NebGuide

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Research-Based Information That You Can Use

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Pulse-Width Modulation (PWM) Sprayers

What, Why, and How?

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Pulse-width modulation sprayers can be effective in pest management by reducing environmental contamination, reducing crop injury, and maximizing pesticide efficacy.

Pulse-width modulation (PWM) sprayers allow for variable rate control of flow through electronically actuated solenoid valves (fig. 1). The solenoid valves are pulsed a designated amount of times per second (standard = 10). The relative proportion of time each valve is open (duty cycle) determines the flow rate (fig. 2).

For example, a nozzle with 08 orifice size will emit 0.8 gallons per minute (gpm) when spraying water at 40 PSI at a 100 percent duty cycle. The same nozzle with the same solution and pressure at a 50 percent duty cycle will emit half the full duty cycle rate, or 0.4 gpm. The benefits of a PWM sprayer include:

- Individual nozzle control
- Overlap and turn compensation
- Quick, real-time flow rate changes while minimally impacting droplet size.

These PWM systems provide the opportunity for more precise and efficient pesticide applications through *reduced inputs and lower environmental contamination potential* as sprayer speed becomes independent from flow rate.

Figure 1. Solenoid valve equipped on PWM sprayer.

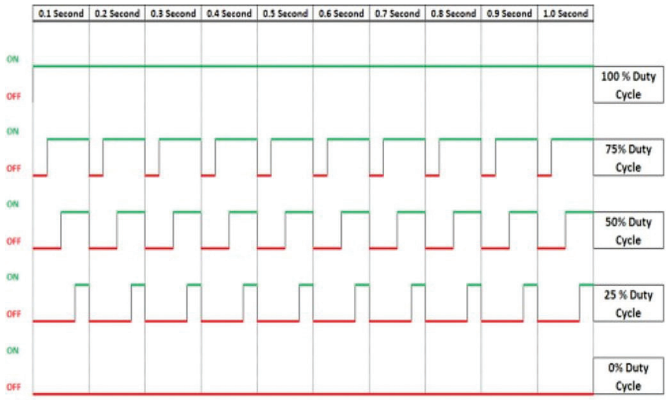

Figure 2. Illustration of a 10 Hz solenoid frequency operated at different duty cycles. Graphic courtesy of Brian Finstrom, Capstan Ag, Inc.

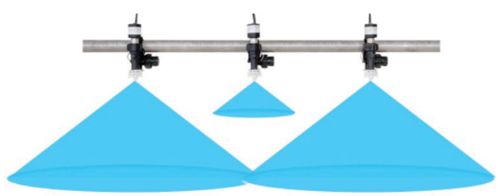

Figure 3. Illustration of blended pulse from a PWM sprayer. Graphic courtesy of Brian Finstrom, Capstan Ag, Inc.

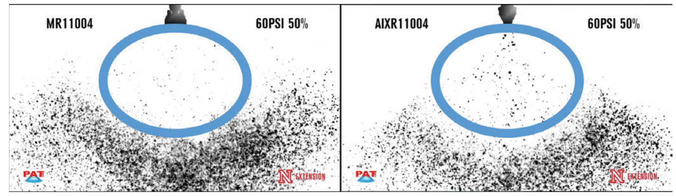

Figure 4. Non-air inclusion (MR11004—left) nozzle versus air inclusion (AIXR11004—right) nozzle when pulsed at a 50 percent duty cycle.

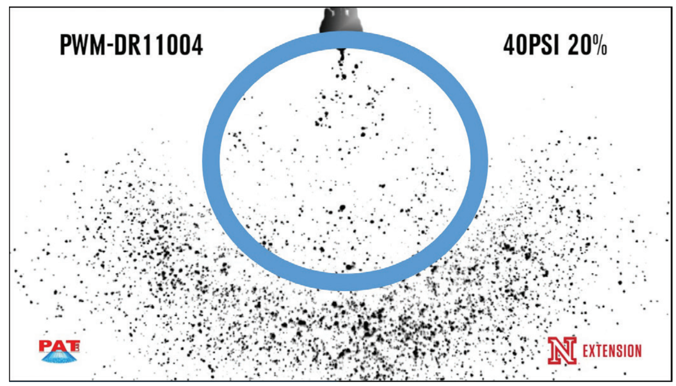

Figure 5. Non-air inclusion (DR11004) nozzle operated at a 20 percent duty cycle.

One concern frequently voiced regarding PWM sprayers is the potential for sprayer skips. Commercial PWM systems (e.g., Capstan PinPoint®, Case IH AIM Command®, John Deere ExactApply™, Raven Hawkeye®, TeeJet DynaJet®, etc.) use a blended pulse, in which every other nozzle operates on an alternate frequency to overcome this concern (fig. 3). This means that if operated at or above a 50 percent duty cycle, two adjacent nozzles will never be off at the same time.

To fully optimize the usage of PWM sprayers, several best use practices should be followed.

1. Air inclusion (AI) nozzles should not be used on pulsing systems. AI nozzles 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 (fig. 4).

2. Operate PWM sprayers at or above a 40 percent duty cycle. Lower duty cycles cause spray pattern and droplet size irregularities (fig. 5). 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 (fig. 6). As nozzle orifice size increases, the reduction in pressure across the solenoid valve increases. As can be seen in figure 6, the nozzles with 04 orifice sizes resulted in a pressure loss of 2–3 PSI, but when a nozzle with 08 orifice size was equipped and operated, the pressure drop across the solenoid valve was approximately 10–12 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.

PWM sprayers provide a unique approach to optimize spray applications as they allow sprayer speed to become independent from flow rate. Additionally, these sprayer systems can benefit applicators by reducing 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

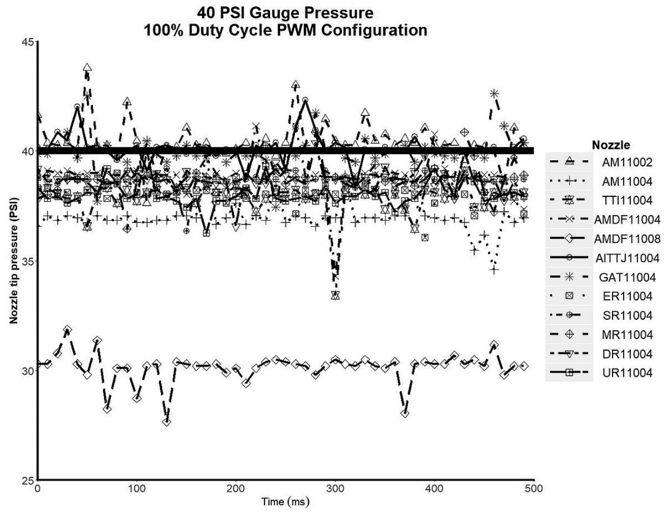

Figure 6. Pressure change across the solenoid valve observed for 12 nozzles operated at a 100 percent duty cycle. The black bar indicates the pressure (40 PSI) prior to the solenoid valve.

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 efficacy of the given pesticide in their unique geographic and weed species environment.

If the best use practices outlined in this publication are followed, PWM sprayers can be effectively used in pest management strategies to reduce environmental contamination, reduce crop injury, and maximize pesticide efficacy.

For more information regarding PWM sprayers or other application technologies, visit the Pesticide Application Technology Laboratory's website at http://pat.unl.edu.

Pesticide Application Technology Research and Extension

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