Dynamics of infection and fungicide resistance in CLS field trials

Eric Branch, NDSU / UMN Extension

Grand Forks, ND: February 6th, 2025

Fargo, ND: February 11th, 2025

Grafton, ND: February 13th, 2025

NDSU NORTH DAKOTA STATE UNIVERSITY

UNIVERSITY OF MINNESOTA EXTENSION

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)

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

CLS field trial, September 2024

Cercospora Leaf Spot (CLS)

Environmental risk factors:

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

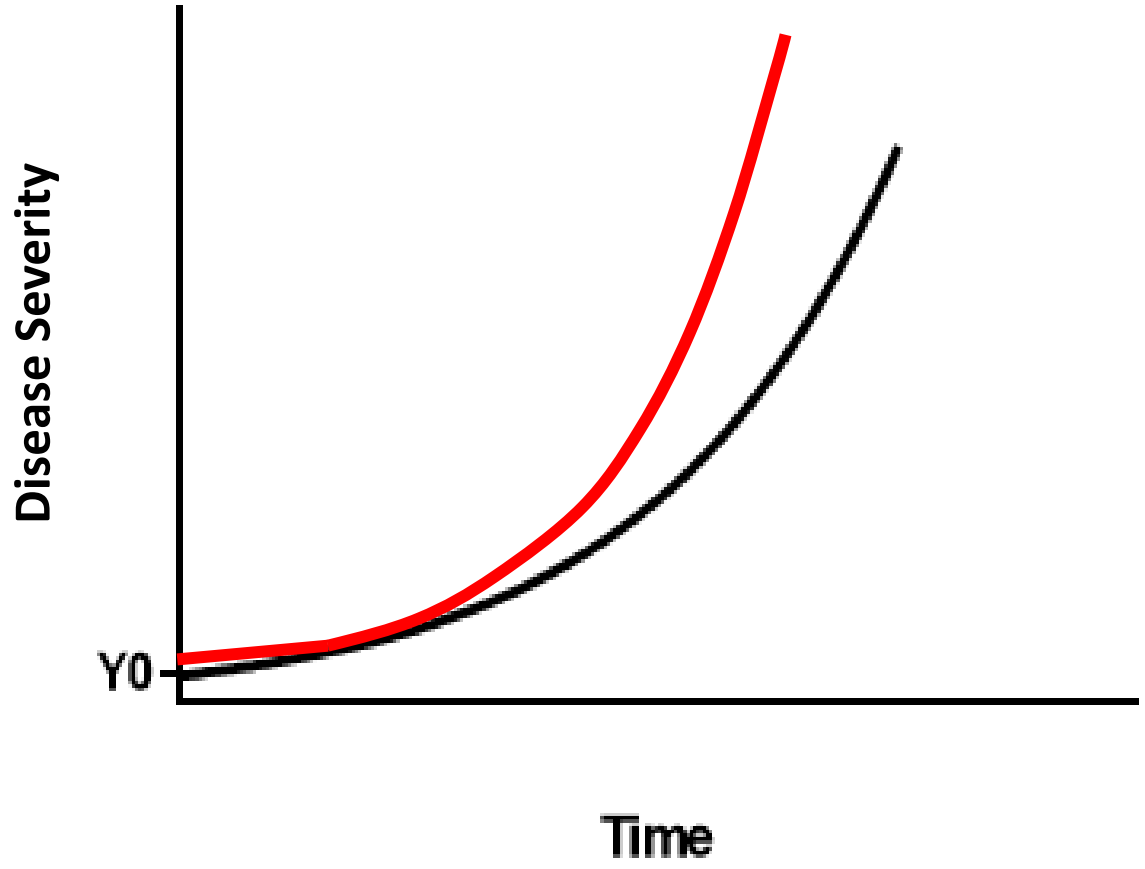
- 80°F daytime, 60°F night temperatures

CLS field trial, September 2024

Cercospora biology affects management

Polycyclic disease cycle

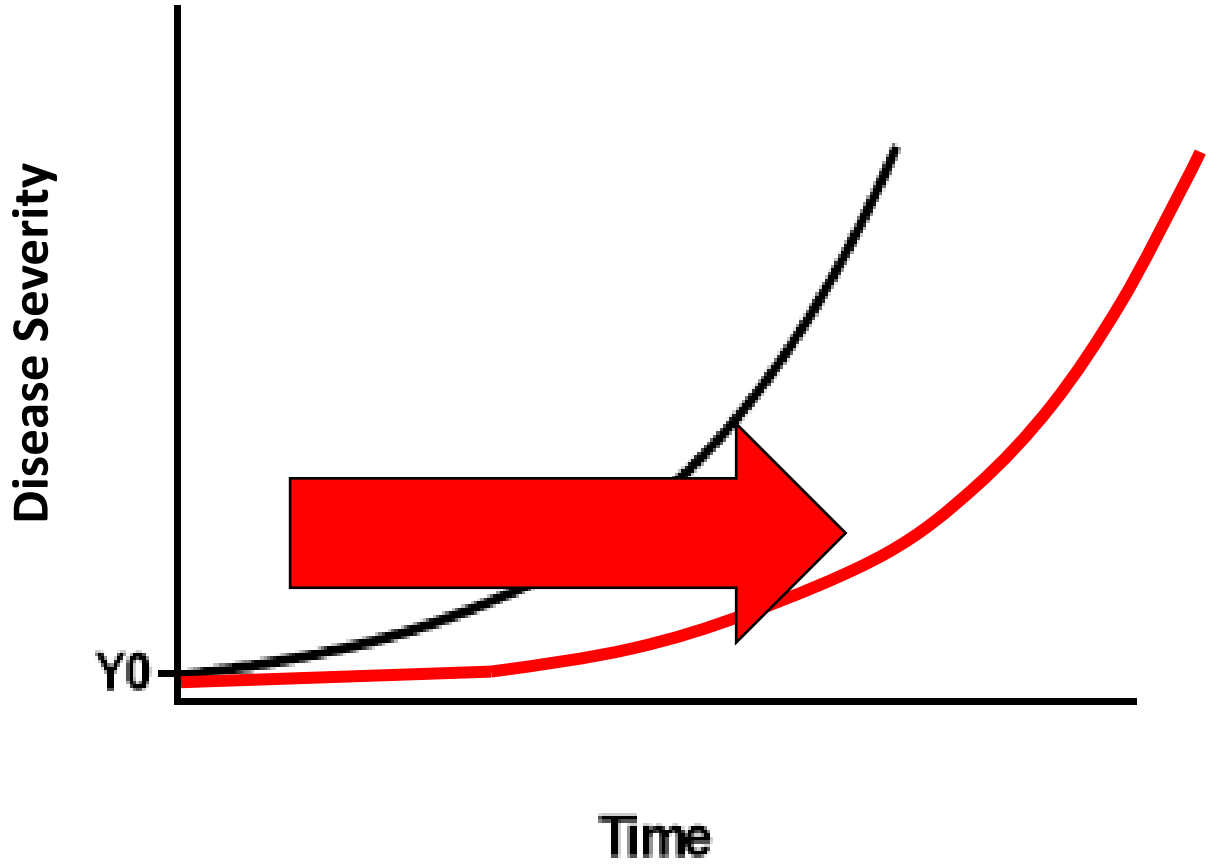
- Each CLS lesion produces hundreds of spores
- If <u>just one</u> additional lesion forms, there is exponential growth



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

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

July 8th, 2024, Foxhome

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 **Low CLS pressure**
- Foxhome, MN **High CLS pressure**

July 8th, 2024, Foxhome

Kragnes, MN trial environment

Planting Date: May 13th

Harvest: September 16th

Environment:

Month	Rainfall (inches)	Average Temperature (max/min, °F)
April (23rd-30th)	2.9	57/ 35
May	5.9	68 / 47
June	4.5	76 / 56
July	1.8	83 / 63
August	2.6	78 / 59
September (1st-25th)	0.1	80 / 56

Foxhome, MN trial environment

Planting Date: April 23rd

Harvest: September 25th

Environment:

Month	Rainfall (inches)	Average Temperature (max/min, °F)
April (23rd-30th)	**2.5**	**58 / 39**
May	**5.5**	**69 / 46**
June	**4.4**	**76 / 54**
July	**5.0**	**82 / 61**
August	**2.6**	**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

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

- Bike sprayer, tractor-mounted sprayer

Bike sprayer, 4 rows

Trials inoculation: July 10th (Foxhome) and July 9th (Kragnes)

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**”

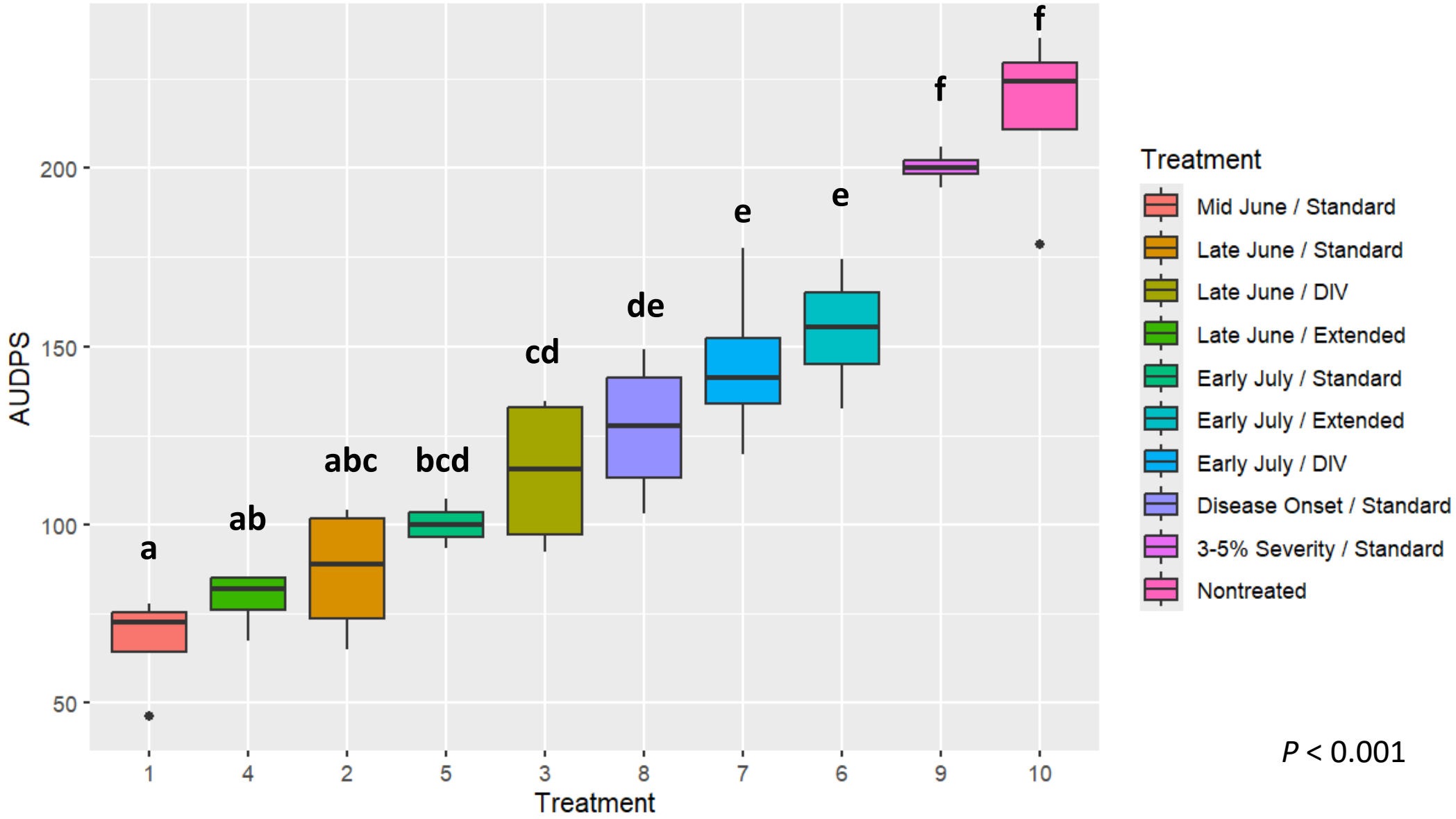
10-14, then 21-28 days = “**extended**”

Trial Results:

Foxhome

(High CLS disease pressure)

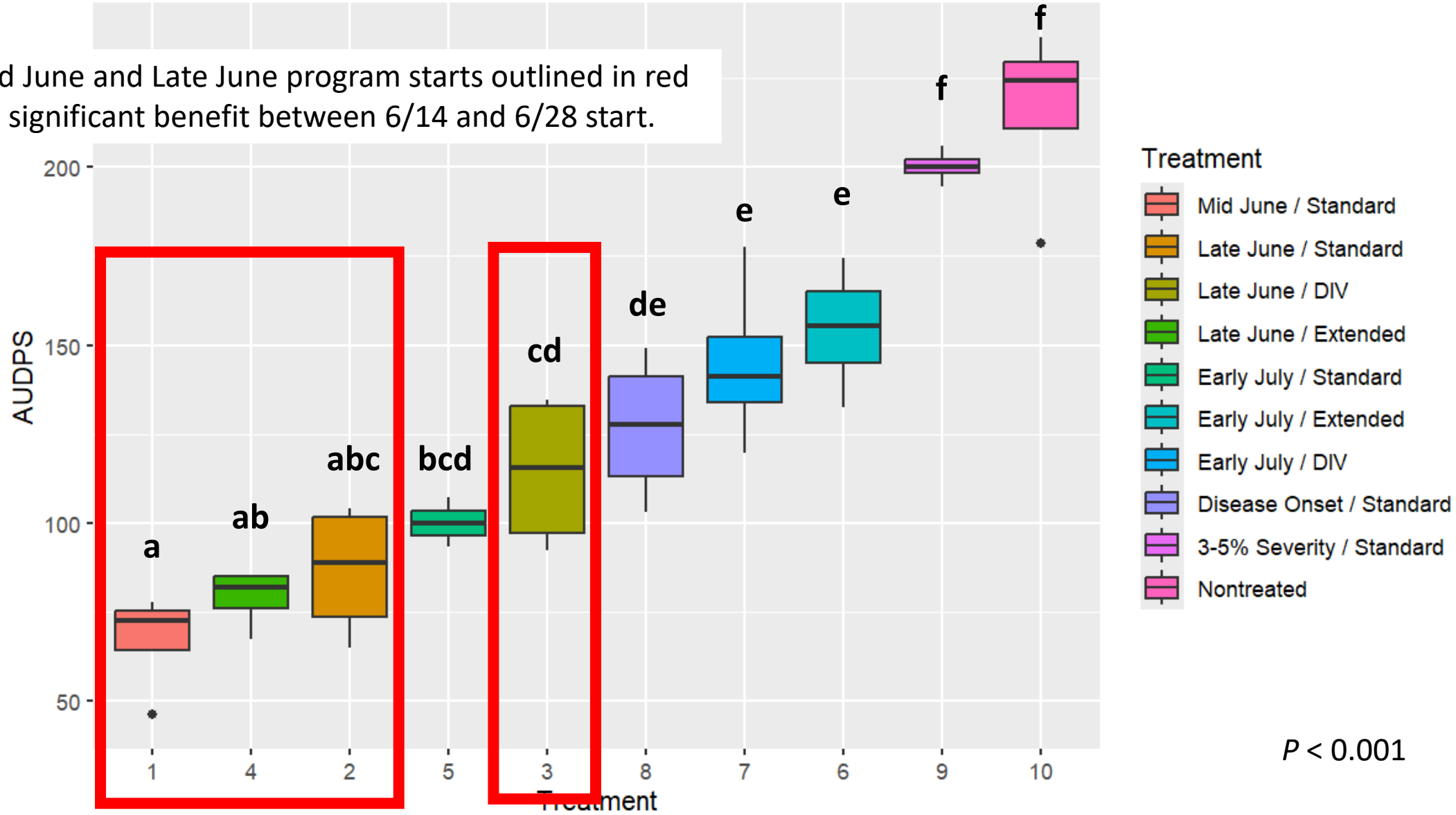
CLS disease severity (AUDPS) in CR+ sugarbeet



$P < 0.001$

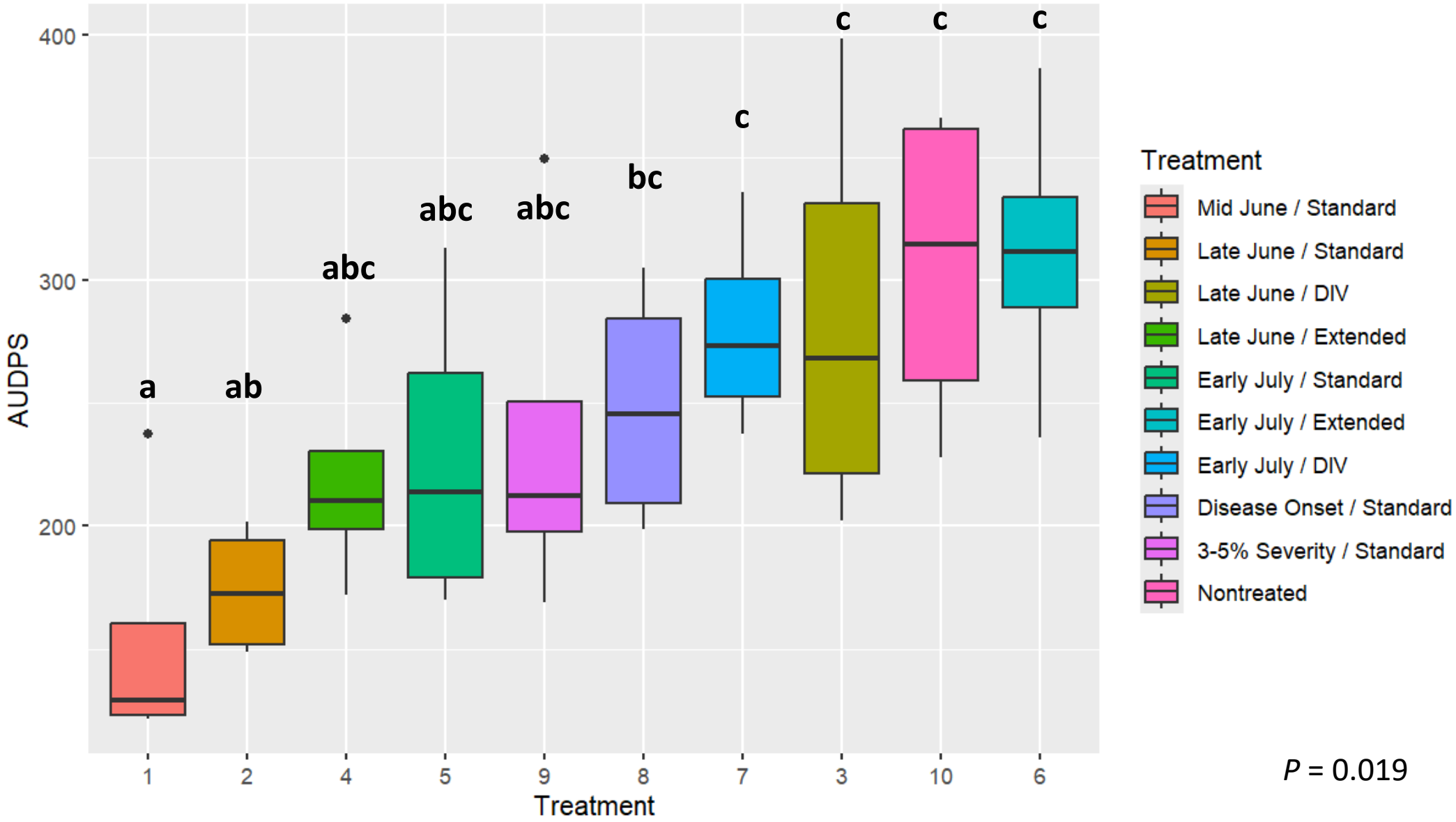
CLS disease severity (AUDPS) in CR+ sugarbeet

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



$P < 0.001$

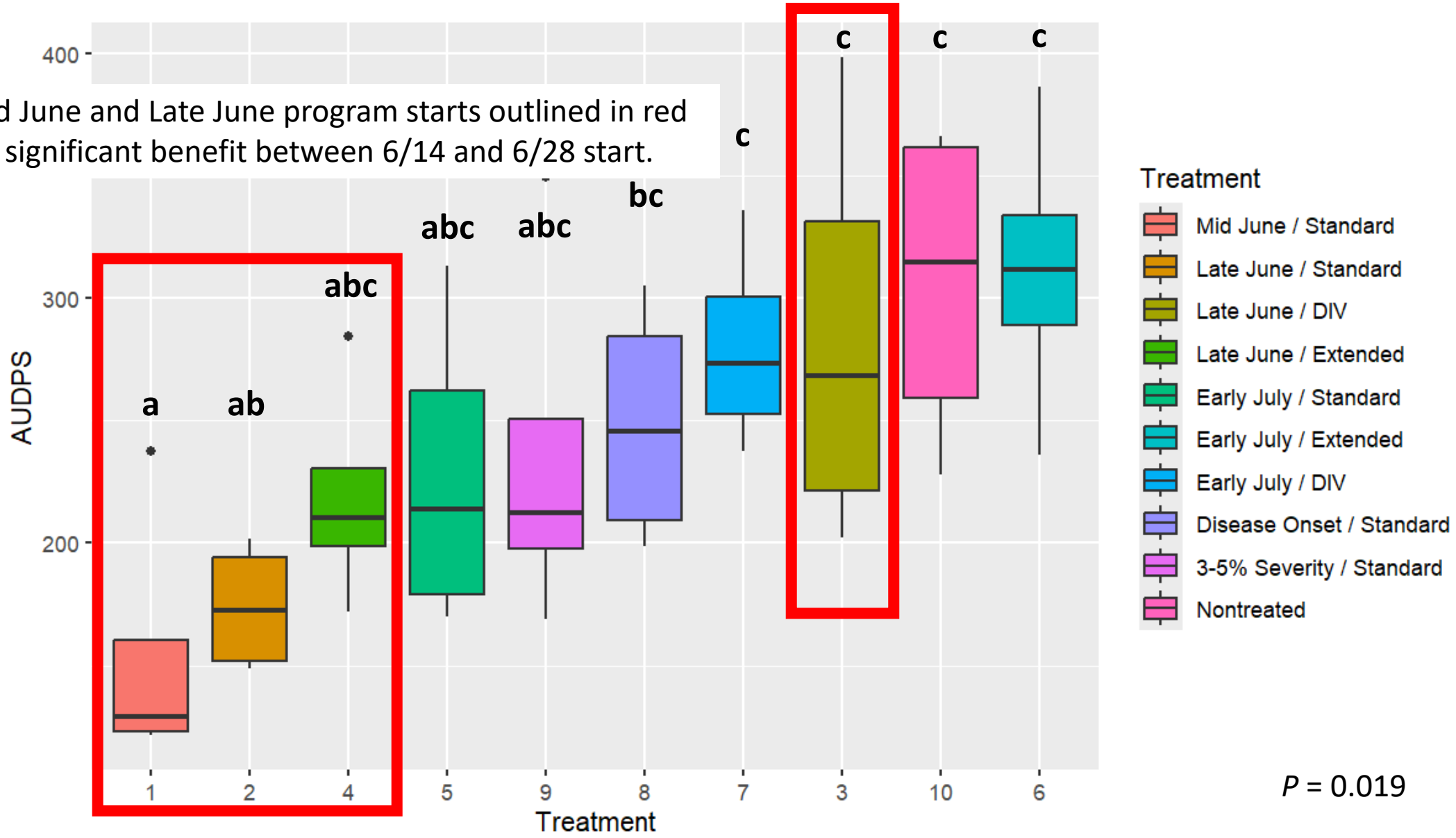
CLS disease severity (AUDPS) in non-CR+ sugarbeet



P = 0.019

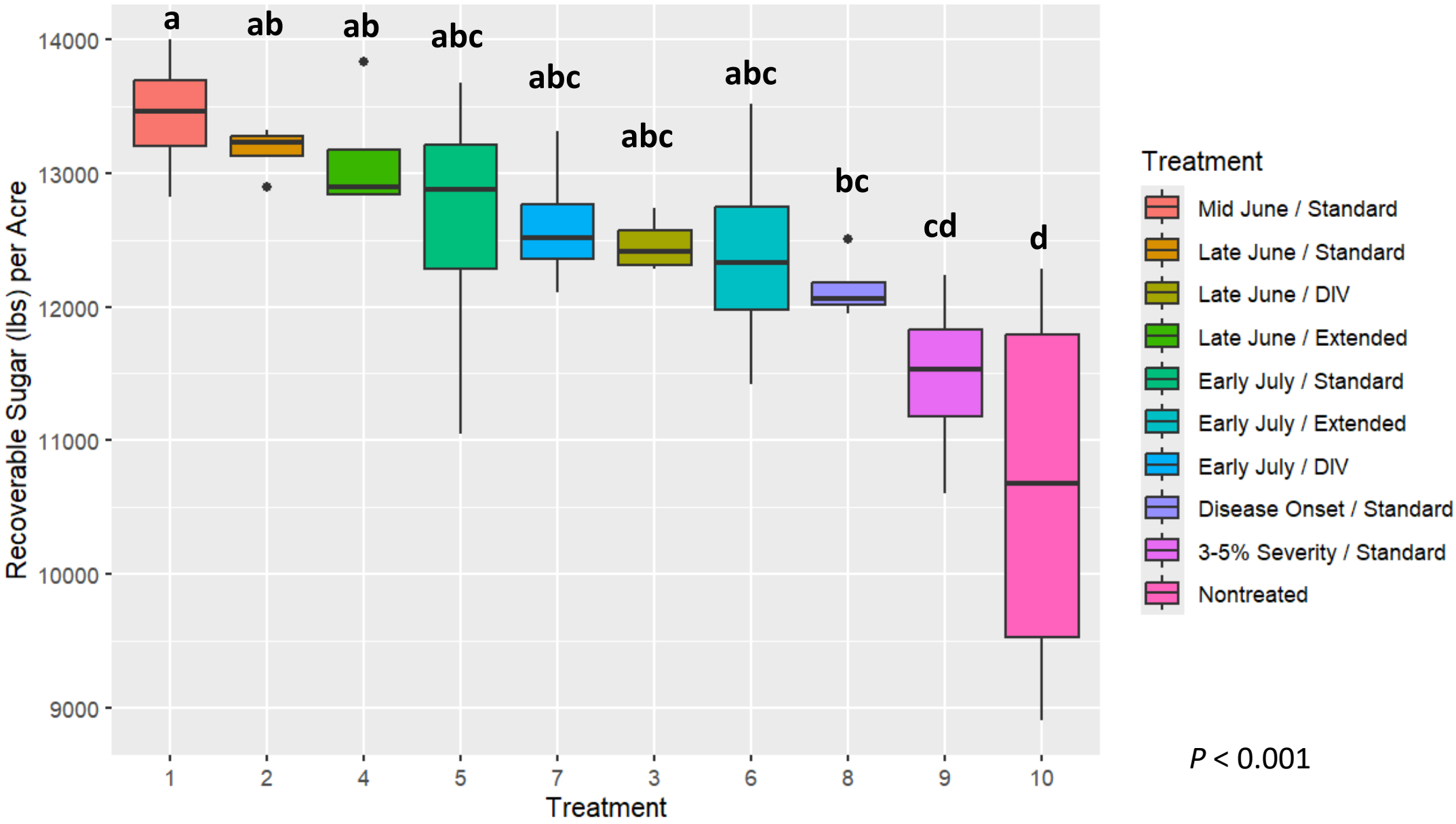
CLS disease severity (AUDPS) in non-CR+ sugarbeet

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



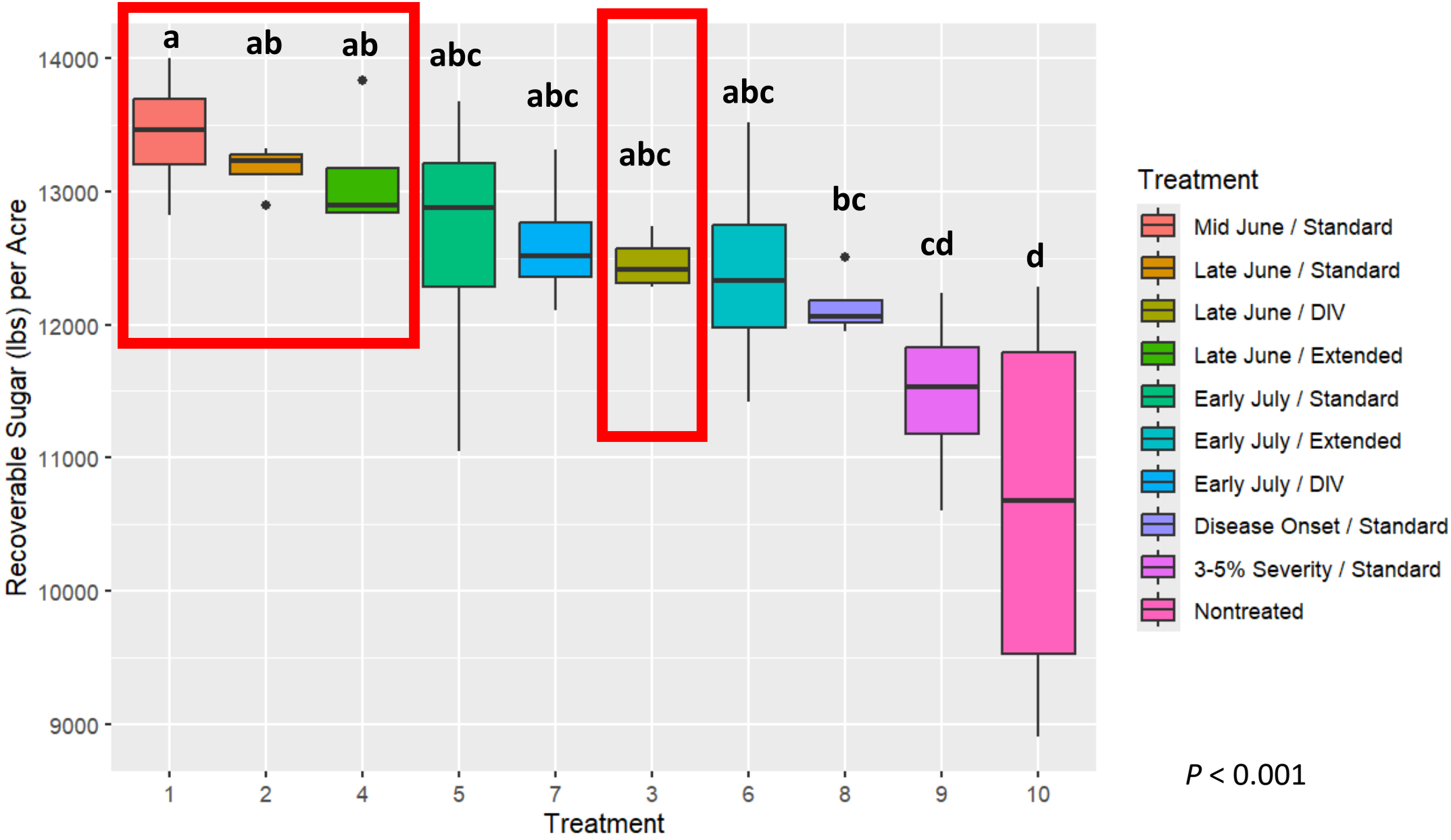
P = 0.019

Recoverable sugar per acre in CR+ sugarbeet



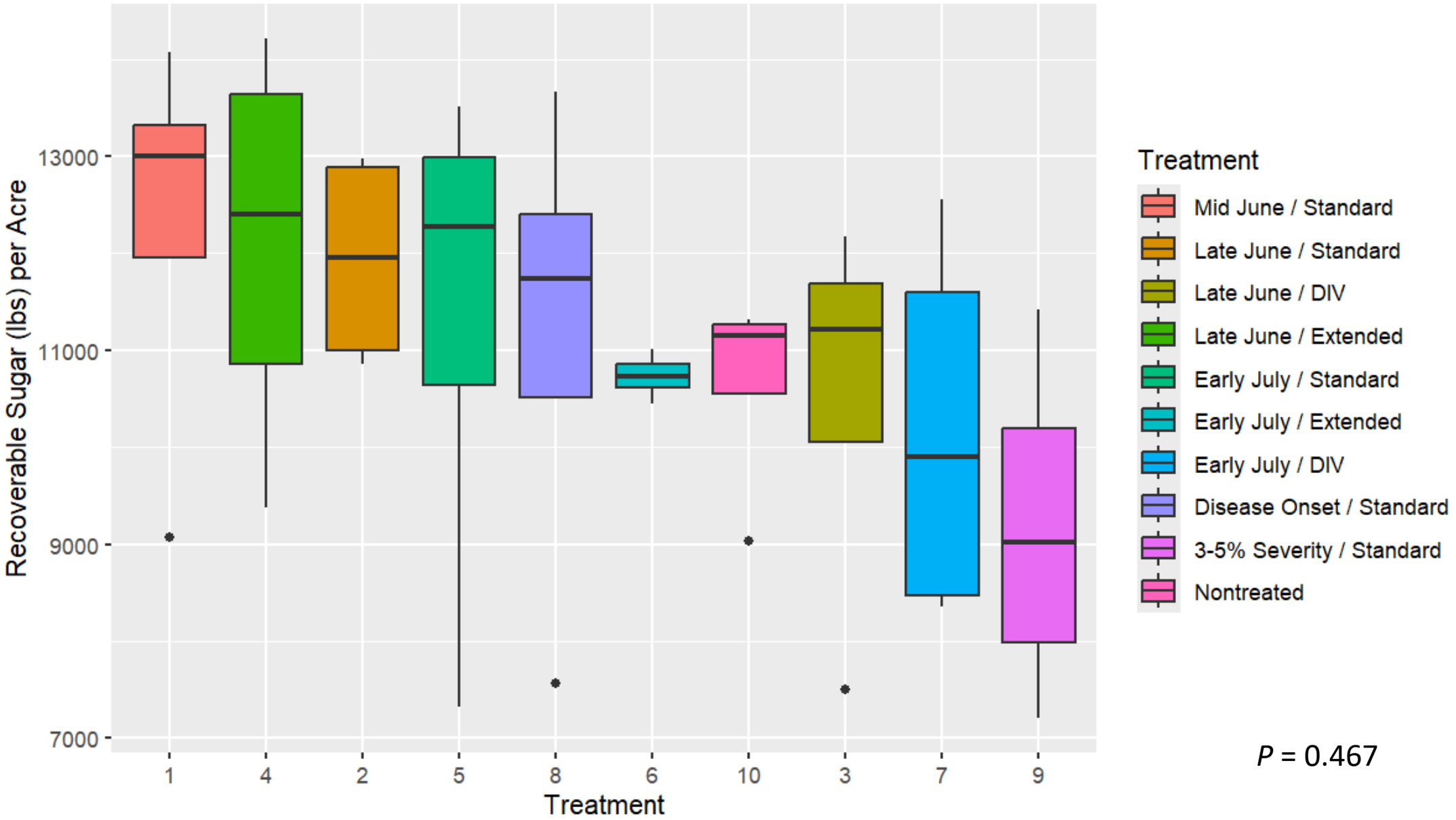
$P < 0.001$

Recoverable sugar per acre in CR+ sugarbeet



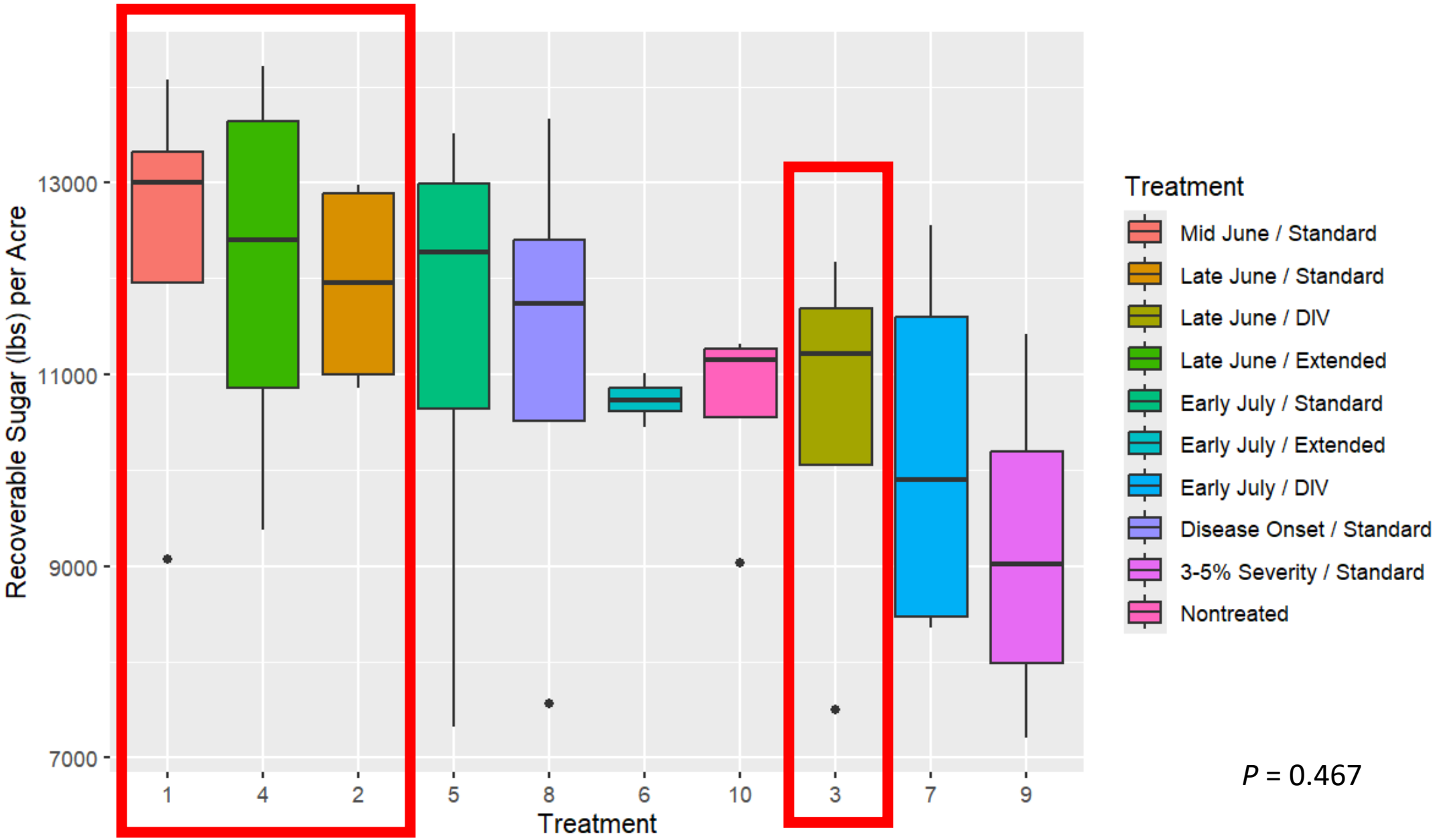
$P < 0.001$

Recoverable sugar per acre in non-CR+ sugarbeet



P = 0.467

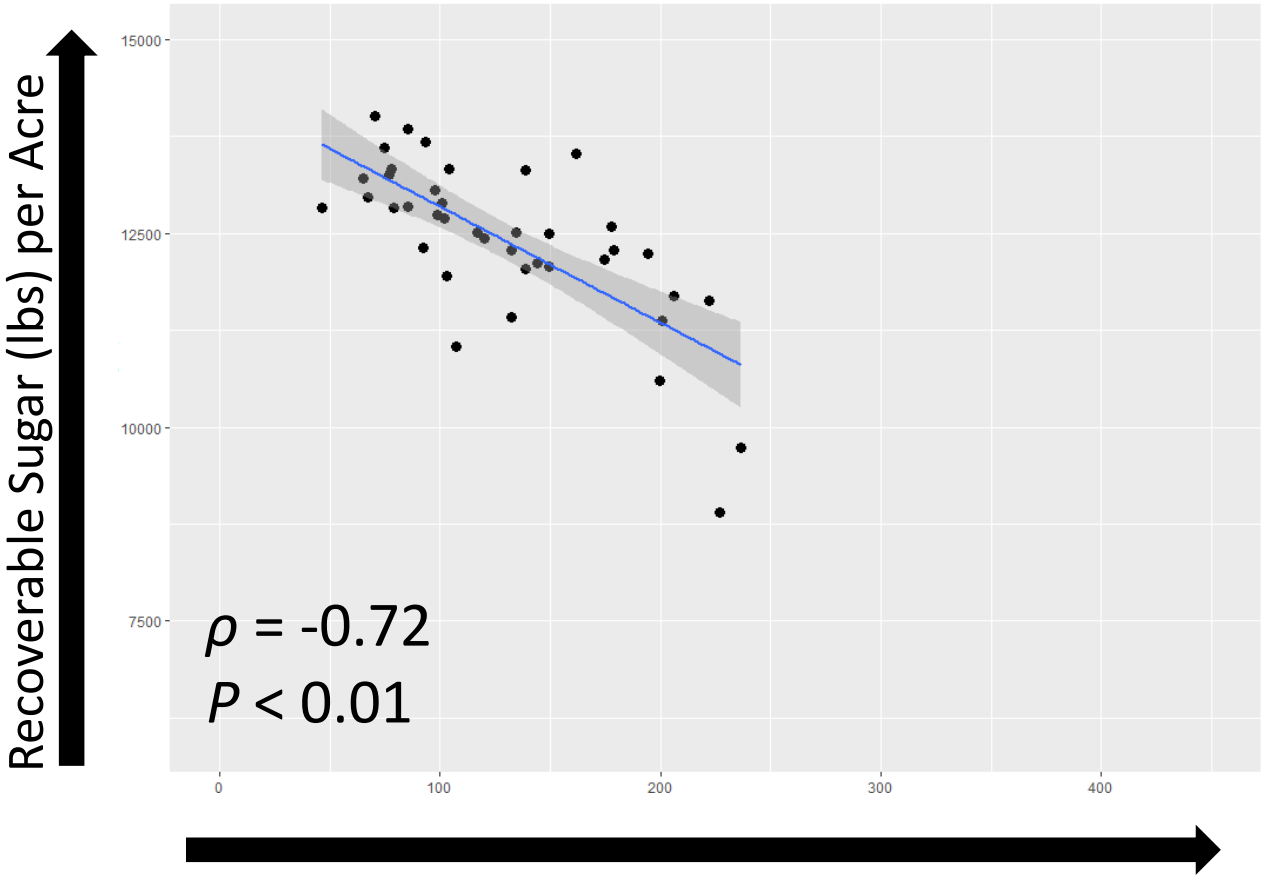
Recoverable sugar per acre in non-CR+ sugarbeet



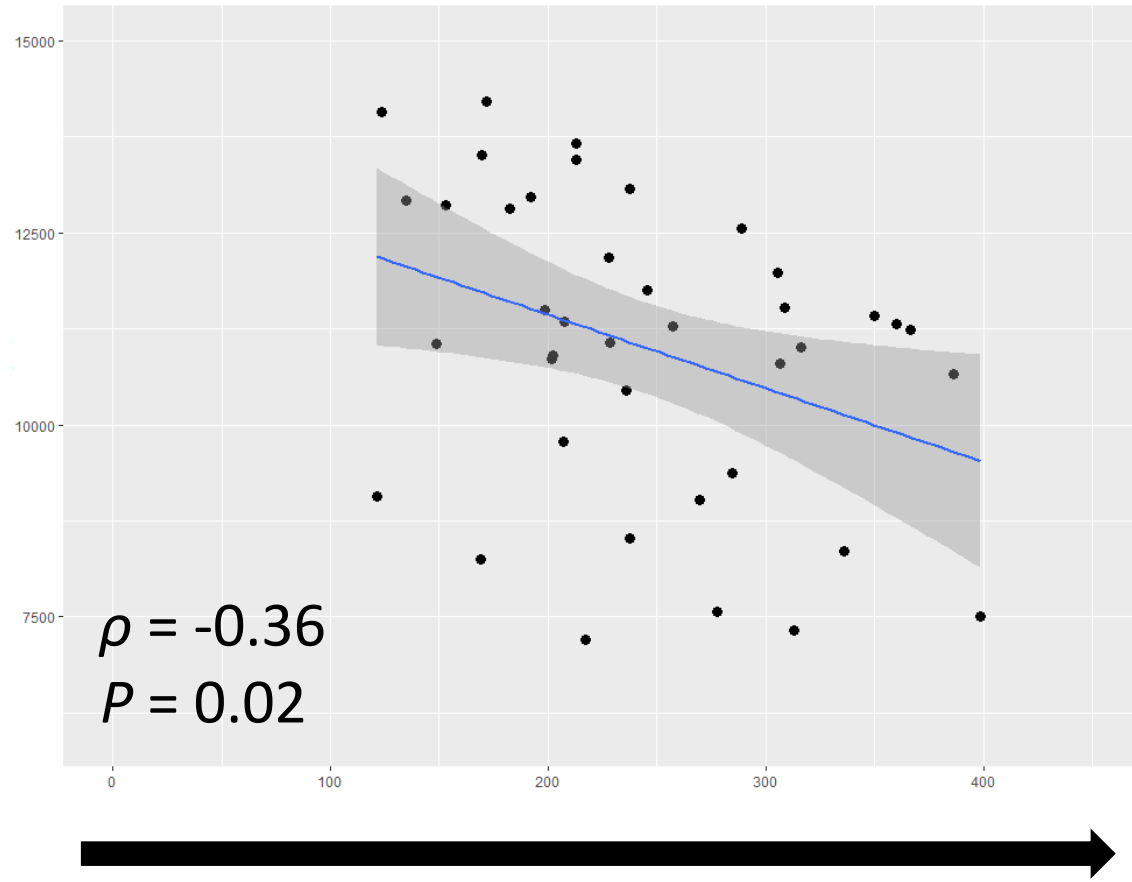
P = 0.467

Increased CLS severity was associated with lower RSA

CR+ Variety



Non-CR+ Variety



CLS, Yield, and RSA (CR+ sugarbeet)

Program start date	CLS severity (AUDPS)	Yield (tons/A)	RSA (lbs)	Gross $/A
Mid June	67 a	37.4 abc	13,439 a	$3,381
Late June	86 ab	38.4 ab	13,171 ab	$3,180
Late June	115 abc	36.1 abcd	12,464 abc	$3,038
Late June	79 bcd	38.2 ab	13,118 ab	$3,174
Early July	100 cd	37.3 abc	12,619 abc	$3,006
Early July	155 de	38.5 a	12,399 abc	$2,816
Early July	145 e	37.3 abc	12,614 abc	$3,002
Disease onset	127 e	35.4 bcd	12,144 bc	$2,940
3-5% CLS severity	200 f	34.7 cd	11,476 cd	$2,674
Nontreated check	216 f	33.1 d	10,637 d	$2,390
P =	< 0.001	< 0.001	< 0.001	

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

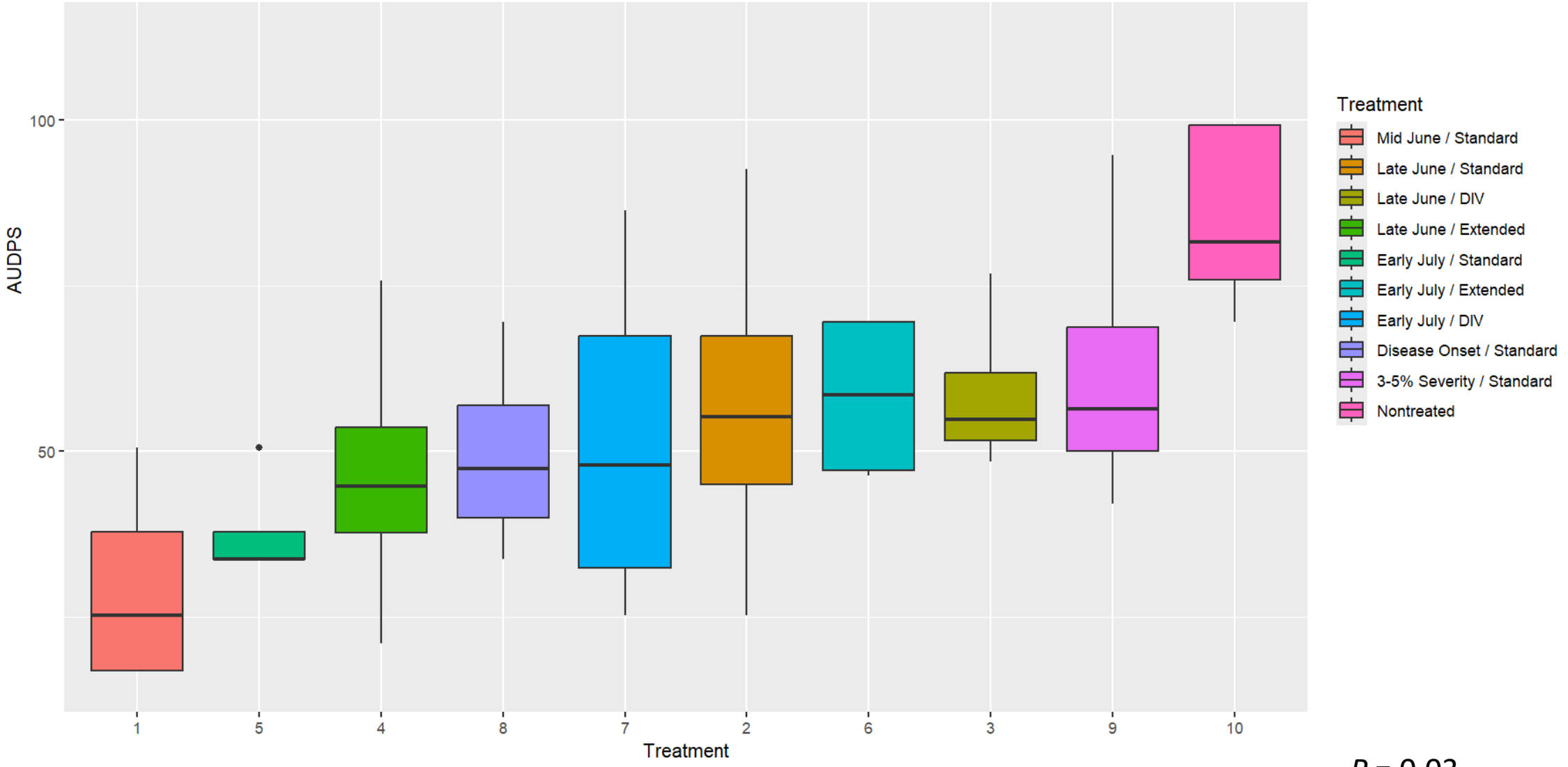
Program start date	CLS severity (AUDPS)	Yield (tons/A)	RSA (lbs)	Gross $/A
Mid June	154 a	42.0	12,286	$2,470
Late June	174 ab	40.4	11,934	$2,449
Late June	284 abc	38.1	10,525	$1,947
Late June	219 abc	42.3	12,097	$2,354
Early July	227 abc	38.9	11,346	$2,250
Early July	311 bc	38.8	10,730	$2,015
Early July	280 c	34.6	10,178	$2,082
Disease onset	249 c	39.1	11,176	$2,160
3-5% CLS severity	235 c	33.8	9,164	$1,664
Nontreated check	306 c	38.5	10,663	$2,035
P =	0.02	NS	NS	

Trial Results:

Kragnes

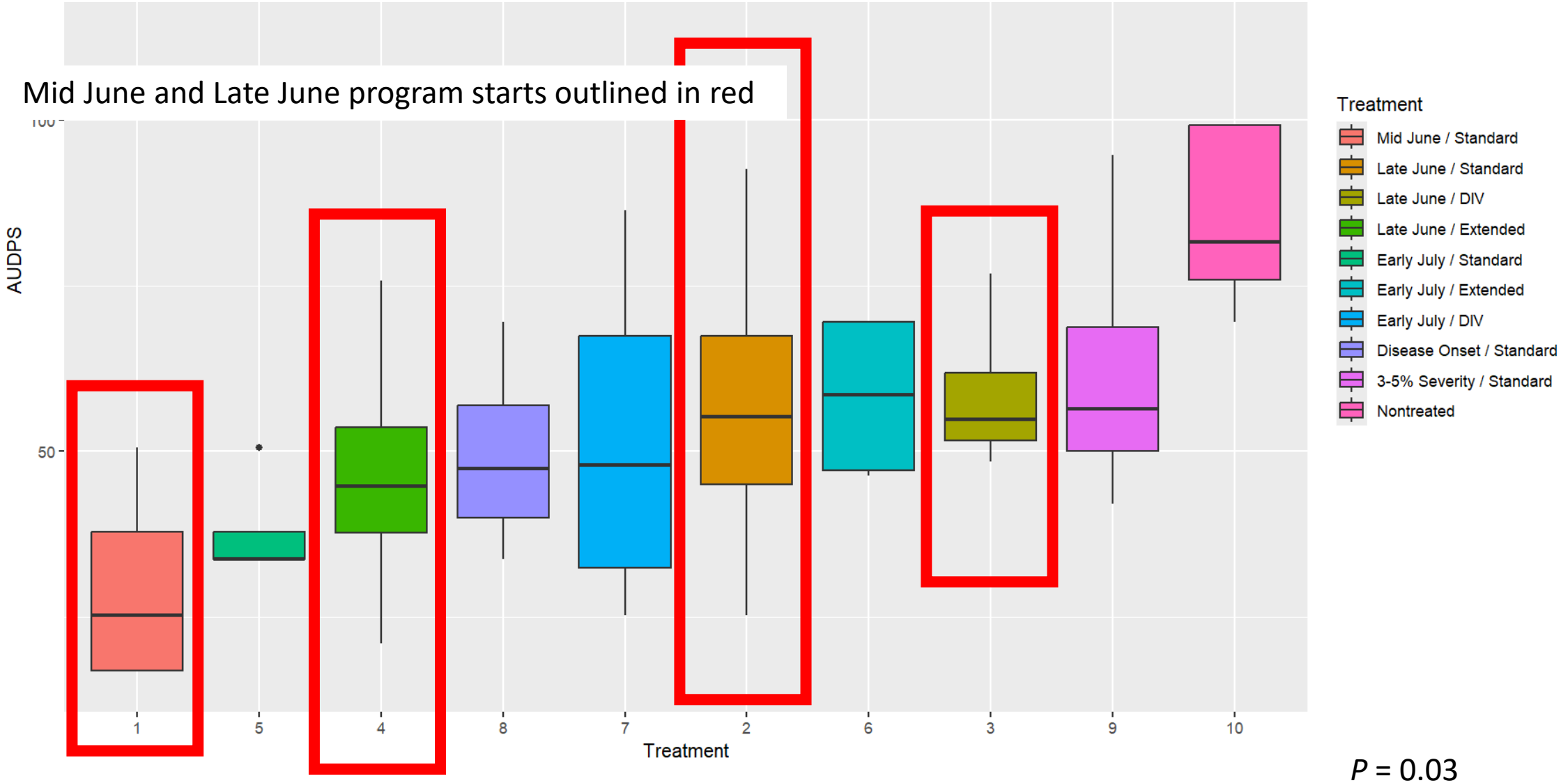
(Low CLS disease pressure)

CLS disease severity (AUDPS) in CR+ sugarbeet



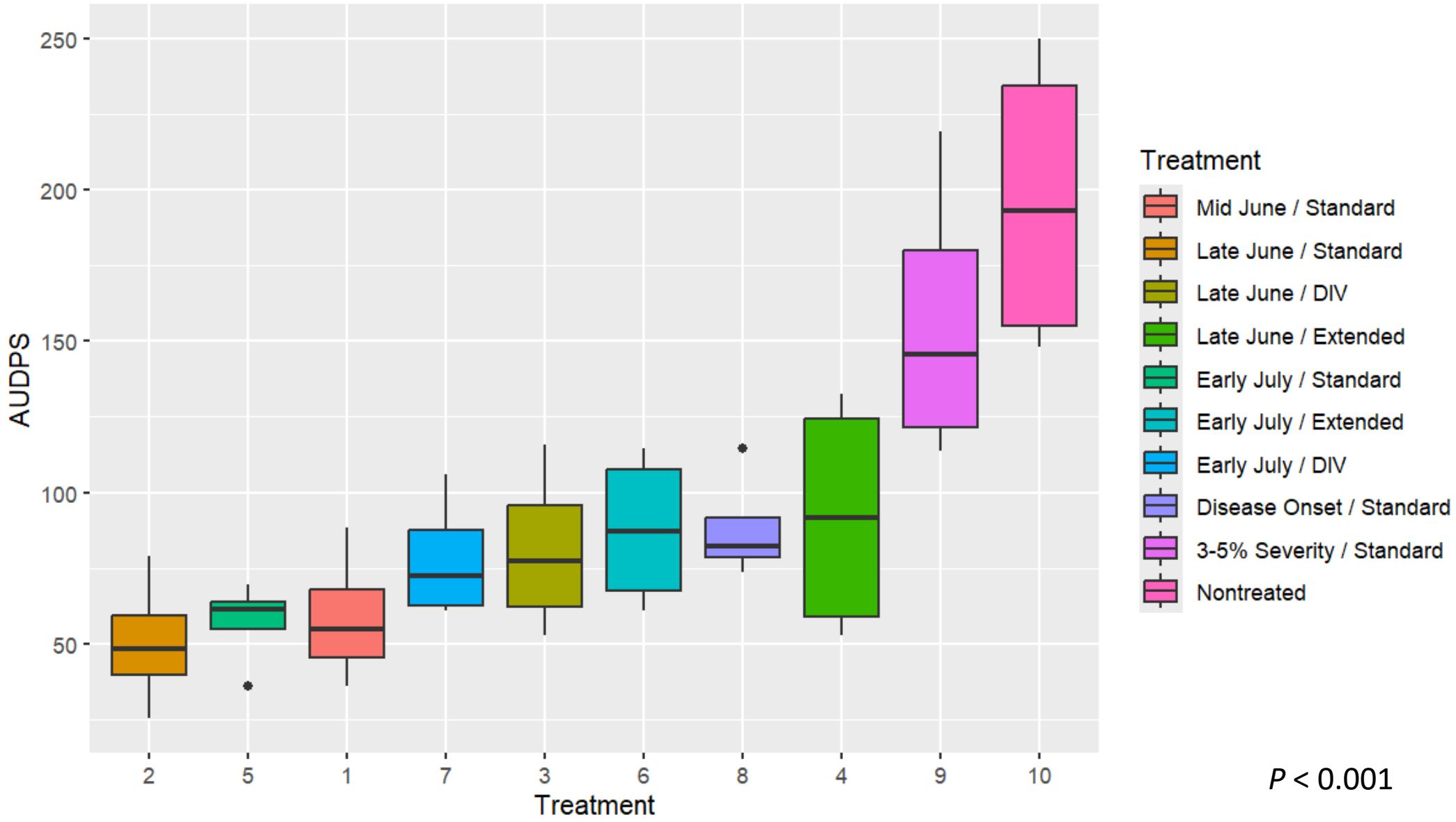
P = 0.03

CLS disease severity (AUDPS) in CR+ sugarbeet



P = 0.03

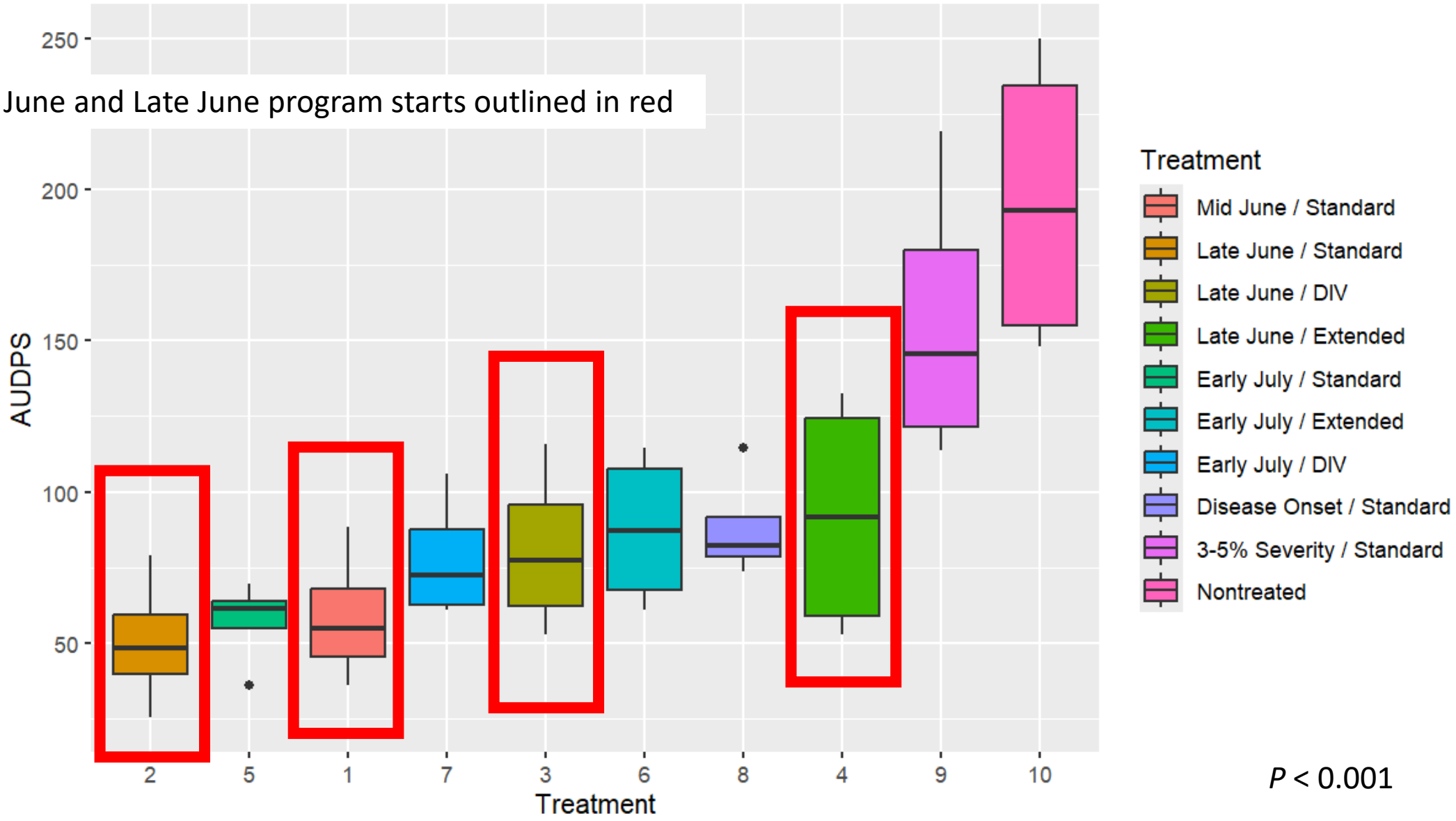
CLS disease severity (AUDPS) in non-CR+ sugarbeet



$P < 0.001$

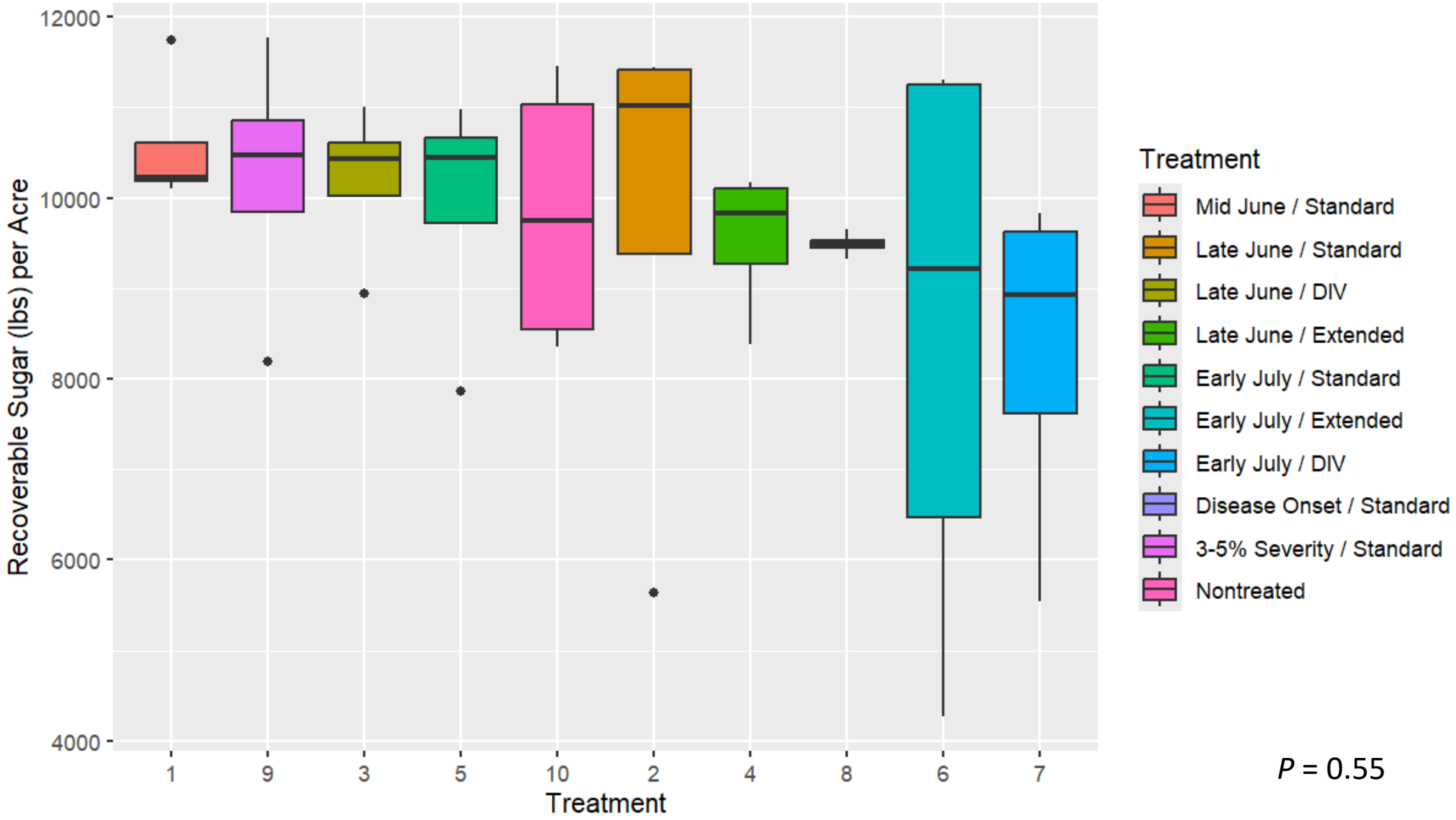
CLS disease severity (AUDPS) in non-CR+ sugarbeet

Mid June and Late June program starts outlined in red



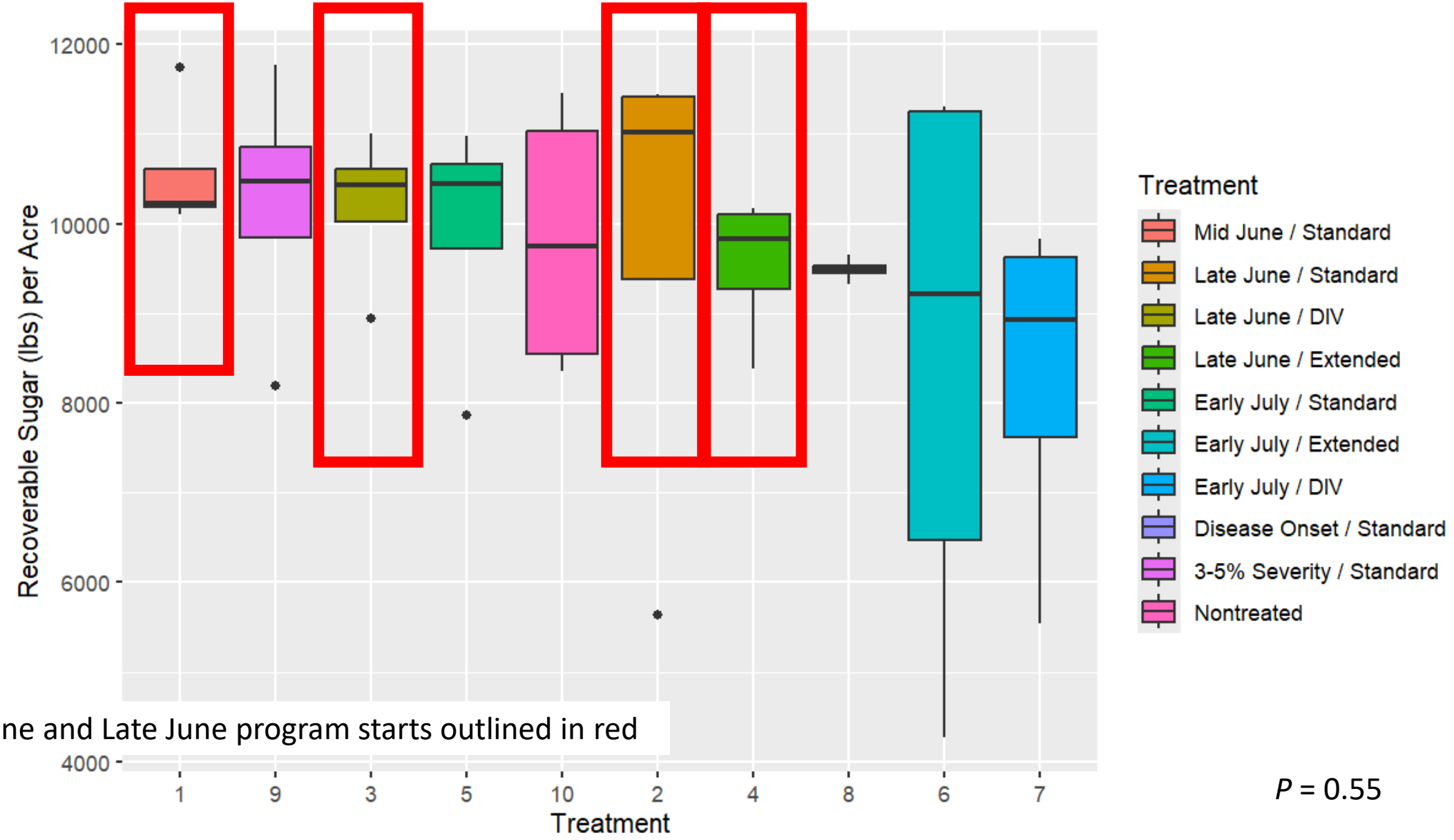
$P < 0.001$

Recoverable Sugar, CR+ variety (Kragnes)



P = 0.55

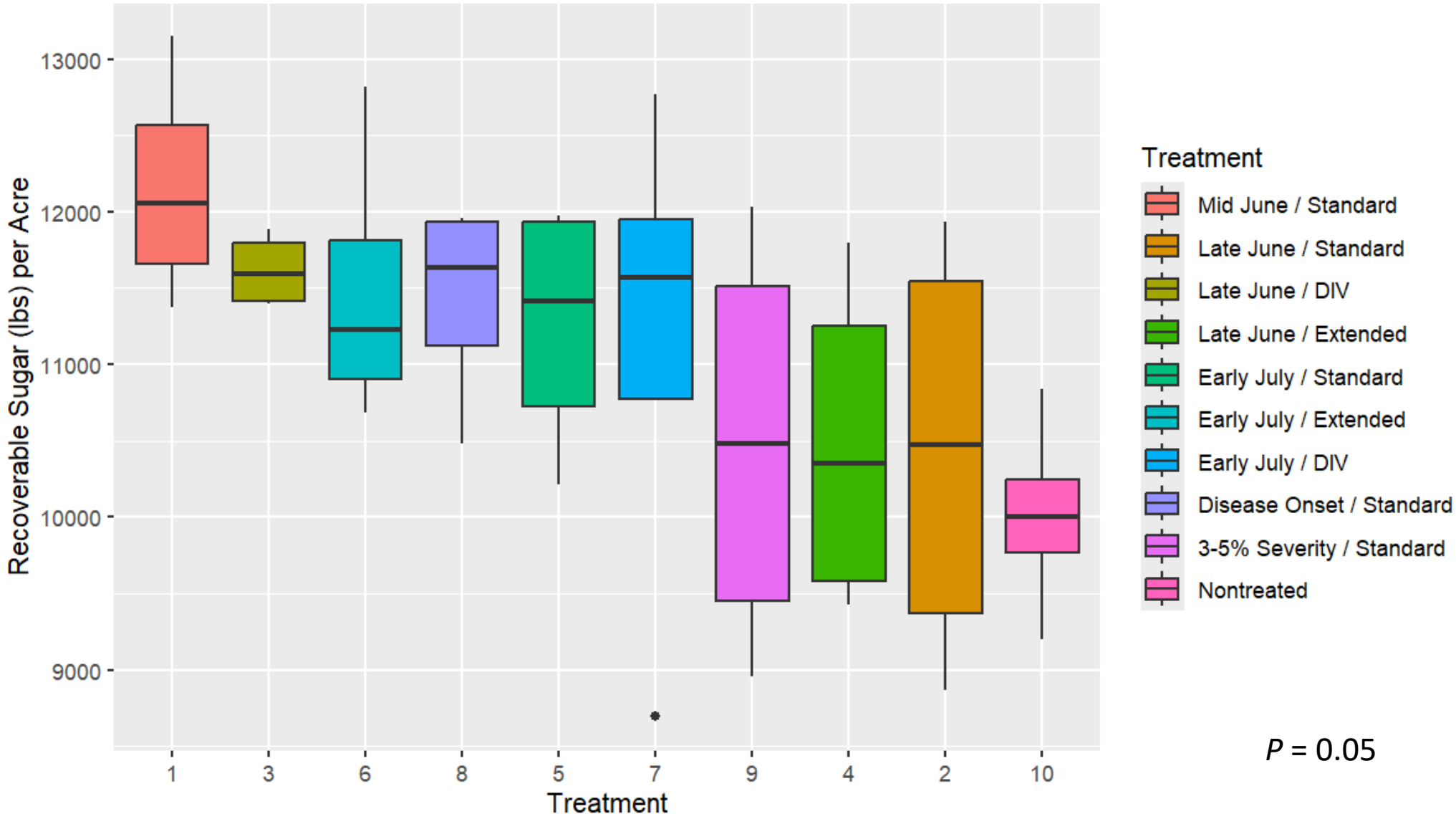
Recoverable Sugar, CR+ variety (Kragnes)



Mid June and Late June program starts outlined in red

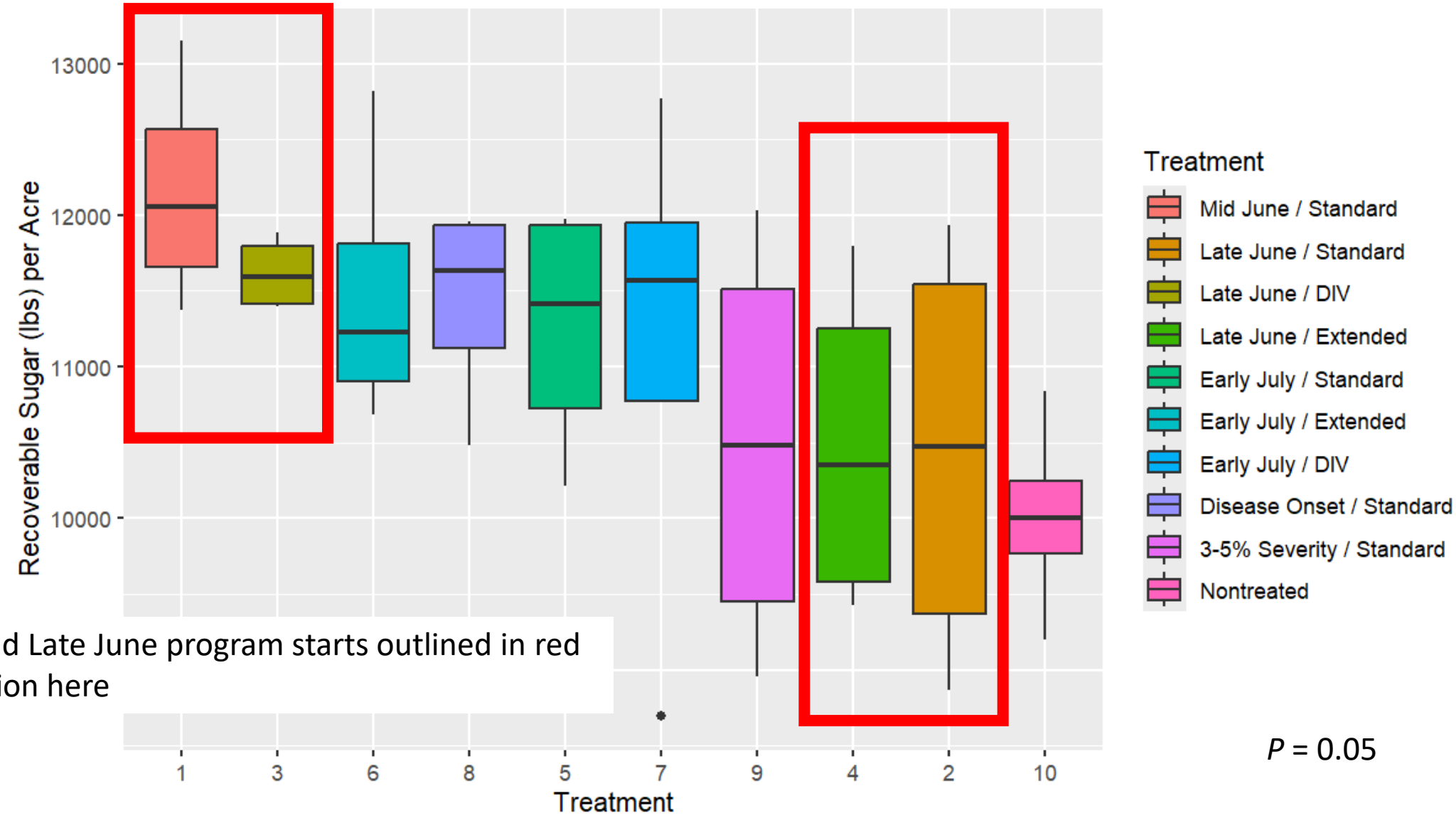
P = 0.55

Recoverable Sugar, non-CR+ variety (Kragnes)



P = 0.05

Recoverable Sugar, non-CR+ variety (Kragnes)



Mid June and Late June program starts outlined in red
More variation here

P = 0.05

CLS, Yield, and RSA (CR+ sugarbeet)

Program start date	CLS severity (AUDPS)	Yield (tons/A)	RSA (lbs)	Gross $/A
Mid June	29.5 a	32.5	10,575	$1,816
Late June	57.1 ab	30.8	9,779	$1,608
Late June	58.7 ab	32.6	10,204	$1,610
Late June	46.5 ab	28.8	9,550	$1,718
Early July	37.9 a	27.6	9,934	$2,021
Early July	58.2 ab	23.9	8,504	$1,687
Early July	51.8 ab	23.5	8,307	$1,639
Disease onset	49.5 ab	28.4	9,941	$1,736
3-5% CLS severity	62.4 ab	28.4	10,228	$2,087
Nontreated check	93.4 b	28.0	9,829	$1,916
P =	0.03	NS	NS	

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

Program start date	CLS severity (AUDPS)	Yield (tons/A)	RSA (lbs)	Gross $/A
Mid June	58.5 a	35.9	12,160	$2,350
Late June	50.3 a	32.0	10,437	$1,828
Late June	80.8 a	34.2	11,617	$2,182
Late June	92.0 a	30.1	10,482	$1,934
Early July	57.1 a	33.2	11,253	$2,117
Early July	87.6 a	33.0	11,491	$2,254
Early July	77.9 a	32.9	11,152	$2,073
Disease onset	88.1 a	32.7	11,427	$2,243
3-5% CLS severity	156.1 b	30.0	10,486	$2,041
Nontreated check	196.1 b	29.2	10,011	$1,307
P =	< 0.001	NS	0.05	

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

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

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
- Similar outcomes in CR+ and non-CR varieties
- Less benefit when CLS severity is low

June application: reduced CLS and increased RSA

Late June applications can benefit both CR+ and non-CR+ varieties

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

Sugarbeet Research and Education Board

NDSU Sugarbeet Extension Team
Andy Fuchs
Peter Hakk

Wyatt Lab Team (USDA-ARS)
Dr. Nathan Wyatt
Sophia Truscott

Industry support

Cooperating Growers

NDSU | EXTENSION

UNIVERSITY OF MINNESOTA
EXTENSION

Questions?

Dr. Eric Branch

eric.branch@ndsu.edu

701-365-1016

NDSU | EXTENSION

UNIVERSITY OF MINNESOTA EXTENSION