Research Grant Proposal for 2021
State Horticultural Association of Pennsylvania

Title: Effect of Mechanical Dormant and Summer Hedging on Growth, Fruit Quality and Return Bloom of Apple Trees in High-Density Plantings

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Duration: Multi-year (Year 2 of 3)

Justification:

This proposal addresses several SHAP Priority Topics: Maintaining Fruit Quality; Novel Pruning Strategies; and Changing Fruit Finish Issues (Sunburn and Color Enhancement). Hedging is a non-selective form of pruning that has been tried in the past as a supplement or replacement to selective hand pruning. Ferree and Lakso (1979) evaluated hedging for dormant pruning of vigorous semi-dwarf apple trees and reported low within-canopy light levels and poor fruit color. Low canopy light levels resulted from a proliferation of new shoots arising from the numerous non-selective heading cuts made by the hedger. Summer hedging, (with dormant selective hand pruning), conversely, was shown to be beneficial in creating higher light levels in the lower canopy (Ferree, 1984). Apple production systems have changed much since those initial studies were conducted.

The previously reported studies were conducted on free-standing M.26 or larger trees, which were at moderate planting density and trained as central leader trees, with permanent scaffolds and a complex branching hierarchy. Modern high-density orchards have a smaller, more accessible canopy. Renewal pruning results in reduced branching hierarchy, and trees are grown at close spacing on M.9 rootstocks or smaller, which may help to control vigorous regrowth from dormant hedging. Mechanical hedging is recommended in modern orchard designs to increase canopy light penetration and red fruit color (Lewis, 2018). Full dwarfing rootstocks may help reduce the risk of excessive growth resulting from the multiple heading cuts caused by hedging.

Trellising reduces the variability in canopy shape and position in a tree wall system. This will facilitate removal of predictable amount of tissue per tree and serves to make the operation of a mechanical hedger simpler and less fatiguing to the tractor operator. Mechanical hedging in June purportedly stimulates flower bud formation closer to the trunk, thereby reducing blind wood.

Since hedging was first evaluated, the cost of labor has continued to rise, and the availability of skilled horticultural labor has become more limited. Mechanized pruning may reduce hand pruning labor. It is time to re-evaluate dormant and summer hedging as a high-density orchard practice.

Potential Pros of Mechanical hedging:

- Simple way to establish a narrow tree wall, with defined canopy height and width;
- Increased light distribution for improved fruit color and quality;
- Minimize blind wood close to trunk;
- Reduced manual pruning costs.

Potential Cons of mechanical hedging:

- Potential for excessively vigorous regrowth of branches on vigorous trees;
- Reduced light distribution leading to loss of fruit quality and color;
- Reduced yield if too many productive branches are pruned away;
- Increased risk of sunburn;
- Increased risk of fire blight spread from summer shearing.

Objectives:

1. Evaluate dormant and summer mechanical hedging on growth, yield, fruit color and fruit quality of tall spindle Fuji/ M.9 apple trees that are being transitioned to a narrow tree wall system.
2. Evaluate mechanical hedging for increasing production efficiency and fruit quality in bi-axis Gala/ M.9 trained as a narrow tree wall system.

Procedures:

General:

Hedging will be conducted in two high-density orchards at FREC. Dormant hedging will be applied in January-February. Summer treatments will be applied in June, when terminal shoots have produced 12-14 expanded leaves. Treatments will be applied to 8-tree plots with 5 replications.

Time required to mechanically hedge and /or manually prune trees will be recorded. Light levels will be measured in mid-season, at two locations in the canopy. Tree growth and canopy dimensions will be evaluated after seasonal growth is complete. Crop load, yield, fruit size distribution, fruit color, fruit sunburn, sugar content, and return bloom will be evaluated for each treatment. Results of season 1 (2020) are being analyzed and will be available by final balloting in late February.

Objective 1. Transition to narrow tree wall:

This study will be conducted in 10-year-old tall spindle 'Brak Fuji"/ M.9 apple trees grown at 3' x 12' spacing. These trees are vigorous and conversion to a narrow tree wall may help increase red fruit color. All treatments will also receive 3-4 sprays of prohexadione calcium (Apogee or Kudos) to prevent the regrowth of long shoots. Mechanical hedging will be supplemented with manual dormant pruning to remove 5-6 large limbs and stimulate limb renewal. One treatment will include root pruning to see if that is an effective technique to control vigorous regrowth of shoots.

The treatments are: 1) control – standard renewal pruning to maintain the tall spindle form; 2) manual dormant pruning to create a narrow tree wall, including 5-6 renewal cuts; 3) dormant mechanical hedging to create the narrow tree wall, with 5-6 manual renewal cuts, followed by mechanical hedging in June when shoots have formed 12-14 leaves; 4) dormant and summer mechanical hedging to create the narrow tree wall, with 5-6 manual renewal cuts, plus root pruning in April/ May. Root pruning will be done with a Phil Brown root pruner with cuts made on both sides of the row at 24 inches from the trunk.

Objective 2. Maintaining an established narrow tree wall system:

This study will be conducted on young bi-axis 'Royal Gala'/ M.9 apple trees at 3' x 12' spacing, which have been trained to a narrow tree wall. Mechanical hedging will be supplemented with manual dormant pruning to remove 5-6 large limbs and stimulate limb renewal.

The treatments are: 1) control – standard manual pruning to maintain a narrow tree wall; 2) dormant mechanical hedging to maintain a narrow tree wall, including 3-4 renewal cuts; 3) dormant mechanical hedging to maintain a narrow tree wall, with 3-4 manual renewal cuts, followed by mechanical hedging in June when shoots have formed 12-14 leaves.

Budget: $12,414.00 (see attached)

Budget Justification:

Wages-$4200.00

Graduate student summer stipend-$6930.00

Horticulture wage payroll assistants (TBD) and MS candidate will assist with experimental design of research plots, applying treatments and collecting and analyzing data. They will assist with plot layout, data collection, data entry and analysis, and preparation of reports.

Fringe Benefits - $884.00

Fringe benefits are computed using the provisional rates of 34.88% applicable to Category I Salaries, 12.35% applicable to Category II Graduate Assistants, 7.94% applicable to Category III Salaries and Wages, 0.31% applicable to Category IV Student Wages, and 23.88% for Category V, Postdoctoral Scholars and Fellows, for fiscal year 2020 (July 1, 2019, through June 30, 2020). If this proposal is funded, the rates quoted above shall, at the time of funding, be subject to adjustment for any period subsequent to June 30, 2020, if superseding Government approved rates have been established. Fringe benefit rates are negotiated and approved by the Office of Naval Research, Penn State's cognizant federal agency.

Supplies - $400

Miscellaneous supplies, such as flagging, tags, markers, bags and batteries are needed for identifying plots and collecting data in both field plots and laboratory procedures.

Literature Cited:

Ferree, D. C. and A. N. Lakso. 1979. Effect of selected dormant pruning techniques in a hedge-row apple orchard. J. Amer. Soc. Hort. Sci. 104:736-739.

Ferree, D. C. 1984. Influence of various times of summer hedging on yield and growth of apple trees. The Ohio State Univ., Ohio Agri. Res. And Dev. Ctr., Res. Circ. 283:33-37.

Lewis, K. 2018. Mechanical Hedging in Apples. WSU Tree Fruit Comprehensive Tree Fruit Site. http://treefruit.wsu.edu/article/mechanical-hedging-in-apples/