2024 Annual Summer Meeting of the American Cranberry Growers Association

AMERICAN CRANBERRY GROWERS association

Rutgers University Marucci Center

Chatsworth, NJ

Thursday
August 22, 2024

RUTGERS
New Jersey Agricultural Experiment Station

Presentation Summaries

American Cranberry Growers Association
2024 Summer Field Day

Thursday August 22, 2024
Rutgers University

P.E. Marucci Center for Blueberry & Cranberry Research & Extension,
Chatsworth, NJ

Parking will be available at the Center's shop (across cranberry bogs).
Transportation for tours will be provided at the Center.
Restrooms (porta-potty) located at the Center's Pole Barn.

CRANBERRY BOGS

8:00–8:30 **Refreshments**

8:30–8:50 **Opening Remarks**
Shawn Cutts, President, American Cranberry Growers Association

8:50–9:10 **A Summary of the 2024 Entomological Research (Bog 19)**
Cesar Rodriguez-Saona, Professor & Extension Specialist, Department of Entomology, Rutgers University and *Robert Holdcraft*, P.E. Marucci Center, Chatsworth, NJ

9:10–9:30 **NJ OSC Research Update (Bog 19)**
Lindsay Wells-Hansen, Senior Agricultural Scientist, Ocean Spray, Chatsworth, NJ

9:30–9:50 **Developing New Spray Regimes for Cranberry Fruit Rot (Bog 15)**
Peter Oudemans, Professor & Extension Specialist, Department of Plant Biology, Rutgers University, and *Matt Hamilton*, P.E. Marucci Center, Chatsworth, NJ

9:50–10:10 **Updates on High-throughput Phenotyping for Cranberry Pre-breeding (Bog 7)**
Jeffrey Neyhart, Research Geneticist, USDA-ARS, *Lindsay Erndwein*, USDA Research Associate, *Pawan Basnet*, USDA ORISE Postdoctoral Research Associate, and *Breanne Kisselstein*, USDA ORISE Postdoctoral Research Associate. P.E. Marucci Center, Chatsworth, NJ

10:10–10:30 **Field Plot Scanning for Cranberry Disease Incidence and Fruit Quality (Bog 5)**
James Polashock, Research Plant Pathologist and *Joseph Kawash*, USDA-ARS, P.E. Marucci Center, Chatsworth, NJ

10:30–10:50 **Update on New Pre- and Post-Emergence Herbicides in Cranberry (Bog 3)**
Wesley Bouchelle, Field Researcher and *Thierry Besancon*, Associate Professor & Extension Specialist, Department of Plant Biology, Rutgers University, P.E. Marucci Center, Chatsworth, NJ

10:50–11:10 **Update on the Development of a Fruit Rot Resistant Cranberry Variety (Bog 2)**
Gina Sideli, Assistant Professor, Department of Plant Biology, Rutgers University, P.E. Marucci Center, Chatsworth, NJ

POLE BARN

11:20–11:30 **Cranberry Statistics**
Bruce Eklund, National Agricultural Statistics Service, Trenton, NJ

11:30–12:00 **Computer Vision in Ag AI on the Bog**
Kristin Dana, Professor, Department of Electrical and Computer Engineering, Rutgers University

12:00–1:00 **LUNCH**

1:00–1:30 **Pesticide Safety and Regulatory Update for 2024**
George Hamilton, Professor & Extension Specialist and State IPM Coordinator, Department of Entomology, Rutgers University

A SUMMARY OF THE 2024 ENTOMOLOGICAL RESEARCH

Cesar Rodriguez-Saona, Professor & Extension Specialist, Department of Entomology, Rutgers University and Robert Holdcraft, P.E. Marucci Center, Chatsworth, NJ

In 2024, research at the Rutgers P.E. Marucci Center focused on four main objectives: 1) studying the seasonal phenology of blunt-nosed leafhoppers; 2) evaluating a new insecticide against various insect pests; 3) understanding the timing of phytoplasma acquisition and transmission between leafhoppers and cranberry plants; and 4) investigating the effects of different fertilizer regimes on the interactions between cranberry plants, phytoplasma, and insects.

Objective 1. Monitor population levels of blunt-nosed leafhoppers to develop a predictive degree-day model.

This study, now in its third year, is being conducted in collaboration with Dr. James Shope, a climatologist at Rutgers University. Multi-year data are essential for developing degree-day models, which is why the research has been ongoing. In 2024, sweep net sampling was conducted from May through August across six beds at a commercial cranberry farm. During this period, the number and developmental stages of blunt-nosed leafhoppers were recorded.

Objective 2. Evaluate new insecticides against cranberry pests.

In 2023, we showed that a new (unregistered) insecticide effectively controls Sparganothis fruitworm and blunt-nosed leafhoppers. In 2024, we extended these studies by evaluating the residual toxicity of this insecticide against Sparganothis fruitworm larvae, spongy moth larvae, blunt-nosed leafhopper nymphs, and toad bug adults in small-plot and laboratory assays at the P.E. Marucci Center (Fig. 1). Insecticide applications were made to small (4-by-4 feet) cranberry plots. Toxicity was assessed by placing insect pests on field-weathered foliage residues collected at various intervals after treatment. On each sampling date, insecticide-treated uprights were inserted into florists' water picks, enclosed in ventilated 40-dram plastic vials, and secured in Styrofoam trays. The plants and insects were then placed in the laboratory, where insect mortality was assessed after transfer. The number of larvae that were alive, dead, or missing was recorded.

Fig. 1. Small plot/lab experiments evaluated toxicity of a new insecticide on insect pests of cranberries.

Objective 3. Understand the timing of acquisition and transmission of phytoplasma between leafhoppers and cranberry plants.

The goal of these studies was to understand the timing of acquisition and transmission of the phytoplasma that causes false blossom disease by blunt-nosed and sharp-nosed leafhoppers.

This research will be conducted in collaboration with Dr. James Polashock of the USDA-ARS. Unfortunately, due to an insufficient number of blunt-nosed leafhoppers, the studies involving this species will be postponed until 2025. However, the studies were conducted with adult sharp-nosed leafhoppers, a known vector of the disease. For the acquisition studies, four adults were placed on both phytoplasma-infected and non-infected (control) plants. Insects were removed 5 and 10 days after feeding and then tested for the presence of phytoplasma using methods developed by Dr. Polashock's lab. We used five plants (replicates) for each insect x stage x time combination. For the transmission studies, we placed five adults on phytoplasma-infected plants. After 5 days of feeding, they were moved to non-infected plants. As a control, four adults were placed on non-infected plants and then moved to another set of non-infected plants after 5 days of feeding. We collected plant material at 15 and 30 days after feeding to test for the presence of phytoplasma. Each treatment (infected-to-non-infected and non-infected-to-non-infected) and time interval was replicated five times. These studies were conducted in growth chambers under controlled environmental conditions.

Objective 4. Investigate the effects of fertilizer regime on cranberry, phytoplasma, and insect interactions.

This study aimed to better understand resistance in cranberries against insect pests and diseases under varying nutrient levels. The research was conducted by PhD student Hao-tian Liu in collaboration with Dr. James Polashock of the USDA-ARS. Two cranberry varieties, Crimson Queen and Ben Lear, either infected or not infected by the phytoplasma that causes false blossom disease, were propagated in the greenhouse and subjected to four different fertilizer rates (Fig. 2). In 2023, we assessed the effects of these treatments on the performance of blunt-nosed leafhoppers and spongy moth larvae. In 2024, we evaluated the impact of these treatments on the performance of Sparganothis fruitworm larvae and Japanese beetle grubs.

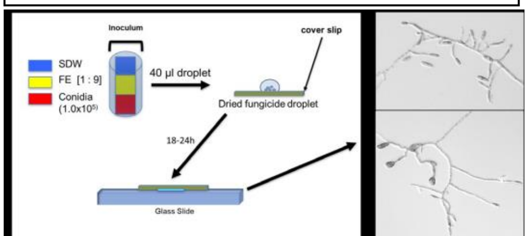
Fig. 2. Greenhouse experiments evaluated the effects of phytoplasma infection and fertilizer rates on insect pests of cranberries.

PROCESS FOR IDENTIFYING NEW FUNGICIDES FOR CRANBERRY FRUIT ROT CONTROL

Peter Oudemans, Matt Hamilton, Luke Mackara, Chris Dib, and Christine Constantelos

Several generations of fungicides have been used to manage the cranberry fruit rot complex with varying degrees of success. Today, with increased use of higher yielding cultivars, implementation of stringent fruit quality standards, and a changing landscape for registration/deregistration of fungicides there is an increasing need find new and effective fungicides. The presentation today will focus on efforts to find replacements for the broad-spectrum fungicides with more site-specific fungicides. Site specific fungicides present many advantages as well as disadvantages. Fungicide resistance is the most critical disadvantage especially as broad-spectrum materials are deregistered. In this presentation I will highlight the process for developing new fungicides for cranberry fruit rot.

Flower Extract (FLEX) Bioassay



A novel, fast bioassay utilizes the flower extract method developed by Tim Waller. It allows rapid identification of new modes of action. Using this FLEX Bioassay we have identified novel FRAC 3, 7, 9 and 29 fungicides that are now being evaluated in efficacy trials.

Field trials are conducted in experimental beds at th Marucci Center. Efficacy trials are conducted to determine if candidate fungicides identified via the FLEX Bioassay show activity in the field. Efficacy trials are conducted using the same treatment repeated 4x during the season. Results from efficacy trials are used to determine how effective a compound is and weather there are any phytotoxic effects. This is in contrast to Use Pattern trials that incorporate multiple treatments during the season and are designed to develop recommendations for effective spray regimes.

These data are then used to support registration requests through either IR4 or via the registrant.

The trials are setup using a statistical design called the Randomized Complete Block Design which allows different treatments to be evaluated in a statistically verified manner. The results shown to the right reflect values taken on Aug. 15, 2024 using a visual rating of 0-5, with 5 being the highest level of fruit rot.

1	0	1	1
1	1	4	4
1.5	2	1	2
3	0	1	3
4	1	1	2
0	1	2	1
1	0	2	2
0	0	1	1
3	2	1	0
2	4	1	1
3	0	1	1
1	0	0	2
1	0	1	0
0	1	1	1
0	1	0	2
1	2	0	2

0
1
2
3
4
5

In 2024 we conducted five efficacy trials and one-use pattern trial.

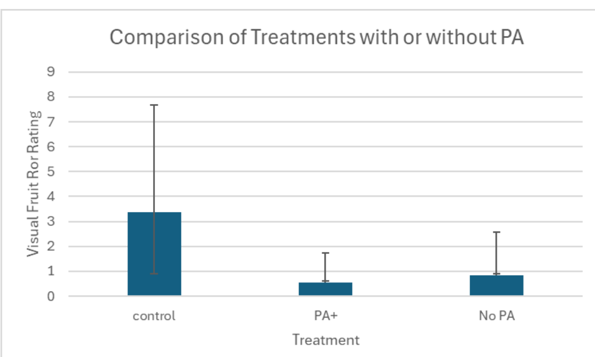
Phosphorous Acid Trial: Phosphorous Acid (PA) is a unique fungicide in that it is systemic (symplastic) and has a secondary mode of action. In other words, it is not only directly toxic to fungi but also induces a plant response to infection. As a solo fungicide it does not affect fruit rot fungi directly, however, previous data suggests a strong effect when used in combination with certain fungicides. In this trial we have taken our strongest candidate fungicides for registration and tested them with or without PA.

SI Trial: SI fungicides also known as FRAC 3 fungicides are widely used for cranberry fruit rot control. These fungicides are systemic (apoplastic) with a single mode of action and are moderately vulnerable to fungicide resistance. In this trial we are examining the effect of incorporating PA with this group of fungicides.

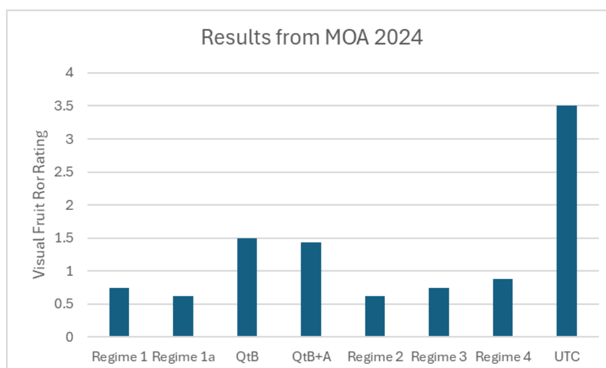
MOA Trial: Three new (not labelled) fungicides are undergoing the 4th season of efficacy trials. This will provide data on reliability and consistency of the effect of these fungicides on fruit rot control.

Proprietary Trials: Three agrichemical companies (BASF, Syngenta and Vive) are testing new modes of action as well as reformulated products for fruit rot control. Two separate trials are being conducted to evaluate these new products for efficacy and phytotoxicity.

Use Pattern Trial: This trial is designed using results from previous years to determine the optimal use patterns of new fungicides. These use patterns are compared against a common grower standard. The use patterns are designed to follow labelled uses and can be translated directly to commercial recommendations.



Preliminary results for 2024 efficacy trial comparing PA combination with SI fungicides



Preliminary results for 2024 use pattern trial testing different regimes for fruit rot control recommendations

UPDATES ON HIGH-THROUGHPUT PHENOTYPING FOR CRANBERRY PRE-BREEDING

Jeffrey Neyhart, Research Geneticist, USDA-ARS, P.E. Marucci Center, Chatsworth, NJ; Taylor Bainbridge, USDA-ARS Technician; Lindsay Erndwein, USDA-ARS Postdoctoral Research Associate; Breanne Kisselstein, USDA-ARS ORISE Postdoctoral Research Associate; Pawan Basnet USDA-ARS ORISE Postdoctoral Research Associate

Cranberry pre-breeding evaluation trial

In 2024, the USDA-ARS cranberry pre-breeding program established its first field trial in bog 7 at the P.E. Marucci Center. The trial contains 437 cranberry genotypes, including new germplasm not found in the Rutgers collection and offspring from crosses between high-yielding clones and wild or native selection clones. These crosses target improved stress tolerance and disease resistance while maintaining yield and fruit quality. We will start collecting data from this trial in 2026, which will be used to test new phenotyping technologies and breeding methods, and to make selections for potential germplasm release.

High-throughput phenotyping

In cranberry breeding, selection decisions for one or more traits are made using measurements of plant *phenotypes*, or observable characteristics. To identify the best clones, phenotypes must be recorded for hundreds or thousands of plants under field settings. Many traits, including yield, quality, and disease resistance, are laborious or time-consuming to measure. We are investing in technologies and building systems that allow us to collect phenotypic data on many more plants, over more time points, and for a wider scope of traits that we could manually. A summary of our current work follows.

CranCart Version 2.0

We modified our proximal sensing cart (the *CranCart*) for high-throughput phenotyping. This system is custom-built and uses computer vision to measure traits in plots in the Rutgers and USDA cranberry breeding programs. Upgrades include:

- Smaller design and more stability when moving through the bed
- Thermal camera for measuring canopy temperature / heat stress
- High-resolution RGB camera for visual trait measurements
- GPS receiver for recording the precise location of sensor readings
- Micro-computer with custom software for controlling sensor and collecting data

The *CranCart* significantly increases the amount of phenotypic data we can collect per person per hour. For example, harvesting fruit for measuring yield takes at least **0.10** person-hours per plot, but estimating fruit yield using the *CranCart* requires only **0.01** person-hours per plot, a **tenfold** increase in throughput.

Task	Number of plots	Persons	Time	Person-hours per plot
Harvesting fruit for yield	~300	10	3 hours	30/300 = 0.10
Yield estimation using the *CranCart*	~300	2	1.5 hours	3/300 = 0.01

Heat stress phenotyping

- Plant heat stress and berry overheating can both lead to yield loss or elevated fruit rot.
- We used the *CranCart* thermal imager to measure canopy temperature on 292 genotypes in bog 1 during two heat stress days (>95°F) in 2023.
- Several cranberry genotypes consistently maintained cooler canopies (i.e. are more heat stress tolerant); **wild cranberry genotypes originating from hotter climates were more heat-tolerant,** and those from cooler climates were less heat-tolerant.
- More data is being collected in 2024 during heat stress and non-stress days. This data will be used to inform crosses in 2025.

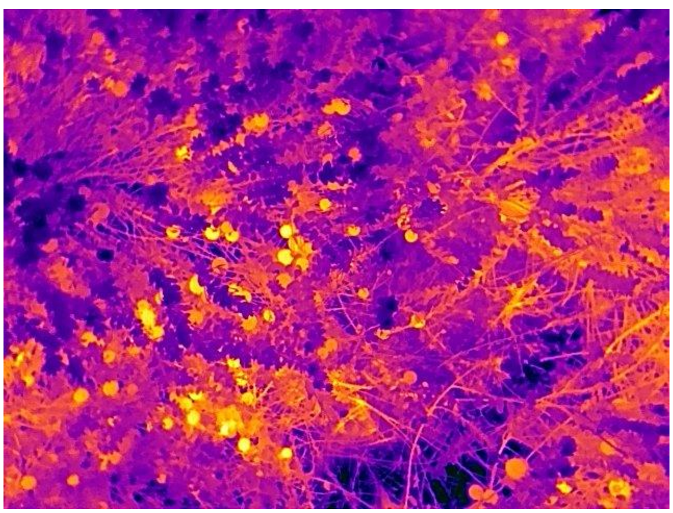


Figure 1. Thermal image of a cranberry plot captured using the *CranCart*.

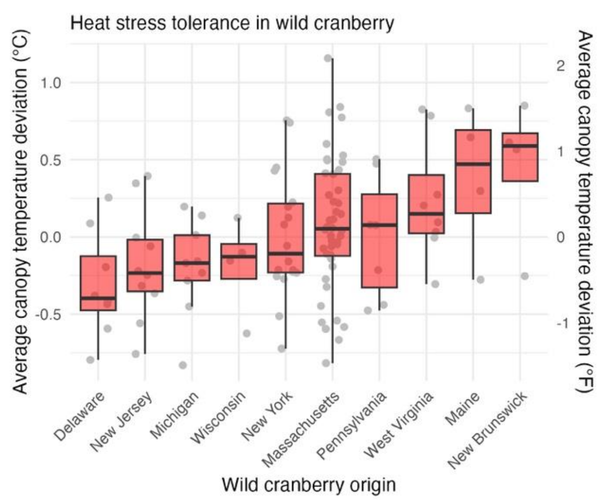


Figure 2. Average canopy temperature for wild cranberry germplasm from different origins. Lower temperature indicates more heat tolerance.

Fruit yield estimation

- Estimating fruit yield using computer vision could help us identify high-yielding genotypes without manually harvesting as many plots.
- We have developed a computer vision/AI model for detecting fruit in cranberry breeding plots using the *CranCart* RGB camera; this model can identify fruit with **95% accuracy**.
- The model was tested in 2021 and 2023 using images of breeding plots from multiple bogs; there was a moderate-high correlation between fruit count and harvested yield, indicating that **yield can be estimated from images of cranberry plots**.
- We are refining the model using higher-resolution images and collecting additional data in 2024; this data will be used to develop predictions.

Figure 3. Example output of our fruit detection computer vision/AI model using an image captured from the *CranCart*.

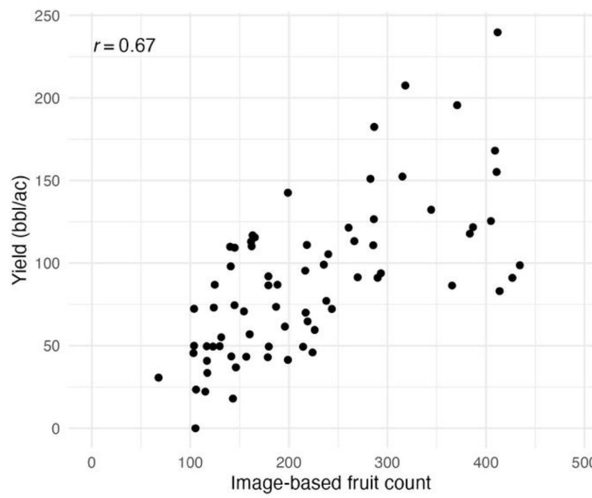


Figure 4. Correlation between fruit counts from our computer vision/AI model and harvested yield.

Other traits

We are developing capabilities for high-throughput phenotyping of additional traits in the field using computer vision:

- Flowering/bloom progress (% in/out bloom)
- Percent fruit rot
- Fruit color

Figure 3. Example output of our flower/bloom detection computer vision/AI model using an image captured from the *CranCart*.

FIELD PLOT SCANNING FOR CRANBERRY DISEASE INCIDENCE AND FRUIT QUALITY

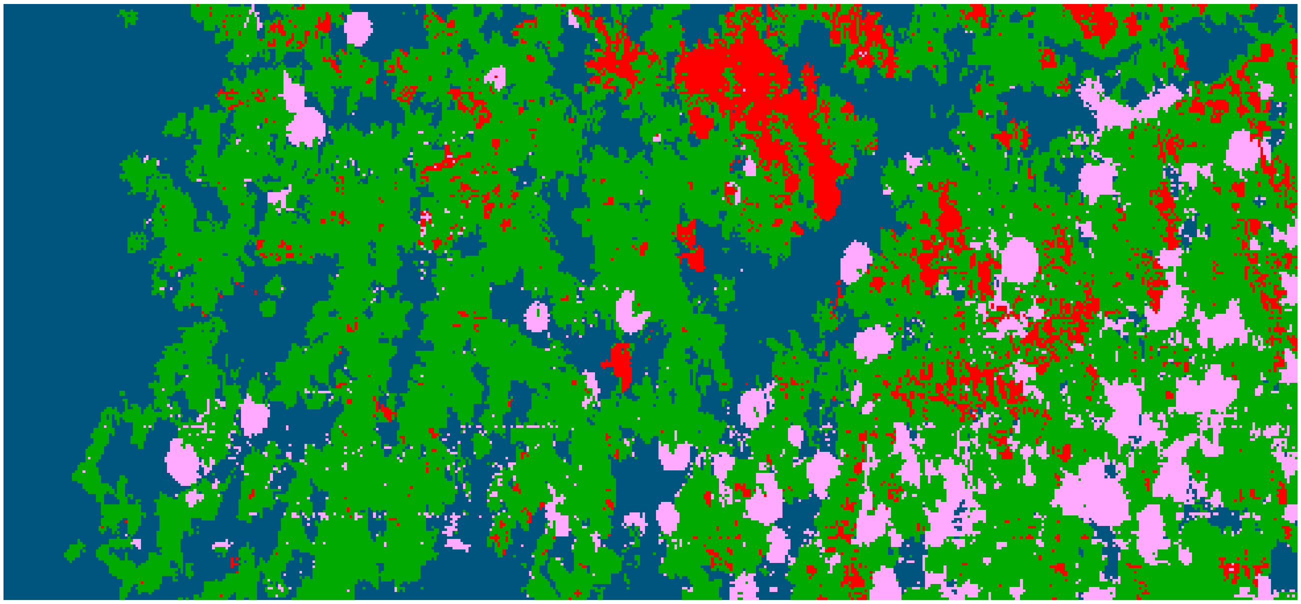
James Polashock, Research Plant Pathologist and Joseph Kawash, Bioinformaticist, USDA-ARS, P.E. Marucci Center, Chatsworth, NJ

We have successfully used our hyperspectral imaging in the laboratory to assess cranberry fruit rot, epicuticular wax, disease states, etc. Our goal is to move the system out to field to capture in-bog data during the season without damaging the plants as well as to automate at least part of the data collection process. The system needs to be robust, flexible, and resistant to general field hazards. While significant progress has been made with previous renditions of camera setups and cart apparatus, one of the most time-consuming steps remains going into the field and scanning each plot. It takes about 90 seconds to scan each plot, plus movement time between plots. To meet the goal of accurate and efficient field phenotyping, we have purchased an all-electric semi-automated micro-tractor. The tractor has a capacity to run for 8 hours on dual lithium batteries while hauling a 1000-pound load.

The tractor computer control module has wireless capability and is programmable using Python. Additionally, the control module can be accurately GNSS/RTK guided with enough resolution to navigate a research bed and identify plot locations. Once programed, the tractor is able run autonomously through the beds and collect data near autonomously. The hyperspectral image data as well as plot data, location and environmental data (exact GPS coordinates, time, temperature, humidity, etc.) can be sent via Wi-Fi directly to servers available at the Center for analyses.

We are currently testing and configuring the system and have mounted our hyperspectral imaging (VNIR, 600-1700 nm) sensor to the tractor. The tractor straddles the cranberry research plots while collecting scanning images of the plot below. This results in a more consistent hyperspectral image with a wider field of view than our previous phenotyping cart. The hyperspectral data are currently being analyzed and compared with lab-based data for accurate field-based classification. When the field-based classifier is built, it will not be necessary to remove samples from the field to quantify for traits such as yield, fruit rot incidence, or plant stress.

In the image example below, the hyperspectral system took a scanning sweep of a research plot, and the system was trained able to classify cranberry leaf material (green), cranberry fruit (pink), diseased material (false blossom, red), and background soil (blue).



NEW JERSEY AGRICULTURAL STATISTICS

Bruce Eklund, State Statistician
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National Agricultural Statistics Service

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New Jersey cranberry producers expect to harvest 580 thousand barrels in 2024, the same level as 2023. NASS released the production forecast for the 2024 crop August 12, 2024.

Massachusetts production is forecast at 2.20 million barrels, up from 1.97 million barrels the year before. Oregon producers expect to harvest 560 thousand barrels, up from 540 thousand barrels in 2023. Wisconsin production is forecast at 4.9 million barrels, down from 2023 production of 5.01 million barrels. Total forecast for these four states is 8.24 million barrels compared to a realized 8.11 million barrels in 2023.

For more detail including acreage and value of production, USDA's National Agricultural Statistics released the 2023 Non-citrus Fruit and Nut Final Summary May 7, 2024 at: https://www.nass.usda.gov/Publications/Reports_By_Date/index.php.

USDA's National Agricultural Statistics will release the 2024 Non-citrus Fruit and Nut Final Summary in May, 2024 also at:
https://www.nass.usda.gov/Publications/Reports_By_Date/index.php We want to work with you to get the best data to accurately represent New Jersey cranberries. Thank you for your help.

You can get e-mail alerts for New Jersey and Regional customized reports:

https://www.nass.usda.gov/Statistics_by_State/New_Jersey/index.php

Look under 'I want to' on the left.

COMPUTER VISION IN AG AI ON THE BOG

Kristin Dana, Professor, Electrical and Computer Engineering, Rutgers University.

Computer vision, a branch of AI, has exciting potential for smart agriculture. In recent work, we developed state-of-the-art computer vision algorithms for image-based crop evaluation and weather-related risk assessment to support real-time decision-making for growers. We developed a cranberry bog monitoring method that maps cranberry density and also predicts short-term cranberry internal temperatures. We have two important algorithm contributions. First, we developed a method for cranberry instance segmentation that provides the number of sun-exposed cranberries (not covered by the crop canopy) that are at risk of overheating. The algorithm is based on a novel weakly supervised framework using inexpensive point-click annotations, avoiding time-consuming annotations of fully-supervised methods. The second algorithmic contribution is an in-field joint solar irradiation and berry temperature prediction in an end-to-end differentiable neural network. The combined system enables over-heating risk assessment to inform irrigation decisions. To support these algorithms, we employ drone-based crop imaging and ground-based sky imaging systems to obtain a large-scale dataset at multiple time points. Through extensive experimental evaluation, we demonstrate high accuracy in cranberry segmentation, irradiance prediction and internal berry temperature prediction. This work is a pioneering step in using computer vision and machine learning for rapid, short-term decision-making that can assist growers in irrigation decisions in response to complex time-sensitive risk factors. Datasets collected over two growing seasons are made publicly available to support further research. The methods can be extended to additional crops beyond cranberries, such as grapes, olives, and grain, where irrigation management is increasingly challenging as climate changes.

Agricultural domains are being transformed by recent advances in AI and computer vision that support quantitative visual evaluation. Using drone imaging, we also develop a framework for characterizing the ripening process of cranberry crops. Our method consists of drone-based timeseries collection over a cranberry growing season, photometric calibration for albedo recovery from pixels, and berry segmentation. By extracting time-series berry albedo measurements, we evaluate four different varieties of cranberries and provide a quantification of their ripening rates. Such quantification has practical implications for 1) assessing real-time overheating risks for cranberry bogs; 2) large scale comparisons of progeny in crop breeding; 3) detecting disease by looking for ripening pattern outliers. This work is the first of its kind in quantitative evaluation of ripening using computer vision methods and has impact beyond cranberry crops including wine grapes, olives, blueberries, and maize.

Three dimensional modelling of cranberry appearance using a new method called NERFs (neural radiance fields) is our most recent approach to using AI on the bog. We discuss our newest results and future directions in this area.

References

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2. Akiva, Peri, Kristin Dana, Peter Oudemans, and Michael Mars. "Finding Berries: Segmentation and Counting of Cranberries using Point Supervision and Shape Priors." In *Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR) Workshops*, 2020
3. Akiva, Peri, Benjamin Planche, Aditi Roy, Kristin Dana, Peter Oudemans, and Michael Mars. "AI on the Bog: Monitoring and Evaluating Cranberry Crop Risk." In *Proceedings of the IEEE/CVF Winter Conference on Applications of Computer Vision (WACV)*, 2021, pp. 2493-2502
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