Effects of Soil-Applied Kaolin Clay on Weed Suppression and Soil Nutrients

Charlie Petersen[1], Mateo Rull-Garza[1], Jon Clements[2], Duane Greene[1], Elizabeth Garofalo[2], Samantha Glaze-Corcorran[2], Jacob Aliengena[3], Jaime C. Piñero[1]

[1]*Stockbridge School of Agriculture, University of Massachusetts Amherst*
[2]*UMass Extension*
[3]*UMass Cold Spring Orchard*

To mitigate weed pressure, farmers and researchers have developed means to reduce the need for herbicides, such as physical barriers (known as groundcovers) that prevent weed growth. One such barrier is made up of kaolin clay, which covers the top layer of soil, in turn blocking sunlight and preventing weeds from sprouting through the clay. Past studies on the effect of soil-applied kaolin clay for weed management have revealed effective control in blackberry (Takeda et al., 2005) and bell pepper (Keay et al., 2018). However, to our knowledge, the impact of kaolin clay on soil health and nutrients has been ignored. Clays have a built-in negative charge with a unique property called cation exchange capacity (CEC) that will attract cations present in the soil such as calcium, magnesium, sodium, and potassium. These cations can then become trapped in the clay due to their structure. Previous studies have not investigated whether plants surrounded by kaolin clay are able to access enough nutrients, or if the clay may hinder their ability to grow by reducing nutrient mobility in the ground substrate.

Here, we examined (1) the ability of soil-applied kaolin clay to suppress weeds and (2) the nutrient content of soil under different groundcover treatments. Tree foliage was also analyzed to determine if trees were able to adequately take up and allocate nutrients from the soil despite the addition of kaolin clay. We hypothesize that the presence of kaolin clay groundcover leads to lower nutrient levels in the soil and leaves of apple trees.

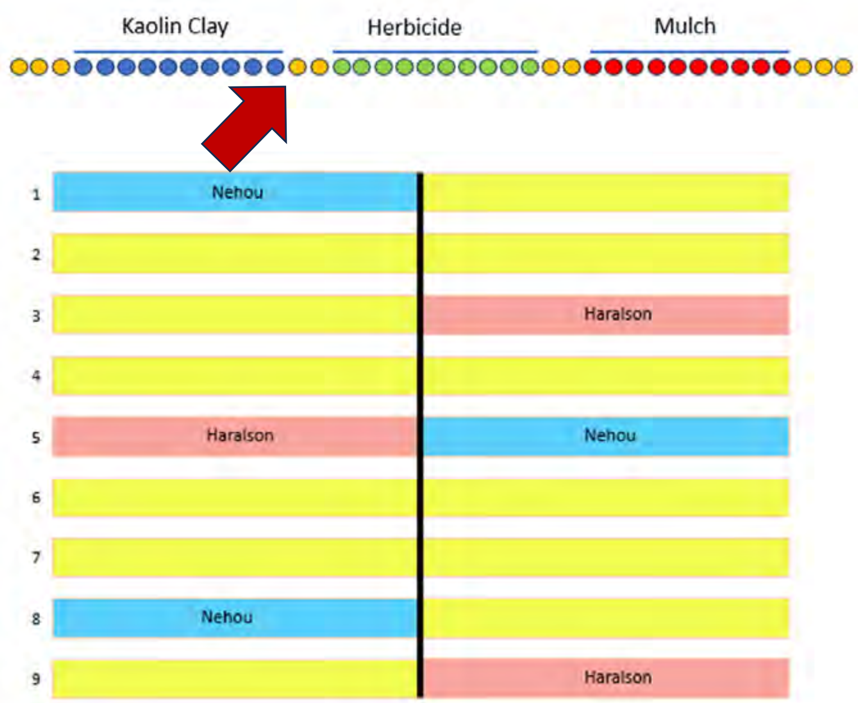


Figure 1. Schematic representation of the experimental area. Although there are nine rows with six cultivars of cider apple trees, we only focused on rows that had Haralson and Nehou. The arrow points to a single row used for data collection**.** Each circle represents one tree. Treatment trees are indicated by overlined area and by color. Orange circles in between treatments represent trees acting as buffer areas to avoid contamination.

Materials and Methods

Study Site. This study was conducted in a cider apple tree block at the University of Massachusetts Cold Spring Orchard (CSO) from April to August 2023. Specifically, our study site was comprised of five rows of trees (Figure 1). We selected these rows to include only two different apple tree cultivars, with 40 trees per cultivar in each row. Within one replication, cultivars were divided into three treatments: (1) pre-emergent herbicide spray (Chateau® EZ, Valent USA LLC) applied on March 28th, 2023, at a rate of 6 oz/A (sprayer output: 50 gpa), (2) kaolin clay (Surround™ NovaSource, Inc.) applied around the tree trunk, and (3) mulch alone. The kaolin clay slurry was prepared by mixing 452 grams of Surround per liter of water. During the applications, we used a ring (8 cm in height) made by cutting a 5-gallon bucket (Figure 2). Each ring was cut transversally to be able to place it around the trunk of experimental trees. Each treatment consisted of 10 trees with buffer trees in between to prevent spillover effects.

Figure 2. Application of kaolin clay around the trunk of experimental trees. One replication consisted of 10 trees per treatment. The orange rings had a 30 cm diameter survey zone.

Weed Assessment. Weeds were sampled three times throughout the summer on June 16th, July 20th, and August 23rd. For the samples taken in June and July, a visual scan was done for every tree in rows where the three treatments were applied (rows one, three, five, eight and nine). For this survey only, other cultivars in treatment rows were also sampled. Weed pressure was given a rating between one and four, with one indicating 'no pressure', two, 'little pressure', three, 'moderate pressure', and four, 'high pressure'. An orange plastic ring (30 cm in diameter) was placed around the rootstock of each tree for a consistent survey area (Figure 2). On August 23rd, weeds were removed from the ground and grouped based on treatment and cultivar for a total of thirty samples. Weeds were then oven-dried overnight and weighed.

Leaf Sampling. Leaf sampling was conducted on July 20th. Fifty leaves were sampled per treatment across rows. Leaves from the midsection of branches were selected, making sure to sample from different heights and sides of the canopy. This was repeated for all treatments in each row for a total of nine samples per cultivar. The leaves were oven dried and sent to Waypoint Analytical for further analysis of nutrient contents. This analysis included the amounts of nitrogen, phosphorus, sulfur, potassium, calcium, magnesium, sodium, copper, boron, manganese, zinc, iron, and aluminum.

Soil Sampling. Soil sampling was conducted on July 28th. Soil was gathered by driving a 25-millimeter diameter soil auger below the topsoil layer. Samples were taken from trees in each treatment (Figure 3) 3) for a total of 180 trees. Each tree had two sub-sample sites: one that went from the top layer of the soil to a depth of ten centimeters, and one from a depth of ten to twenty centimeters. All sub-samples from the topsoil to 10 cm depth for a given 10 tree treatment were combined into one unified sample. The same process was done for all sub-samples from the 10-20 cm depth. Once combined, the soil was oven dried on a low setting for 24 hours and sent to the Soil and Plant Nutrient

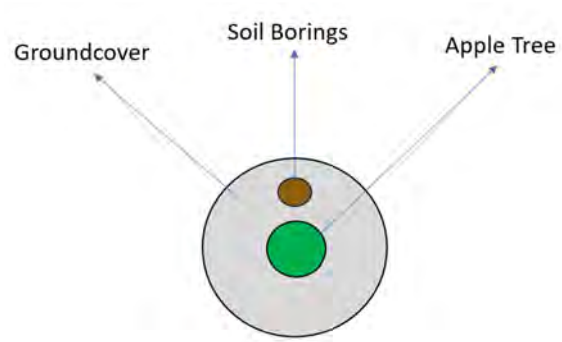


Figure 3. Schematic of soil sampling at a model apple tree. Soil borings were made roughly 8 centimeters away from the rootstock of each apple tree after the clay was peeled back.

Testing Laboratory at the UMass Amherst, where they were tested for soil pH, extractable nutrients (same as leaf nutrient analyses except for nitrogen and sulfur) as well as lead, cation exchange capacity, and percent base saturation. In total, there were thirty-six samples, with twelve per treatment.

Results

Weed Assessments. The mulch and kaolin treatments reduced weed pressure significantly when compared to a single pre-emergent herbicide application (Figure 4). However, mulch and kaolin were not different from one another.

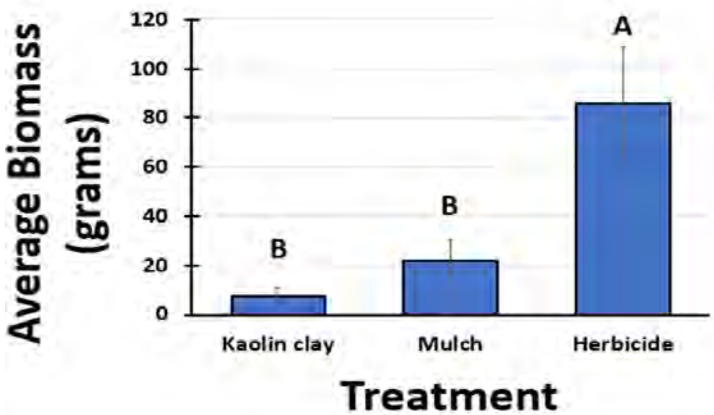


Figure 4. Average biomass of weeds across different treatments.

Leaf Sampling. When comparing nutrient levels between cultivar irrespective of treatment conditions, we found no significant differences in nitrogen, calcium, or potassium (Figure 5W, X, Y). However, magnesium levels in the leaves of Neohu trees were significantly lower than those recorded in Haralson trees (Figure 5Z).

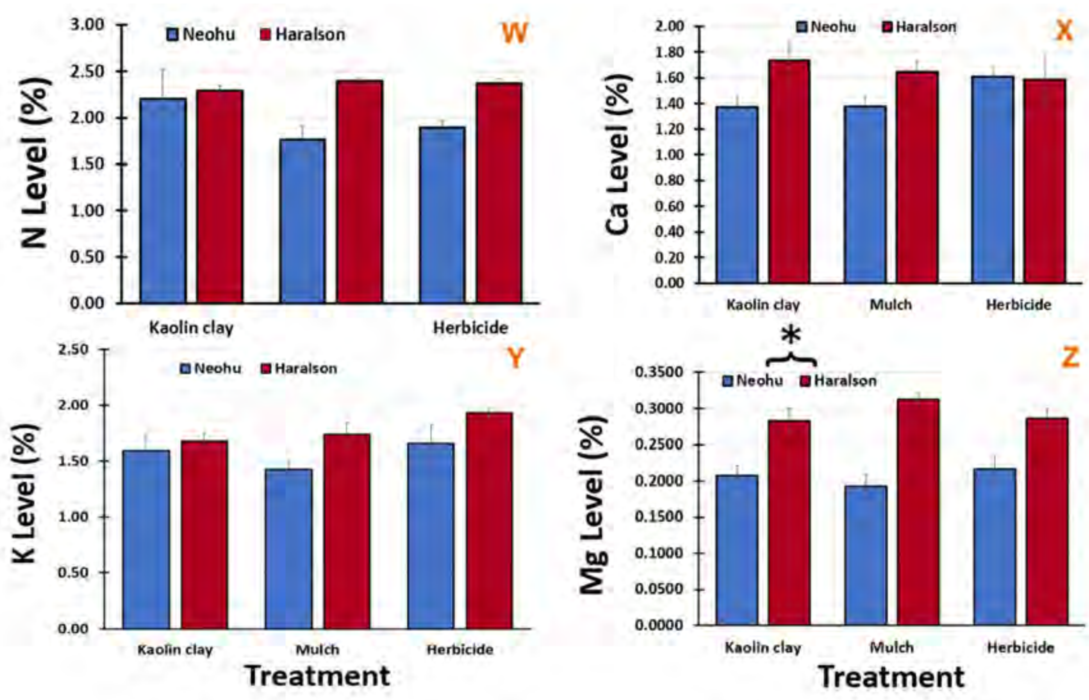


Figure 5. Leaf nutrient levels for nitrogen, calcium, potassium, and magnesium across treatments and apple tree cultivars.

Soil pH and nutrients. When disregarding the depth of samples, kaolin clay-covered soil had significantly lower pH when compared to herbicide-treated soil (Figure 6W). When comparing soil levels of potassium (Figure 6X), calcium (Figure 6Y), and magnesium (Figure 6Z) (irrespective of soil depth), we found no statistically significant differences between treatments.

When comparing pH level of soil samples between depths, we found no significant differences across treatments (Figure 7W). There were also no significant differences in potassium levels (Figure 7Y). However, we found significantly higher calcium content in kaolin clay-covered soil samples from the topsoil-10 cm sample depth than those from the deeper, 10-20 cm depth (Figure 6X) but found no significant differences in the mulch or herbicide treatments (Figure 7X). There was a significantly higher magnesium content in the superficial samples (topsoil-10

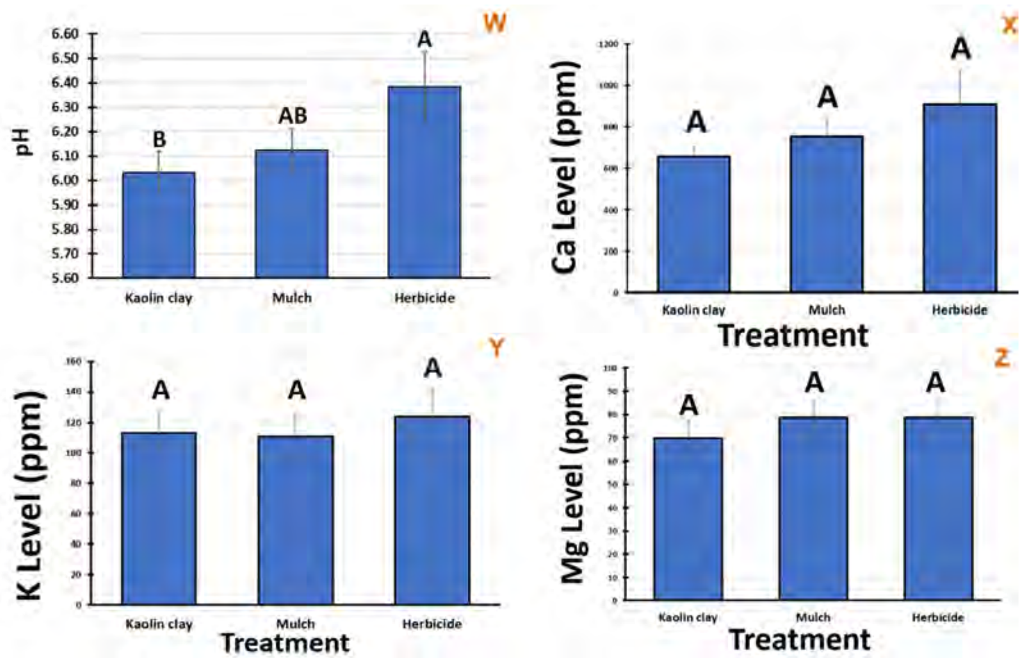


Figure 6. Effects of soil treatment on soil pH, potassium, calcium, and magnesium levels regardless of sampling depth.

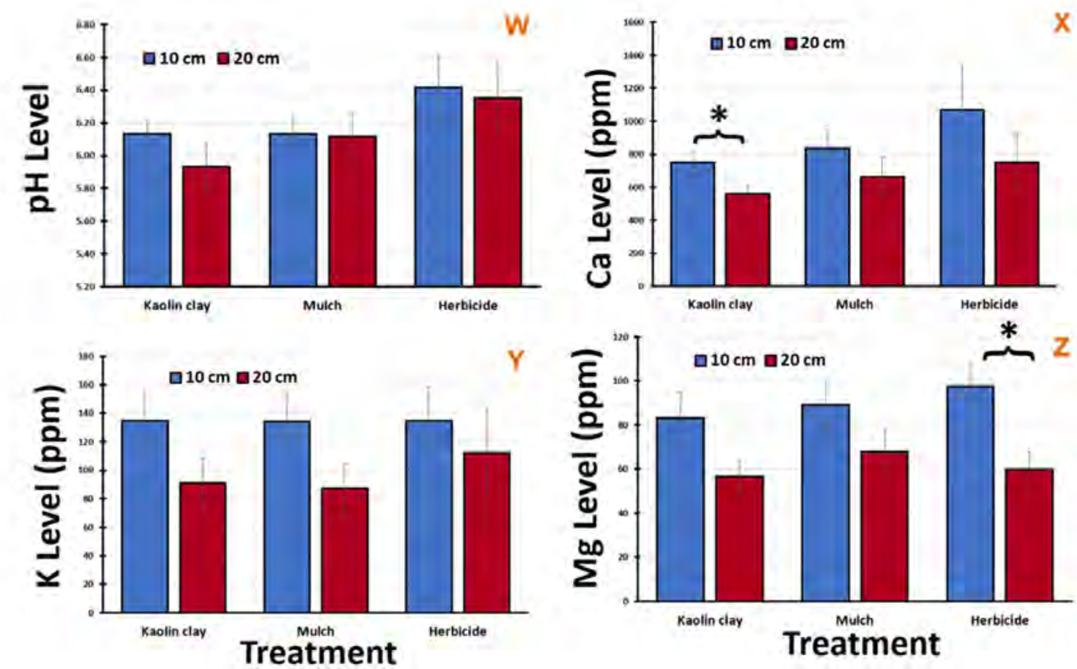


Figure 7. Soil pH and calcium, potassium, and magnesium levels between soil depths and across treatments.

cm) of herbicide-treated soil when compared to the deeper (10-20 cm) soil samples. However, we found no significant differences between the kaolin clay or mulch treatments (Figure 7Z).

Conclusions

The results from this study showed that kaolin clay and mulch were equally effective at suppressing weeds over a 4-month period. The single pre-emergent herbicide application was less effective at controlling weeds compared to the other treatments. We report no significant effects of treatment on soil and leaf nutrient levels but did find cultivar-specific differences, the leaves from trees of the Haralson cultivar had significantly higher magnesium content than those of Nehou. Soil pH was significantly lower in kaolin clay-treated soil compared to soil treated with herbicide. This finding could be useful to growers trying to grow fruits that require more acidic soil, such as blueberries.

The trees planted in the cider block from which we collected our data are still young, and the kaolin clay was only applied this spring, so it will be interesting to see how long-term groundcovers impact trees and the soil over time.

Acknowledgments

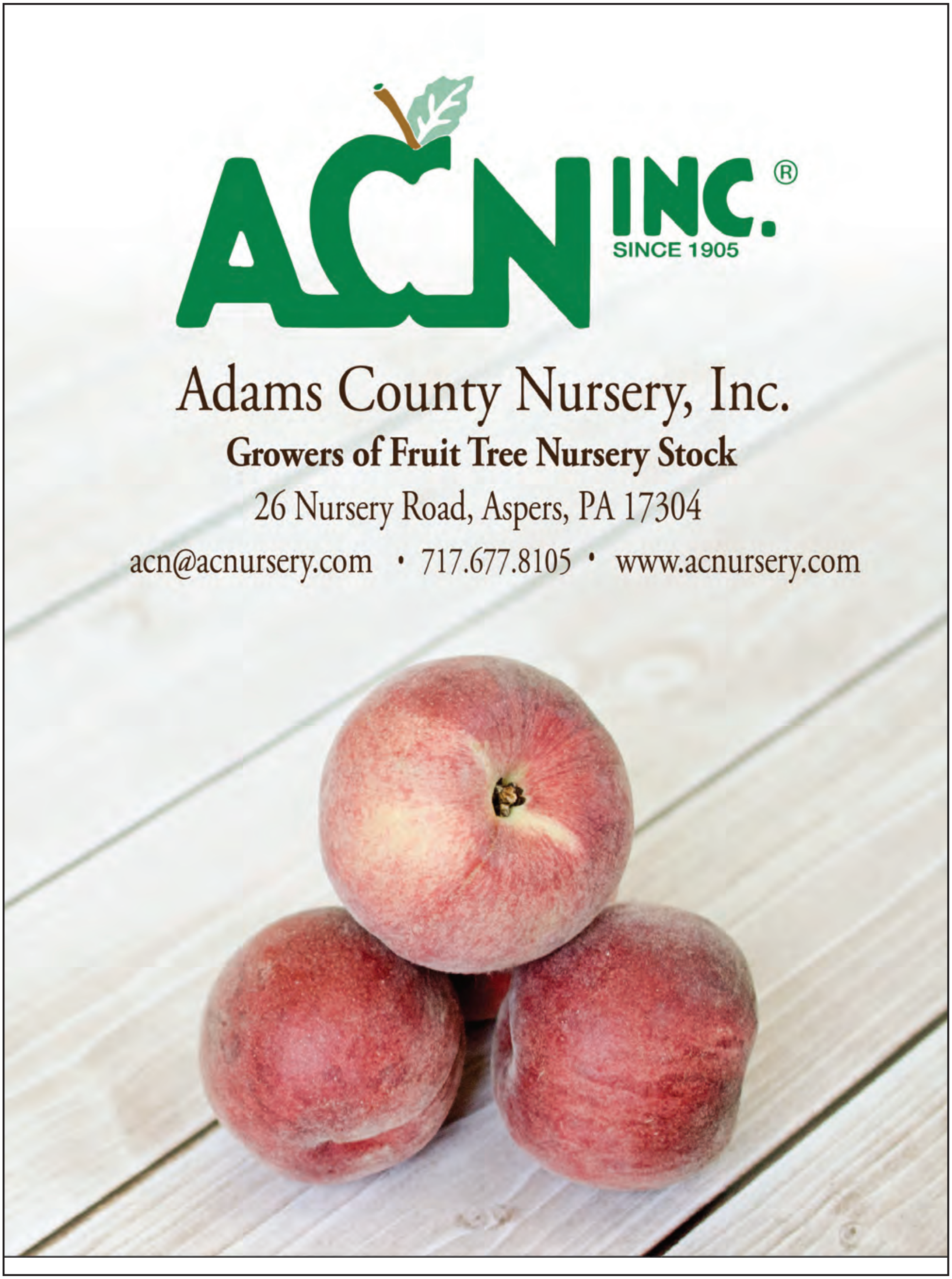
We thank Jaelyn Kassoy, Ajay Giri, and Hayat Junejo (UMass Stockbridge students) for technical support. Financial support for this student research project as part of the 2023 REEU internship program was provided by the NIFA's Agriculture and Food Research Initiative - Education and Workforce Development program through Award 2022-67037-36619.

Literature Cited

Keay, J. 2018. Optimizing sustainable weed suppression methods in organic vegetable systems: cover crops and particle film mulches. MS Thesis, Lincoln University.

Takeda, F., Glenn, D.M. and Tworkoski, T., 2005. Weed control with hydrophobic and hydrous kaolin clay particle mulches. HortScience, 40(3), pp.714-719.

Charlie Petersen is an undergraduate student in the Stockbridge Plant and Soil Science BS program and he participated in the 2023 REEU summer internship program.


ACN INC.®
SINCE 1905
Adams County Nursery, Inc.
Growers of Fruit Tree Nursery Stock
26 Nursery Road, Aspers, PA 17304
acn@acnursery.com • 717.677.8105 • www.acnursery.com