



## RESEARCH FOCUS

# A Retrospective Study on Application Technology in the Vineyards of New York

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OR

### You can't build the business of tomorrow with the sprayer of yesterday



*Andrew Landers*

It is no secret: business has changed – in every way, for every business. Modern technologies have brought new opportunities and new challenges that old sprayers just weren't built for. Many growers are still using legacy sprayers, designed and built in the 1960's with little thought to modern vineyards and business conditions.

In 1998, I arrived at Cornell University to take up a position in extension, research and teaching for what I thought would be an adventure for a few years. I was charged with the task of improving orchard and vineyard spraying via engineering methods. Assisted by an excellent team of students, post-doc researchers and colleagues I set about my task, initially based in Ithaca and then Geneva.



*Photo by Andrew Landers*

*Direct the airflow/spray plume towards the target.*

Very helpful cooperating growers kindly agreed to let us loose in their vineyards, enabling us to demonstrate the effectiveness of various modifications to traditional sprayers. The information gleaned from our research was cascaded to growers through a pro-active extension programme, initially in NY and PA but very quickly onto a national and international stage. Growers will recall demonstrations where sprayer manufacturers demonstrated their new designs, some with great success, others never to be seen again!

**Liquid flow and Airflow.** There are two main areas of concern regarding spraying machine design: liquid flow and airflow. Liquid flow is relatively easy to remedy, whereas airflow is more interesting to solve. Legacy sprayers were originally intended for orchards but we see so many of them being used in vineyards. They are strong, reliable (even at 40 years old) but are inaccurate and lack finesse! They produce too much air; the air is moving too fast and not directed towards the canopy. We see the spray plume going upwards, outwards and past the target throughout the growing season.

Our early research began in the defunct aircraft buildings at Seneca Army Depot where we conducted trials into airflow from axial fan sprayers. This very important area of research has continued for the whole of my tenure at Cornell, indeed, the answer is blowing in the wind! Air flow should be directed, via a tower or deflectors, towards the canopy.

In redirecting the air towards the vines, instead of allowing it to be blown upwards and onwards towards the sky, the result was too much air volume! We have all seen spray passing through the canopy into the next row or worse; shut down the air volume! Why use an old axial fan producing air at 50,000cu. ft /hr when the canopy might only require 11,000 cu. ft/hr. Growers should consider modern sprayers fitted with adjustable pitch propellers or hydraulic motors to provide a variable airflow as the canopy develops.

The Cornell doughnut is the simple answer, made of plywood and with air intake holes of varying diameters to limit air intake as the canopy develops. A further development, with a patent application, was the Cornell louvre, an infinitely adjustable method of controlling the volume of air leaving the sprayer. Air speed is also of great importance. Using our wind tunnel at Geneva and helium-filled soap bubbles to mimic spray droplets, I have shown growers videos of droplets passing around bunches of grapes and the effect of high air speed in creating a boundary layer. Lower the airspeed to get better coverage. Beware of fake news claiming that airspeeds over 100 mph are necessary, remember my photographs and comments regarding the thrilling Audi R8 Spyder, rainfall and keeping dry. If you want to remain dry, drive fast; the opposite applies to vineyard spraying!

Remember simple, less expensive techniques are often preferable for the non-adventurous, so reducing tractor PTO speed and adjusting forward speed will allow excessive air volume to be controlled and to keep the spray plume in the canopy.

**Droplets, Nozzles, Rates, and Calibration.** Attention to droplet formation, nozzle selection, applica-



Photo by Andrew Landers

*The Cornell University patternator developed to measure vertical spray distribution*

tion rate and calibration were also the subject of our field trials. We purchased a vertical patternator from our Italian colleague, Paolo Balsari, to demonstrate spray plume and how to change spray direction to account for airflow. After comparing hundreds of growers' sprayers around the state, the now infamous handout "What's your orientation?" described how growers could adjust the orientation of their sprayer nozzles to ensure the spray hit the target. Always being aware of growers' priorities and their desire to save money (perhaps for a Ford F350 King Ranch truck?) we developed a number of simple systems.

The Cornell vertical patternator, a simple yet effective visual aid using window fly-screens and J-channel received many plaudits. Some growers still found this an inconvenience, so we demonstrated a method of using a 14-foot tall wooden pole with a cash register paper tape stapled along the leading edge. Placing the pole between two vines within the row and spraying a mixture of clean water and food dye provides a stain on the paper where it hits. Altering the orientation of the nozzles or deflectors until the spray is only hitting the portion of the vertical pole/vines is desirable.

Nozzles have remained a steadfastly tedious subject area. The only excitement was the introduction of Air Induction (AI) nozzles. AI nozzles use a small



Photo by Andrew Landers

*Calibration is so important.*

hole to introduce an air-stream into the liquid flow. The extremely large droplets don't drift and the included air bubbles allow the droplets to go splat on leaves rather than bounce. These nozzles, when used properly, can improve deposition and reduce drift by at least 50 percent.

Calibration, my *cri de coeur*, remains a challenge for many. In spite of countless extension demonstrations, creating videos for You Tube and four Cornell distance-learning courses, I still see plenty of sprayers using old-fashioned basic ceramic nozzle tips with large holes created by either old-age, wettable powders or abuse by Bowie hunting knives. Seasonal calibration and a change to modern colour-coded ceramic nozzles is the answer.

Application rate has been a constant cause for concern. When I arrived in the USA 100 gallons of water per acre was the norm, often irrespective of canopy growth stage. Working with colleagues we have seen good insect and disease control by adjusting the application rate and avoiding recreational spraying! We often see growers starting off with 35 gallons per acre and then increasing application rate with the developing canopy.

Much encouragement was given to my learned colleague from Spain, Emilo Gil, who spent one year with us developing DOSAVINA, a computer program devised to select application rate depending upon canopy dimensions, sprayer design, weather and nozzle configuration. A particular aspect of the programme is spray

concentration and we have had a loyal band of practitioners who are still saving up to 30% of their spray use. Spray concentration is the key and I encourage growers to remain aware of changes in label rates and terminology in the rest of the world.

Growers must, of course, be aware of the "risk versus reward", too little spray (risk) may result in less saleable fruit (reward), but, as always commonsense should prevail, it is all a question of balance. I recommend grape growers speak with NY apple growers who have been practicing Tree Row Volume (TRV) application rates since the 1960s. TRV can easily be translated into Vine Row Volume.

**Cluster zone-limited *Botrytis* sprays.** The application of *Botrytis* spray should be made to the grape clusters but all too often we see applicators applying *Botrytis* spray to the whole canopy. We developed a secondary sprayer system (tank, pump, nozzles) to target the expensive spray and focus it upon the fruit zone. With colleagues and cooperating growers, we have seen considerable savings in spray for *Botrytis*, grape berry moth and Japanese beetle using this system.

**Multi-row Sprayers.** Another mechanical development of note has been the increase in multi-row sprayers. All too often I see examples of poor timeliness due to an inability to keep up with a good spray regime. The ever-increasing acreage of vineyards coupled with struggling outputs from existing, tired



Photo by Andrew Landers

*Multi-row sprayers improve output and can increase deposition by 30%*

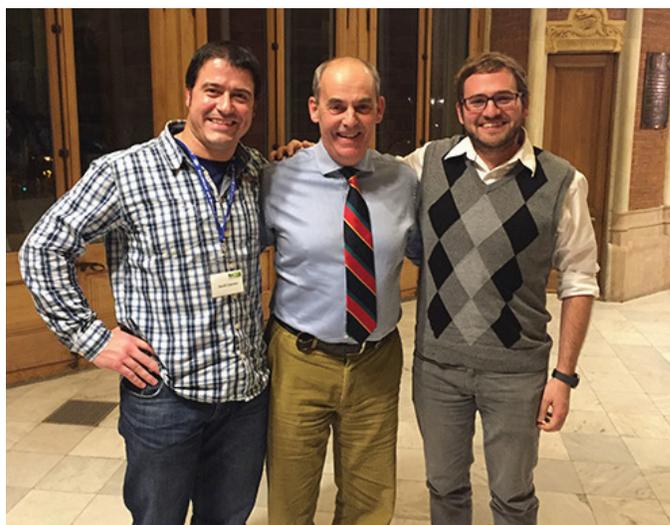
sprayers and operators results in missed opportunities. Two or three row sprayers overcome the challenges of timeliness and it pleases me to see the large-scale forward-thinkers buying these machines. As always, the sprayer is part of the spraying system, additional improvements in output are attainable with the use of rapid-filling techniques such as induction bowls and in-field water bowsers.

**Precision Fruit Spraying.** In recent years, my team has been at the forefront of international developments under the name of Precision Fruit Spraying, receiving high academic acclaim with many journal papers and invited presentations at international conferences.

We developed methods to monitor and record the amount of spray applied, using Global Positioning Systems (GPS) or Radio Frequency Identification Devices (RFID) for location, flow meters to record sprayer output, and a data logger to record all information. A simple wireless system downloads this information to the office computer. Traceability is key in modern food production.

We are able to monitor canopy development in real-time using ultra-sonic sensors and then adjust air-flow using the Cornell louvre or hydraulically driven fans as the canopy requires. Similarly, liquid flow can also be adjusted using these sensors by using pulse-width technology (PWT) nozzles or Lechler Vario Select nozzles.

We are also in the development stage of a device to monitor spray coverage and deposition in an attempt to speed up the field trials process for researchers and to assist growers with knowing how much spray has been deposited on the leaves and the fruit.



*Photo by Andrew Landers*

*The author with his researchers Jordi Llorens and Tomas Palleja in Catalonia*

**Outreach.** Cascading our research to grape growers around the world has been both fun and extremely rewarding. In New York, I have met many good people, have developed excellent relationships and have an extremely good repartee. I have tried to make engineering science fun, for both growers and students alike, if you think my presentations were boring, I suggest you listen to an engineering 101 class! I have travelled the world meeting interesting fruit growers with great ideas which I brought back to NY and shared with growers.

One of my greatest pleasures has been to see the number of growers (nearly 100) take advantage of the grants we arranged via Soil and Water Conservation Districts and National Resource Conservation Service enabling them to purchase an item of “envi-



*Photo by Mike White*

*Attendees at the one-day workshop on Effective Vineyard Spraying held in Iowa.*

ronmentally sound” spraying equipment with a 50-60% grant. The most popular items were low level induction bowls to reduce operator contamination and automatic flow rate controllers.

**Project Funding.** My research and extension programme has been well funded over the years by commodity groups such as the NY State Wine Grape Growers, NY Wine and Grape Foundation, NY Ag and Markets and NY Farm Viability Institute. Fortunately, many ideas we have developed were funded by the NY Apple Research and Development Program (the research fund generated by a production levy greatly supported by very sensible apple growers) and is transferrable to grape production. National bodies, such as EPA, USDA and SCRI have also funded the program.

Teaching students from Cornell University, Finger Lakes Community College and Brock University each year has also been fun and most rewarding. As all teachers will admit, seeing your past students become successful is praise enough.

**Thanks and Best Wishes.** My two-year sojourn to Cornell University and NY has been extended somewhat and I would like to thank my colleagues at Cornell University, the excellent members of my “Spray Team” and the growers for their support and encouragement.

I would like to thank you all for allowing me to share my enthusiasm for my subject with you. To those who missed some presentations it would be remiss of me not to mention that copies of my book, *Effective Vineyard Spraying*, are available from [www.effectivespraying.com](http://www.effectivespraying.com). Those who chose to benefit from my advice, did so.

As I languish in my bath, drinking a preprandial gin and tonic and contemplating the days’ events I will reflect on the fond memories of my time working with wonderful fruit growers and collaborators of New York. My best wishes to you all for a prosperous grape industry. As Cicero observed in his orations against Verres and Catiline, “O tempora o mores!”



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