Airblast sprayer calibration:

Opportunities to improve performance and save money

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Is sprayer calibration on the top of the "to do list" for your clients next spring? Proper calibration verifies that materials are applied at the intended rate. Too little could result in a crop failure, and too much could exceed legal rates and waste valuable dollars.

Dr. Andrew Landers, a world leader in pesticide application technology, has demonstrated that 10–15% of spray material is routinely lost to drift and 40–60% to the ground during early-season applications (Hutton-Squire, 2010). These inefficiencies cost growers thousands of dollars each year and increase risks to human and environmental health.

For example, based on current prices for a commonly used fungicide tank mix, a grower can expect to spend $45/ac at recommended label rates. Sprays where an insecticide, fungicide, and foliar nutrients are included could cost upwards of $100/ac. Using an average $70/ac cost, a 10% improvement in sprayer performance on a 20-ac orchard would generate $140 in savings per spray. A 30% improvement would potentially save $420 per application in the same 20-ac orchard.

During visits with apple producers in Minnesota and Wisconsin this year, we emphasized that Extension and manufacturer-recommended calibration procedures are essential to the success of integrated pest management (IPM) programs. Grower reactions were varied. Most were skeptical. One grower suggested that if we know exact measurements of the orchard and the volume of water in the tank, it should be more than adequate to calibrate by observing how many acres it takes to empty the tank. Another indicated the sprayer was brand new and delivered ready to go, even though the dealer never inquired about the orchard's row spacing or tractor forward speed—essential for calibrating an airblast sprayer (Hamilton, 2012).

When we calibrate, the goal is to optimize performance and prevent equipment failure. Are nozzles worn, increasing orifice size and application rate? Are other mechanical problems present? This season, we calibrated air-blast sprayers for 11 tree fruit producers in Minnesota and Wisconsin with funding from the USEPA Strategic Agricultural Initiative. Results suggest that growers generally do not know proper calibration methods and do not routinely evaluate sprayer performance. The USDA-NRCS recommends that application rates should be within 5% accuracy (USDA-NRCS, 2006). Ninety-six percent of the application scenarios we calibrated were outside of this range.

Airblast sprayers are the industry standard for applying crop protection materials in citrus groves, orchards, tree nuts, and vineyards. These axial-fan-driven sprayers deliver materials to the target by displacing air and creating turbulence in the canopy. This design has changed little since it was patented by George Daugherty in 1949 (Fox et al., 2008). Sixty-three years later, 95% of the industry is still using Daugherty's basic airblast sprayer design (USDA, 2010).

Effective Vineyard Spraying: A Practical Guide for Growers (Landers, 2010) provides an excellent step-by-step approach to calibrating airblast and boom sprayers and outlines strategies to minimize drift and improve pesticide deposition. Here we summarize key information consultants can share with clients.

First, determine the make and model of all of the pesticide application equipment that will be used, and collect the manufacturer recommendations for maintenance and calibration. Review the instructions, and ensure they are

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followed, including recommended intervals for inspection, maintenance, and replacement of key parts.

Second, address three key questions:

1. **What's your speed?** Tractor forward speed impacts the application rate and the volume applied per acre and should be calibrated prior to first use each season. We found actual travel speeds were off by two- to three-tenths of a mile per hour, resulting in sprayer output differences of about 5%, risking exceeding USDA-NRCS standards for accuracy.

Applicators relying on charts that estimate travel speed based on gear setting and tachometer reading need to make ground speed calibration a top priority. Tractors equipped with speedometers also need calibration. When calibrating speed, it is important to accurately measure the distance and not to rely on pacing. A tape measure or a measuring wheel is the right tool for this job (Landers, 2010).

2. **What's your nozzle size?** Nozzles determine the droplet size and spray pattern. Droplets that are too large will not stick to the foliage; droplets that are too small are prone to drift. The ideal droplet size depends on the target. Airblast sprayers applying materials for insects and diseases on foliage should use fine (183–280 µ) or medium (281–429 µ) textured sprays (Landers, 2010).

Applicators can influence how much spray is directed to different parts of the canopy by adjusting nozzle orientation and varying the gallon-per-minute (GPM) nozzle flow rate. For example, nozzles on the bottom and very top of the boom can be set for lower GPM than nozzles in the middle of the array.

Spray material and tank sediments can accelerate nozzle wear and even plug nozzles. All nozzles—ceramic, brass, aluminum, stainless steel, and plastic—will wear over time, thereby changing the application rate. GPM for each sprayer nozzle should be measured at least once per season, including new nozzles. Any that deviate 10% or more from manufacturer specifications should be replaced and recalibrated immediately (Landers, 2010).

3. **What's your pressure?** We frequently encountered broken or missing pressure gauges. These are prone to corrosion from exposure to agrichemicals and damage from improper storage. Maintaining the right pressure influences droplet size. Higher pressure creates a finer droplet; as pressure decreases, droplet size increases. Pressure also impacts the rate of nozzle wear; set pressure within the recommended range for the nozzle. Pressure can also influence GPM; a fourfold increase in pressure doubles nozzle output (Landers, 2010).

Row spacing

The area covered with a sprayer is measured in linear acres traveled, not the square acres of the planting. To accurately determine area covered, tree-row spacing must be considered. Many orchards and vineyards have transitioned to high-density plantings, and many have a variety of row widths on the farm. Applicators need to be aware that as they travel between plantings, application rate changes as row spacing changes unless they adjust travel speed and/or GPM.

Minimizing drift and improving spray deposition

Crop protection materials are applied to prevent crop loss from pests. If materials do not reach their target, what purpose has the application served? Assessing the quality of coverage with water or oil-sensitive cards, ultraviolet dyes, or kaolin clay allows an applicator to determine if the material is reaching the target and if the droplet size is adequate. Droplet sizing charts and instructions are included with water-sensitive paper designed for spray coverage assessments. Digital imaging software is also available for more precise measurement.

This AgTech sprayer is equipped with a Raven spray control system to maintain application rates in the uneven orchard topography of Wisconsin's Driftless region. Peter Werts/IPM Institute of North America, Inc.

Taking the technology to the next level

Complete spray control systems that maintain a constant application rate regardless of changes in speed,

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terrain, or boom sections in operation are available to retrofit existing equipment for as little as $1,650. Tower booms and airflow regulators are also available with new equipment and as retrofits. Michigan State University researchers report tower sprayers have lower operating costs over conventional airblast sprayers (Swinton et al., 1997). Cornell University research indicates airflow modifications can improve pesticide deposition by 30% (Landers, 2012). Finally, Smart Spray technology relies on ultrasonic sensors to regulate pesticide delivery based on tree size and canopy shape and can turn off nozzles where gaps in tree rows are present.

Training

Are you confident in your abilities to help your clients ensure accurate application rates with all of their equipment? If not, seek professional training. In our case, Peter Werts was trained by Landers in a small-group workshop, organized and hosted by Regina Hirsch of the Center for Integrated Agricultural Systems at the University of Wisconsin. This training was critical to open our eyes to the opportunities for improving and developing the skills necessary to effectively deliver this service to our clients. On average, our 11 sprayers were overapplying water and pesticide by 52%. Correcting these errors was a remarkable return on our investment in training and time on this project and a great service to our clients. We plan to expand the project this coming year. &

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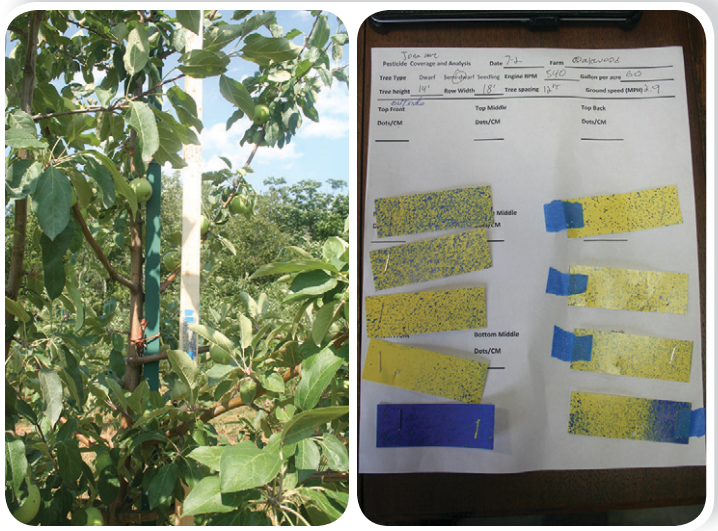
Calibration resources

Calibration worksheet: http://extension.psu.edu/fruit-production/files/air-blast-sprayer-worksheet/view

Pre-calibration instructions: http://extension.psu.edu/fruit-production/files/sprayer-calibration-instructions/view

Water-sensitive paper for monitoring spray distribution: www.qinstruments.com/uploads/media/wsp_use-it-in-agriculture.pdf



Left: Water and oil-sensitive paper was hung in this high-density planting by dividing the canopy into nine zones and using furring strips to locate the paper in through the canopy. **Right:** Overspray is observed where water-sensitive paper turned completely blue and can result in pesticide sheeting off the leaf surface. Peter Werts/IPM Institute of North America, Inc.

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