



Improving management of white mold in dry edible beans:  
1. Row spacing

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**Michael Wunsch**

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# Impact of row spacing on dry bean agronomic performance under white mold pressure

Carrington and Oakes, ND

2019, 2020

## Pinto beans

Varieties:

'Palomino' (24 studies)

'Vibrant' (3 studies)

Row spacing <i>inches</i>	Seeding rate pure live (viable) seeds <i>pls/ac</i>	Plant population end-of-season (at maturity) <i>plants/ac</i>	Low disease pressure <20% of canopy (30-inch rows) 12 studies	Intermediate disease pressure 20-40% of canopy (30-inch rows) 8 studies	High disease pressure >40% of canopy (30-inch rows) 7 studies
<b>WHITE MOLD SEVERITY (% of canopy)</b>					
<b>30</b>	70,000	50,894	<b>9</b> a	<b>29</b> a	<b>53</b> a
<b>22.5</b>	70,000	52,427	<b>11</b> ab	<b>36</b> ab	<b>60</b> a
<b>15</b>	70,000	52,818	<b>11</b> ab	<b>38</b> b	<b>59</b> a
<b>7.5</b>	70,000	53,144	<b>13</b> b	<b>35</b> ab	<b>55</b> a
			CV: 27.7	CV: 17.7	CV: 10.2
<b>YIELD (pounds/acre)</b>					
<b>30</b>	70,000	50,894	<b>3015</b> b	<b>2596</b> a	<b>1919</b> a
<b>22.5</b>	70,000	52,427	<b>3022</b> b	<b>2424</b> a	<b>1836</b> a
<b>15</b>	70,000	52,818	<b>3398</b> a	<b>2522</b> a	<b>1876</b> a
<b>7.5</b>	70,000	53,144	<b>3305</b> a	<b>2482</b> a	<b>1738</b> a
			CV: 7.4	CV: 8.1	CV: 8.0

Data are from studies conducted in Carrington and Oakes, ND in 2019 and 2020 with no foliar fungicide, one or two fungicide applications (Topsin at 40 fl oz/ac or Topsin followed by Endura at 8 oz/ac 10-14 days later), fallow ground, direct-seeded into winter rye terminated 10-14 days prior to planting, or direct-seeded into rye terminated 0-3 days after planting.

Plots were 10 feet wide and 25 feet long at seeding. The middle 5 feet by 20 feet were assessed for disease and yield.

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

# Impact of row spacing on dry bean agronomic performance under white mold pressure

Carrington and Oakes, ND

2019, 2020

## Kidney beans

Varieties:

'Pink Panther'

(6 studies)

'Dynasty' (6 studies)

'Rosie' (6 studies)

Row spacing <i>inches</i>	Seeding rate pure live (viable) seeds <i>pls/ac</i>	Plant population end-of-season (at maturity) <i>plants/ac</i>	Low disease pressure <20% of canopy (30-inch rows) 6 studies	Intermediate disease pressure 20-40% of canopy (30-inch rows) 5 studies	High disease pressure >40% of canopy (30-inch rows) 7 studies
<b>WHITE MOLD SEVERITY (% of canopy)</b>					
<b>30</b>	70,000	52,559	<b>5</b> ab	<b>34</b> a	<b>46</b> a
<b>22.5</b>	70,000	50,606	<b>4</b> ab	<b>32</b> a	<b>47</b> a
<b>15</b>	70,000	53,488	<b>5</b> b	<b>33</b> a	<b>49</b> a
<b>7.5</b>	70,000	55,979	<b>2</b> a	<b>35</b> a	<b>46</b> a
			CV: 19.2	CV: 14.9	CV: 11.0
<b>YIELD (pounds/acre)</b>					
<b>30</b>	70,000	52,559	<b>3015</b> ab	<b>1799</b> b	<b>1446</b> a
<b>22.5</b>	70,000	50,606	<b>3022</b> b	<b>1878</b> b	<b>1514</b> a
<b>15</b>	70,000	53,488	<b>3398</b> a	<b>2309</b> a	<b>1632</b> a
<b>7.5</b>	70,000	55,979	<b>3305</b> ab	<b>2054</b> ab	<b>1466</b> a
			CV: 6.4	CV: 10.6	CV: 13.1

Data are from studies conducted in Carrington and Oakes, ND in 2019 and 2020 with no foliar fungicide, one or two fungicide applications (Topsin at 40 fl oz/ac or Topsin followed by Endura at 8 oz/ac 10-14 days later), fallow ground, direct-seeded into winter rye terminated 10-14 days prior to planting, or direct-seeded into rye terminated 0-3 days after planting.

Plots were 10 feet wide and 25 feet long at seeding. The middle 5 feet by 20 feet were assessed for disease and yield.

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

## Optimizing row spacing

### Impact of row spacing on white mold:

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#### PINTO BEANS:

- White mold severity was minimized in wide (30-inch) rows at all levels of disease pressure.
- When less than 20% of the canopy was diseased at the end of the season, pinto bean yield was maximized when pinto beans were grown in narrow (7.5-inch or 15-inch) rows.
- When more than 20% of the canopy was diseased at the end of the season, there was no statistical difference in yields across row spacings but a trend of higher yield in wide (30-inch) rows.



## Optimizing row spacing

### Impact of row spacing on white mold:

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#### KIDNEY BEANS:

- When less than 20% of the canopy was diseased at the end of the season, white mold severity was minimized in narrow (7.5-inch) rows that maximized the spacing between adjacent plants.
- When more than 20% of the canopy was diseased at the end of the season, row spacing had little or no impact on white mold severity in kidney beans.
- At all levels of white mold pressure, yields were maximized when kidney beans were seeded to 15-inch rows.





Improving management of white mold in dry edible beans:  
2. Seeding rate

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**Michael Wunsch**

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# Impact of seeding rate on dry bean agronomic performance under white mold pressure

Carrington and Oakes, ND

2019

## Pinto beans

Varieties: 'Palomino' (6 studies), 'Vibrant' (3 studies)

Row spacing inches	Seeding rate pure live (viable) seeds pls/ac	Plant population end-of-season (at maturity) plants/ac	WHITE MOLD (% of canopy)			YIELD (pounds/acre)		
			Low disease pressure <20% of canopy (30-inch rows) 4 studies	Intermediate disease pressure 20-40% of canopy (30-inch rows) 4 studies	High disease pressure 40-60% of canopy (30-inch rows) 1 study	Low disease pressure <20% of canopy (30-inch rows) 4 studies	Intermediate disease pressure 20-40% of canopy (30-inch rows) 4 studies	High disease pressure 40-60% of canopy (30-inch rows) 1 study
30	120,000	96,439	11 a	36 ab	57 ab	3182 de	2846 ab	2403 a
30	70,000	48,536	8 a	22 a	58 ab	3083 e	2937 a	2267 a
22.5	120,000	85,054	12 a	44 b	60 ab	3614 bcd	2439 b	2318 a
22.5	70,000	42,646	8 a	28 ab	51 ab	3326 cde	2653 ab	2345 a
15	120,000	90,750	10 a	42 b	75 b	3867 ab	2849 ab	2041 a
15	70,000	48,972	8 a	35 ab	56 ab	3737 abc	2772 ab	2430 a
7.5	120,000	115,454	10 a	36 ab	72 b	4148 a	2826 ab	1888 a
7.5	70,000	49,513	9 a	37 ab	46 a	3937 ab	2643 ab	2173 a
			CV: 26.7	CV: 20.4	CV: 15.0	CV: 6.1	CV: 6.4	CV: 13.6

Impact of increasing **seeding rate** from 70,000 to 120,000 viable seeds/ac on white mold severity and yield in pinto beans. Data are from studies conducted in Carrington and Oakes, ND in 2019 with no foliar fungicide, one or two fungicide applications, fallow ground, direct-seeded into winter rye terminated 10-14 days prior to planting, or direct-seeded into rye terminated 0-3 days after planting. *Within-column means followed by different letters are sign. different (P < 0.05; Tukey procedure).*

# Impact of seeding rate on dry bean agronomic performance under white mold pressure

Carrington, ND

2020

## Pinto beans

Varieties: 'Palomino' (3 studies)

Row spacing	Seeding rate	Plant population	Low disease pressure: <20% of canopy (30-inch rows) 3 studies	
<i>inches</i>	<i>pls/ac</i>	<i>plants/ac</i>	<b>WHITE MOLD</b> (% of canopy)	<b>YIELD</b> (pounds/acre)

Impact of increasing seeding rate from 70,000 to 90,000 viable seeds/ac on white mold severity and yield in pinto beans. Data are from studies conducted in Carrington, ND in 2020 with no foliar fungicide, one or two fungicide applications.

Within-column means followed by different letters are sign. different ( $P < 0.05$ ; Tukey procedure).

<b>30</b>	<b>90,000</b>	<b>76,935</b>	<b>8</b> a	<b>3205</b> b
<b>30</b>	<b>70,000</b>	<b>60,959</b>	<b>8</b> a	<b>3193</b> b
<b>22.5</b>	<b>90,000</b>	<b>84,820</b>	<b>10</b> a	<b>3166</b> b
<b>22.5</b>	<b>70,000</b>	<b>70,218</b>	<b>8</b> a	<b>3142</b> b
<b>15</b>	<b>90,000</b>	<b>85,476</b>	<b>11</b> a	<b>3356</b> ab
<b>15</b>	<b>70,000</b>	<b>65,817</b>	<b>7</b> a	<b>3494</b> a
<b>7.5</b>	<b>90,000</b>	<b>89,685</b>	<b>10</b> a	<b>3301</b> ab
<b>7.5</b>	<b>70,000</b>	<b>68,483</b>	<b>8</b> a	<b>3265</b> ab

CV: 25.4

CV: 4.1



# Impact of seeding rate on dry bean agronomic performance under white mold pressure

Carrington, ND

2020

## Kidney beans

Varieties: 'Pink Panther' (3 studies), 'Dynasty' (3 studies), 'Rosie' (6 studies)

Row spacing <i>inches</i>	Seeding rate pure live (viable) seeds <i>pls/ac</i>	Plant population end-of-season (at maturity) <i>plants/ac</i>	Low disease pressure <20% of canopy (30-inch rows) <b>6 studies</b>		Intermediate to high disease pressure >20% of canopy (30-inch rows) <b>6 studies</b>		Low disease pressure <20% of canopy (30-inch rows) <b>6 studies</b>		Intermediate to high disease pressure >20% of canopy (30-inch rows) <b>6 studies</b>	
			<b>WHITE MOLD</b> (% of canopy)				<b>YIELD</b> (pounds/acre)			
<b>30</b>	90,000	60,875	<b>4</b> ab	<b>37</b> a	<b>2150</b> bc	<b>1916</b> b				
<b>30</b>	70,000	53,477	<b>5</b> ab	<b>36</b> a	<b>2152</b> bc	<b>1920</b> b				
<b>22.5</b>	90,000	59,822	<b>6</b> b	<b>37</b> a	<b>2225</b> abc	<b>2112</b> ab				
<b>22.5</b>	70,000	51,680	<b>4</b> ab	<b>36</b> a	<b>2130</b> c	<b>2060</b> ab				
<b>15</b>	90,000	65,216	<b>5</b> ab	<b>35</b> a	<b>2501</b> a	<b>2480</b> a				
<b>15</b>	70,000	53,974	<b>5</b> ab	<b>35</b> a	<b>2358</b> abc	<b>2495</b> a				
<b>7.5</b>	90,000	68,385	<b>4</b> ab	<b>37</b> a	<b>2443</b> ab	<b>2189</b> ab				
<b>7.5</b>	70,000	57,744	<b>2</b> a	<b>36</b> a	<b>2318</b> abc	<b>2182</b> ab				
			CV: 18.3	CV: 12.9	CV: 7.0	CV: 11.2				

Impact of increasing seeding rate from 70,000 to 90,000 viable seeds/ac on white mold severity and yield in pinto beans. Data are from studies conducted in Carrington, ND in 2020 (pinto beans) and Carrington and Oakes in 2019 and 2020 (kidney beans) with no foliar fungicide, one or two fungicide applications. Within-column means followed by different letters are sign. different ( $P < 0.05$ ; Tukey procedure).

## Optimizing seeding rate

### Impact of seeding rate on white mold:

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#### PINTO AND KIDNEY BEANS:

- Increasing seeding rate from 70,000 to 90,000 viable seeds/ac (pinto and kidney beans) was generally associated with higher white mold severity.
- Increasing seeding rate from 70,000 to 120,000 viable seeds/ac (pinto beans) conferred moderate to sharp increases in white mold severity.
- Increasing seeding rate above 70,000 viable seeds/ac was associated with little or no yield gains in pinto and kidney beans grown under white mold pressure.





Improving management of white mold in dry edible beans:  
3. Fungicide application timing

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**Michael Wunsch**

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# Optimizing fungicide application timing for white mold management in dry beans

## 1. PINTO BEANS

Carrington and Oakes, ND (2017, 2020, 2021)

In pinto beans, **fungicide applications were optimized when 10-20% of plants had initial pods when the canopy was at or near closure at this growth stage**  
(average  $\geq 95\%$  of the ground covered)

### AVERAGE RESULTS $\geq 95\%$ canopy closure when 10-20% of plants had pods

2 studies conducted across 1 year, 1 location

Fungicide application timing - 1 <sup>ST</sup> application	Canopy closure	SINGLE FUNGICIDE APPLICATION:		TWO APPLICATIONS 10 to 14 days apart:	
		White mold % of canopy	Yield lbs/ac	White mold % of canopy	Yield lbs/ac
Non-treated control		84	1291	84	1291
34-80% of plants in bloom < 5% of plants with pods	70-95%	87	1212	77	1703
55-100% of plants in bloom 10-20% of plants with pods	95-99%	78	1823	72	2161
84-100% of plants in bloom 50-64% of plants with pods	98-100%	79	1729	72	1986
88-100% of plants in bloom 65-100% of plants with pods	100%	78	1681	77	1777
		CV: 1.2	CV: 6.0	CV: 1.3	CV: 1.9

Fungicide applied: SINGLE FUNGICIDE APPLICATION – Topsin @ 30 fl oz/ac (studies from 2017, 2020); Topsin @ 40 fl oz/ac (studies conducted in 2021)  
TWO FUNGICIDE APPLICATIONS – Topsin @ 30 fl oz/ac followed by Endura @ 8 oz/ac (2017, 2020), Topsin @ 40 fl oz/ac followed by Endura @ 8 oz/ac (2021)

Spray volume: 15 gal/ac

Nozzles & droplet size: When average canopy closure was < 80%, TeeJet DG110015 nozzles at 40 psi (fine droplets). When average canopy closure was 80-90%, TeeJet DG110015 nozzles at 30 psi (medium droplets). When average canopy closure was 90-95%, TeeJet AIXR11015 nozzles at 60 psi (medium-coarse droplets). When average canopy closure was 95-100%, TeeJet AIXR nozzles at 50 psi (coarse droplets)

# Optimizing fungicide application timing for white mold management in dry beans

## 1. PINTO BEANS

Carrington and Oakes, ND (2017, 2020, 2021)

In pinto beans, fungicide applications were optimized when 50-100% of plants had initial pods when the canopy was open at these growth stages (average < 95% of the ground covered)

### AVERAGE RESULTS < 95% canopy closure when 10-20% of plants had pods

4 studies conducted across 2 years, 2 locations

Fungicide application timing - 1 <sup>ST</sup> application	Canopy closure	SINGLE FUNGICIDE APPLICATION:		TWO APPLICATIONS 12 days apart:	
		White mold % of canopy	Yield lbs/ac	White mold % of canopy	Yield lbs/ac
Non-treated control		44	2470	44	2470
34-80% of plants in bloom < 5% of plants with pods	40-89%	38	2622	25	2887
55-100% of plants in bloom 10-20% of plants with pods	45-91%	36	2624	27	2890
84-100% of plants in bloom 50-64% of plants with pods	53-93%	29	2770	21	3003
88-100% of plants in bloom 65-100% of plants with pods	67-93%	27	2870	20	3077
		CV: 18.3	CV: 4.7	CV: 27.5	CV: 5.6

Fungicide applied: SINGLE FUNGICIDE APPLICATION – Topsin @ 30 fl oz/ac (studies from 2017, 2020); Topsin @ 40 fl oz/ac (studies conducted in 2021)  
TWO FUNGICIDE APPLICATIONS – Topsin @ 30 fl oz/ac followed by Endura @ 8 oz/ac (2017, 2020), Topsin @ 40 fl oz/ac followed by Endura @ 8 oz/ac (2021)

Spray volume: 15 gal/ac

Nozzles & droplet size: When average canopy closure was < 80%, TeeJet DG110015 nozzles at 40 psi (fine droplets). When average canopy closure was 80-90%, TeeJet DG110015 nozzles at 30 psi (medium droplets). When average canopy closure was 90-95%, TeeJet AIXR11015 nozzles at 60 psi (medium-coarse droplets). When average canopy closure was 95-100%, TeeJet AIXR nozzles at 50 psi (coarse droplets)

# Optimizing fungicide application timing for white mold management in dry beans

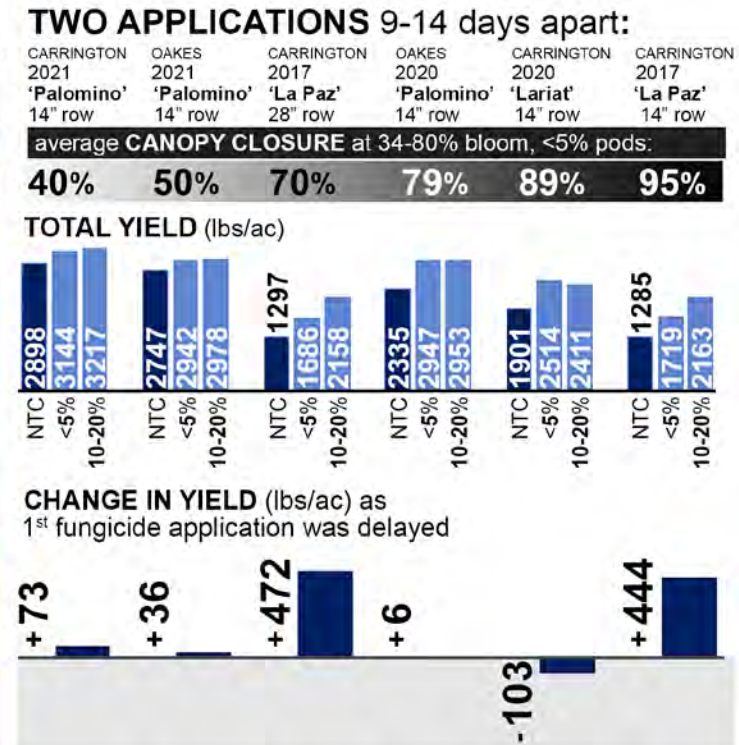
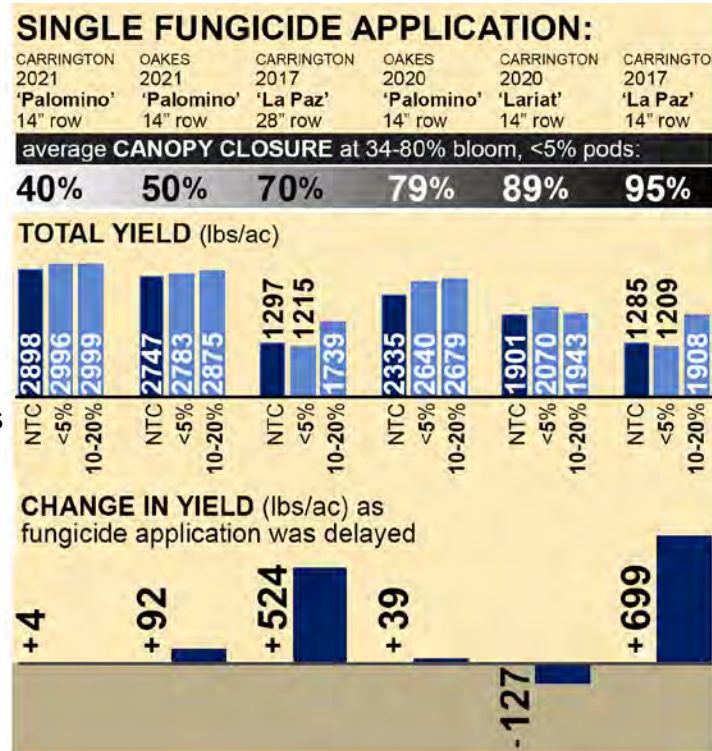
## 1. PINTO BEANS

Carrington and Oakes, ND (2017, 2020, 2021)

**Delaying the first fungicide application from bloom initiation (<5% of plants with pods) to initial pod development (10-20% of plants with pods) was associated with increased yield in 5 of 6 studies when fungicides were applied once and 5 of 6 studies when fungicides were applied twice.**

### IMPACT OF DELAYING FIRST FUNGICIDE APPLICATION

**from**  
34-80% of plants in bloom,  
<5% of plants with pods  
  
**to**  
55-100% of plants in bloom,  
10-20% of plants with pods



**Fungicide applied:** SINGLE FUNGICIDE APPLICATION – Topsin @ 30 fl oz/ac (studies from 2017, 2020); Topsin @ 40 fl oz/ac (studies conducted in 2021)  
TWO FUNGICIDE APPLICATIONS – Topsin @ 30 fl oz/ac followed by Endura @ 8 oz/ac (2017, 2020), Topsin @ 40 fl oz/ac followed by Endura @ 8 oz/ac (2021)

**Spray volume:** 15 gal/ac **Nozzles & droplet size:** When average canopy closure was < 80%, TeeJet DG110015 nozzles at 40 psi (fine droplets). When average canopy closure was 80-90%, TeeJet DG110015 nozzles at 30 psi (medium droplets). When average canopy closure was 90-95%, TeeJet AIXR11015 nozzles at 60 psi (medium-coarse droplets). When average canopy closure was 95-100%, TeeJet AIXR nozzles at 50 psi (coarse droplets)

# Optimizing fungicide application timing for white mold management in dry beans

## 1. PINTO BEANS

Carrington and Oakes, ND (2017, 2020, 2021)

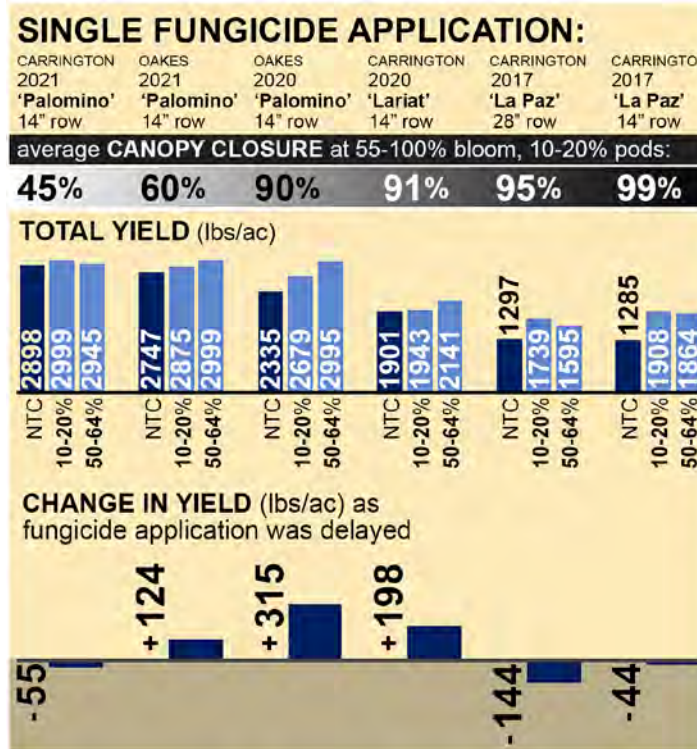
### Delaying the first fungicide application

from **10-20% of plants with pods** to **50-64% of plants with pods**

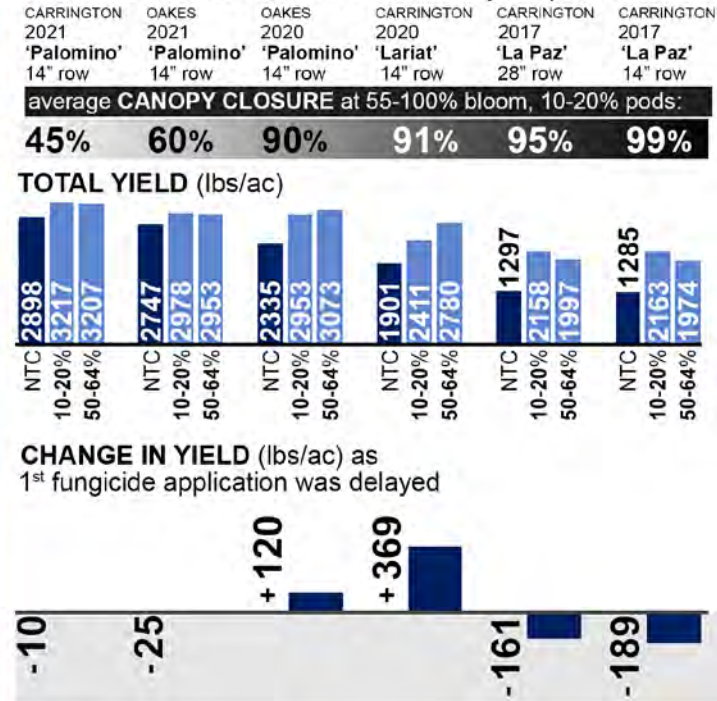
was generally associated with increased yield when the canopy was open at 10-20% pod and consistently associated with reduced yield when the canopy was at/near closure at 10-20% pod.

### IMPACT OF DELAYING FIRST FUNGICIDE APPLICATION

from  
55-100% of plants in bloom,  
10-20% of plants with pods  
to  
84-100% of plants in bloom,  
50-64% of plants with pods



### TWO APPLICATIONS 9-14 days apart:



**Fungicide applied:** SINGLE FUNGICIDE APPLICATION – Topsin @ 30 fl oz/ac (studies from 2017, 2020); Topsin @ 40 fl oz/ac (studies conducted in 2021)

TWO FUNGICIDE APPLICATIONS – Topsin @ 30 fl oz/ac followed by Endura @ 8 oz/ac (2017, 2020), Topsin @ 40 fl oz/ac followed by Endura @ 8 oz/ac (2021)

**Spray volume:** 15 gal/ac **Nozzles & droplet size:** When average canopy closure was < 80%, TeeJet DG110015 nozzles at 40 psi (fine droplets). When average canopy closure was 80-90%, TeeJet DG110015 nozzles at 30 psi (medium droplets). When average canopy closure was 90-95%, TeeJet AIXR11015 nozzles at 60 psi (medium-coarse droplets). When average canopy closure was 95-100%, TeeJet AIXR nozzles at 50 psi (coarse droplets)

# Optimizing fungicide application timing for white mold management in dry beans

## 1. PINTO BEANS

Carrington and Oakes, ND (2017, 2020, 2021)

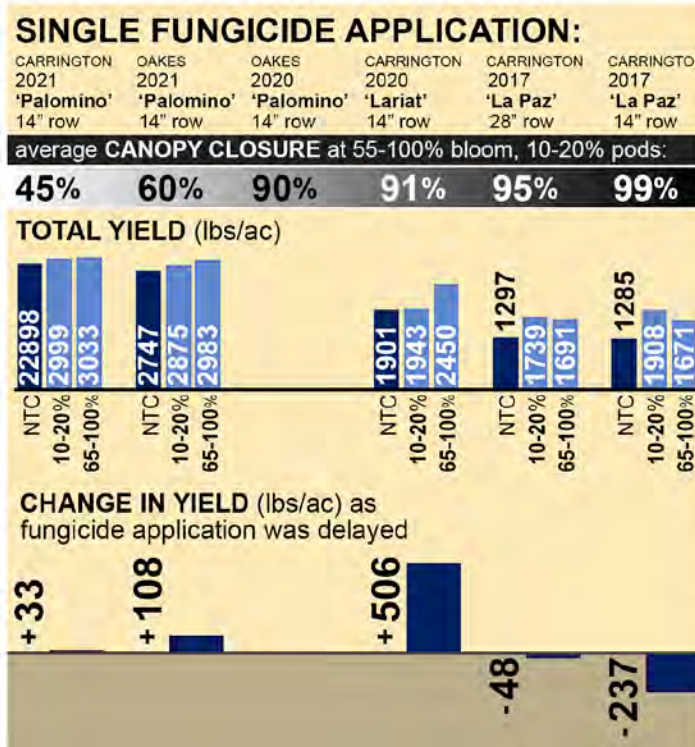
### Delaying the first fungicide application

from **10-20% of plants with pods to 65-100% of plants with pods**

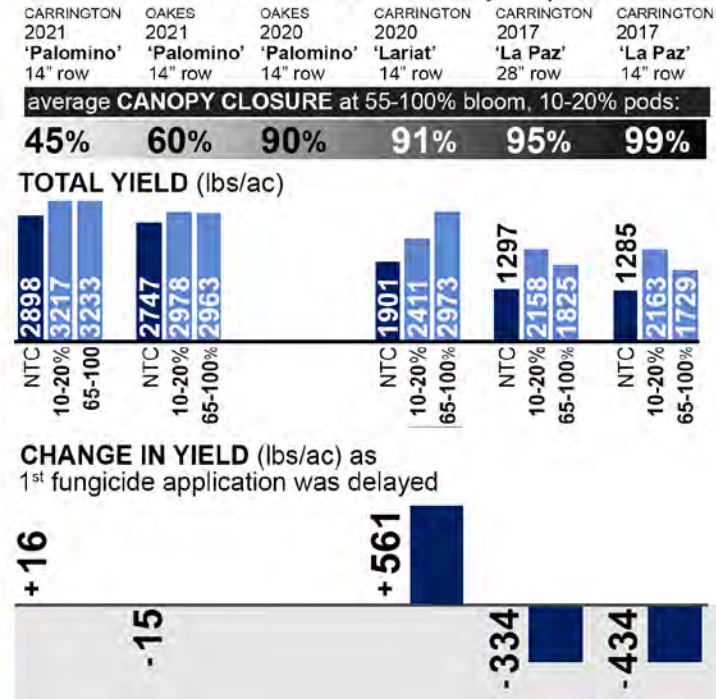
was generally associated with increased yield when the canopy was open at 10-20% pod and consistently associated with reduced yield when the canopy was at/near closure at 10-20% pod.

#### IMPACT OF DELAYING FIRST FUNGICIDE APPLICATION

from  
55-100% of plants in bloom,  
10-20% of plants with pods  
  
to  
88-100% of plants in bloom,  
65-100% of plants with pods



#### TWO APPLICATIONS 9-14 days apart:



**Fungicide applied:** SINGLE FUNGICIDE APPLICATION – Topsin @ 30 fl oz/ac (studies from 2017, 2020); Topsin @ 40 fl oz/ac (studies conducted in 2021)

TWO FUNGICIDE APPLICATIONS – Topsin @ 30 fl oz/ac followed by Endura @ 8 oz/ac (2017, 2020), Topsin @ 40 fl oz/ac followed by Endura @ 8 oz/ac (2021)

**Spray volume:** 15 gal/ac    **Nozzles & droplet size:** When average canopy closure was < 80%, TeeJet DG110015 nozzles at 40 psi (fine droplets). When average canopy closure was 80-90%, TeeJet DG110015 nozzles at 30 psi (medium droplets). When average canopy closure was 90-95%, TeeJet AIXR11015 nozzles at 60 psi (medium-coarse droplets). When average canopy closure was 95-100%, TeeJet AIXR nozzles at 50 psi (coarse droplets)



## Optimizing fungicide application timing

### Impact of fungicide application timing on white mold:

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#### PINTO BEANS:

- Applying fungicides when 10-20% of plants had at least one initial pin-shaped pod was optimal in pinto beans when the canopy was at or near closure ( $\geq 95\%$  average closure).
- Applying fungicides when 50-100% of plants had at least one initial pin-shaped pod was optimal in pinto beans when the canopy was open ( $< 95\%$  average closure) initial pod development.

The number of field studies conducted was small, and follow-up research is needed to confirm these findings. Continued fungicide timing research is planned for 2022.



# Optimizing fungicide application timing for white mold management in dry beans

## 2. BLACK BEANS

Carrington and Oakes, ND (2017, 2020)

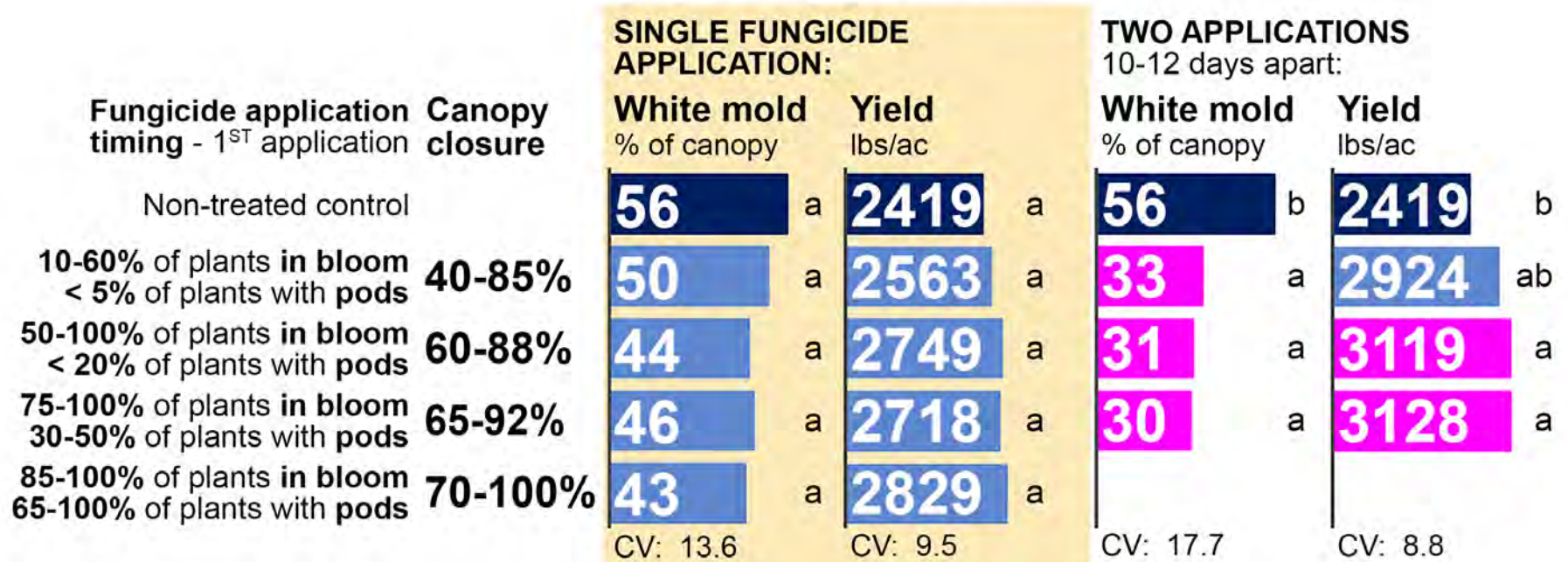
In black beans, **average yields were maximized by delaying fungicide applications until 30-50% or 65-100% of plants had initial pods**

**BUT** delaying applications beyond 20% plants with pods conferred highly variable results across individual studies - see next slides.

### AVERAGE RESULTS

across all studies

4 studies conducted across 3 years, 2 locations



Fungicide applied: SINGLE FUNGICIDE APPLICATION – Topsin @ 30 fl oz/ac; TWO FUNGICIDE APPLICATIONS – Topsin @ 30 fl oz/ac followed by Endura @ 8 oz/ac

Spray volume: 15 gal/ac Nozzles & droplet size: When average canopy closure was < 80%, TeeJet DG110015 nozzles at 40 psi (fine droplets). When average canopy closure was 80-90%, TeeJet DG110015 nozzles at 30 psi (medium droplets). When average canopy closure was 90-95%, TeeJet AIXR11015 nozzles at 60 psi (medium-coarse droplets). When average canopy closure was 95-100%, TeeJet AIXR nozzles at 50 psi (coarse droplets)

# Optimizing fungicide application timing for white mold management in dry beans

## 2. BLACK BEANS

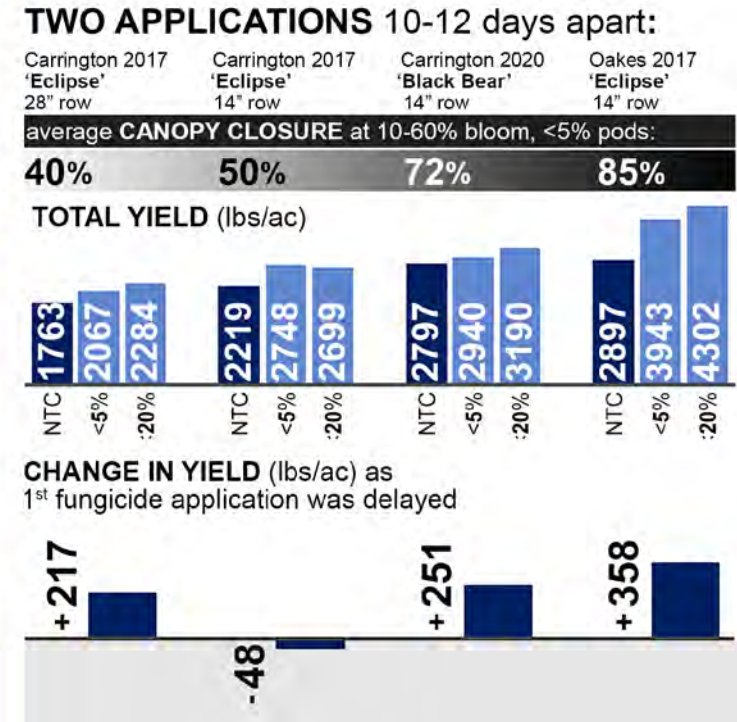
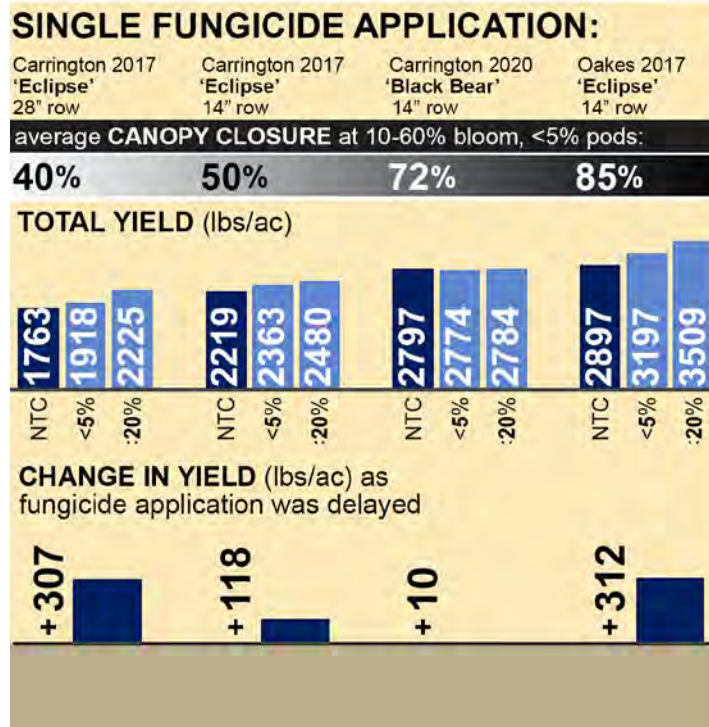
Carrington and Oakes, ND (2017, 2020)

**Delaying the first fungicide application from bloom initiation (<5% of plants with pods) to initial pod development (5-20% of plants with pods) was associated with increased yield in 4 of 4 studies when fungicides were applied once and 3 of 4 studies when fungicides were applied twice.**

### IMPACT OF DELAYING FIRST FUNGICIDE APPLICATION

**from**  
10-60% of plants in bloom,  
<5% of plants with pods

**to**  
50-100% of plants in bloom,  
5-20% plants with pods



**Fungicide applied:** SINGLE FUNGICIDE APPLICATION – Topsin @ 30 fl oz/ac; TWO FUNGICIDE APPLICATIONS – Topsin @ 30 fl oz/ac followed by Endura @ 8 oz/ac

**Spray volume:** 15 gal/ac **Nozzles & droplet size:** When average canopy closure was < 80%, TeeJet DG110015 nozzles at 40 psi (fine droplets). When average canopy closure was 80-90%, TeeJet DG110015 nozzles at 30 psi (medium droplets). When average canopy closure was 90-95%, TeeJet AIXR11015 nozzles at 60 psi (medium-coarse droplets). When average canopy closure was 95-100%, TeeJet AIXR nozzles at 50 psi (coarse droplets)

# Optimizing fungicide application timing for white mold management in dry beans

## 2. BLACK BEANS

Carrington and Oakes, ND (2017, 2020)

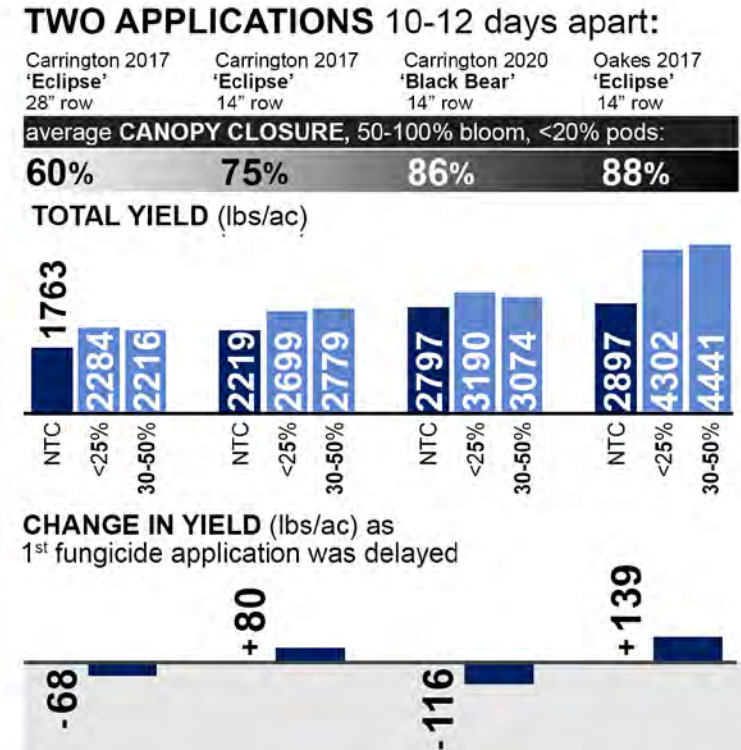
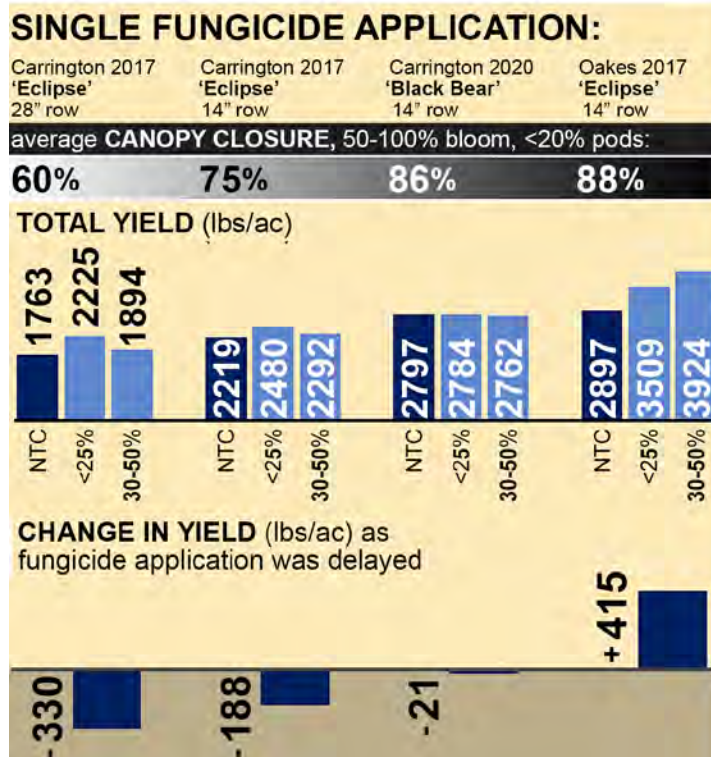
**Delaying the first fungicide application from 5-20% of plants with pods to 30-50% of plants with pods**

was associated with decreased yield in 3 of 4 studies when fungicides were applied once and 2 of 4 studies when fungicides were applied twice.

### IMPACT OF DELAYING FIRST FUNGICIDE APPLICATION

**from**  
50-100% of plants in bloom,  
<20% of plants with pods

**to**  
75-100% of plants in bloom,  
30-50% plants with pods



**Fungicide applied:** SINGLE FUNGICIDE APPLICATION – Topsin @ 30 fl oz/ac; TWO FUNGICIDE APPLICATIONS – Topsin @ 30 fl oz/ac followed by Endura @ 8 oz/ac

**Spray volume:** 15 gal/ac **Nozzles & droplet size:** When average canopy closure was < 80%, TeeJet DG110015 nozzles at 40 psi (fine droplets). When average canopy closure was 80-90%, TeeJet DG110015 nozzles at 30 psi (medium droplets). When average canopy closure was 90-95%, TeeJet AIXR11015 nozzles at 60 psi (medium-coarse droplets). When average canopy closure was 95-100%, TeeJet AIXR nozzles at 50 psi (coarse droplets)

## Optimizing fungicide application timing

### **Impact of fungicide application timing on white mold:**

---

#### BLACK BEANS:

- Applying fungicides when 5-20% of plants had at least one initial pin-shaped pod was optimal in black beans when the canopy was open (< 90% average closure) at this growth stage.
- No testing was conducted on black beans with a closed canopy during initial pod development.
- Once 20% of plants have developed initial pods, fungicide applications should only be delayed if conditions do not favor white mold

The number of field studies conducted was small, and follow-up research is needed to confirm these findings. Continued fungicide timing research is planned for 2022.



# Optimizing fungicide application timing for white mold management in dry beans

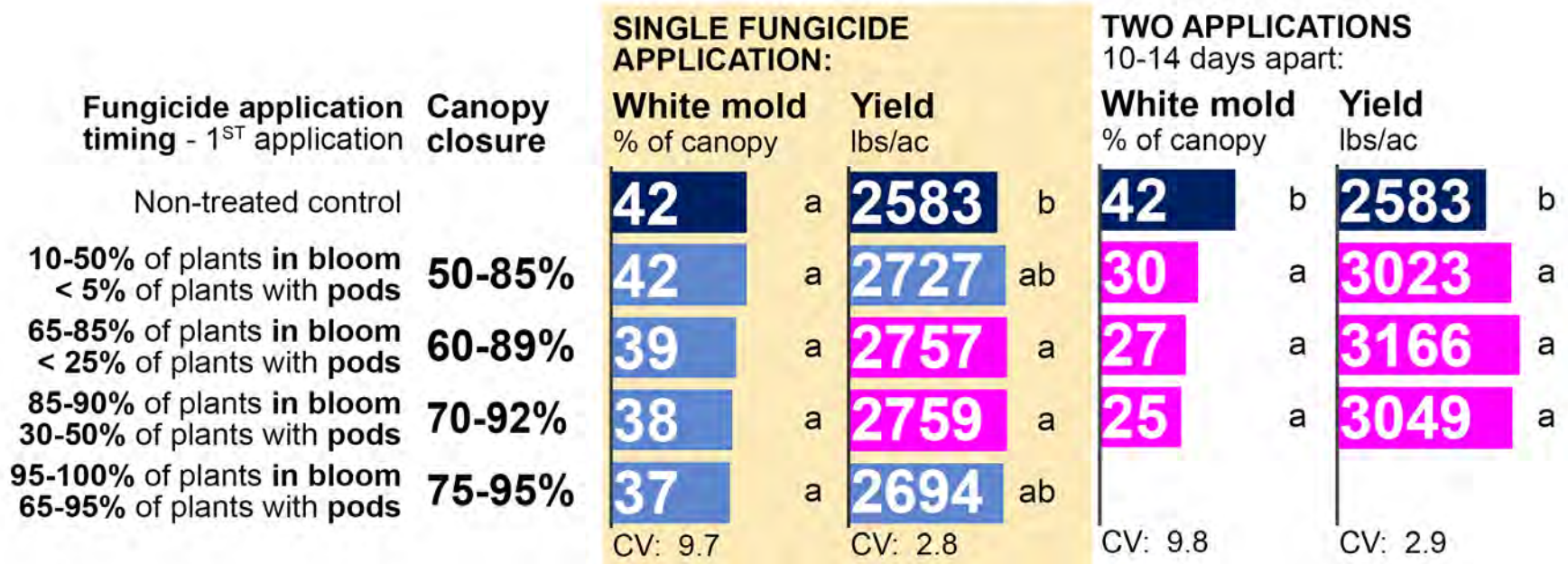
## 3. NAVY BEANS

Carrington, ND (2017, 2020, 2021)

In navy beans, **average yields were maximized by delaying fungicide applications until 5-50% had initial pods (one application) or 5-25% had initial pods (two applic.)**  
**BUT** delaying applications beyond 25% plants with pods conferred highly variable results across individual studies - see next slides.

### AVERAGE RESULTS across all studies

4 studies conducted across 3 years, 1 location



**Fungicide applied:** SINGLE FUNGICIDE APPLICATION – Topsin @ 30 fl oz/ac (studies from 2017, 2020); Topsin @ 40 fl oz/ac (studies conducted in 2021)

TWO FUNGICIDE APPLICATIONS – Topsin @ 30 fl oz/ac followed by Endura @ 8 oz/ac (2017, 2020), Topsin @ 40 fl oz/ac followed by Endura @ 8 oz/ac (2021)

**Spray volume:** 15 gal/ac **Nozzles & droplet size:** When average canopy closure was < 80%, TeeJet DG110015 nozzles at 40 psi (fine droplets). When average canopy closure was 80-90%, TeeJet DG110015 nozzles at 30 psi (medium droplets). When average canopy closure was 90-95%, TeeJet AIXR11015 nozzles at 60 psi (medium-coarse droplets). When average canopy closure was 95-100%, TeeJet AIXR nozzles at 50 psi (coarse droplets)

# Optimizing fungicide application timing for white mold management in dry beans

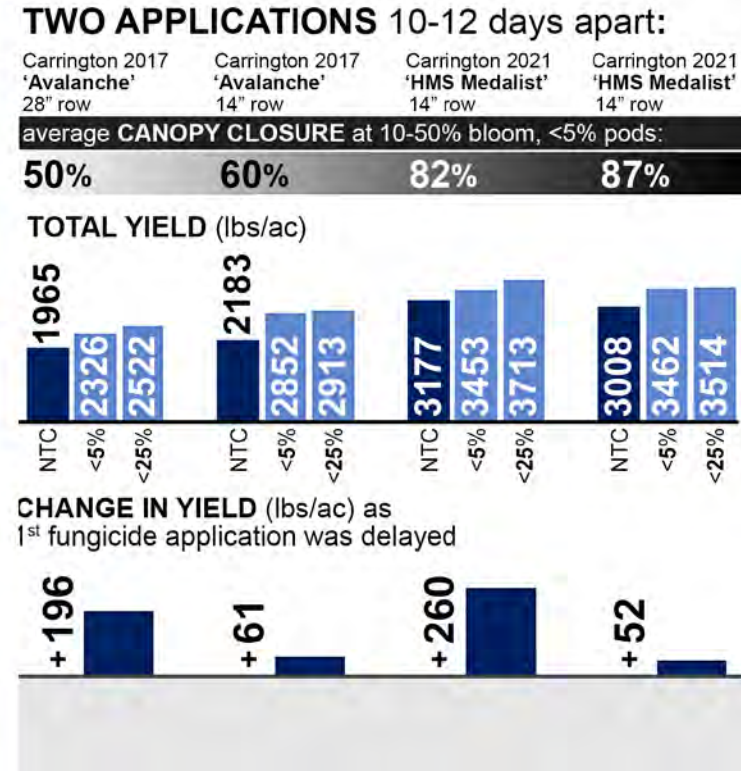
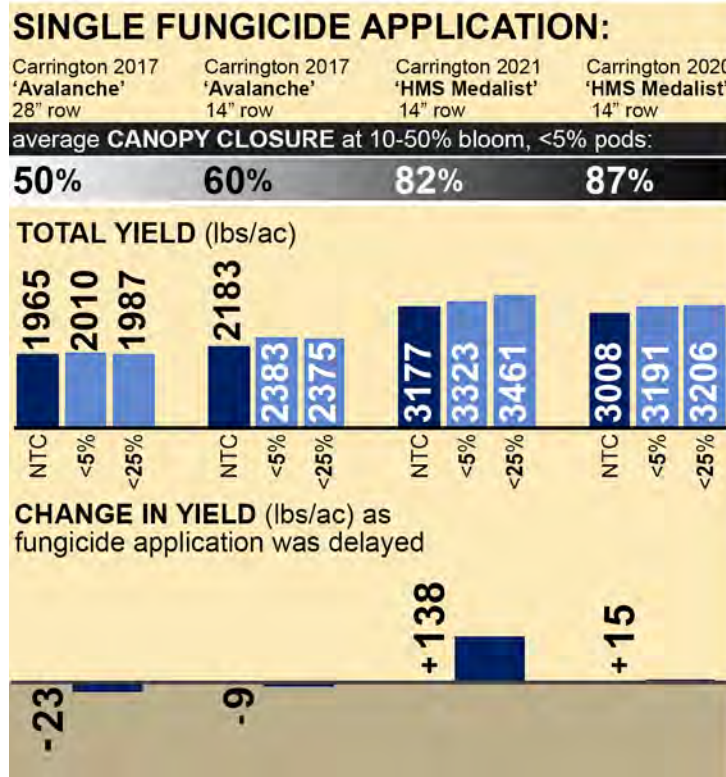
## 3. NAVY BEANS

Carrington, ND (2017, 2020, 2021)

**Delaying the first fungicide application from bloom initiation (<5% of plants with pods) to initial pod development (5-25% of plants with pods) was associated with increased yield in 2 of 4 studies when fungicides were applied once and 4 of 4 studies when fungicides were applied twice.**

### IMPACT OF DELAYING FIRST FUNGICIDE APPLICATION

**from**  
10-50% of plants in bloom,  
<5% of plants with pods  
  
**to**  
65-85% of plants in bloom,  
5-25% plants with pods



**Fungicide applied:** SINGLE FUNGICIDE APPLICATION – Topsin @ 30 fl oz/ac (studies from 2017, 2020); Topsin @ 40 fl oz/ac (studies conducted in 2021)

TWO FUNGICIDE APPLICATIONS – Topsin @ 30 fl oz/ac followed by Endura @ 8 oz/ac (2017, 2020), Topsin @ 40 fl oz/ac followed by Endura @ 8 oz/ac (2021)

**Spray volume:** 15 gal/ac **Nozzles & droplet size:** When average canopy closure was < 80%, TeeJet DG110015 nozzles at 40 psi (fine droplets). When average canopy closure was 80-90%, TeeJet DG110015 nozzles at 30 psi (medium droplets). When average canopy closure was 90-95%, TeeJet AIXR11015 nozzles at 60 psi (medium-coarse droplets). When average canopy closure was 95-100%, TeeJet AIXR nozzles at 50 psi (coarse droplets)

# Optimizing fungicide application timing for white mold management in dry beans

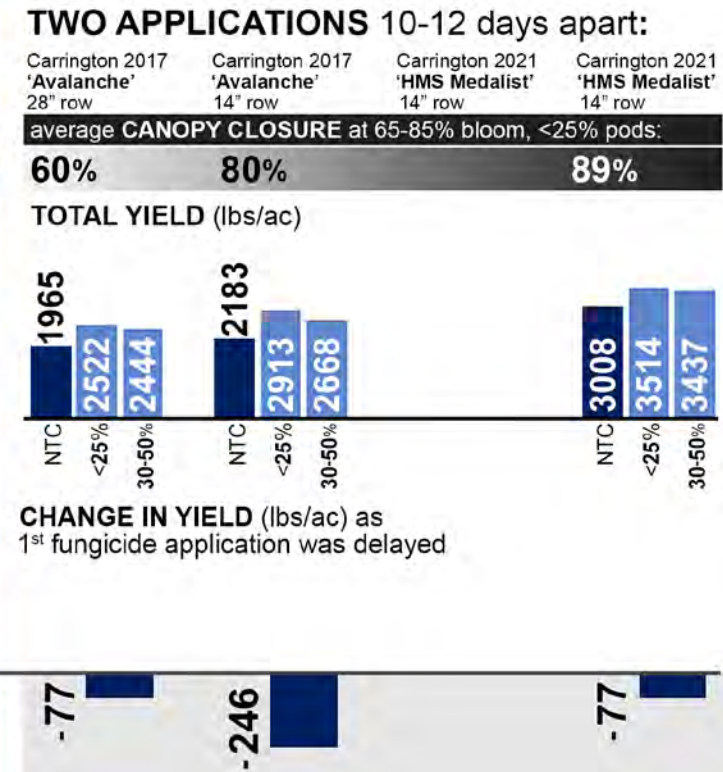
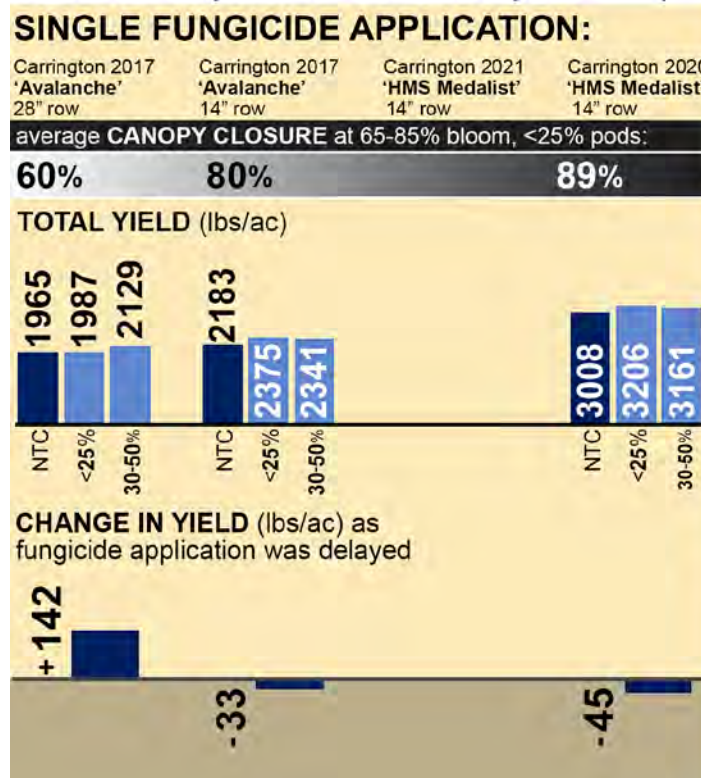
## 3. NAVY BEANS

Carrington, ND (2017, 2020, 2021)

**Delaying the first fungicide application from bloom initiation (<5% of plants with pods) to initial pod development (5-25% of plants with pods) was associated with decreased yield in 2 of 3 studies when fungicides were applied once and 3 of 3 studies when fungicides were applied twice.**

### IMPACT OF DELAYING FIRST FUNGICIDE APPLICATION

**from**  
65-85 % of plants in bloom,  
5-25% of plants with pods  
  
**to**  
85-90% of plants in bloom,  
30-50% plants with pods



**Fungicide applied:** SINGLE FUNGICIDE APPLICATION – Topsin @ 30 fl oz/ac (studies from 2017, 2020); Topsin @ 40 fl oz/ac (studies conducted in 2021)

TWO FUNGICIDE APPLICATIONS – Topsin @ 30 fl oz/ac followed by Endura @ 8 oz/ac (2017, 2020), Topsin @ 40 fl oz/ac followed by Endura @ 8 oz/ac (2021)

**Spray volume:** 15 gal/ac **Nozzles & droplet size:** When average canopy closure was < 80%, TeeJet DG110015 nozzles at 40 psi (fine droplets). When average canopy closure was 80-90%, TeeJet DG110015 nozzles at 30 psi (medium droplets). When average canopy closure was 90-95%, TeeJet AIXR11015 nozzles at 60 psi (medium-coarse droplets). When average canopy closure was 95-100%, TeeJet AIXR nozzles at 50 psi (coarse droplets)



## Optimizing fungicide application timing

### Impact of fungicide application timing on white mold:

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#### NAVY BEANS:

- Applying fungicides when up to 25% of plants had at least one initial pin-shaped pod was optimal in navy beans when the canopy was open (< 90% average closure) at this growth stage.
- No testing was conducted on navy beans with a closed canopy during initial pod development.
- Once 25% of plants have developed initial pods, fungicide applications should only be delayed if conditions do not favor white mold

The number of field studies conducted was small, and follow-up research is needed to confirm these findings. Continued fungicide timing research is planned for 2022.



# Optimizing fungicide application timing for white mold management in dry beans

## 4. KIDNEY BEANS

Carrington, ND (2020, 2021)

In kidney beans, **optimum fungicide application timing appeared to differ by the number of fungicide applications (one versus two)**

**BUT** only two field studies were conducted, an insufficient sample size for reaching rigorous conclusions.

### AVERAGE RESULTS

across all studies

2 studies conducted across 2 years, 1 location

Fungicide application timing - 1 <sup>ST</sup> application	Canopy closure	SINGLE FUNGICIDE APPLICATION:		TWO APPLICATIONS 10 to 14 days apart:	
		White mold % of canopy	Yield lbs/ac	White mold % of canopy	Yield lbs/ac
Non-treated control		<b>33</b> a	<b>2849</b> a	<b>33</b> a	<b>2849</b> a
45-65% of plants in bloom < 10% of plants with pods	<b>80-89%</b>	<b>35</b> a	<b>2771</b> a	<b>21</b> a	<b>3178</b> a
60-90% of plants in bloom 30-40% of plants with pods	<b>87-90%</b>	<b>32</b> a	<b>2866</b> a	<b>24</b> a	<b>3115</b> a
85-96% of plants in bloom 60-80% of plants with pods	<b>91-93%</b>	<b>29</b> a	<b>2922</b> a	<b>20</b> a	<b>3073</b> a
		CV: 10.7	CV: 1.4	CV: 17.7	CV: 2.5

**Fungicide applied:** SINGLE FUNGICIDE APPLICATION – Topsin @ 30 fl oz/ac (study from 2020); Topsin @ 40 fl oz/ac (study conducted in 2021)

TWO FUNGICIDE APPLICATIONS – Topsin @ 30 fl oz/ac followed by Endura @ 8 oz/ac (2020), Topsin @ 40 fl oz/ac followed by Endura @ 8 oz/ac (2021)

**Spray volume:** 15 gal/ac **Nozzles & droplet size:** When average canopy closure was < 80%, TeeJet DG110015 nozzles at 40 psi (fine droplets). When average canopy closure was 80-90%, TeeJet DG110015 nozzles at 30 psi (medium droplets). When average canopy closure was 90-95%, TeeJet AIXR11015 nozzles at 60 psi (medium-coarse droplets). When average canopy closure was 95-100%, TeeJet AIXR nozzles at 50 psi (coarse droplets)

# Optimizing fungicide application timing for white mold management in dry beans

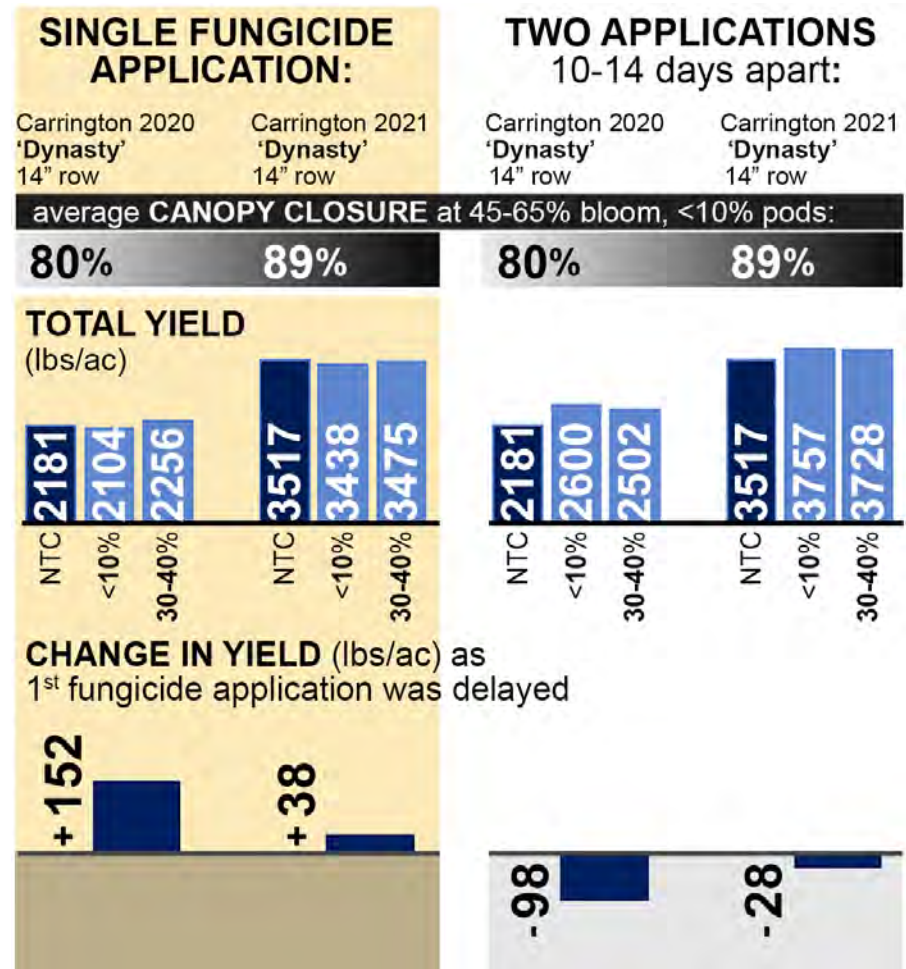
## 4. KIDNEY BEANS Carrington, ND (2020, 2021)

**Delaying the first fungicide application from bloom initiation (<10% of plants with pods) to initial pod development (30-40% of plants with pods) was associated with increased yield in 2 of 2 studies when fungicides were applied once and decreased yield in 2 of 2 studies when fungicides were applied twice.**

### IMPACT OF DELAYING FIRST FUNGICIDE APPLICATION

*from*  
45-65 % of plants in bloom,  
**<10% of plants with pods**

*to*  
60-90% of plants in bloom,  
**30-40% plants with pods**



**Fungicide applied:** SINGLE FUNGICIDE APPLICATION – Topsin @ 30 fl oz/ac (study from 2020); Topsin @ 40 fl oz/ac (study conducted in 2021)  
TWO FUNGICIDE APPLICATIONS – Topsin @ 30 fl oz/ac followed by Endura @ 8 oz/ac (2020), Topsin @ 40 fl oz/ac followed by Endura @ 8 oz/ac (2021)

**Spray volume:** 15 gal/ac

**Nozzles & droplet size:** When average canopy closure was < 80%, TeeJet DG110015 nozzles at 40 psi (fine droplets). When average canopy closure was 80-90%, TeeJet DG110015 nozzles at 30 psi (medium droplets). When average canopy closure was 90-95%, TeeJet AIXR11015 nozzles at 60 psi (medium-coarse droplets). When average canopy closure was 95-100%, TeeJet AIXR nozzles at 50 psi (coarse droplets)

# Optimizing fungicide application timing for white mold management in dry beans

## 4. KIDNEY BEANS Carrington, ND (2020, 2021)

**Delaying the first fungicide application from 30-40% of plants with pods to 60-80% of plants with pods was associated with increased yield in 2 of 2 studies when fungicides were applied once and decreased yield in 1 of 2 studies when fungicides were applied twice.**

### IMPACT OF DELAYING FIRST FUNGICIDE APPLICATION

*from*  
60-90 % of plants in bloom,  
**30-40% of plants with pods**

*to*  
85-96% of plants in bloom,  
**60-80% plants with pods**

### SINGLE FUNGICIDE APPLICATION:

Carrington 2020 'Dynasty' 14" row      Carrington 2021 'Dynasty' 14" row

average **CANOPY CLOSURE** at 60-90% bloom, 30-40% pods:  
**87%**      **90%**

### TOTAL YIELD (lbs/ac)



### CHANGE IN YIELD (lbs/ac) as 1<sup>st</sup> fungicide application was delayed

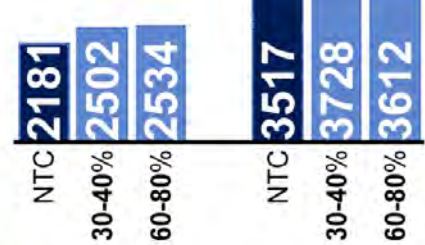


### TWO APPLICATIONS 10-14 days apart:

Carrington 2020 'Dynasty' 14" row      Carrington 2021 'Dynasty' 14" row

average **CANOPY CLOSURE** at 60-90% bloom, 30-40% pods:  
**87%**      **90%**

### TOTAL YIELD (lbs/ac)



### CHANGE IN YIELD (lbs/ac) as 1<sup>st</sup> fungicide application was delayed



**Fungicide applied:** SINGLE FUNGICIDE APPLICATION – Topsin @ 30 fl oz/ac (study from 2020); Topsin @ 40 fl oz/ac (study conducted in 2021)  
TWO FUNGICIDE APPLICATIONS – Topsin @ 30 fl oz/ac followed by Endura @ 8 oz/ac (2020), Topsin @ 40 fl oz/ac followed by Endura @ 8 oz/ac (2021)

**Spray volume:** 15 gal/ac

**Nozzles & droplet size:** When average canopy closure was < 80%, TeeJet DG110015 nozzles at 40 psi (fine droplets). When average canopy closure was 80-90%, TeeJet DG110015 nozzles at 30 psi (medium droplets). When average canopy closure was 90-95%, TeeJet AIXR11015 nozzles at 60 psi (medium-coarse droplets). When average canopy closure was 95-100%, TeeJet AIXR nozzles at 50 psi (coarse droplets)

## Optimizing fungicide application timing

### Impact of fungicide application timing on white mold:

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#### KIDNEY BEANS:

- Optimum fungicide application timing appeared to differ by the number of fungicide applications (one versus two)
  - When a single fungicide application was made, kidney bean yield was maximized when applications were delayed until 60-80% of plants had initial pods.
  - When two fungicide applications were made, kidney bean yield was maximized when the first application was made before 30% of plants had initial pods.
- BUT only two field studies were conducted, an insufficient sample size for reaching rigorous conclusions. Continued fungicide timing research is planned for 2022.





Improving management of white mold in dry edible beans:  
4. Optimizing fungicide spray droplet size

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**Michael Wunsch**

North Dakota State University Carrington Research Extension Center

## Droplet size

**Cutting droplet diameter in half**

**Results in eight times as many droplets**



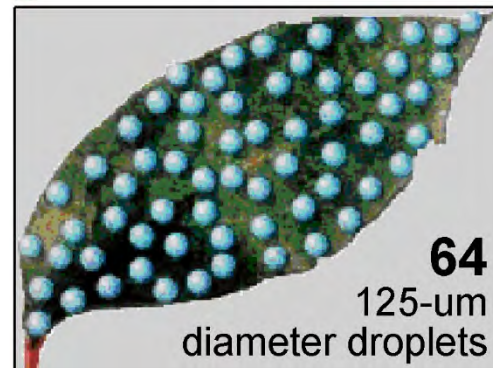
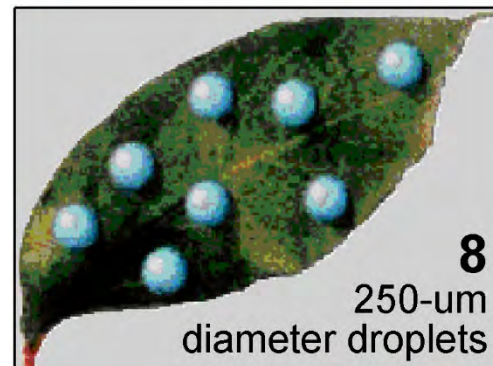
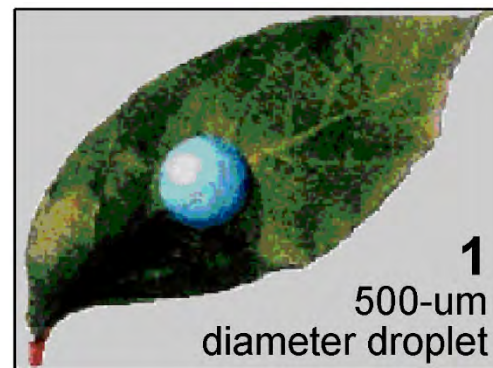
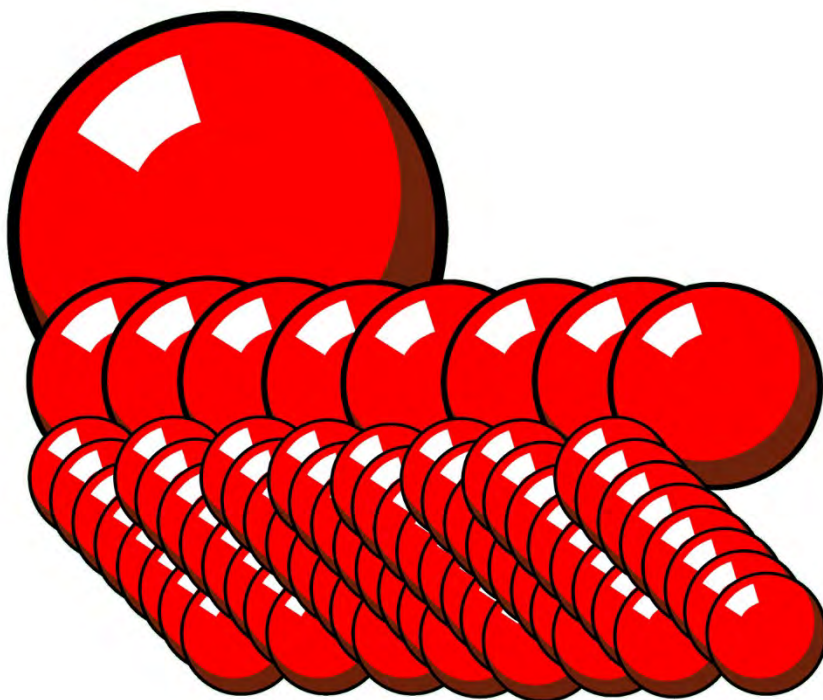
**=**



*(there is one more droplet in the rear)*

## Droplet size

**0.065 mm<sup>3</sup> spray volume =**  
**one** 500-um diameter droplet  
**eight** 250-um diameter droplets  
**sixty-four** 125-um diameter droplets

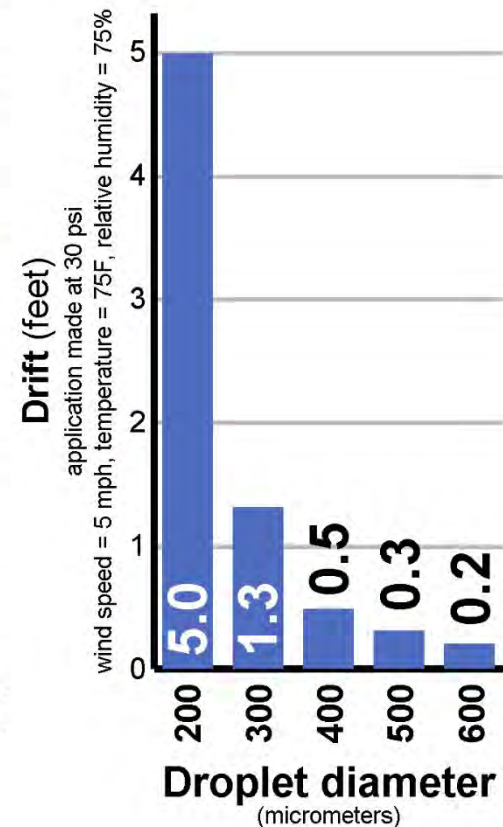
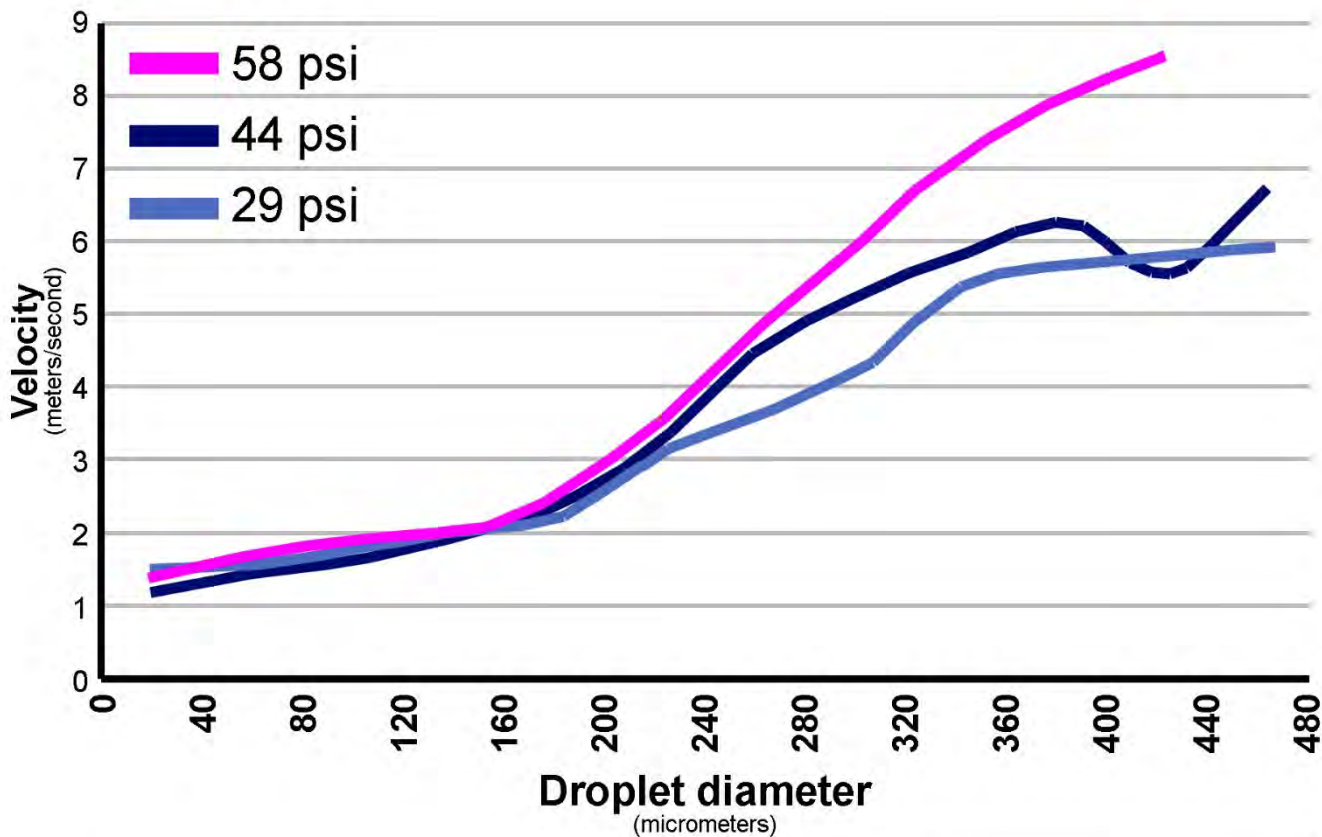




# Droplet size

**... but larger droplets have greater velocity, drift less.**





*Increased velocity and reduced drift improves canopy penetration.*



# Experimental Methods

## 1. WILGER nozzles

Spray droplet size estimates were based on information provided by the manufacturer.

																		
			Recommended Pressure: 25-70 PSI				Recommended Pressure: 30-100 PSI				Recommended Pressure: 30-100 PSI				Recommended Pressure: 35-100 PSI			
Tip Cap No.	Flow Rate USGPM	PSI	VMD (Droplet Size in $\mu$ ); %<141 $\mu$ (Drift %); %<200 $\mu$ (Drift %); %<600 $\mu$ (Small Droplets)															
			110° ER Series				110° SR Series				110° MR Series				110° DR Series			
			VMD	<141	<200	<600	VMD	<141	<200	<600	VMD	<141	<200	<600	VMD	<141	<200	<600
<b>04</b>	0.43	50	<b>209</b>	26%	47%	96%	<b>275</b>	15%	30%	96%	<b>355</b>	8%	17%	91%	<b>447</b>	5%	10%	79%
			<span style="color: orange;">■</span> Fine 106-235 $\mu$				<span style="color: yellow;">■</span> Medium 236-340 $\mu$				<span style="color: blue;">■</span> Coarse 341-403 $\mu$				<span style="color: green;">■</span> Very Coarse 404-502 $\mu$			

**ER110-04**

50 psi

**FINE DROPLETS**

**SR110-04**

50 psi

**MEDIUM DROPLETS**

**MR110-04**

50 psi

**COARSE DROPLETS**

**DR110-04**

50 psi

**VERY COARSE DROPLETS**

# Experimental Methods

## 2. TEEJET nozzles

Spray droplet size estimates were based on information provided by the manufacturer.

### XR TeeJet® (XR)

	PSI						
	15	20	25	30	40	50	60

**XR11004** 50 psi  
FINE DROPLETS

<b>XR11004</b>	M	M	M	M	M	F	F
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**XR11005** 40 psi  
MEDIUM-FINE DROPLETS

<b>XR11005</b>	M	M	M	M	M	F	F
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**XR11006** 35 psi  
MEDIUM DROPLETS

<b>XR11006</b>	C	M	M	M	M	M	F
----------------	---	---	---	---	---	---	---

**XR11008** 40 psi  
MEDIUM-COARSE DROPLETS

<b>XR11008</b>	C	C	C	C	M	M	M
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**XR11010** 30 psi  
COARSE DROPLETS

<b>XR11010</b>	VC	C	C	C	M	M	M
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# Calibration

**The initial calibration was conducted with water.**

**Objectives:**

1. **Nozzle selection:** Tips with output deviating from advertised specifications discarded
2. **Initial identification of pulse width** needed to deliver 15 gal/ac spray volume at target driving speed



Spot-On sprayer calibrator model SC-1  
(Innoquest, Inc.; Woodstock, IL)

**The final calibration was conducted with fungicide in the field immediately before application.**

**Objectives:**

1. **Ensure a precise spray volume of 15 gal/ac.** Manual adjustments to pulse width were made as needed.
2. **Confirm that all nozzles are operating correctly** – consistent output across all nozzles; no plugs.



## Applications

**Tractor-mounted sprayer equipped with a pulse-width modulation system from Capstan AG.**

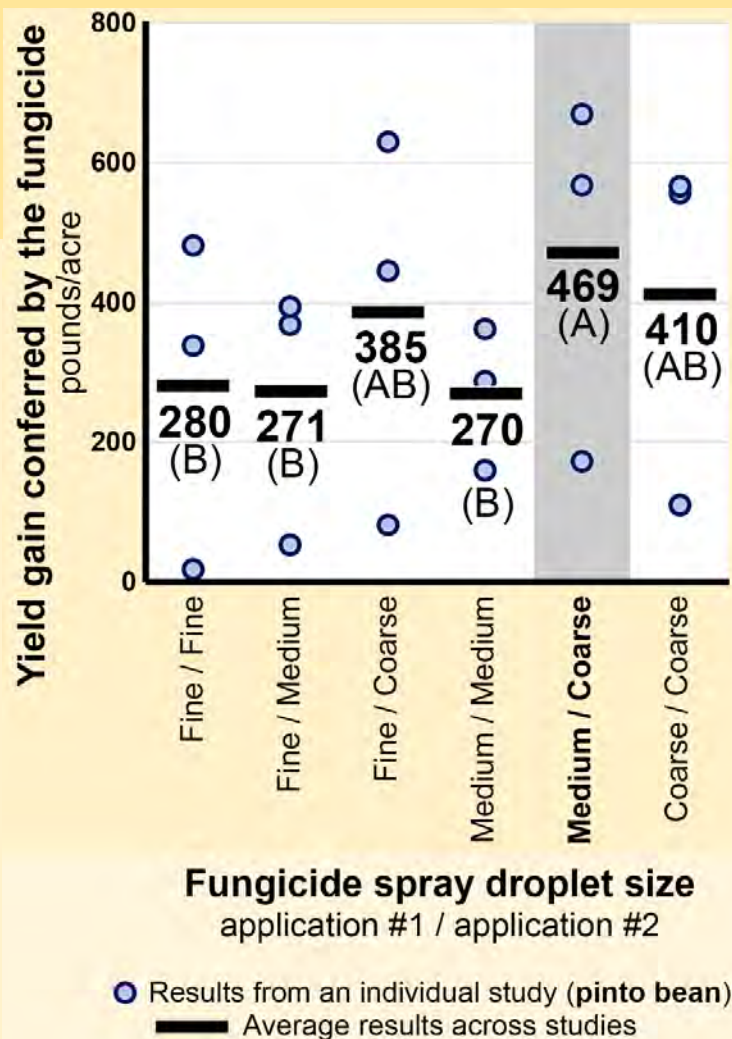
**Spray volume: 15 gal/ac** Pulse width manually calibrated to maintain a constant spray volume across tips differing in output.

**Driving speed: 6.0 to 10.5 mph, depending on the study.**



**PINTO BEANS: Fungicide efficacy was optimized with medium droplets in the 1<sup>st</sup> application and coarse droplets in the 2<sup>nd</sup> application when the canopy was open (average <80% closure) at the 1<sup>st</sup> fungicide application and at /near closure (average 91-95% closure) at the 2<sup>nd</sup> fungicide application.**

	Carrington 2021 no cover crop 'Palomino'	Oakes 2021 rye, late term. 'Palomino'	Oakes 2021 rye, early term. 'Palomino'	Combined Analysis 3 studies	
<b>CANOPY CLOSURE when fungicides were applied</b>					
application #1	40-60% (52%)	45-85% (64%)	45-90% (76%)	52-76% (64%)	
application #2	80-100% (95%)	50-100% (91%)	75-100% (92%)	91-95% (93%)	
<b>WHITE MOLD (% of canopy)</b>					
Fungicide droplet size 1 <sup>st</sup> application / 2 <sup>nd</sup> application	Non-treated	55 a	12 a	27 b	31 b
	Fine/Fine	46 a	8 a	12 a	22 a
	Fine/Med.	45 a	9 a	14 a	23 a
	Fine./Coarse	47 a	10 a	16 a	25 a
	Med./Med.	48 a	10 a	14 a	24 a
	Med./Coarse	43 a	7 a	14 a	21 a
	Coarse/Coarse	42 a	7 a	15 a	21 a
	CV: 13.2	CV: 46.4	CV: 34.1	CV: 8.9	
<b>YIELD (pounds/acre)</b>					
Fungicide droplet size 1 <sup>st</sup> application / 2 <sup>nd</sup> application	Non-treated	2161 a	3363 a	2944 b	2822 b
	Fine/Fine	2642 a	3382 a	3282 ab	3102 ab
	Fine/Med.	2529 a	3416 a	3337 a	3094 ab
	Fine./Coarse	2605 a	3445 a	3573 a	3208 a
	Med./Med.	2522 a	3523 a	3230 ab	3092 ab
	Med./Coarse	2829 a	3536 a	3510 a	3292 a
	Coarse/Coarse	2716 a	3473 a	3509 a	3233 a
	CV: 9.8	CV: 7.4	CV: 8.1	CV: 3.7	



LETTERS DENOTE STATISTICAL SEPARATION (P < 0.05 in bar graphs at left and P < 0.10 in scatter plot at right)

Fungicide: Topsin at 40 fl oz/ac followed by Endura at 8 oz/ac Application timing: Early bloom, initial pod development Spray volume: 15 gal/ac

Row spacing: 14 inches Seeding rate: 90,000 pure live seeds/ac Driving speed: 10.5 mph (Carrington); 6.0 mph (Oakes)

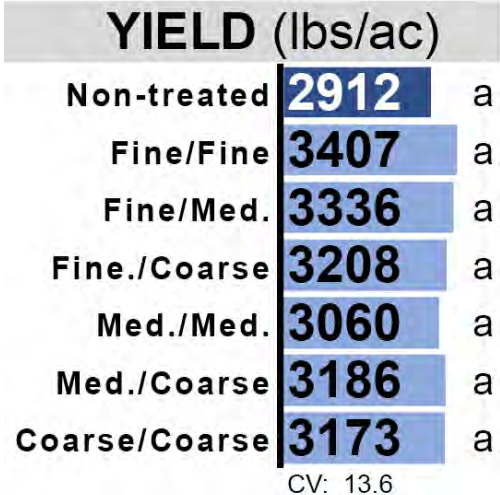
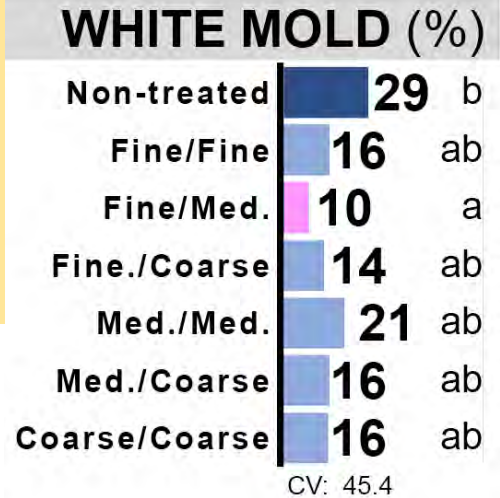
Nozzles (Carrington): TeeJet XR11005 nozzles at 60 psi, medium droplets were applied with XR11006 nozzles at 35 psi, and coarse droplets were applied with XR11010 nozzles at 30 psi

Nozzles (Oakes): TeeJet XR11004 nozzles at 60 psi, medium droplets were applied with XR11006 nozzles at 35 psi, and coarse droplets were applied with XR11010 nozzles at 30 psi

**PINTO BEANS:**  
**When the canopy was open at both applications**  
**(<85% closure)**  
**applying fungicides with fine droplets**  
**appeared to maximized yield**

Statistical separation was lacking  
and follow-up research is needed to confirm.

**Oakes**  
2021  
no cover crop  
variety 'Palomino'  
**CANOPY CLOSURE**  
application #1 45-95% (68%)  
application #2 40-100% (82%)



LETTERS DENOTE STATISTICAL SEPARATION (P < 0.05)

**Fungicide:** Topsin at 40 fl oz/ac followed by Endura at 8 oz/ac

**Application timing:** Early bloom, initial pod development

**Spray volume:** 15 gal/ac **Row spacing:** 14 inches **Seeding rate:** 90,000 pure live seeds/ac

**Driving speed:** 6.0 mph (Oakes) **Nozzles (Oakes):** TeeJet XR11004 nozzles at 60 psi, medium droplets were applied with XR11006 nozzles at 35 psi, and coarse droplets were applied with XR11010 nozzles at 30 psi

## Optimizing fungicide droplet size

### Impact of fungicide droplet size on white mold:

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#### PINTO BEANS:

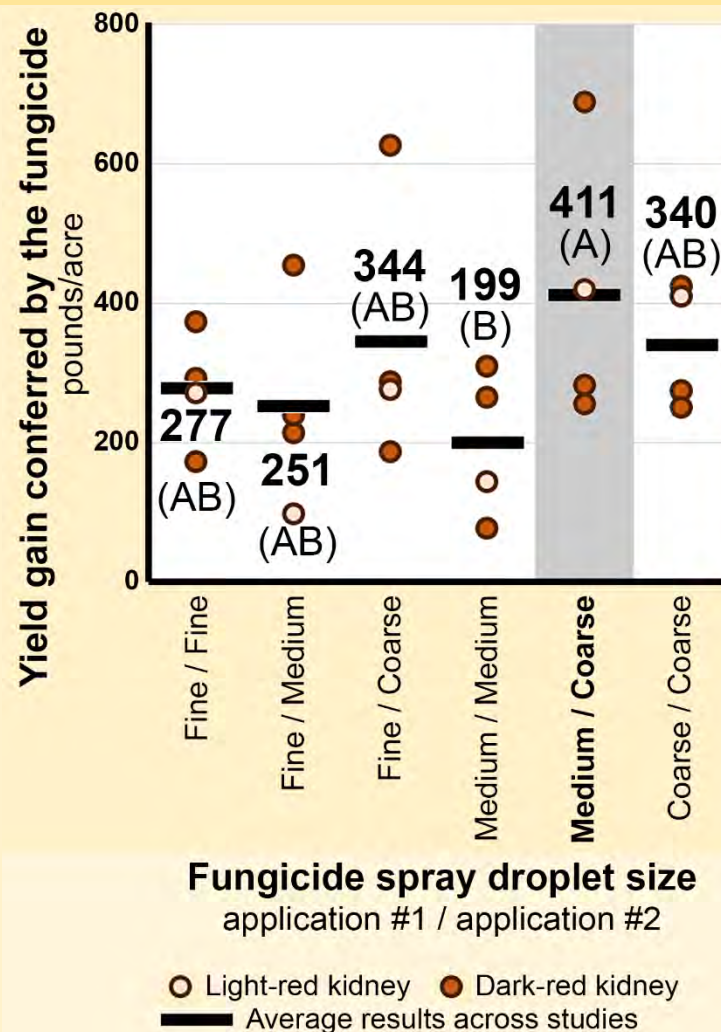
- White mold management was optimized when fungicide droplet size was calibrated relative to canopy closure when fungicides were applied
- When canopy closure was open at the first application (<80% average closure) and near closure (91-95% average closure) at the second application, applying fungicides with medium droplets at the first application and coarse droplets at the second application optimized white mold management
- When the canopy was very open at the first application (68% average closure) and open at the second application (82% average closure), applying fungicides with fine droplets at the first application and fine to medium droplets at the second application appeared to optimize fungicide performance.
- This is research in progress, and additional testing is planned for 2022.





**KIDNEY BEANS: Fungicide efficacy was optimized with medium droplets in the 1<sup>st</sup> application and coarse droplets in the 2<sup>nd</sup> application** when the canopy was near closure (87-94% average closure) at the 1<sup>st</sup> fungicide application and at or near closure (91-99% closure) at the 2<sup>nd</sup> fungicide application

droplet size treatment	Oakes 2021 no cover crop 'Dynasty'	Oakes 2021 rye, late term. 'Dynasty'	Carrington 2021 no cover crop 'Dynasty'	Carrington 2021 no cover crop 'Pink Panther'	Combined Analysis 4 studies	
<b>CANOPY CLOSURE when fungicides were applied</b>						
application #1	80-100% (94%)	75-100% (94%)	60-100% (87%)	75-100% (91%)	87-91% (92%)	
application #2	60-100% (91%)	95-100% (99%)	100% (100%)	90-100% (99%)	91-100% (97%)	
<b>WHITE MOLD (% of canopy)</b>						
Fungicide droplet size 1 <sup>st</sup> application / 2 <sup>nd</sup> application	Non-treated	50 a	30 a	56 b	53 a	47 b
	Fine/Fine	45 a	30 a	46 a	46 a	42 ab
	Fine/Med.	41 a	27 a	51 ab	52 a	43 ab
	Fine./Coarse	42 a	28 a	50 ab	49 a	42 ab
	Med./Med.	49 a	29 a	49 ab	48 a	44 ab
	Med./Coarse	36 a	26 a	50 ab	42 a	39 a
	Coarse/Coarse	38 a	25 a	47 a	46 a	39 a
	CV: 26.8	CV: 34.1	CV: 13.7	CV: 23.9	CV: 6.5	
<b>YIELD (pounds/acre)</b>						
Fungicide droplet size 1 <sup>st</sup> application / 2 <sup>nd</sup> application	Non-treated	2934 a	3189 a	2431 b	2659 b	2803 b
	Fine/Fine	3307 a	3361 a	2723 ab	2931 ab	3080 a
	Fine/Med.	3387 a	3429 a	2645 ab	2757 ab	3054 a
	Fine./Coarse	3560 a	3470 a	2619 ab	2941 ab	3148 a
	Med./Med.	3199 a	3266 a	2740 a	2804 ab	3002 ab
	Med./Coarse	3622 a	3470 a	2686 ab	3078 a	3214 a
	Coarse/Coarse	3354 a	3439 a	2706 ab	3074 a	3143 a
	CV: 11.7	CV: 6.9	CV: 9.1	CV: 11.4	CV: 3.2	



LETTERS DENOTE STATISTICAL SEPARATION (P < 0.05 in bar graphs at left and P < 0.10 in scatter plot at right)

Fungicide: Topsin at 40 fl oz/ac followed by Endura at 8 oz/ac Application timing: Early bloom, initial pod development Spray volume: 15 gal/ac

Row spacing: 14 inches Seeding rate: 90,000 pure live seeds/ac Driving speed: 10.5 mph (Carrington); 6.0 mph (Oakes)

Nozzles (Carrington): TeeJet XR11005 nozzles at 60 psi, medium droplets were applied with XR11006 nozzles at 35 psi, and coarse droplets were applied with XR11010 nozzles at 30 psi

Nozzles (Oakes): TeeJet XR11004 nozzles at 60 psi, medium droplets were applied with XR11006 nozzles at 35 psi, and coarse droplets were applied with XR11010 nozzles at 30 psi

**KIDNEY BEANS:**

**When the canopy was closed at both applications  
(average 98% closure)  
applying fungicides with coarse droplets  
appeared to maximized yield**

Statistical separation was lacking  
and follow-up research is needed to confirm.

**Oakes**  
2021  
rye, early term.  
variety 'Dynasty'  
**CANOPY CLOSURE**  
application #1 90-100% (98%)  
application #2 90-100% (98%)

**WHITE MOLD (%)**

Non-treated	30	a
Fine/Fine	26	a
Fine/Med.	26	a
Fine./Coarse	33	a
Med./Med.	23	a
Med./Coarse	31	a
Coarse/Coarse	30	a

CV: 42.3

**YIELD (lbs/ac)**

Non-treated	3174	a
Fine/Fine	3494	a
Fine/Med.	3587	a
Fine./Coarse	3418	a
Med./Med.	3455	a
Med./Coarse	3433	a
Coarse/Coarse	3625	a

CV: 8.9

LETTERS DENOTE STATISTICAL SEPARATION (P < 0.05)

Fungicide: Topsin at 40 fl oz/ac followed by Endura at 8 oz/ac

Application timing: Early bloom, initial pod development

Spray volume: 15 gal/ac Row spacing: 14 inches Seeding rate: 90,000 pure live seeds/ac

Driving speed: 6.0 mph (Oakes) Nozzles (Oakes): TeeJet XR11004 nozzles at 60 psi, medium droplets were applied with XR11006 nozzles at 35 psi, and coarse droplets were applied with XR11010 nozzles at 30 psi

## Optimizing fungicide droplet size

### Impact of fungicide droplet size on white mold:

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#### KIDNEY BEANS:

- White mold management was optimized when fungicide droplet size was calibrated relative to canopy closure when fungicides were applied
- When canopy closure was near closure at the first application (87-94% average closure) and at or near closure (91-99% average closure) at the second application, applying fungicides with medium droplets at the first application and coarse droplets at the second application optimized white mold management
- When the canopy was closed at both applications, applying fungicides with coarse droplets at both applications appeared to optimize fungicide performance.
- This is research in progress, and additional testing is planned for 2022.





# Thank You!

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RESEARCH FUNDED BY THE **NORTHARVEST BEAN GROWERS ASSOCIATION**,  
**USDA SPECIALTY CROP BLOCK GRANT PROGRAM** ADMINISTERED BY THE ND  
DEPARTMENT OF AGRICULTURE, AND THE **ND CROP PROTECTION PRODUCT**  
**HARMONIZATION BOARD AND REGISTRATION BOARD**

**NDSU** NORTH DAKOTA AGRICULTURAL  
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