Project Title:

Evaluating pre-emergence (PRE) and post-emergence (POST) herbicide tank mixes for residual weed management and sucker control in grapes

Principal Investigator:

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New Research X Continued Research ☐

Amount Funded: $10,556

Summary Impact Statement:

- A novel active ingredient, tiafenacil (WSSA 14), was as effective as Aim (WSSA 14) at controlling root suckers; no off-target damage was observed to grape trunks or vine canopies.
- Tank mixes of tiafenacil or Aim with either Chateau (WSSA 14) or Matrix (WSSA 2) were able to reduce under vine, weedy vegetation and provide residual weed suppression during the production season.
- The addition of tiafenacil, Chateau, or Matrix to a low rate of Rely (WSSA 10) increased both sucker and weed control.
- The trial will be repeated in 2022 to confirm 2021 results and support a potential label registration.
- Separate trials showed that herbicide applications made using a vision-guided, precision sprayer could be as effective as banded treatments for controlling annual weeds; 2022 research trials will evaluate the use of a vision-guided sprayer to apply tiafenacil, and other registered herbicides, selectively to grapes, for sucker control with the goal of reducing herbicide use and costs and enhancing crop safety potential.

Objectives:

Weeds are problematic in vineyard ecosystems because they compete with the vines for water and nutrient. Additionally, weeds can serve as alternate hosts for pests and pathogens, contaminating mechanically harvested fruit, and interfere with vineyard operations. Weed growth can also impact the microclimates around vines, facilitating disease development and increasing the risk of spring frost. The critical period of weed competition is from bloom until veraison, although effective weed management begins in early spring (before crop budbreak and weed emergence occurs) with the application of

residual, PRE herbicides. Weed control efforts can continue through the season to ensure unwanted vegetation does not interfere with grape harvest operations.

Grape suckers are undesirable because they divert crop nutrients away from desirable tissues and alter fruit:shoot ratios. Unmanaged suckers also increase the amount of tissue available for pest and pathogen colonization and impede crop production practices and fruit harvest. Sucker removal can be achieved 1) by hand, which is time consuming and expensive, 2) mechanically, which may be physically damaging to the vines, or 3) chemically, as a banded spray, using POST contact herbicides to eliminate green stem tissue.

The goal of this project, which directly addresses the New York Wine & Grape Foundation's (NYWGF) "Floor and weed management" priority, was to describe the efficacy and safety of spring-applied PRE and POST herbicide tank mixes for weed control and sucker management in New York grapes. Specifically, how foliar- and soil-applied herbicide combinations can best be used to (1) eliminate emerged weeds, (2) extend in-season residual weed control, and (3) reduce unproductive growth that diverts crop nutrient resources away from fruit production.

Activities/Methods:

The 2021 trial was conducted at Cornell's Lake Erie Research and Extension Laboratory (CLEREL) (6592 W. Main Road, Portland, NY 14769 [42.3717, -79.4859]) (CLEREL | CALS (cornell.edu)). The study was conducted in Seyval blanc on 3309 rootstocks. The block was planted on June 1, 2008, on a Chenango gravel loam (3.0-3.5% OM and 6.0-6.4 soil pH). Rows are spaced 9 feet apart and vines are spaced 8 feet apart within the row. Individual treatment plots were 25 feet long with two to three vines per plot; the under-row area was 3 feet (0.9 m) across. The block was pruned the week of 4/5/21.

Treatments included in the trial were: **1)** an untreated check, **2)** tiafenacil at 1.5 oz/A, **3)** Aim at 2 oz/A, **4)** tiafenacil at 0.25 oz/A plus Chateau at 12 oz/A, **5)** tiafenacil at 0.25 oz/A plus Matrix at 4 oz/A, **6)** Aim at 2 oz/A plus Chateau at 12 oz/A, and **7)** Aim at 2 oz/A plus Matrix ay 4 oz/A. The reduced rate of tiafenacil in the tank mixes was based on conversations with the manufacturer about its degree of effectiveness with other burndown products. An additional set of treatments evaluated the addition of tiafenacil (0.25 oz/A), Chateau (12 oz/A), and Matrix (4 oz/A) to a low rate of Rely 280 (29 oz/A) to enhance sucker burndown and weed control. MSO at 1% v/v was included in each treatment.

Aim and Rely are currently labeled for use in grapes and tiafenacil is being explored for registration in numerous perennial specialty crops. Like Aim, tiafenacil is a PPO-inhibiting herbicide with no residual activity; it is strong on broadleaves and can control some annual grasses. Chateau and Matrix have PRE and some POST weed control activity; the Chateau and Matrix labels recommend that the products should not contact green grape tissue, except for undesirable suckers.

All herbicide applications were directed to the base of the vines (on both sides of the vine row) using a single nozzle (11002), shielded boom and a CO2-pressurized backpack sprayer calibrated to deliver at a rate of 20 GPA. Treatments were made on 6/1/2021 when suckers were 8 inches in length and weeds were no more than 2 inches tall. Air temperature at the time of application was 74 F, soil temperature was 68 F, RH was 44%, and windspeed was 5.5 mph. One-half inch of rainfall was received within 48 hours of treatment, which activated the residual products. Each treatment was replicated four times.

Sucker control ratings were made on 6/9/21, 6/20/21, and 6/28/21. Control was assessed using a scale ranging from 0% (no control) to 100% (complete control). All remaining suckers were harvested from each vine in each plot on 6/28/21 and the biomass weighed. Per plot weed cover was assessed using a scale ranging from 0% (no weeds present) to 100% (complete cover of the entire plot) at the same time sucker control ratings were made. On 6/28/2021, weed biomass was harvested from a $1m^2$ area from the center of each plot and weighed. The entire trial site was treated with Rely herbicide soon after to remove all remaining weed cover. A weed cover rating was made on 8/26/21 to describe the degree of residual herbicide control at harvest. Individual plots were machine-picked on 9/7/2021 using an Oxbo 6030 (Oxbo International Corp., Roosendaal, Netherlands) multifunction grape harvester. Berries were weighed and the yield converted to a per plant estimate (dividing by the number of vines per plot).

Prior to analysis, all percentage data were transformed, using an arcsine square root transformation. Continuous data were log-transformed. Data were subjected to analysis of variance in SAS 9.4 and means separated using Tukey's method. Fixed effects included herbicide treatment; replication was considered a random variable. All results in the report have been back transformed for presentation.

Results:

Sucker control and biomass: Tiafenacil and Aim, alone and tank-mixed with Chateau or Matrix, provided 76% to 94% visual control of grape suckers on 6/9/21, 6/20/21, and 6/28/21 (Figure 1). Averaged over residual herbicide tank mix partners and observation dates, sucker control with tiafenacil and Aim was 88% and 84%, respectively. Herbicide injury, which included tissue necrosis, was only observed on suckers; no damage was seen on trunks or in the vine canopy.

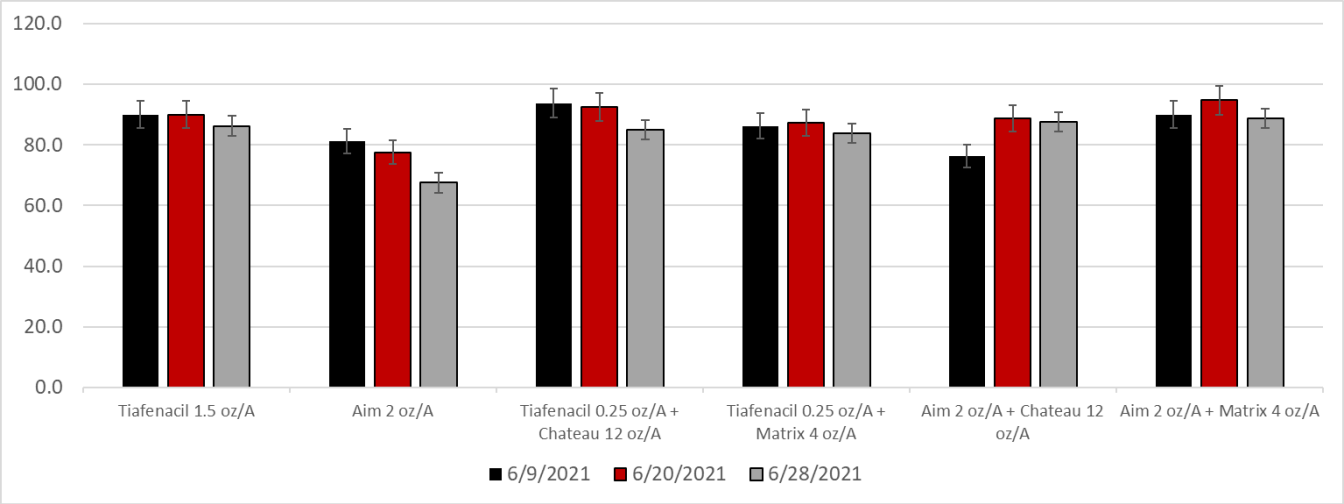

Figure 1. Visual sucker control ratings (%) on 6/9/21, 6/20/21, and 6/28/21 following applications of tiafenacil and Aim applied alone and in combination with Chateau or Matrix.

Sucker biomass, expressed as a percent of the untreated check (which produced, on average, 443 grams per vine), was significantly ($P < 0.05$) reduced 80% to 90% at four weeks after treatment by tiafenacil and Aim applied alone or in combination with Chateau or Matrix (Figure 2). Averaged over residual tank

mix partners, tiafenacil and Aim reduced sucker biomass by 85% and 83%, respectively. The addition of Chateau and Matrix to tiafenacil and Aim did not significantly affect sucker biomass estimates ($P > 0.05$).

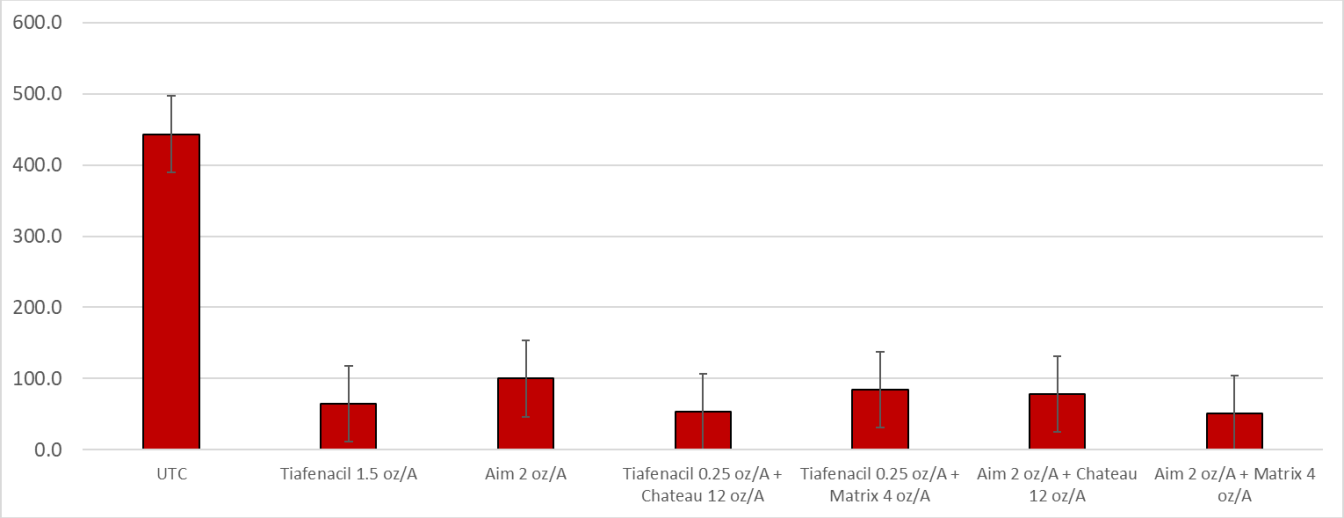

Figure 2. Sucker biomass (in grams per vine) on 6/28/21 following applications of tiafenacil and Aim applied alone and in combination with Chateau or Matrix. UTC = untreated check.

The addition of tiafenacil, Chateau, or Matrix to a low rate of Rely statistically ($P < 0.05$) improved grape sucker control relative to Rely applied alone. Sucker biomass in the Rely treatment was reduced by almost 50%, relative to the untreated check. tank mixes with tiafenacil, Chateau, or Matrix reduced sucker biomass by at least 80% (Figure 3).

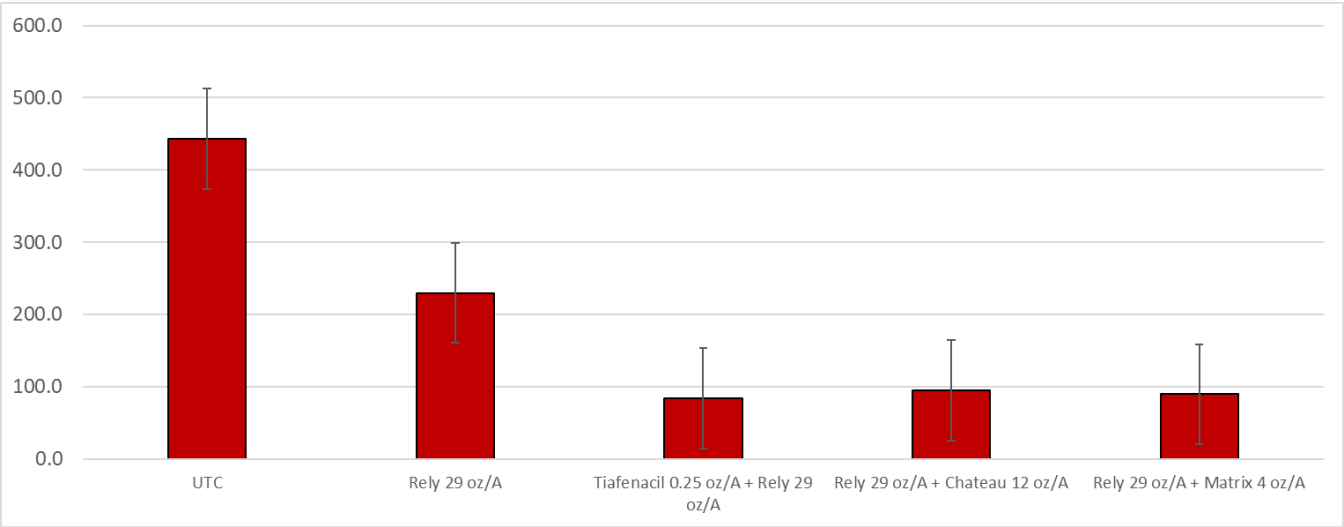

Figure 3. Sucker biomass (in grams per vine) on 6/28/21 following applications of Rely applied alone and in combination with tiafenacil, Chateau, or Matrix. UTC = untreated check. UTC = untreated check.

Weed control and biomass: Weeds present at the site included horsenettle (SOLCA), common lambsquarters (CHEAL), common ragweed (AMBEL), pigweed spp. (AMAXX), and ladysthumb (POLPE), crabgrass spp. (DIGXX) and barnyardgrass (ECHCG), although the distribution of the species across plots was highly uneven. Consequently, all ratings represent assessments of the collective weed community. Visual weed cover ratings in the untreated check plots ranged from 40% to 90% from 6/9/21 to 6/28/21. Herbicide treatments were able to significantly ($P < 0.05$) reduce standing vegetation in the plots, relative to the untreated check (Figure 4). Averaged over residual tank mix partners, weed cover in the tiafenacil and Aim treated plots were 11% and 21%, respectively, on 6/28/21. Averaged over burndown partners, weed cover in the Chateau and Matrix plots were 2% and 10% respectively.

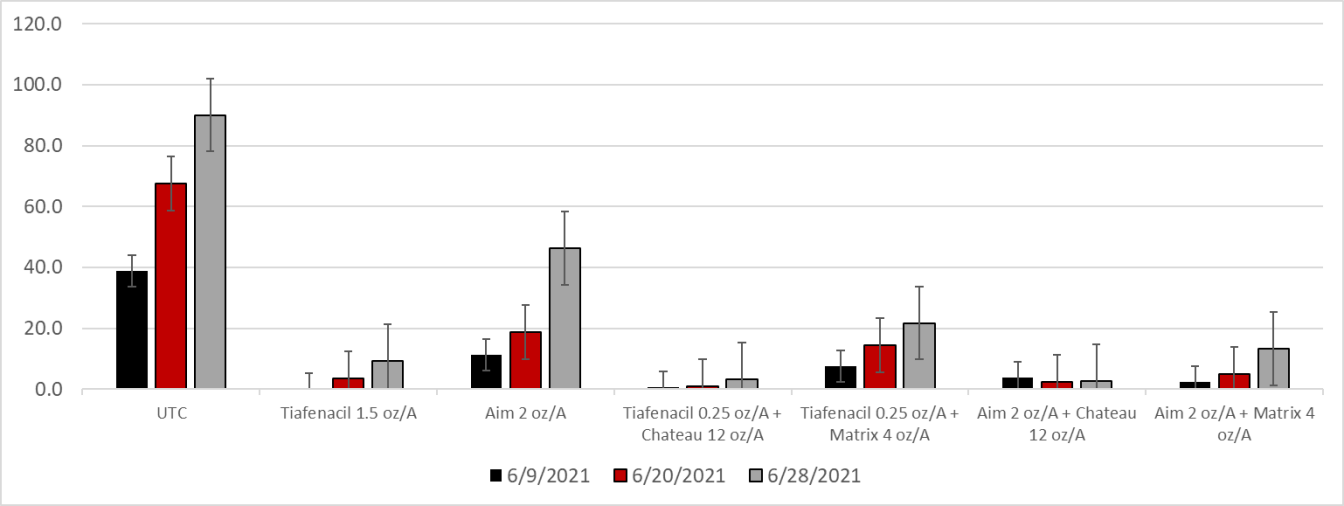

Figure 4. Visual weed cover (ratings (%) on 6/9/21, 6/20/21, and 6/28/21 following applications of tiafenacil and Aim applied alone and in combination with Chateau or Matrix.

Weed biomass, expressed as a percent of the untreated check (which produced, on average, 605 g per m^2 per plot), was significantly ($P < 0.05$) reduced 75% to 97% at four weeks after treatment by tiafenacil and Aim applied alone or in combination with Chateau or Matrix (Figure 5). Averaged over residual tank mix partners, tiafenacil and Aim reduced weed biomass by 95% and 90%, respectively. Averaged over burndown partners, Chateau and Matrix reduced weed biomass by 98% and 92% respectively.

The addition of tiafenacil, Chateau, or Matrix to a low rate of Rely statistically ($P < 0.05$) improved weed control relative to Rely applied alone. Weed biomass in the Rely treatment was reduced by 400%, relative to the untreated check. Tank mixes with tiafenacil, Chateau, or Matrix reduced sucker biomass by 90% to 99% (Figure 6).

Weed cover ratings were made on 8/26/2021 to describe the degree of residual weed control at harvest. Weed cover in the untreated check plots was 81% whereas weed cover in the Chateau and Matrix plots, averaged over all burndown herbicides, was 12% and 22%, respectively. With respect to crop yields, there were no differences among treatments with respect to per vine fruit weights, which averaged 30 lbs per vine.

In summary, statistical analyses showed that tiafenacil at 1.5 oz/A was as effective as Aim at 2 oz/A at reducing sucker biomass, weed cover, and weed biomass. Even when tiafenacil was applied at a low dose (0.25 oz/A) in combination with Chateau or Matrix, significant sucker and weed suppression was still achieved. Chateau and Matrix were effective residual weed control partners for tiafenacil and Aim, providing significant residual control of weeds throughout the season. A low dose of tiafenacil improved sucker and weed control success when using Rely at 29 oz/A. Chateau and Matrix also improved sucker and weed control with a low dose of Rely and provided extended weed suppression in crop. 2022 Greenhouse trials will describe the efficacy of tiafenacil against glyphosate resistant weeds and grass species that are not easily controlled.

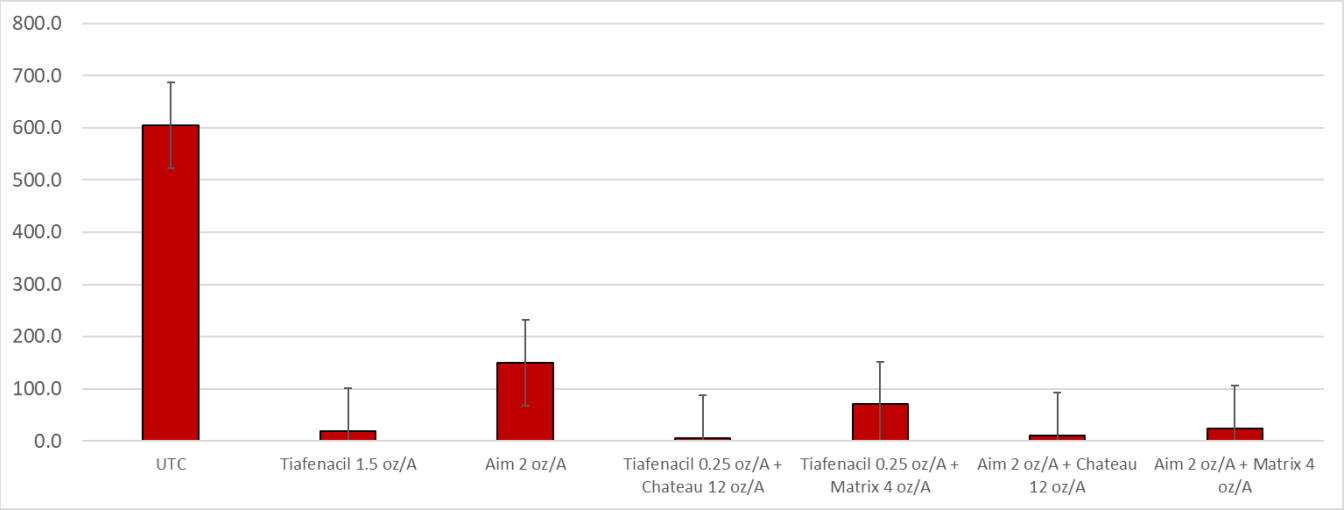

Figure 5. Weed biomass (in grams per m^2 per plot) on 6/28/21 following applications of tiafenacil and Aim applied alone and in combination with Chateau or Matrix. UTC = untreated check

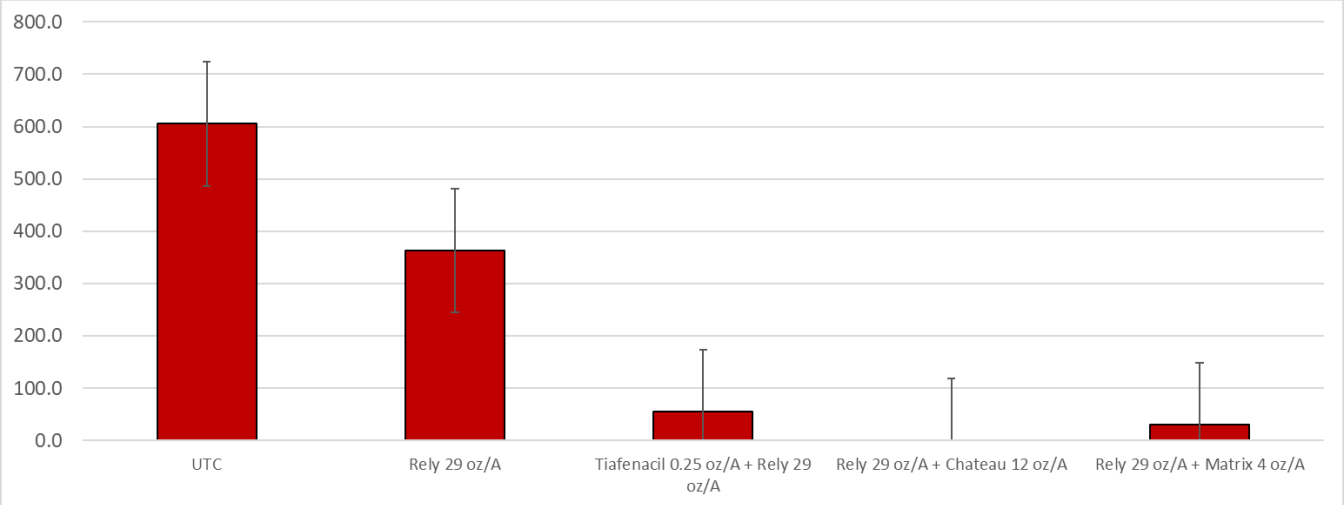

Figure 6. Weed biomass (in grams per m^2 per plot) on 6/28/21 following applications of Rely applied alone and in combination with tiafenacil, Chateau, or Matrix. UTC = untreated check. UTC = untreated check.

Next Steps:

Replication of 2021 trial: The 2021 trial will be repeated in 2022 to confirm the efficacy of tiafenacil as an effective sucker and weed control product. Additional rates of tiafenacil (0.5 oz/A, 1 oz/A, etc…) will be included to evaluate its effectiveness as a stand-alone product and identify a possible rate range for the active ingredient. Tiafenacil will also be applied in combination with other postemergence products to identify possible synergism and opportunities to reduce herbicide use rates. Additional tiafenacil trials are being conducted in apples and hops. Data will be shared with the IR-4 Project and the manufacturer to support a potential registration.

Novel 2022 study: Grape suckers are undesirable because they are excess vegetation that divert nutrients away from desirable tissues, altering fruit:shoot ratios. Unmanaged suckers increase the amount of tissue available for pest and pathogen colonization and can impede crop production practices and fruit harvest. Sucker removal can be achieved 1) by hand, which is time-consuming and expensive, 2) mechanically, which may be physically damaging to the vines, and 3) chemically, using post-emergence contact herbicides to eliminate unwanted growth. While chemical sprays are efficient and effective tools for managing suckers, many growers want to limit herbicide use because of environmental impact concerns and changing public perception about pesticides. Furthermore, Indiscriminate sprays are wasteful when suckers are not present on a vine and/or when weeds are not emerged between the vines.

One possible strategy for reducing total herbicide applications and minimizing damage potential to vine trunks and canopies is the use of vision-guided spray technology to target unwanted tissue. In summer of 2021, research trials were conducted at Cornell AgriTech (Geneva, NY) to evaluate the performance of a commercially available, vision-guided precision sprayer system (Weed-It Quadro (Precision Spraying – Weed Sprayer | WEED-IT) for controlling annual weeds as compared to broadcast applications. Results from these trials indicate that the Weed-it Quadro was as effective at reducing weed biomass as treatments made with a backpack sprayer, relative to the untreated checks (Figures 7 and 8). The amount of herbicide used with the vision-guided, precision-spray system was one-quarter to one-third the amount applied in the broadcast spray.

Current research trials at Cornell AgriTech have been focused on maximizing the utility of the Weed-it Quadro system for eliminating weedy vegetation under tree and vine canopies. The same technology should be investigated to evaluate its ability to detect and target-spray suckers. Based on 2021 grape sucker control studies, tiafenacil will be included as a treatment. Other treatments will include Aim, Venue, and Rely. Direct benefits would include reduced herbicide use, decreased crop injury potential, and economic savings. Future integration of this, or similar, technology with canopy maps or other spatial decision layers would fallow for the automated application of directed sprays where vine growth is good and leaving renewal suckers where vine growth is declining.

Technology Transfer Plan:

Outreach efforts in 2021 and 2022, discussing current and proposed grape research included field days sponsored by the FLGP (5/11/21, 4/26/22), a LEGRP coffee pot meeting (7/29/21), and the LERGP 2022

Winter Grower Conference (3/16/22). Additional outreach events included the CCE Ag In-Service (11/16/21).

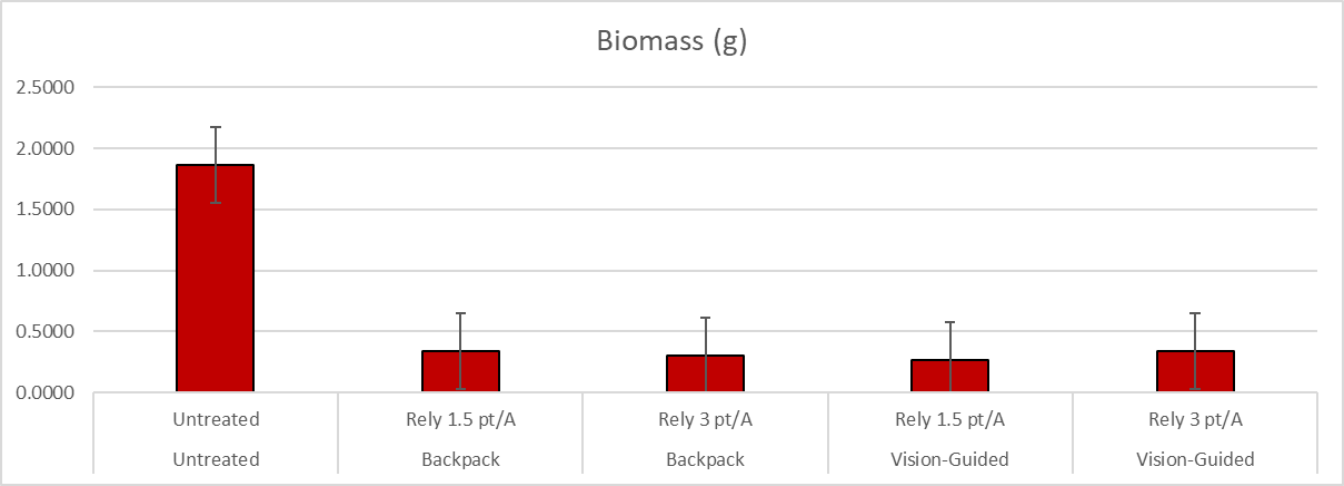

Figure 7. Reductions in pigweed biomass following applications of Rely at 1.5 pt/A and 3 pt/A using a backpack sprayer and a precision, vision-guided sprayer.

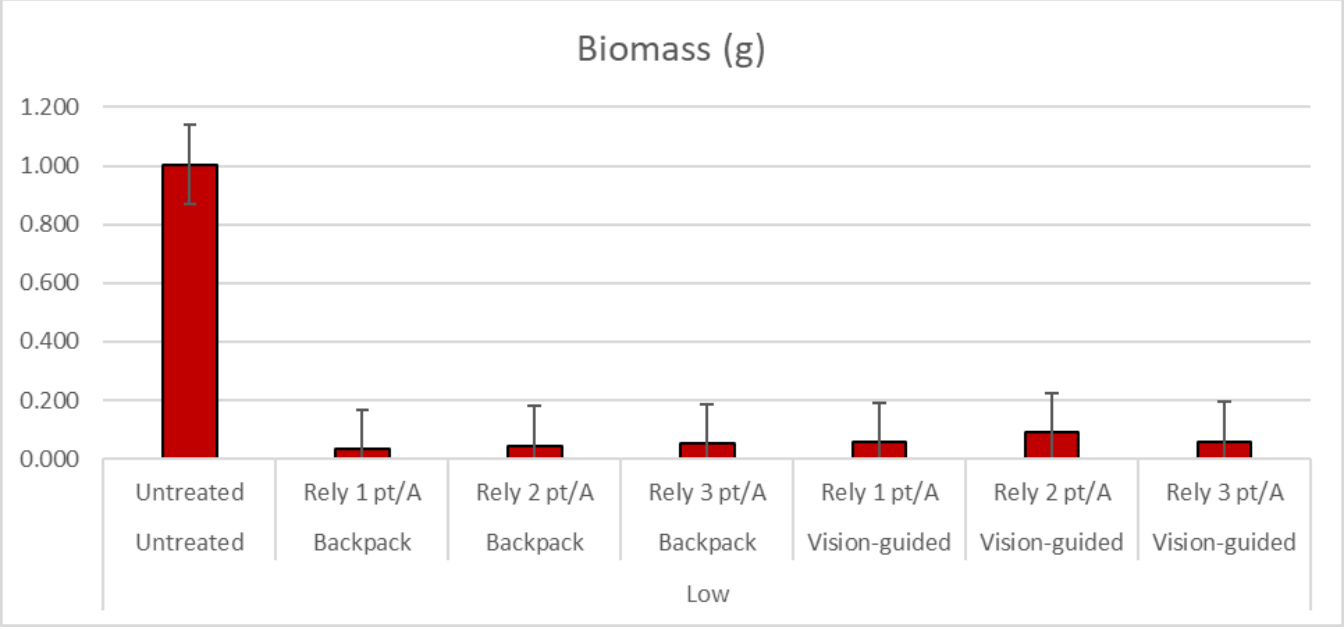

Figure 7. Reductions in horseweed biomass following applications of Rely at 1 pt/A, 2 pt/A, and 3 pt/A using a backpack sprayer and a precision, vision-guided sprayer.

Early-season differences in weed control between the untreated check (left) and plots treated with burndown and residual herbicides (right).

Mid-season differences in weed control between the untreated check (right) and plots treated with burndown and residual herbicides (left).