Assessing As-Applied Data Quality and Accuracy of Current Spray Technologies for Site-Specific Pesticide Applications

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Introduction

- Precise and efficient pesticide applications are important for effective pest management while also minimizing the adverse effects on environment.
- Recent advancements in spray technology such as pulse width modulation (PWM) technology (Butts et al. 2018) have enabled capabilities for site-specific pesticide applications on modern application equipment.
- As grower interest in site-specific pesticide applications increases, it is important to assess and understand the application performance of agricultural sprayers equipped with modern spray technologies to better understand their capabilities and limitations.

Hypothesis

Latest spray technologies such as Pulse Width Modulation (PWM) will demonstrate improved application rate and mapping accuracy compared to traditional rate control system.

Objectives

To evaluate application rate accuracy and mapping for single- and variable-rate site-specific applications performed with an agricultural sprayer equipped with latest spray technologies.

Material and Methods

Location: University of Georgia Research Farms, Tifton, GA

Equipment: John Deere 6110R equipped with a 4600 Gen4 Display and a 6-row LMC sprayer equipped with a TeeJet® Technologies:

- **IC45 Rate Controller:** – Regulates system flow rate by adjusting spray pressure to achieve and attain target application rate
- **DyanJet IC7140 PWM system:** – Regulates nozzle flow rate by altering the duty cycle of electronically actuated solenoid valves to maintain target application rate

Study Design and Treatments: The study consisted of implementing a single-rate (SS) and variable-rate (VR) site-specific prescription (Rx) maps with both rate controller (RC) and pulse width modulation (PWM) systems.

- The SS Rx map consisted of a single-rate of 15 gallons per acre (GPA) with spray zones of varying lengths of 16, 33, 49, 66, 82 and 98 ft (Figure 1A)
- The VR Rx map consisted of three different rates of 10.0, 12.5 and 15.0 GPA with spray zones of constant 98 ft length (Figure 2A)

Data Collection & Analysis:

- As-applied data for both RC and PWM systems were recorded on the 4600 Gen4 Display while implementing the SS and VR Rx maps in the field. All applications were made with both systems at a constant ground speed of 6 mph.
- The as-applied data was exported and spatially analyzed using AgLeader SMS Advanced software to determine the amount of under- and over-application (±5%, ±10% and >10% errors) associated with each system.
- All statistical comparisons were conducted in JMP Pro 16 using an alpha value of 0.05.

Results

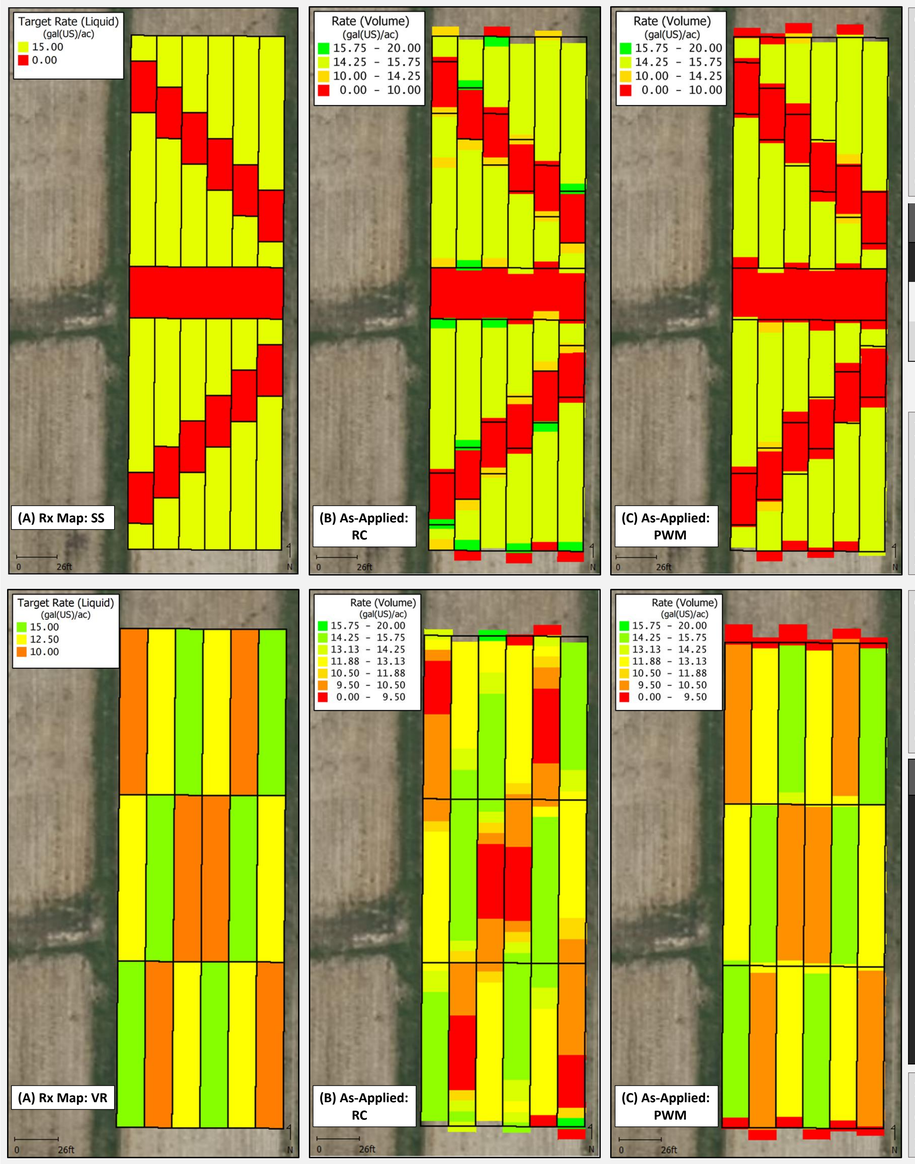

Table 1. Application rate accuracy for rate controller (RC) and pulse width modulation (PWM) systems for single-rate, site-specific application. Values represent percentage of area where actual rate was exactly as prescribed (On Target), within ±5%, ±10%, and >10% deviation from the target rate. Values with same letter within a column are not significantly different from each other ($p>0.05$).

Single-Rate, Site-Specific Application				
System	**On Target**	**± 5%**	**± 10%**	**> ± 10%**
RC	76% b	12% a	3%	9%
PWM	88% a	0% b	0%	12%

Figure 1. Prescription map (A), as-applied map for the rate controller (B) and, pulse width modulation (PWM) system (C) for single-rate (SS), site-specific application. Solid yellow boxes (N-S direction) in the prescription map (A) represent spray zones with varying lengths whereas red boxes represent non-spray (zero rate) areas.

Table 2. Application rate accuracy for rate controller (RC) and pulse width modulation (PWM) systems for variable-rate, site-specific application. Values indicate percent area where actual rate was correctly as prescribed, within ±5%, ±10%, and >10% deviation from the target rate. Values with same letter within a column for each rate are not significantly different ($p>0.05$).

Variable Rate, Site-Specific Application					
Rate (GPA)	System	On Target	± 5%	± 10%	> ± 10%
10.0	RC	19% b	20% a	26% a	35% a
	PWM	95% a	1% b	0% b	4% b
12.5	RC	65% b	7% a	3%	25% a
	PWM	96% a	1% b	0%	3% b
15.0	RC	39% b	38% a	8% a	15% a
	PWM	91% a	2% b	1% b	6% b

Figure 2. Prescription map (A) and as-applied map for the rate controller (B) and pulse width modulation (PWM) system (C) for variable-rate (VR), site-specific application.

Conclusions

- Both RC and PWM systems exhibited application errors that were greater than ±10% during single-rate and variable-rate site-specific applications.
- For single-rate, site-specific application, the PWM system showed 88% application accuracy compared to the RC system, which provided 76% application accuracy.
- For variable-rate, site-specific application, the RC system demonstrated poor performance with 19% to 65% application accuracy compared to the >90% application accuracy displayed by the PWM system.
- The study results suggest that the sprayers equipped with PWM technology provides superior application performance in terms of meeting target application rates during site-specific pesticide applications.

Future Research

Future research will aim to measure actual flow rate at the nozzle to generate as-applied maps and compare their quality and accuracy with in-cab display/controller maps.

References

Butts, T.R., Kruger, G.R. (2018) Pulse-Width Modulation (PWM) Sprayers: Why, Why, and How? Publication Number G2302, University of Nebraska-Lincoln Extension.

Acknowledgements

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