Understanding your Chemical Sprayer

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Every year it seems there's a new insect or disease threatening to show up. Perhaps it's an old one returning from a much-too-brief hiatus. Either way, a lot of thought goes into what can be done to deal with the problem. Do I need to spray something? What chemicals work? When do they need to go out? Something that doesn't get enough attention is: How should that chemical be applied?

Most sprayer operators will add the label-indicated amount of chemical to the solution tank with what they feel should be sufficient water to cover the crop. Then it's spray-and-pray until the tank is empty. But how much time went into adjusting the sprayer to optimize coverage? Let's consider how sprayers work and what you can reasonably expect from them before the stress of pest management season distracts you from getting your sprayer set up right.

At their core, every agricultural sprayer should satisfy the same mechanical functions. They use a water pump to move spray solution from place A (the tank) and convey it as efficiently as possible to place B (the target). This requires power, typically derived from the tractor engine, to pump that solution from the tank. It travels via pipes and/or hoses to either circulate back to the solution tank (bypass and/or hydraulic agitation) but ultimately leaves the system via some manner of atomizer (typically a nozzle). As a sprayer operator, it is your job to understand how this basic system works and how to bend, tweak and otherwise manipulate it to get the spray where you want it to go.

Depending on your sprayer design, you may have options where you can change how liquid flows. With positive displacement pumps, you can adjust the system pressure (affecting overall flow) using a pressure regulator. You can alter the overall flow, or redistribute that flow, by changing nozzle sizes or inline metering discs.

Cannon type sprayers are common in Christmas tree growing systems. You can quickly spray several rows into the plot. If you look closely, the spray cloud is much larger and denser near the sprayer. Either too much spray is hitting the first tree or not enough is reaching the 3rd or 4th row in. Photo by Jill O'Donnell-MSUE retired. Photo credit to Jeff Owen

You also have the ability to change air settings. As long as your tractor has sufficient power and your sprayer uses a positive displacement pump, you can gear up and throttle down the tractor to slow the axial fan. You could also change the fan gear, or if the manufacturer recommends it, the blade pitch. Perhaps surprisingly, the easiest and most effective way to adjust the air is to change your travel speed. Just as driving faster reduces the liquid flow to the trees, it also reduces air energy. As a result, driving slower increases the height of the spray and the depth of canopy penetration. In that last situation, you begin to see that changing one setting potentially affects the others.

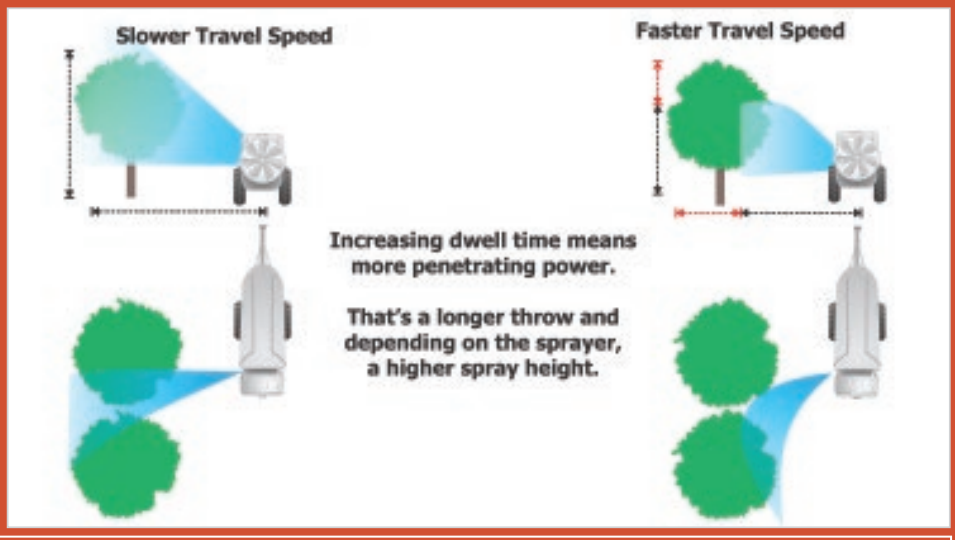
If your sprayer supports changing the operating pressure, it can have dramatic effects. It will change the rate of solution flowing through the nozzles. It will also change the sizes of the droplets that exit the nozzles, but unlike field sprayers, this only plays a small role in airblast spraying. Changing it will also optimize the system for different chemicals (i.e., thicker tank slurries). There is one thing, however, that it will not do.

The droplets produced by most airblast sprayers are a Medium spray quality, or smaller. This means they have very little kinetic energy when they leave the sprayer, so predicting how they will move is difficult. A feather is a good comparison. Attempting to throw a feather across a room with different amounts of effort does not translate into significant changes in how far the feather goes. This is why most specialty crop sprayers use air assist; the air will direct and carry the droplets from the sprayer to the target.

We mentioned changing nozzles as a method for adjusting the sprayer. There are many makes, models and sizes of nozzles available, and their labelling system can sometimes be confusing. Most are classified by their flow rate and the spectrum of droplet sizes they produce at a given pressure. Flow rate is easy to understand. A higher flow at a constant travel speed should mean more product on the trees. Droplet size is trickier to understand. Larger (i.e., coarser) droplets move in a straight line and settle out of the air quicker. On the plus-side, this makes them less prone to off-target drift. On the negative side, they are more likely to bounce and run off the target, and they are unlikely to get carried deep into the canopy with the sprayer air. Smaller (i.e., finer) droplets are guided by the sprayer air, and will get carried more deeply in the canopy, but they are also very drift prone and in some circumstances they might evaporate before they reach the target. No one droplet size is perfect. Nozzle choice is an important part of the overall spraying strategy and will help get the spray where you want it to go.

Operators should also pay close attention to which nozzles are active and which are inactive. Turning nozzle

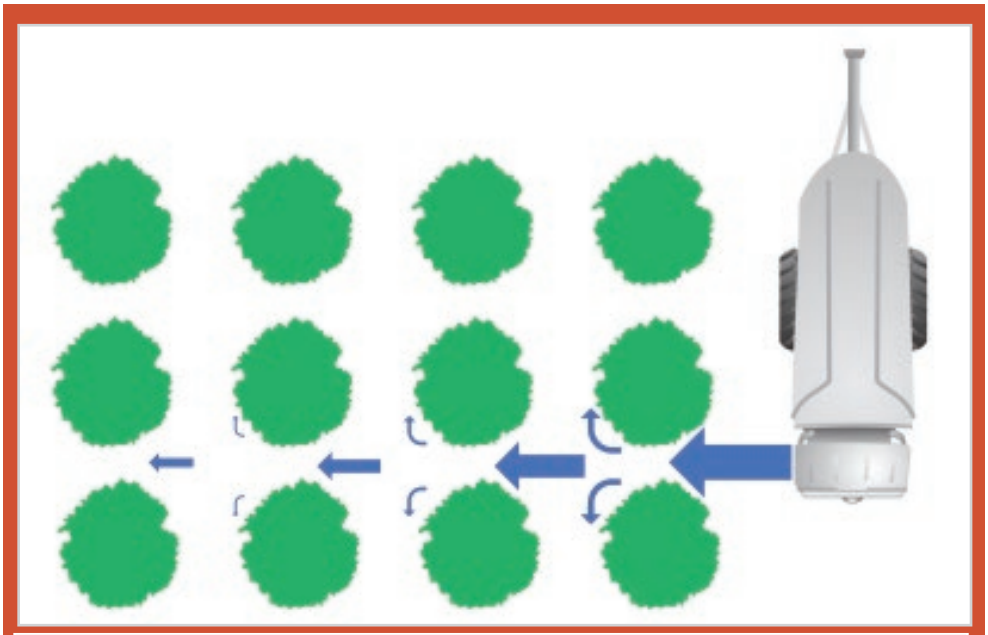
Imagine throwing a feather. Now imagine throwing it as hard as you can. It may travel a little farther, but not much relative to the extra effort. This is the primary reason for the "air" in air-assist spraying. Graphic and caption from Airblast 101.



Travel speed can be used to change the duration a target is in the air wash. Slowing down increases throw. If you halve your travel speed, you double your air energy (or penetrating power). Graphic and caption from Airblast 101.

positions on or off changes how much chemical is used and ensures that spray is directed at the target. Spray that goes over or under the tree is wasted chemical, which is unnecessary environmental contamination and a waste of time and money.

The last major adjustment is in changing your travel speed. If everything else stays the same, you can change the amount of chemical applied by simply speeding up or slowing down. A common practice is to drive as fast as possible to save time, and compensate by increasing pressure and/or moving to a larger nozzle size. But, this can have a negative impact on coverage because of something called dwell time. Dwell time is the amount of time the sprayer is in front of its target. Think of dwell time as "penetrating power". The slower you go, the longer you are pushing air into the crop. The more air you displace, the further into that crop you deposit the spray. Depending on whether you drive every alley, or attempt to spray multiple rows in a single pass, the idea is to replace the "empty" air in the target canopy with spray-laden air.



Air wash from a sprayer likes to move in a straight line. As air mingles with the trees, it will slow down. Some will change direction and hit the back side of the trees. Most will go on to the next row of trees and slow down even further.

The most efficient way to maximize spray coverage while minimizing drift or over-coverage is to spray each row individually. Over the row sprayers can be produced or adapted to work on Christmas trees. This sprayer is set up for smaller nursery trees, but the same system can work on taller trees. Photo by Jason Deveau-OMAFRA.

This displacement concept is universal to any crop sprayed with an airblast sprayer, but achieving it can be difficult. The sprayer settings depend on the physiology of the target canopy. Christmas trees, for example, are very different structures from, say, grapes or apple trees. Their dense, stiff needles make excellent windbreaks, slowing or deflecting wind. Every time air hits an obstacle, it changes direction and loses some of its energy. When spray-laden air hits this canopy, it quickly slows or deflects and the droplets settle and are filtered out.

Operators can see this when they try to spray multiple rows with a single pass. It is relatively easy to displace the air on the front side of the first tree you are trying to spray. But far more difficult to use enough spray and air energy to penetrate through the entire canopy to the back side. It is exponentially more difficult to achieve suitable coverage on multiple rows.

To be clear, the decay of air energy over distance is exponential. For example, if spraying through one tree takes X amount of air energy, then spraying through two trees might take 4X or more! It is a difficult proposition. Driving slower to increase dwell time can help, but eventually it's too slow to get the job done. Plus, the spray coverage becomes non-uniform. You drench those parts of the tree closest to the sprayer in an effort to penetrate deeper. So what can you do to improve coverage?

One option is to reduce the number of rows you need to spray in one pass. Have a drive row between every 4-6 rows of trees (or less, if possible). If you do this, the backsides of those rows further in become the front sides of the

trees when going down the next drive row. You also create a situation where spray will overlap in the middle, increasing the odds of good coverage from multiple angles. This does reduce the total number of trees you grow per acre, but each of those trees has the potential to be better quality when it comes time to sell them.

Another option is to invest in a different spray system. There are a number of homemade and locally produced spray systems that increase work rate by spraying multiple rows in a single pass. These Over the Row (OTR) sprayers have outriggers that reach over the first row you are spraying to better reach the rows past it. Others don't use air to assist moving the droplets around. They rely on pressure to direct larger droplets from droplegs suspended from an overhead boom between tree rows. This design is similar to what you see in vegetable or row crop spray systems. The big difference is that Christmas trees are far taller so they will need several nozzles on each dropleg to span the canopy.

Before you make any major financial commitments or permanent changes to your plots, the first thing to do is to see how good your coverage already is. Water-sensitive papers are yellow papers that turn blue when liquid touches them. They will show where spray is going (or not going). Short lengths of flagging tape tied on the upwind and far side of tree canopies will move when sprayer air reaches them, indicating if more or less air is needed. If things don't look the way you want, make a single adjustment at a time and try again. There are many strategies for improving coverage that are not discussed in this article. Talk to your equipment dealer, local chemical representative, extension educator or do a little reading on your own (see sidebar for a really good one that just came out) to find out more about your sprayer.

We're pleased to announce that "Airblast101

Your Guide to Effective and Efficient Spraying, 2nd edition" is now freely available as an ePub, or at cost via print-on-demand publishing, via **www.sprayers101.com/airblast101 .**

Airblast101 began in 2010 as a classroom-based workshop for Ontario's airblast sprayer operators. It was intended as a primer and decision-support tool for operators to become safer, more effective and more efficient.

After several iterations, the first textbook edition was made available in 2015. It won the 2016 Canadian Agri-Marketing Association's "Certificate of Merit" in the Special Publications Category. Well over a thousand copies have been circulated worldwide… but it was never really intended for an international audience.

In late 2019, working with US sprayer specialist Mark Ledebuhr (Application Insight LLC) and with contributions from NZ sprayer specialist Dr. David Manktelow (Applied Research and Technologies Ltd.), we began developing more advanced and globally-relevant content.

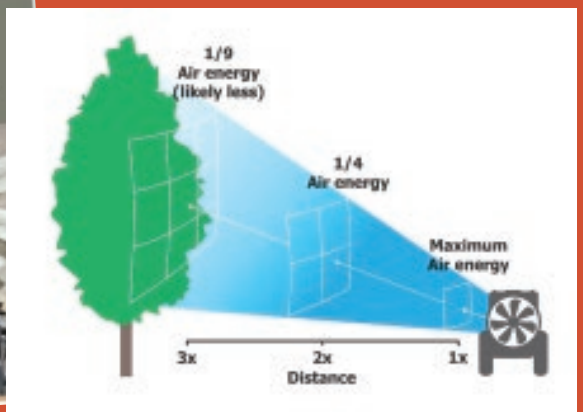
The familiar "Airblast 101" title is, perhaps, no longer accurate. The original emphasis was on the classic, low profile radial design developed in the 1940's when it was recognized that pushing spray with air gave better coverage with less water. These sprayers continue to dominate in specialty crops around the world because they are simple, economical, and can operate effectively across a wide range of canopy forms and planting geometries.

But, air-assist sprayer design has evolved and diversified. With this new edition we've broadened the scope to include all air-assist sprayers. We hope to introduce you to equipment and practices you may never have personally encountered. We will also give you the tools to assess their relevance to your operation. This required a deeper dive into the physics of spraying, but we've kept the tone conversational and relied heavily on illustration to make concepts accessible.

The new edition continues to focus on three central themes:

- Understanding the forces that influence air and spray droplet behaviour.
- How to configure a sprayer to optimize coverage and minimize waste.
- How to evaluate spray coverage.

So, perhaps you're new to air-assist spraying and deciding which sprayer is right for your operation. Perhaps you're an experienced operator re-evaluating your practices. Maybe you're a farm manager, a government pesticide regulator, an agricultural extension specialist, an equipment manufacturer, a consultant, an agrichemical sales representative or a researcher. No matter your perspective, if you're interested in air-assisted spraying, the new edition will have something for you.



All new content, 33% longer, and more than 200 colour illustrations and figures.