


Reducing Cost While Maintaining Quality

Roch Gaussoin
rgaussoin1@unl.edu
 @rockinsince57


 Turfgrass Science
 University of Nebraska

1

RESEARCH LETTER

Estimating economic minimums of mowing, fertilizing, and irrigating turfgrass

Douglas J. Soldat¹ | James T. Bronnan² | Ambika Chandra¹ | Roch E. Gaussoin¹ | Alec Kowalewski¹ | Bernd Leitauer¹ | Frank S. Rossi¹ | John C. Stier¹ | J. Bryan Unruh¹

Abstract
The public health crisis and economic recession...




COMMENTARY

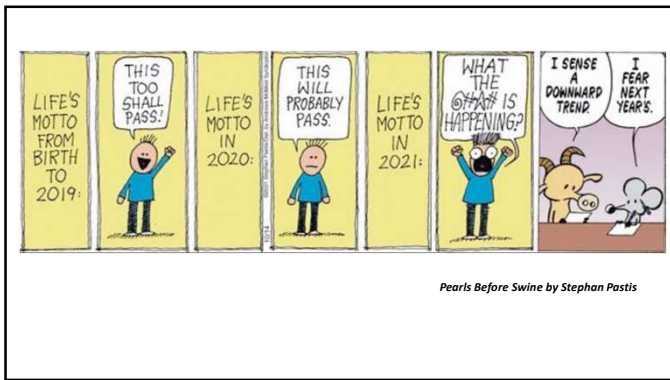
A justification for continued management of turfgrass during economic contraction

James T. Bronnan¹ | Ambika Chandra² | Roch E. Gaussoin¹ | Alec Kowalewski¹ | Bernd Leitauer¹ | Frank S. Rossi¹ | Douglas J. Soldat¹ | John C. Stier¹ | J. Bryan Unruh¹

Abstract
A novel coronavirus, termed COVID-19, spread worldwide and became a global pandemic in 2020. Forecasts show that COVID-19 will cause substantial economic contraction...



2



3



As we slide into 2022 what can we expect?

- Supply chain issues
- Increase cost, especially fertilizer

4

- Strong demand and the high cost of raw materials have dramatically increased the price of fertilizer in 2021.
 - Trend will continue in 2022
- Just-in-time philosophy is causing shortages, and “rush” orders increase cost

5

Raw Material	Nov 8, 2021	Nov 1, 2021	2020	Increase from 2020-2021
Urea Nitrogen – Import Prill U.S. Gulf NOLA	\$723	\$715	\$263	2.8X
Diammonium Phosphate (DAP) U.S. Gulf NOLA	\$672	\$675	\$357	1.9X
Monoaammonium Phosphate (MAP) U.S. Gulf NOLA	\$757	\$763	\$383	2.0X
Muriate of Potash (MOP) U.S. Gulf NOLA	\$678	\$668	\$205	3.3X
Sulfate of Potash (SOP) Southeast	\$775	\$750	\$575	1.3X

From: <https://www.lebanonturf.com/blog/golf/the-latest-on-the-rising-fertilizer-market>

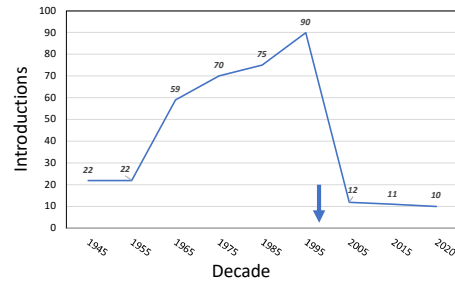
6

Shortage reasons for fertility and pesticide products

- Reduced laborers to unload tanker ships at gulf ports
- Lack of truck transportation from the ports to get ingredients to U.S. formulation plants or formulated products to distributors
- Reduced supplies of inert ingredients
- Shortage of materials to make containers and packaging
- Production facilities in 2020 were not running at 100 percent because demand was low
- The uncertainty of the pandemic could not anticipate the increase in consumer demands for product and services
- Winter storms early in the year in Texas and across Louisiana increased transportation delays

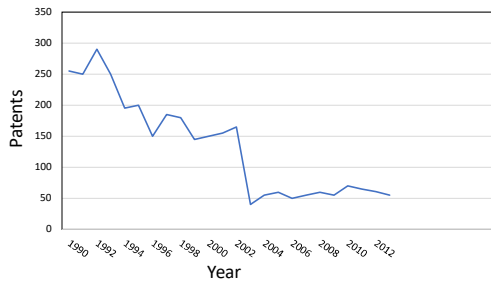
7

Herbicide Active Ingredient Introduction (US) by Decade



8

Herbicide Patent Approval (US) Since 1990



9

Cost Offsetting

- Take advantage of early order programs; calibrate; increase training; inventory
- Increase routing efficiencies; offer other services to increase margins per stop
- Apply less product or equally efficacious yet less expensive products
- May be more problematic in 2022 because prepay notices may have been sent out prior to increased costs

10



11

What are you willing to reduce?

- Mowing Requirement?
- Irrigation Requirement?
- Fertility Requirement
- Pesticide Requirement?
- All of the Above?

12

What are you willing to sacrifice?

- Aesthetics?
 - Color, density, leaf texture etc.
- Function?
 - Playability, erosion abatement etc.

Should you have to sacrifice anything?

13

“Conventional Wisdom” Low Maintenance Grasses

- Tall Fescue
- Buffalograss
- Fine Fescue(s)

Why is Kentucky bluegrass often excluded?

14

Rate of Establishment

- Tall Fescue
- Ky. Bluegrass
- Buffalograss
- Fine Fescue(s)

Fast
↑
Slow

15

Drought Response

- Buffalograss
- Fine Fescue(s)
- Tall Fescue
- Ky. Bluegrass

Best
↑
Worst

16

Drought Resistance



- Tolerance
- Avoidance
- Escape

J. Levitt, 1980

17

Drought Escape

- Plant completes its life cycle prior to the onset of drought

Example: *Poa annua* var. *annua*




18

Drought Tolerance

- Increased tolerance of dehydration
- Osmotic adjustment
 - Na⁺, K⁺, Cl⁻
- Recycling of CO₂
- Ability to recover

Example: Kentucky bluegrass




19

Drought Avoidance Mechanisms


- Reduced ET
- Deep, Extensive Root System
- Root Plasticity
- High Root:Shoot
- Reduced radiation absorption
- Xeromorphic characteristics

Example: Tall Fescue



20

Turfgrass water use



Total amount of water used for growth plus that lost by transpiration and evaporation from plant and soil surfaces.

J. B. Beard, 1973

May or may not be related to drought resistance

21


Turfgrass ET Classification

Relative Ranking	ET (mm day ⁻¹)
Very low	< 4.0
Low	4.0-4.9
Medium-low	5.0-5.9
Medium	6.0-6.9
Medium-high	7.0-7.9
High	8.0-8.9
Very high	>9.0

J. B. Beard, 1985

Tall fescue (indicated by a red arrow pointing to the 7.0-7.9 ET range)

Kentucky bluegrass, buffalograss (indicated by a red arrow pointing to the 4.0-4.9 ET range)



22

Reported range of turfgrass ET by species:

Common Name	Scientific Name	ET ^a (mm day ⁻¹)	Rank
Tall Fescue	<i>Festuca arundinacea</i>	7-13	2.0-3.0
Perennial Ryegrass	<i>Lolium perenne</i>	7-11	1.8-3.1
St. Augustinegrass	<i>Stenotaphrum secundatum</i>	6-11	
Seashore Paspalum	<i>Paspalum vaginatum</i>	6-8	
Bahiagrass	<i>Paspalum notatum</i>	6-8	
Kikuyugrass	<i>Pennisetum clandestinum</i>	6-9	
Creeping Bentgrass	<i>Agrostis Palustris</i>	6-10	
Centipede grass	<i>Eremochloa ophiuroides</i>	5-9	
Bermudagrass	<i>Cynodon spp.</i>	4-9	
Zoysiagrass	<i>Zoysia spp.</i>	5-8	
Kentucky Bluegrass	<i>Poa pratensis</i>	4-7	1.1-1.8
Buffalograss	<i>Buchloe dactyloides</i>	3-6	1.5-2.8

^aField grown under high evaporative demand conditions

23



24



25

Supra-optimal Temperature Tolerance

- Buffalograss
- Tall Fescue
- Ky. Bluegrass
- Fine Fescue(s)

Best
↑
Worst

26

Relative Rooting Depth

- Buffalograss
- Tall Fescue
- Fine Fescue(s)
- Ky. Bluegrass

Deepest
↑
Shallowest

27

pH Optimums

• Tall Fescue	5-8.5
• Fine Fescue	4.5-6.5
• Ky. Bluegrass	5-7.5
• Buffalograss	6-8.5

28

Shade Tolerance

- Fine Fescue
- Tall Fescue
- Ky. Bluegrass
- Buffalograss

Best
↑
Worst

29

Select Adapted Grasses

- Environment
- Soil conditions
- Intensity of use
- Intensity of culture
- Pest problems

30



Kentucky bluegrass summer patch susceptibility

31



Mid-Atlantic ecotype of Kentucky bluegrass showing excellent summer stress tolerance

32



Kentucky bluegrass cultivars differ in spring green-up and winter color retention

33

National Turfgrass Evaluation Program

www.ntep.org


34

Proceed with caution.....

35

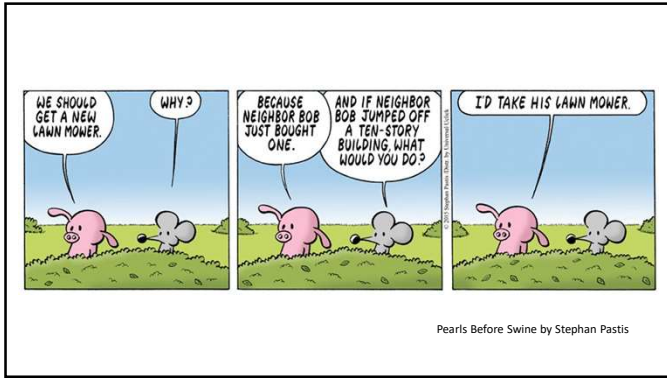


Management matters (KB in Indiana)

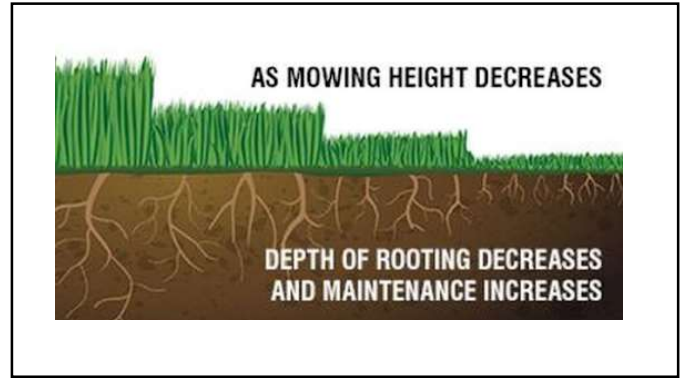
 **Ross Braun**
@Ross_Braun
These two lawns were established with the same sod at the same time (2017). Both lawns have never received a pesticide application. However, one is fertilized twice a year (mainly fall) and mowed higher all year. #Lowinputturf pic.twitter.com/Zl4Hy0nEYg
7/31/20, 7:24 AM

Note: both receive similar amounts of water (rain only with no in-ground irrigation) with the one on the right receiving hose sprinkler watering when minimal rain has occurred for 3+ weeks.

36



37



38

Height effects on rhizome development

Mowing Height	1"	1.75"	2.5"
	rhizome	weight	(mg)
Kentucky bluegrass	1.0	64	656

39

Height effects on leaf area & photosynthetic capacity

Mowing Height	1"	2"	3"
	relative	change	(%)
turfgrass	1.0	240	5760

40

Height Effects on Turfgrass Quality

Mowing Height	1.5"	2.5"	4"
species	quality	1-9,	9=best
tall fescue	5.7	6.6	7.4
Kentucky bluegrass	5.2	6.4	6.8
perennial ryegrass	5.2	5.8	5.5

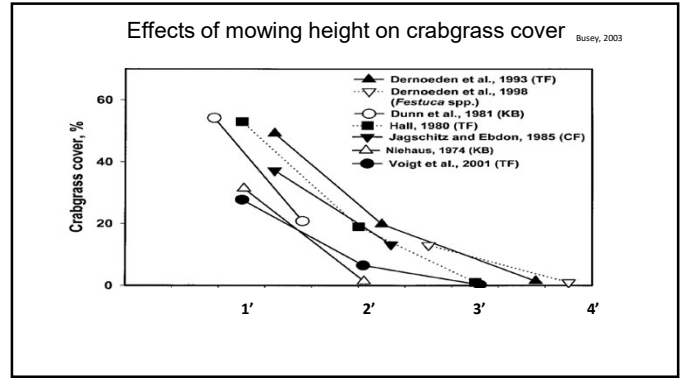
41

- Effects of deeper rooting and increased photosynthesis
- root pathogens & insects
 - increased tolerance
 - Drought
 - deeper water harvesting
 - better recovery
 - Traffic
 - better cushion
 - better recovery

42



43



44

Height Effects on Weed Pressure

Mowing Height	1.5"	2.5"	4"
species	weed	infestation	(%)
tall fescue	45	23	2
Kentucky bluegrass	55	25	7
perennial ryegrass	57	58	52

45

Height effects on crabgrass pressure

Mowing Height	1.25"	2"	3.5"
crabgrass cover			(%)*
Kentucky bluegrass	49	20	2

46

Mowing Facts & Tips

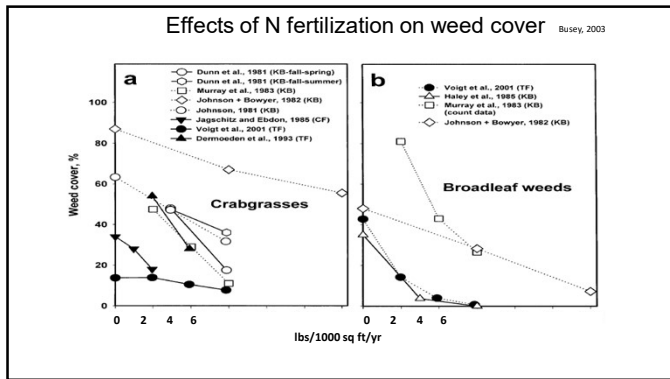
- Reducing height and increasing frequency results in smaller plants, increased density and a shorter root system.
- Increasing height reduces surface temperature, increases rooting, and decreases frequency.
- Turf mowed at $\geq 2.5"$ will tolerate occasional scalping better than turf mowed at $< 2"$.
- In drought or unirrigated areas, water conservation is best served increasing height.
- A dull mower increases water use and disease and insect pressure.
- Mowing and removing clippings harvests 0.06 – 0.14 lbs. of nitrogen/week.

Mow it high and leave it lie

47



48



49

Nitrogen Fertilization Considerations

- Don't fertilize turf that isn't actively growing.
- Eliminate late fall fertility.
- Older lawns need less fertilizer and fewer applications annually than newer stands. Eliminate applications during high mineralization periods such as mid-summer or spring.
- Over-fertilized turf wastes money, can lead to excessive thatch accumulation, increased diseases and nitrate leaching to groundwater.
- Different fertilizer sources have different release characteristics.

50

Compacted Soil = Prostrate knotweed, goosegrass, and crabgrass

51

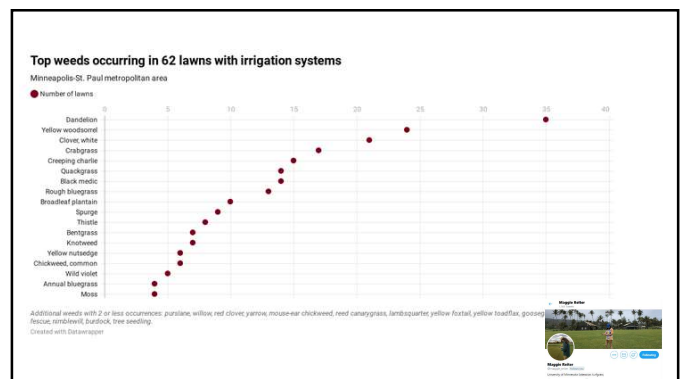
Control **Compacted**

52

Cultivation Practices

- Core cultivation
- Slicing
- Spiking
- Deep-tine cultivation
- Drilling
- Solid-tine cultivation

53



54



55

“low impact pesticides” (herbicide) options

- Preemergence
 - Corn gluten meal
 - Distiller grains
- Postemergence
 - multiple
- Non-selective
 - multiple

56

Corn Gluten Meal

- Multiple years required to attain equivalent synthetic control (cumulative effect)
- Significant N input in first year
- Available mail order and limited retail

57

Dried distiller grains (DDGs)

- Dried distiller grains (DDGs) are a co-product of the dry milling process, which currently accounts for approx 75 percent of the domestic ethanol production
- DDGs are used almost exclusively used as animal feed
- Much like corn gluten meal, weed control ,and fertilizer value has been documented
- DDGs contain an estimated 10% fatty oils that causes the byproduct to go rancid if not used in a relatively short time period
- Research by the USDA has been ongoing since 2008

58

Selective postemergence trial

59

Materials and Methods

Spring Applications: May 4 and May 31, 2018 (4 weeks after initial treatment)
Fall Applications: September 13 and October 5, 2018

Product	Active Ingredient	Rate
Untreated Check	N/A	N/A
Iron X	26.52% Iron HEDTA	25.2 oz/M
A.D.I.O.S.	Sodium chloride + NIS	1 lb product/gallon
ICT Halo	Eugenol, Clove Oil	10 oz/M
Fiesta Weed Killer	26.52% Iron HEDTA	12.6 fl oz/M or 25.2 fl oz/M
Fiesta Weed Killer + Xiameter OFX-0309	26.52% Iron HEDTA and Silicon Adjuvant	12.6 oz/M
Natria Lawn Weed and Disease Control	26.52% Iron HEDTA	25.2 fl oz/M
Trimec Classic	2,4-D	4 pt/A
Borax	Boric Acid	Spray to runoff
EcoSmart Weed & Grass Killer	Rosemary Oil	Spray to runoff
AgraLawn Weed and Crab Killer	Cinnamon	Shake on foliage

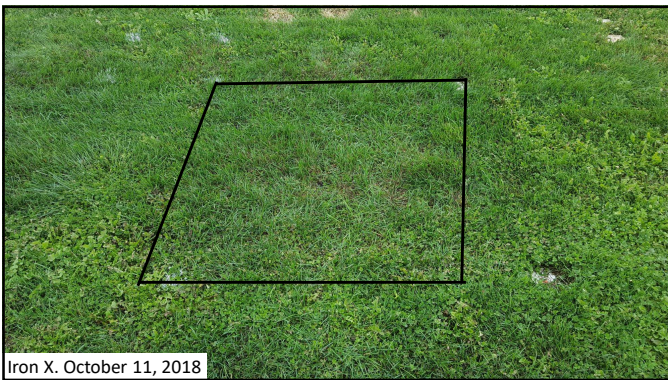
60



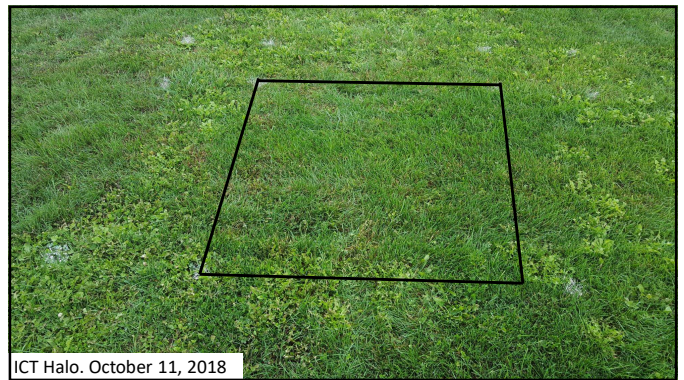
61



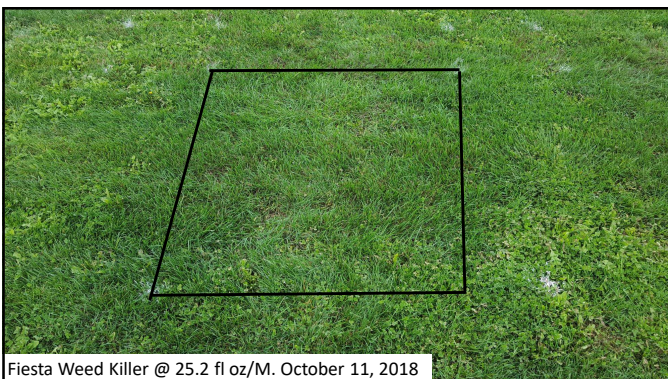
62



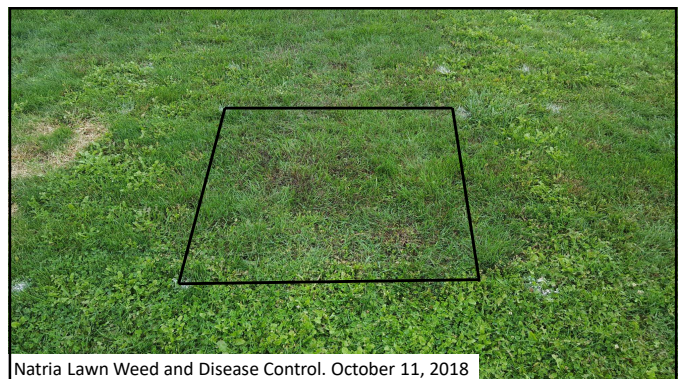
63



64



65



66

Materials and Methods

Spring Applications: May 4 and May 31, 2018 (4 weeks after initial treatment)
Fall Applications: September 13 and October 5, 2018

Product	Active Ingredient	Rate
Untreated Check	N/A	N/A
Iron X	26.52% Iron HEDTA	25.2 oz/M
A.D.I.O.S.	Sodium chloride + NIS	1 lb product
ICT Halo	Eugenol, Clove Oil	10 oz/M
Fiesta Weed Killer	26.52% Iron HEDTA	25.2 fl oz/M
Fiesta Weed Killer + Xiameter OFX-0309	26.52% Iron HEDTA and Silicon Adjuvant	12.6 oz/M
Natria Lawn Weed and Disease Control	26.52% Iron HEDTA	25.2 fl oz/M
Trimec Classic	2,4-D	4 pt/A
Borax	Boric Acid	Spray to runoff
EcoSmart Weed & Grass Killer	Rosemary Oil	Spray to runoff
AgraLawn Weed and Crab Killer	Cinnamon	Shake on foliage
Fiesta Weed Killer	26.52% Iron HEDTA	12.6 fl oz/M

67

Conclusions

- Trimec Classic was always numerically the top performer for both trials
- Products containing **iron HEDTA** and **ICT Halo** often were statistically as effective as Trimec Classic short term.
 - Iron X
 - Fiesta Weed Killer (full rate or w/ Xiameter)
 - Natria Lawn Weed and Disease Control
- When using most organics, multiple applications will be required
 - Unpublished UNL study showed significantly diminished effectiveness if reapplications (<3X) are not made

68

Cost Analysis

Product	Rate	Cost per 1000 sq. ft.
Untreated Check	N/A	--
Iron X	25.2 oz/M	\$102.00
A.D.I.O.S.	1 lb product/gallon	\$202.74
ICT Halo (name changed to Branch Creek Weed Shield)	10 oz/M	\$6.58
Fiesta Weed Killer	25.2 fl oz/M	\$16.73
Fiesta Weed Killer + Xiameter OFX-0309	12.6 oz/M	\$38.78
Natria Lawn Weed and Disease Control	25.2 fl oz/M	\$17.85
Trimec Classic	4 pt/A	\$0.61
Borax	Spray to runoff	\$5.00/ 64 oz
EcoSmart Weed & Grass Killer	Spray to runoff	\$25/ 64 oz
AgraLawn Weed and Crab Killer	Shake on foliage	\$23/ 2 lb
Fiesta Weed Killer	12.6 fl oz/M	\$8.37

69

Organic glyphosate alternatives (non-selective)

70

Product	Days after initial application						
	Before app	1	2	8	14	21	28
Untreated control							
Avenger (trifluralin)							
Burnout (picric acid, clove oil)							
Finalsan (fatty acid)							
Suppress (capric/caprylic acid)							
WeedPharm (20% acetic acid)							
Ranger PRO (glyphosate)							
Ranger PRO + Fusilade II							

Organic alternatives to glyphosate applied to hybrid bermudagrass in central California

Credit: Maggie Reiter @maggie_reiter University of California Cooperative Extension

71

Comparison of Acetic Acid to Glyphosate for Weed Suppression in the Garden

Joseph C. Duenkel

Acetic acid, sodium acetate, potassium acetate, organic garden, vinegar

Summary: In organic vegetable gardening, we favor non-selective organic weed control. Glyphosate is commonly applied before planting. Several studies have evaluated the effectiveness of glyphosate at controlling weeds in crop production systems (Casper, 2006; Gallo et al., 2006; Nandoriya et al., 2009; Stone and Arnold, 2012), whereas others have compared glyphosate with non-selective products to control weeds (Chen et al., 2008; Farnsworth and Wainwright, 2010; Young, 2004). Research on the use of natural products to control weeds has generally been limited to herbicides with contact activity such as acetic acid (Kilgus, 2008). Acetic acid has been compared to glyphosate in the control of weeds in the garden (Kilgus, 2008). Acetic acid has been compared to glyphosate in the control of weeds in the garden (Kilgus, 2008). Acetic acid has been compared to glyphosate in the control of weeds in the garden (Kilgus, 2008).

Weed control product	Product name	Conc in spray solution	Product source or manufacturer
Acetic acid (5%)	Great Value distilled white vinegar	Undiluted	Wal-Mart, Bentonville, AR
Acetic acid (20%)	Natural safe 20% vinegar	Undiluted	Factory Direct Chemicals, Long Island, NY
Acetic acid (30%)	Natural safe 30% vinegar	Undiluted	Factory Direct Chemicals
Glyphosate	FarmWoods 41% glyphosate plus	1.00 x	Ragan and Moore, Proctorville, IA

Table 1. Summary of the weed control products with active ingredients and manufacturer sources used during weed suppression studies in 2010 and 2011 in Ithaca, NY.

- Results indicated that glyphosate, when compared with AA, is the more effective weed suppression method.
- Although all three AA treatments (5%, 20%, and 30%) initially damaged weeds faster than glyphosate, AA did not control weeds for an extended period like glyphosate.
- The 20% and 30% AA applications required 3 to 4 treatments for equivalent control to glyphosate.

72

Organic weed control synopsis

- Pro's
 - Viable options available, with research ongoing
 - Market or regulatory niche products
- Con's
 - Product cost
 - Labor cost
 - Contact vs systemic
 - More applications
 - Selectivity
 - Efficacy

73

Turfgrass Weed Control for Professionals

https://mdc.itap.purdue.edu/item.asp?item_Number=TURF-100




74

How to Use the Tables in this Publication	70	Successfully Using Plant Growth Regulators in Turf	117
Nonselective Herbicides/Fumigants for Turfgrass Renovation	71	Plant Growth Regulator Suppression and Suggested Reapplication Intervals	119
Nonselective Herbicides for Turfgrass Border Maintenance (Edging)	72	Annual Bluegrass Suppression in Creeping Bentgrass Putting Greens with Plant Growth Regulators (PGRs)	120
Preemergence Herbicides	73	Pesticide and Plant Growth Regulator Math	121
Weed Control Ratings for Preemergence Herbicides	73	Common Weights and Measures	121
Turfgrass Tolerance to Preemergence Herbicides	74	Ounces or Ounces	122
Preemergence Herbicides	75	Amount of Product Needed	122
Postemergence Herbicides	79	Amount to Add to the Spray Tank	123
Weed Control Ratings for Postemergence Broadleaf Herbicides	79	How Many Tanks (trips with my sprayer) Does it Take?	123
Weed Control Ratings for Postemergence Grass Herbicides	82	What If the Recommended Rate is in Pounds of Active Ingredient?	123
Turfgrass Tolerance to Postemergence Herbicides	84	How Much Does This Herbicide Cost per Acre for 1,000 ft ² ?	124
Postemergence Herbicides	86		

75

Sedge Control Herbicides

From - Turfgrass Weed Control for Professionals

Sedge Control and Turfgrass Tolerance Ratings

Herbicide	Sedges and Killings					Turf Tolerance							
	Sedges and Killings					Cool-season				Warm-season			
	annual sedge	lake-green lyllaga	purple nuttall	yellow nuttall	annual bluegrass	creeping bentgrass	fine fescue	Kentucky bluegrass	perennial ryegrass	tall fescue	bermudagrass	buffalograss	zyrgrass
2,4-D + fluroxypyr + triclopyr + sulfentrazone (Momentum 4-Scout)	P	P	P	F	S	S	S	S	S	S	S	NR	NR
2,4-D + MCPA + dicamba + sulfentrazone (Triad SFZ Select)	P	P	P	F	S	S	S	S	S	S	S	S	S
2,4-D + quinclorac + dicamba + sulfentrazone (Q4 Plus)	P	P	P	F	S	NR	S	S	S	S	S	NR	S
2,4-D + triclopyr + dicamba + sulfentrazone (Foundation)	P	P	P	F	S	NR	S	S	S	S	NR	NR	NR
bentazon (Bastagan TriO)	G	F-G	P	F	S	S	S	S	S	S	S	S	S
dimethenamid (Tenor)	G	G	F	F-G	NR	NR	NR	NR	NR	NR	NR	S	S
dimethenamid + pendimethalin (FreeHand)	G	G	F	F-G	NR	NR	NR	NR	NR	NR	NR	S	S
flazasulfuron (Katana)	G	G	G-E	G-E	NR	NR	NR	NR	NR	NR	NR	S	S
halosulfuron (SedgeHammer)	G	F	G	G-E	NR	S	S	S	S	S	S	S	S
halosulfuron + dicamba (Yukon)	G	F	G	G-E	NR	S	S	S	S	S	S	S-1	S
imazapic (Plateau)	F	F	F	F	NR	NR	NR	NR	NR	NR	NR	S	S
imazazapic (Image 700G)	G	G-E	G	F	NR	NR	NR	NR	NR	NR	NR	S	NR
imazosulfuron (Celero)	G	E	G-E	G-E	NR	S	S	S	S	S	S	NR	S
mesotrione (Tenacity)	P	P	P	G	NR	NR	S	S	S	S	NR	S	NR
mesotrione (Desaver) MCGHUM	G	F	F	S	NR	NR	NR	NR	NR	NR	NR	S	NR

76

Other resources:

- <http://www.mobileweedmanual.com/> Jim Brosnan, Ph.D.



77


Doug Kasher
 @Doug_Kasher

The Turf Analyzer software team is pleased to offer Turf Analyzer & Field Analyzer at no cost moving forward! We are grateful for all of your past support. Happy Holidays!

Free downloads, user manual, and how-to video at: turfanalyzer.com




78

NATIONAL / State

TEMPERATURE PRECIPITATION COMBINED

TEMPERATURES nationwide over time

SEARCH MONTH: July YEAR: 2021

COMPARE TO: PREVIOUS MONTH TEMPERATURE IN °F

Where in the US are temperatures hitting monthly extremes?

Glacier County, Montana
LARGEST DECREASE

La Salle County, Texas
LARGEST INCREASE

In July 2021, 76% of counties in the US experienced temperatures above the 20th century normal. During the same time period, 26% of counties in the US experienced lower than normal monthly temperatures. 92% of counties experienced temperatures normal for the 20th century.

79

<https://turf.unl.edu/>

80



81

Contact Information

- Roch Gaussoin
- rgaussoin1@unl.edu
- [@rockinsince57](https://twitter.com/rockinsince57)

Thank you!

82