Dynamics of infection and fungicide resistance in CLS field trials

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Cercospora Leaf Spot (CLS)

The most economically important foliar disease of sugarbeet in Minnesota

Symptoms:

- Brown or tan spots, gray centers

  Smaller lesions than other diseases

Pseudostromata form in center of lesion

- Leaves become brown and die as lesions grow together/multiply

Photo: O. Neher

Cercospora Leaf Spot (CLS)

Environmental risk factors:

- High relative humidity
- Leaf wetness (dew or rain)
- Row closure promotes a humid canopy and wet leaves

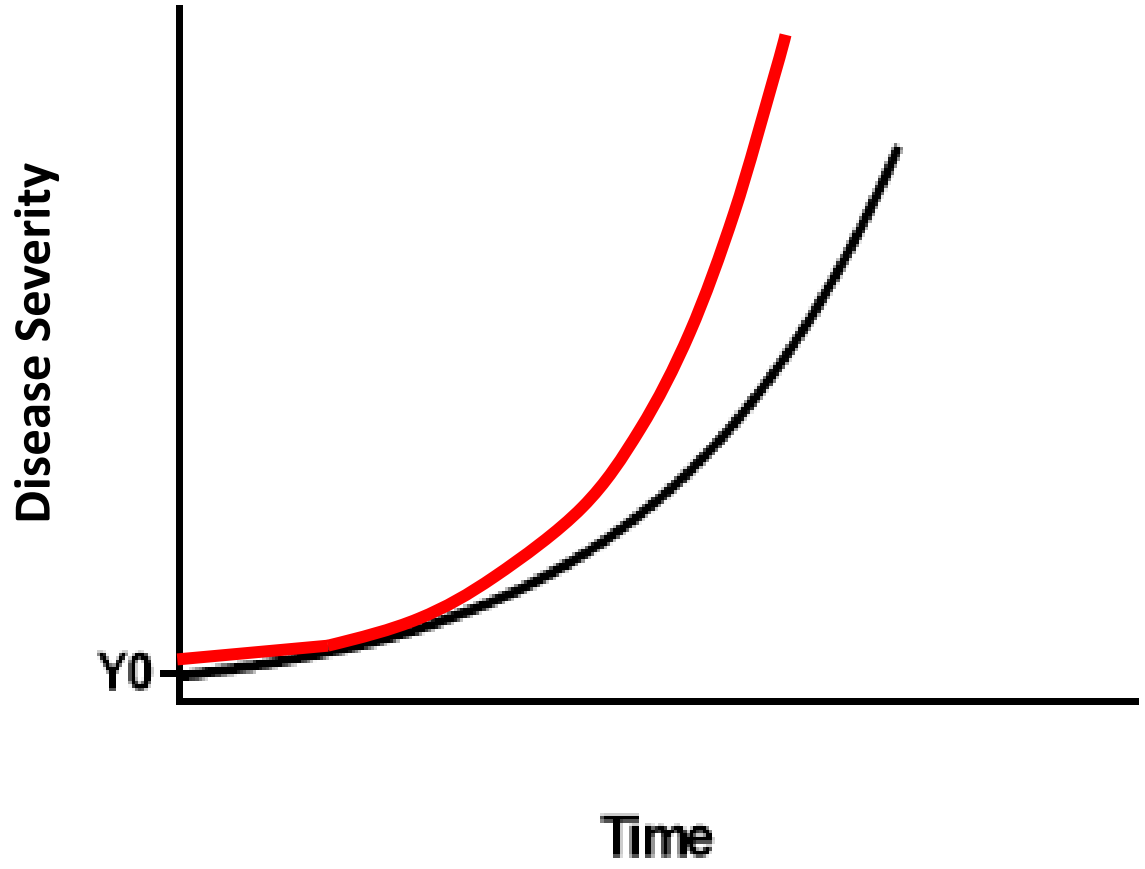
- 80°F daytime, 60°F night temperatures

CLS field trial, September 2024

Cercospora biology affects management

Polycyclic disease cycle

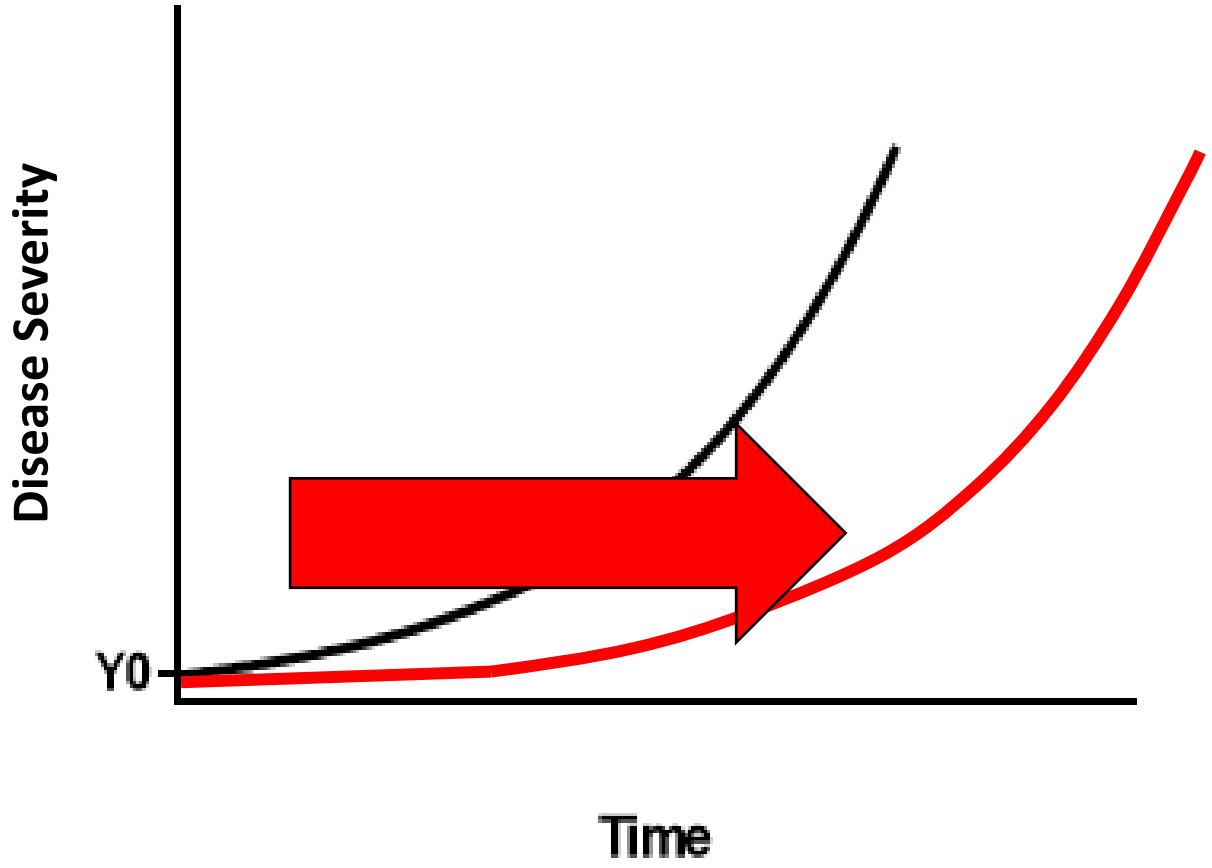
- Each CLS lesion produces hundreds of spores
- If <u>just one</u> additional lesion forms, there is exponential growth



The Goal:

Reduce CLS disease progression

Maintain healthy sugarbeet plant season-long



CLS Field Trial Objectives

1. Assess different fungicide program **start dates and spray intervals** to control CLS and improve yield and RSA

2. Evaluate the relationship between latent *C. beticola* infections and June or July fungicide program start dates.

3. Investigate changes in resistance profiles of *C. beticola* populations following fungicide applications

Note: objectives 2 and 3 are in progress

Methods: Field Trials

Replicated small-plot field trials

- One CR+ and one non-CR+ variety used
- 10 treatments (per variety)
- Plots were 6 rows, 30 feet long with rows 2-5 treated
- 4 replications

Repeated at two locations

- Kragnes, MN
- Foxhome, MN

Focus for today

July 8th, 2024, Foxhome

Foxhome trial background

Planting Date: April 23rd

Harvest: September 25th

Environment:

Month	Rainfall (inches)	Average Temperature (max/min, °F)
April (23rd-30th)	**2.9**	**58 / 39**
May	**5.5**	**69 / 46**
June	**4.4**	**76 / 54**
July	**5.0**	**82 / 61**
August	**2.9**	**78 / 57**
September (1st-25th)	**0.1**	**79 / 53**

Methods: Fungicide Applications

All treatments received fungicides in the same sequence

- Only spray timing (program start date and intervals) differed between treatment

- 0 to 6 applications per treatment

Tractor-mounted sprayer, 4 rows

Trials were inoculated July 10th

Ground-leaf Cercospora inoculum was applied (mixed with talc at a 2:1 ratio)

Approximately 3 grams applied per row

- 18 grams per plot (6 rows)

Applied by hand

Fungicide Sequence

Application	Mode of action	Product @ Rate
1st	EBDC	Koverall @ 2 lbs/A
2nd	DMI (tetraconazole) + EBDC	Minerva @ 13 fl oz/A + Koverall @ 2 lbs/A
3rd	Tin + EBDC	Super Tin @ 8 fl oz/A + Koverall @ 2 lbs/A
4th	DMI (difenoconazole, Propiconazole) + EBDC	Inspire XT @ 7 fl oz/A + Koverall @ 2 lbs/A
5th	Tin + EBDC	Super Tin @ 8 fl oz/A + Koverall @ 2 lbs/A
6th	Copper + EBDC	Badge SC @ 2 pt/A + Koverall @ 2 lbs/A

Fungicide Timing

Treatment	Program start date		Interval	Number of applications
1	Mid June	6/14	10-14 days	6
2	Late June	6/28	10-14 days	5
3	Late June	6/28	based on DIV	4
4	Late June	6/28	10-14, then 21-28 days	4
5	Early July	7/12	10-14 days	4
6	Early July	7/12	10-14, then 21-28 days	3
7	Early July	7/12	Based on DIV	3
8	Disease onset	7/29	10-14 days	3
9	3-5% CLS severity	8/12	10-14 days	2
10	Nontreated check	-	-	0

Fungicide Timing

Treatment	Program start date		Interval	Number of applications
1	Mid June	6/14	10-14 days	6
2	Late June	6/28		
3	Late June	6/28		
4	Late June	6/28	10-14, then 21-28 days	4
5	Early July	7/12		
6	Early July	7/12	10	
7	Early July	7/12	Based on DIV	3
8	Disease onset	7/29	10-14 days	3
9	3-5% CLS severity	8/12	10-14 days	2
10	Nontreated check	-	-	0

Pre-row closure

Row closure

Fungicide Timing

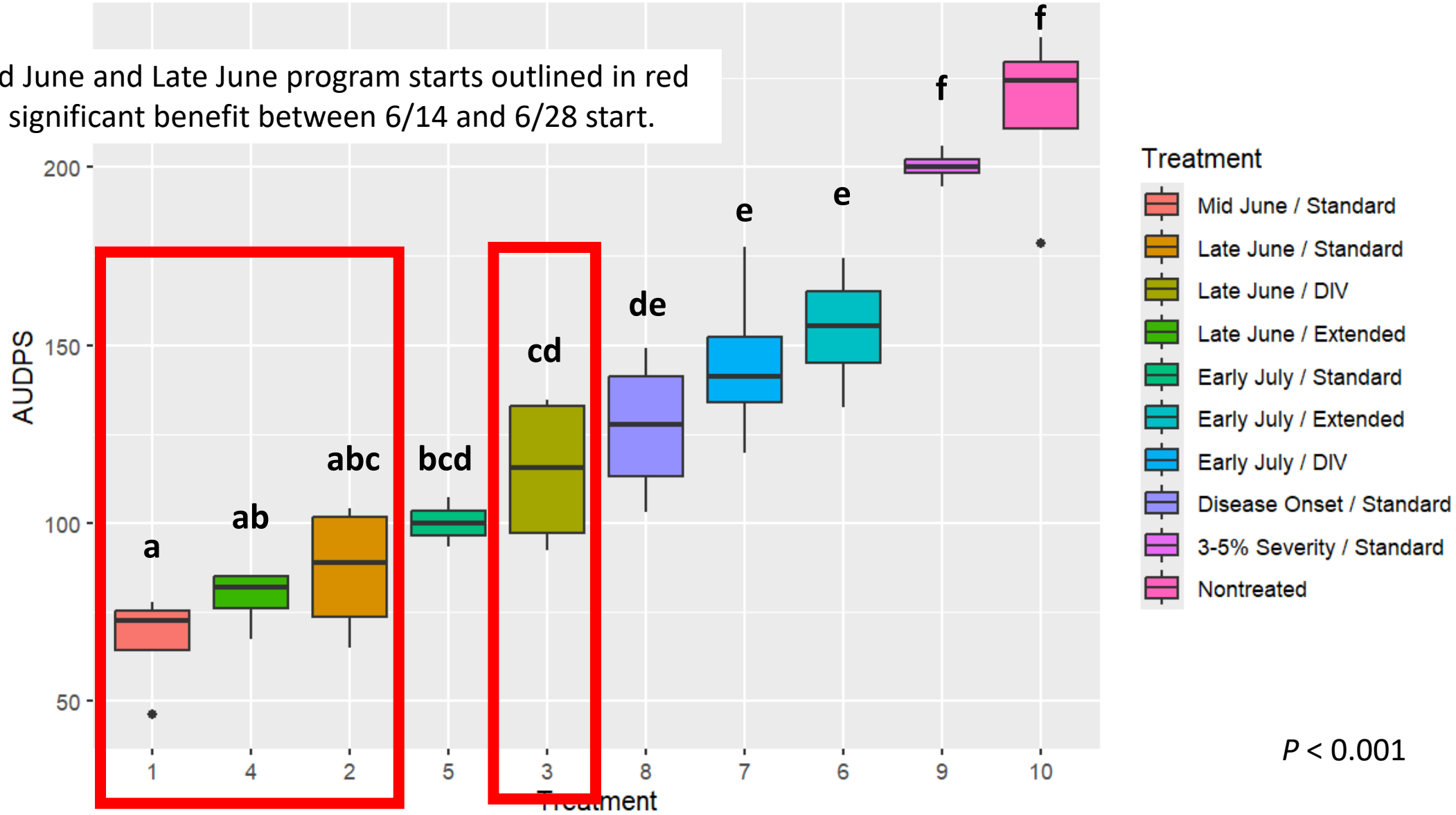
Treatment	Program start date		Interval	Number of applications
1	Mid June	6/14	10-14 days	6
2				5
3				4
4			ys	4
5				4
6			ys	3
7				3
8				3
9	3-5% CLS severity	8/12	10-14 days	2
10	Nontreated check	-	-	0

10-14 days = “**standard**”

10-14, then 21-28 days = “**extended**”

CLS disease severity (AUDPS) in CR+ sugarbeet

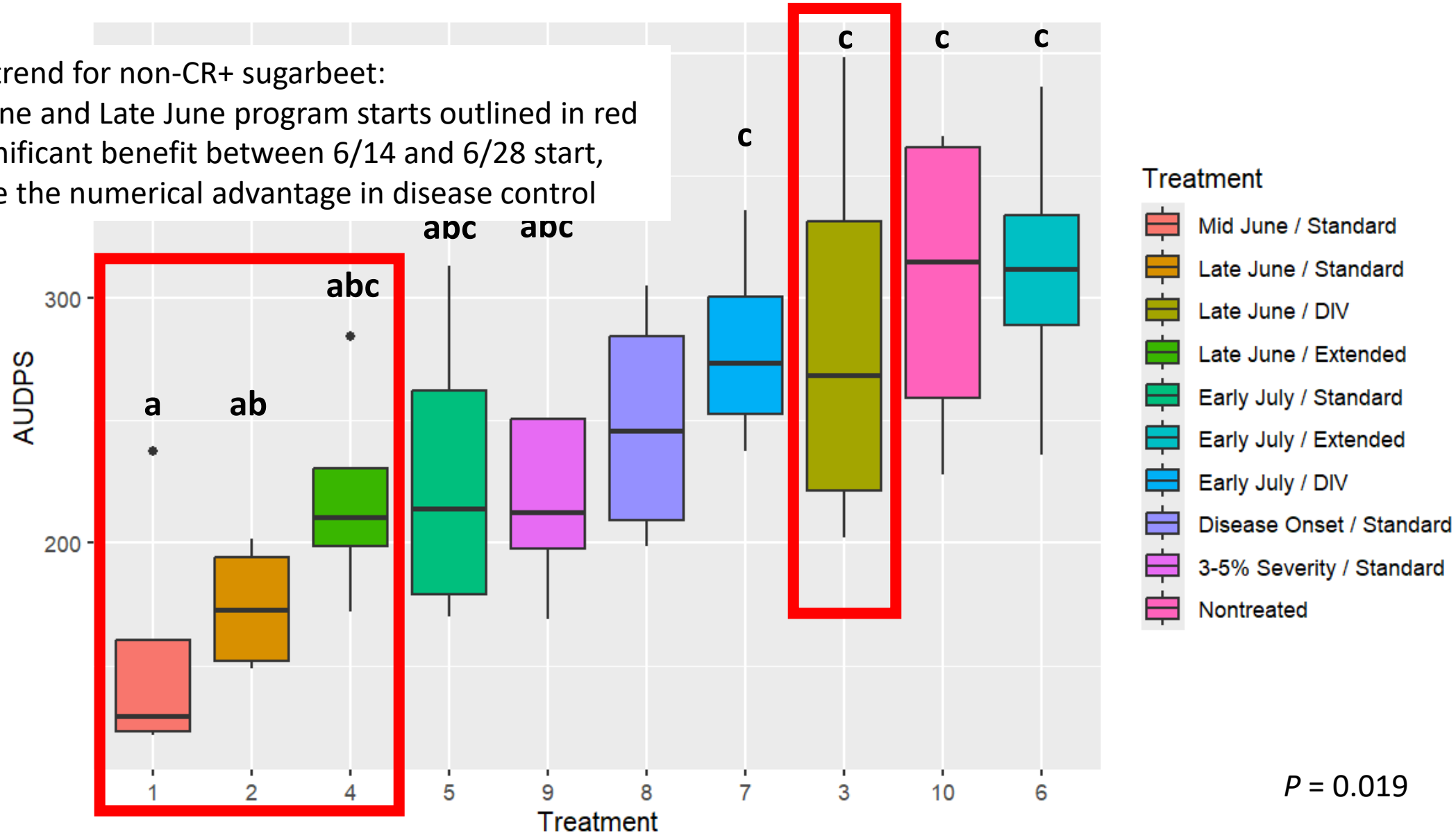
Mid June and Late June program starts outlined in red
No significant benefit between 6/14 and 6/28 start.



$P < 0.001$

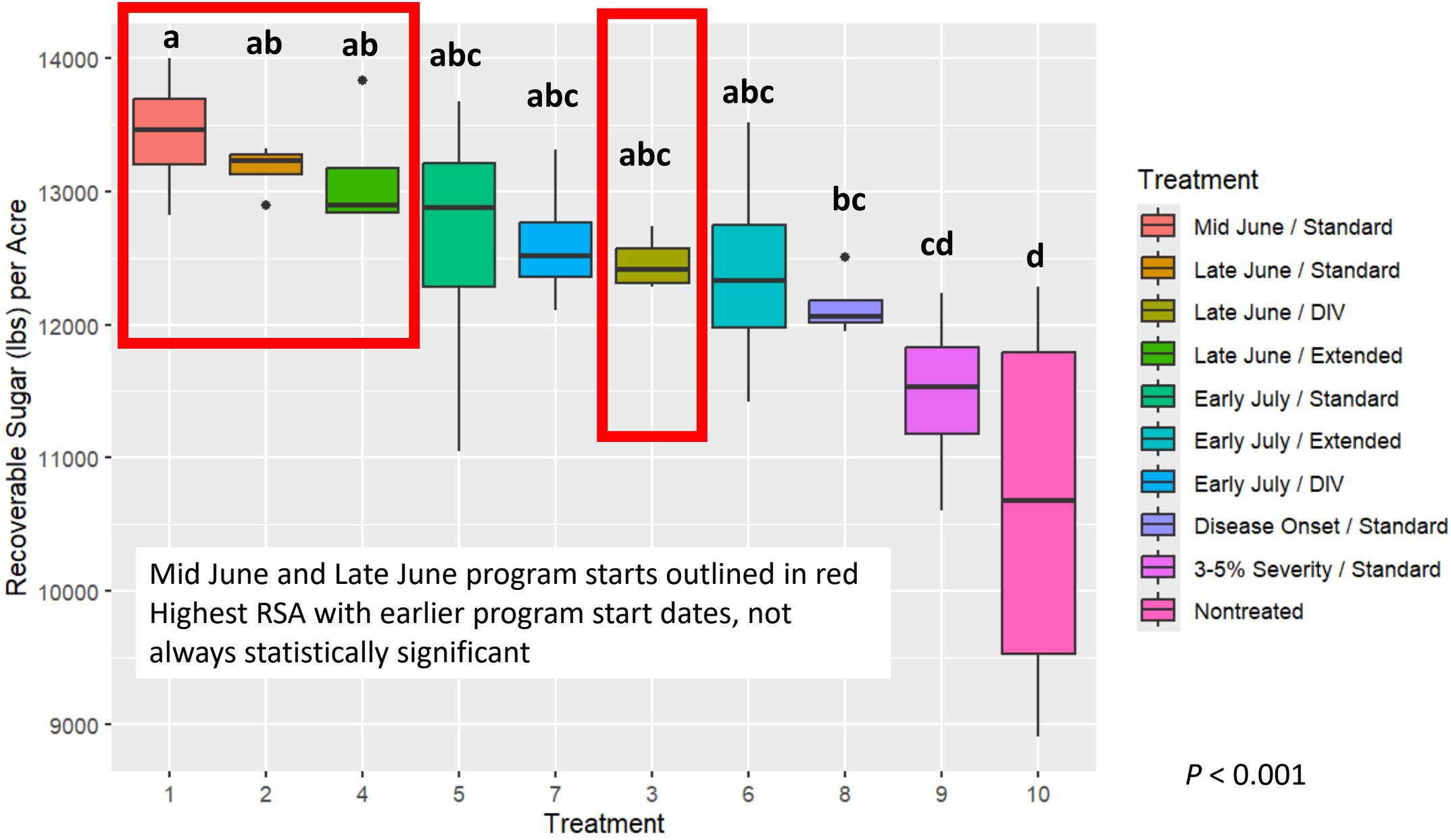
CLS disease severity (AUDPS) in non-CR+ sugarbeet

Same trend for non-CR+ sugarbeet:
Mid June and Late June program starts outlined in red
No significant benefit between 6/14 and 6/28 start, despite the numerical advantage in disease control



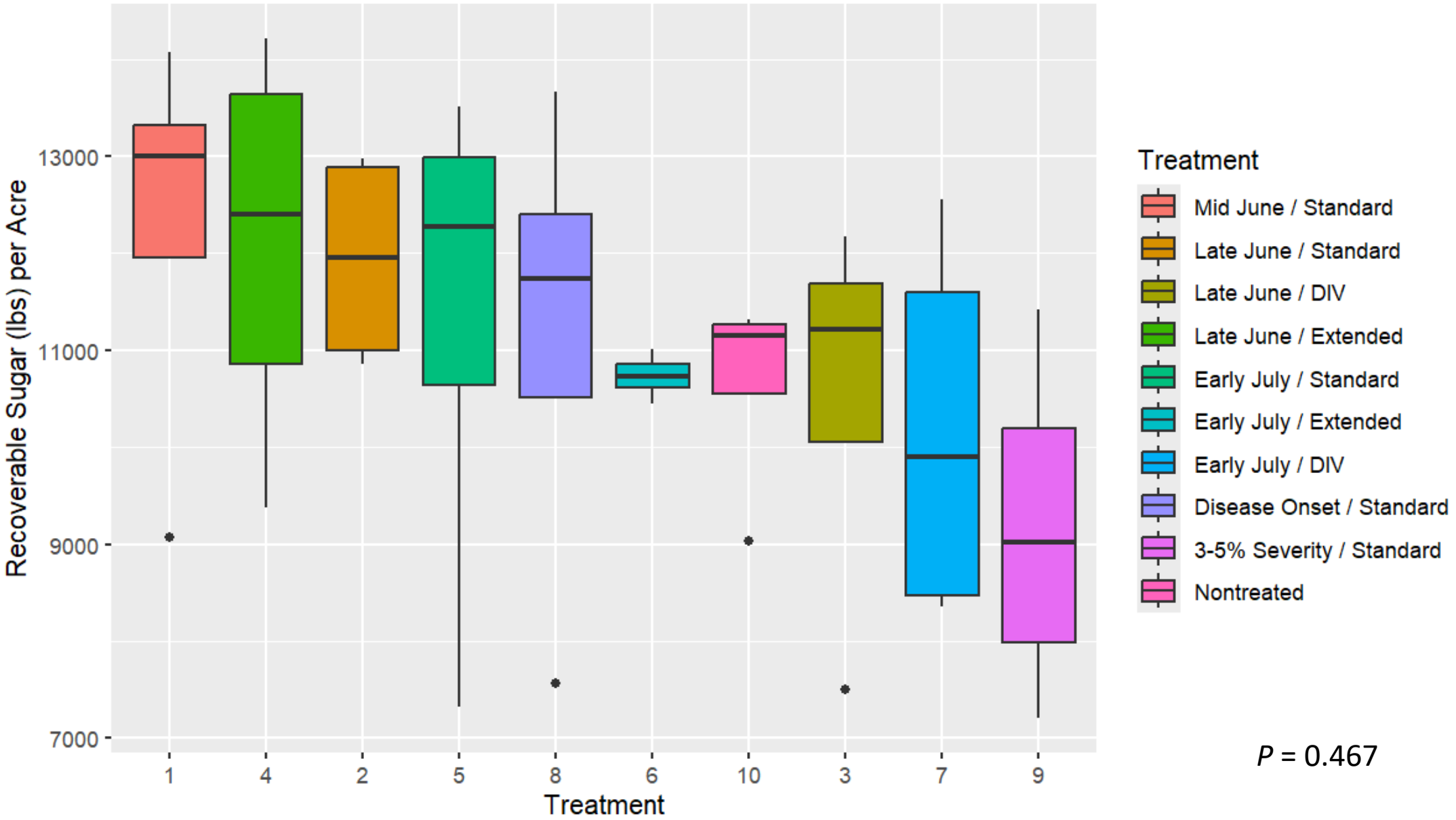
P = 0.019

Recoverable sugar per acre in CR+ sugarbeet



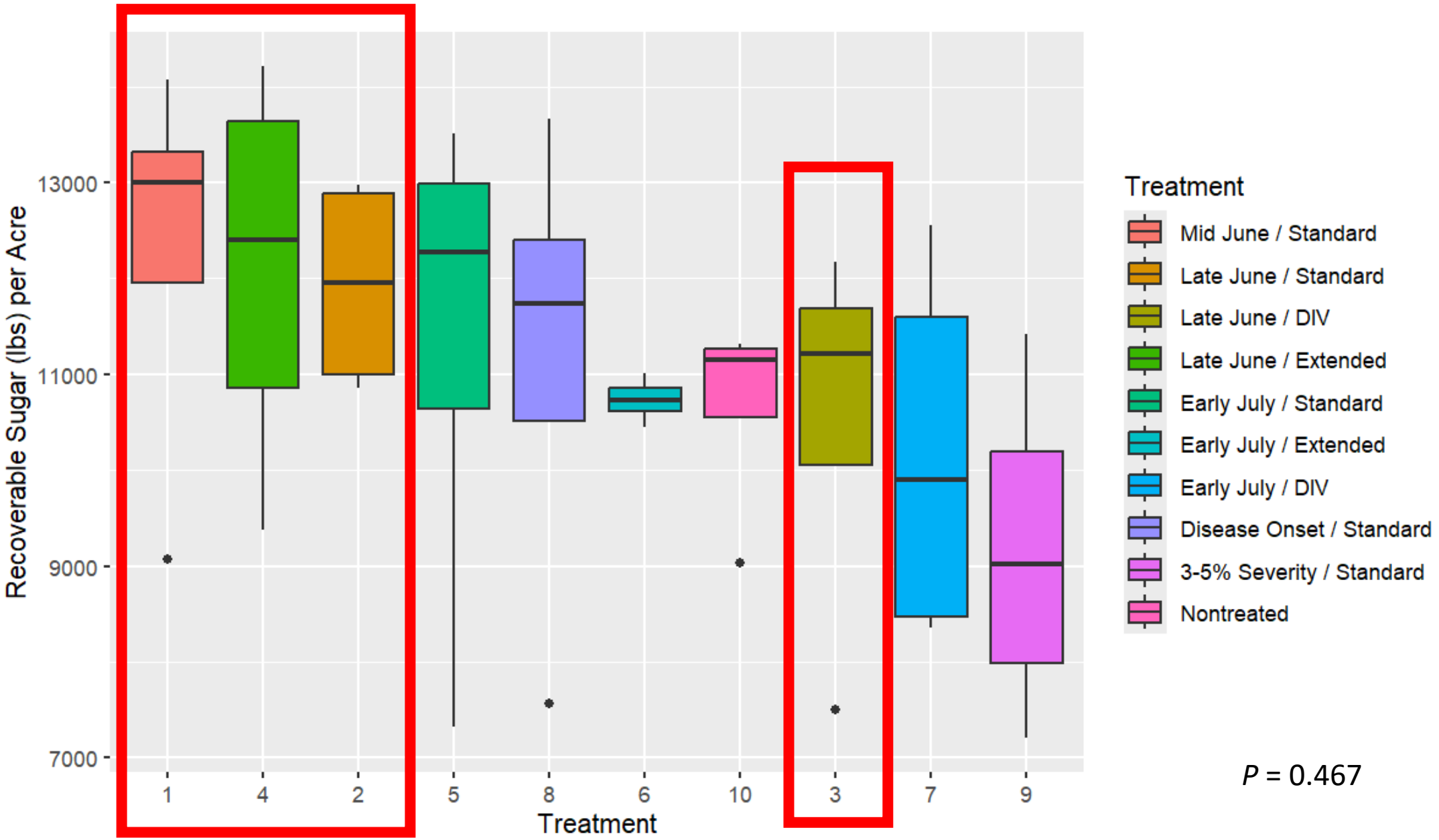
$P < 0.001$

Recoverable sugar per acre in non-CR+ sugarbeet



P = 0.467

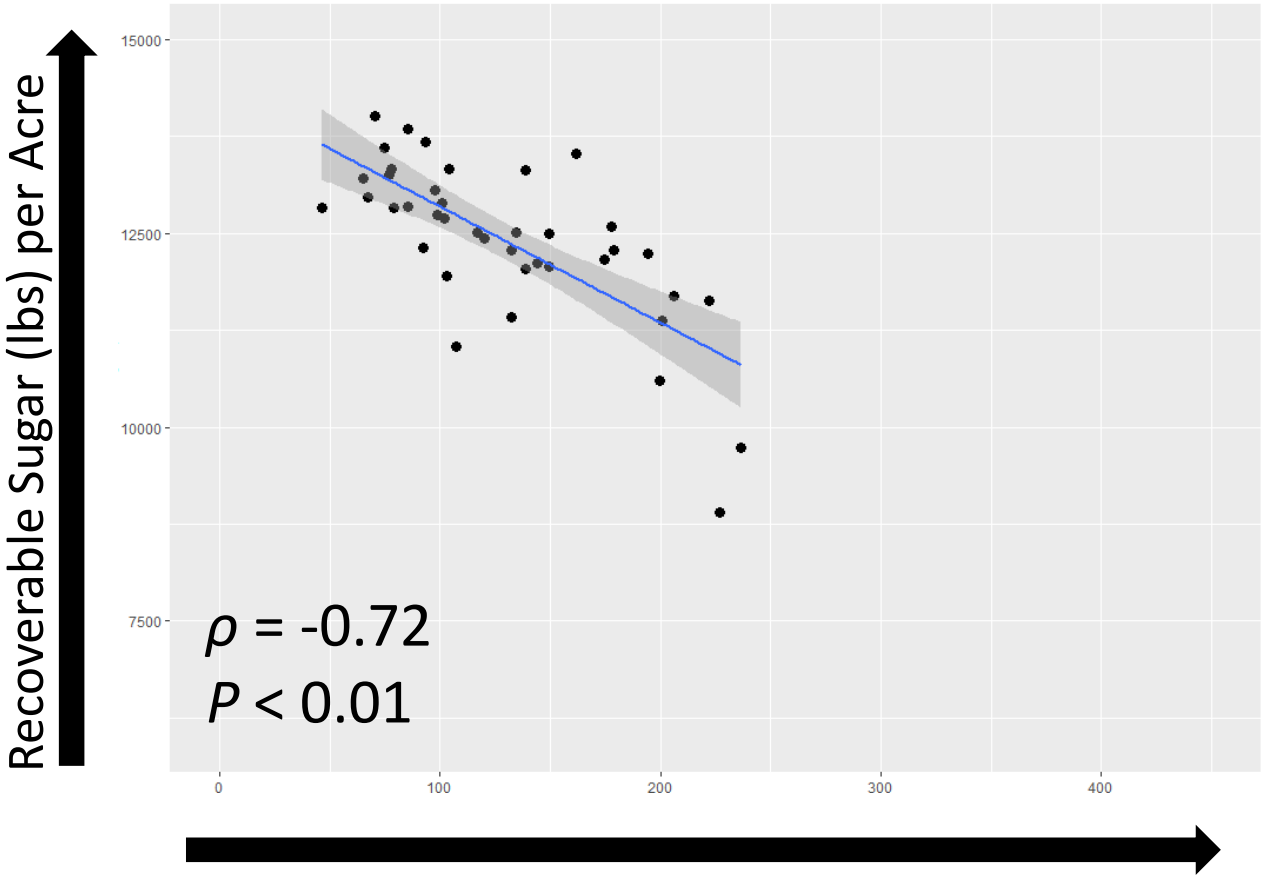
Recoverable sugar per acre in non-CR+ sugarbeet



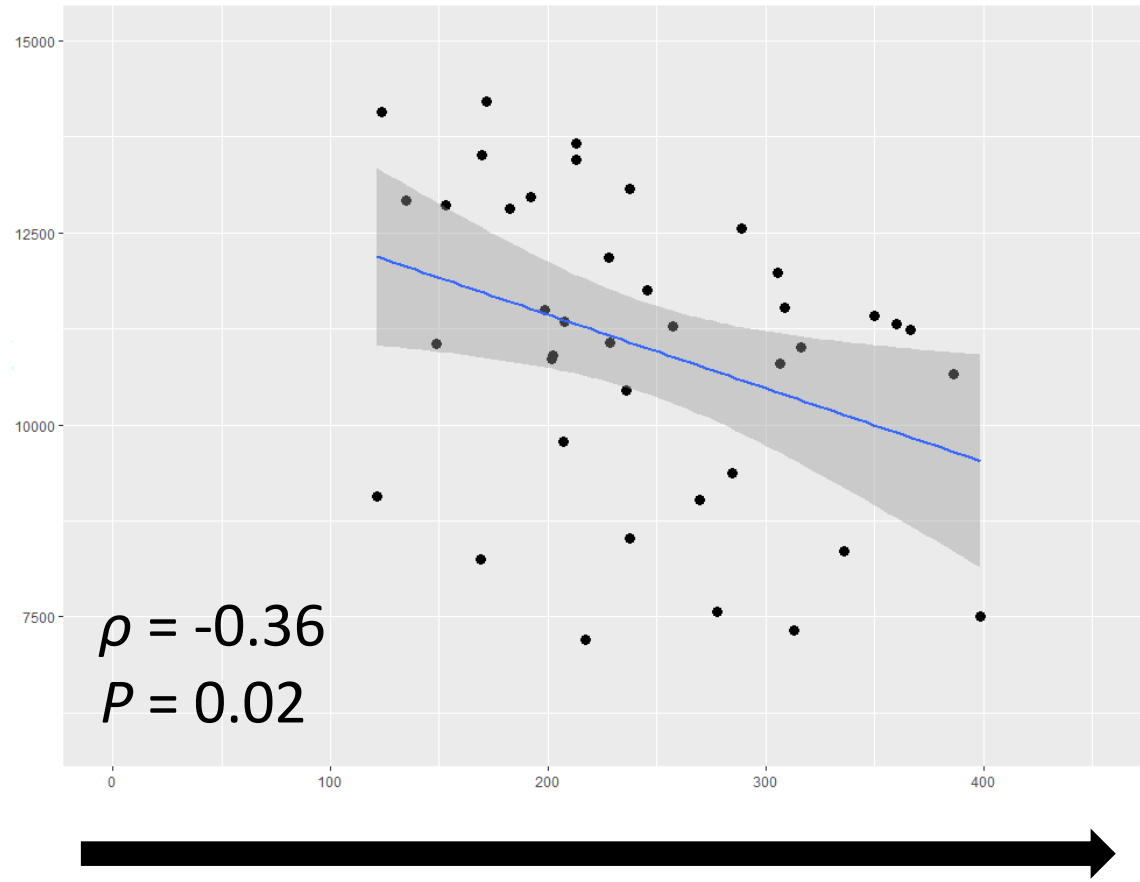
P = 0.467

Increased CLS severity was associated with lower RSA

CR+ Variety



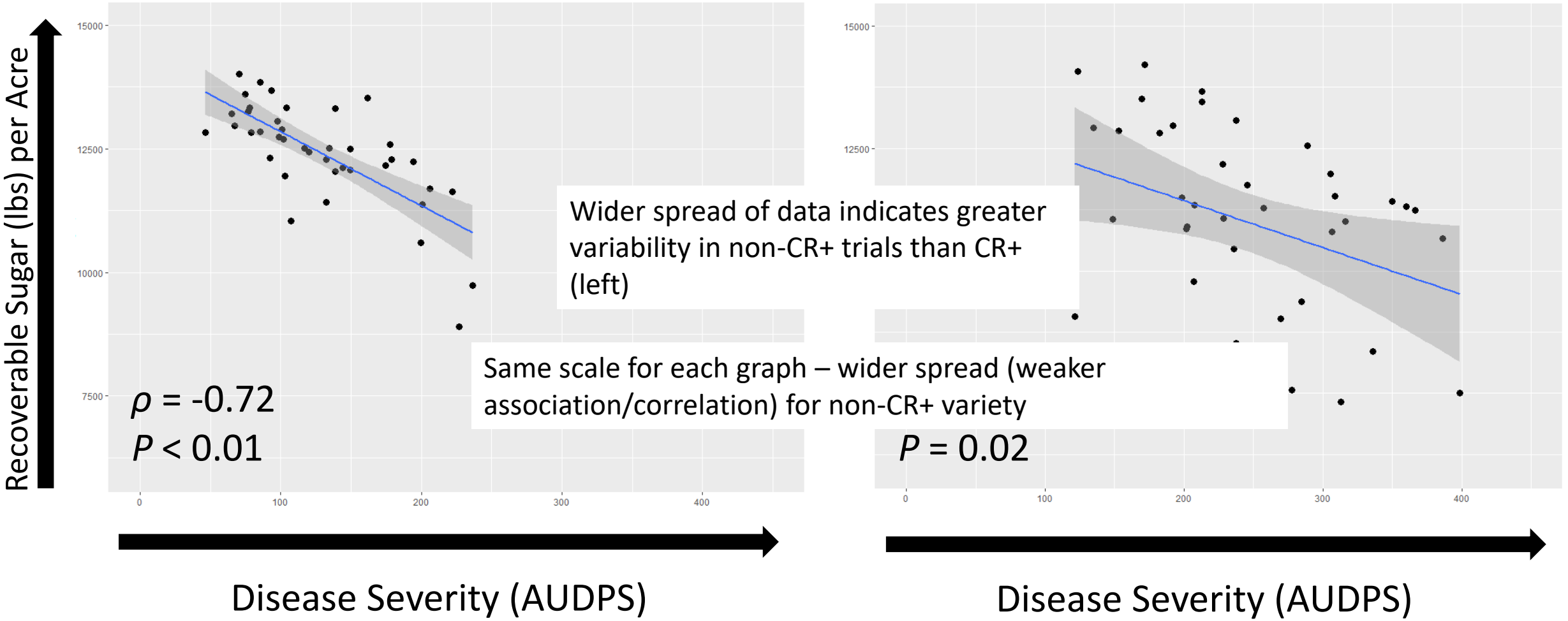
Non-CR+ Variety



Increased CLS severity was associated with lower RSA

CR+ Variety

Non-CR+ Variety



Wider spread of data indicates greater variability in non-CR+ trials than CR+ (left)

Same scale for each graph – wider spread (weaker association/correlation) for non-CR+ variety

CLS, Yield, and RSA (CR+ sugarbeet)

Program start date	CLS severity (AUDPS)	Yield (tons/A)	RSA (lbs)
Mid June	67 a	37.4 abc	13,439 a
Late June	86 ab	38.4 ab	13,171 ab
Late June	115 abc	36.1 abcd	12,464 abc
Late June	79 bcd	38.2 ab	13,118 ab
Early July	100 cd	37.3 abc	12,619 abc
Early July	155 de	38.5 a	12,399 abc
Early July	145 e	37.3 abc	12,614 abc
Disease onset	127 e	35.4 bcd	12,144 bc
3-5% CLS severity	200 f	34.7 cd	11,476 cd
Nontreated check	216 f	33.1 d	10,637 d
P =	< 0.001	< 0.001	< 0.001

CLS, Yield, and RSA (non-CR+ sugarbeet)

Program start date	CLS severity (AUDPS)	Yield (tons/A)	RSA (lbs)
Mid June	154 a	42.0	12,286
Late June	174 ab	40.4	11,934
Late June	284 abc	38.1	10,525
Late June	219 abc	42.3	12,097
Early July	227 abc	38.9	11,346
Early July	311 bc	38.8	10,730
Early July	280 c	34.6	10,178
Disease onset	249 c	39.1	11,176
3-5% CLS severity	235 c	33.8	9,164
Nontreated check	306 c	38.5	10,663
P =	0.02	NS	NS

Leaf sampling and fungicide resistance screening

- Leaf samples collected from rows 3 and 4 prior to each fungicide application

- All treatments were sampled in mid-June and again in September

Collaboration with Dr. Nathan Wyatt (USDA-ARS) to determine fungicide resistance

ddPCR assay for QoI, benzimidazole, DMI resistance

First CLS latent detection – Foxhome location

Earlier date highlighted in red

Treatment	Date / Interval	First latent CLS detection date	
		CR+	Non-CR+
1	Mid June / Standard	June 25th	June 14th
2	Late June / Standard	June 25th	July 12th
3	Late June / DIV	June 14th	July 12th
4	Late June / Extended	June 25th	July 12th
5	Early July / Standard	June 25th	July 12th
6	Early July / Extended	July 26th	June 14th
7	Early July / DIV	June 25th	July 12th
8	Disease onset / Standard	July 26th	July 12th
9	3-5% CLS severity / Standard	July 12th	July 12th
10	Nontreated check	July 12th	July 12th

First CLS latent detection – Kragnes location

Earlier date highlighted in red

Treatment	Date / Interval	First latent CLS detection date	
		CR+	Non-CR+
1	Mid June / Standard	July 8th	July 8th
2	Late June / Standard	July 8th	June 20th
3	Late June / DIV	June 20th	August 1st
4	Late June / Extended	July 8th	August 13th
5	Early July / Standard	August 1st	August 1st
6	Early July / Extended	August 1st	August 1st
7	Early July / DIV	June 20th	June 20th
8	Disease onset / Standard	July 8th	June 20th
9	3-5% CLS severity / Standard	August 1st	August 13th
10	Nontreated check	June 20th	June 20th

Conclusion/Next Steps

- Late June start to fungicide programs are beneficial
  - Unclear benefit to mid-June vs. late June

June application: reduced CLS and increased RSA

- Evaluate the relationship between latent *C. beticola* infections and June or July fungicide program start dates.

In progress

- Further analysis of fungicide resistance profiles of isolates

In progress

Acknowledgements

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