

WEED MANAGEMENT IN RICE

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Outlines

- Study mechanism of herbicide resistance in weeds and identify programs to manage resistant biotypes, provide diagnosis services to growers and PCA to confirm cross/multiple resistance in rice fields.
- Test new compounds that address critical weed control needs in rice cropping systems to ensure they are efficacious, compatible, and useful for California rice production.
- Optimize and improve efficacy of herbicide applied alone, in tank mixes, or/and in sequential treatments in different California rice production systems.

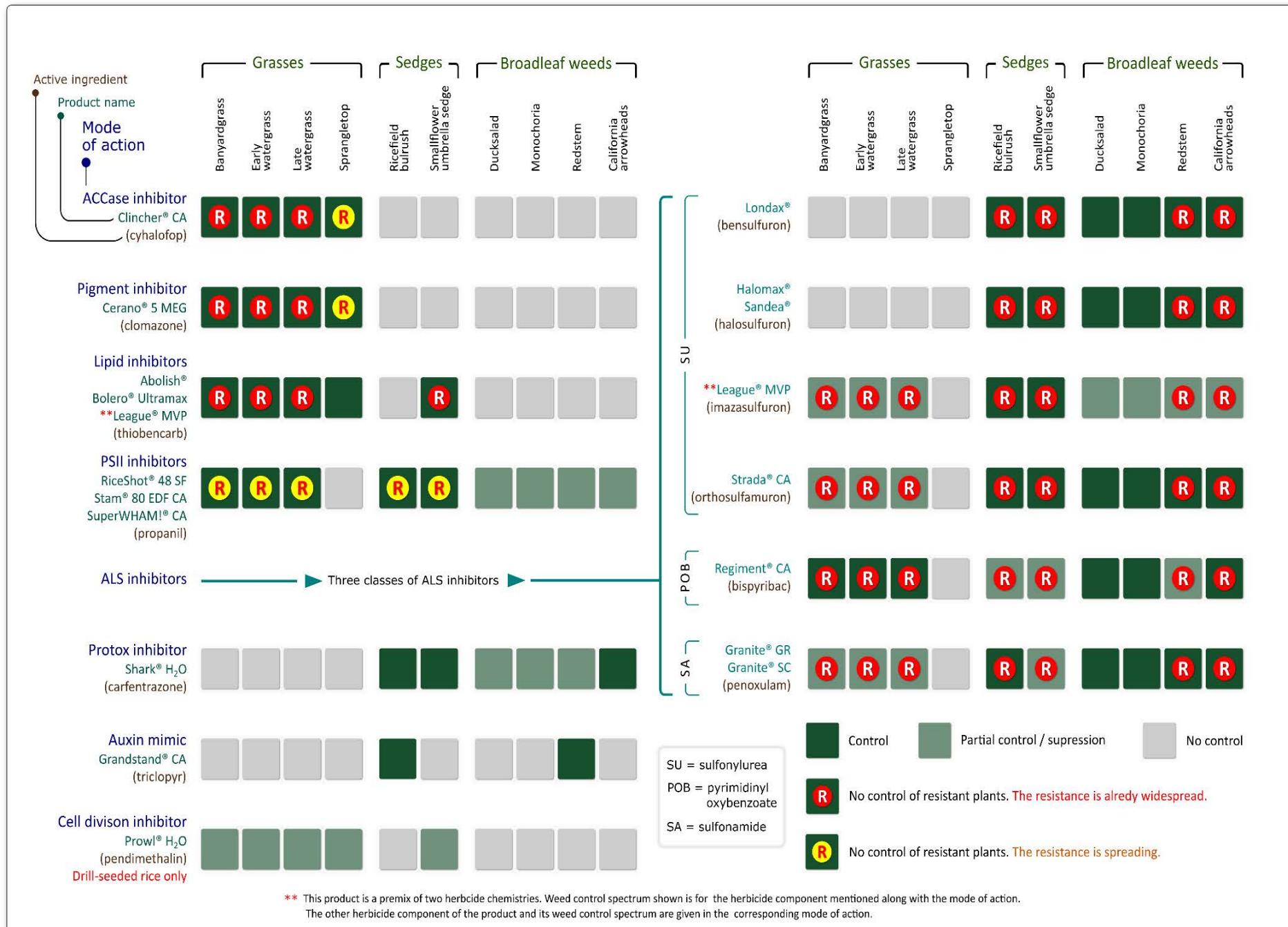
Herbicide Resistance

- Provide diagnosis for cross/multiple resistance in rice fields and map the resistance for the rice production area In California
- Study mechanism of herbicide resistance in weeds and identify programs/herbicides to manage to control resistant biotypes

California history of herbicide resistant weeds in rice

Weed	Year	Mode of action
Smallflower umbrella sedge	1993	ALS inhibitor
California arrowhead	1993	ALS inhibitor
Redstem	1997	ALS inhibitor
Ricefield bulrush	1997	ALS inhibitor
Late watergrass	1998	ACCase inhibitor
Late watergrass	1998	Thiocarbamates
Barnyardgrass	2000	ACCase inhibitor
Barnyardgrass	2000	Thiocarbamates
Early watergrass	2000	ACCase inhibitor
Early watergrass	2000	ACCase inhibitor
Late watergrass	2000	Thiocarbamates
Smallflower Umbrella Sedge	2013	PSII inhibitor
Ricefield Bulrush	2014	PSII inhibitor

Herbicide Resistant Weeds in California Rice Fields



Herbicide resistance is associated with:

- Mono culture
- Mono herbicide situations or using herbicide with the same mode of action
- No or little IPM practices are used (cultivation, stale seed bed treatment)
- Weeds emerged in narrow time window
- Herbicide rate/reduced rate

2017 Resistance Testing

Weed	Herbicides
Echinochloa species complex	Thiobencarb, Cerano, Clincher, Propanil, Londax, Regiment, Butte, and Granite
Smallflower umbrella sedge	Thiobencarb, Propanil, Londax, Regiment, Granite, Butte, and Shark,
Ricefield Bulrush	Propanil, Londax, Regiment, Granite, Shark, Butte, and Grandstand
Redstem	Londax, Granite, and Grandstand
Sprangletop	Thiobencarb, Cerano, Butte, and Clincher

HERBICIDE RESISTANCE TESTING FORM RFBR-10-04

Name of weed: Ricefield bulrush

Date of collection:

Submitter Information:

Name: [REDACTED]
Email: [REDACTED]
Phone #: [REDACTED]

Grower Information:

Name: [REDACTED]
Address: [REDACTED]
Phone #: [REDACTED]

Herbicides used	Resistance		Test result X=Resistant (This is for our internal use only)		
	In the past	This year		Known	Suspected
Ambush EC	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Baltic UltraMax	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Carnegie MEG	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Chaser CA	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
CrossGuard CA	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Cynipro GR	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Cynipro SC	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Milestone	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
League MVP	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Lionate	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Regiment CA	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
RiceEdge + DP	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Rinseout + EC	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Spadic	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Sting MHD	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Stop-n-EDMA CA	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
SuperGator CA	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
SuperWhirl CA	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Other	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Field/Site Information:

CPS Coordinates:

Township: [REDACTED]

Nearest Road: [REDACTED]

Size of the field: 320 acres

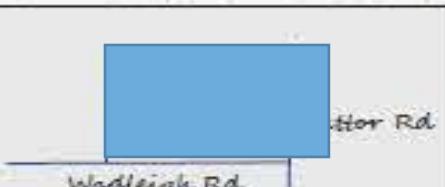
Percentage of field that is suspected to be resistant: 5%

When was the resistance suspected in this field: 2023

Please mark the tentative location of the field on the map.



Please draw a brief map of field with location of sampling.



How many plants were sampled: 30 acres

Water Management

- SOURCE(s) of water:
- Pump
 - Canal
 - Both
- Irrigation management:
- Continuous flow
 - Precision
 - Lateral method

Was water compromised or lost during time of the report? Yes No



Resistance status to the herbicides TESTED	Comments on the herbicides NOT TESTED
Grandstand No	
Shark H ₂ O No	Halomax = As your sample is resistant to Strada CA (other ALS-inhibitor herbicides), it is likely that your sample also resistsant to Halomax.
Propanil Yes	Regiment = This herbicide is labeled for partial control or suppression of ricefield bulrush. As your sample is resistant to Strada CA, there is a a fair chance that your sample is also resistant to this ALS-inhibitor herbicide. In any case, do not rely exclusively on this herbicide for controlling your ricefield bulrush.
Granite SC No	RiceEdge (propanil + halosulfuron) = See the comment for Halomax. If your sample is susceptible to Halomax, then this herbicide is STILL an option.
Strada CA Yes	Granite GR = Your sample should be susceptible to Granite GR (penoxulam). Granular formulation of penoxulam (Granite GR) may be less effective than the liuid formulation (Granite SC).
Yes Your sample is RESISTANT to this herbicide.	
No Your sample is SUSCEPTIBLE to this herbicide.	

Summary table for the results of herbicide resistance testing for rice weed seed samples received in 2017-2018

Weed species	<u>Herbicides</u>									
	Abolish/ Bolero	Butte	Cerano	Clincher	Grandstand	Granite GR/ SC	Londax	Propanil	Regiment	Shark H2O
	Number of resistant samples ²									
Barnyardgrass [67;60]	60	0	0	30		48		0	42	
Early watergrass [3;3]	3	0	0	3		2		0	2	
Late watergrass [41;41]	41	0	0	40		39		0	39	
Redstem [8;8]					0	6		0	6	0
Smallflower umbrellasedge [55;55]	0	0				50	54	54	49	0
Sprangletop [39;34]	2	0	5	11						
Waterplantain [3;3]		NC			NC	NC		NC	NC	NC

Smallflower umbrella sedge resistance to ALS-inhibitors

Common name	Trade name	Chemistry
Bensulfuron	Londax	Sulfonylureas
Bispyribac-sodium	Regiment	Pyrimidinylthiobenzoates
Halosulfuron	Sandeа, Sempra	Sulfonylureas
Orthosulfamuron	Strada	Sulfonylureas
Penoxsulam	Granite	Triazolopyrimidines
Imazosulfuron	Part of League MVP	Sulfonylureas



Average of 3WATcorr

120

100

80

40

20

0

-20

2

3

4

10

18

29

32

41

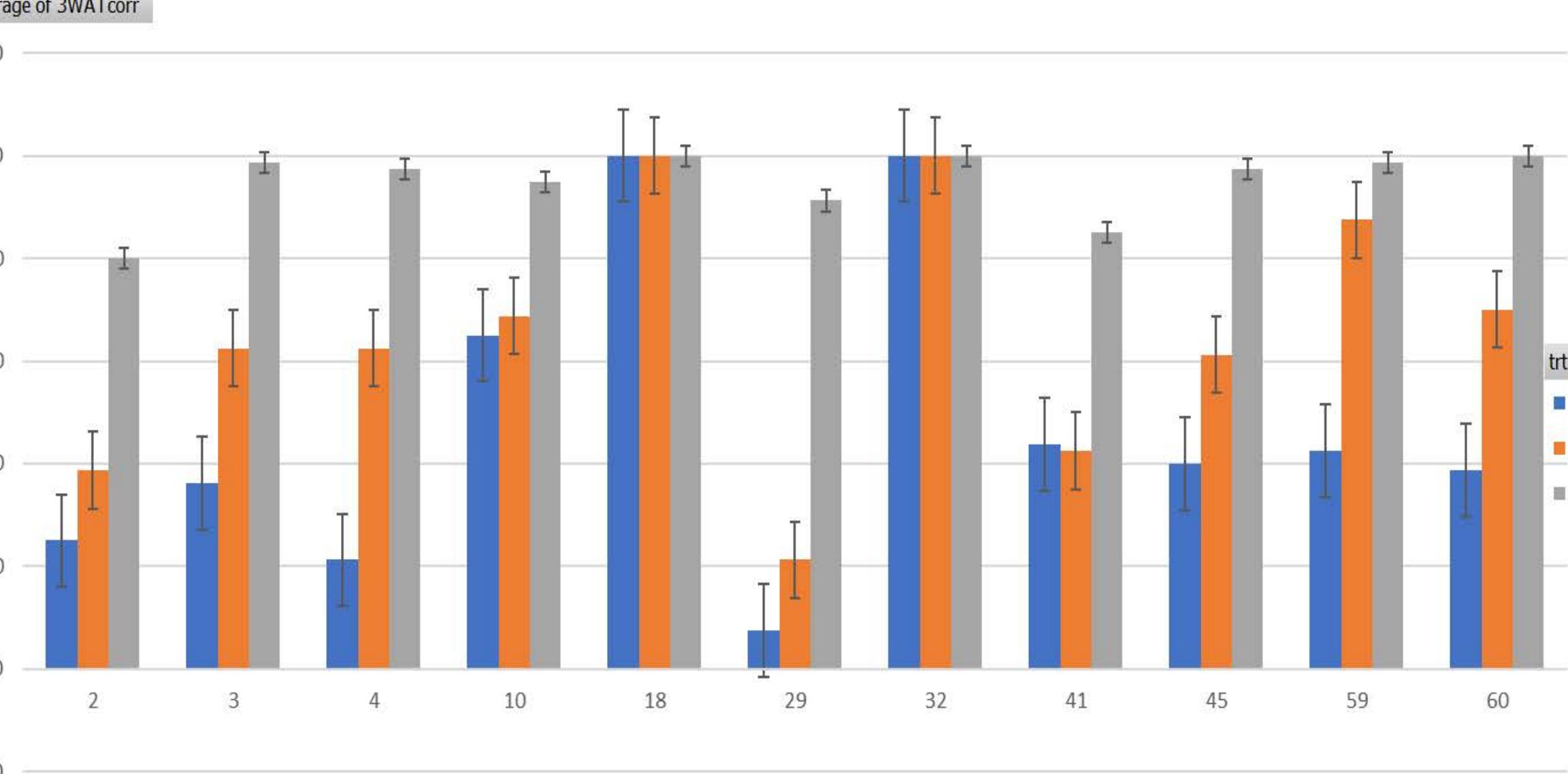
45

59

60

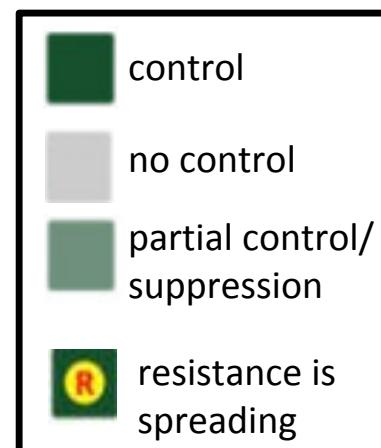
trt
prop 0.5x
prop 1x
prop 3x

pop



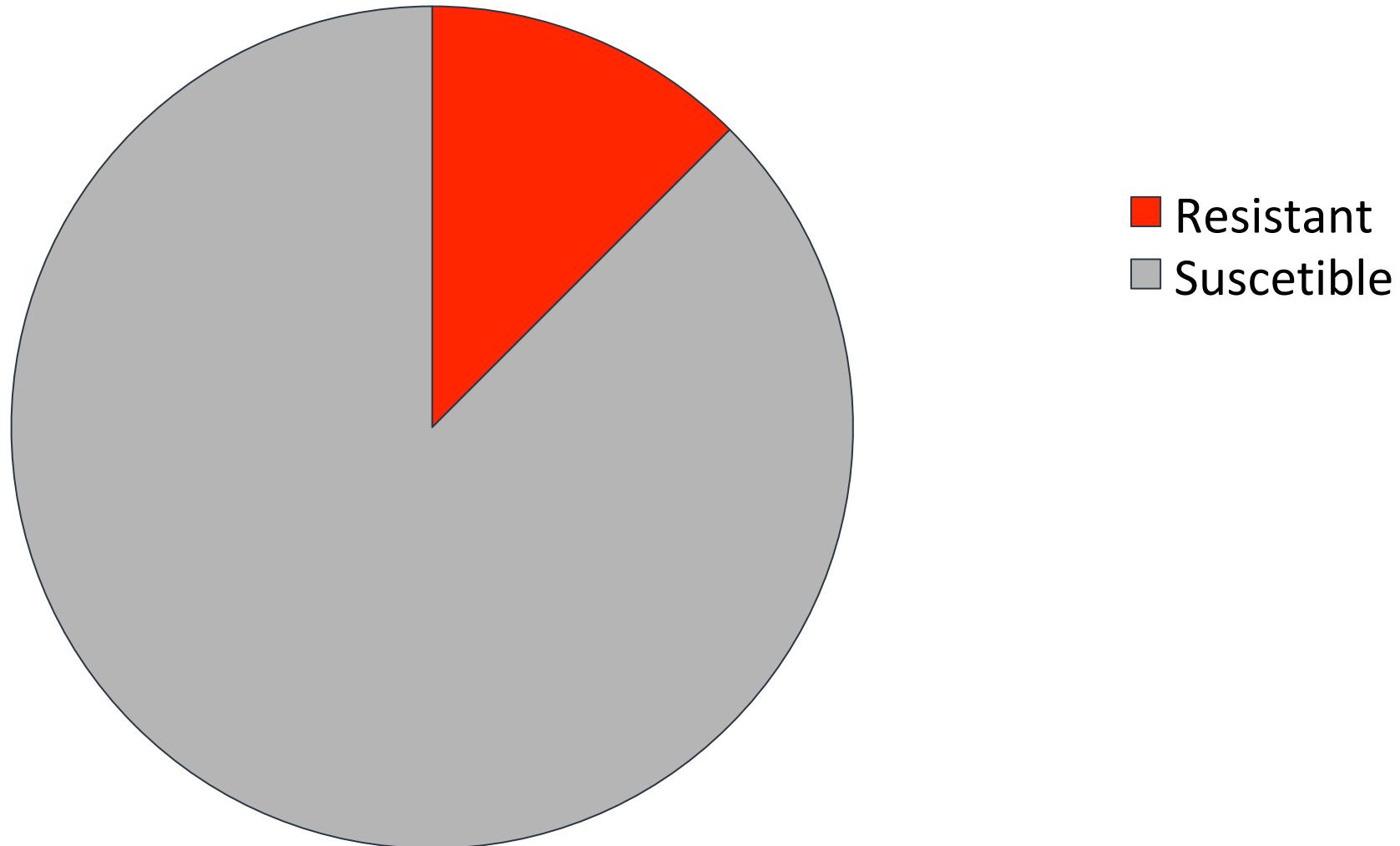
Current State of Bearded Sprangletop Control in CA Rice

<u>Mode of Action</u>	<u>Product Name</u> <u>(active Ingredient)</u>		<u>Mode of Action</u>	<u>Product Name</u> <u>(active Ingredient)</u>
ACCase inhibitor ►	Clincher ® CA (cyhalofop)		Pigment synthesis inhibitor + ALS (SU) ►	Butte ® (benzobicyclon + halosulfuron)
Pigment synthesis inhibitor ►	Cerano ® 5 MEG (clomazone)			
Lipid synthesis inhibitor ►	Abolish ® 8 EC Bolero ® Ultramax (thiobencarb)			
	Pendimethalin in Direct seeded rice			
	SuperWHAM! ® CA (propanil)			
Protox inhibitor ►			Lipid Synthesis Inhibitor + ALS inhibitor (SU) ►	League ® MVP (thiobencarb + imazosulfuron)
Auxin mimic ►	Grandstand ® CA (triclopyr)			
	Prowl® H2O (pendimethalin) Drill-seeded rice only			



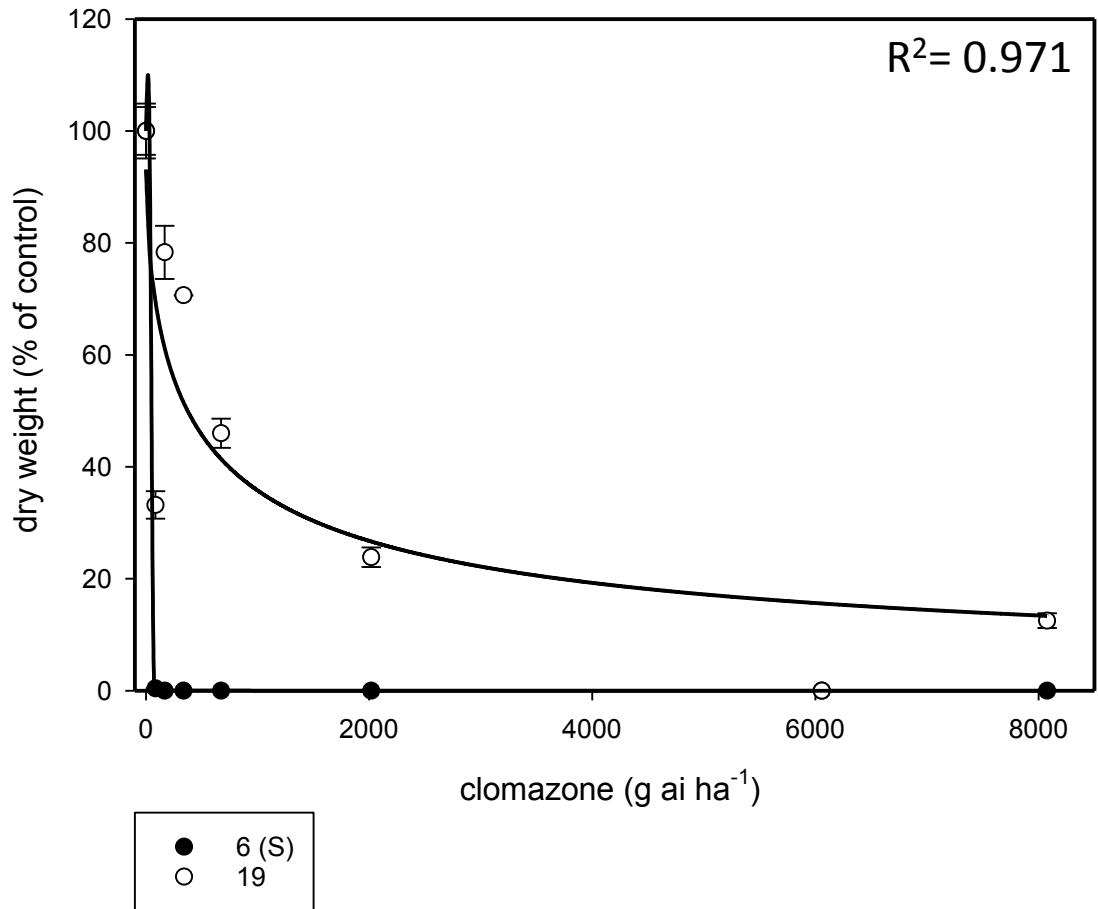
Clomazone Resistant Bearded Sprangletop (dry weight)			
Population	NT	1x	3x
1	24.4 ^{cd}	0 ^a	0 ^a
2	24.6 ^{cd}	4.9 ^c	2.5 ^d
3	10.1 ^{ab}	0 ^a	0 ^a
4	1 ^a	0.8 ^{ab}	0 ^a
5	11.9 ^b	0 ^a	0 ^a
6	0.5 ^a	0 ^a	0 ^a
7	0.9 ^a	0 ^a	0 ^a
8	23.8 ^{cd}	0 ^a	0 ^a
9	23.5 ^{cd}	0.5 ^{ab}	0.3 ^{ab}
10	13.8 ^{bc}	0 ^a	0 ^a
12	6.9 ^{ab}	0 ^a	0 ^a
13	2.7 ^{ab}	0 ^a	0 ^a
15	5.2 ^{ab}	3.6 ^c	1.7 ^{cd}
17	6.1 ^{ab}	0 ^a	0 ^a
18	4.8 ^{ab}	0 ^a	0 ^a
19	14 ^b	3.1 ^c	1.6 ^{cd}
20	11.2 ^b	0 ^a	0 ^a
21	4.5 ^{ab}	0 ^a	0 ^a
28	3.5 ^{ab}	0 ^a	0 ^a
31	32.7 ^{cd}	0 ^a	0 ^a
32	2 ^a	0 ^a	0 ^a

Percentage of Resistant Breaded Sprangletop



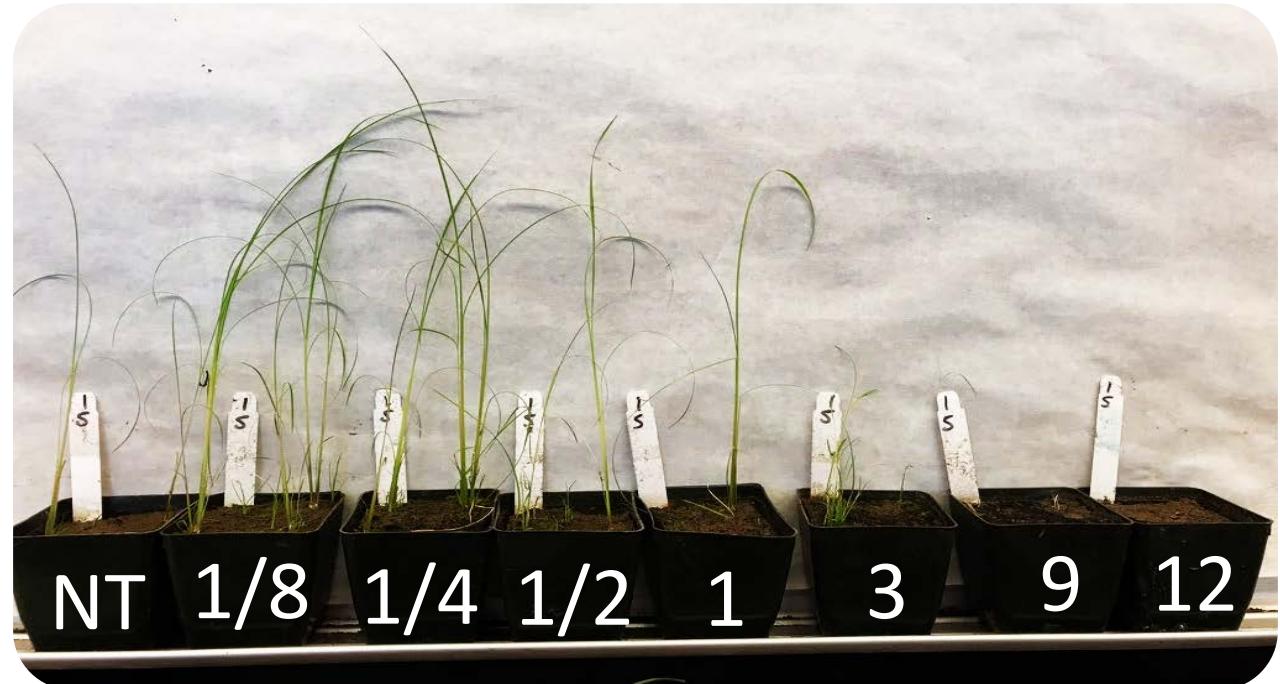
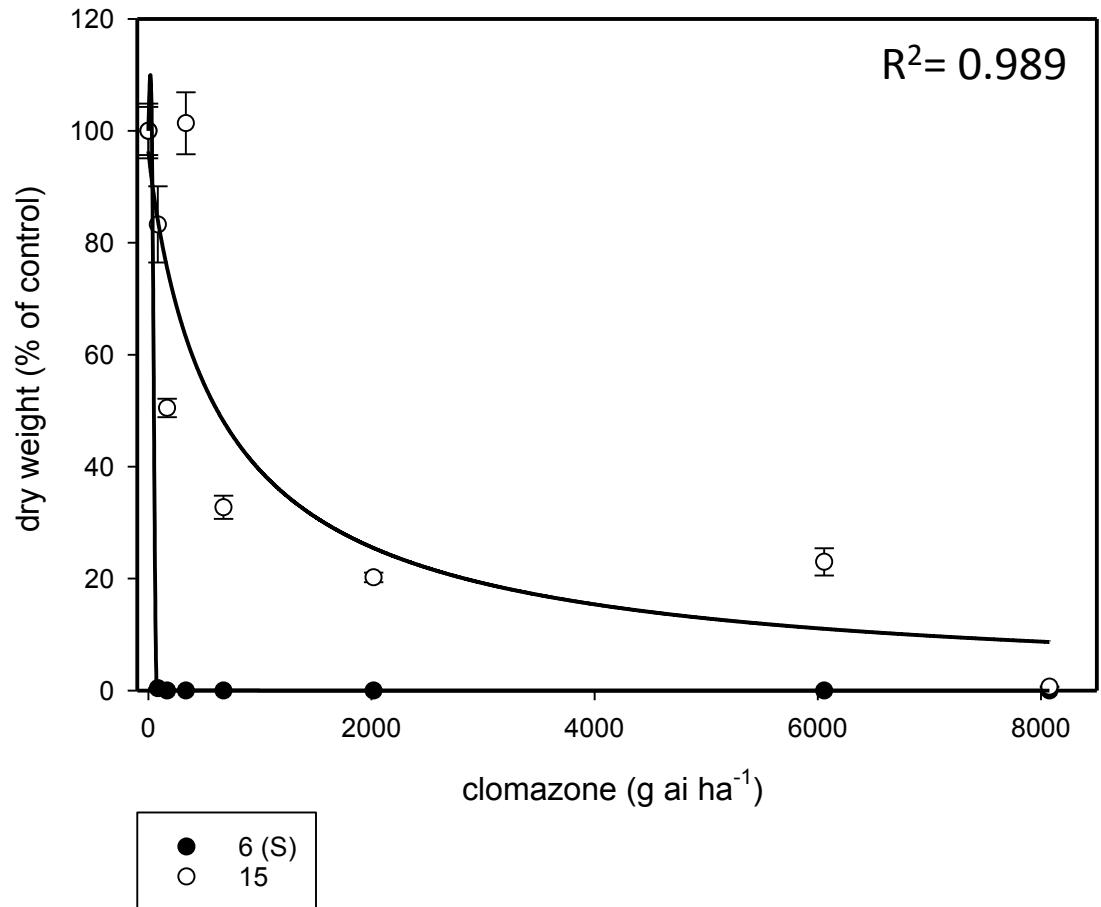
$$\text{GR}_{50} = 725 \text{ g ai ha}^{-1}$$

1.25x



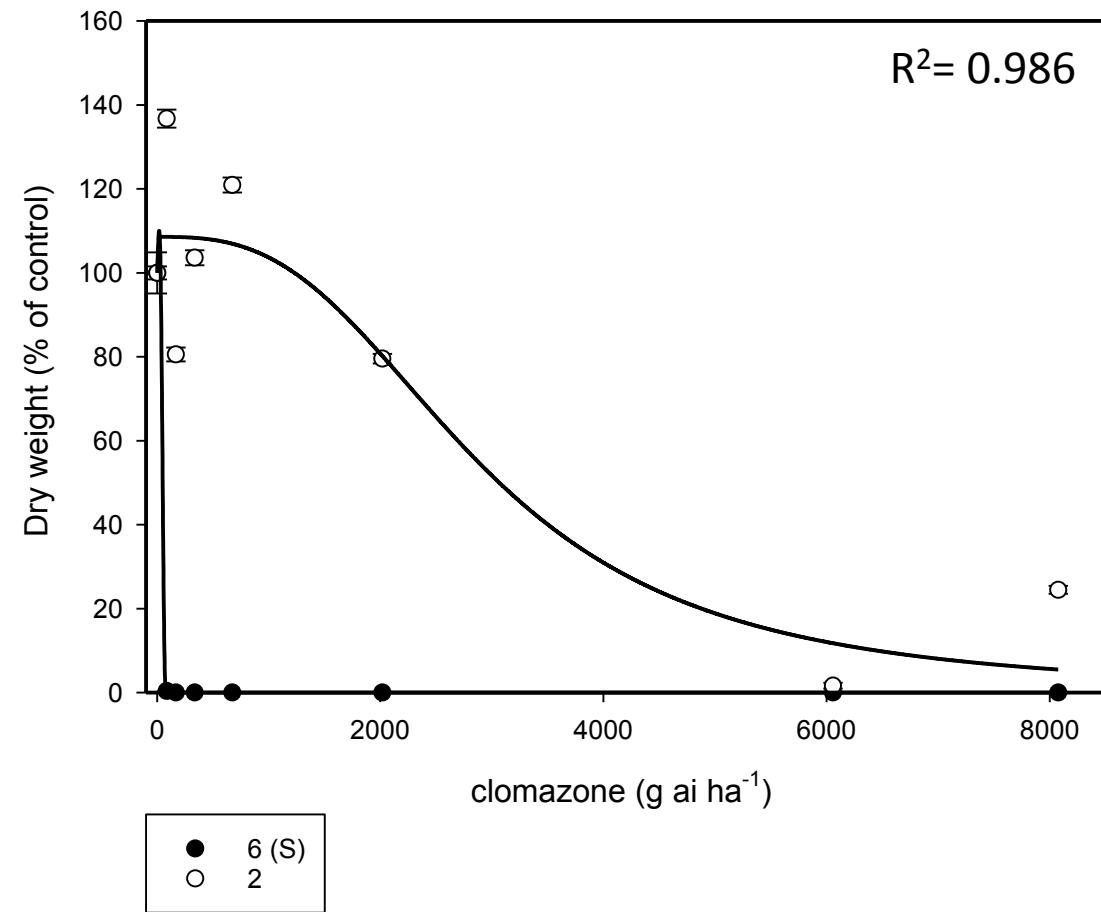
$$\text{GR}_{50} = 740 \text{ g ai ha}^{-1}$$

2x



$$\text{GR}_{50} = 3351 \text{ g ai ha}^{-1}$$

5x



Methods

- Three field sites:
 - late April planting date
 - mid-May planting date
 - early June planting date
- Ten 76 cm PVC pipes were placed in each field to control flood levels
 - 100 seed of:
 - bearded sprangletop
 - smallflower umbrella sedge
 - barnyardgrass
- Germination counts were taken daily
- Temperature of water and air recorded



Methods

- Growing Degree Days (Thermal time)

$$GDD = \sum [T_{max} + T_{min}/2 - T_{base}]$$

- T_{max} = maximum temperature observed
- T_{min} = minimum temperature observed
- T_{base} = minimum temperature where growth starts

- Weibull model with lag phase

$$y = G_{max} [1 - \exp(-b(x - lag)^c)]$$

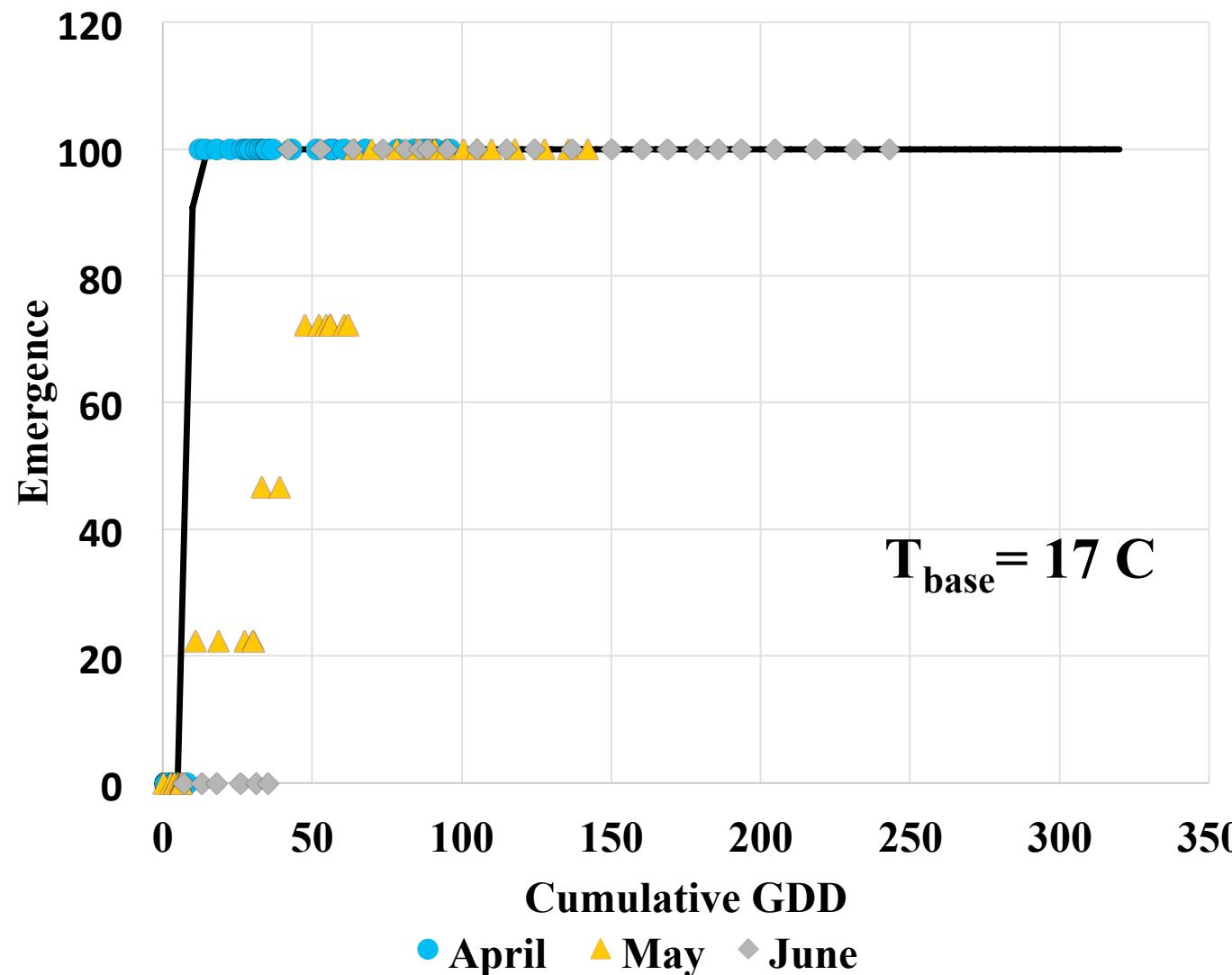
y = number of emerged shoots

G_{max} = maximal asymptote

c = shape parameter which determines the skewness and kurtosis of the equation

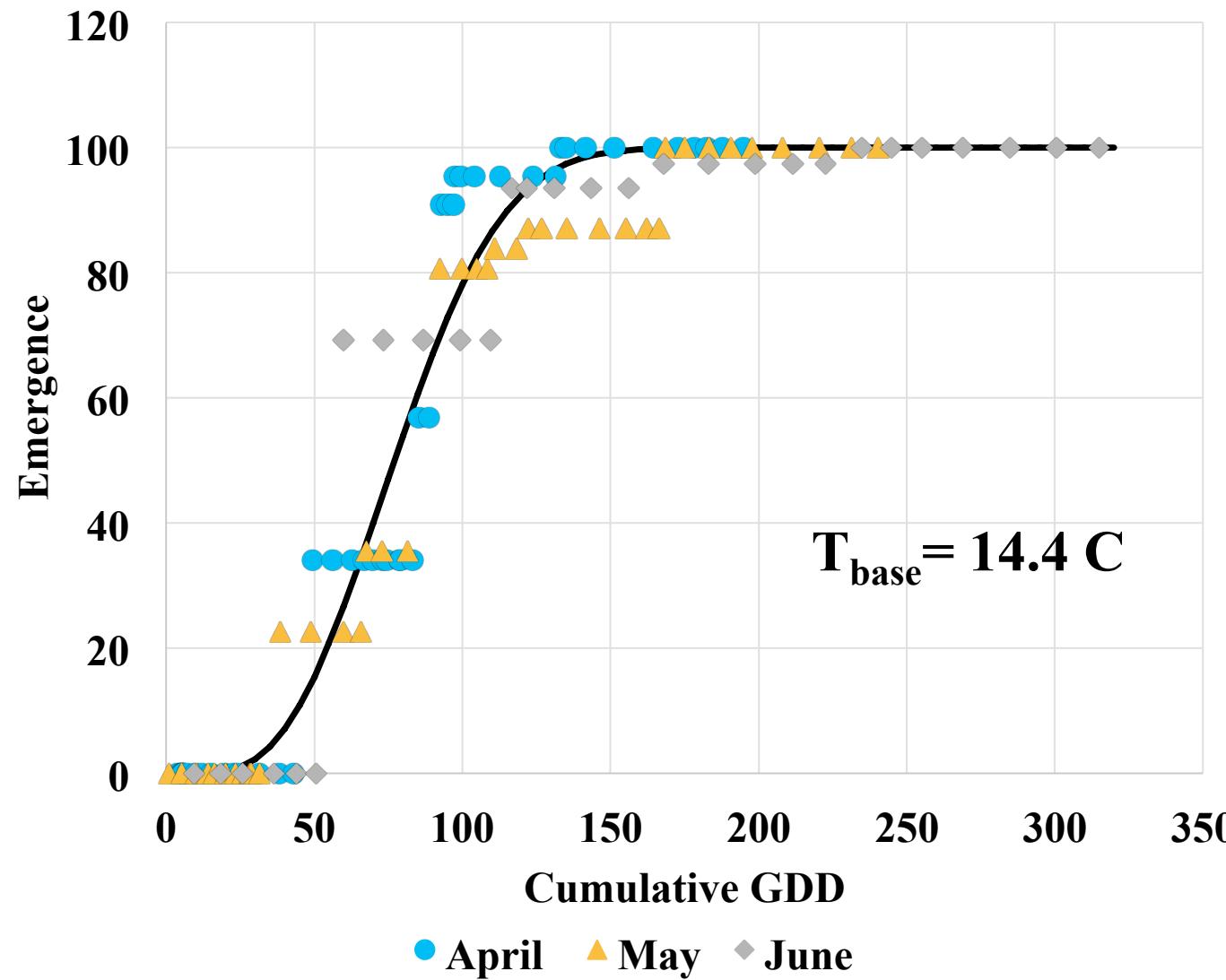
b = scale parameter regardless of the shape value at $GDD = lag + b$

Smallflower Umbrella Sedge Emergence Affected by Thermal Time



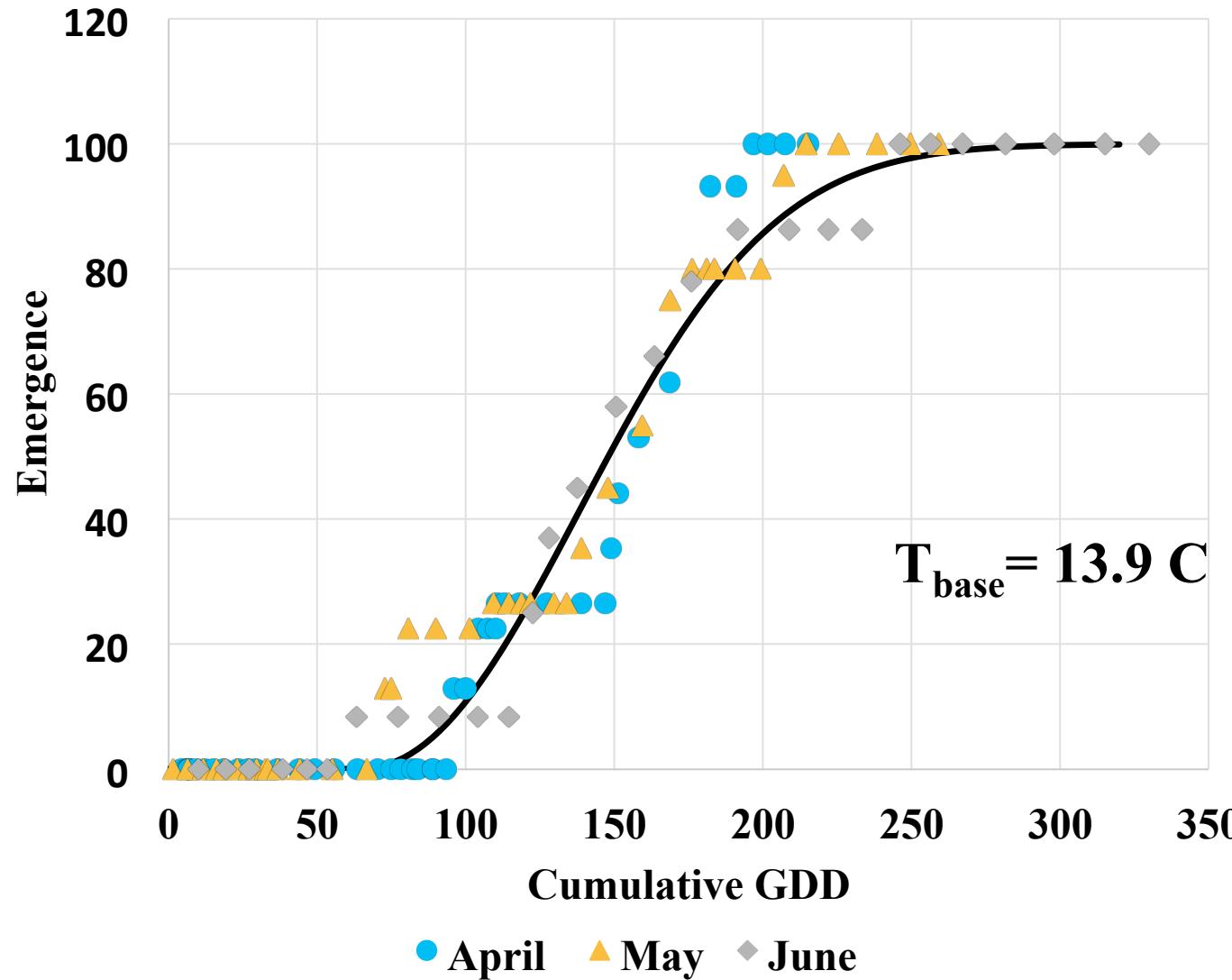
% Emergence	GDD
10	9.5
20	9.6
30	9.7
40	9.7
50	9.8
60	9.8
70	9.9
80	9.9
90	10

Barnyardgrass Emergence Affected by Thermal Time



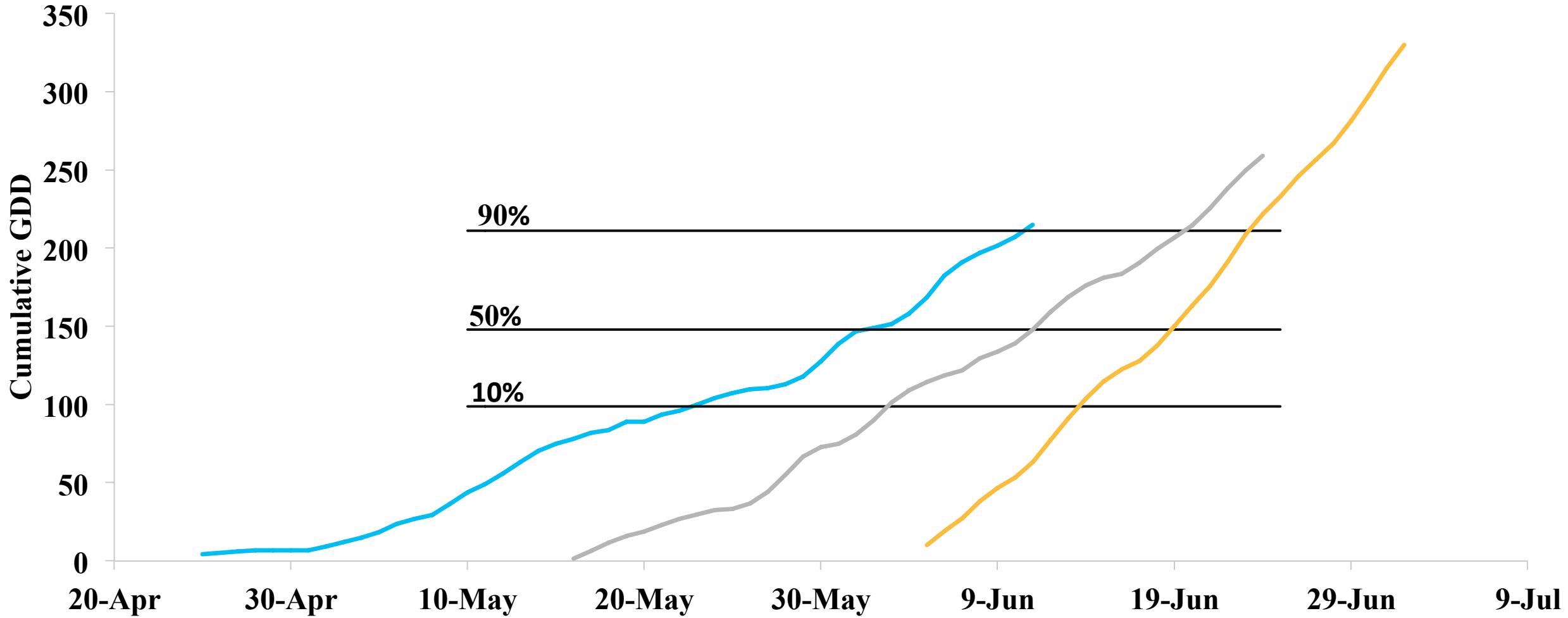
% Emergence	GDD
10	43.9
20	54.4
30	62.6
40	70.0
50	77.2
60	84.5
70	92.5
80	101.9
90	115.1

Bearded Sprangletop Emergence Affected by Thermal Time



% Emergence	GDD
10	98.7
20	113.4
30	125.5
40	136.8
50	147.9
60	159.7
70	172.7
80	188.5
90	211.1

Sprangletop Emergence Over Time



Test New Herbicides

- Pyraclonil (a PPO inhibitor) from Nichino America. This herbicide has similar mode of action to Shark and oxyfluorfen - continuous-flood
- Rinskor - Loyant, florpyrauxifen-benzyl, Corteva
- Roxy Rice
- New FMC grass control herbicide

Pyraclonil



Loyant, florpyrauxifen-benzyl



FMC Grass Herbicide



Untreated control



New FMC grass herbicide



Untreated control



Goal 2XL 2 pints/A

Develop herbicide alternatives and optimization

- Optimizing Butte herbicide
 - Butte-based programs in comparison to other programs
 - Timing

Weed Species	Average % control 3 WAT				
	pre-emergence	sprouting	1 leaf stage	3 leaf stage	5 leaf stage
Late watergrass	100	100	93	28	10
Barnyardgrass	100	100	95	53	13
Sparangletop	100	100	100	78	21
Ricefield bulrush	100	100	100	97	53
Smallflower umbrellasedge	100	100	100	57	42
Ducksalad	100	100	100	60	30