NYWGF RESEARCH - FINAL REPORT

Funding for fiscal year: 2022 to 2023

SECTION 1:

Project title: Evaluating vision-guided spray technology for selective sucker control in grapes

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New Research ☒ **Continued Research** ☐

Amount Funded **$** 13,179

SECTION 2:

Project Summary Impact Statement: Basal grape suckers divert nutrients away from desirable tissues, which can alter fruit:shoot ratios. Unmanaged suckers also increase the amount of tissue available for pest and pathogen colonization, interfere with crop production practices, and impede 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. Chemical removal of grape suckers via may be undesirable because of crop injury potential, environmental impact concerns, and changing public perceptions about pesticide use. Banded applications directed at the root stock are also wasteful 1) when suckers are small or absent and 2) if herbicides are applied to weed-free soil between vines. Results from 2022 NYWGF-supported research trials at Cornell's Lake Erie Research and Extension Laboratory (CLEREL) showed that herbicide applications made using a commercially available, vision-guided, precision-spray system (Weed-It, from AgriTech America) controlled suckers in Concord grapes as well as continuous, directed applications. Furthermore, targeted sucker treatments applied >40% less herbicide compared to a conventional banded spray.

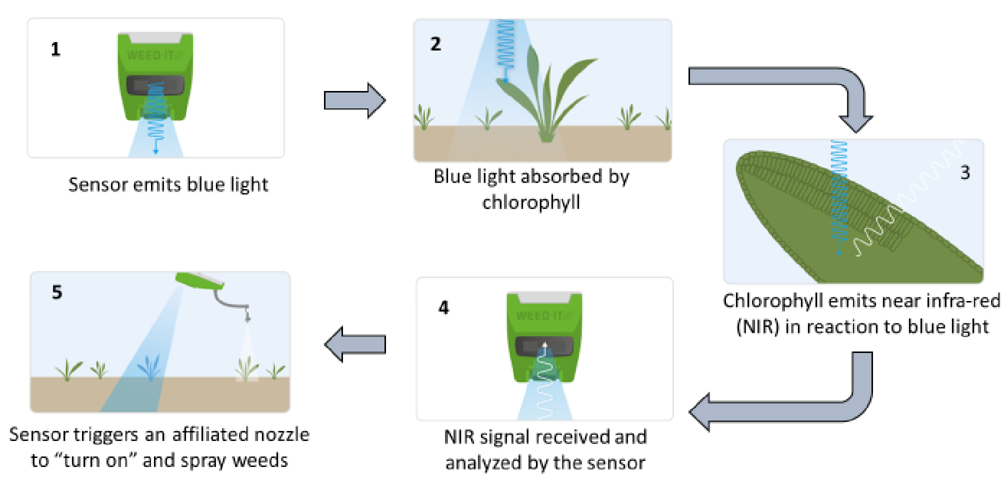
Objectives: This project addresses the New York Wine & Grape Foundation's (NYWGF) "mechanization and precision agriculture" priority. Specifically, this project evaluated the ability of a commercially available, vision-guided "see-and-spray" system to 1) control suckers, 2) minimize spray contact with non-target tissue, and 3) reduce chemical use as compared to banded, under-vine sprays.

Materials & Methods: The study was conducted at the Cornell Lake Erie Research Extension Laboratory in a weed-free block of Concord that is planted on a Chenango gravel loam (3.0-3.5% OM and 6.0-6.4 soil pH). Rows were spaced 9 feet apart and individual vines were spaced 8 feet apart within each row.

On 25 May 2022, Aim EC (2 oz/A), Rely 280 (58 oz/A), and tiafenacil (Gamma) (1.5 oz/A) were applied for grape sucker control. Suckers at the time of treatment had, on average, 3 to 5 unfolded leaves (BBCH 13-15). Aim EC (carfentrazone, a PPO-inhibiting herbicide) and Rely 280 (glufosinate, a nitrogen metabolism inhibiting herbicide) are currently labeled for sucker management. Tiafenacil is a novel PPO-inhibiting herbicide that is being investigated for possible registration in NY. An untreated check was included for comparison.

Herbicide and Rate	**Application Strategy**
None	No sucker control
Aim EC at 2 oz/A	Continuous application using backpack sprayer
Rely 280 at 58 oz/A	Continuous application using backpack sprayer
tiafenacil at 1.5 oz/A	Continuous application using backpack sprayer
Aim EC at 2 oz/A	Vision-guided application with Weed-it Quadro
Rely 280 at 58 oz/A	Vision-guided application with Weed-it Quadro
tiafenacil at 1.5 oz/A	Vision-guided application with Weed-it Quadro

The continuous application was made using CO2-pressurized backpack sprayer equipped with two nozzles (flat fan 11002) set 19 inches apart and held at a height of 19 inches above the soil surface. The continuous application was made at a travel speed of 2.5 mph. Vision-guided sprayer treatments were made using a customized Weed-It Quadro system with 4 sensor-nozzle units conveyed on a Polaris Sportsman ATV driven at 5 mph. Sensors and spray nozzles (TG3) on the Weed-It Quadro were also positioned at a height of 19 inches. Unlike the backpack sprayer, which applies herbicide across the entirety of a treated area, the precision sprayer nozzles were only turned on when a coupled sensor detected plant material via chlorophyll fluorescence (Figures 1 and 2). All applications were made at a spray volume of 20 GPA. Applications were made as a single pass to each side of the vine row.



No crop-weed discrimination so fast when weeds and sensitive commodity tissue are separated in time/space

Figure 1. Visualization of chlorophyll detection and nozzle actuation using the Weed-It system.

Figure 2. Setup of the Weed-It spray system on an ATV. Four sensors (green box) are trained to four unique zones under the canopy s. If chlorophyll from a living plant is detected by a sensor, a unique, affiliated nozzle is turned on.

Individual plots were 24 to 29 vines in length. Each herbicide-by-application strategy (listed below) was replicated three times.

Herbicide spray deposition on the, at canopy height, and to the under-canopy floor between the vines was measured using water-sensitive paper and the Snap Card application, which was developed by the University of Western Australia and the Department of Agriculture and Food, Western Australia (https://www.agric.wa.gov.au/grains/snapcard-spray-app) to quantify droplet coverage. Sucker control efficacy was evaluated on 2 June, 10 June, and 18 June 2022 by visually assessing sucker damage using a scale ranging from 0% (no injury) to 100% (dead suckers). Grape vines were also evaluated for direct (where spray contact occurs) and remote damage (which may be indicative of drift) damage. On 23 June 2022, suckers were manually harvested from all vines and the mean biomass per vine per treatment was determined. Individual plots were machine-picked using an Oxbo 6030 (Oxbo International Corp., Roosendaal, Netherlands) multifunction grape harvester to evaluate yields.

Percent (%) crop injury, sucker number, sucker biomass, and yield data were analyzed using PROC GLIMMIX in SAS (Statistical Analysis Software) with herbicide treatment and spray system considered as fixed effects and replication considered as a random effect. Data are displayed in tabular form and as box and whisker plots. A note about reading box and whisker plots: the middle line of the box represents the median or middle number, the ‘x’ in represents the mean. whiskers (vertical lines) extend from the ends of the box to the minimum and maximum values in the data set.

Results/Outcomes/Next Steps:

Visual Sucker Control Estimates:

Sucker control was significantly affected by herbicide ($P < 0.05$), but not spray system, nor the interactions between herbicide and spray system ($P > 0.05$), on 2 June, 10 June, and 18 June 2022 (Table 1, Figures 3 and 4). Averaged over application strategies, tiafenacil (1.5 oz/A) was as effective ($P > 0.05$) as Aim EC (2 oz/A) for controlling suckers and both herbicides were significantly better ($P <0.05$) than a single Rely 280 application (58 oz/A). Averaged over herbicides, there were no differences ($P > 0.05$) between the backpack sprayer application and the Weed-It application, suggesting that the Weed-It system was effective for eliminating unwanted basal tissue.

Results – Sucker Number and Biomass:

Sucker number and biomass per vine were significantly affected by herbicide ($P < 0.05$), but not spray system, nor the interactions between herbicide and spray system ($P >0.05$) on 23 June (Table 2, Figures 5 and 6). The untreated check vines averaged 2.19 suckers per vine with a total mean biomass per vine of 55.6 g. In the Aim EC and tiafenacil treatments, mean sucker numbers per vine were reduced 38% to 54% while mean sucker biomass per vine was reduced by more than 80%. There were no significant differences ($P >0.05$) between the Aim and the tiafenacil applications although both were statistically better ($P < 0.05$) than Rely 280 for reducing both sucker number and weight. Averaged over herbicides, there were no differences ($P >0.05$) between the backpack sprayer application and the Weed-It application.

Results – Herbicide Deposition:

Averaged across herbicides, there were no differences ($P > 0.05$) between spray systems with respect to the amount of herbicide delivered directly to the suckers, suggesting that the Weed-It and backpack sprayers both delivered effective doses did not differ between the Weed-It sprayer and the backpack application (Figure 7). Almost no herbicide spray was detected on the vines above sucker height, suggesting minimal to no drift, regardless of system used (Figure 7). Averaged across herbicides, the vision-guided Weed-It system reduced herbicide spray deposition on the ground between vines by up to 44% relative to the backpack treatment (Figure 7).This value could have been greater, but the between row cover crop triggered the innermost sensors and nozzles on the unit.

Results – Grape Yield:

Neither herbicide not spray system affected grape yields ($P > 0.05$); averaged across all plots, individual grape vines yielded 23 lbs of fruit (data not shown).

Table 1. Mean Concord grape sucker control (0% (no control) to 100% (sucker death)) in response to herbicide and spray system (2022). Averaged across spray systems (backpack vs vision-guided), less sucker control was achieved with Rely 280 as compared to tiafenacil and Aim EC at all three observation dates. There were no differences in sucker control in response to spray system.

Treatment		Mean Percent (%) Control (0= no control, 100 = complete control)		
Herbicide	Application	6/2/2022	6/12/2022	6/18/2022
Aim EC 2 oz/A + MSO 1% v/v	Backpack	85	80	70
Aim EC 2 oz/A + MSO 1% v/v	Vision	72	67	58
Rely 280 58 oz/A + MSO 1% v/v	Backpack	58	53	40
Rely 280 58 oz/A + MSO 1% v/v	Vision	60	53	42
Tiafenacil 1.5 oz/A + MSO 1% v/v	Backpack	87	82	72
Tiafenacil 1.5 oz/A + MSO 1% v/v	Vision	88	80	68
UTC	UTC	0	0	0

Table 2. Mean number of Concord grape suckers per vine and suckers per vine expressed as a percent (%) of the untreated check (UTC) and mean sucker biomass per vine and biomass per vine expressed as a percent (%) of the UTC on 25 June in response to herbicide and spray system (2022). Averaged across spray systems (backpack vs vision-guided), less sucker control was achieved with Rely 280 as compared to tiafenacil and Aim EC at all three observation dates. There were no differences in sucker control in response to spray system.

Treatment		Mean Data Adjusted Per Vine Per Plot			
Herbicide	Application	Suckers/Vine	% UTC	Sucker Biomass (g)/Vine	% UTC
Aim EC 2 oz/A + MSO 1% v/v	Banded	1.00	46	7.16	13
Aim EC 2 oz/A + MSO 1% v/v	Vision	1.36	62	9.87	18
Rely 280 58 oz/A + MSO 1% v/v	Banded	1.88	86	24.85	45
Rely 280 58 oz/A + MSO 1% v/v	Vision	1.83	84	20.74	37
Tiafenacil 1.5 oz/A + MSO 1% v/v	Banded	1.00	46	6.77	12
Tiafenacil 1.5 oz/A + MSO 1% v/v	Vision	0.91	42	9.90	18
UTC	UTC	2.19	100	55.56	100

Figure 3. Box and whisker plots for sucker control in Concord grapes at the CLEREL station on 2 June, 10 June, and 18 June 2022 in response to herbicide treatment.

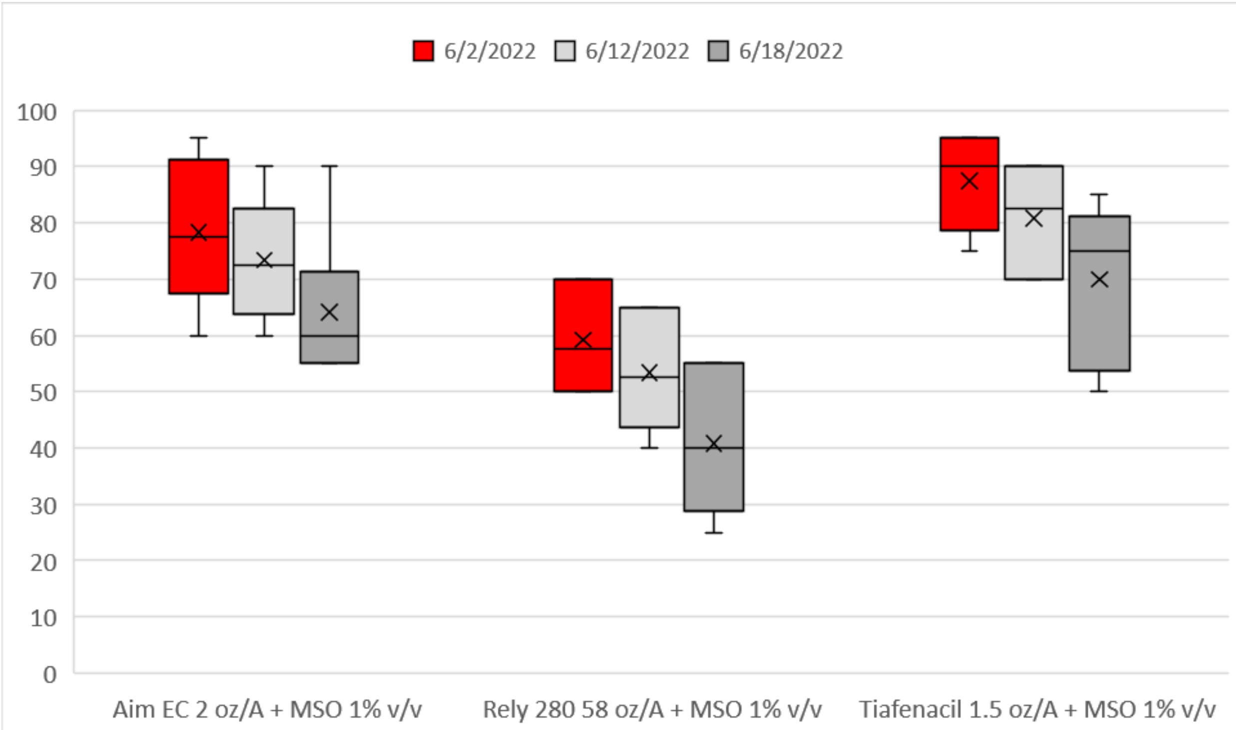


Figure 4. Box and whisker plots for sucker control in Concord grapes at the CLEREL station on 2 June, 10 June, and 18 June 2022 in response to spray system.

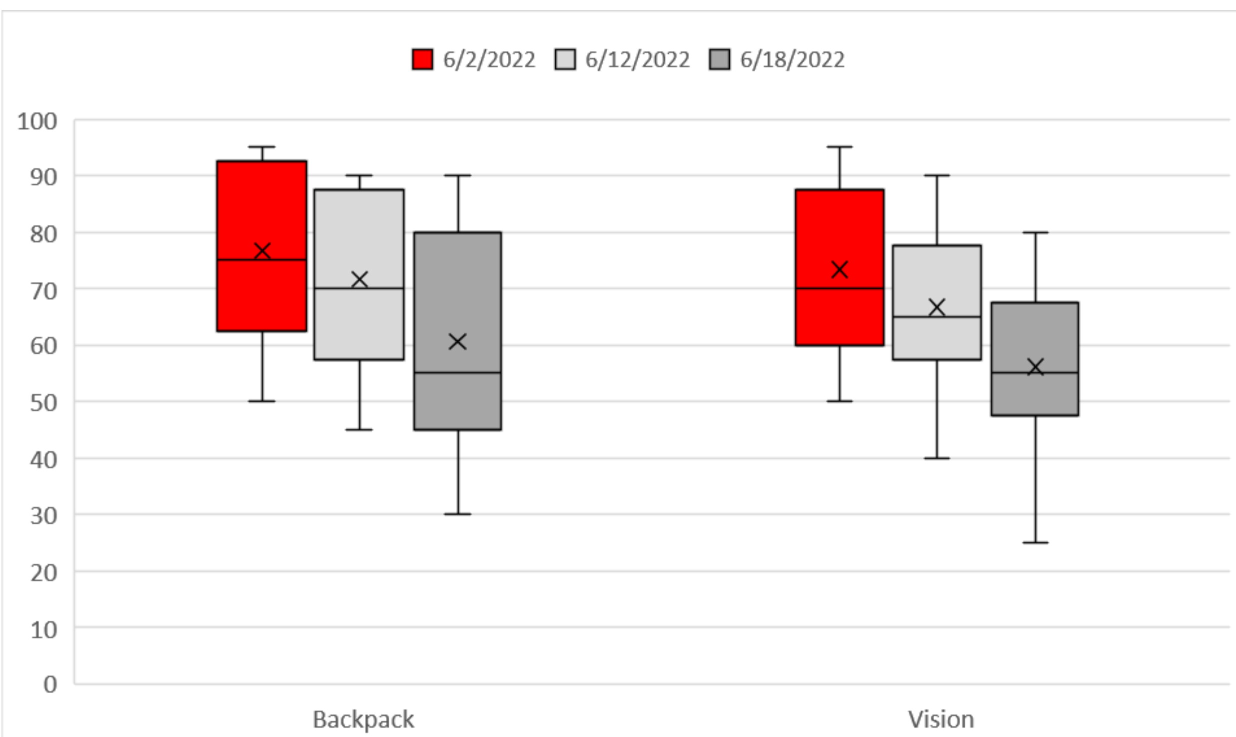


Figure 5. Box and whisker plots for sucker number and biomass per vine, as a percent (%) of the untreated check, in Concord grapes at the CLEREL station on 23 June 2022 in response to herbicide treatment.

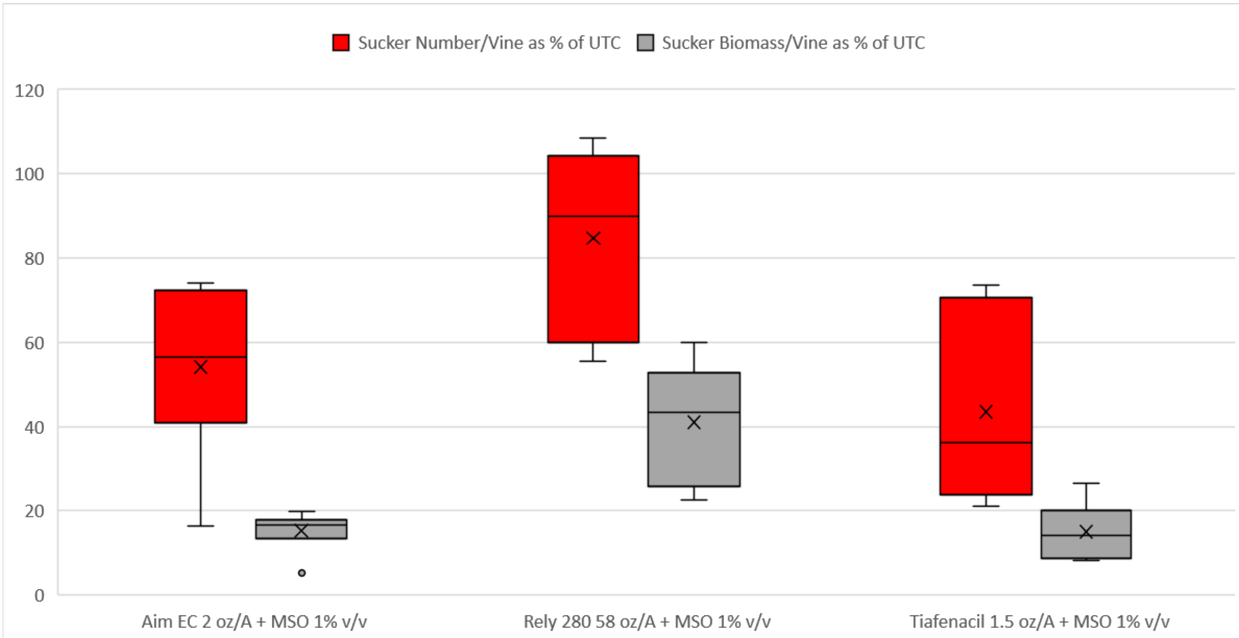


Figure 6. Box and whisker plots for sucker number and biomass per vine, as a percent (%) of the untreated check, in Concord grapes at the CLEREL station on 23 June 2022 in response to spray system.

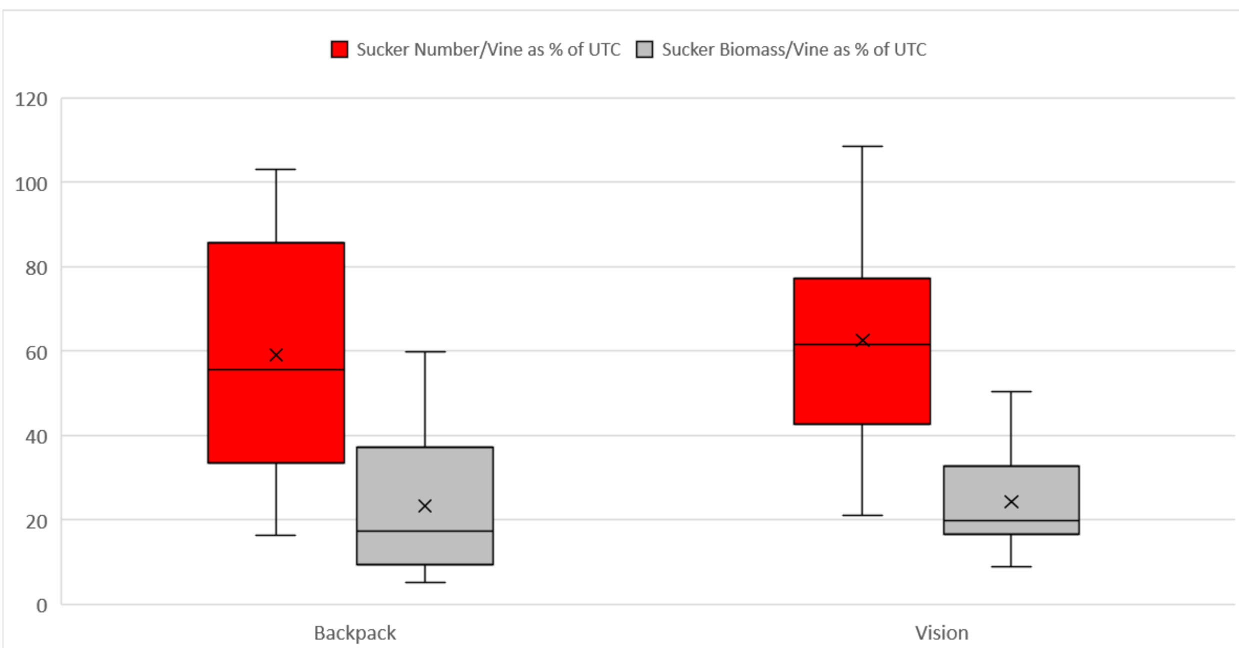
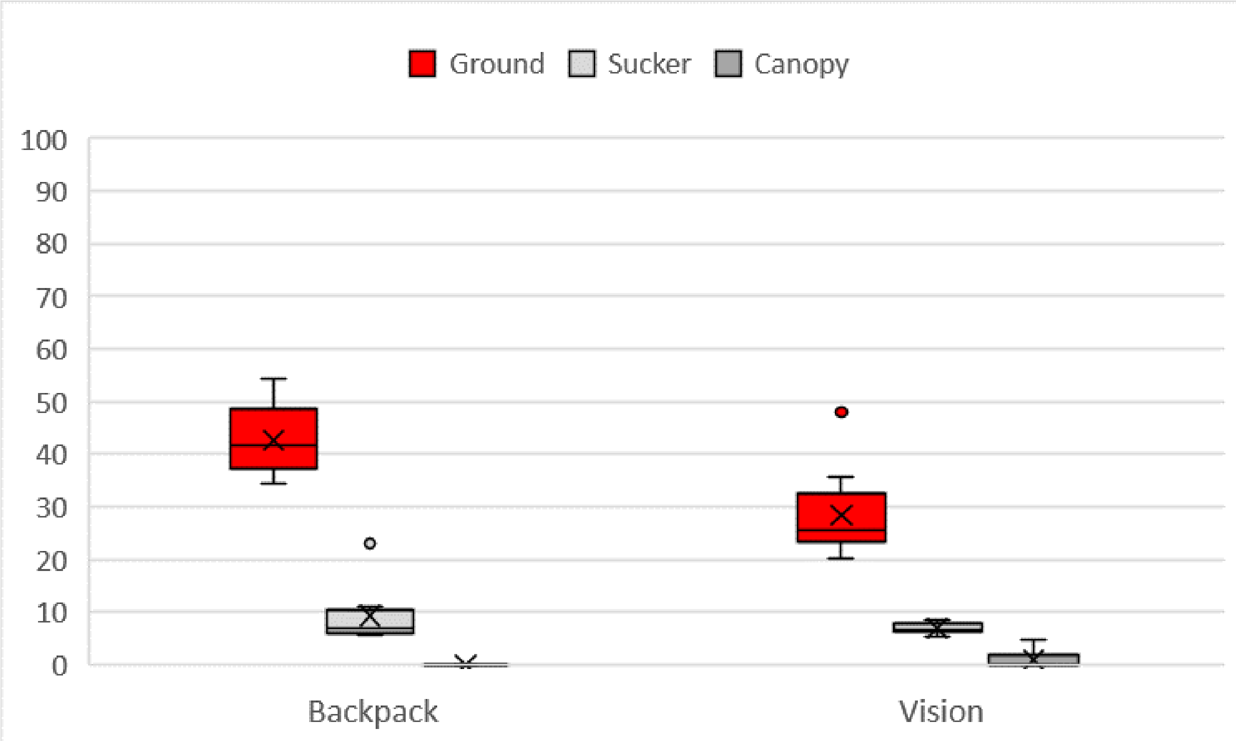


Figure 7. Box and whisker plots for spray card coverage between vines (ground), at sucker height (sucker), and near the canopy (canopy) in Concord grapes at the CLEREL station on 25 May 2022 in response to spray system.



Technology Transfer Plan: Outreach efforts included presentations at the Ontario Fruit and Vegetable Conference (23 February 2023), the Lake Ontario Fruit Team winter meeting (27 February 2023), the LERGP Winter Grower Conference (16 March 2023), and B.E.V. NY (29 March 2023). A graduate student in the Sosnoskie lab presented the data at the 2023 Joint Meeting of the Weed Science Society of America/Northeast Weed Science Society (30 January to 2 February 2023) and prepared an article for Appellation Cornell. The trial will be expanded in 2023 and a journal article submitted to the American Journal of Viticulture and Enology.

SECTION 3: (The goal of this research is to benefit growers and producers across New York State. Result summaries will be shared on the NYWGF website and via email newsletters. To that end, this section should be brief and written in terms understandable for the average grower and producer, as well as consumers and trade interested in our industry.)

Project summary and objectives: Basal grape suckers divert crop nutrients away from desirable tissues, which can alter fruit:shoot ratios. Unmanaged suckers also increase the amount of tissue available for pest and pathogen colonization, interfere with crop production practices, and impede 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, as a directed spray, using post-emergence contact herbicides to eliminate unwanted growth. While chemical sprays are efficient and effective tools for managing suckers, many growers may want to limit herbicide use because of environmental impact concerns and changing public perception about pesticide use. Our goals were to evaluate the ability of a commercially available, vision-guided "see-and-spray" system (Weed-It from AgriTech America) to 1) chemically control basal suckers, 2) minimize spray contact with non-target tissue, and 3) reduce chemical use compared to continuous banded, under-vine sprays.

Importance of research to the NY wine industry: This project addresses the New York Wine & Grape Foundation's (NYWGF) *"mechanization and precision agriculture"* priority. Indiscriminate sprays are wasteful when suckers are not present on a vine and/or when weeds are not emerged between the vines Furthermore, a changing regulatory landscape may require growers to engage in additional mitigation efforts to prevent off-target movement of pesticides. Precision spray technology . may lead to reduced herbicide use, which can result in economic savings and a more favorable pesticide footprint. Additionally, integration of precision spray technology with canopy maps or other spatial decision layers would allow for the automated application of directed sprays where vine growth is good and leaving renewal suckers where vine growth is declining.

Project Results/next steps: Results from our 2022 trials at Cornell's Lake Erie Research and Extension Laboratory (CLEREL) demonstrated that targeted herbicide applications using the Weed-It system were as effective as conventional, banded treatments for sucker number and biomass in Concord grapes, relative to an untreated check. Additionally, targeted sucker treatments applied 30 to 40% less herbicide compared to a conventional banded spray. The CLEREL station has been building their own vision-guided, precision-sprayer. 2023 trials will compare the in-house unit to the commercial Weed-It system with respect to weed and sucker control, herbicide use, and cost of purchase/construction, and operation.

Supporting attachments: