

Research Grant Proposal Outline for 2022 State Horticultural Association of Pennsylvania

Title: Interaction of Extenday reflective groundcover with ReTain® applications on mid-Atlantic apple cultivars: impact on red coloration, fruit quality and canopy light distribution

Personnel:

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Duration of Project: One year

Justification:

The retail sector is requiring a minimum 50-60% red skin blush in high apple value cultivars, such as Honeycrisp. However, Honeycrisp marketability and the continued growth of the industry across the eastern US, and particularly in the mid-Atlantic, is threatened by the lack of effective strategies for reaching the required red fruit coloration, with dramatic losses as a result of poor or marginal development of skin red coloration.

Although many factors, directly or indirectly, influence apple skin color development (genetic background, developmental stage of the fruit, nutritional status, canopy architecture, crop load), it is also affected by environmental factors such as temperature and light. Red coloration development is suppressed at warmer temperatures (hot days (>90°F) and warm nights (>68°F)), thus it is difficult to produce apples with sufficient red coloration in some locations, e.g., the mid-Atlantic Region. Besides temperature, light intensity affects apple red blush. Increasing light intensity and exposure on the fruit surface has potential to increase red blush. Hence, it is necessary that light is uniformly distributed throughout the canopy.

The common practice to increase color by delaying harvest is generally harmful to overall fruit quality and storability, as over-mature apple fruits soften faster, abscise from the tree before harvest, and have a shorter shelf-life. To solve this problem, the use of preharvest plant growth regulators, such as the ethylene biosynthesis inhibitor aminoethoxyvinylglycine (AVG; ReTain®, Valent USA), can slow down fruit maturity, allowing to delay harvest without fruit becoming over-mature, and decreasing fruit abscission/ drop, but can also negatively affect the development of red skin coloration, slowing it down. Therefore, there is a need for developing new preharvest orchard management strategies that can optimize apple fruit red coloration without affecting fruit quality, so as to improve overall profitability.

One innovative strategy developed to amplify the cumulative light intensity reaching the apple fruit surface and apple fruit exposure in the orchard is through the installation of reflective groundcovers, such as Extenday. The use of reflective groundcovers has been widely and successfully adopted in important apple producing areas around the US, such as Washington State. However, research is lacking in terms of evaluating the effect of this technology in apple orchards established under the mid-Atlantic region environmental conditions and its interaction with the use of plant growth regulators such as ReTain®. Thus, understanding the effect of using these important tools of modern fruit production is of great importance for potentially improving the

marketability of commercially important apple cultivars without affecting fruit quality and for promoting the long-term profitability of mid-Atlantic apple growers.

Considering this background, the goal of the proposed research is to characterize the interaction between the use of Extenday reflective groundcover and ReTain® preharvest applications on fruit skin red coloration, overall quality characteristics and canopy light distribution of commercially important apple cultivars grown in the mid-Atlantic.

The results of this study will be reported to the mid-Atlantic apple industry and will form the basis for development of a future USDA-NIFA-AFRI proposal. This study will also complement a Maryland Specialty Crop Grant awarded to Dr. Farcuh that will evaluate the effect of reflective groundcovers in overall fruit quality (including fruit ripening patterns and physicochemical properties) throughout different ripening stages on the tree, and at different canopy levels of Honeycrisp grown in the mid-Atlantic.

Dr. Jim Schupp has agreed to collaborate in this project by assisting with the measuring the light distribution within the canopy (third objective of this proposal). (Please see support letter included as part of this submission.) His knowledge and experience will be of great value for conducting this study.

2022 SHAP Topical Priority List Categories:

Horticulture

- Maintaining Fruit Quality
- Changing Fruit Finish Issues: Color Enhancement
- Strategic Management of Apple Variety Maturity Progression

Objectives:

1. Evaluate the interaction effect of Extenday reflective groundcover and ReTain® ethylene inhibitor applications on red skin coloration, fruit quality indices and ethylene production throughout ripening on the tree of Honeycrisp fruit grown in the mid-Atlantic.
2. Evaluate the interaction effect of Extenday reflective groundcover and ReTain® ethylene inhibitor applications on preharvest fruit drop and cracking throughout ripening on the tree of Honeycrisp fruit grown in the mid-Atlantic.
3. Measure the effect of Extenday reflective groundcover on light distribution within the canopy of Honeycrisp fruit grown in the mid-Atlantic.

Procedures:

1. Grower-cooperator recruitment.

Our team will partner with grower-cooperators to evaluate the impact different combinations of Extenday reflective groundcovers and ReTain® applications, on red skin coloration, fruit quality indices and ethylene production as well as preharvest fruit drop and cracking throughout ripening on the tree of Honeycrisp fruit. At the time of this writing, Joy Cline from Bear Mountain Orchards, Aspers, Pennsylvania has agreed to participate in this study. She has already previously acquired Extenday fabric.

2. Extenday deployment and ReTain® ethylene inhibitors application

A commercial block of Honeycrisp will be selected for study. Four treatments will be established: (i) Extenday fabric deployed and ReTain® applied; (ii) Extenday fabric deployed and no ReTain®

applied; (iii) No Extenday fabric deployed and ReTain® applied and (iv) No Extenday fabric deployed and no ReTain® applied. Extenday reflective groundcover will be deployed approximately three to four weeks before anticipated commercial harvest, while ReTain® will be applied at a rate of 166g/acre 21 days before anticipated harvest. Twenty to thirty trees will be used by treatment in the same orchard block, with adequate separation among treatments to avoid Extenday fabric reflectance or product drift. The growers will deploy Extenday and spray the ethylene inhibitor and will allow us access to the block for fruit sampling and for measurement of fruit drop and cracking. The grower will communicate and coordinate harvests with the investigators.

3. Evaluate the interaction effect of Extenday reflective groundcover and ReTain® ethylene inhibitor applications on red skin coloration, fruit quality indices and ethylene production throughout ripening on the tree of Honeycrisp fruit grown in the mid-Atlantic.

Fruit samples from each treatment will be collected from the lower third of the canopy three times throughout ripening on the tree: (i) at anticipated commercial harvest, (ii) 1 week after anticipated commercial harvest, (iii) 2 weeks after anticipated commercial harvest.

Immediately following harvest, apples sampled from each treatment will be evaluated at the Fruit Quality Laboratory, University of Maryland (UMD), for:

- Ethylene production
- Fruit size
- Skin color:
 - Surface color (percent red color and by using a Minolta colorimeter)
 - Ground color (using a Delta A meter, a Minolta colorimeter)
- Flesh color (using a Minolta colorimeter)
- Fruit firmness (Texture analyzer or handheld penetrometer)
- Soluble solids (benchtop refractometer)
- Titratable acidity (malic acid equivalents, using an automatic titrator)
- Starch Pattern index (iodine-potassium iodide solution)

Pictures of the different cultivars at the different harvest maturities will also be taken.

4. Evaluate the interaction effect of Extenday reflective groundcover and ReTain® ethylene inhibitor applications on preharvest fruit drop and cracking throughout ripening on the tree of Honeycrisp fruit grown in the mid-Atlantic.

For each treatment, four weeks before anticipated commercial harvest we propose to flag several limbs per plot and count the number of fruits per each limb as well as the number of cracked fruit per flagged limb. We will count the fruits on each limb and assess the presence of cracking every week starting 1 week before anticipated commercial harvest through 3 weeks after anticipated commercial harvest. The percentage of fruit drop and cracking at each stage will be calculated relative to the initial fruit count per limb.

5. Measure the effect of Extenday reflective groundcover on light distribution within the canopy of Honeycrisp fruit grown in the mid-Atlantic.

We propose to measure light interception in photosynthetically active radiation (PAR), and ultraviolet (UV) A+B radiation bandwidths, since both ranges are vital to red fruit blush

development and quality. The investigators will measure canopy light distribution with a LI-COR PAR meter and a Spectrum Technologies UV meter, with primary focus on the lower third of the canopy on one treatment with and one another treatment without Extenday groundcover. This will be done proximal to solar noon on cloud-free days on the north and south sides of the trees. Additionally, groundcover reflectance will also be measured in both PAR and UV bandwidths.

Budget:

Budget Items	Justification	Total May 2022-April 2023
Student Labor	\$12.5/hour × 3 students x 20 hours/week × 10 weeks	\$ 7,500.00
Fringe Benefits	Hourly labor at University of Maryland at 7.7%	\$ 577.50
Travel	6 round trips to PA × 200 miles/trip × 0.56/mile	\$ 672.00
Supplies	Farcuh lab and field supplies	\$ 438.00
<u>Total Direct Cost</u>		<u>\$ 9,187.50</u>
Total Cost		\$ 9,187.50

Other Support:

This proposal has not been submitted to any other agency. As mentioned above, this study will complement a Maryland Specialty Crop Grant awarded to Dr. Farcuh that will evaluate the effect of reflective groundcovers on overall fruit quality (including fruit ripening patterns and physicochemical properties) throughout different ripening stages on the tree, and different levels of the canopy, of Honeycrisp grown in the mid-Atlantic. Furthermore, objective 3 will be conducted by our collaborator Dr. Schupp and he will be using the leftover budget assigned to him on the SHAP project we got funded on 2021: “Use of Extenday reflective groundcover on mid-Atlantic apple cultivars: impact on red blush and canopy light distribution.”

Results:

Research results will be published in the *Pennsylvania Fruit News* and a poster will be presented at the Mid-Atlantic Fruit and Vegetable Convention as well as in Pennsylvania and Maryland growers’ meetings.