of the same variety in any year measured (seed treatment effect: $F_{1,304}$=0.0004; p=0.98).

Final Report for Maryland Soybean Board 2021 Grant

Evaluating Soybean Variety Performance and Response to Deer Grazing

PI: Luke Macaulay, Wildlife Management Specialist, University of Maryland Extension
Co-PI: James Lewis, Agent, Caroline County, University of Maryland Extension
Co-PI: Nicole Fiorellino, Assistant Professor, University of Maryland

Summary: Our study sought to better understand deer herbivory of forage soybeans. Our original proposal sought to understand 1) what varieties of soybeans can produce the best yields under heavy herbivory, 2) what varieties can best withstand deer grazing, 3) what varieties can attract deer away from conventional crops, and 4) estimate the costs and potential benefits of using particular varieties to attract deer away from conventional crops. Our research yielded important information on how to better design our studies in the future and uncovered insights that advance our knowledge of the timing and pattern deer damage on soybean crops that, if replicated in a second year, provide promising opportunities to develop strategies to reduce deer damage on soybean crops.

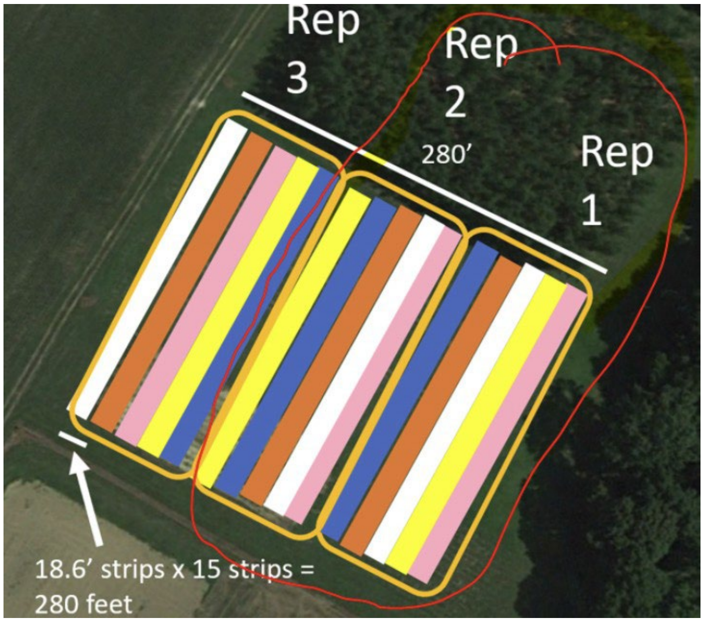
We developed a more detailed understanding of the patterns of deer grazing on soybeans and how these patterns are influenced by precipitation, and gained better insights into yields that can be expected from 3 different forage soybean varieties and how they compared to two conventional soybean varieties. We found that group 5 soybeans produced the highest yields under moderate deer grazing, with the highest yields from a conventional 5.3 soybean, which yielded 54.1 bushels/acre, followed closely by a group 4.7 forage soybean. The latest maturing group 7 forage soybean yielded only 36.4 bu/acre, but may have served to attract deer away from other varieties when they would have been most vulnerable to yield losses from deer grazing. In terms of deer grazing patterns, we documented that 74% of grazing activity occurred at night, with 44% of all grazing activity occurring in just five days of June and July (fig. 2). Statistical analysis of precipitation patterns found that grazing was significantly affected by rainfall events, with decreased grazing activity during rainfall events, increasing grazing activity one day following rainfall, and even greater grazing activity the second day after rain (see table 2 and fig. 3).

Anecdotally, we saw some evidence of deer preferring later maturing forage soybeans later in the season, which may provide relief to conventional soybeans during the full pod, beginning seed, and full seed stages (R4, R5, and R6) of development. 1 , 2 Co-PI James Lewis planted a buffer of forage soybeans around an irrigated cornfield, and anecdotally felt that the reduction in damage was well worth the investment and losses of yield from the buffer strip itself.

We have learned much in our first year studying this topic and made progress towards understanding what varieties produce the best yields under a moderate deer grazing situation, however, the highly variable nature of both deer grazing and deer populations limited our ability to answer the objectives as they were originally designed. Deer grazing intensity at the Wye Research & Education Center (Wye REC) was not as high as expected in 2021, possibly due to a die-off of deer from Epizootic Hemorrhagic Disease (EHD) in the fall of 2020 (field personnel found at least 5 deer carcasses on the center that fall). This led to only moderate levels of deer damage, which produced counterintuitive results, such as decreased plant biomass in plots protected from grazing, and non-significant effects of deer grazing on soybean yields.

[1] Board, J.E., Wier, A.T. and Boethel, D.J. (1994), Soybean Yield Reductions Caused by Defoliation during Mid to Late Seed Filling. Agron. J., 86: 1074-1079. https://doi.org/10.2134/agronj1994.00021962008600060027x
[2] Fehr, W. R., B. K. Lawrence, and T. A. Thompson."Critical stages of development for defoliation of soybean 1" Crop Science 21.2 (1981): 259-262.

Research Methods:
We used a randomized complete block design to test three glyphosate-tolerant soybean varieties and two conventional varieties in two separate fields (we planted additional varieties in the second field as space allowed) (Fig. 1). Each of these fields border forested areas and have historically experienced problems with deer damage on crops. We placed 5-10' diameter hog-wire deer exclosures on each plot and use trail cameras on ten strip plots (replicate 1 and 2) to quantify deer grazing activity by varieties. We clipped 2-3 plants from both inside and outside each exclosure to better understand how biomass of plants varied based on deer herbivory.



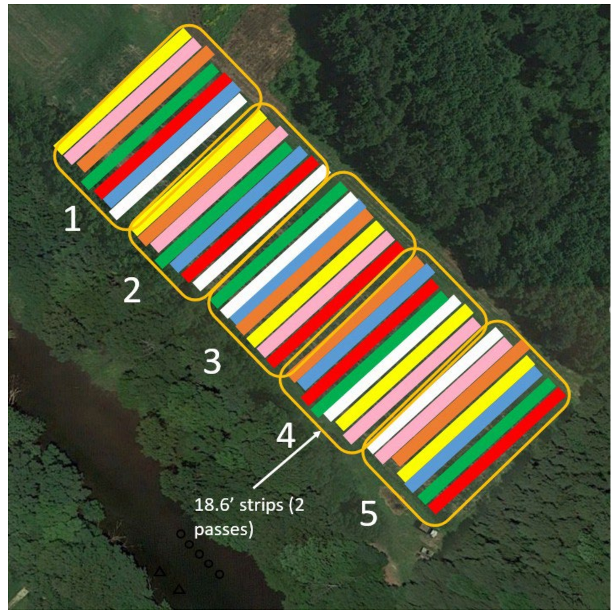


Fig.1: Randomized complete block design of forage and conventional soybean varieties planted in field C8/C9 (left) and field E5 (right) at the Wye Research & Education Center. Red circle on field C8/C9 denotes the plots monitored with 10 motion activated trail cameras.

Our study tested the following five soybean varieties:

<u>Forage soybeans:</u>
- La Crosse Seed, var. GT1 Brier Ridge; Group 4.7
- Biologic, var. R13-2423RR, Group 6
- Eagle Seed, var. Big Fellow, Group 7

<u>Conventional soybeans:</u>
- Pioneer Group 3.1, var. 86160724
- Pioneer Group 5.3, var. 5PQYD12

Each trail camera was set to take a single photo when motion was detected, and would continue to take a photo every 5 seconds that motion was detected. Undergraduate student employees from the University of Maryland used automated computer vision tools to classify photos (Wildlife Insights) and manually reviewed photos of deer and classified them by whether they were grazing or passing through the field. We used the number of photos of deer grazing as an indicator of level of grazing activity.
We used a generalized linear model coupled with a time lag variable to assess correlations between deer grazing activity and rainfall events.
We provided demonstration seeds of forage varieties at a collaborating farmer's fields in Caroline County, MD, and near Harrington, DE, to evaluate performance of these varieties in different soil types and with different deer populations.

Results and Discussion:

Yield Results: Yield results found that the group 4.7 forage soybeans (GT1 Brier Ridge) and the conventional group 5.3 soybeans (Pioneer), provided the highest yields (see table below), with the lowest yield from the group 7 forage soybeans by Eagle Seed. Although the Big Fellow forage soybeans yielded the lowest amounts, they did appear to attract deer most in August, which may have helped alleviate deer grazing pressure during the R4-6 stages of development on conventional soybeans. We plan to more closely monitor this dynamic in the coming year.

Table 1: Average yields for different varieties of forage and conventional soybeans in 2021 at Wye Research & Education Center.

Variety	Yield (bu/acre)
Pioneer, Group 5.3, Conventional	54.1
GT1 Brier Ridge Group 4.7, Forage	53.5
Pioneer Group 3.1, Conventional	52.2
Biologic, Group 6, Forage	49.0
Big Fellow, Group 7, Forage	36.4

Camera Trap Results: We found that during the 60-day growing period approximately 45% of deer grazing activity in the field across all soybean varieties occurred in just 5 days: June 23 and 23, July 1 and 3, and 11. We also found that 74% of all deer grazing activity occurred at between sunset and sunrise (fig. 2).

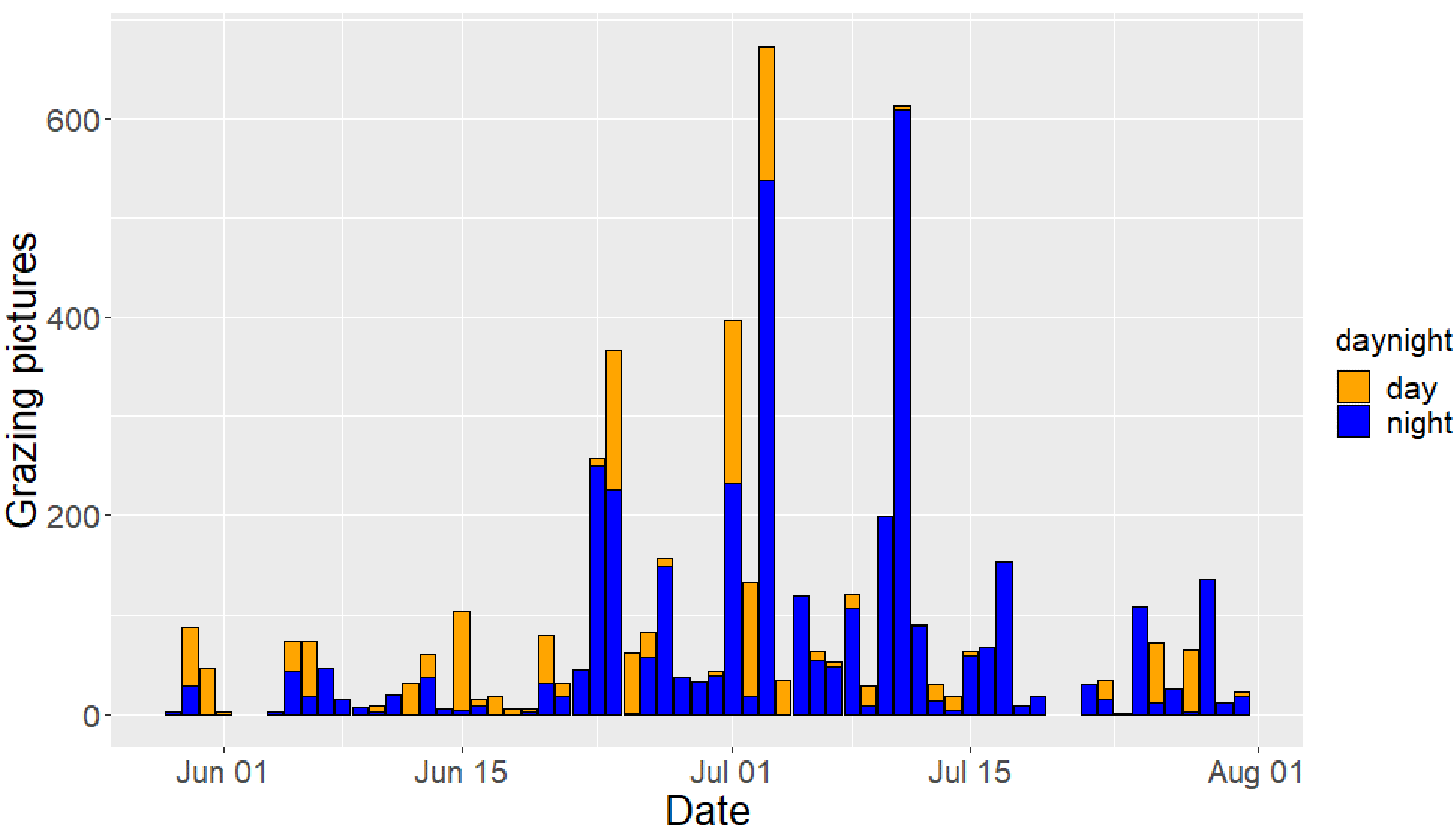


Fig. 2: Number of pictures of deer grazing by day or night across all soybean varieties in summer 2021.

Initial review of precipitation data suggested that these spikes in deer grazing were associated with a 1-2 day time delays after rainfall events. A generalized linear model showed a statistically significant increase of deer grazing on soybeans one day after rain, and an even stronger effect two days after rainfall events (Table 2 and Fig. 3). The model also showed a statistically significant decreased in deer grazing activity during rainfall events. We are continuing to analyze this data for other weather-related predictors for deer activity such as wind and barometric pressure to better plan timing for deer deterrent activities.

	Estimate	Std. Error	z value	Pr(>|z|)	
(Intercept)	2.75591	0.03014	91.425	<2e-16	***
Lag0	-256833	0.39784	-6.456	1.08E-10	***
Lag1	2.90027	0.09054	32.033	<2e-16	***
Lag2	3.20245	0.07978	40.139	<2e-16	***
Lag3	-0.21909	0.1876	-1.168	0.243	***

Table 2: Results from generalized linear model assessing significance of deer grazing activity following precipitation. Lag0 is during the same day as rainfall, Lag 1 is one day following rain, etc. A negative estimate (red) shows decreased deer grazing activity while positive esitimates show statistically positive grazing activity following rainfall events.

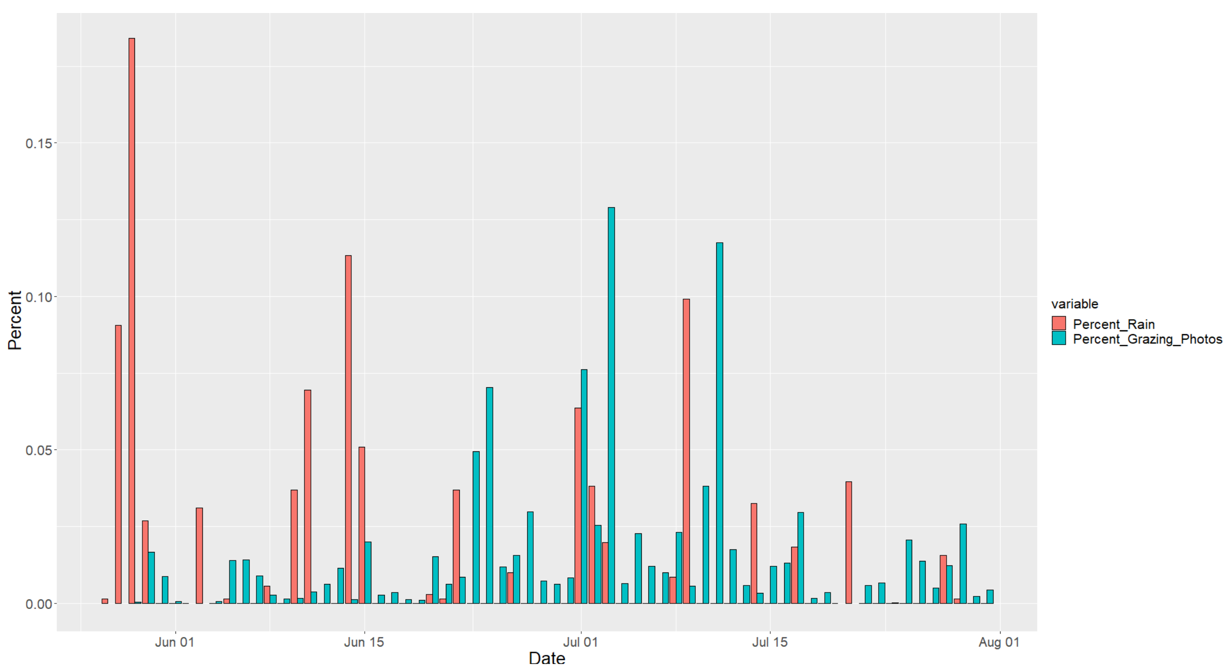
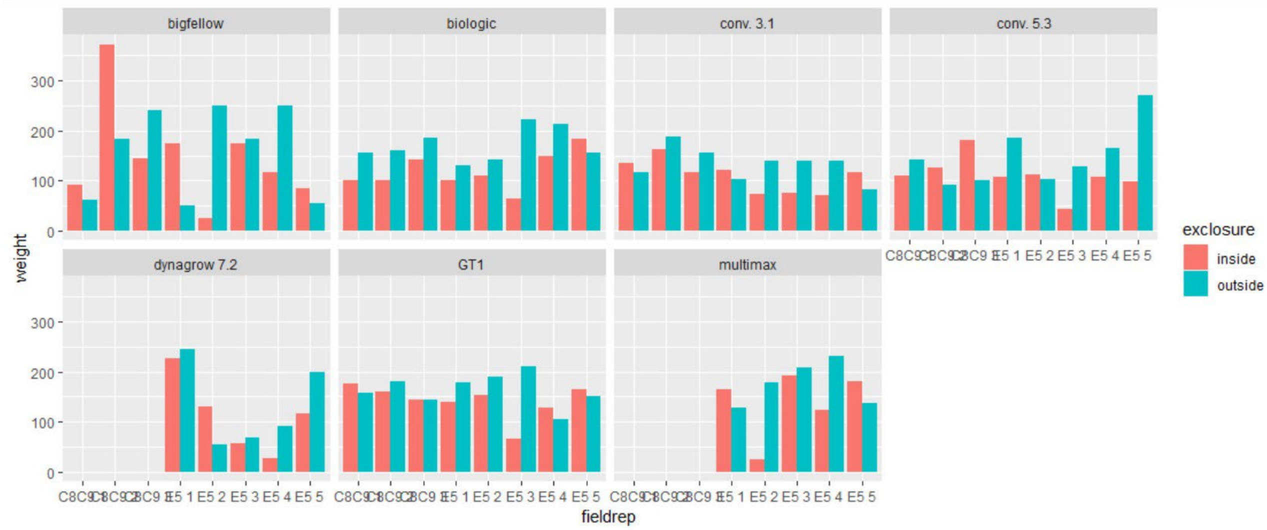


Fig. 3: Percent of deer grazing photos (blue) and percent of rainfall (red) in June and July 2021 at Wye Research & Education Ctr.

We collected biomass data and found that moderate grazing that occurred at the Wye Research & Education center oftentimes served to increase the biomass of soybean plants (fig. 4a). However, very high densities of deer severely reduced biomass of soybean plantings at a cooperating farmers' property near Harrington, DE (fig. 4b). Yield estimates from within and outside exclosures were highly variable, but and confounded by rabbit grazing and limited size of exclosures that we do not feel confident in making assessments about yield effects by moderate deer grazing experienced at the Wye in the summer of 2021.

A)



B)

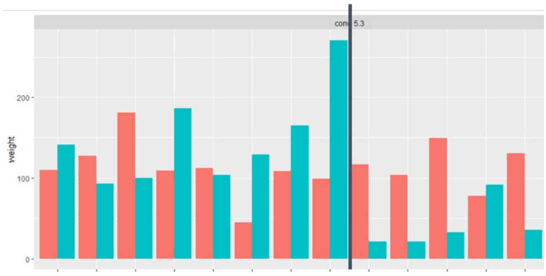


Fig. 3: Biomass measurements from inside (blue) and outside (red) deer grazing exclosures. Table 3a) denotes biomass of different varieties at the Wye Research & Educaiton center, which experienced only moderate deer grazing pressure in 2021, while 3b) compares biomass of the Pioneer group 5.7 variety between the Wye REC (left of black line) and a cooperating farmer's field near Harrington, DE (right of black line), which had notably greater deer grazing pressure.

Improvements for future work: Our experience over the year yielded important insights to guide future research, in particular, widening our treatments to reduce error associated with classification of images of deer grazing, placing deer exclosures a greater distance from cameras, widening exclosures to a full 10' diameter, using chicken-wire exclosures instead of hog-wire to keep rabbits from grazing in exclosures, conducting monthly forage analysis of soybean leaves, and developing a clipping experiment to artificially reproduce herbivory in a controlled manner designed to mimic deer grazing. Grazing activity between soybean varieties varied considerably and may have been confounded by the placement of deer grazing exclosures, so we will remedy this problem in the coming year. Yield measurements from exclosures to full 10' diameter exclosures will also provide more confidence in the difference in yields under grazing and non-grazing situations. We believe a second year of data needs to be gathered to assess deer preferences with greater confidence. In 2022 we are also testing the effectiveness of planting into green cover crops as a way to reduce early seeding mortality from deer grazing.

Outreach and Education: We participated in a field day for the Wildlife Subcommittee of the Maryland Farm Bureau on 7/20/21 and presented a poster at the Maryland Commodity Classic on 7/22/21. We also participated in the Maryland Soybean Board Field Day on August 11, 2021. We have given presentations to the Maryland Farm Bureau annual convention (~50 attendees), a webinar for Lower Shore farmers (~20 attendees, hosted by Meaghan Perdue), at the Talbott County Corn Club (~50 attendees), to the Caroline County Winter Agronomy meeting (to 110 attendees via recording), and to the University of Maryland Extension monthly administrative meeting (~200 attendees). We have written articles for the Maryland Farm Bureau magazine (coming out in summer 2022), and for the Crop Damage Quarterly newsletter mailed out by Delaware Department of Natural Resources. We have engaged with undergraduate research assistants to help with the research, who have learned about the issue of wildlife damage on crops and one of them presented her research findings in the classroom setting at the University of Maryland as part of a class research project.

Emerald Ash Borer Biocontrol via Interactions with Native and Introduced Parasitoid Wasps

Devin Jameison, University of Maryland

Introduction

The emerald ash borer (EAB; *Agrilus planipennis*) is an invasive beetle species that has wrought immense havoc upon ash trees in deciduous forests across the eastern US and Canada. First detected in Michigan in 2002, EAB was detected in Maryland just one year later, although the pest likely escaped detection for at least a decade. It is estimated that EAB has caused billions of dollars in environmental and industry damage (Kovacs et al. 2010). EAB adults are easily identifiable due to their iridescent, metallic green hue and body size measuring about 1 cm in length. In contrast, the larvae stay out of sight, boring into the inner cambium of ash trees. Here they feast upon the nutrient-rich wood tissue in serpentine, S-shaped patterns known as galleries. With high density galleries carved throughout their inner bark, ash trees' phloem nutrient supply is cut off, ultimately leading to their demise. Once larvae grow in size through four instars, larvae bore deeper chambers within the wood to pupate and then later emerge as adults.

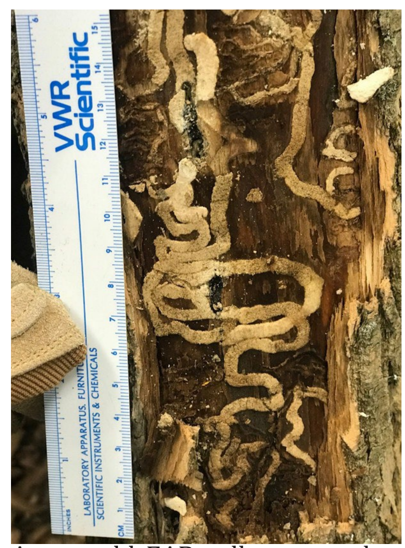
An EAB larvae inside a chamber. Larvae instars are L1, L2, L3, L4, JL, Pre-pupae, and Pupae. The above larvae is a JL since it is in a chamber but has not begun to metamorphosize.

Photo credit: A. Saenz

Ongoing Research: Biological Control

The Gruner Lab at the University of Maryland is currently partnered with the USDA in EAB biocontrol management. Initially, the use of pesticides as a large-scale biocontrol method was investigated. More specifically, emamectin benzoate tree injections were administered in infested ash trees and found to confer a protective neighboring effect between trees. However, high tree proximity is necessary for this to occur. Not only is such spacing seldom seen in nature, but large-scale tree injection treatments are too costly an endeavor to sustain for such a widespread invasive species. Given this, the focus shifted towards classical biological control, in which natural predators of the invasive species are introduced into non-native environments. In this case, the introduced predators are four parasitoid wasp species from Eurasia, namely *Tetrastichus planipennisi, Oobius agrili, Spathius agrili*, and *Spathius galinae*. Of the four, *Spathius galinae* currently shows the greatest potential for biocontrol. To collect relevant data, the lab identifies Maryland sites with heavy EAB damage, extracts infested trees to incubate and rear larvae in barrels, and then assesses parasitoid presence through analysis of parasitism rates. Larvae retrieval also involves debarking trees, in which smaller diameter trees have their bark stripped off. Parasitism rates are measured primarily as a function of parasitoid wasp presence per year for a given site rather than EAB counts. In the last two years there has a been a sharp uptick in parasitism rates across all our field sites. However, our data is still under further analysis and more time is necessary to conclusively state that the introduced species are established.

An adult EAB.
Photo Credit: David Cappaert



A very old EAB gallery carved into a debarking log. The sawdust-colored substance is beetle frass. Fresher frass is whiter and hints where a JL has created a chamber.

Photo credit: A. Saenz

Left: Spathius (S.galinae), one of the the four parasitoids wasps introduced for EAB biocontrol. Photo credit: Gruner Lab

Right: One of the 20-gallon barrels in the UMD greenhouse used to incubate EAB from collected logs. The urine sample cups are used to capture emerging EAB adults and associate arthropods on from logs.

Photo credit: Gruner Lab

EAB and Ash Tree Identification

Ash Tree Identification

Ash trees are hydrophytes, which means that they are naturally abundant in swamps, wetlands, or deciduous forests with high water tables. The most common species of ash in Maryland are green ash, white ash, and black ash. Ash trees possess the following distinguishing characteristic from other trees:

1.) **Bark:** Mature ash trees possess corky, ridged bark that often forms diamond shaped patterns (Fig. 1). How pronounced the corky bark is varies between species. For immature ash, the bark is not as corky, but still displays the diamond pattern and often is covered with splotches of moss in swampy environments.

2.) **Opposite Branches:** Branches split from nodes opposite each other rather than in an alternating fashion (Fig 2).

3.) **Compound Leaves and Bud Shape**: Ash tree leaves are pinnately compound; there are at least 5 leaflets, but usually 7-9, alongside 1 terminal leaflet on separate stalks attached to the main stalk (Fig 3). Pairs of leaflets are positioned opposite each other along the petiole. Moreover, the axillary buds are shaped like Hershey kisses (Fig 4).

4.) **Leaf Color and Smoothness:** Newly formed ash leaves for white ash may be reddish green in color (Fig 5). Moreover, some species of ash (such as blue ash) have leaves that are slightly toothed or serrated (Fig 6).

Ash trees are commonly confused with hickory, box elder, elm, walnut, and mountainash. Careful observation and looking for the traits mentioned above will always help to distinguish between them.

Fig 1: Close up of ash bark. Note the rugged corkiness and diamond-like pattern. Photo credit: A. Saenz

Fig 2: Opposite branches on a ash sapling. Photo credit: D. Jameison

Fig 3: Pinnately compound leaves with about 7 leaflets. Photo credit: D. Jameison

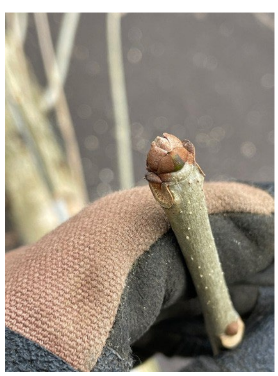


Fig 4: Hershey kiss-shaped axillary bud. Photo credit: D. Jameison

Fig 5, Left: Newly formed white ash leaves. These can be mistaken for poison ivy if the pinnate leaflets are overlooked.

Photo credit: D. Jameison

Fig 6, Right: Backside of blue ash leaves. Note the serrated edges on the leaflets.

Photo credit: Illinois Wildflowers

Signs of EAB Infestation

The presence of current or previous EAB infestation is often made obvious by numerous dead ash trees accompanied by trees that are half dead. Half dead ash trees exhibit at least one of the following "signs" of ongoing EAB infestation:

1.) **D-shaped Exit Holes:** When adult EAB bore their way out of host trees they leave behind D-shaped exit holes that are similar in size to this "D" right here. Exit holes are markedly obvious when located and are the most reliable indicator of EAB presence (Fig 7).

2.) **Bark Splits and Galleries:** The bark will have long, irregular splits due to the tree attempting to grow over and engulf the larvae (Fig 8). Trees also do this to repair phloem damage caused by EAB galleries. Bark splits are usually where old galleries are visible, and are also common where the bark is falling off since the galleries result in dead cambium tissue.

3.) **Woodpecks:** Heavily infested ash trees typically are covered in woodpecks across the entire length of the tree (Fig 9). Since woodpeckers will predate upon all larval stages, woodpecks are almost always found near galleries.

4.) **Thinning Crown:** The crown of an infested ash tree is usually in poor health, lacking fully flushed leaves on some branches and exhibiting evidence of dieback (Fig 10).

5.) **Epicormics:** Offshoots from the main trunk that trees produce under immense stress. Most occur around the base of trees, but some can form higher up as well (Fig 11).

Lastly, infested ash trees may be covered with vines, such as wild grape or ivy, especially in swampy habitats. This is due to thinned crowns allowing light to penetrate further below and the weakened state of stressed trees.

Fig 7: D-shaped exit holes. EAB may become stuck as they attempt to leave exit holes, like the one shown here.

Fig 8: Bark split in an ash tree likely caused by damage from a gallery. Photo credit: A. Saenz

Fig 9: Woodpecks near an exit hole. Woodpecks are typically oval shaped. Photo credit: A. Saenz

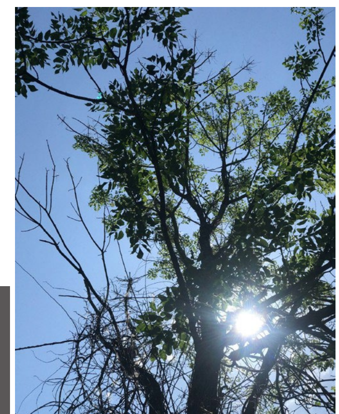


Fig 10: Middling crown condition, notable from the uppermost branches bereft of foliage. Photo credit: A. Saenz

Fig 11: A well-developed epicormic coming off a large ash tree. Photo credit: A. Saenz

Outreach

Given the speed at which EAB decimate ash populations, field sites provide trees and larvae for only a few years at most. As such, research labs at University of Maryland and USDA-ARS are always in search of new leads for EAB-infested ash trees or stands to supply us with further infestation data, ash health recovery, and EAB larvae, which we require to rear parasitoid wasps for biocontrol release. The best way to contribute to our research and EAB management as a whole begins with learning how to identify ash trees and EAB infestation signs, as described in the section above. If you have or know of ash trees that we could potentially use in the future, we strongly encourage you to reach out to us at the following contacts:

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Gruner Lab website: https://www.google.com/url?q=https://www.grunerlab.org/emerald-ash-borer.html&sa=D&source=docs&ust=1686961145051291&usg=AOvVaw3Ko04dYoAtLH28HIM9wUF_

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