



# Improving management of white mold in **kidney beans**: Optimizing **fungicide spray volume**

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## Optimizing fungicide spray volume

Research question tested in these studies:

**what is the impact of fungicide spray volume** on white mold management in kidney beans?

# Improving white mold management in dry beans:

## Fungicide spray volume – methods

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**Study location:** Carrington

**Row spacing** = 14 inches

**Seeding rate** = 90,000 viable seeds/ac

**Fungicide spray volume** = 15 gal/ac.

**Driving speed, nozzles, and application pressure within each study were kept constant across spray volumes by modifying pulse width.**

**Fungicide spray droplet size:** calibrated relative to canopy density and lodging from 2022-2024; medium droplets in both applications in 2020-2021.

**Number of experimental replicates** = 7 to 13, depending on the study year

**White mold assessment:** Assessed at or near dry bean maturity by evaluating every plant individually in minimum half of the rows per plot for percent of the plant impacted by white mold.

**Harvest:** To ensure that variability in dry bean standability (lodging) across the study did not bias yields, plants were clipped at base concurrent with disease assessments, wind-rowed to dry, and manually lifted into the combine.

**Supplemental irrigation:** Supplemental overhead irrigation was applied as needed to establish the white mold disease pressure needed to evaluate fungicide performance.

# Improving white mold management in dry beans:

## Fungicide spray volume – methods

**Table 1. Detailed methods – fungicide spray volume studies, kidney beans**

Location and year		Carrington 2020	Carrington 2021	Carrington 2022	Carrington 2023	Carrington 2024
App. #1	Driving speed	6.0 mph	6.0 mph	9.0 or 11.5 mph	6.0 mph	6.0 mph
	Fungicide	Endura 8 oz/ac	Topsin 40 fl oz	Topsin 40 fl oz	Topsin 40 fl oz	Topsin 40 fl oz
	Droplet size	Medium	Medium	Medium	Medium	Medium
	Nozzles, psi	XR11006, 35 psi	XR11006, 35 psi	XR11008, 50 psi	XR11006, 35 psi	XR11006, 35 psi
App. #2	Driving speed	6.0 mph	6.0 mph	8.0 mph	7.0 mph	6.0 mph
	Fungicide	Endura 8 oz/ac	Endura 8 oz/ac	Endura 8 oz/ac	Endura 8 oz/ac	Endura 8 oz/ac
	Droplet size	Medium	Medium	Coarse	Coarse	Coarse
	Nozzles, psi	XR11006, 35 psi	XR11006, 35 psi	XR11010, 30 psi	XR11008, 30 psi	XR11010, 30 psi
Applic. interval		11 days	12 days	11 days	10 days	7 days
Plot size (average)		5 x 10.9 ft	5 x 16.8 ft	5 x 17.8 ft	5 x 15.2 ft	5 x 16.5 ft
Exp. replicates		13	8	8	12	7

**Plot size =** Harvested plot size. The planted plot size and sprayed area were larger.

Non-harvested plots were established on either side and either end of sprayed plots to permit overspray of treatments and facilitate turning on and off the spray boom between treatment plots while maintaining full driving speed.

## Calibration

**Pulse width was modified as needed to maintain the same driving speed, nozzles and application pressures across spray volume treatments.**

**Pulse-width calibration was manually conducted in the field (with the fungicide in the tank) immediately before application.**

### **Objectives:**

- 1. Ensure the precise target spray volume.** Manual adjustments to pulse width were made as needed.
- 2. Confirm that all nozzles are operating correctly –** consistent output across all nozzles; no plugs.



## Calibration

A pulse width modulation system from Capstan AG that permits manual pulse width calibration was utilized.

- Immediately before applying treatments (after the fungicide was added to the tank), the sprayer was run for 10.0 seconds. Spray output was measured for each nozzle.
- Pulse width was manually adjusted until the correct output was achieved for the driving speed and spray volume



## Application methods

Applications were made with a PTO-driven tractor-mounted sprayer equipped with a pulse-width modulation system





Fungicide spray volume: kidney beans

Growth stage	2020		2020		2021		2022		2023		2023		2024	
at time of application	LR KIDNEY		DR KIDNEY		DR KIDNEY		DR KIDNEY		LR KIDNEY		DR KIDNEY		LR KIDNEY	
kidney bean variety	Pink Panther		Dynasty		Dynasty		Red Hawk		Pink Panther		Red Hawk		Pink Panther	
	applic. #1		applic. #1		applic. #1		applic. #1		applic. #1		applic. #1		applic. #1	
% plants in bloom:	63		24		85		no data		100		100		100	
% plants with pods:	28		2		40		no data		39		40		76	
max pod length (in.)	no data		no data		1.0		no data		1.2		1.1		1.0	
	app 1	app 2	app 1	app 2	app 1	app 2	app 1	app 2	app 1	app 2	app 1	app 2	app 1	app 2
canopy closure (%)	66.1	85.0	61.7	88.4	87.1	100.0	93.5	95.9	91.9	93.8	95.3	97.4	81.0	85.0
canopy height (in.)	12.5	17.2	13.6	19.1	18.5	23.5	no data	22.1	19.8	21.5	21.0	23.0	19.6	21.0
trifoliates/plant	no data		no data		no data		no data		14.1	33.4	13.5	29.8		
lodging (% from vertical)	no data		no data		no data		no data		26.2	32.2	31.1	25.2	26.4	51.9
Delta T	2020		2020		2021		2022		2023		2023		2024	
at time of application	LR KIDNEY		DR KIDNEY		DR KIDNEY		DR KIDNEY		LR KIDNEY		DR KIDNEY		LR KIDNEY	
kidney bean variety	Pink Panther		Dynasty		Dynasty		Red Hawk		Pink Panther		Red Hawk		Pink Panther	
application number	app 1	app 2	app 1	app 2	app 1	app 2	app 1	app 2	app 1	app 2	app 1	app 2	app 1	app 2
Non-treated														
10 gal/ac	7.6	3.7	7.6	3.7	5.7	4.3	9.2	1.8	6.5	3.9	6.5	3.9	3.9	4.6
15 gal/ac	6.8	3.4	6.8	3.4	5.1	3.1	9.3	1.7	6.5	3.8	6.5	3.8	3.9	4.6
20 gal/ac	7.3	3.8	7.3	3.8	5.3	4.0	9.2	1.4	6.4	3.6	6.4	3.6	4.0	4.6
25 gal/ac	7.3	4.0	7.3	4.0	6.0	4.8	9.2	1.2	6.3	3.6	6.3	3.6	4.1	4.6

2020, 2021, 2023, 2024: All treatments were applied under optimal Delta T (optimal evaporative potential)

2022: Treatments were applied under marginal Delta T

Application #1, 2022: High Delta T (high evaporative potential)    Application #2, 2022: Low Delta T (low evaporative potential)



## Fungicide spray volume: **kidney beans**

The response to spray volume was inconsistent across studies.

**A trend of improved white mold management and increased yield was sometimes observed with a spray volume of 25 gal/ac.**

A trend of reduced disease and increased yield as spray volume increased to 25 gal/ac was observed in 2 of 7 studies. The trend was not statistically significant in either study.

WHITE MOLD		2020	2020	2021	2022	2023	2023	2024	Combined analysis
% of canopy		LR KIDNEY	DR KIDNEY	DR KIDNEY	DR KIDNEY	LR KIDNEY	DR KIDNEY	LR KIDNEY	
kidney bean variety		Pink Panther	Dynasty	Dynasty	Dynasty	Pink Panther	Red Hawk	Pink Panther	
1	Non-treated	11 b	46 b	55 a	60 b	40 a	51 a	13 b	39 b
2	10 gal/ac	6 ab	31 a	56 a	38 a	32 a	41 a	4 a	30 a
3	15 gal/ac	4 a	38 ab	56 a	31 a	37 a	42 a	8 ab	31 a
4	20 gal/ac	4 a	36 ab	52 a	36 a	35 a	43 a	4 a	30 a
5	25 gal/ac	4 a	36 ab	49 a	33 a	28 a	39 a	4 a	28 a
CV:		84.2	33.3	11.9	31.4	41.6	33.4	85.8	12.6
KIDNEY BEAN YIELD (lbs/ac)		2020	2020	2021	2022	2023	2023	2024	Combined analysis
kidney bean variety		LR KIDNEY	DR KIDNEY	DR KIDNEY	DR KIDNEY	LR KIDNEY	DR KIDNEY	LR KIDNEY	
kidney bean variety		Pink Panther	Dynasty	Dynasty	Dynasty	Pink Panther	Red Hawk	Pink Panther	
1	Non-treated	2293 a	1749 a	2409 a	2307 b	2713 b	2244 a	3702 a	2488 b
2	10 gal/ac	2490 a	2018 a	2570 a	2841 a	2904 ab	2518 a	3942 a	2755 a
3	15 gal/ac	2374 a	1866 a	2568 a	3050 a	2919 ab	2569 a	3957 a	2758 a
4	20 gal/ac	2420 a	1887 a	2643 a	2848 a	2827 ab	2502 a	3930 a	2722 a
5	25 gal/ac	2541 a	1932 a	2859 a	2945 a	2967 a	2647 a	4036 a	2847 a
CV:		9.6	11.8	12.3	7.3	11.7	16.0	8.0	3.4
Within-column means followed by different letters are significantly different ( <i>P</i> < 0.05; Tukey multiple comparison procedure)									

# Fungicide spray volume: **kidney beans**





RESPONSE TO FUNGICIDE SPRAY VOLUME:

**Combined analysis across 7 studies** conducted over 5 years

Carrington, ND (2020-2024)

**Endura** 8 oz/ac applied twice (2 studies)

**Topsin** 40 fl oz f.b. **Endura** 8 oz (5 studies)

Fungicide spray volume	White mold % of canopy	Yield lbs/ac	Yield gain (lbs/ac) from fungicide
Non-treated	<b>39</b> b	<b>2488</b> b	
<b>10 gal/ac</b>	<b>30</b> a	<b>2755</b> a	 <b>267</b> ab
<b>15 gal/ac</b>	<b>31</b> a	<b>2758</b> a	 <b>269</b> ab
<b>20 gal/ac</b>	<b>30</b> a	<b>2722</b> a	 <b>234</b> b
<b>25 gal/ac</b>	<b>28</b> a	<b>2847</b> a	 <b>358</b> a
CV:	12.6	3.4	24.4

Within-column means followed by different letters are significantly different ( $P < 0.05$ ; Tukey multiple comparison procedure)

## Fungicide spray volume: **pinto beans**

**On average across seven studies, a weak response was observed to increasing fungicide spray volume to 25 gal/ac.** The response to spray volume was inconsistent across studies. No response was observed to increasing spray volume from 10 to 15 gal/ac or 10 to 20 gal/ac.

**Most of the testing was conducted under optimal spray conditions. A stronger response to spray volume might be observed under sub-optimal spray conditions.**

- Spray volume testing under sub-optimal spray conditions in one study (2022; application #1 applied when evaporative potential was high, application #2 applied when evaporative potential was low).
- High evaporative potential = low relative humidity, especially when combined with warm temperatures
- Low evaporative potential = increased risk of drift and, when leaves are wet with dew, risk of runoff and irregular fungicide deposition
- Response to spray volume is expected to be highest under conditions of high evaporative potential





## People

Staff, Carrington: Aaron Fauss, Suanne Kallis, Jesse Hafner, Gabriela Henson

Collaborators – Oakes: Heidi Eslinger, Spencer Eslinger, Leonard Besemann, Kelly Cooper





## Funding support

### Research funding:

- Northarvest Bean Growers Association
- ND Crop Protection Product Harmonization & Registration Board
- USDA Specialty Crop Block Grant Program admin. by ND Dept. of Ag.
- Contract testing (BASF, Bayer, Corteva, FMC, Gowan, Syngenta, Valent, others)

### Seed was donated by:

- Bollingberg Seeds Company (Kurt Bollingburg; Cathay, ND)
- Green Valley Bean Company (John Berthold; Park Rapids, MN)
- Kelley Bean Company; Hatton, ND (Dean Nelson)