Spray Deposition and Quality Assessment at Varying Ground Speeds for a Boom Sprayer with and without a Rate Controller

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Introduction

- For conventional boom sprayers, maintaining a target rate during pesticide applications is challenging, yet inevitable due to frequent ground speed variations in the field.
- A rate controller is a spray technology integrated on boom sprayers, which helps in maintaining the target application rate by adjusting spray pressure based on the changes in ground speed.
- Previous research suggests that changes in sprayer ground speed affects spray deposition and drift (Nuyttens et al., 2007). However, information on influence of ground speed variations on spray quality (droplet size) is limited.
- Better understanding of how spray deposition and quality is impacted by rate controller during pesticide applications can help inform better management practices for achieving optimum application performance while keeping spray drift to a minimum.

Hypothesis

Integrating a rate controller on boom sprayer will help in maintaining optimal spray deposition and quality during pesticide applications while spray performance will degrade without a rate controller.

Objective

To compare and evaluate the effect of varying ground speed on spray deposition and quality during pesticide application for a boom sprayer equipped with and without a rate controller.

Material and Methods

Application Equipment:

- A commercial boom sprayer (60 ft boom length, 18 in. nozzle spacing) without a rate controller and equipped with a rate controller was used for pesticide applications in 2021 and 2022, respectively.

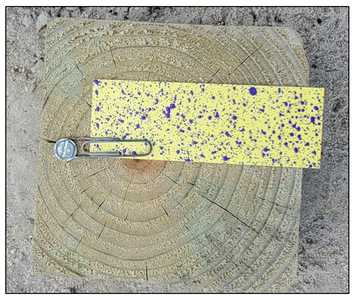
Treatments:

- **Five Ground Speeds**: 6, 8, 10, 12, 14 mph (whole plot factor; sprayer calibrated at 6 mph for 20 GPA)
- **Three Nozzle types**: XRC, AIXR and TTI nozzle to produce Medium (M), Very Coarse (VC) and Ultra-Coarse (UC) spray qualities (ASABE S572.3, 2020), respectively. (sub-plot factor)

Experimental Design: Split-Plot Design with each treatment replicated three times

Data Collection & Analysis:

- Water sensitive paper were placed in a grid pattern (18 x 50 ft.) under each nozzle during application and were scanned using DropScope 2.4.1 for spray deposition and quality data.
- Analysis of variance (ANOVA) and multiple pairwise comparisons using student t-test (α = 0.10) were conducted using JMP® Pro 16.0 (SAS, Cary, NC).



Conclusions

- For pesticide application without a rate controller, spray deposition reduced drastically with an increase in ground speed across all nozzle types, primarily due to the decrease in the total number of spray droplets per unit area.
- For pesticide application with a rate controller, spray deposition was similar for ground speeds up to 10 mph across all nozzle types and decreased thereafter. The increase in quantity of spray droplets per unit area is due to the more finer droplets being produced at higher spray pressures.
- Spray quality variations with increase in ground speed were observed across both sprayers – with and without a rate controller. However, changes in spray quality were larger during application with a rate controller due to increase in spray pressure with ground speed.

Results

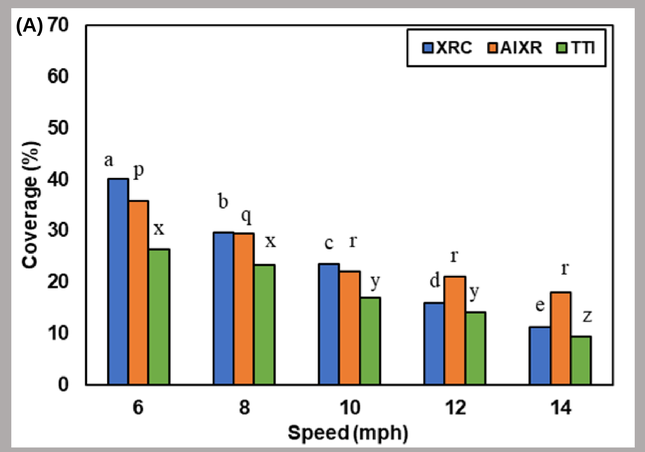
Table 1. Quantity of droplets produced by XRC, AIXR and TTI nozzles at varying ground speeds (6 to 14 mph) for the sprayer without and with a rate controller. Means with same letters are not significantly different from each other *(p>0.10)*.

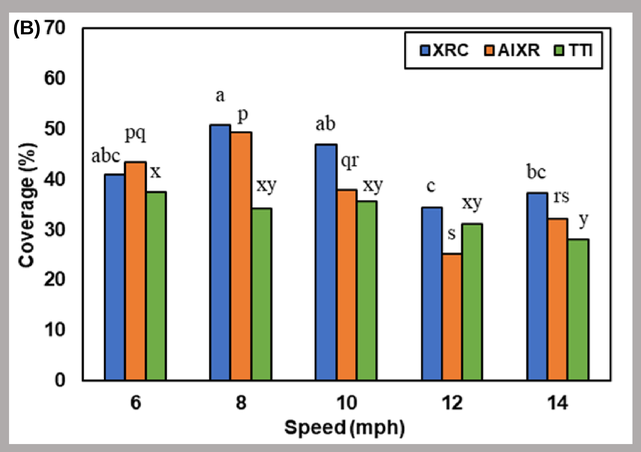
Spray performance without a rate controller

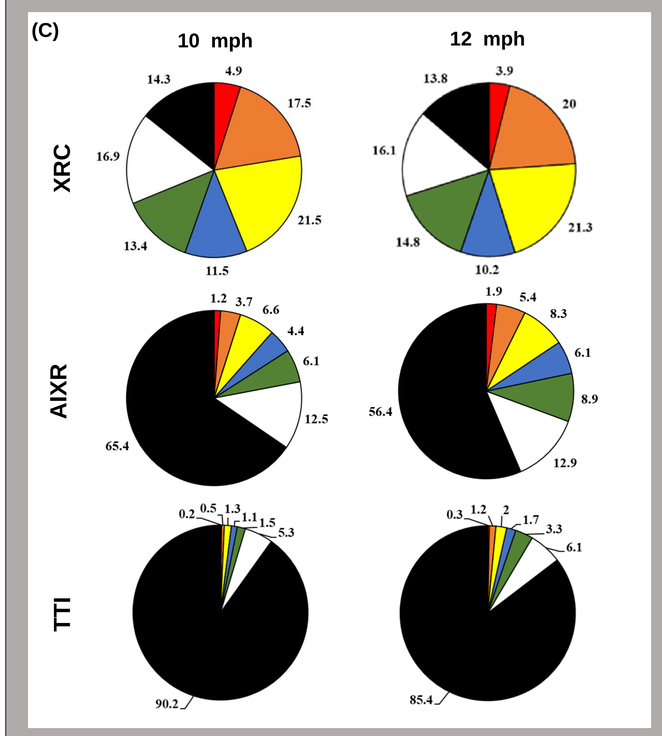
Speed (mph)	Quantity of Droplets		
	XRC	AIXR	TTI
6	5746 a	2733 pq	905 x
8	4933 ab	3089 p	601 z
10	4589 b	2074 q	404 yz
12	2819 c	2921 pq	604 y
14	2363 c	2955 pq	566 y

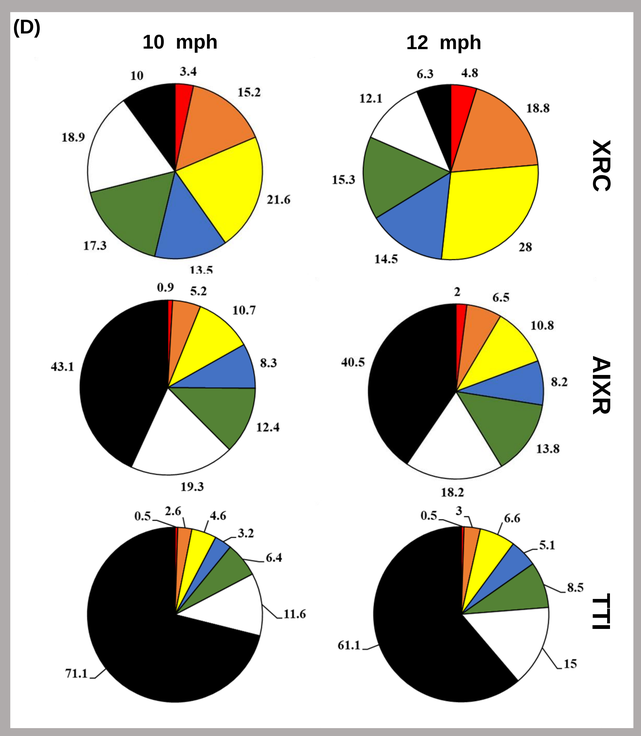
Spray performance with a rate controller

Speed (mph)	Quantity of Droplets		
	XRC	AIXR	TTI
6	6845 a	2441 q	1325 y
8	7893 a	5736 p	1677 xy
10	8626 a	3371 q	2263 xy
12	7355 a	3366 q	2092 xy
14	8218 a	5970 p	2334 x









Very Fine | Fine | Medium | Coarse | Very Coarse | Extremely Coarse | Ultra Coarse

Figure 2. Spray deposition (% coverage) at different ground speeds for a boom sprayer (A) without a rate controller and (B) with a rate controller across all three nozzle types used in this study. Illustration of spray quality from XR, AIXR and TTI nozzles at 10 and 12 mph for application (C) without a rate controller and (D) with a rate controller.

References

ASABE/ANSI. S572.3. (2020). Spray Nozzle Classification by Droplet Spectra. American Society of Agricultural and Biological Engineers. St. Joseph, MI.

Nuyttens, D., De Schampheleire, M., Baetens, K., & Sonck, B. (2007). The influence of operator-controlled variables on spray drift from field crop sprayers. *Trans. ASABE*, *50*(4), 1129-1140.

Future Research: Evaluation of spray deposition and quality for a sprayer equipped with advanced spray technologies like Pulse width Modulation (PWM).

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