NYWGF RESEARCH - FINAL REPORT

Funding for fiscal year: 2024-2025

SECTION 1:

Project title: Evaluating vision-guided spray technology in New York grapes.

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New Research ☐ **Continued Research** ☒

Amount Funded **$** 15,780

SECTION 2: (This section should be in depth and akin to an academic report)

Project Summary Impact Statement:

The removal of basal grape suckers and under vine weeds via herbicides may be undesirable because of crop injury potential, environmental impact concerns, changing public perceptions about pesticide use, and anticipated regulatory constraints.

Perennial crop growers, including members of the grape industry, have expressed interest in novel technology, including precision, vision-guided spray systems, for removing unwanted vegetation (e.g., suckers and weeds).

Results from two trial sites (NY and NJ) demonstrated that the commercially available Weed-IT™ spray system effectively detected and treated Concord and Cabernet Franc grape suckers (83% to 99% control). Over sites, the Weed-IT™ system performed as well as, or better than, the spray wand (87% to 97% control) and manual suckering (67% to 98% control) treatments for sucker removal.

Objectives:

This project addressed the New York Wine & Grape Foundation's (NYWGF) *"mechanization and precision agriculture"* and *"floor and weed management"* priorities.

The 2024 project expanded upon previous years' efforts, specifically:

1. TARGETED, VISION-GUIDED HERBICIDE APPLICATIONS: Describe grape sucker control, crop safety, and impacts on herbicide use when employing a vision-guided, precision-sprayer compared to conventional directed applications.

Materials & Methods:

Crop management practices, such as pruning, training, and suckering, are essential for optimizing crop health and vigor, as well as fruit yield quantity and quality. Basal grape suckers divert nutrients from desirable tissues, altering fruit-to-shoot ratios, while also increasing tissue availability for pest and pathogen colonization, interfering with crop production practices, and complicating fruit harvest. Sucker removal can be performed manually, which is labor-intensive and costly; mechanically, which risks damaging the vines; or chemically, using directed post-emergence contact herbicides or synthetic growth regulators. Although chemical sprays are efficient and effective, indiscriminate spraying wastes herbicide when suckers are absent, or weeds have not emerged. Conventional post-emergence (POST) applications can also lead to spray drift, causing crop injury without proper mitigation measures, such as shields. Additionally, public concerns over pesticide use, worker safety, and regulatory challenges, including compliance with the Endangered Species Act (EPA, https://www.epa.gov/laws-regulations/summary-endangered-species-act) are driving interest in reducing herbicide use.

Precision sprayers offer a transformative approach to managing weeds and grape suckers using sensor technology that detects and targets unwanted vegetation in real-time. Research on automated identification of grape suckers remains in its early stages, with most studies focusing on computer vision and machine learning techniques to distinguish suckers from primary vine structures based on morphological characteristics and position. Current detection systems have demonstrated promising accuracy in controlled environments, but face challenges in varied field conditions due to occlusion, lighting variations, and the visual similarity between young shoots and suckers. Integration of multispectral imaging and deep learning approaches shows potential for improving detection reliability, though commercially viable robotic systems for targeted sucker removal are still under development and not yet widely deployed in vineyard operations.

Another strategy for sensing grape suckers involves distinguishing green vegetation from soil backgrounds using differences in reflectance patterns. This is the technology employed by the commercially available WEED-IT™ system (Agritech America). The sensor (Figure 1.2, Figure 2) used by the WEED-IT™ emits blue light (450-500 nm) (Figure 1.3, Figure 2) that is directed towards the ground and absorbed by chlorophyll contained in plant tissues. In reaction to light absorption, chlorophyll will radiate a near-infrared (NIR) light signal in return, which is known as 'chlorophyll fluorescence'. The WEED-IT™ sensor is equipped with four independent photodetectors (Figure 1.2, Figure 2) that control four individual TG-3.5 spray

nozzles (TeeJet Technologies, Glendale Heights, IL) (Figure 1.4, Figure 2). The presence of a living plant tissue in one of the detection zones will actuate (i.e., turn on) the affiliated nozzle and treat the unwanted tissue, in this case basal suckers, with a dose of herbicide.

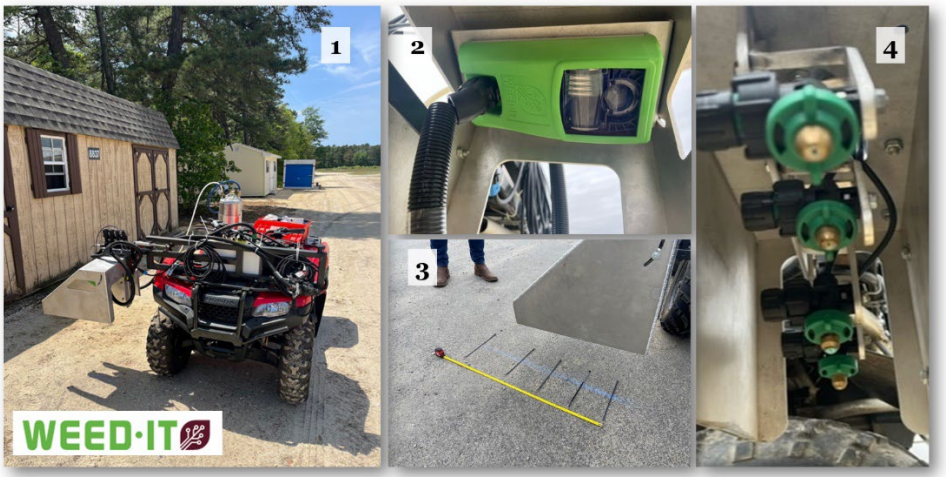

Figure 1.1 The WEED-IT™ system, custom built for perennial crop use, mounted on an ATV.
Figure 1.2 The WEED-IT™ sensor unit with blue light source and four photodetectors.
Figure 1.3 The blue light signal divided into four sections affiliated with the photodetectors.
Figure 1.4. The four independent TG 3.5 nozzles affiliated with the photodetectors.

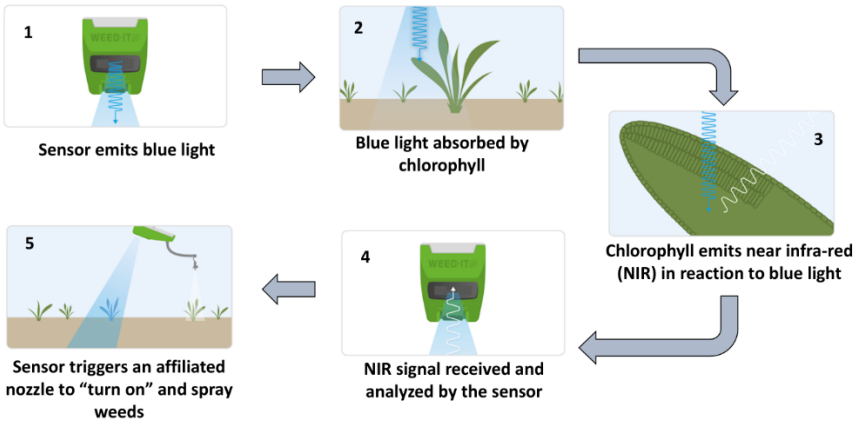

Figure 2. Diagrammatic representation of weed, or other unwanted tissue detection and removal using the WEED-IT™ system. There is no discrimination among tissues, anything that is detected by the sensor is assumed to be "unwanted" and is treated with an herbicide spray. This system can be rapid, efficient, and affordable for vineyard systems

In 2024, research trials were conducted in Concord grapes (Cornell Lake Erie Research and Extension Laboratory [CLEREL], Portland, NY) and in Cabernet Franc grapes (in Collaboration with Dr. Thierry Besançon [Rutgers University] and Bellview Winery, Landisville, NJ) to compare the performance of the precision, optically-guided WEED-IT™ spray system for chemical suckering (Aim EC at 2 oz/A) relative to spray wand treatments (Aim EC at 2 oz/A) and manual removal/hand suckering. A non-treated check was also included for comparison. Applications at both sites were made to suckers that were 6 to 24 inches in length with 3 to 10 flat leaves. The trial at CLEREL was initiated on 30 May 2024 in

a weed-free block of Concord grapes. Plots contained 29 vines with vines spaced 8 feet apart within each row. The NJ study was initiated on 3 June 2024 in a block of Cabernet Franc. Plots contained 10 vines with vines spaced 8 feet apart within the row. The time to spray or hand-remove suckers was recorded for each plot. For the herbicide treatments, spray volumes were also determined. Sucker control efficacy was evaluated on 7, 14, 21 DAT by visually assessing sucker damage using a scale ranging from 0% (no injury) to 100% (dead suckers). At 30 DAT, suckers were manually harvested from all vines and the mean biomass per vine per treatment was determined. All data were analyzed using PROC GLIMMIX in SAS.

Results/Outcomes/Next Steps:

Results demonstrated that the Weed-IT™ spray system effectively detected and treated Concord and Cabernet Franc grape suckers (Table 1, Figures 3 and 4). Sucker control ratings of 83% to 99%, were achieved using the Weed-IT™ system. Over sites, the Weed-IT™ performed as well as or better than the spray wand (87% to 97%) and manual suckering (67% to 98%) for sucker removal. Compared to untreated plots, Weed-IT™ reduced sucker biomass per plant by 96%.

Table 1. Results from 2024 sucker control trials in New York and New Jersey. Concord plots in New York were 29 vines in length with 8-foot spacing between vines in row; each treatment was replicated five times. Cabernet Franc plots in New Jersey were 10 vines in length with 8-foot spacing between vines in row; treatments were replicated four times.

	Time to sucker	Sucker control[a]			Sucker biomass 30 DAT
		7 DAT[b]	14 DAT	21 DAT	
	seconds plot^{-1} -	---------- Percent (%) ----------			----- kg vine^{-1} -----
New York					
Non-treated[c]	-	-	-	-	0.39 a
Hand removal	281 a[d]	98	96	90 b	0.04 b
Spray wand[e]	82 c	97	97	94 ab	0.03 b
WEED-IT™	108 b	99	99	98 a	0.01 c
P-value	***<0.0001***	***0.4096***	***0.1143***	***0.0402***	***<0.0001***
New Jersey					
Non-treated	-	-	-	-	0.40 a
Hand removal	662 a	97 a	89 a	67 b	0.05 b
Spray wand	33 b	96 a	89 a	87 ab	0.02 c
WEED-IT™	23 b	90 ab	83 a	84 ab	0.05 b
P-value	***<0.0001***	***0.0002***	***0.0001***	***0.0141***	***<0.0001***

[a] Sucker control was rated on a scale from 0% (no control) to 100% (sucker death).
[b] DAT = Days after treatment
[c] Non-treated checks (0% control) were not included in the statistical
[d] Means followed by the same letter within a column for each state are not different at the alpha = 0.05 level.
[e] Spray wand and Weed-IT™ applications both included Aim EC at 2 oz/A

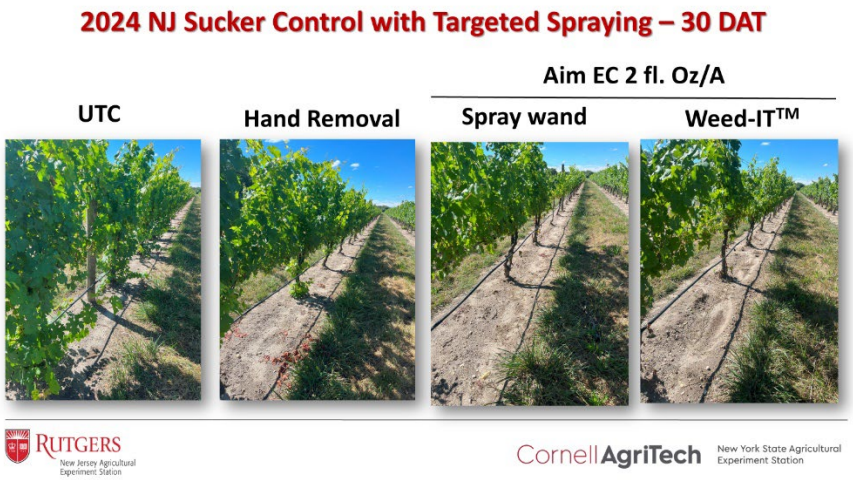

Figure 3. Images showing the degree of sucker control in Cabernet Franc grapes in response to treatment. The UTC plot is the non-treated check where no sucker management was conducted.

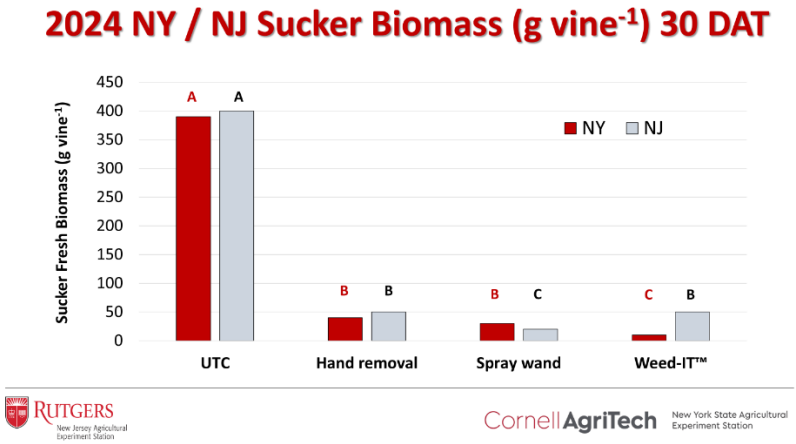

Figure 4. Bar chart showing per vine sucker biomass in Concord and Cabernet Franc grapes in response to sucker control treatment. The UTC plot is the non-treated check where no sucker management was conducted.

Hand suckering was the slowest method at both sites in terms of efficiency (Table 1). In New York, the WEED-IT™ required 108 seconds to spray a plot, which was faster than a team of 2-3 people hand suckering (281 seconds plot-1) but slightly slower than the spray wand (82 seconds plot-1) However, WEED-IT™ treatments in New York involved passes on both sides of the vines, while spray wand applications were completed in a single pass. A follow-up study in New York confirmed that a single WEED-IT™ pass was as effective at controlling suckers as two passes (data not shown). In New Jersey, the WEED-IT™ was the fastest method, requiring only 23 seconds per plot, significantly outperforming hand removal (662 seconds plot-1). These results underscore the WEED-IT™ sprayer's efficiency and effectiveness as a tool for autonomous sucker control in vineyards. Both trials reported equal or greater herbicide use efficiency with the WEED-IT™ system; at Bellview Winery, total herbicide applied was reduced 50% (data not shown).

Technology Transfer Plan:

Results from the 2024 NYWGF-sponsored studies at the 2024 New England Vegetable and Fruit Convention (Manchester, NH), the 2025 ENY Horticulture Conference (Albany, NY), the 2025 New Jersey Ag Convention (Atlantic City, NJ), the 2025 Ontario Fruit and Vegetable Convention (Niagara Falls, ON), the 2025 Grape Expectations Symposium (Mays Landing, NJ), and the 2025 Washington Advancements in Viticulture and Enology (WAVE) Summit (Richland, WA).

In June 2024, Dr. Sosnoskie hosted a new technology field day for the Finger Lakes grape industry at Cornell AgriTech and participated in a similar event hosted by Dr. Terry Bates at the CLEREL center. Both events featured discussions on innovative weed control technologies, including the WEED-IT™ system,

Popular press, online outreach, and peer-reviewed publications: Dr. Sosnoskie's research on the WEED-IT™ sprayer has been shared in the agricultural press (On Target for a Weed Control Victory in Vineyards - Growing Produce). National and International audiences will be reached via peer-reviewed publications; results from the 2022 and 2024 trials are in preparation for a submission to the journal Weed Technology.

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:

In 2024, field trials in New York and New Jersey evaluated the precision, optically-guided WEED-IT™ spray system for chemical suckering in Concord and Cabernet Franc grapes, comparing it with spray wands, manual suckering, and an untreated control.

The WEED-IT™ system showed high efficacy, with sucker control ratings ranging from 83% to 99%, which was as good as or better than spray wand and manual treatments across locations.

Additionally, the WEED-IT™ system significantly reduced sucker biomass by 96% compared to untreated plots.

The WEED-IT™ system proved to be significantly more time-efficient than hand suckering. Additionally, it demonstrated greater herbicide use efficiency, with a 50% reduction in total herbicide applied at the New Jersey site.

Importance of research to the NY wine industry:

This research highlights the potential of the WEED-IT™ precision sprayer to significantly reduce labor demands and chemical use for sucker control in New York vineyards.

The system matched or exceeded the effectiveness of conventional spray wand and manual methods.
Importantly, it maintained high sucker control levels even with a single pass, improving operational

efficiency.

The WEED-IT™ can also reduce herbicide use, supporting more sustainable and cost-effective vineyard management.

These findings offer New York grape growers a viable path toward mechanization and input reduction, enhancing competitiveness and long-term vineyard sustainability.

Project Results/next steps:

Robotics technologies are poised to significantly alleviate labor shortages in agriculture, particularly in the production of specialty crops. While many commercial robots are task-specific and come with high costs, efforts are underway to develop versatile, compact robotic platforms adaptable to various crops and operations. The Amiga robotic platform (Farm-ng Inc.) is a viable option, featuring a lightweight design that minimizes soil compaction while delivering ample power to support diverse implements and equipment. Currently, the Amiga platform itself is notably affordable compared to other robotic mobile platforms, offering growers a cost-effective entry point into automation. Its utility as a carrier for advanced precision technologies, such as the WEED-IT™ spray system, makes it a promising solution for vineyard floor management and sucker control.

By combining the Amiga's mobility and autonomy with the targeted application capabilities of WEED-IT™, growers can achieve precise weed and sucker control, reduce chemical use, enhance worker protection, adapt to labor shortages, and improve vineyard sustainability.

Further precision in weed sensing: Recent advances in AI and imaging technologies have significantly improved the accuracy of weed identification and classification. However, most of these innovations are proprietary and tied to specific products or service packages, which restricts their widespread adoption and integration with existing agricultural equipment and technologies. The Open Weed Locator (OWL) is an open-source, cost-effective solution designed to address these limitations. By integrating OWL with Amiga and Weed-It, we can collect images both when WEED-IT™ is triggered and when it is not. This approach allows us to: i) evaluate the efficacy of WEED-IT™ detection, and ii) generate new datasets to train vision-based models for weed identification and classification. These advancements will pave the way for more precise and flexible weed management solutions in the future.