Delivering a Droplet to the Target

Did you know that spray droplets bounce? A few weeks ago I wrote about spray application methodology but there is an entire science behind the practical application that, like vine physiology, if a grower can gain a fundamental understanding of the principles and physics of spraying vines, it can help increase effectiveness, efficiency, costs and even appreciation of spraying.

Dr. Andrew Landers is an applied scientist extraordinaire who has found a unique niche in our industry to apply his skills. As such, he is in demand all over the world to share his knowledge. He is a grape growers' and extension agents' best friend, the researcher who comes up with novel and practical ideas, figures out a cost effective way to bring them into the field, then extending the information out into industries he serves. Dr. Landers is well known for his pink shirts and wry British humor. Woe be to the speaker who has to follow him on an event program (sorry Bryan). I have been there myself and it's like being asked to do standup after the Marx Brothers. But even the jokes and good natured comments are embedded with information meant to deliver or emphasize a point about some practical aspect of spray technology or method. I would venture to guess that if all grape growers followed Dr. Landers' suggestions, overall wine quality would jump 2-3 notches in a single season. We spray a lot, but are we delivering the goods to the target? That is the fundamental question.

The following are some excerpts from Dr. Landers' recent presentations at the grape disease workshop in Pennsylvania.

We are trying to gain an appreciation for spraying by understanding the importance of the target and the effects of spraying. The type of target, whether bug or leaf, matters greatly to a spray droplet and the efficacy of the pesticide it is transporting. Droplet size and speed are critical characteristics. Spray droplet size falls within a wide range, from 10 to 450 microns. When a droplet is halved in size, the number of resulting droplets increases eight fold. Dr. Landers provided a visual example using a tennis ball, which if tossed into the audience might hit one person and is likely to bounce off of the target. If halved, the 8 ping pong balls will likely strike more targets with less bounce effect. Slice a ping pong ball in half and you have 64 marbles that will scatter and hit many people in the audience with even less pronounced bounce effect. It follows then that a large droplet of 500 microns when cut in half would result in eight droplets of 250 microns and if sliced again would become 64 droplets of 125 micron size and so on. Using a field example of trying to kill a Japanese beetle with a contact fungicide, what are the chances of the large droplet scoring a direct hit on the beetle target vs. many smaller droplets? The physics dictate that big droplets will tend to bounce off the target and smaller ones will have less bounce or be more likely to stick to the target. However, there is an outer limit to shrinking droplet size where drift, pollution and cost-benefit become issues. There is correct droplet size for the material you are applying, the equipment that is applying it, and the intended target.

A classification system exists for droplet sizes and Dr. Landers explained that certain pesticides should fall into specific size categories.

- Fine (119-216 microns) is best for insecticides and some fungicides
- Medium (217-353) for herbicides and systemic fungicides where a leaf is the target
- Coarse (334-464) for soil applied materials such a pre-emergence herbicides

The bounce effect of spray droplets on targets was the object of curiosity for Dr. Landers so he set up a test to see how much bounce would occur for droplets of a certain size and velocity. A remarkable set of slides showed a 650 micron droplet hitting a pea leaf at 5 ft/sec and bouncing eight times, boing, boing, boing... decrease droplet size to 375 microns reduces bouncing to 4x.

The moral of this story is to use the right nozzle and pressure to get the right size droplet for the intended target in the vineyard. You absolutely, positively cannot do this without a proper nozzle catalog with its calibration chart. Guessing what size/type nozzle to use is silly and wasteful. The correct nozzle should be selected based on output and spray quality. Three factors affect the application rate – pressure, forward speed and volume (determined by nozzle tip size).

For the grower who suffers from calibration anxiety there are some excellent training resources including two-20 minute *YouTube* videos by Dr. Landers entitled *Calibrating Air Blast Sprayers in Vineyards*:

http://www.youtube.com/results?search_query=calibrating+airblast+sprayers+for+vineyards&search_type=&aq=f

and the excellent calibration section of the *New York and Pennsylvania Pest Management Guidelines for Grapes:*

http://ipmguidelines.org/grapes/

Your nozzle catalog is also very likely to have a section on sprayer calibration. Please note that calibration and nozzles for each type of spraying, e.g. fungicide vs. herbicides will be different in some aspects.

Dr. Landers insisted that there is only one way to properly calibrate a sprayer and that is right way. The output of EACH nozzle needs to be measured and this demands hose connections to collection containers for each sprayer nozzle. Run the sprayer with the fan OFF for one minute and compare outputs. Variations in quantities of water will usually indicate a defective nozzle. Use a correctly calibrated measuring container. A graduated cylinder is likely to be much more accurate than the measured buckets provided by chemical vendors.

Nozzles are the key to good spraying. Along with pressure and speed, they determine how and how much material gets to the target. They often do not get the attention and respect they deserve. Dr. Landers gave the frightful example of cleaning clogged nozzles with a Bowie knife. It has no doubt happened. He warned that nozzles should never touch the lips and suggested carrying a small can of compressed air to clean nozzles. They should be replaced when worn and properly selected for the application job. One nozzle type does not fit all targets!

Growers should be aware that air blast sprayers do not deliver the same volume, speed or direction of air from both sides of the fan outlet. Fans generally turns counterclockwise so air from the right side tends to move faster and upwards and air on the left more downward. Changing nozzle orientation is a cheap (zero cost) and quick improvement. Dr. Landers suggests turning off the right-side top nozzle completely and positioning nozzles 2 and 3 at 20 degrees below horizontal and 4/5 to horizontal. Left size nozzles should all be positioned at 45 degrees above horizontal to push the airflow upwards. Tying flagging tape to the nozzles or using tape on the end of a pole and holding it in the airstream can tell you exactly what direction the air is moving.

Air volume and speed are very important to getting materials to their target. Too little or too much of either will compromise the quality of the application. Using a patternator device Dr. Landers can evaluate the amounts and location of spray material exiting the sprayer. A fruit zone spray should hit the clusters. A shoot tip spray for JBs should not cover the entire canopy. It turns out that often a lot of what we spray is nowhere near the intended target. Dr. Landers has plans for a simple patternator that only costs about $400 to build and is intended for grower use.

This is what a sprayer should do:

- Deliver droplets from sprayer to the target
- Produce correct size droplets
- Protect droplets from the wind
- Provide shaking of the target

Spray materials should not be pushed through and past the canopy. Ideally, air and spray materials should mix around the canopy zone but excessive shaking of the target will reduce the quality of coverage.

A patternator demonstrates the potential for spray coverage but how do you know for sure that the material is getting to the target? Dr. Landers suggest three methods to check for deposition pattern and coverage. Surround is a kaolin material that has multiple purposes in vineyards but can be used as a spray coverage indicator. Water sensitive cards placed in the vine canopy will show the quality of spray penetration into the canopy. Dyes will highlight where the spray material is going. In spraying, more is not necessarily better. He gave the example of a canopy sprayed with 35 gpa vs. 70 gpa. The run-off from the higher rate resulted in greatly reduced leaf coverage. Spray amounts should be calibrated to canopy size.

The most effective sprayers direct the optimal volume and speed of air towards the canopy. In vineyards, there are many variations on canopy size and shape and a sprayer must be used to accommodate these features, from tall divided canopies, to wide horizontally divided canopies, early season growth to a full canopy and zonal spray applications. If possible, control the volume of air and direct it at the target. Tunnel sprayers like the Lipco are perhaps the most effective, and ultimately, with their recycling abilities, the most economical sprayers. The Cima and Hardi tower sprayers are very effective at covering the canopy, as are the Sardi crop sprayers that use multiple, smaller fan/spray heads that wrap around the canopy to direct spray from different angles and directions. The Landers team has also developed spray deflectors which are simple and inexpensive, wing-like retrofit devices that guide the air from the fan towards the target.

A big spray plume is not a sign of effective spraying, in fact, quite the opposite. The idea that drifting spray will eventually hit a target is false and much of it is simply lost and wasted. Dr. Landers says (contrary to my statement in my previous article) that sprayer operators should not be wedded to 540 RPMs In fact, on flat surfaces running the sprayer at lower RPMs (he suggested 410) and reducing air speed (but maintaining pressure and ground speed) will help the effectiveness of the spray application. Lowering air speed can reduce drift up to 75%. On hilly vineyards 540 is necessary to maintain speed and power to the pump.

To adjust air intake volume Dr. Landers created the "Cornell Donut" which is placed over the fan and the size of the opening restricts the amount of air sucked in by the fan. A European device has an electrically actuated iris that can open/close according to desired volume of air. Dr. Landers' team has taken a different approach to improving the donut and created a device that regulates the output of air from the fan via a sliding louver that adjusts the opening from one to four inches. In early season applications it can reduce drift by as much as 75% and increase target deposition by 82%.

Finally, Dr. Landers emphasized traceability as an important tool to monitor spray coverage. Every grower has missed rows or sprayed the same rows twice because, in the dullness of an eight hour spray day, it simply too hard to keep track of every pattern. Using technology a running record of spray pattern and coverage can be collected that will indicate if a not enough or too much spray material was delivered. It can even detect if a nozzle has an erratic output pattern and needs to be checked for problems.

As growers in the Eastern U.S. we spray a lot, a lot more than growers just about anywhere else in the world. We need to spray better and more efficiently. We are lucky to have Dr. Landers and his team working hard to help us to get our materials to their proper targets. I thank Dr. Landers for making the trip to Pennsylvania to enlighten us and encourage anyone who has made it to the end of this article to go immediately to his web site:

http://www.nysaes.cornell.edu/ent/faculty/landers/pestapp/

Dr. Landers has also published a book entitled *Effective Vineyard Spraying: A Practical Guide for Growers* that is expected to be available this spring. It will cover the A to Z of spraying vineyards and includes a CD with video clips of nozzle selection and sprayer calibration, a spreadsheet-based "what if" programs to help guide growers through operating parameters and costs of spraying. It should be an essential supplement to the NY-PA IPM guide. You can pre-order the book and find more information about it at:

http://effectivespraying.com/

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