

# Bayer Large Scale Dicamba Off Target Movement (OTM) Study

Summary of 20-ARL-SB24 study

*Rodrigo Werle<sup>1</sup>, Ryan DeWerff<sup>2</sup>, Nick Arneson<sup>3</sup>, Sarah Striegel<sup>4</sup>, Nikola Arsenijevic<sup>5</sup>, Felipe Faleco<sup>5</sup>, Kolby Grint<sup>5</sup>, Haleigh Ortmeier-Clarke<sup>5</sup>, Jose Nunes<sup>6</sup> and Emily Glaeser<sup>7</sup>*

*<sup>1</sup> Principal Investigator, <sup>2</sup> Research Technician, <sup>3</sup> Outreach Research and Extension Associate, <sup>4</sup> Former Graduate Student, <sup>5</sup> Graduate Student, <sup>6</sup> Visiting Scholar, <sup>7</sup> Undergraduate Research Assistant*

Questions on the contents of this report should be directed to Rodrigo Werle ([rwerle@wisc.edu](mailto:rwerle@wisc.edu)) and Sarah Striegel ([sstriegel@wisc.edu](mailto:sstriegel@wisc.edu)).



**Cropping Systems Weed Science**  
UNIVERSITY OF WISCONSIN-MADISON

# Contents

1	Methods.....	6
1.1	Plant Material and Area Management.....	6
1.2	Modeling.....	7
2	Results.....	8
2.1	Weather data.....	8
2.2	Modeling injury on non-DR soybean.....	11
2.2.1	East.....	11
2.2.2	North.....	15
2.2.3	West.....	19
2.2.4	South.....	23
2.3	GPS mapping to 5% injury.....	27

## List of Figures

Figure 1. Wind-rose of frequency and speed averaged three days after dicamba treatment application at the University of Wisconsin-Madison.....	9
Figure 2. Wind-rose of frequency and speed in each of the three days after dicamba treatment application at the University of Wisconsin-Madison.....	10
Figure 3. Non-DR soybean injury with distance from the treated block in the East direction 21 DAT.....	11
Figure 4. Non-DR soybean height with distance from the treated block in the East direction 21 DAT.....	12
Figure 5. Non-DR soybean injury under the covered area in the East direction 21 DAT.....	13
Figure 6. Non-DR soybean injury under the non-covered area in the East direction 21 DAT.....	14
Figure 7. Non-DR soybean injury with distance from the treated block in the North direction 21 DAT.....	15
Figure 8. Non-DR soybean height with distance from the treated block in the North direction 21 DAT.....	16
Figure 9. Non-DR soybean injury under the covered area in the North direction 21 DAT.....	17
Figure 10. Non-DR soybean injury under the non-covered area in the North direction 21 DAT.....	18
Figure 11. Non-DR soybean injury with distance from the treated block in the West direction 21 DAT.....	19
Figure 12. Non-DR soybean height with distance from the treated block in the West direction 21 DAT.....	20
Figure 13. Non-DR soybean injury under the covered area in the West direction 21 DAT.....	21
Figure 14. Non-DR soybean injury under the non-covered area in the West direction 21 DAT.....	22
Figure 15. Non-DR soybean injury with distance from the treated block in the South direction 21 DAT.....	23
Figure 16. Non-DR soybean height with distance from the treated block in the South direction 21 DAT.....	24
Figure 17. Non-DR soybean injury under the covered area in the South direction 21 DAT.....	25
Figure 18. Non-DR soybean injury under the non-covered area in the South direction	

21 DAT.....	26
Figure 19. Distance to 5% non-DR soybean injury from edges of treated block at 14 DAT.....	27
Figure 20. Distance to 5% non-DR soybean injury from edges of treated block at 21 DAT.....	28

## List of Tables

Table 1. Weather data of the three days after POST herbicide treatment in the large scale dicamba OTM study at the University of Wisconsin-Madison.....	8
Table 2. Parameter estimation of non-DR soybean injury in the East direction from the large scale dicamba OTM study at the University of Wisconsin-Madison.....	11
Table 3. Parameter estimation of non-DR soybean height in the East direction from the large scale dicamba OTM study at the University of Wisconsin-Madison.....	12
Table 4. Parameter estimation of non-DR soybean injury in the North direction from the large scale dicamba OTM study at the University of Wisconsin-Madison.....	15
Table 5. Parameter estimation of non-DR soybean height in the North direction from the large scale dicamba OTM study at the University of Wisconsin-Madison.....	16
Table 6. Parameter estimation of non-DR soybean injury in the West direction from the large scale dicamba OTM study at the University of Wisconsin-Madison.....	19
Table 7. Parameter estimation of non-DR soybean height in the West direction from the large scale dicamba OTM study at the University of Wisconsin-Madison.....	20
Table 8. Parameter estimation of non-DR soybean injury in the South direction from the large scale dicamba OTM study at the University of Wisconsin-Madison.....	23
Table 9. Parameter estimation of non-DR soybean height in the South direction from the large scale dicamba OTM study at the University of Wisconsin-Madison.....	24

# 1 Methods

## 1.1 Plant Material and Area Management

- Soybean variety
  - Dicamba-resistant (DR) soybean: AG21X7
  - Non-DR soybean: Stine 19BA23 (GT/LL)
- Soybean seeding rate: 160,000 seeds  $\text{ac}^{-1}$  at 1.25" depth
- Soybean row width: 30" row width
- Soybean planting date: May 22
- Herbicide application
  - PRE: May 22, 4 oz  $\text{ac}^{-1}$  Sonic + 24 fl oz  $\text{ac}^{-1}$  Moccasin II Plus
  - POST: June 17, 24 fl oz  $\text{ac}^{-1}$  Durango DMA + 6 fl oz  $\text{ac}^{-1}$  Clethodim 2EC
- POST herbicide treatment (Xtendimax) application: 12:55 to 1:12 PM June 30
  - Plastic removal –
    - South transect, 2:03 PM
    - West transect, 2:10 PM
    - North transect, 2:17 PM
    - East transect, 2:24 PM
- Soybean stage at POST application date:
  - DR soybean: V5 stage; ht range – 17.5 to 26.5-cm, avg – 25-cm
  - Non-DR soybean: V5 stage; ht range – 24 to 28-cm, avg – 26.5-cm
- Results presented at 21 DAT (days after treatment)
- GPS waypoints to 5% soybean injury from treated area edges presented at 14 and 21 DAT
- Photos taken at 21 DAT

## 1.2 Modeling

*Non-DR soybean injury (%)* was collected from three soybean plant distance<sup>-1</sup> at 21 DAT. A three-parameter logistic model (Equation 1) was fit to non-DR soybean injury (%) over distance from the dicamba treated area (m) using the “drc” package 3.0-1.

Equation 1:

$$Y = \frac{d}{(1 + \exp [b(\log (x) - \log (e))])}$$

where  $Y$  is the non-DR soybean injury (%),  $x$  is the distance (m) from the dicamba treated area, the parameter  $d$  is the upper limit (asymptote), the parameter  $b$  is the slope, and the parameter  $e$  is the ED<sub>50</sub> (effective  $x$  that causes 50% reduction in  $Y$ ).

*Non-DR soybean height (cm)* was collected from three soybean plant distance<sup>-1</sup> at 21 DAT. A linear model (Equation 2) was fit to non-DR soybean height (cm) over distance from the dicamba treated area (m).

Equation 2:

$$Y = A + bx$$

Where  $Y$  is the non-DR soybean height (cm),  $x$  is the distance (m) from the dicamba treated area, and  $b$  is the slope.

## 2 Results

### 2.1 Weather Data

Table 1. Weather data of the three days after POST herbicide treatment in the large Scale dicamba OTM study at the University of Wisconsin-Madison.<sup>a</sup>

Date	Relative humidity (%)			Air temp (C)			Wind speed (m s <sup>-1</sup> )		
	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min
0-24 h	77.0	93.5	54.7	25.1	30.5	19.8	2.8	8.0	0.6
24-48 h	66.7	94.0	46.3	23.7	29.9	16.6	1.9	6.7	0.0
48-72 h	69.3	96.5	44.6	25.1	29.9	18.2	1.3	5.7	0.0

<sup>a</sup>Weather data obtained from Campbell Scientific CR300 datalogger equipped with a Vaisala Temperature/RH probe 1.7-m from the ground and a WindSonic4-L 2-D Sonic Wind Sensor with SDI-12 Output 3.1-m from the ground and programmed to collect measurements every 3-seconds to record 5-second averages for all parameters.



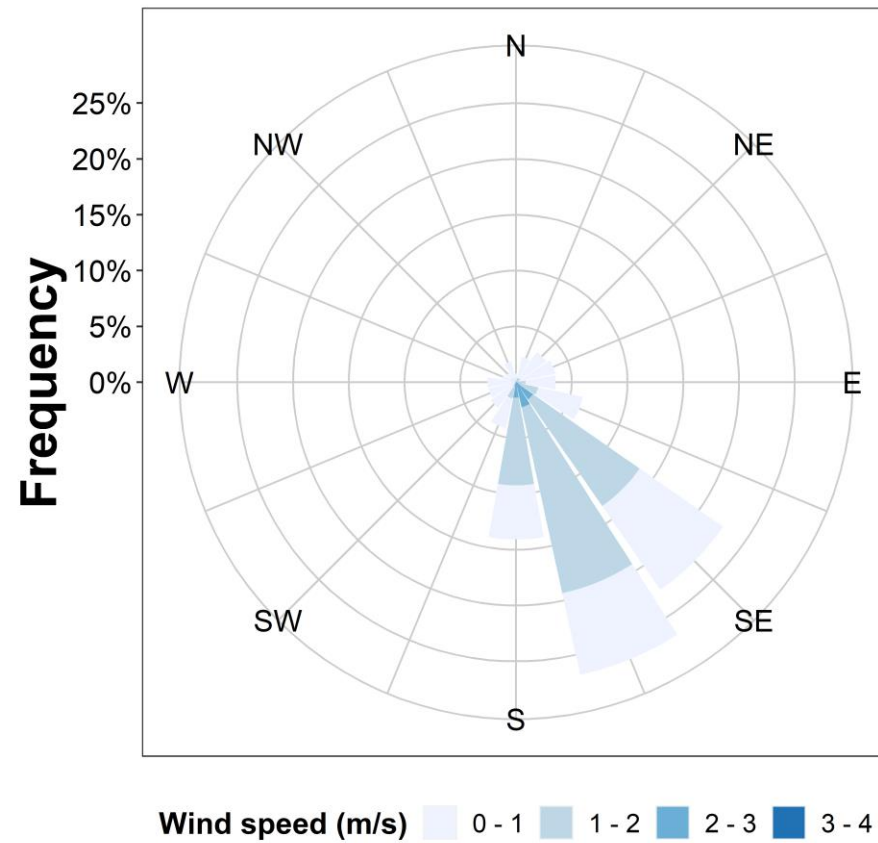


Figure 1. Wind-rose of frequency and speed averaged three days after dicamba treatment application at the University of Wisconsin-Madison.

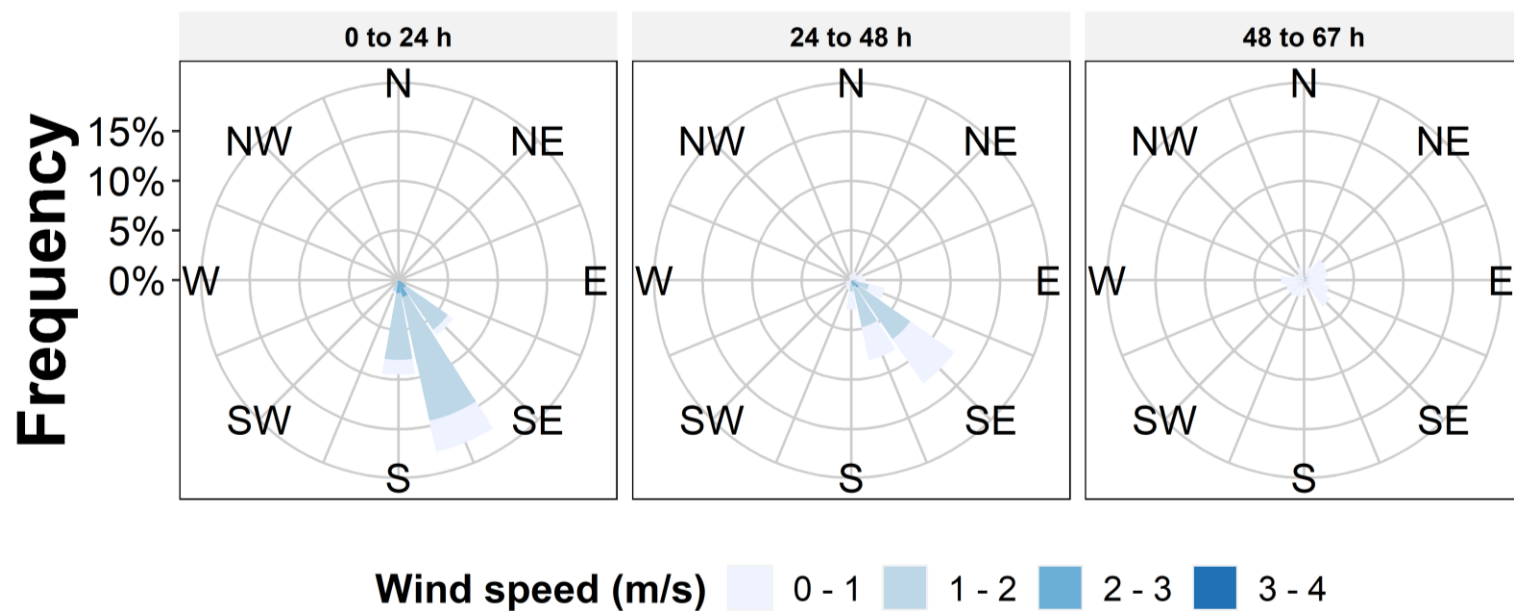
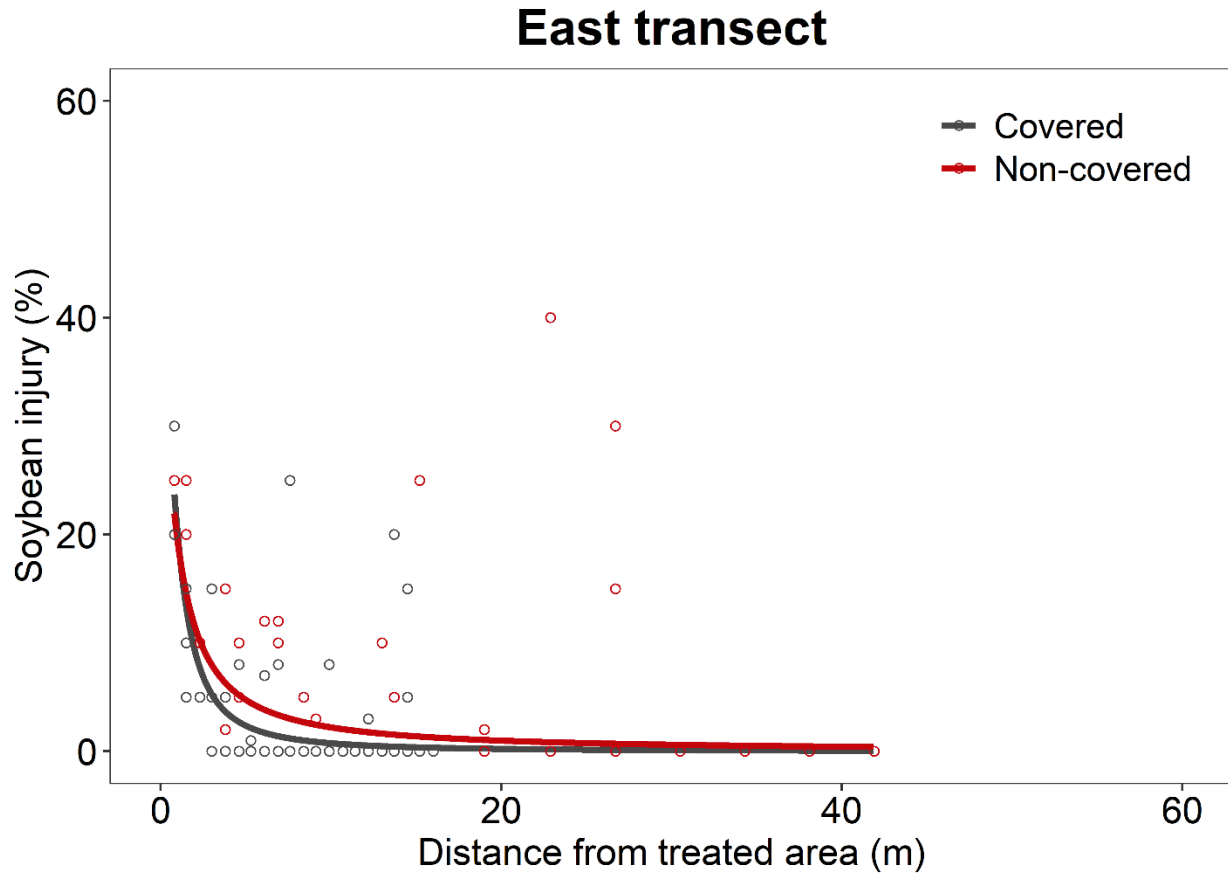


Figure 2. Wind-rose of frequency and speed in each of the three days after dicamba treatment application at the University of Wisconsin-Madison.

## 2.2 Modeling injury on non-DR soybean

### 2.2.1 East



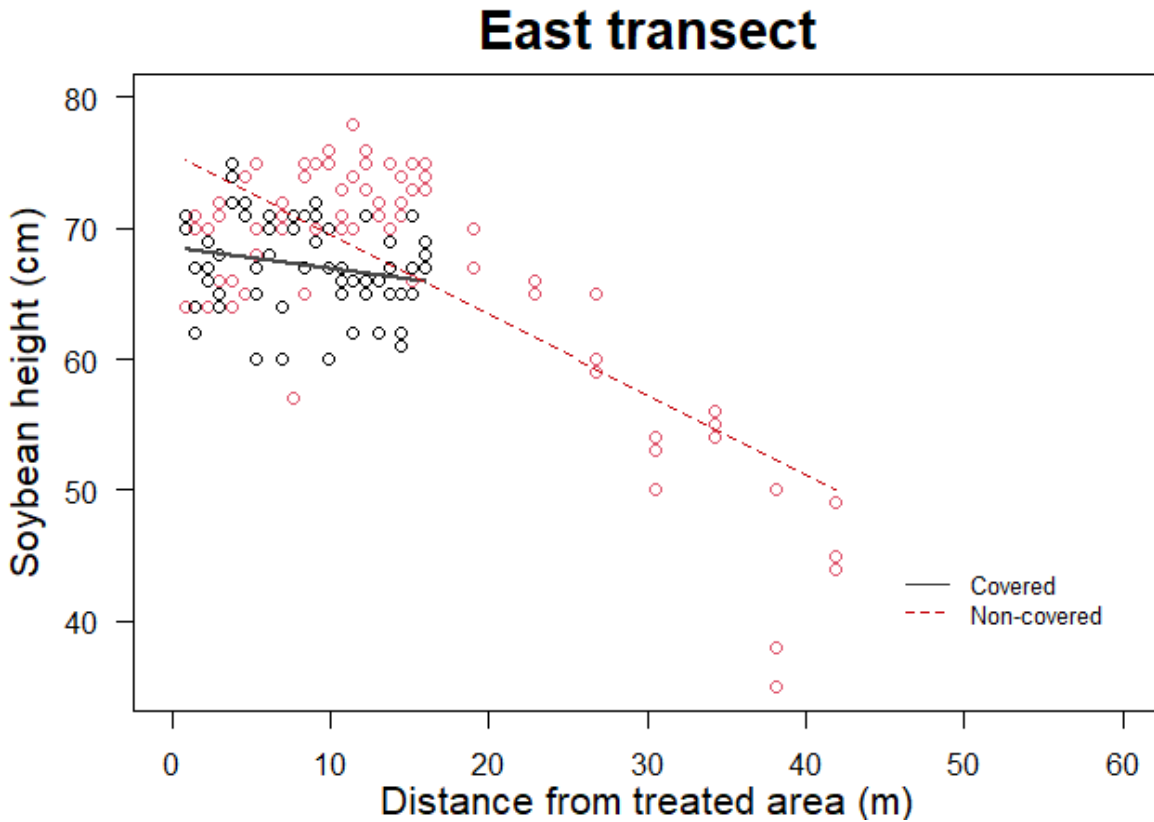
Source: University of Wisconsin-Madison Cropping Systems Weed Science, 2020

Figure 3. Non-DR soybean injury with distance from the treated block in the East direction 21 DAT.

Table 2. Parameter estimation of non-DR soybean injury in the East direction from the large scale dicamba OTM study at the University of Wisconsin-Madison.

Parameter	Type	Estimate	Standard error	P-value
Slope	Covered	1.7	0.5	0.00
	Non-covered	1.2	0.3	0.00
Upper limit	Covered	40.0 <sup>a</sup>	na	na
	Non-covered	40.0 <sup>a</sup>	na	na
Inflection point	Covered	1.0	0.2	0.00
	Non-covered	0.9	0.2	0.00

<sup>a</sup>Parameter was set to maximum observed injury due to model overfitting.



Source: University of Wisconsin-Madison Cropping Systems Weed Science, 2020

Figure 4. Non-DR soybean height with distance from the treated block in the East direction 21 DAT.

Table 3. Parameter estimation of non-DR soybean height in the East direction from the large scale dicamba OTM study at the University of Wisconsin-Madison.

Parameter	Type	Estimate	Standard error	P-value
Intercept	Covered	68.5	0.9	0.00
	Non-covered	75.8	1.0	0.00
Slope	Covered	-0.2	0.1	0.10
	Non-covered	-0.6	0.1	0.00

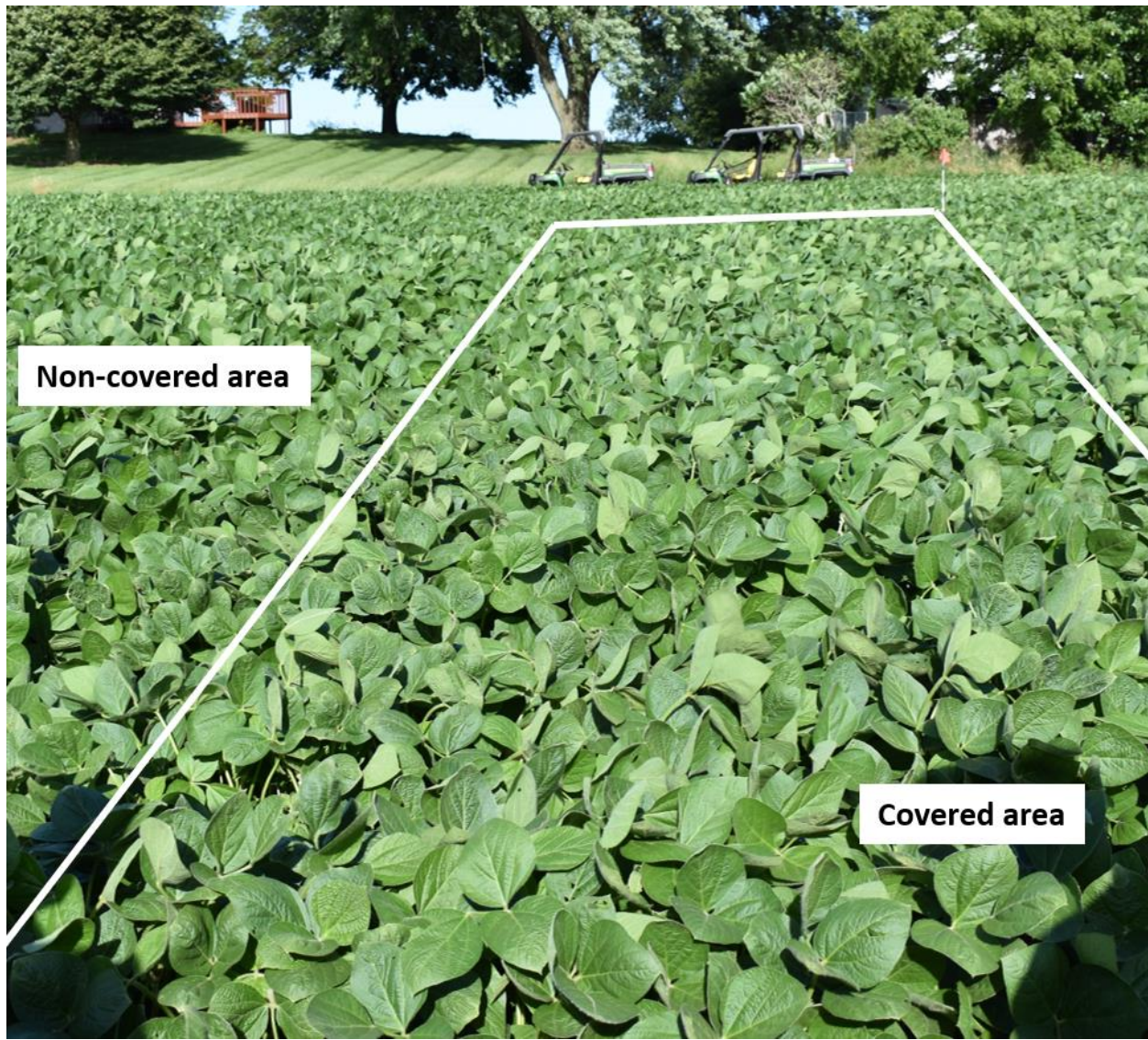


Figure 5. Non-DR soybean injury under the covered area in the East direction 21 DAT.





Figure 6. Non-DR soybean injury under the non-covered area in the East direction 21 DAT.

### 2.2.2 North

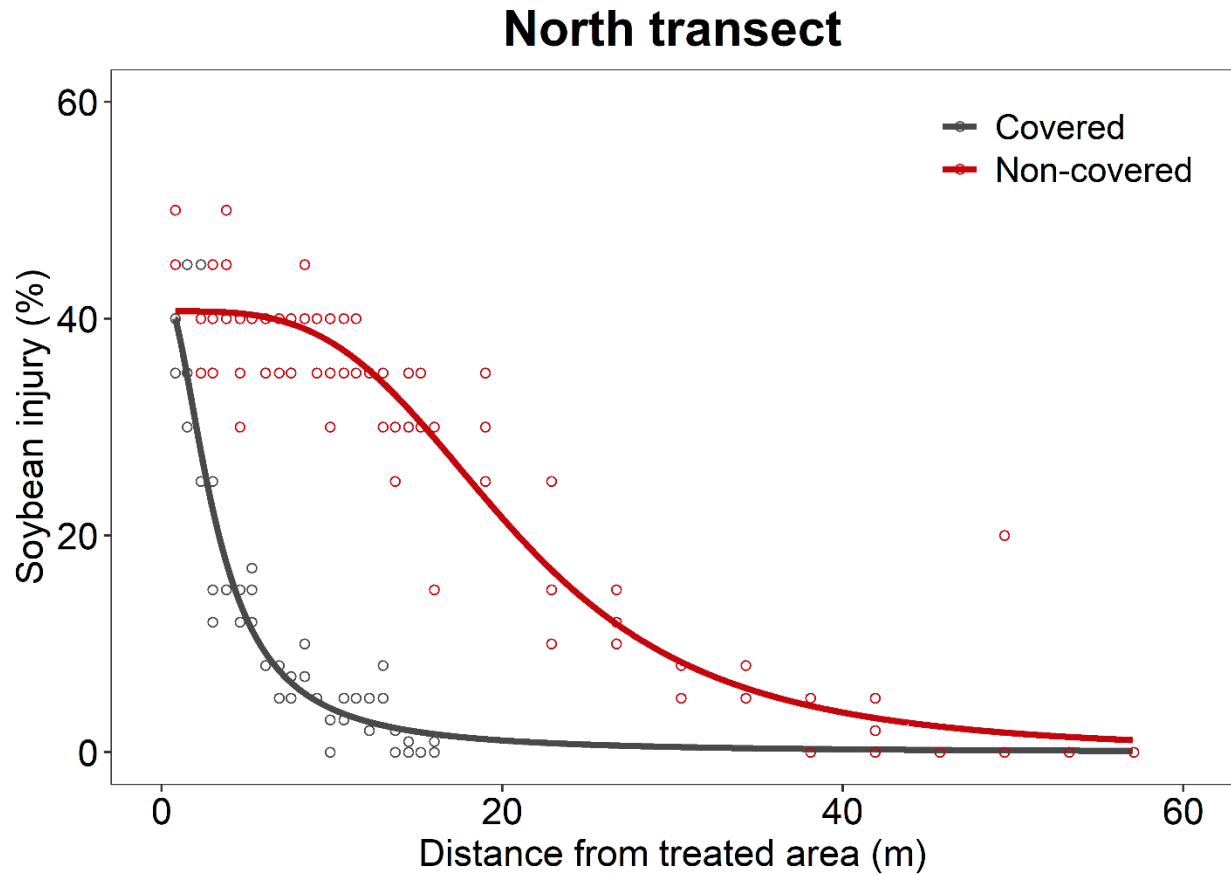


Figure 7. Non-DR soybean injury with distance from the treated block in the North direction 21 DAT.

Table 4. Parameter estimation of non-DR soybean injury in the North direction from the large scale dicamba OTM study at the University of Wisconsin-Madison.

Parameter	Type	Estimate	Standard error	P-value
Slope	Covered	2.0	0.2	0.00
	Non-covered	3.5	0.3	0.00
Upper limit	Covered	42.7	3.2	0.00
	Non-covered	40.7	0.8	0.00
Inflection point	Covered	3.1	0.3	0.00
	Non-covered	20.7	0.7	0.00

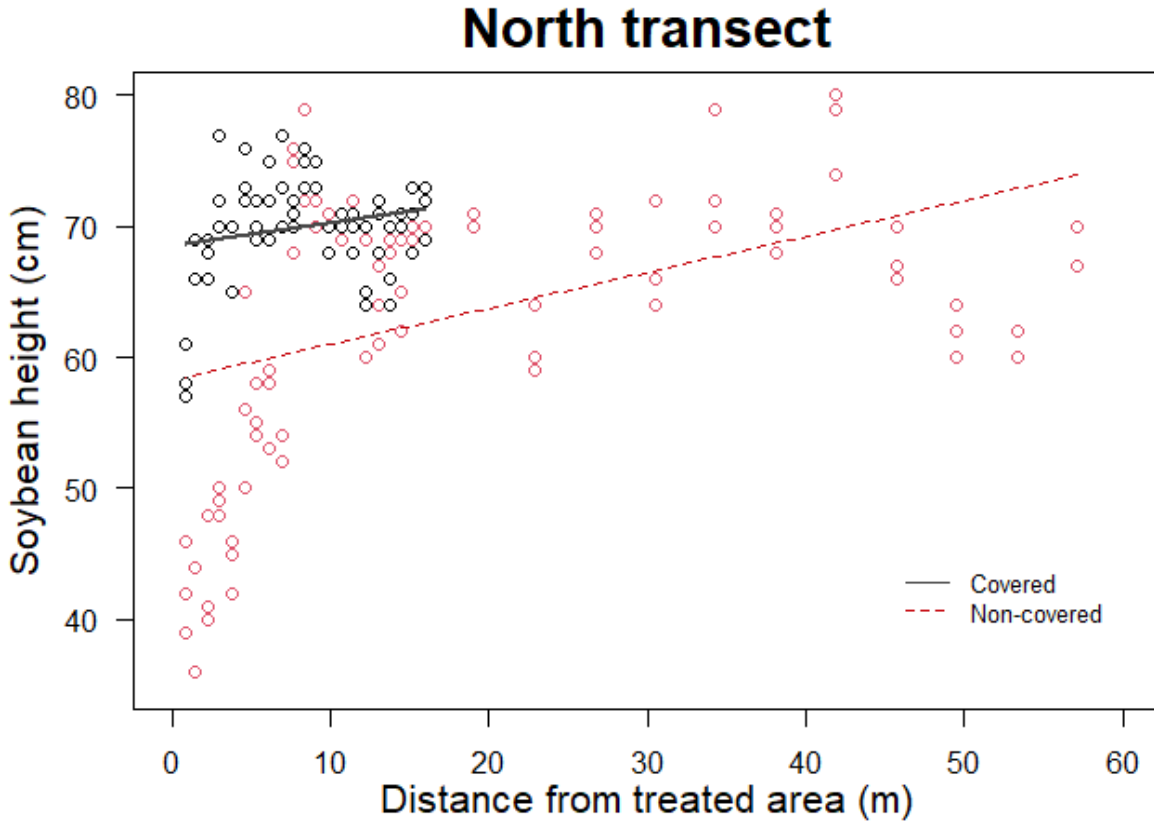


Figure 8. Non-DR soybean height with distance from the treated block in the North direction 21 DAT.

Table 5. Parameter estimation of non-DR soybean height in the North direction from the large scale dicamba OTM study at the University of Wisconsin-Madison.

Parameter	Type	Estimate	Standard error	P-value
Intercept	Covered	68.5	1.0	0.00
	Non-covered	58.2	1.5	0.00
Slope	Covered	0.2	0.1	0.10
	Non-covered	0.3	0.1	0.00



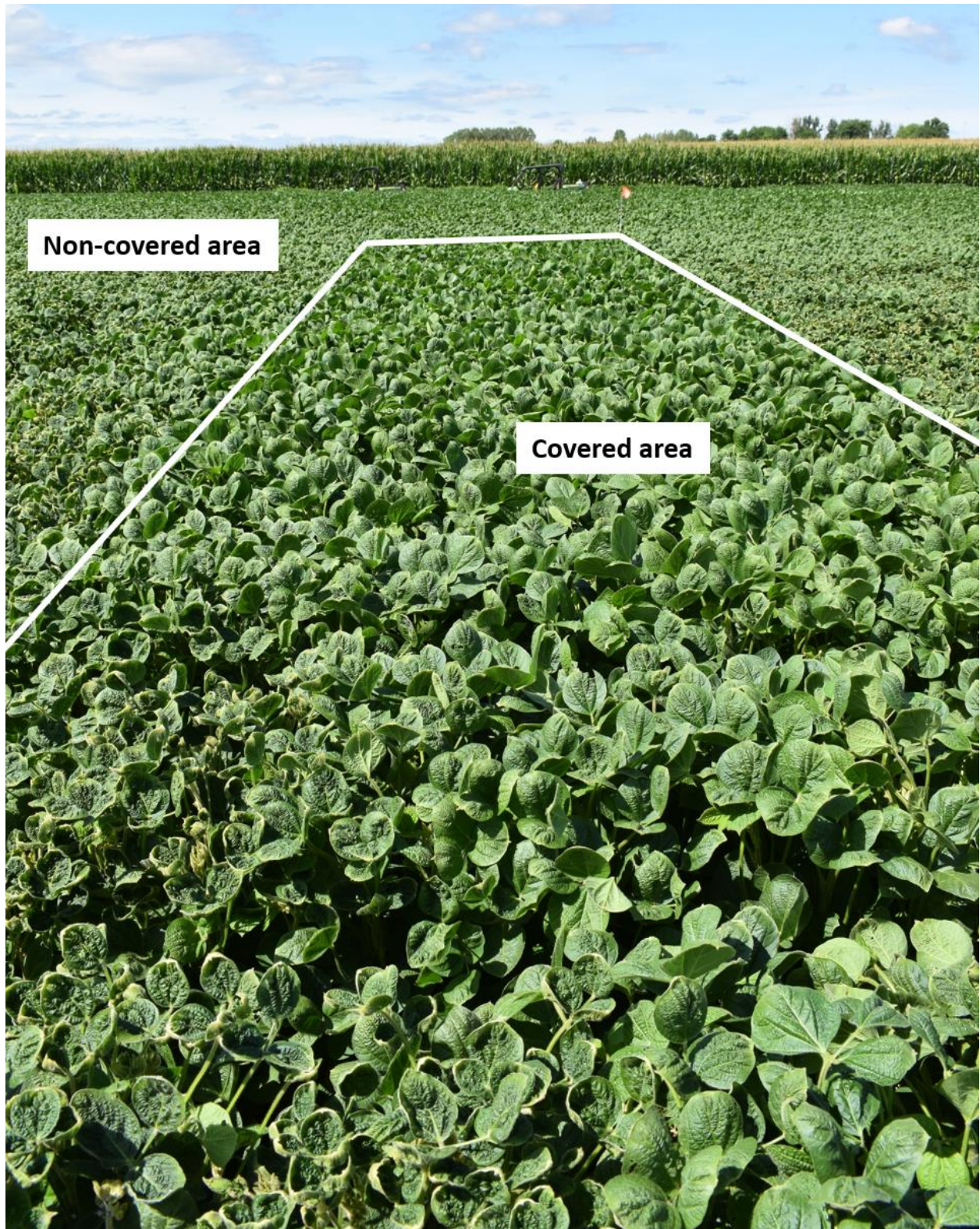


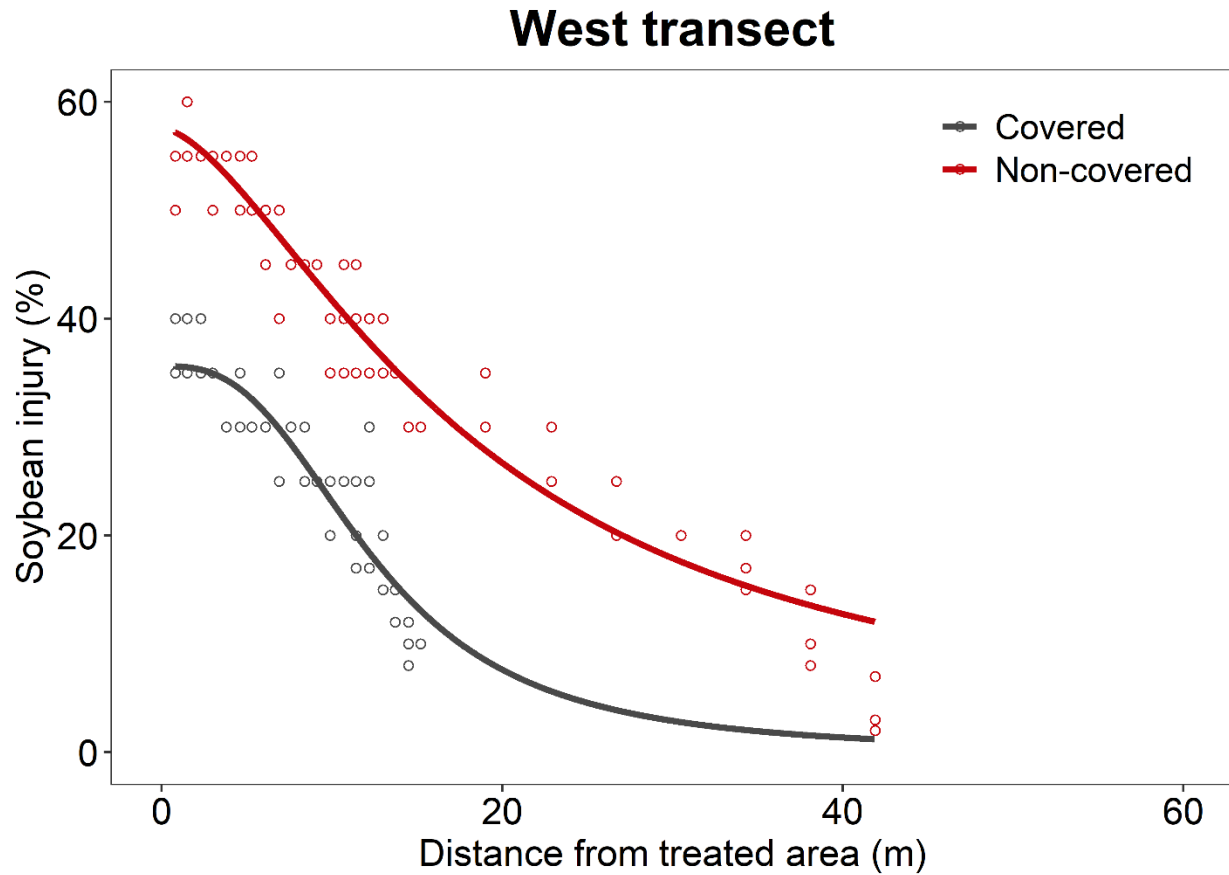
Figure 9. Non-DR soybean injury under the covered area in the North direction 21 DAT.





Figure 10. Non-DR soybean injury under the non-covered area in the North direction 21 DAT.

### 2.2.3 West

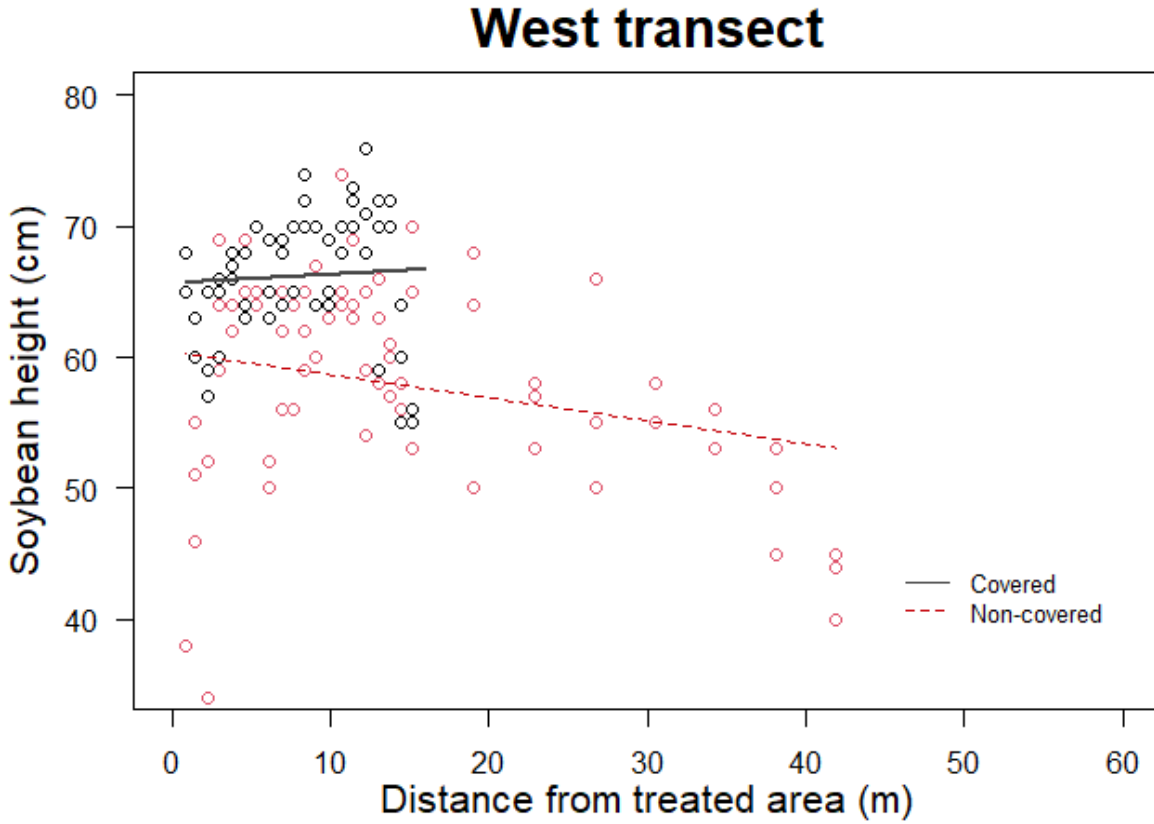


Source: University of Wisconsin-Madison Cropping Systems Weed Science, 2020

Figure 11. Non-DR soybean injury with distance from the treated block in the West direction 21 DAT.

Table 6. Parameter estimation of non-DR soybean injury in the West direction from the large scale dicamba OTM study at the University of Wisconsin-Madison.

Parameter	Type	Estimate	Standard error	P-value
Slope	Covered	2.8	0.5	0.00
	Non-covered	1.6	0.1	0.00
Upper limit	Covered	35.6	1.3	0.00
	Non-covered	57.6	1.2	0.00
Inflection point	Covered	12.5	0.5	0.00
	Non-covered	18.3	0.8	0.00



Source: University of Wisconsin-Madison Cropping Systems Weed Science, 2020

Figure 12. Non-DR soybean height with distance from the treated block in the West direction 21 DAT.

Table 7. Parameter estimation of non-DR soybean height in the West direction from the large scale dicamba OTM study at the University of Wisconsin-Madison.

Parameter	Type	Estimate	Standard error	P-value
Intercept	Covered	65.8	1.4	0.00
	Non-covered	60.5	1.6	0.00
Slope	Covered	0.1	0.1	0.67
	Non-covered	-0.2	0.1	0.05



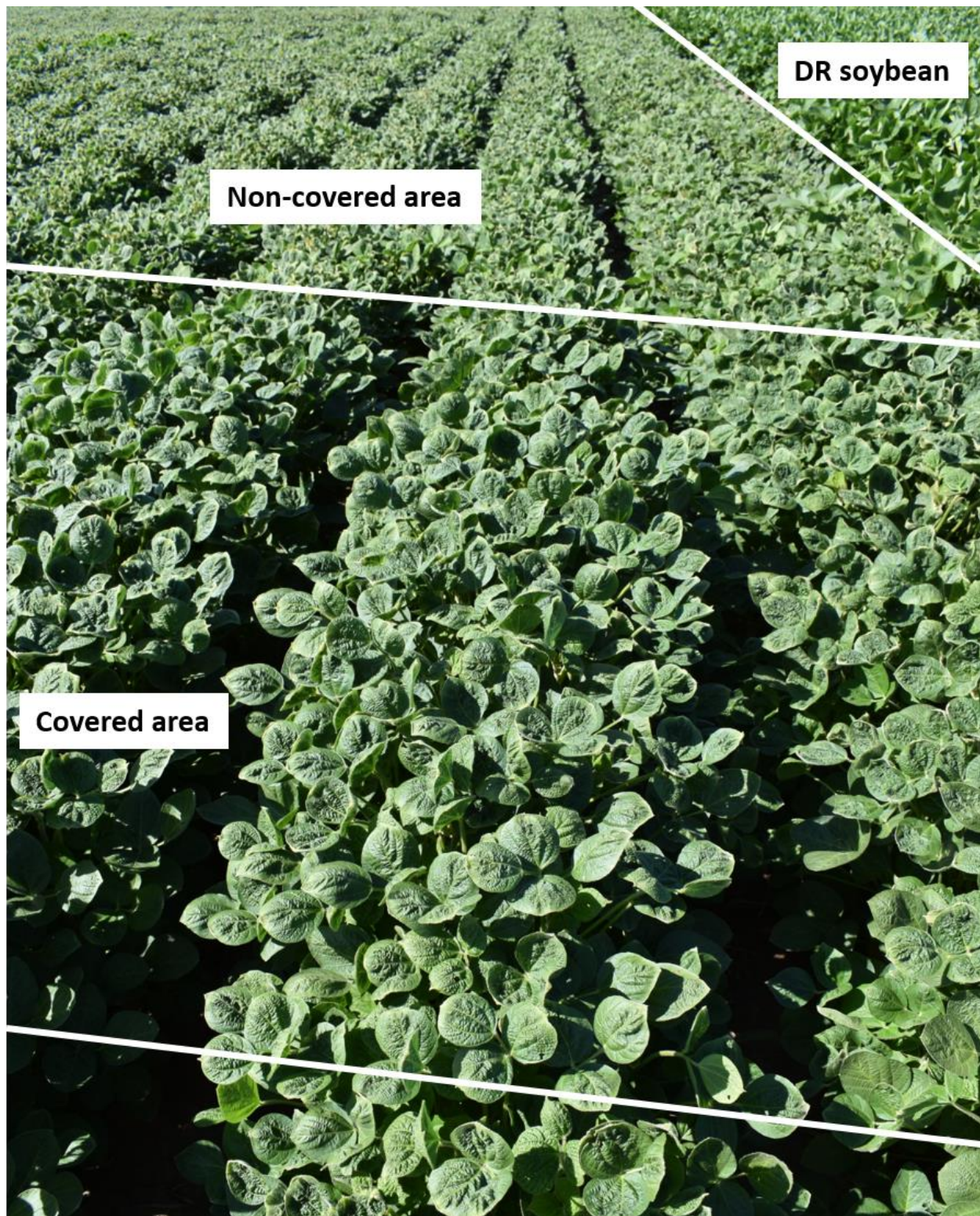


Figure 13. Non-DR soybean injury under the covered area in the West direction 21 DAT.





Figure 14. Non-DR soybean injury under the non-covered area in the West direction 21 DAT.

## 2.2.4 South

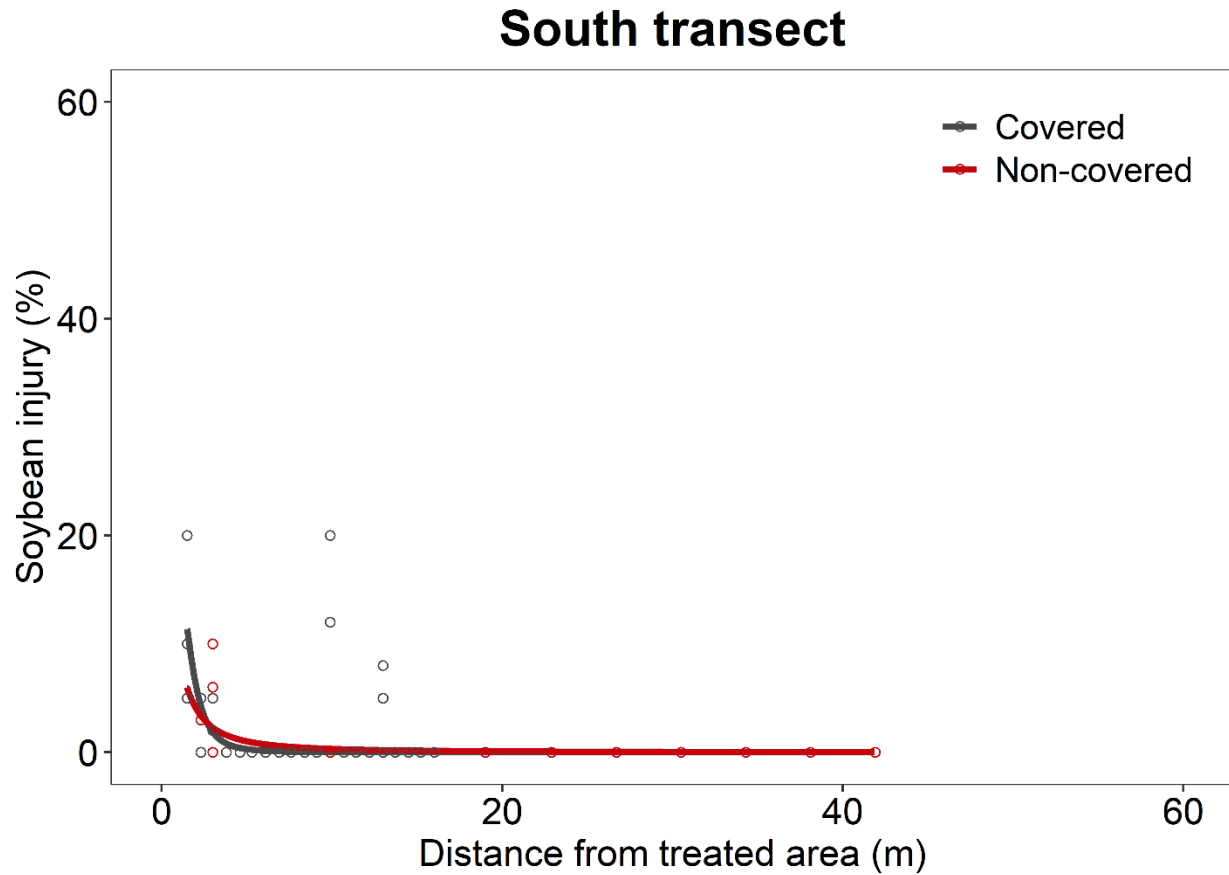


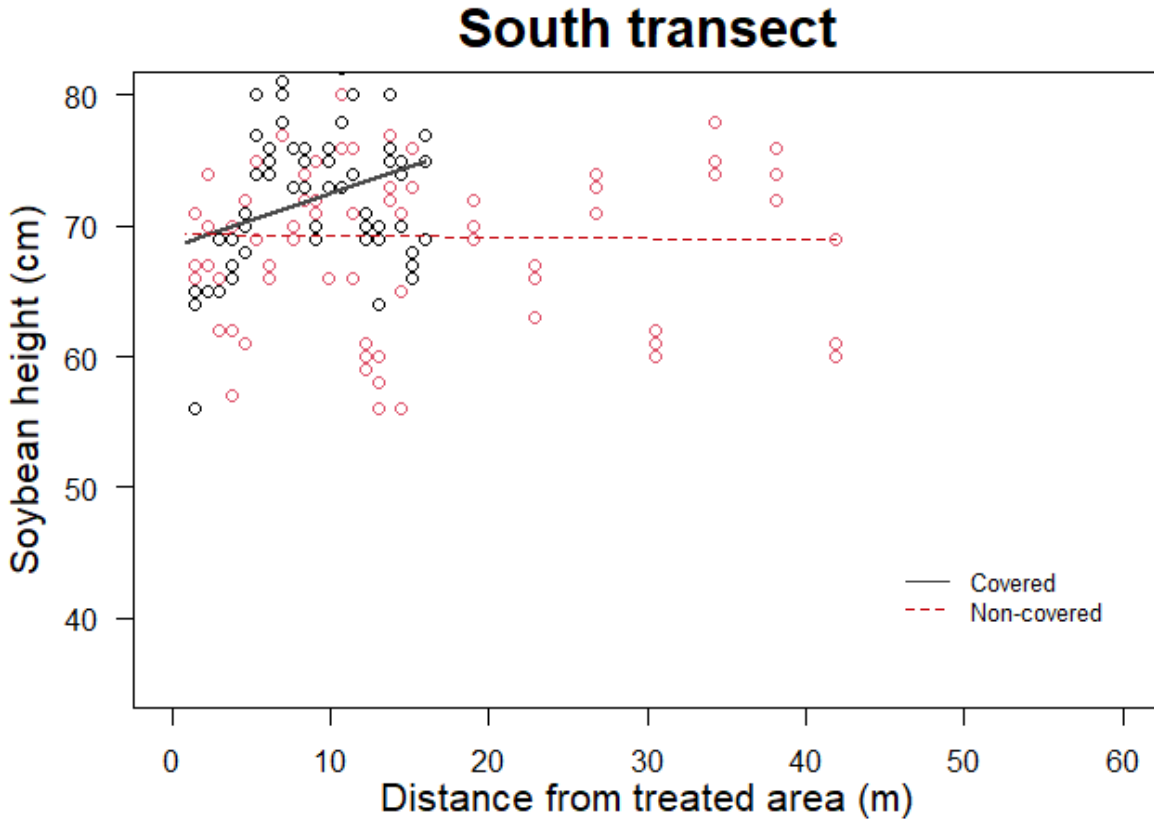
Figure 15. Non-DR soybean injury with distance from the treated block in the South direction 21 DAT.<sup>b</sup>

Table 8. Parameter estimation of non-DR soybean injury in the South direction from the large scale dicamba OTM study at the University of Wisconsin-Madison.<sup>b</sup>

Parameter	Type	Estimate	Standard error	P-value
Slope	Covered	3.7	1.4	0.01
	Non-covered	1.7	0.6	0.00
Upper limit	Covered	20.0 <sup>a</sup>	na	na
	Non-covered	20.0 <sup>a</sup>	na	na
Inflection point	Covered	1.6	0.1	0.00
	Non-covered	0.9	0.3	0.01

<sup>a</sup>Parameter was set to maximum observed injury due to model overfitting.

<sup>b</sup>Data collected 0.8-m from treated area were excluded from modeling for this transect due to direct exposure and extreme values (e.g. 80% injury and 20-cm ht).



Source: University of Wisconsin-Madison Cropping Systems Weed Science, 2020

Figure 16. Non-DR soybean height with distance from the treated block in the South direction 21 DAT.<sup>b</sup>

Table 9. Parameter estimation of non-DR soybean height in the South direction from the large scale dicamba OTM study at the University of Wisconsin-Madison.<sup>b</sup>

Parameter	Type	Estimate	Standard error	P-value
Intercept	Covered	68.4	1.3	0.00
	Non-covered	69.4	1.9	0.00
Slope	Covered	0.4	0.1	0.00
	Non-covered	0.0	0.1	0.11

<sup>b</sup>Data collected 0.8-m from treated area were excluded from modeling for this transect due to direct exposure and extreme values (e.g. 80% injury and 20-cm ht).



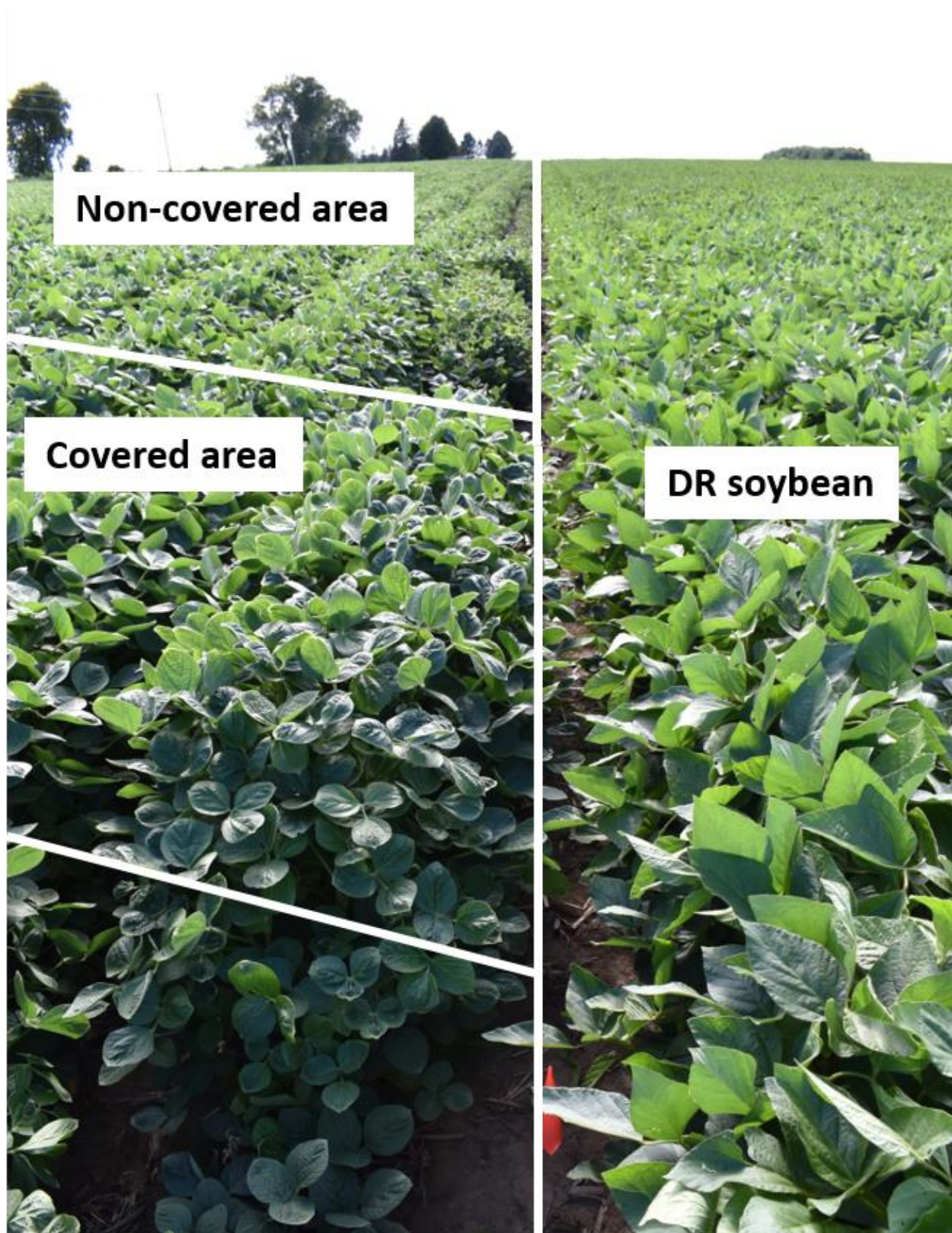


Figure 17. Non-DR soybean injury under the covered area in the South direction 21 DAT.



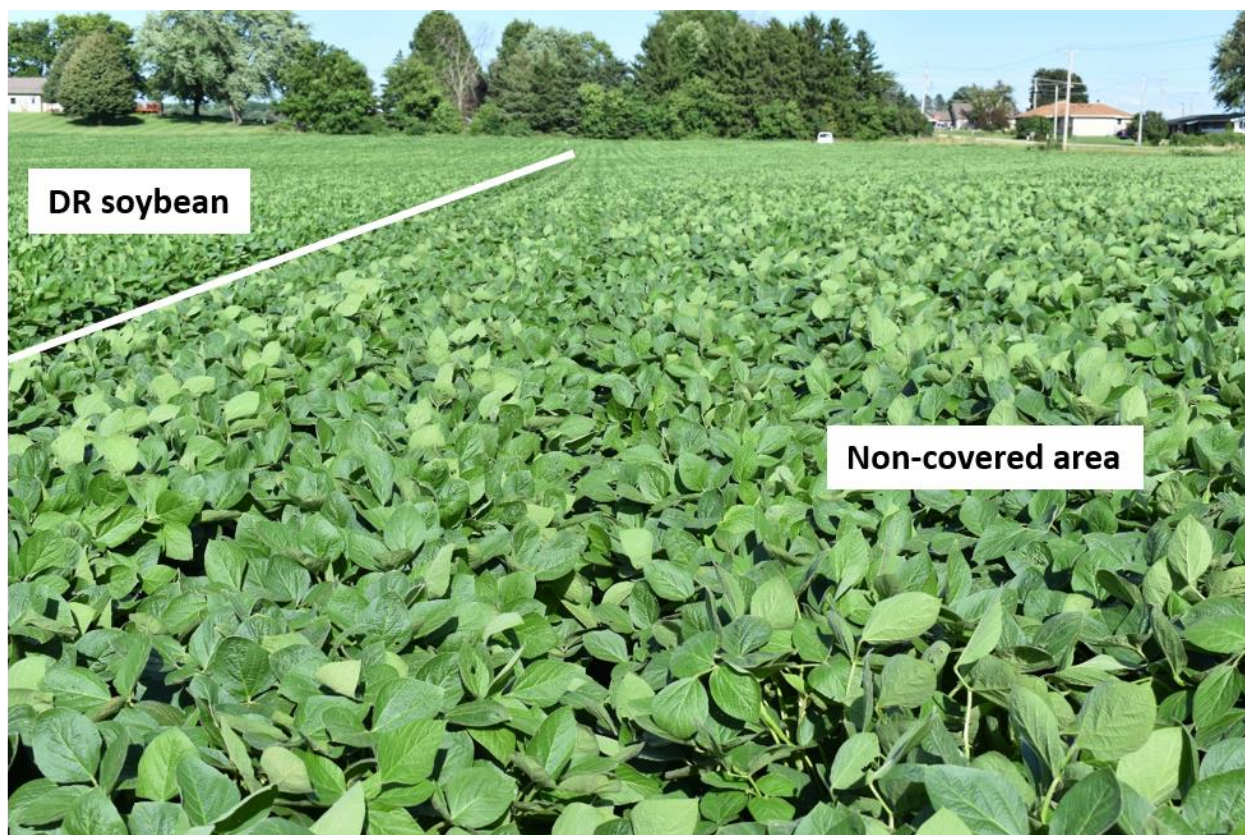


Figure 18. Non-DR soybean injury under the non-covered area in the South direction 21 DAT.

### 2.3 GPS mapping to 5% injury.



Figure 19. Distance to 5% non-DR soybean injury from edges of treated block at 14 DAT.



Figure 20. Distance to 5% non-DR soybean injury from edges of treated block at 21 DAT.