



Plant Growth Regulators for Lawns and Landscapes

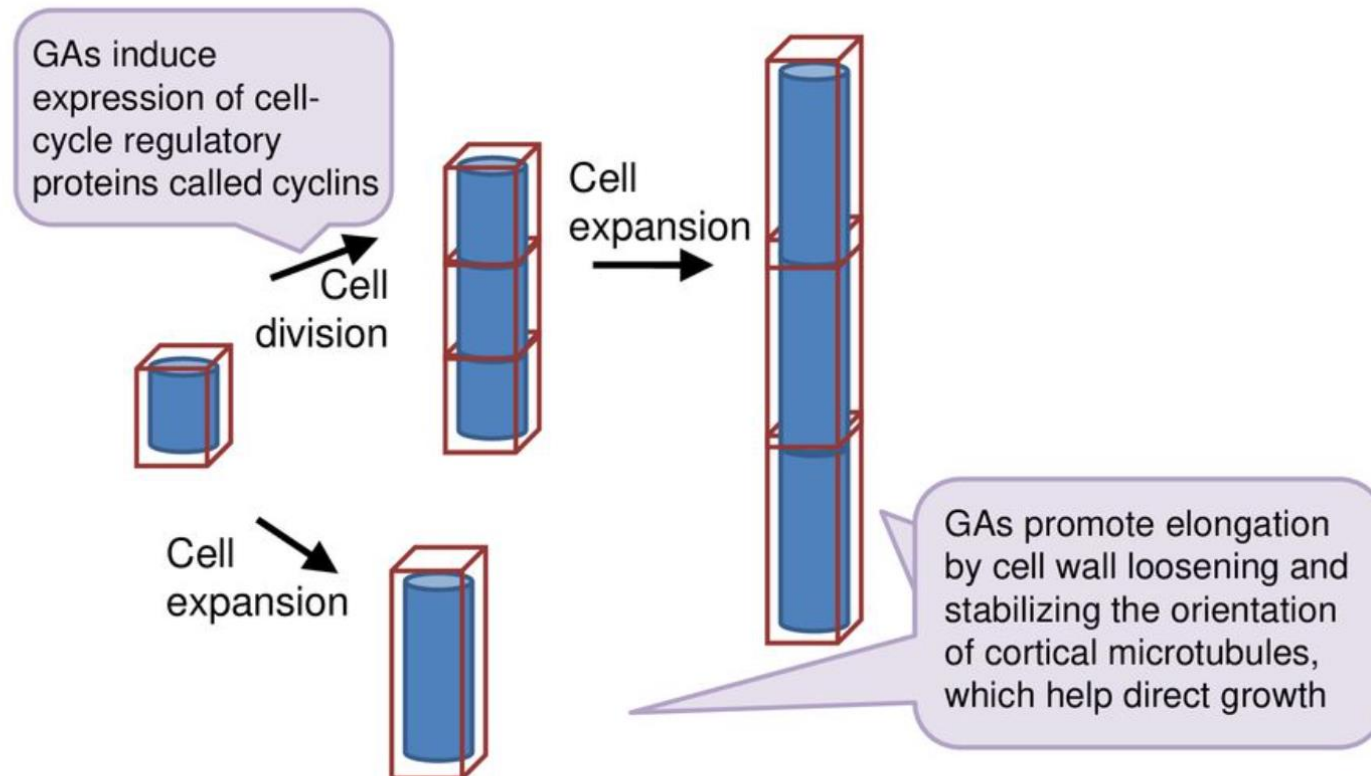
Doug Soldat / Professor & Turfgrass Extension Specialist

Dept. of Soil Science / UW-Madison

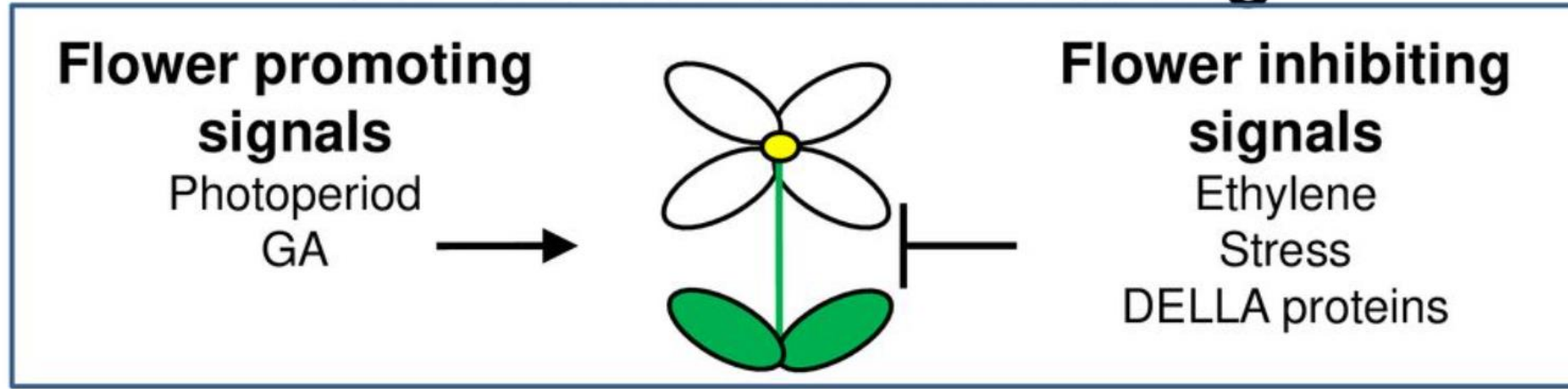
djsoldat@wisc.edu

Gibberellic Acid (GA)

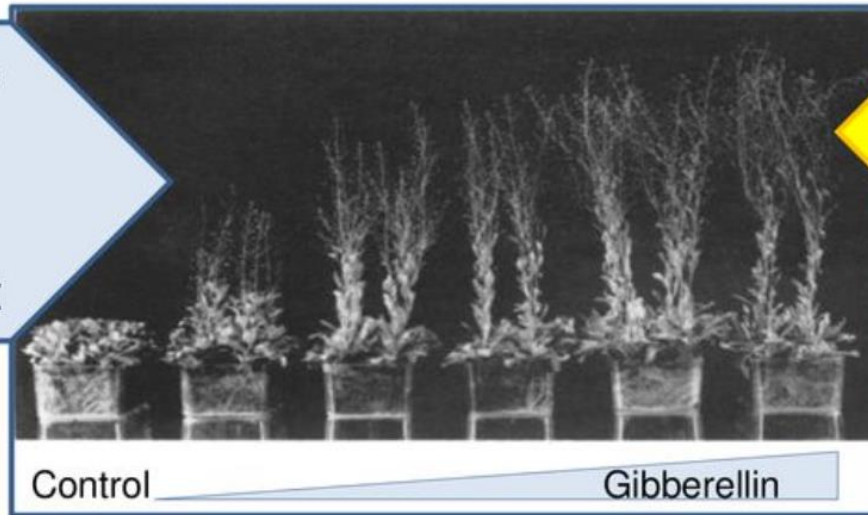
GAs promote growth through cell expansion and division



In some plants, GAs contribute to the control of flowering



Samolus parviflorus, a long-day plant, grown in short-days without or with gibberellin treatment



In some plants that require long days for flowering, GA can promote flowering even in short days

Lawns are growing quickly and seedheads are appearing

Kevin Frank, Michigan State University Extension, Department of Plant, Soil and Microbial Sciences - May 28, 2020

Warm temperatures and abundant precipitation have resulted in rapid turf growth and seedheads are now appearing in lawns.

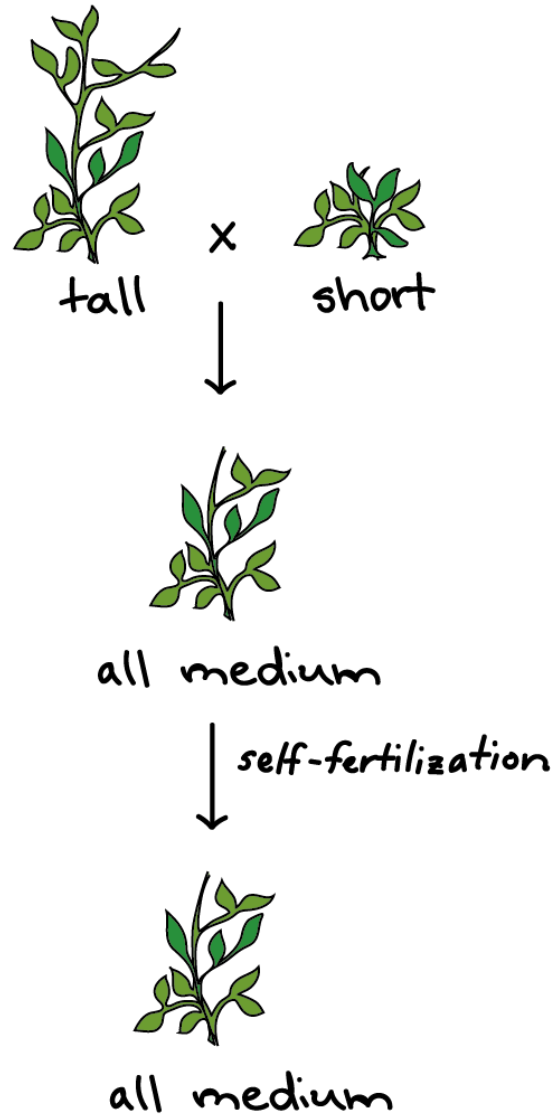


Seedheads in a Kentucky bluegrass turf. Photo by Kevin Frank, MSU.

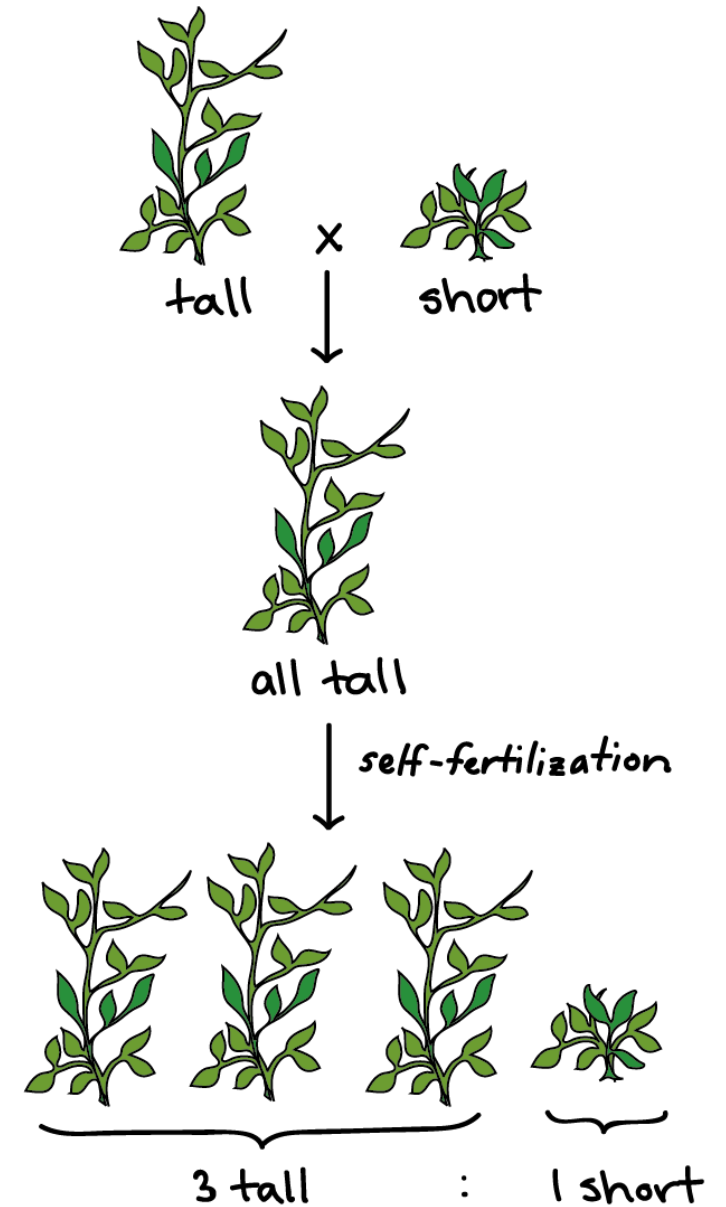
Gregor Mendel



BLENDING MODEL PREDICTION



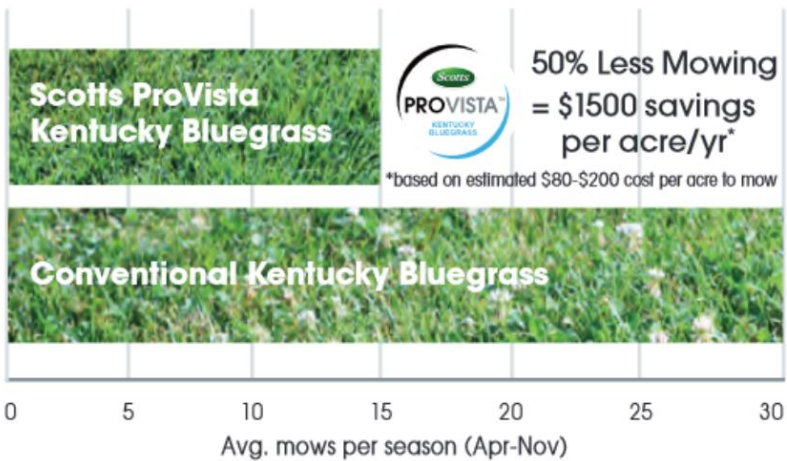
MENDEL'S ACTUAL RESULTS



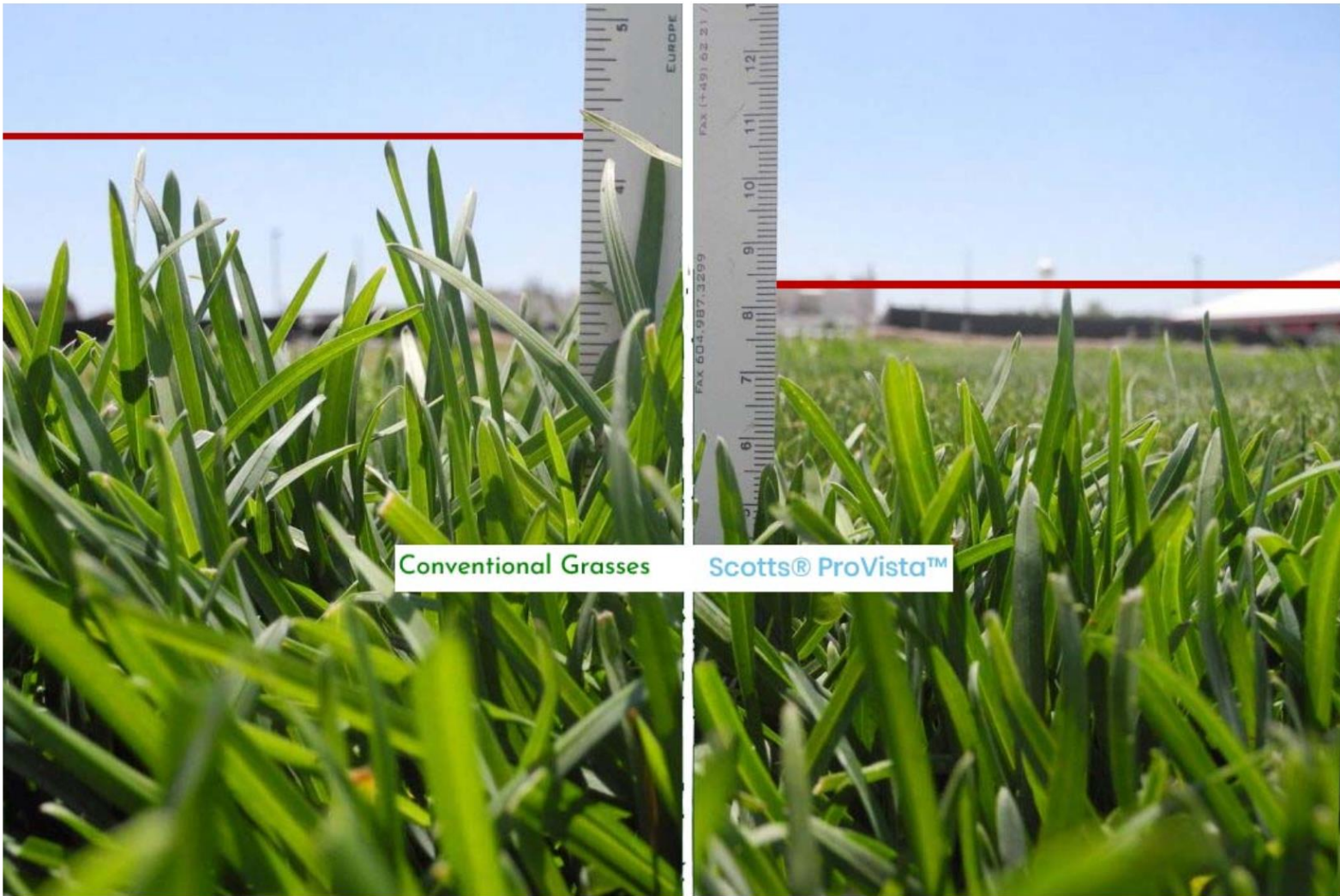


Cost Effective

Scotts® ProVista™ grows slower than conventional Kentucky Bluegrass, saving valuable mowing time and reducing maintenance costs.



◀ Conventional Grasses Scotts® ProVista™ ▶





GA has been described as “an inhibitor of an inhibitor”

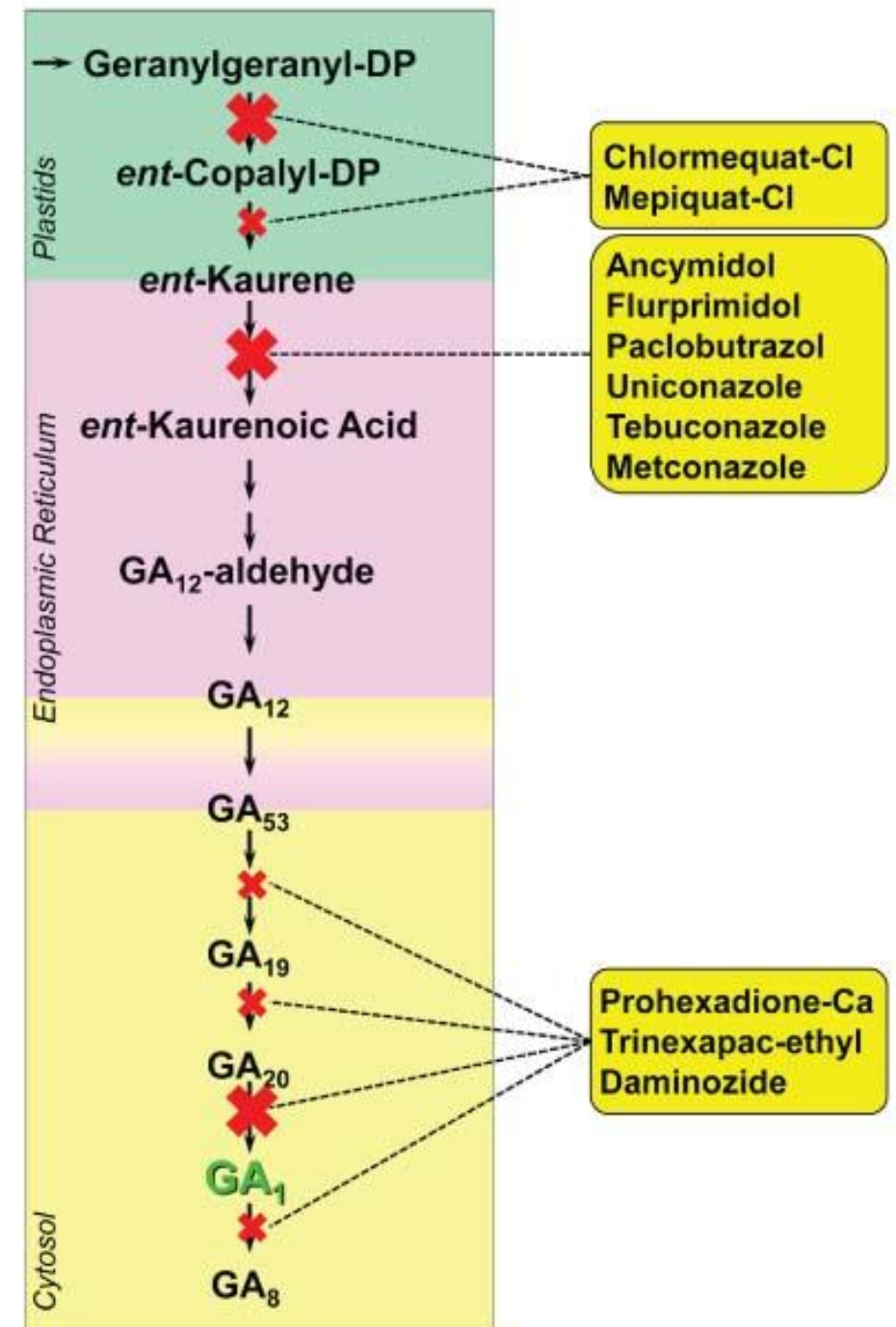
A car doesn't roll down a hill when the brake is on to inhibit it. Releasing the brake “inhibits the inhibitor”, allowing another force (gravity) to move it



GA doesn't promote growth on its own, but instead inhibits growth inhibitors (i.e. releases the brakes)

Modern PGRs work by inhibiting Gibberellic Acid

- Today, we will be covering the four most common PGRs used in the turf industry:
 - Flurprimidol
 - Paclobutrazol
 - Prohexadione calcium
 - Trinexacpac-ethyl

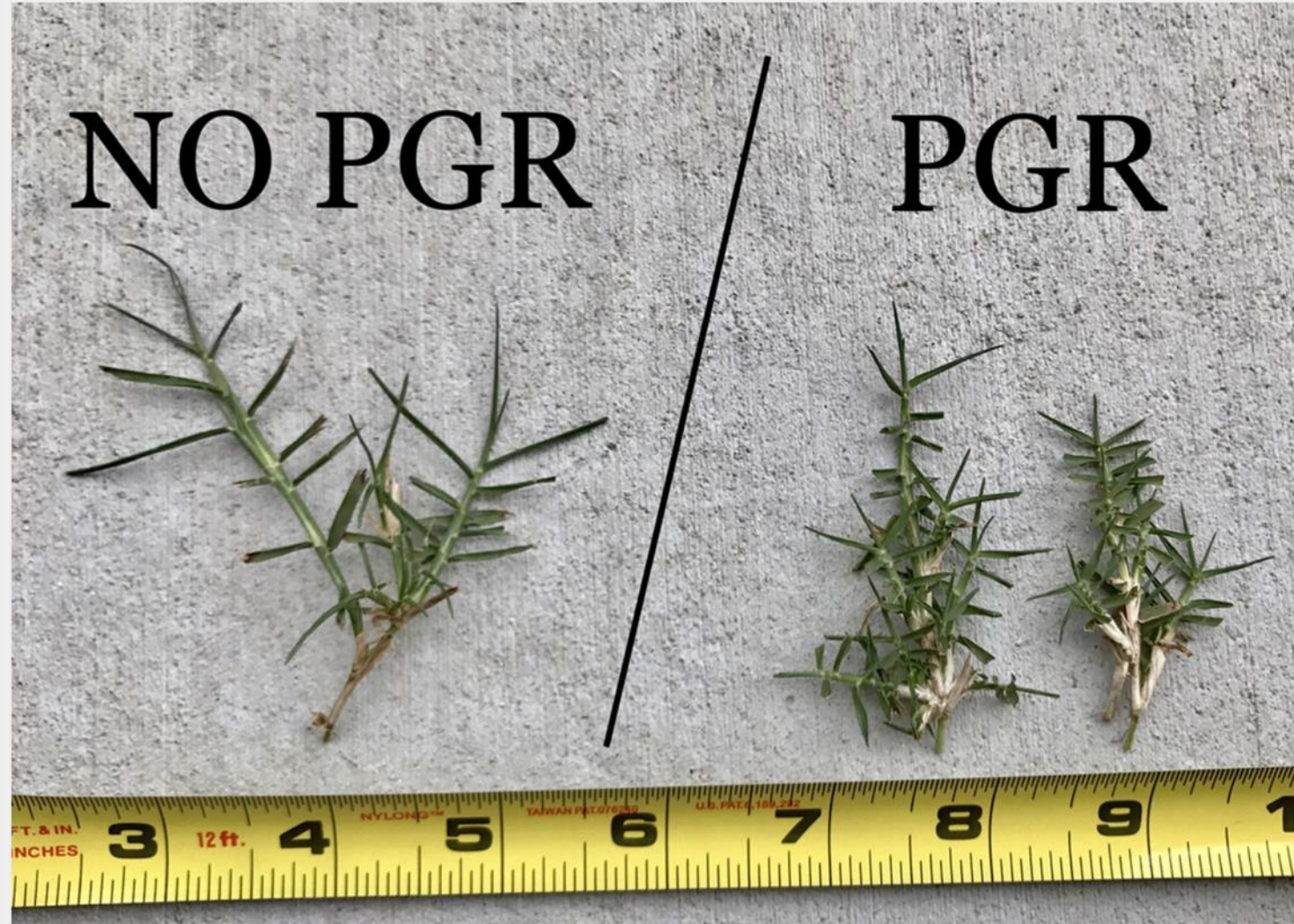


- Plant growth regulators were originally developed for the lawn/landscape industry but are now used primarily in the golf market.
- There are many types of PGRs, but you don't want to use the types we aren't talking about today. They can damage the turf.
 - Pre-1980s = cell division inhibitors (weak herbicides)
 - 1980s and later = hormone disruptors (less damaging)

PGR vs. No PGR

by Ware » Sat Aug 12, 2017 2:06 pm

These are probably not textbook-worthy grass samples, but I pulled the sprig on the left from my neighbor's yard (no PGR) and the sprigs on the right from my yard (with PGR) a few minutes ago...







Density and color are enhanced, heat and drought stress are decreased

Which do you prefer?



A

B

C

Economics of using PGRs

- If you are getting paid each time you mow, PGRs probably don't make sense – but it can make mowing easier or faster
- If you are getting paid to maintain a property, PGRs may save you time and money
- If your homeowner/client is mowing, they may be interested in decreasing their mowing
- If your homeowner has robotic mowers, PGRs may help reduce the amount of trimming required
- PGRs use is desirable for most high end lawns – low mowing, high quality, etc.

Paclobutrazol*

* not labeled for residential lawns

- Industrial strength: Regulates hard, but can cause damage if over-applied
- Trimmit ~\$50/A
- Off-brand ~\$25/A
- Lasts ~6 weeks
- Root absorption – must irrigate after application

Tide Paclo 2SC

Ornamental Plant Growth Regulator for Turfgrass & Trees

ACTIVE INGREDIENT:
Paclobutrazol: ((±)-(R*,R*)-β-[(4-chlorophenyl methyl]-α-(1,1-dimethylethyl)-1H-1,2,4-triazole-1-ethanol)..... 22.3%

OTHER INGREDIENTS..... 77.7%

TOTAL..... 100.0%



Trimmit[®] 2SC
Plant growth regulator

syngenta.

Plant Growth Regulator

For Turfgrass

Active Ingredient:
Paclobutrazol
(±)-(R*,R*)-beta-[(4-chlorophenyl)methyl]-alpha-(1,1-dimethylethyl)-1H-1,2,4-triazole-1-ethanol 22.9%

Other Ingredients: 77.1%

Total: 100.0%

SHAKE WELL BEFORE EACH USE

Manufacture for:
Zhejiang Tide Crop Science Co., Ltd.
21 Hubble, Irvine, CA 92618

Trinexapac Ethyl

- The standard
- Often improves turf quality
- Primo Maxx ~\$70/A
- Off-brand ~\$35/A
- Lasts ~4 weeks
- Foliar absorption



Plant Growth Regulator

For Turf Growth Management

For managing growth, improving quality and stress tolerance, and edging of warm- and cool-season turfgrasses

<i>Active Ingredient:</i>	
Trinexapac-ethyl (CAS No. 95266-40-3)	11.3%
<hr/>	
<i>Other Ingredients:</i>	88.7%
<hr/>	
<i>Total:</i>	100.0%

Primo MAXX® is a microemulsion concentrate containing one pound trinexapac-ethyl per gallon.

Podium®

PLANT GROWTH REGULATOR FOR TURF GROWTH MANAGEMENT

For managing growth, improving quality and stress tolerance, and edging of warm- and cool-season turfgrasses

<i>Active Ingredient:</i>	
Trinexapac-ethyl (CAS No. 95266-40-3)	11.3%
<hr/>	
<i>Other Ingredients:</i>	88.7%
<hr/>	
<i>Total:</i>	100.0%

Podium® is a microemulsion concentrate containing one pound trinexapac-ethyl per gallon.

KEEP OUT OF REACH OF CHILDREN.

CAUTION

See additional precautionary statements and directions for use inside booklet.

Product of Switzerland
Formulated in the USA

SCP 937B-L1D 1215
4061883

1 gallon



PLANT GROWTH REGULATOR FOR TURF GROWTH MANAGEMENT

Contains trinexapac-ethyl, the active ingredient used in Primo MAXX®

A micro emulsion concentrate used to manage growth and improve quality and stress tolerance of turf edging and warm- and cool-season turfgrasses.

<i>ACTIVE INGREDIENT:</i>	
Trinexapac-ethyl:	12.0%
<i>OTHER INGREDIENTS:</i>	88.0%
<hr/>	
<i>TOTAL:</i>	100.0%

*Contains 1 pound of active ingredient per gallon

**KEEP OUT OF REACH OF CHILDREN
CAUTION**

See additional precautionary statements and directions for use inside booklet.

EPA Reg. No. 53883-353
EPA Est. No. 53883-TX-002

Prohexadione Calcium

- New kid on the block
- Very promising results: safe and good regulation
- ~\$60/A
- No off-brands
- Lasts ~4 weeks
- Foliar absorption



Plant Growth Regulator

For managing growth, improving quality and stress tolerance of turf.

ACTIVE INGREDIENT:

Prohexadione calcium [calcium 3-oxido-5-oxo-4-propionylcyclohex-3-enecarboxylate]..... 27.5%

OTHER INGREDIENTS:..... 72.5%

TOTAL: 100.00%

Flurprimidol

- Not great results in cool-season turf
- ~\$70/A
- Lasts ~4 weeks
- Root absorption, must irrigate after application

Cutless® MEC

Turf Growth Regulator

SPECIMEN



FOR GROWTH MANAGEMENT AND QUALITY IMPROVEMENT OF TURFGRASSES ON GOLF COURSES.

Active Ingredient:

Flurprimidol: α -(1-methylethyl)- α -[4-(trifluoromethoxy)phenyl]-5-pyrimidinemethanol 16.0%

Other Ingredients..... 84.0%

TOTAL 100.0%

Contains 1.3 pounds active ingredient per gallon of product.

Combination products

- Legacy
 - Contains flurprimidol and trinexapac ethyl
- Musketeer*
 - Contains flurprimidol, paclobutrazol, and trinexapac ethyl

* not labeled for residential lawns

Legacy[®]

Turf Growth Regulator

SPECIMEN



For growth management and quality improvement of turfgrasses on golf courses.

Active Ingredients

Flurprimidol: α -(1-methylethyl)- α -[4-(trifluoromethoxy)phenyl]-5-pyrimidinemethanol..... 13.26%
Trinexapac-ethyl: 4-(cyclopropyl- α -hydroxymethylene)-3,5-dioxo-cyclohexanecarboxylic acid ethyl ester..... 5.00%

Other Ingredients..... 81.74%

TOTAL 100.00%

Contains 1.10 pounds of flurprimidol per gallon of product.

Contains 0.41 pound of trinexapac-ethyl per gallon of product.

Musketeer[®]

Turf Growth Regulator



For growth management and quality improvement of turfgrasses on golf courses.

Active Ingredients

Flurprimidol: α -(1-methylethyl)- α -[4-(trifluoromethoxy)phenyl]-5-pyrimidinemethanol..... 5.6%
Paclobutrazol: (\pm) -(*R*^{*}, *R*^{*})- β -[4-(4-chlorophenyl)methyl]- α -(1,1-dimethylethyl)-1H-1,2,4-triazole-1-ethanol..... 5.6%
Trinexapac-ethyl: 4-(cyclopropyl- α -hydroxymethylene)-3,5-dioxo-cyclohexanecarboxylic acid ethyl ester..... 1.4%

Other Ingredients..... 87.4%

TOTAL 100.0%

Summary: trinexapac ethyl and prohexadione calcium most promising for lawns



Plant Growth Regulator

For Turf Growth Management

For managing growth, improving quality and stress tolerance, and edging of warm- and cool-season turfgrasses

Active Ingredient:

Trinexapac-ethyl
(CAS No. 95266-40-3) 11.3%

Other Ingredients: 88.7%

Total: 100.0%

Primo MAXX® is a microemulsion concentrate containing one pound trinexapac-ethyl per gallon.

Podium®

PLANT GROWTH REGULATOR FOR TURF GROWTH MANAGEMENT

For managing growth,
improving quality and stress
tolerance, and edging of
warm- and cool-season
turfgrasses

Active Ingredient:
Trinexapac-ethyl
(CAS No. 95266-40-3) 11.3%
Other Ingredients: 88.7%
Total: 100.0%
Podium® is a microemulsion
concentrate containing one
pound trinexapac-ethyl per
gallon.

KEEP OUT OF REACH
OF CHILDREN.
CAUTION
See additional precautionary
statements and directions for
use inside booklet.
Product of Switzerland
Formulated in the USA
SCP 937B-L1D 1215
4061883
1 gallon



PLANT GROWTH REGULATOR FOR TURF GROWTH MANAGEMENT

Contains trinexapac-ethyl, the active ingredient used in Primo MAXX®

A micro emulsion concentrate used to
manage growth and improve quality
and stress tolerance of turf edging and
warm- and cool-season turfgrasses.

ACTIVE INGREDIENT:
Trinexapac-ethyl 12.0%
OTHER INGREDIENTS: 88.0%
TOTAL: 100.0%
*Contains 1 pound of active ingredient
per gallon.

KEEP OUT OF
REACH OF CHILDREN
CAUTION
See additional precautionary statements
and directions for use inside booklet.
EPA Reg. No. 53883-353
EPA Est. No. 53883-TX-002



Plant Growth Regulator

For managing growth, improving quality and stress tolerance of turf.

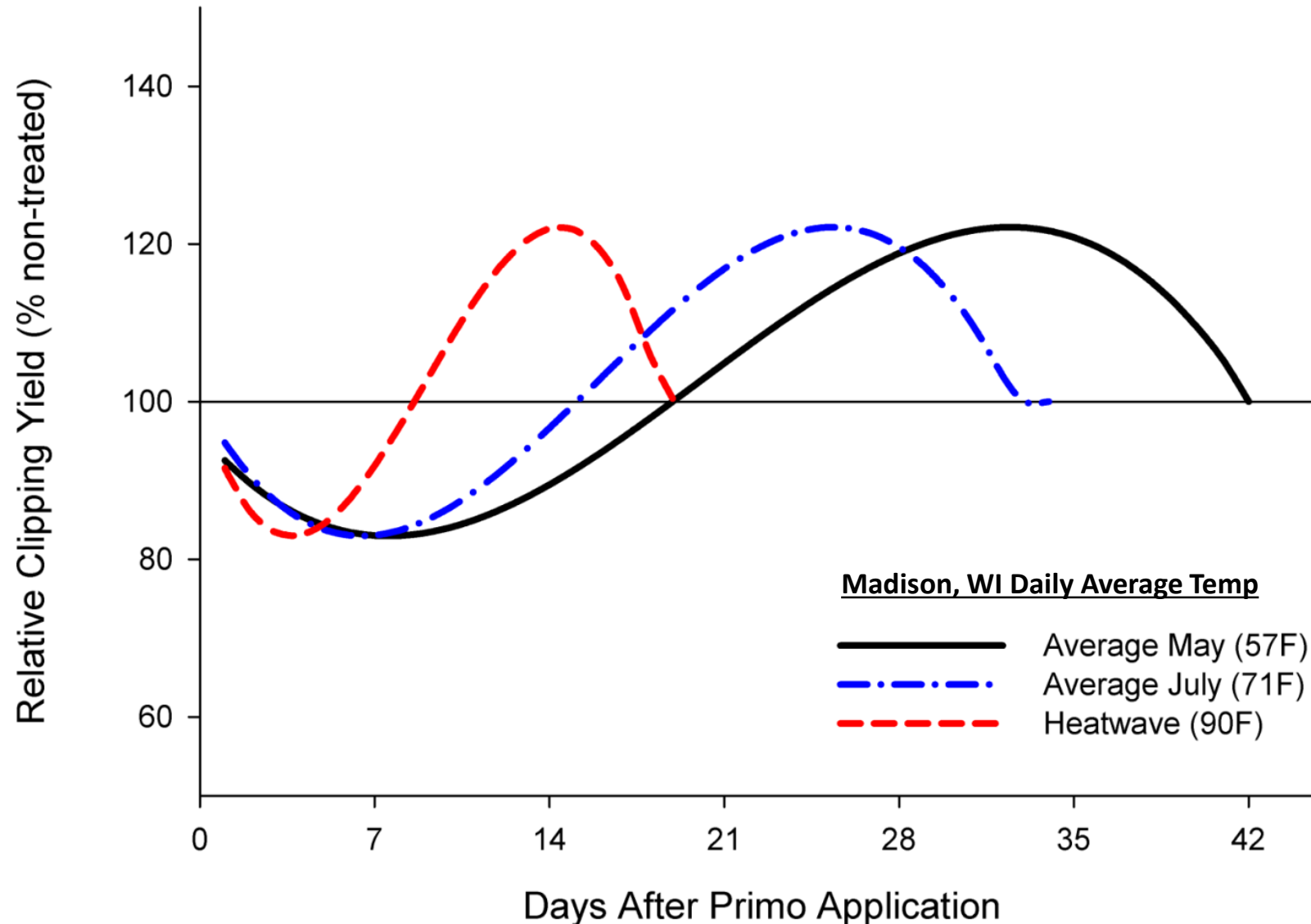
ACTIVE INGREDIENT:

Prohexadione calcium [calcium 3-oxido-5-oxo-4-propionylcyclohex-3-enecarboxylate] 27.5%

OTHER INGREDIENTS: 72.5%

TOTAL: 100.00%

Ideal Re-Application Interval Varies With Weather



We've been creating growing degree day models at UW-Madison for over a decade

- Ben Henke
 - BS: Iowa State
 - MS: UW-Madison



- Bill Kreuser
 - BS/MS: UW-Madison
 - PhD: Cornell



Anuew lasts longer than Primo Maxx but not as long as Trimmit

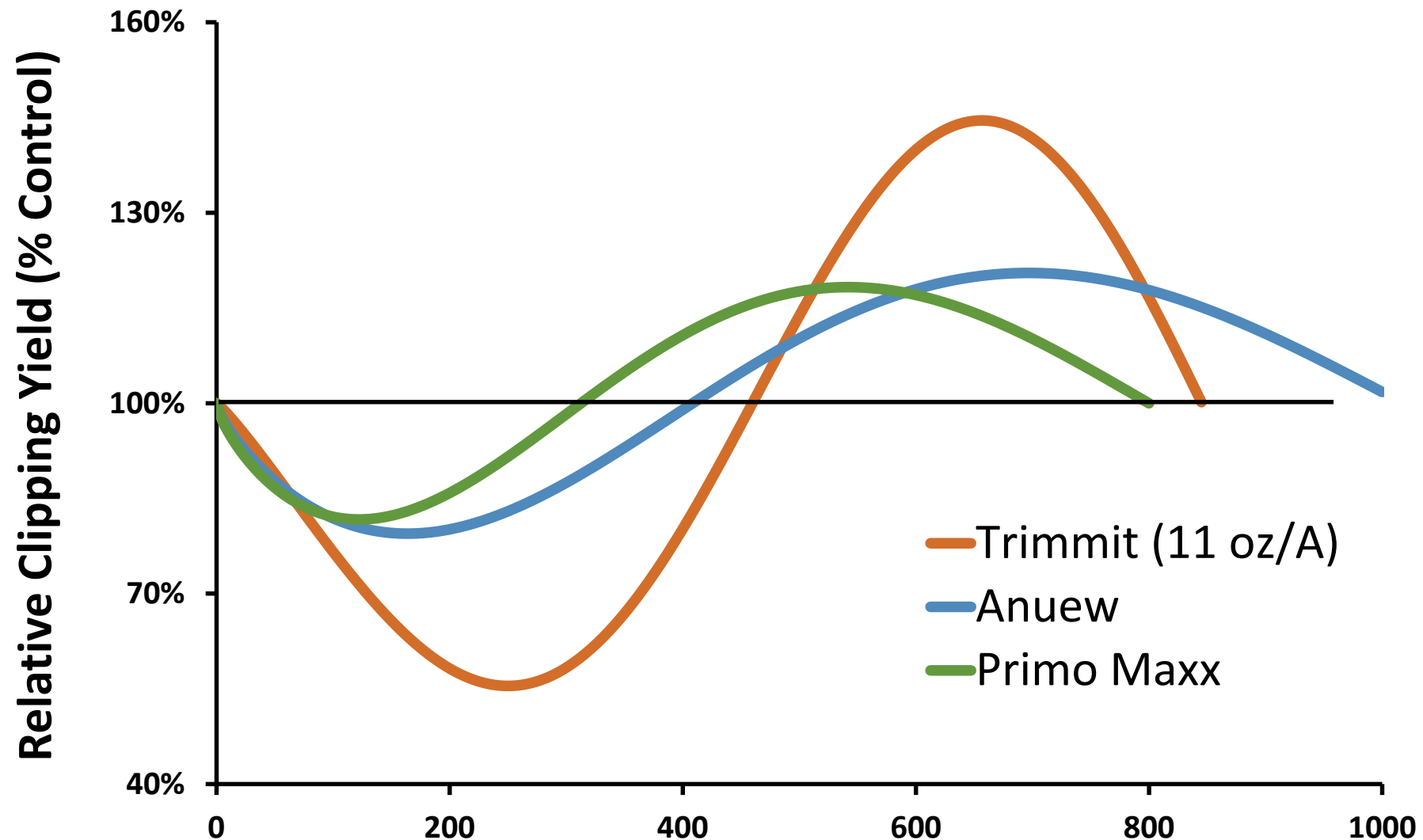


Table 1. The PGR treatments evaluated in 2015.

Plant growth regulator	Active ingredients (%)	Application rate	GDD re-application interval (base °C)
Non-treated control	Na	Na	Na
Anuew	Prohexadione-Ca (27.5%)	0.184 wt. oz./1000 ft ²	300
Anuew	Prohexadione-Ca (27.5%)	0.184 wt. oz./1000 ft ²	1000
Trimmit 2SC	Paclobutrazol (22.9%)	0.125 fl. oz./1000 ft ²	1000
Trimmit 2SC	Paclobutrazol (22.9%)	0.250 fl. oz./1000 ft ²	1000
Trimmit 2SC	Paclobutrazol (22.9%)	0.375 fl. oz./1000 ft ²	1000
Cutless 50W	Flurprimidol (50%)	0.046 wt. oz./1000 ft ²	1000
Cutless 50W	Flurprimidol (50%)	0.184 wt. oz./1000 ft ²	1000
Legacy	Flurprimidol (13.26%) Trinexapac-ethyl (5.00%)	0.110 fl. oz./1000 ft ²	1000
Legacy	Flurprimidol (13.26%) Trinexapac-ethyl (5.00%)	0.220 fl. oz./1000 ft ²	1000
Musketeer	Flurprimidol (5.6%) Paclobutrazol (5.6%) Trinexapac-ethyl (1.4%)	0.275 fl. oz./1000 ft ²	1000
Musketeer	Flurprimidol (5.6%) Paclobutrazol (5.6%) Trinexapac-ethyl (1.4%)	0.510 fl. oz./1000 ft ²	1000

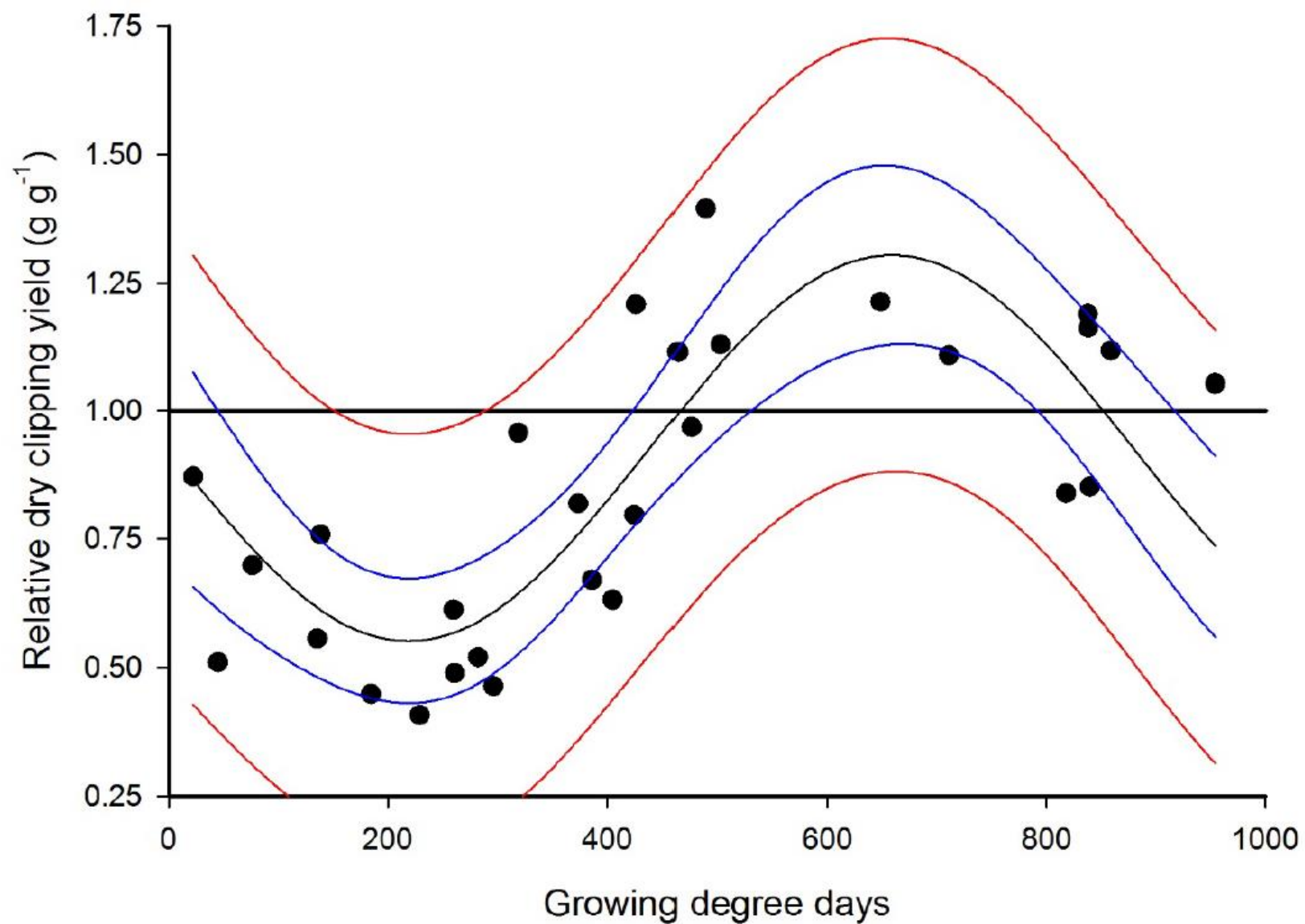
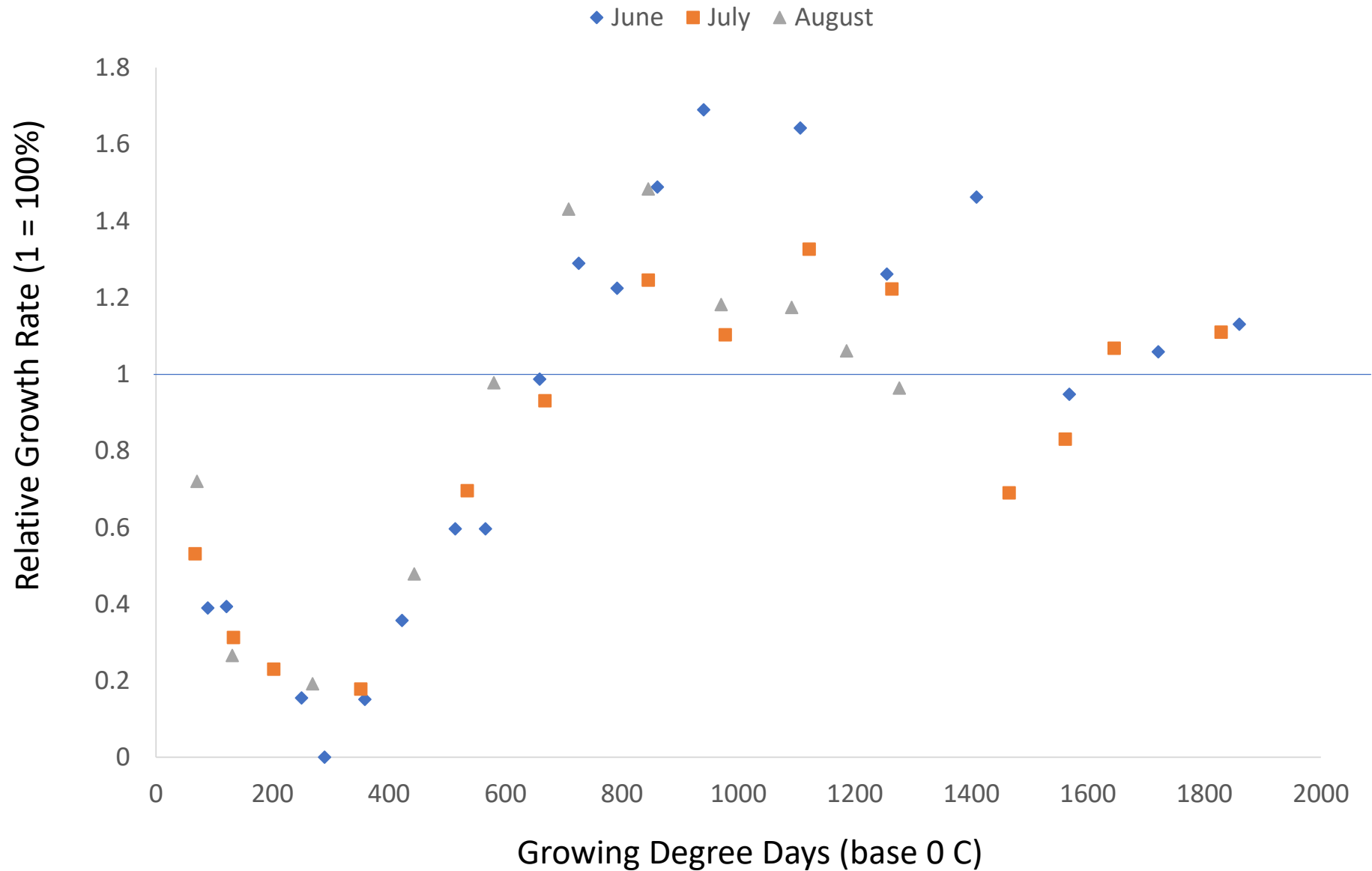
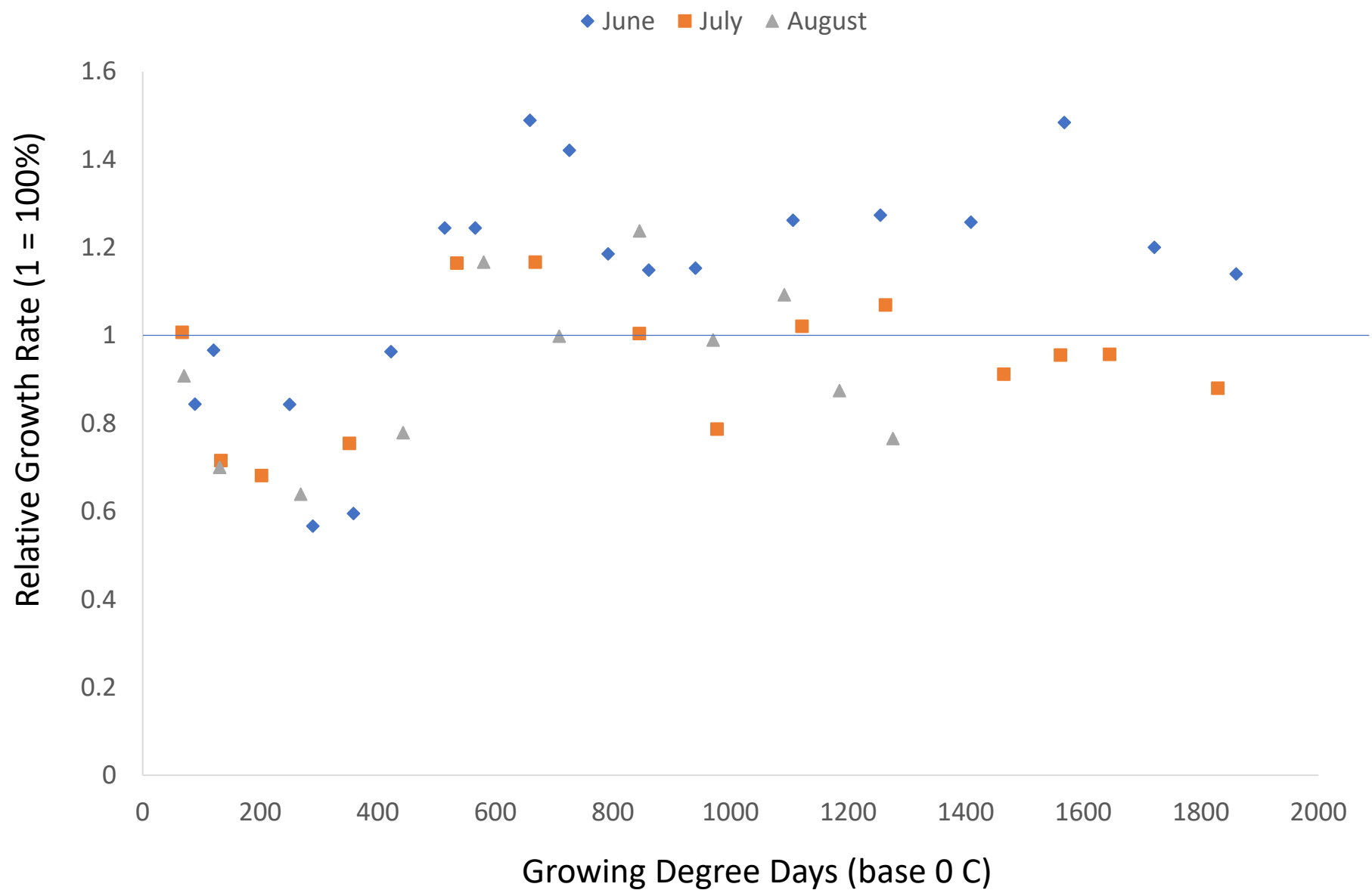


Figure 11. High-labeled rate of Musketeer PGR (0.510 fl. oz./1000 ft² every 1000 GDD).

PRIMO HIGH



CUTLESS LOW



GreenKeeperApp.com



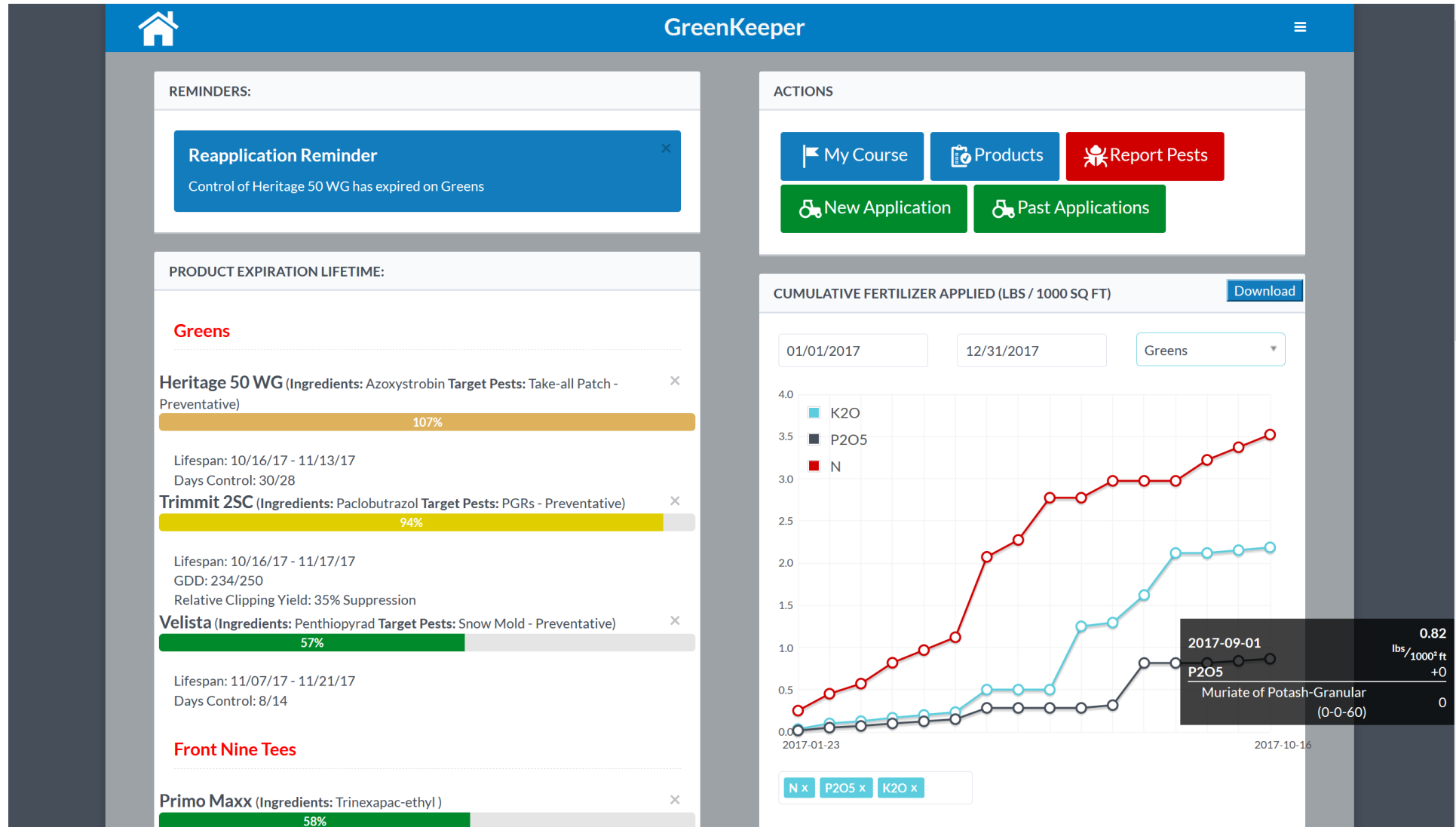
[Home](#) [Features](#) [Pricing](#) [Register](#) [Login](#)

Greenkeeper is an essential decision - support tool designed exclusively for turfgrass professionals by the Turf Program at the University of Nebraska - Lincoln.

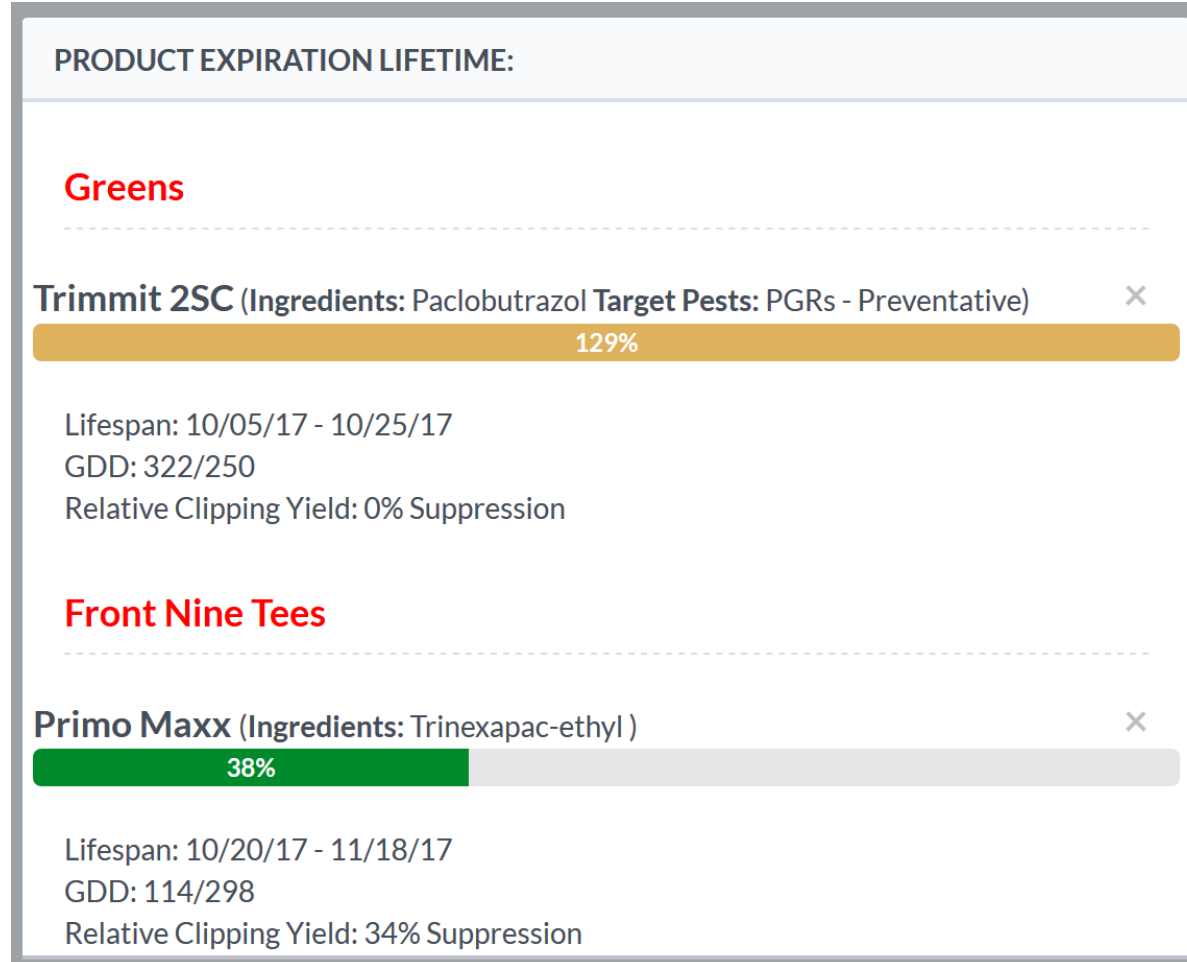
FEATURES



GreenKeeper Homepage





GreenKeeper can help plan timing and even rates in the future



- Latest research
 - Use an equation to calculated how much PGR to apply at set intervals
- GreenKeeper will display the amount to apply
- Limit the risk of over-suppression

Define the area, sprayer, and excess square footage

GreenKeeper

APPLICATION STATUS

Greens

11/14/2016

1.77

309.75

Tanks

Gallons

Finalize Mix

Application Setup:

Application Name & Notes (Optional)

Greens

2000

11/14/2016

Toro 1750-Greens

Save

Mix In Products:

Available Products

Add To Mix

Manage Products

Pick the Products for the Application

Define the:

- Application Rate
- Units of Measure
- Reapplication interval
 - Days
 - GDD (PGRs)
- Pests
 - Curative
 - Preventative
- Notes about the product
 - EPA Reg #
 - Batch #
 - Etc.

Mix In Products:

Available Products ▼

Add To Mix

Manage Products

Anuew

Application Rate

.17

Application Rate Unit

Oz per 1000 Square Feet ▼

Custom GDD (Leave blank to use default)

Default GDD: 252

GA Pathway ▼



Preventative

Target Pest ▼



Preventative

Target Pest ▼



Preventative

Notes

EPA Reg ###, Applicator: Matt P, 70F, Wind calm

Save

Hide

Total product required and mixing instructions provided real time

Total Required Product

Product	Quantity Required
TriCure	929.25 Fluid Oz
0-0-62	309.75 Lbs
Pinpoint	26.3 Fluid Oz
Anuew	26.34 Oz
Total Mix	302.28 Gallons

Tank Recipes

Product	Full Tank	Partial Tank
TriCure	525 Fluid Oz	404.25 Fluid Oz
0-0-62	175 Lbs	134.75 Lbs
Pinpoint	14.86 Fluid Oz	11.45 Fluid Oz
Anuew	14.88 Oz	11.45 Oz
Total Mix	170.78 Gallons	131.5 Gallons

Finalize Mix

Toro 1750-Greens

Save

Mix In Products:

Available Products

Add To Mix

Manage Products

TriCure

×

0-0-62

×

Pinpoint

×

Anuew

×

Push "Finalize Mix" when complete

Easy PDF printouts for assistants of spray tech to reduce math errors

Greens	14 Nov 2016
--------	-------------

Overview:

Area: Greens	Required Tanks: 1.77
Excess: 2000 sq ft	Total Gallons: 309.75
Sprayer: Toro 1750-Greens	

Products:

TriCure

Rate: 6 Fluid Oz per 1000 Square Feet

0-0-62

Rate: 2 Lbs per 1000 Square Feet

Pinpoint

Rate: 7.4 Fluid Oz per Acre

Target Pests:

Dollar spot - Curative

Anuew

Rate: 0.17 Oz per 1000 Square Feet

Notes: EPA Reg ###, Applicator: Matt P, 70F, Wind calm

Target Pests:

GA Pathway - Preventative

Total Required Product:

Product	Total Required
TriCure	929.25 Fluid Oz
0-0-62	309.75 Lbs
Pinpoint	26.31 Fluid Oz
Anuew	26.33 Oz

Full Tank Recipe: 1 tank

Product	Quantity Required
TriCure	525 Fluid Oz
0-0-62	175 Lbs
Pinpoint	14.86 Fluid Oz
Anuew	14.88 Oz
Total Mix	170.78 Gallons

Partial Tank Recipe: 0.77 tank

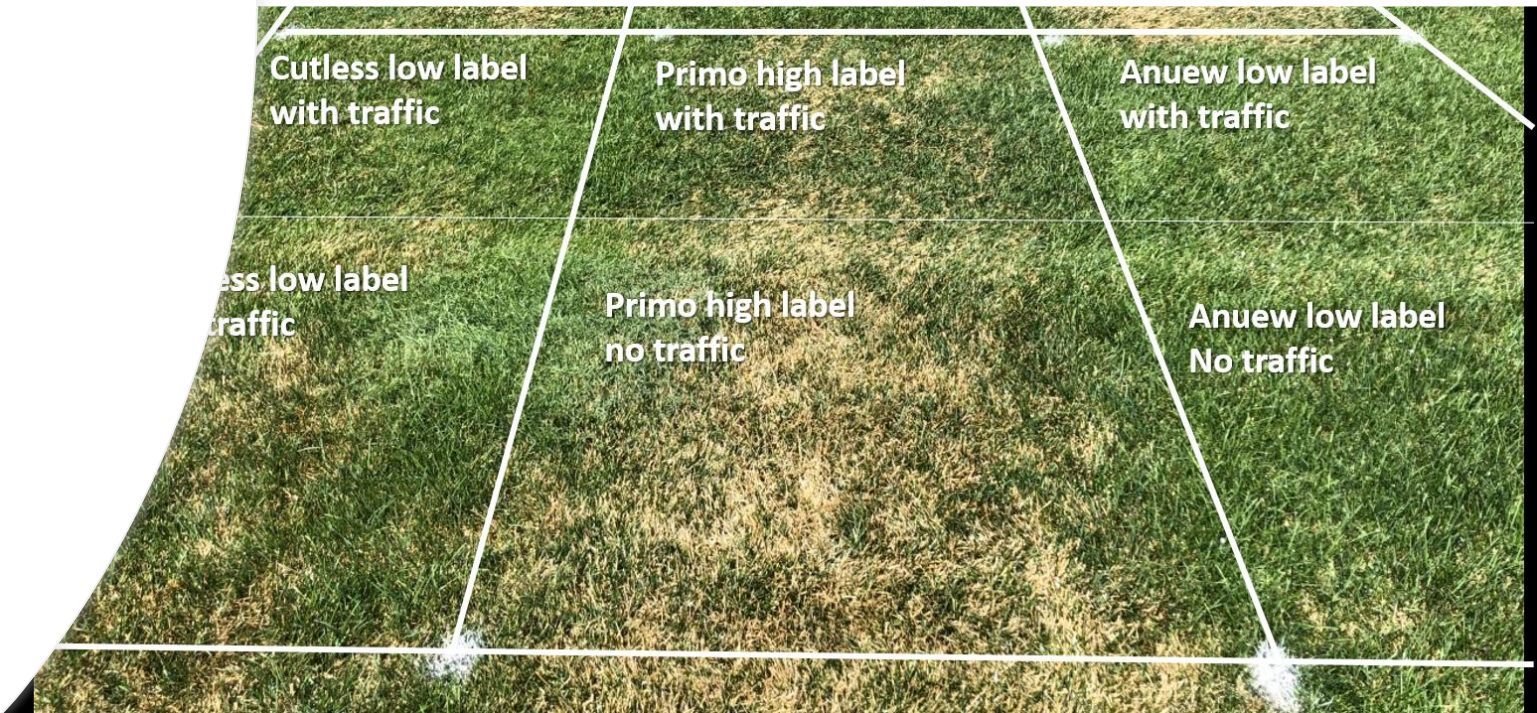
Product	Quantity Required
TriCure	404.25 Fluid Oz
0-0-62	134.75 Lbs
Pinpoint	11.45 Fluid Oz
Anuew	11.45 Oz
Total Mix	131.5 Gallons

**Grant employees
access and save
paper**

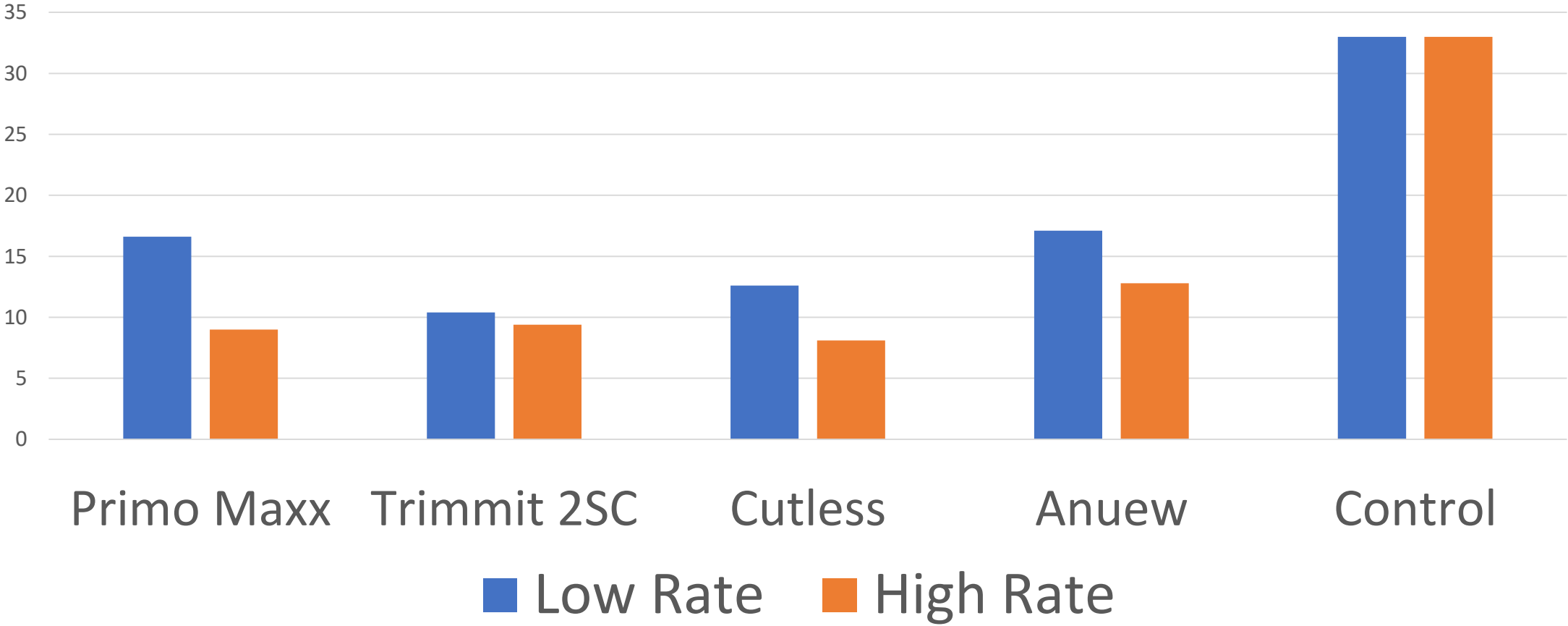


PGR Research Results

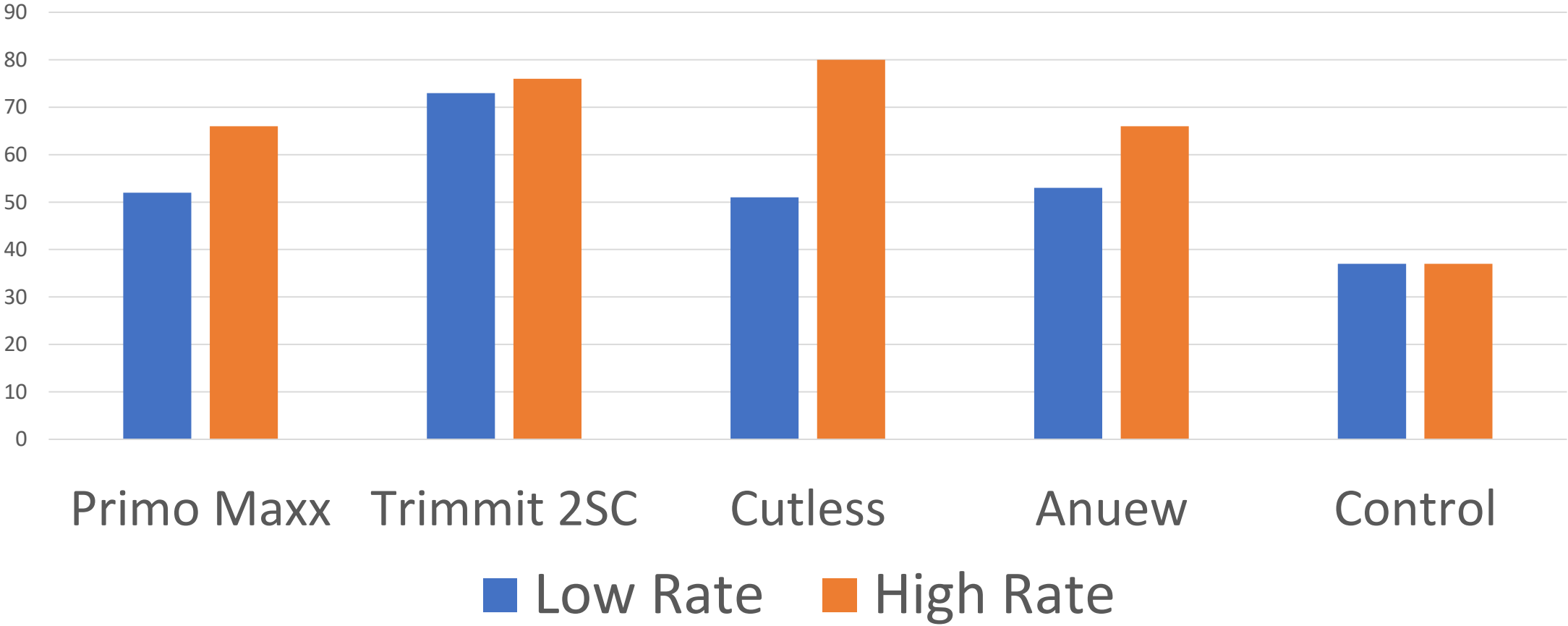
2020 PGR Study at UW-Madison



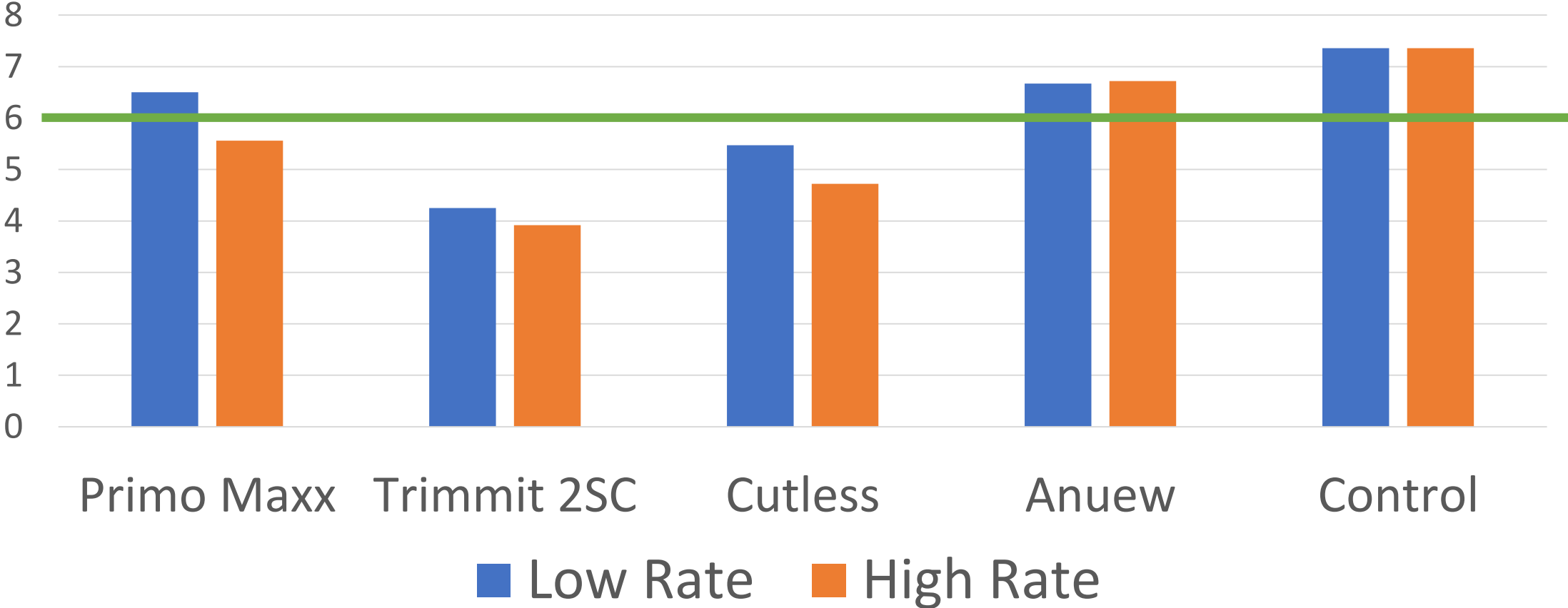
Turfgrass Clipping Yield



Turfgrass Density (tillers per 3 in²)



Turfgrass Visual Quality




Conclusions

- Anuew appeared to provide a good combination of clipping reduction, increased density, and maintained turfgrass quality
- Primo Maxx (Trinexapac-ethyl) at the lower rate (11 oz/A) also provided good results, but damage was too great at 33 oz/A.
- Primo Maxx would cost \$24/acre (half of that if generic is used)
- Anuew at the low rate = \$60/acre (double for the high rate)
- Applications should be made approximately every four weeks, but following a growing degree schedule is best



Using PGRs in golf course roughs

Using PGRs to reduce rough height and mowing costs can save time and money for the golf course maintenance team.

January 2018 | Philip Brown, M.S.; Don Garrett, CGCS; and Bert McCarty, Ph.D. 

Results

% phytotoxicity of treatments

Treatment	% phytotoxicity (0%-100%)			
	1 WAT*	2 WAT	3 WAT	4 WAT
Untreated	1.4b	0.6b	0b	0.6c
Primo	4.7b	2.2b	1.4b	0c
Plateau	5.8b	15.8a	18.1a	2.1bc
Primo + Plateau	5.6b	18.3a	23.4a	2.8bc
Anuew	0.6b	0.6b	0.6b	0c
Cutless	0b	0b	0b	0c
Legacy (low)	0b	0b	0.8b	0c
Legacy (high)	5.6b	0.6b	0.3b	0.4c
Musketeer	0.8b	0b	0b	0c
Roundup	5.3b	0b	0b	3.3abc
Finale	73.6a	17.2a	0.8b	7.2a
Journey + NIS	5.3b	23.9a	25.6a	5.6ab

*WAT, weeks after treatment.

Table 2. Average percent phytotoxicity of various products over the course of the study exploring various PGR use on golf course roughs. Ratings above 30% were considered unacceptable. Different letters within a column indicate statistical differences.

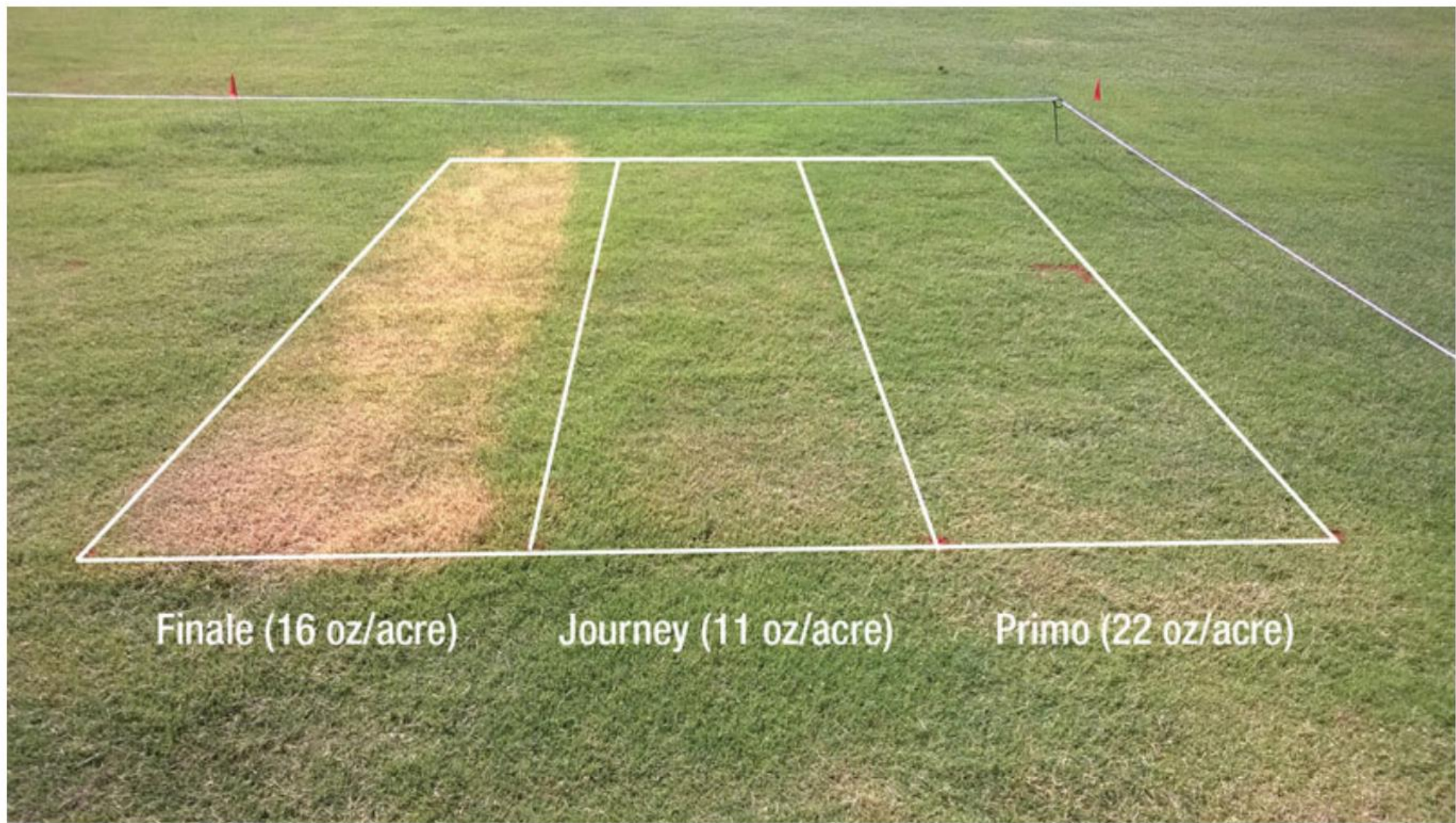


Figure 1. Distinct phytotoxicity symptoms are seen in bermudagrass rough one week after initial application of Finale at 16 ounces/acre; plots treated with Journey and Primo do not show phytotoxicity. **Photos by Philip Brown**



Figure 2. Three weeks after initial application, bermudagrass rough plots treated with Journey (imazapic) show phytotoxicity, whereas plots treated with Finale and Primo do not. The Finale plot had recovered from initial phytotoxicity (see Figure 1).



Figure 3. Four weeks after initial application of Finale, Journey and Primo, all the treated plots in the bermudagrass rough had recovered from phytotoxicity. The Primo plot has visibly lower turf height and darker green color.

Turf height

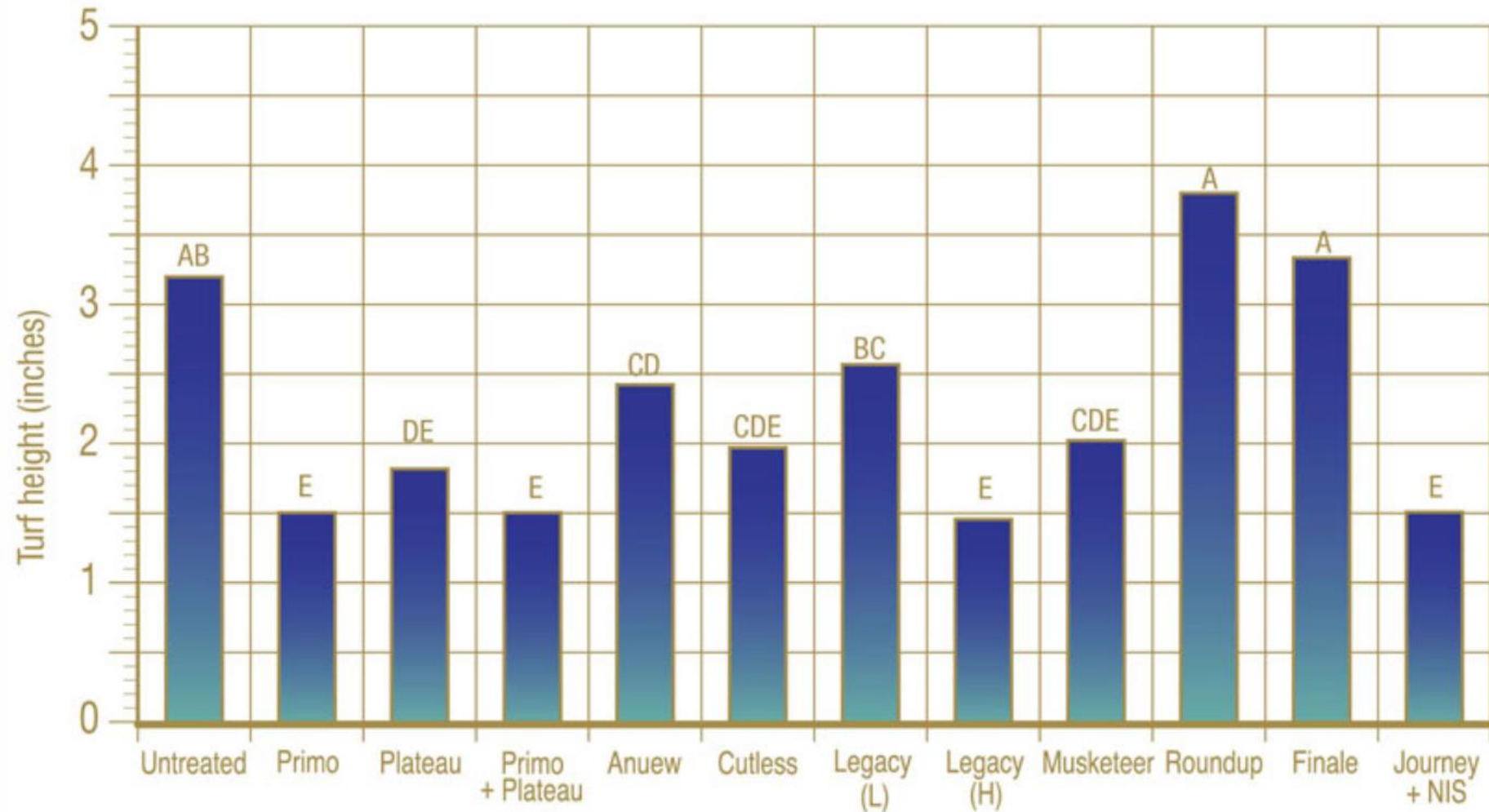
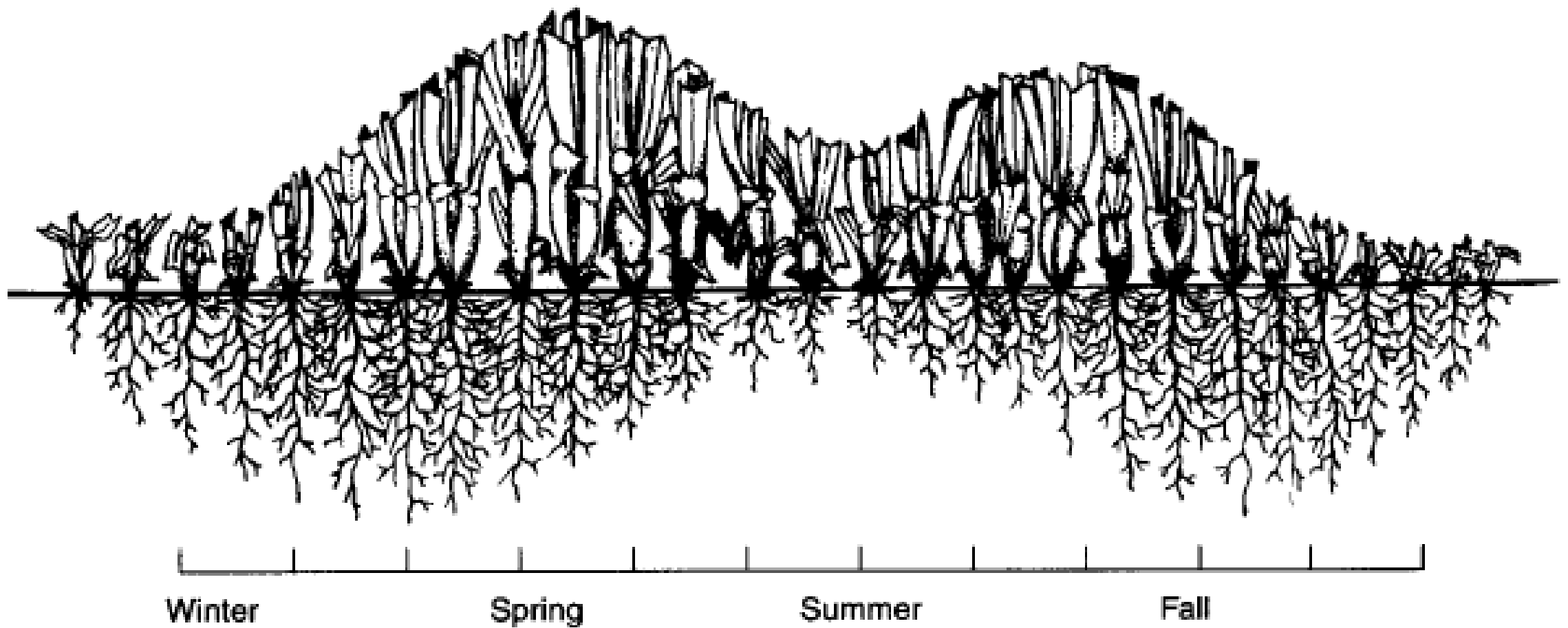


Figure 4. Bermudagrass turf height (inches) of plots treated with various PGR and herbicide products four weeks after initial application. Bars designated with different letters are statistically different.

Practical Tips

- Mow the lawn first
- Don't mow the lawn for as long as possible
- Pay attention to the weather

When to apply?





Plant Growth Regulators for Lawns and Landscapes

Doug Soldat / Professor & Turfgrass Extension Specialist

Dept. of Soil Science / UW-Madison

djsoldat@wisc.edu