THE INS AND OUTS OF PULSE-WIDTH MODULATION SPRAYERS

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Pesticide applications are complex processes with many variables potentially impacting the biological outcome of the application. Additionally, greater regulatory demands have increased the need for more precise application methods.

Pulse-width modulation (PWM) sprayers provide an opportunity to increase precision through variable rate flow control by pulsing electronically actuated solenoid valves at each nozzle. The solenoid valves are pulsed a designated amount of times per second (standard = 10). The percentage of time each valve is open (duty cycle) determines the flow rate.

Benefits of PWM sprayers include: (i) individual nozzle control, (ii) overlap and turn compensation to reduce herbicide overapplication, (iii) quick flow rate response times, (iv) minimal influence on droplet size, and (v) providing more application flexibility in terms of sprayer speed and maintaining proper output.

Although there are numerous potential benefits of the technology, little research had been previously conducted to characterize sprays and droplet dynamics from these systems, especially with current nozzle technologies. Therefore, multiple research projects were conducted to investigate the influence of PWM on droplet size, droplet velocity, nozzle tip pressure, and spray pattern. The research projects identified that to fully reap the benefits of PWM sprayers, some best use practices must be implemented.

1. Air inclusion (AI) nozzles should not be used on pulsing systems. AI nozzles (i.e. AIXR, AITTJ60, TDXL, ULD, etc.) cause pattern deformities, droplet size variation, and nozzle tip pressure fluctuations when pulsed. Additionally, spray solution can be forced out of the AI ports, negating their drift reduction benefits. AI nozzles simply do not provide the same consistency and precision in spray pattern and droplet size as non-air inclusion-type nozzles (i.e. XR, DR, 3D, Guardian, etc.).

2. Operate PWM sprayers at or above a 40 percent duty cycle. Lower duty cycles cause spray pattern and droplet size irregularities. Proper nozzle selection (specifically, orifice size) paired with appropriate sprayer speeds is critical to achieving this best use practice and optimizing a PWM sprayer application.

3. Operate PWM sprayers at or above 40 PSI. Solenoid valves contain an internal restriction that causes a pressure loss even when operated at a 100 percent duty cycle. As nozzle orifice size increases, the reduction in pressure across the solenoid valve increases. Nozzles with 04 orifice sizes result in a pressure loss of 2–3 PSI, but when a nozzle with 08 orifice size is equipped and operated, the pressure drop across the solenoid

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valve is approximately 10 to 12 PSI. This pressure loss can affect nozzle performance by reducing pressure at the nozzle below manufacturer's recommended minimum pressures, especially if operated with system pressures less than 40 PSI.

Through these practices, applicators can increase the efficiency of PWM pesticide applications and reduce potential environmental contamination. For example, when spraying a field border, applicators with a PWM system could reduce sprayer speed to more effectively manage drift potential and still maintain the proper application rate without changing nozzles. Site-specific management strategies could also be implemented as droplet size is relatively unaffected by PWM sprayers (no pressure-based changes required to maintain flow rates). Therefore, applicators could choose a nozzle and pressure combination to achieve a specific droplet size that would reduce drift potential while simultaneously maximizing pest control in their unique environment.

For more information regarding PWM sprayers and their operation, please scan the QR codes below (Figures 1, 2, and 3).

Figure 1. Pulse-width modulation (PWM) sprayers: What, why, and how?

G2302 Univ. of Nebraska-Lincoln Extension NebGuide.

Figure 2. Droplet size and nozzle tip pressure from a pulse-width modulation sprayer.

Biosystems Engineering article.

Figure 3. How to better utilize pulse-width modulation sprayers.

Video – Univ. of Nebraska-Lincoln.