GROWING KNOWLEDGE

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Setting up for spray success

Growers of variable crops can reduce chemical waste and ensure coverage by systematically adapting their approach

BY BRIAN HILL AND LLOYD NACKLEY

"WE CAN'T ALL mount lasers on our air-blast sprayers," a Willamette Valley grower said recently in a conversation with researchers.

It's true that some growers actually can mount lasers. Lasers are now a component of some "Smart sprayers," like the retrofit kit developed by the USDA Intelligent Sprayer system and now offered commercially by Smart Guided Systems.

The technology uses an air-blast sprayer mounted LIDAR (light detection and ranging) to map canopy area and density in real time. It then controls solenoids and nozzles on an air-blast sprayer for highly accurate coverage of pesticides.

But aside from these systems, the options for applicators attempting to reduce wastage, while maintaining efficacy, are fairly limited.

For growers that can't mount lasers to their sprayers, then what?

Figure 1. Intelligent Sprayer with LIDAR. PHOTO COURTESY OF OREGON STATE UNIVERSITY

Looking for consistent coverage

Pesticide spraying is an important part of Oregon's greenhouse and nursery production systems. Nursery crops are highly variable due to plant age, spacing and seasonal changes, not to mention the possible presence of multiple species per acre. The large size, shape, and canopy density differences between these species create increased challenges for pesticide applicators who are striving for consistent coverage.

Nursery spray managers must strike a balance between efficacy and the economy of protocols. The ideal point of balance is often skewed by the weight of impact for error. To understand this, it's necessary to set pesticides aside for the moment and talk about statistics.

One can never rule out the possibility of being wrong in statistical analysis. This uncertainty is assessed through hypothesis testing. In hypothesis testing, there are two types of errors, aptly named Type I (false positive) and Type II (false negative).

For example, if a hypothesis states that a suspect is guilty of a crime, a false positive conclusion would mean an innocent per-

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Nurseries often group crops with high variability in size and density.

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son gets wrongly convicted. With the same hypothesis, a false negative conclusion would mean a guilty person would be set free. In summary, a false positive error means trusting a wrong conclusion, and a false negative means rejecting a correct conclusion.

How does these principles apply to pesticides? If an applicator's hypothesis is that the pesticide tank mix and sprayer settings are correct for effective coverage of a crop, the false-positive conclusion would mean the applicator wrongly accepts these settings and the crop would be sprayed with less than the required amount.

The same hypothesis but with a false negative conclusion would mean that the applicator would not accept the settings and make unnecessary adjustments, ending up spraying more pesticide than needed. The consequences of getting it wrong are some wasted pesticide versus potential crop loss, financial damages, and possible job loss. This creates a situation where there is minimal incentive to experiment with adapting different spray rates.

It is assumed here we are referring to rates lower than the label states and never exceeding the label's max rate. This statistical concept is important because it describes the situation that has led applicators to favor overusing pesticides. But even if a pesticide applicator wants to adapt the level of pesticides, they have adequate adjustment protocols to match the variability of targets.

Spraying herbicide on the ground is a two-dimensional application that fits the two-dimensional target, an acre per tank mix, which is provided on the label. Spraying a fungicide into a shade tree canopy is a three-dimensional target that doesn't always fit the two-dimensional directions on the label. No example cano-

The front view (left) and rear view (right) of the Air-blast Tower Sprayer.
PHOTOS COURTESY OF OREGON STATE UNIVERSITY

py size/density is given for reference.

Label rates are usually set for pest control at maximum scenarios, or fully leafed-out canopy in the shade tree example. In practice, most seasoned pesticide applicators in the nursery have figured out a level that works for all settings and stick to that. It works for dense canopy and therefore works at bud break. This error-type analogy means that the risk of under spraying greatly outweighs the risk of over spraying and results in one application rate for a highly variable block.

The downsides are wastage and environmental.

Adapting to the actual crop

Crop-adaptive spraying (CAS) provides a simple framework that applicators can use to make adjustments.

There are many examples of crop-adapted spraying. **Sprayers101.com** is a great reference, and it is free to use.

There are many adaptation strategies nursery professionals can use. This is a summary of the Sprayers101.com CAS method. Before you perform the CAS method, read the comprehensive guide for important details.

Park a well maintained and visually inspected air-blast sprayer/tractor in-between target rows, filled with only water. Tie ribbons or flagger tape to each nozzle and turn on only the air. Use ribbons to add and adjust deflectors and turn off nozzles that are aimed at the ground or sky. Consider using an air induction nozzle for the top position(s) to reduce drift where the wind has the most impact.

Attach ribbons or flagger tape to the far side of a target crop, one at the top and one at the widest/most dense part of the canopy. Drive past in the selected spraying gear, at the ideal RPM, and check that ribbons are blowing outward at or just below a 45° angle. Use these observations to adjust for more or less air and to adjust ground speed.

Once nozzles are aimed at the target and air penetrates the canopy correctly, test coverage. Place water-sensitive cards at the top, center, and bottom of the canopy. Make a pass and then collect cards for analysis. Using an online software program or the guide sheet provide cards to see if coverage is at 10–15%surface area and 85 discrete droplets per square centimeter. If coverage is not within this goal approximation, switch nozzles out for higher or lower flow ones until the goal is met.

Once the tractor is calibrated to the crop, mix a tank as usual and note how much more acreage one tank covers for future planning adjustments.

As the season progresses and the canopy fills in repeat steps 2 and 3, creating two protocols for the crop as it changes.

The CAS method works for customizing sprayer settings to a target crop. Sprayers are quite variable between makes/models, as well as usage and age.

Step 5, above, discusses the need for two protocols due to changes in canopy density. This applies to production nurseries as well, although a nursery rarely has a full acre of identical age/shape crops. Sometimes the 3-year-old oaks and the 2-year-old boxwoods are both in need of the same pesticide. Sometimes every other tree has been dug over winter to allow room for next year's growth and last year's protocols don't apply.

Setting up for success

Should you create a spray settings cheat sheet for every different crop/spacing/maturity? No.

Should you set your sprayer up for the largest densest crop and use those »

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Researchers working on the Intelligent Spray Project.
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settings for all? No.

Like everything in life, the answer lies somewhere in the middle, and you have to decide what's right for you and your system.

The decisions about how many spray situations will require a different equipment setup usually comes down to time. How long do the adjustments take, and what is the time window to complete a spray task? This gets more challenging in the Pacific Northwest as spray events are often forced into narrow weather windows.

To make the best decision, one must look at all the possible adjustments and pick the setup that lends itself to the most applications while still setting yourself up for success.

So are you a lumper or a splitter? This term refers to the way a person groups things, tasks, or concepts. Lumpers will combine groups based on similarities while splitters will divide groups based on differences. Humans like putting things into categories. It helps us be more efficient when processing and planning. Nature does not work like this. This becomes apparent when you are looking at your nursery trying to decide how many different CAS recipes you should spend time creating.

When you stop seeing crops as biological entities and start looking at them as shapes, two important variables emerge. Height and density. How tall is tall and how dense is dense? These median lines depend on your nursery. Looking at what you are growing, set these lines. List all your crops and then go through deciding if they are:

1. Short/Dense
2. Short/Sparse
3. Tall/ Dense
4. Tall/Sparse

Next, put a colored dot next to each based on its new categorization. Now go to the field and perform the steps needed to create a recipe of tractor/sprayer settings following the CAS method, which you read about at Sprayers101.com.

Repeat this for a crop that represents each of the four categories you have created. Assign each category a color and hang a laminated copy of your four recipe cards in each spray tractor and the area they are stored. Maybe even use a colored magnet in the cab, like a clean/dirty magnet on the dishwasher.

Next time you need to spray your crops, start with a colored block. Use the Google map you printed out and highlighted to find these areas needing spray. Then switch tractor settings based on the colored blocks you are spraying. In theory, the time you spend creating the system will be all up front, and in season changes will go quickly due to the color-coded cheat sheets.

Lastly, take good notes and use a stopwatch so time spent traveling, mixing, and spraying are all logged. Do this once with the spray program in use before reading this article. This way you can evaluate the old system against the new.

Once you have this info, head back to Sprayers101.com and download the "Airblast Budget and Work Rate Calculator" created by Dr. David Manktelow. This will help you realize the potential areas of change that would have the most impact on time/labor.

Perhaps this new approach will influence next year's planting layouts because using CAS colored blocks for special planning will save you time traveling between spray plots. Then perhaps nurse trucks with mobile filling stations can be added to the master plan, reducing travel time for refilling, keeping you in the field as much as possible.

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Height and density

	Sparse	Dense
Tall	1	2
Short	3	4

Recipe #2
Tall & Dense

- Red deflectors in position # 2, both sides
- Air-blast Gearbox-High
- Tractor- 3rd Gear
- Throttle to 540 RPM
- Nozzle 9 Capped
- Nozzle 1 & 2 Air Induction
- Nozzles 3 – 6 Grey
- Nozzles 7 & 8 Black
- Pump 80 PSI

Above: Crops can be divided by height and density. **Right:** Each category can be colored and used to create recipe cards for tractor/sprayer settings.