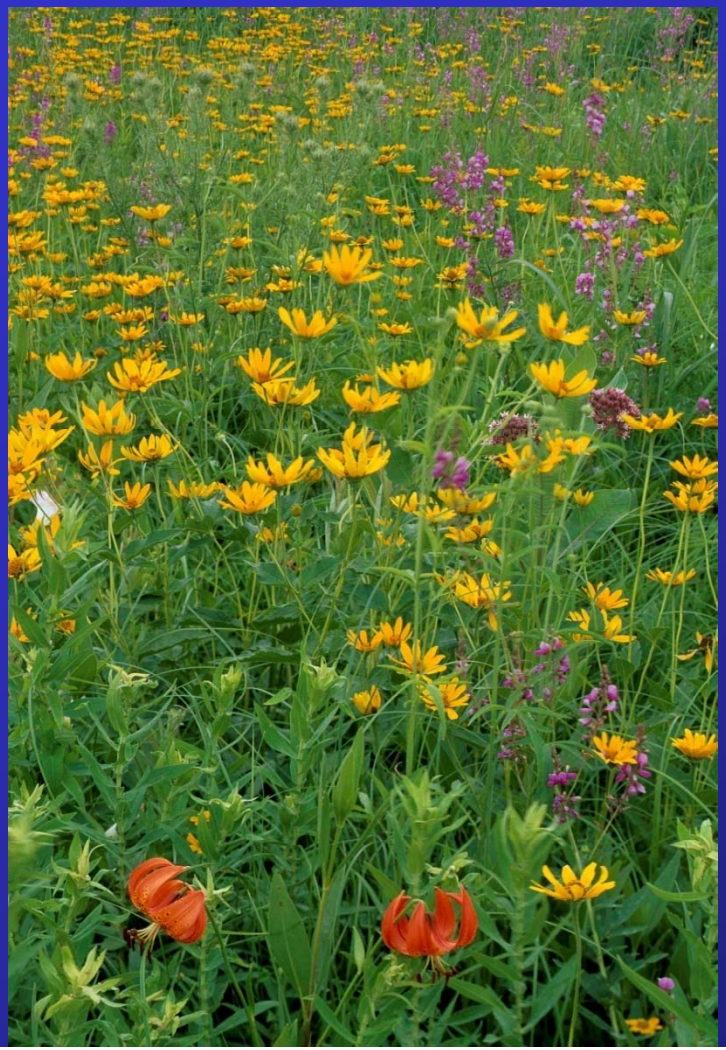
Restoring Native Grasslands With Herbicides: Lessons Learned From the Coast of Texas to The Northern Great Plains



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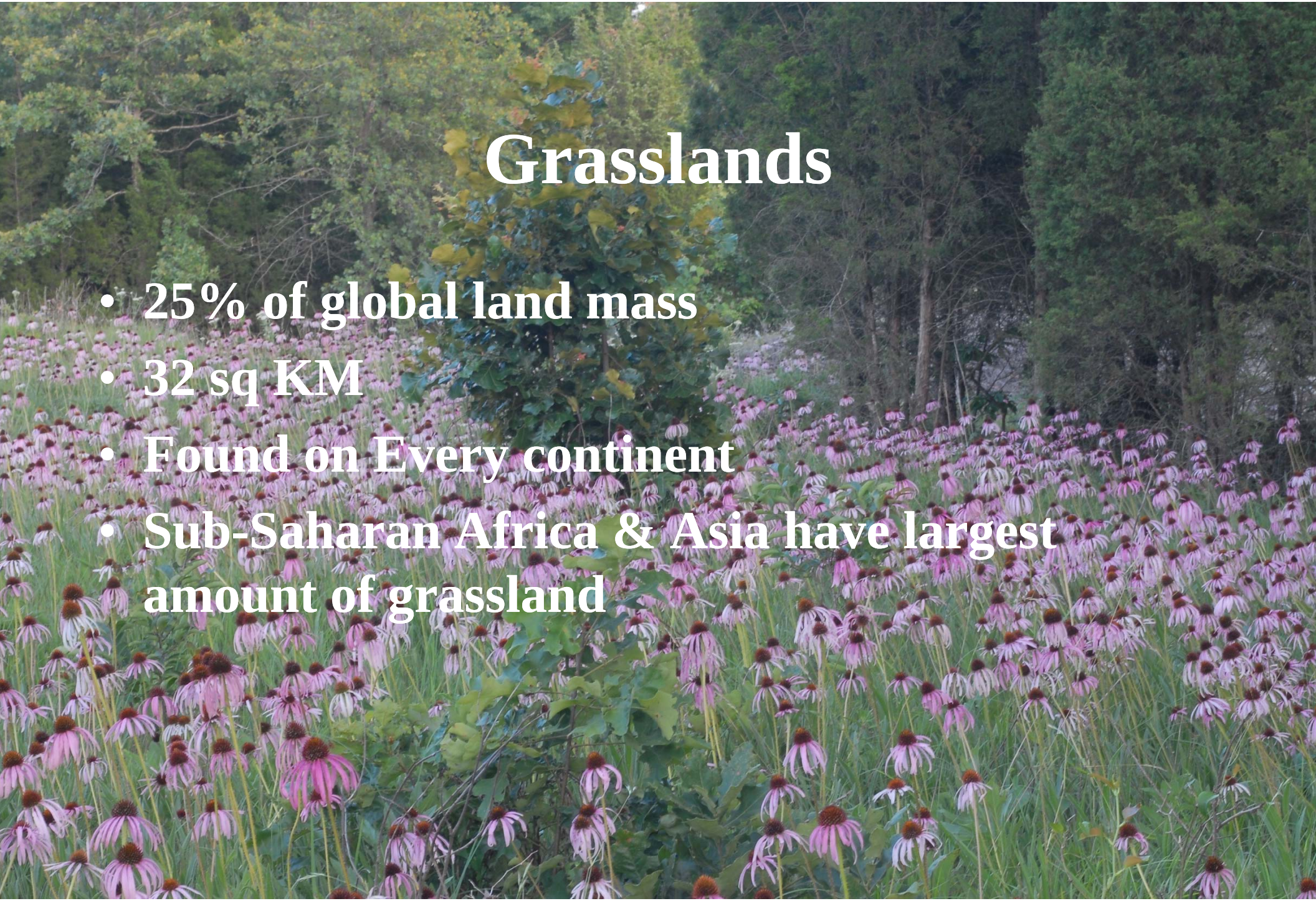
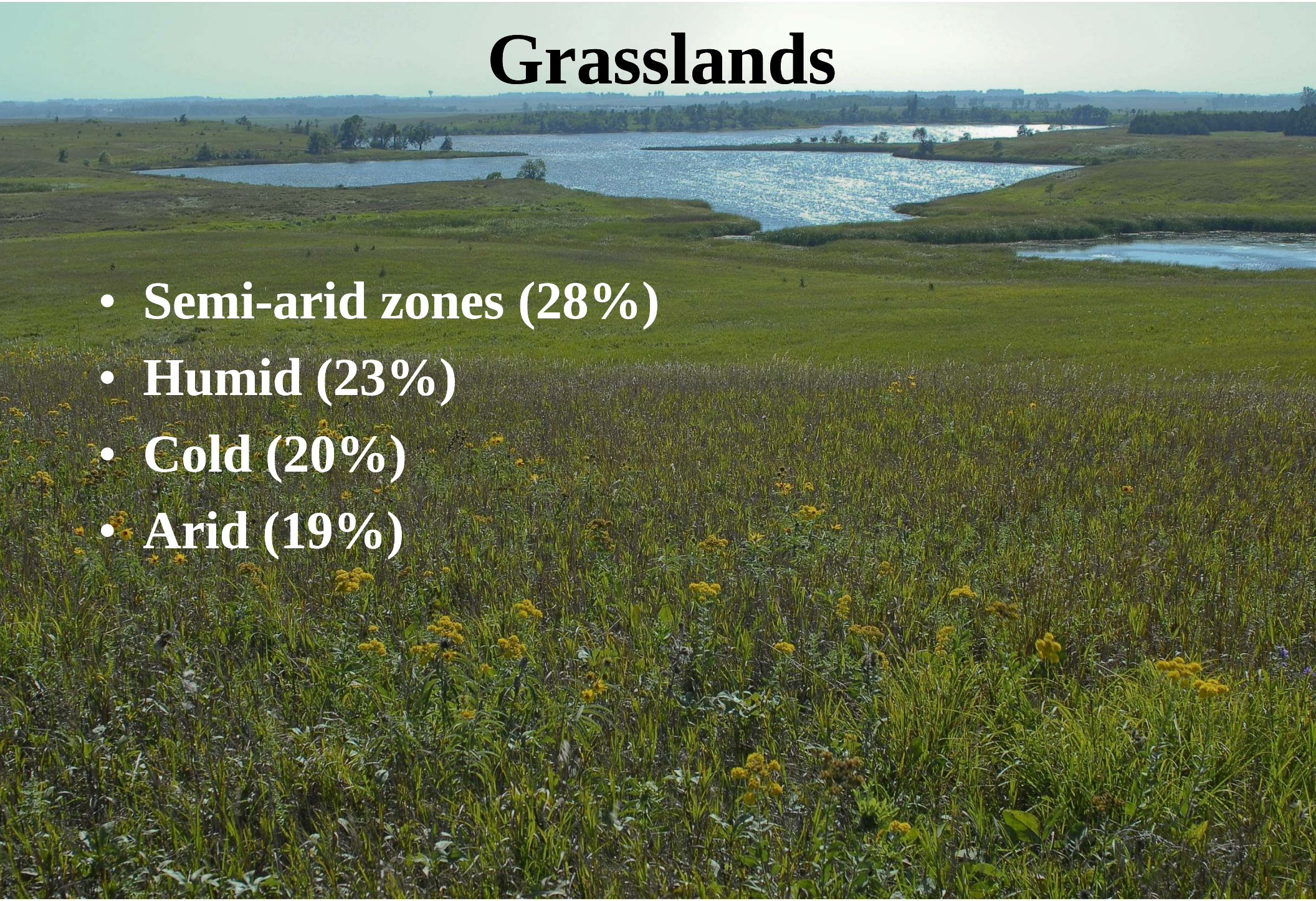


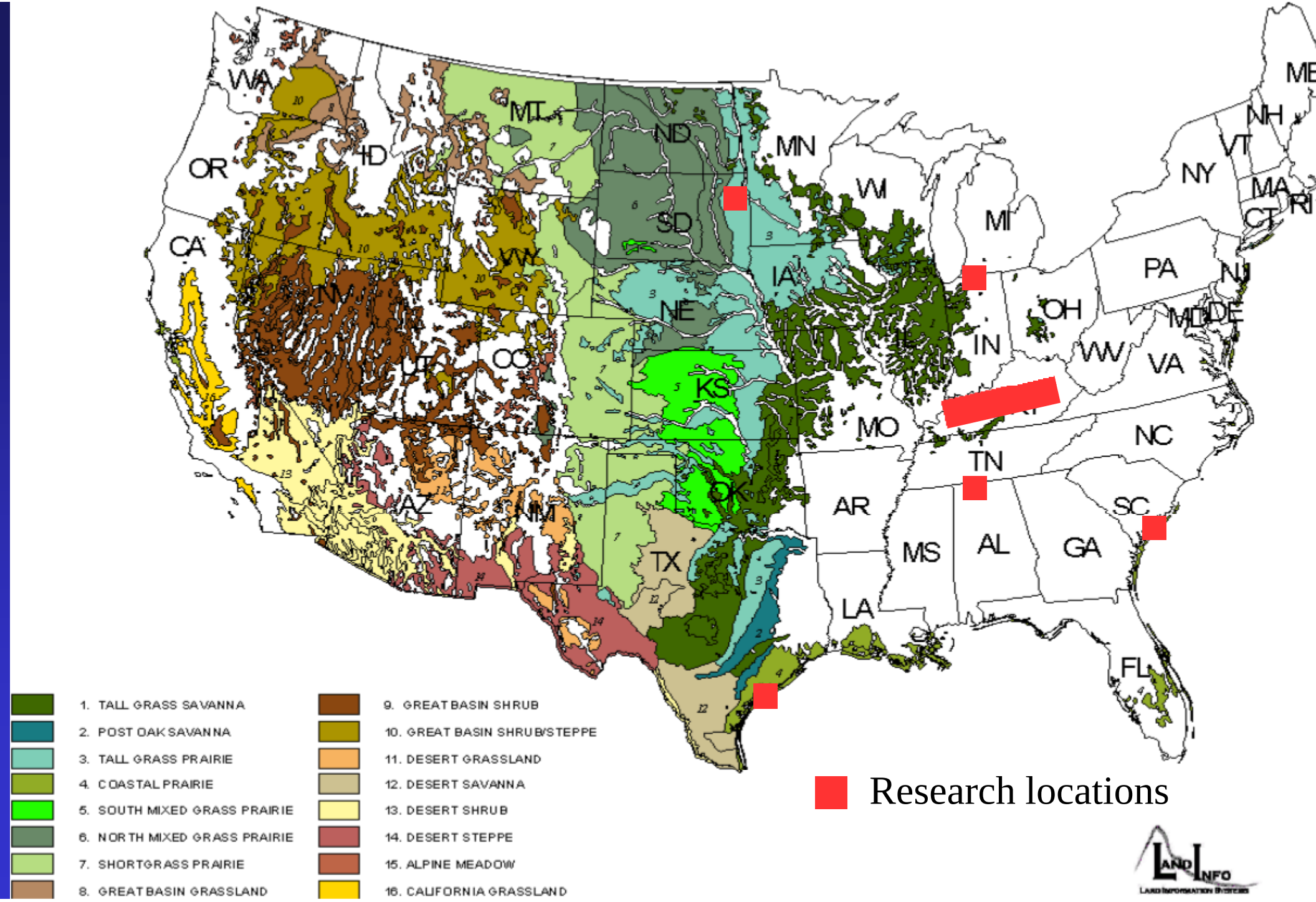
Grasslands

- 25% of global land mass
- 32 sq KM
- Found on Every continent
- Sub-Saharan Africa & Asia have largest amount of grassland

Grasslands



- Semi-arid zones (28%)
- Humid (23%)
- Cold (20%)
- Arid (19%)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NJ
CT
RI
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Research locations
1. TALL GRASS SAVANNA
2. POST OAK SAVANNA
3. TALL GRASS PRAIRIE
4. COASTAL PRAIRIE
5. SOUTH MIXED GRASS PRAIRIE
6. NORTH MIXED GRASS PRAIRIE
7. SHORTGRASS PRAIRIE
8. GREAT BASIN GRASSLAND
9. GREAT BASIN SHRUB
10. GREAT BASIN SHRUB/STEPPE
11. DESERT GRASSLAND
12. DESERT SAVANNA
13. DESERT SHRUB
14. DESERT STEPPE
15. ALPINE MEADOW
16. CALIFORNIA GRASSLAND

Changes in Grasslands

	% Total Decline
• Tropical/subtropical	28
• Temperate	65
• Flooded	50
• Montane	28
• Mediterranean	50

Changes in Grasslands

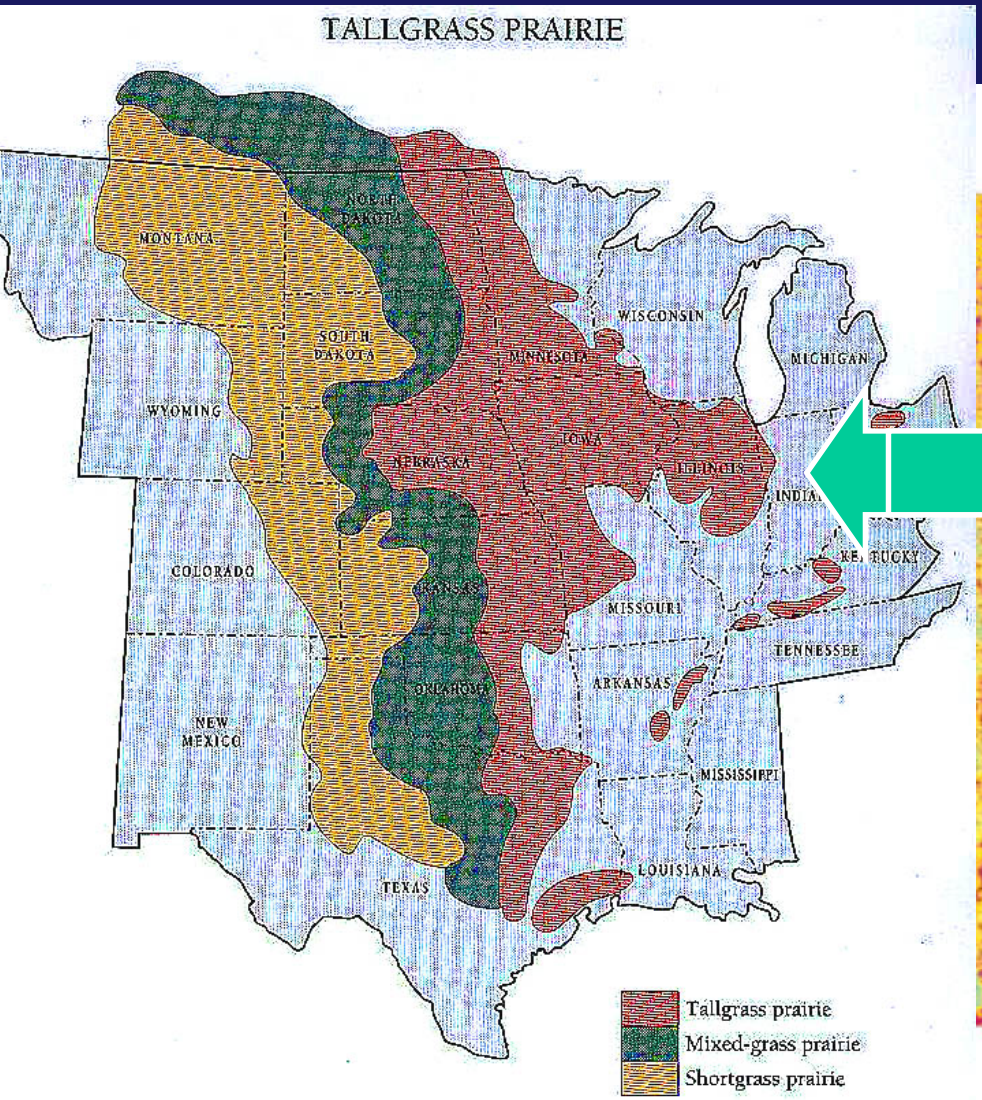
	% Remaining
• No. Am. Tallgrass	3
• So. Am. Cerrado	21
• Asian Steppe	72
• Central & Eastern Mopane/Miombo Woodlands	73
• SW Australian Shrublands	57

Changes in Grasslands

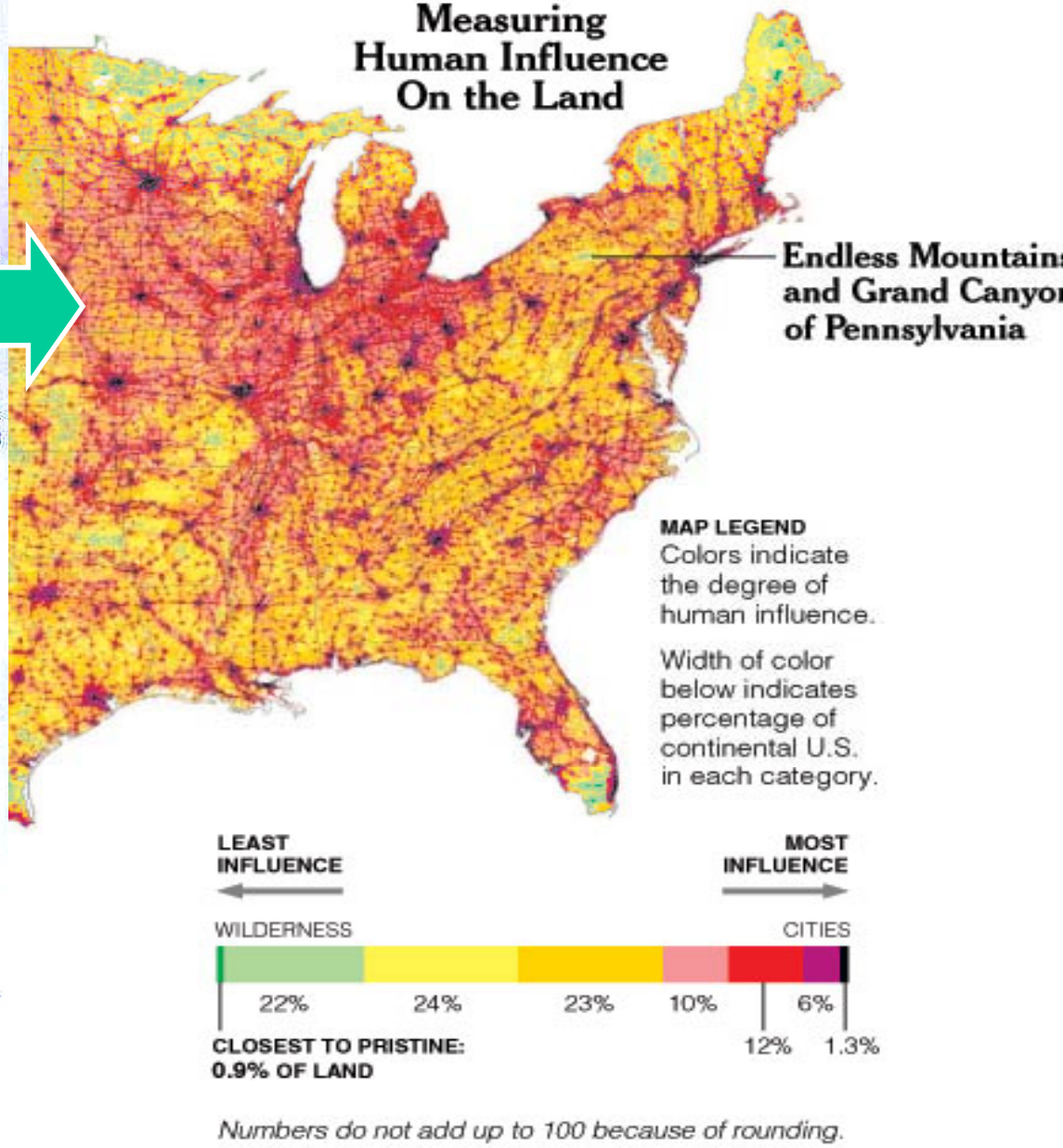
- **USGS estimate losses in North America**
- **Tallgrass prairie 97%**
- **Mixed grass prairie 64%**
- **Short grass prairie 66%**
- **Overall decline more than 79%**

Why the Declines in North America

- Agriculture
- Urbanization
- Desertification
- Fragmentation
- Non-native species
- Loss of fire
- Overgrazing domestic stock



This map shows the original boundries of tallgrass, mixed-grass, and shortgrass prairies that once spanned much of mid-America. Today only small remnants of the tallgrass prairie remain unplowed or undeveloped.



Numbers do not add up to 100 because of rounding.

What is a healthy grassland?

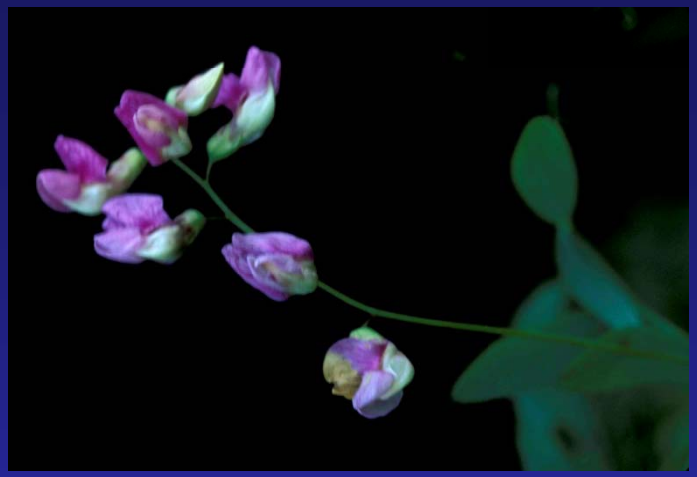
- **Integrity of soil and ecological processes are sustained**
- **Dominated by native species**
  - **Our research fits in**

Major Southeastern United States Grasslands (selected examples)

- Big Barrens (KY & TN into AL)
- Grand Prairie (Ark)
- Southern Ridge & Valley Mesic (TN)
- Southern Switchgrass Tidal Fringe (FL, AL, MS, LA)
- SW Florida Coastal
- Gulf Mexico Dune (FL, AL)
- Southern Appalachian Grass/Shrub Bald
- Pine Savanna

Why Care?

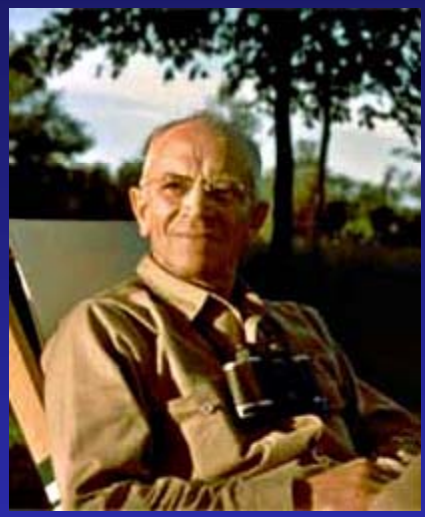
- We have to live with what's left
- Other standard reasons (medicine, agriculture, etc.)



Highland Rim Wet Barrens Rare Plants

Courtesy USFWS/Steve Maslowski

History Return of Prairie



- 1st reconstruction at UWM arboretum by Aldo Leopold
- Historical method was to till (typically once a month during growing season) keep weeds out then seed
- Next was till once in spring and use of Glyphosate applied monthly for an entire growing season then seed

Return of Natives

- Development of no-till technology and more advanced herbicides beginning with glyphosate
- Establishment still slow – weed competition
- Release of new herbicides soil active and suppress annual weeds – revolutionized no-till establishment

Return of Natives

To be successful:

1. assess situation with respect to three approaches
   - release natives with herbicides
   - kill existing vegetation & no-till seed
   - conventional tillage and start over
2. know the system & its ecology
3. know your herbicides & how they work

The Journey Into Finding A Better Mouse Trap Using Herbicides

Use of Herbicides

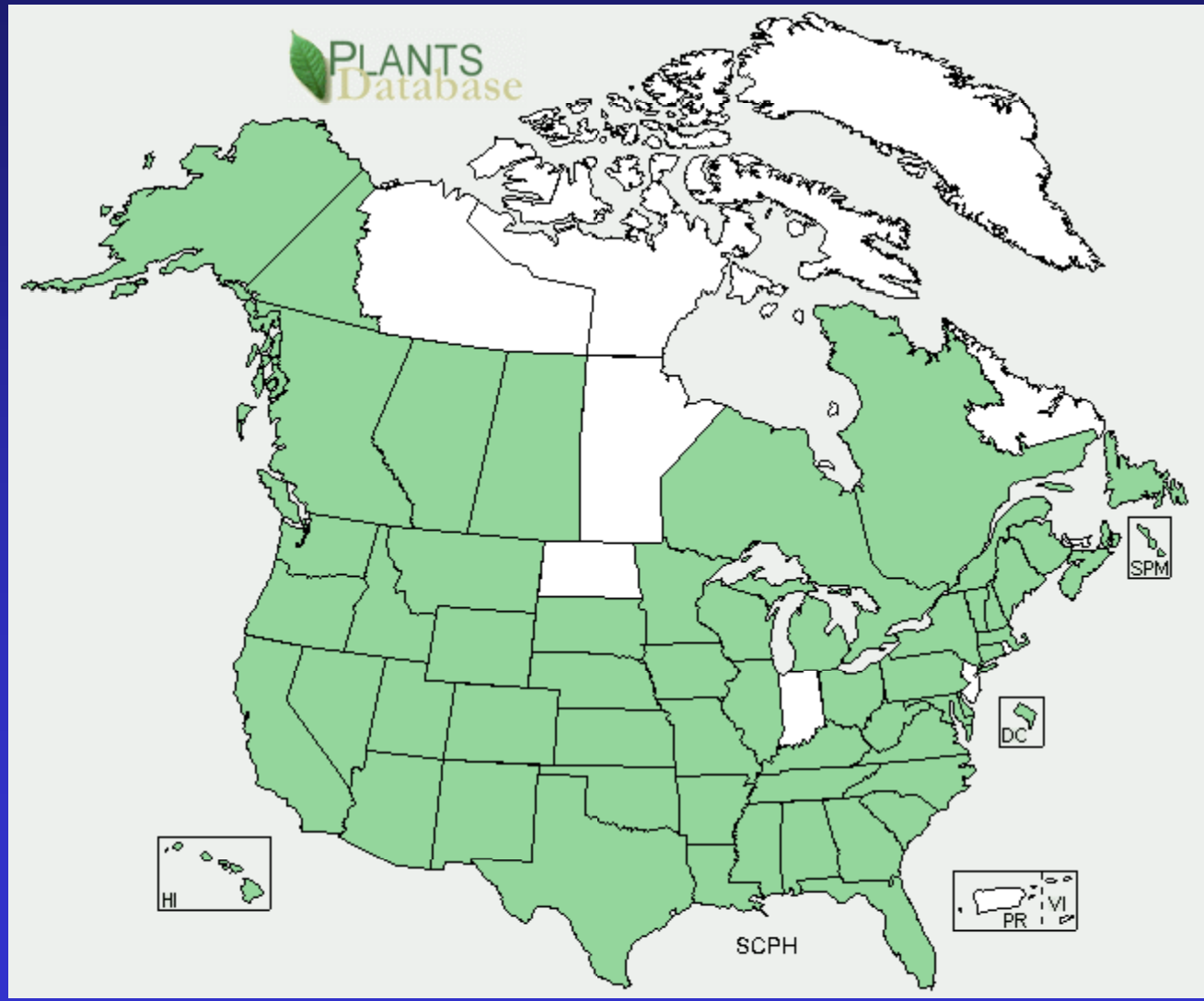
Important Considerations

1. Which herbicide
2. What rate
3. When to use

Cool Season Grasses

Tall Fescue
KY Bluegrass
Reed Canary Grass
Smooth Brome
Quackgrass

Tall Fescue



Which Herbicides Work

- Glyphosate (spring only maximum label rate)
- Imazapic (spring best, kill anytime)
- Sulfosulfuron (spring)
- Graminicides (developed for control in broadleaf crops – annual grasses – need higher concentrations for perennial grasses) – examples Select (clethodim), Fusion (fluazifop P + fenoxyprop), Fusilade (fluazifop P) – older not very good (sethoxydim)

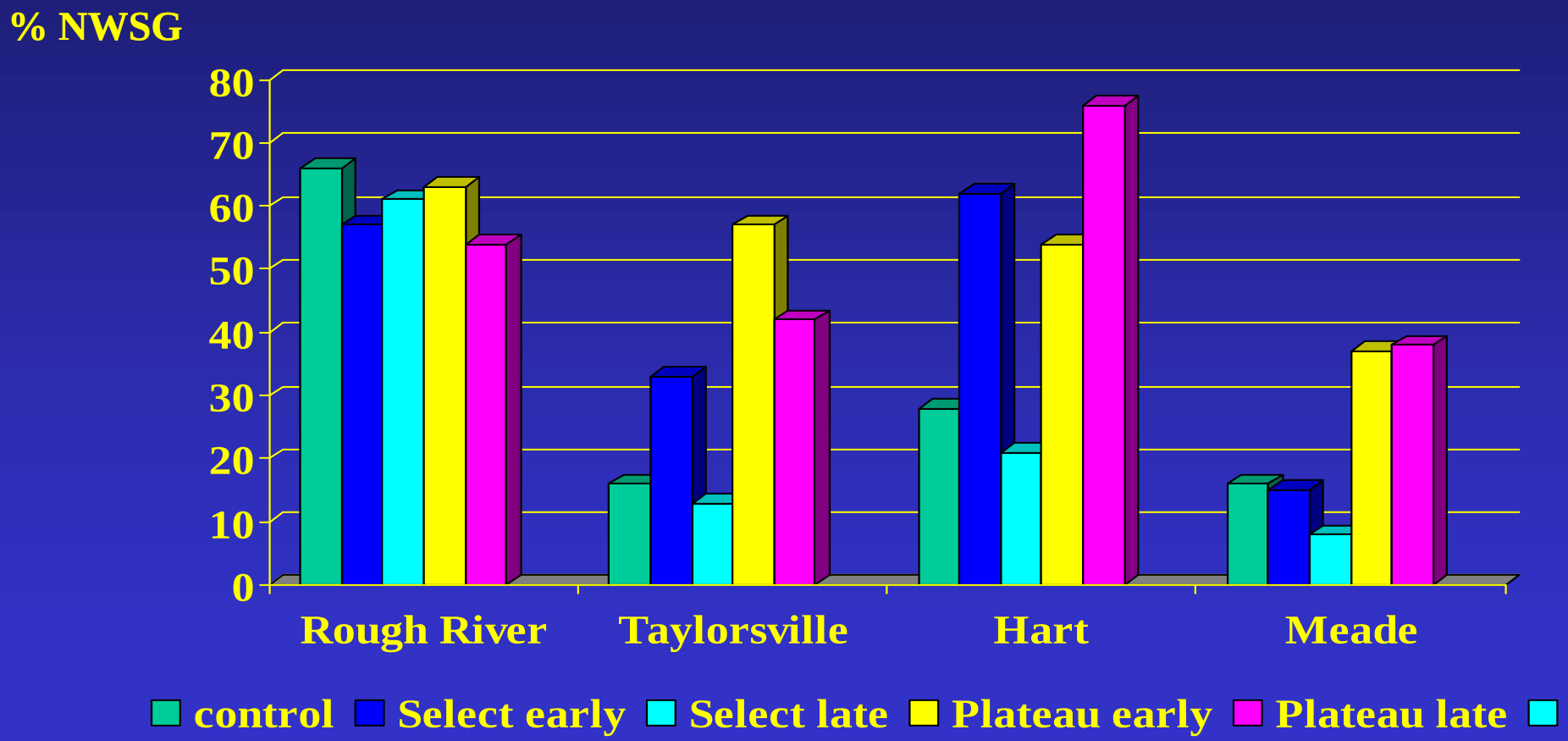
Releasing Native Grasses With Herbicides

- Several herbicides work (glyphosate, imazapic, sulfosulfuron, graminicides)
- Issue becomes one of timing – get the cool-season before warm seasons begin active growth

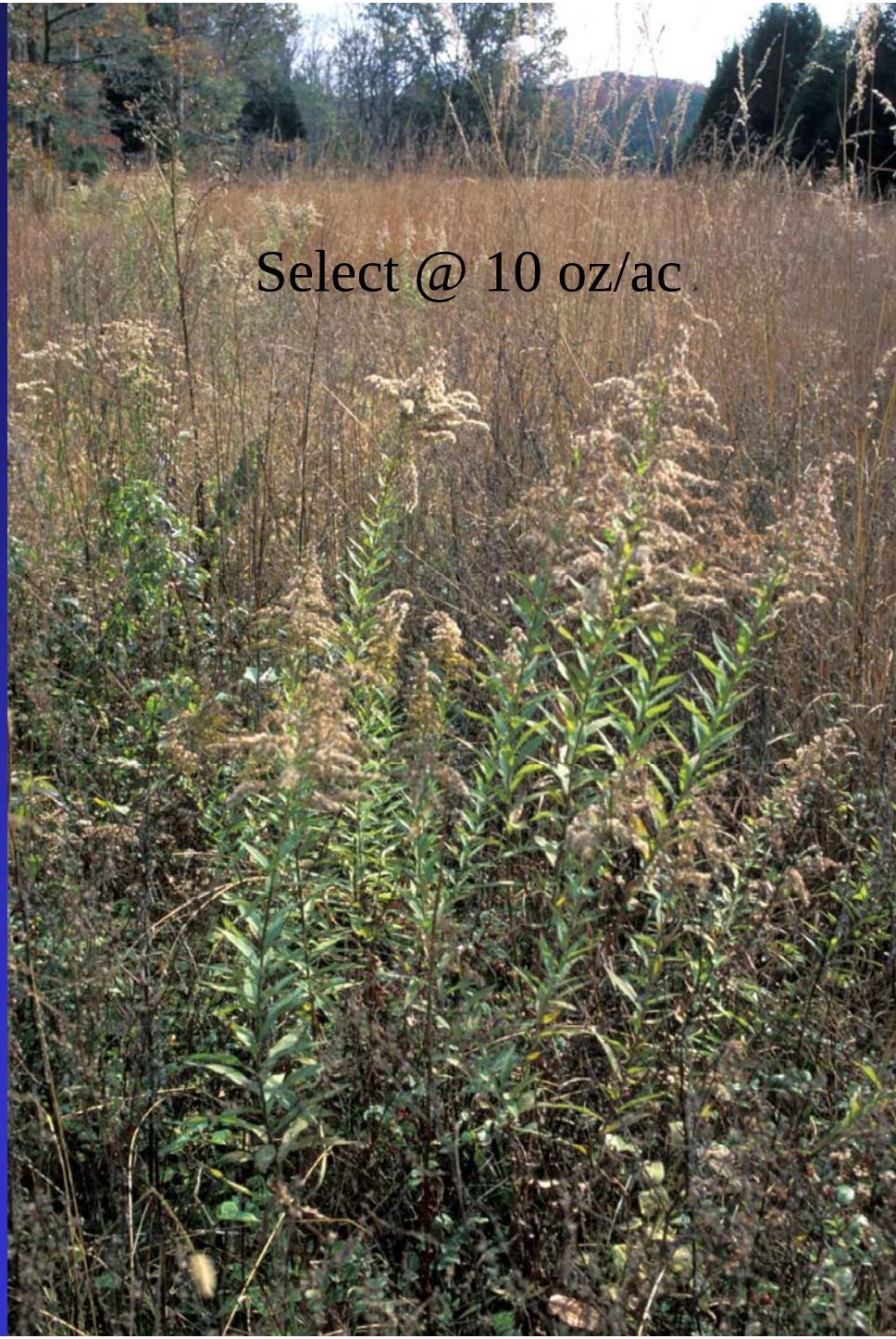
Results Indicate Best Treatment For Removing Fescue & Releasing NWSG

Spring Burn followed
By 10 oz Imazapic
With a Surfactant

Herbicide Comparisons For Releasing NWSG in Native Barrens




Plateau @ 10 oz/ac

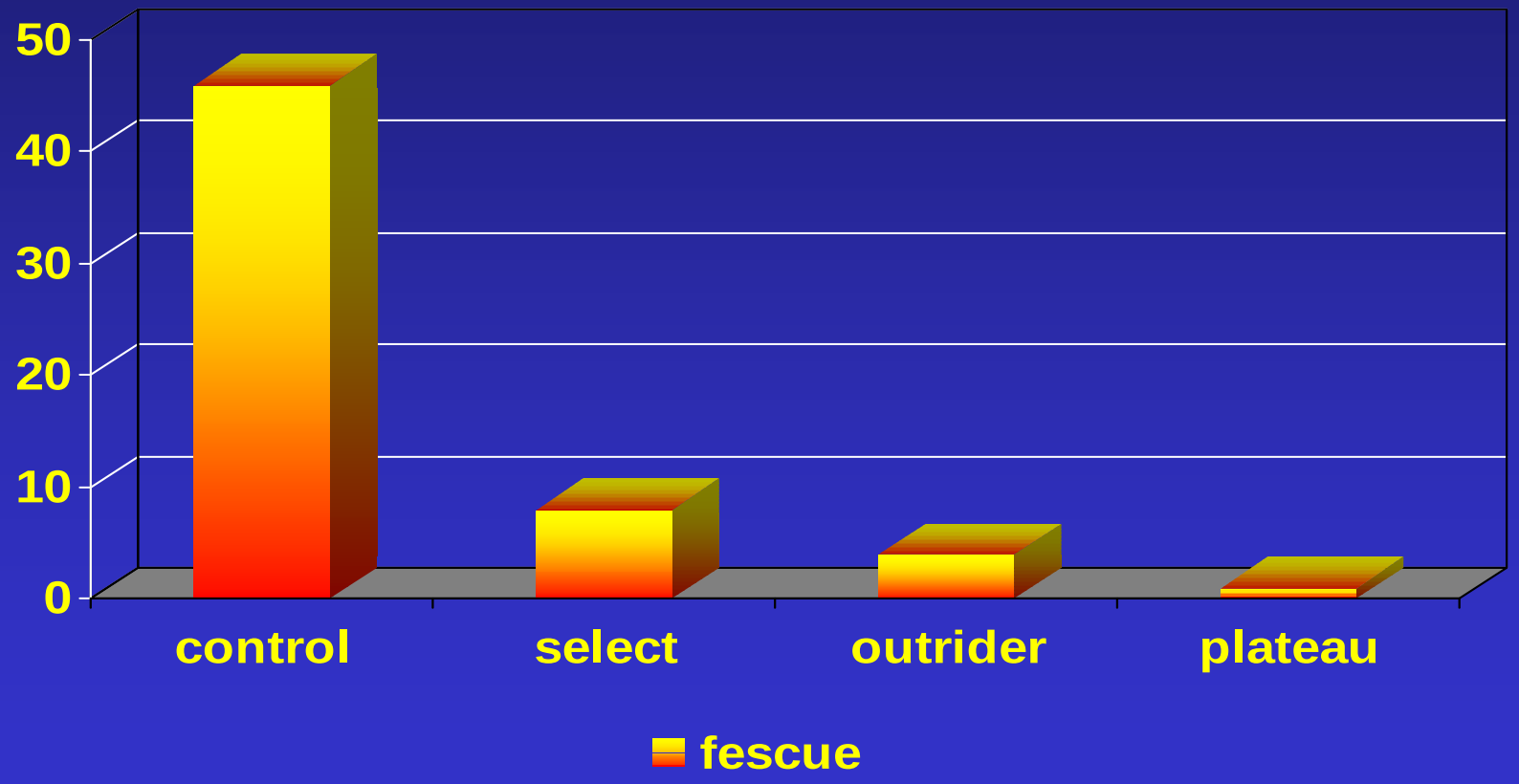

Select @ 10 oz/ac

Release Study Tall Fescue

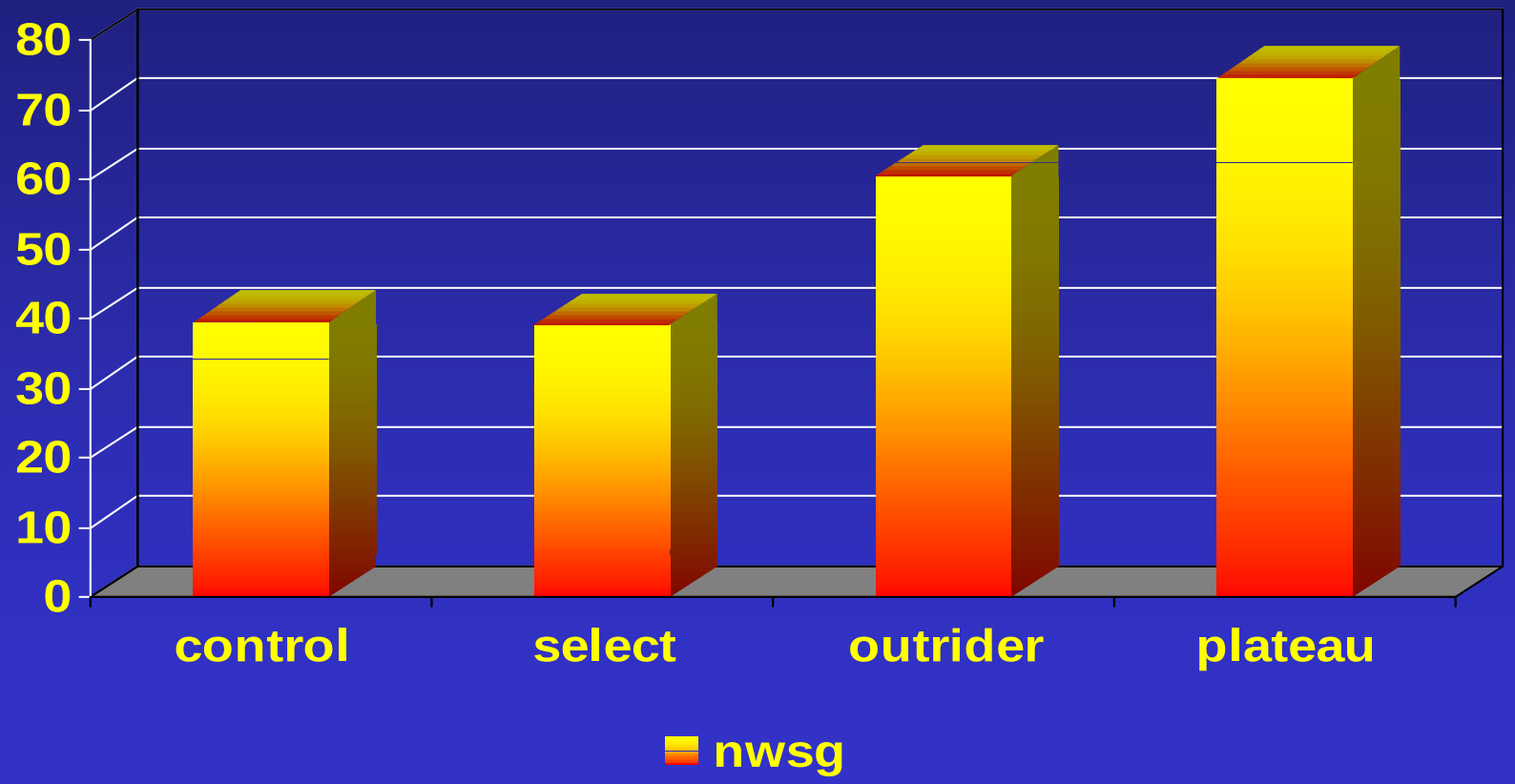
- Compare Plateau, Select, Outrider to examine ability to kill fescue, release NWSG, and what forbs are tolerant across 14 sites throughout KY

Mixed Grass System

Percent Fescue



Percent NWSG



All three do good job after two years of taking out fescue, forb species do not vary much between herbicides

Select

Plateau

Outrider

Exercise Caution

- **Invasive exotic forbs, legumes**
- **Crown vetch, sericea lespedeza, spotted knapweed, white & yellow sweet clover, Japanese honeysuckle**

Plateau Tolerant Forbs

- **Eupatorium coelestinum, hyssopifolium, serotinum, fistulosum**
- **Aster pilosus, dumosus, patens, ontarionensis, lateriflorus, novae-angliae**
- **Solidago altissima, rugosa, odorata, nemoralis**
- **Asclepias tuberosa, viridis, viridiflorus**
- **Silphium terebinthenaceum, pinnatifidum**
- **Rudbeckia hirta, fulgida, Ratibida pinnata, Helianthus divaricatus, H. atrorubens**

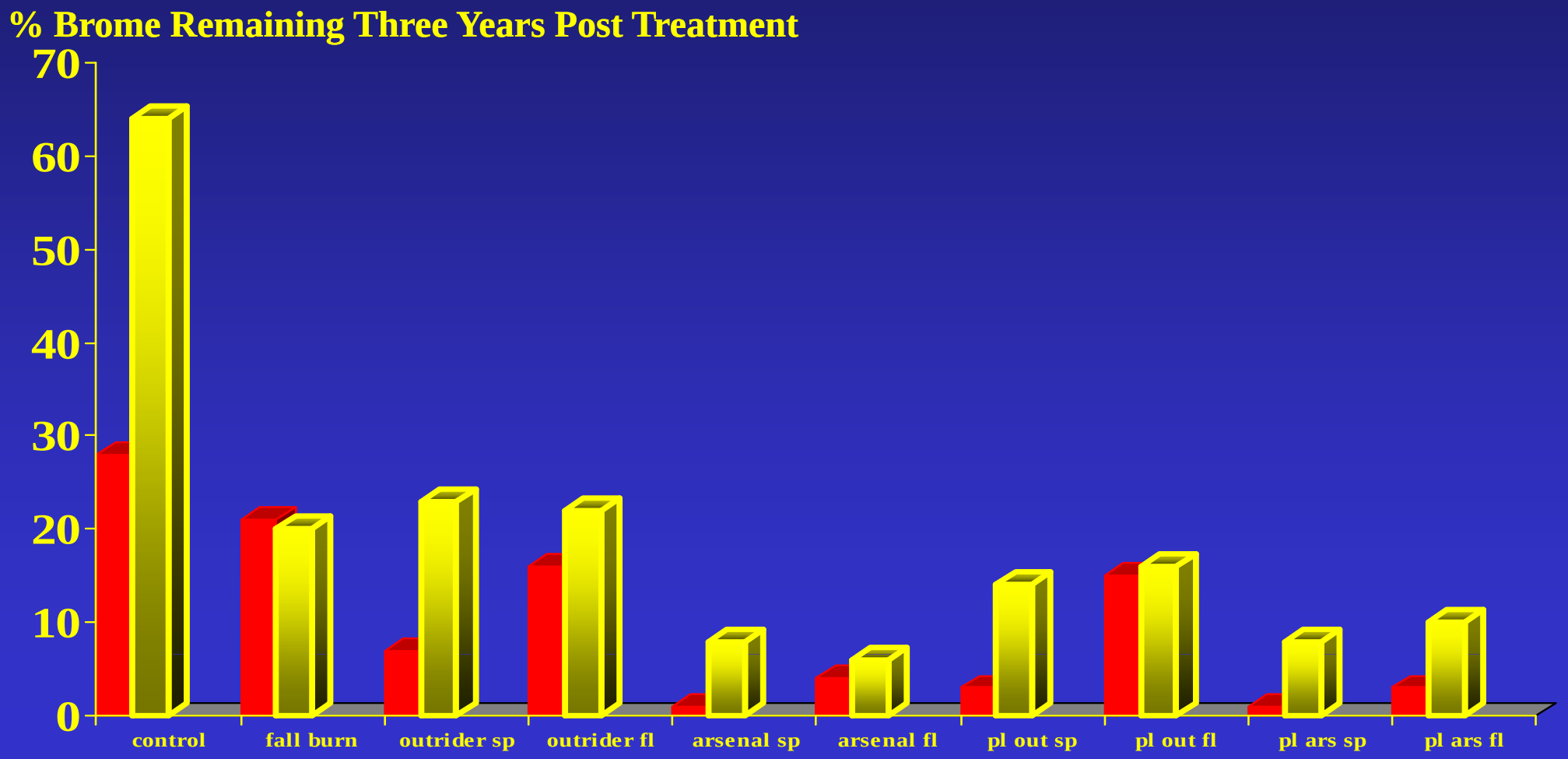
Smooth Brome and KY Bluegrass

- Smooth brome and KY Bluegrass tolerant to imazapic – how to select because system dominated by both native cool and warm season grasses & forbs

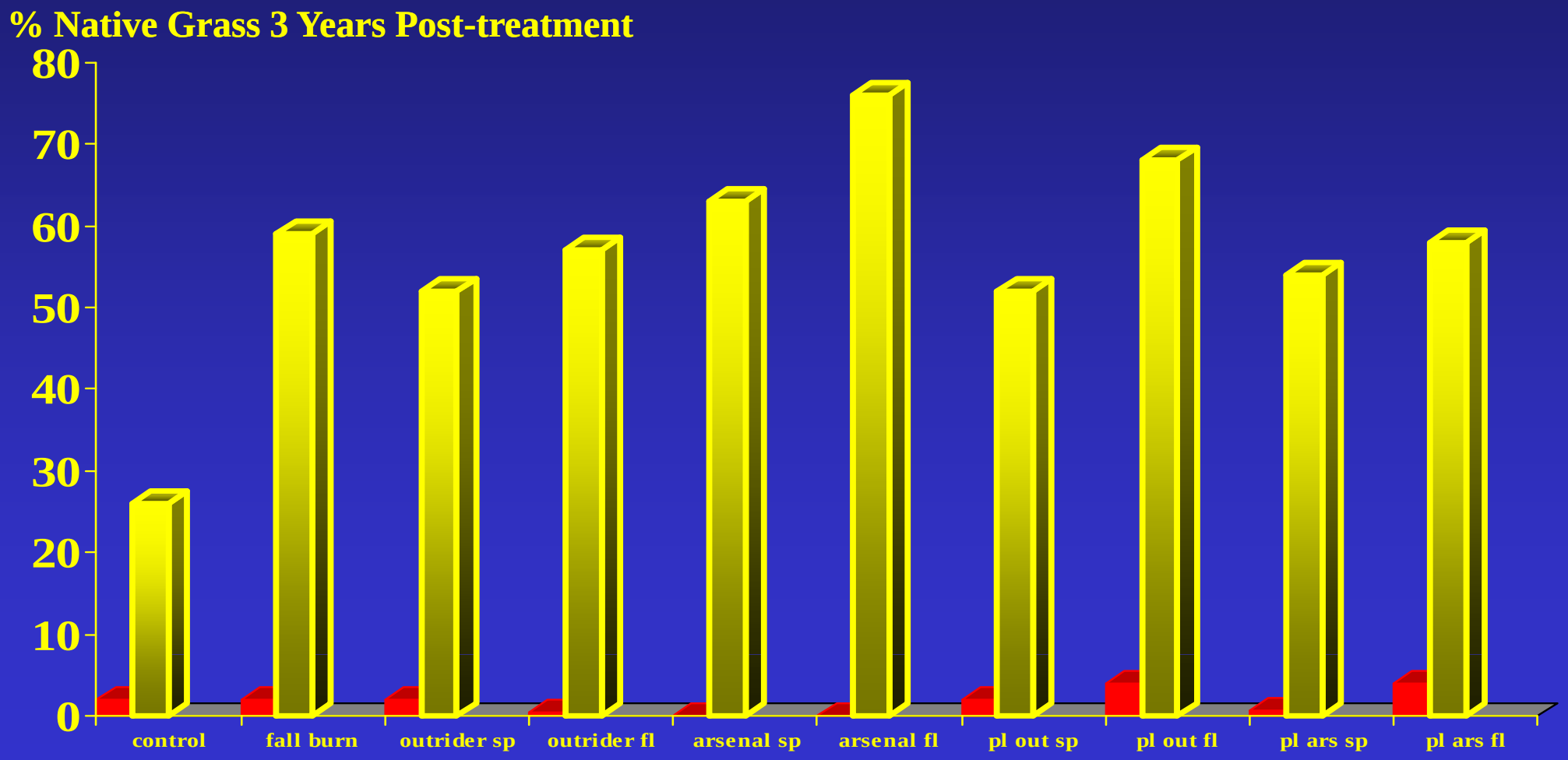
Smooth Brome

Kentucky Bluegrass

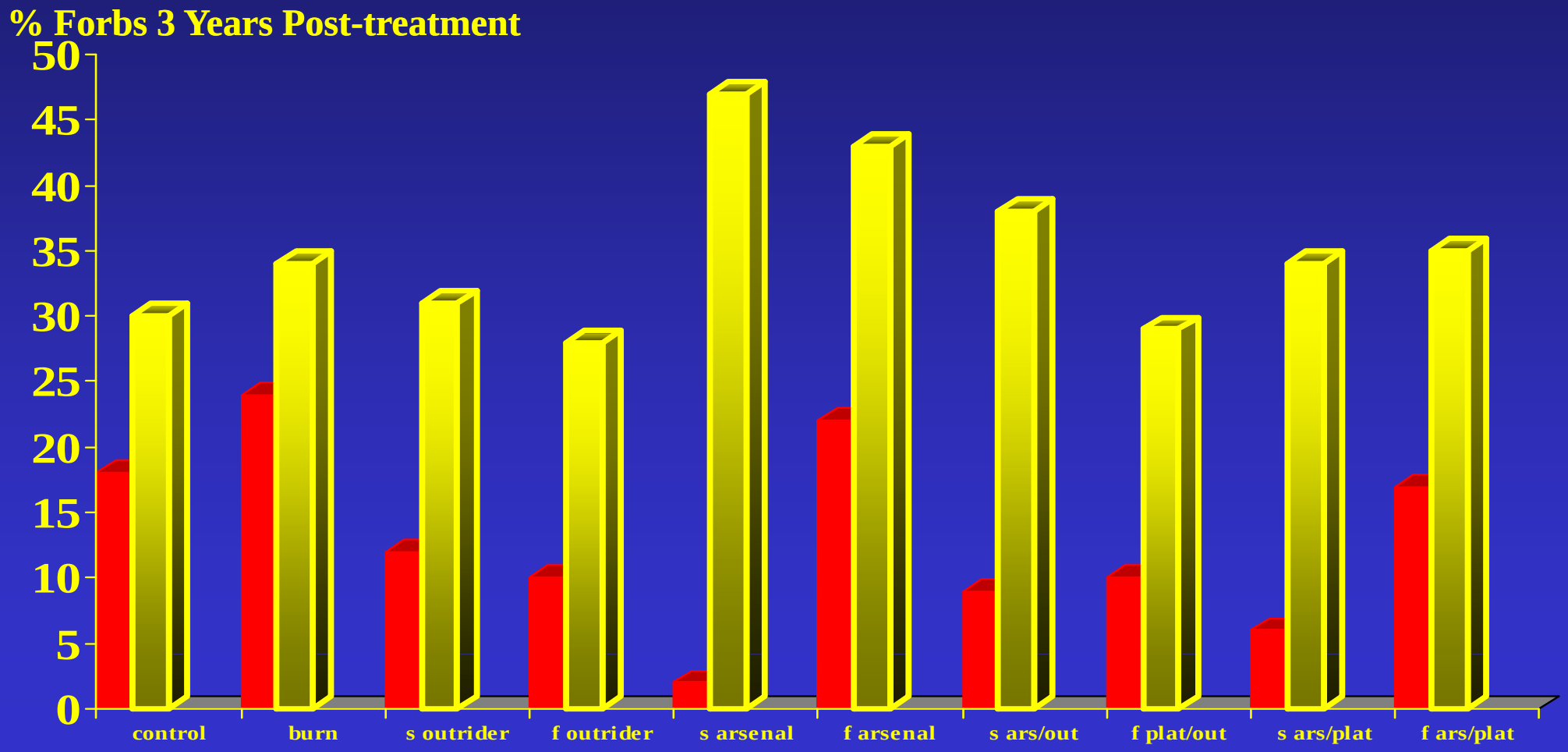
Smooth Brome Response



Native Grass Response



Native Forb Response

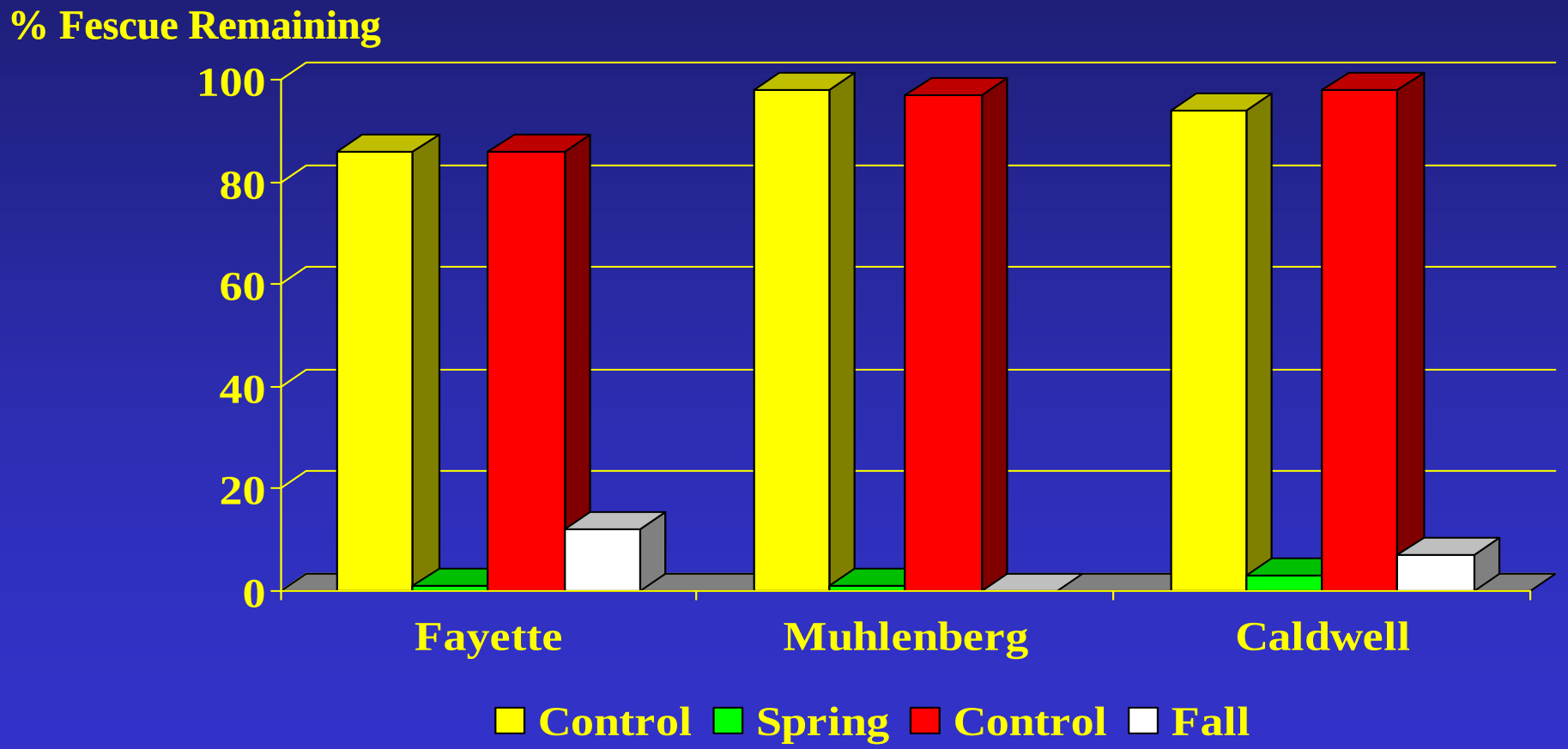


Strategy Two: No-till Conversion With Seeding

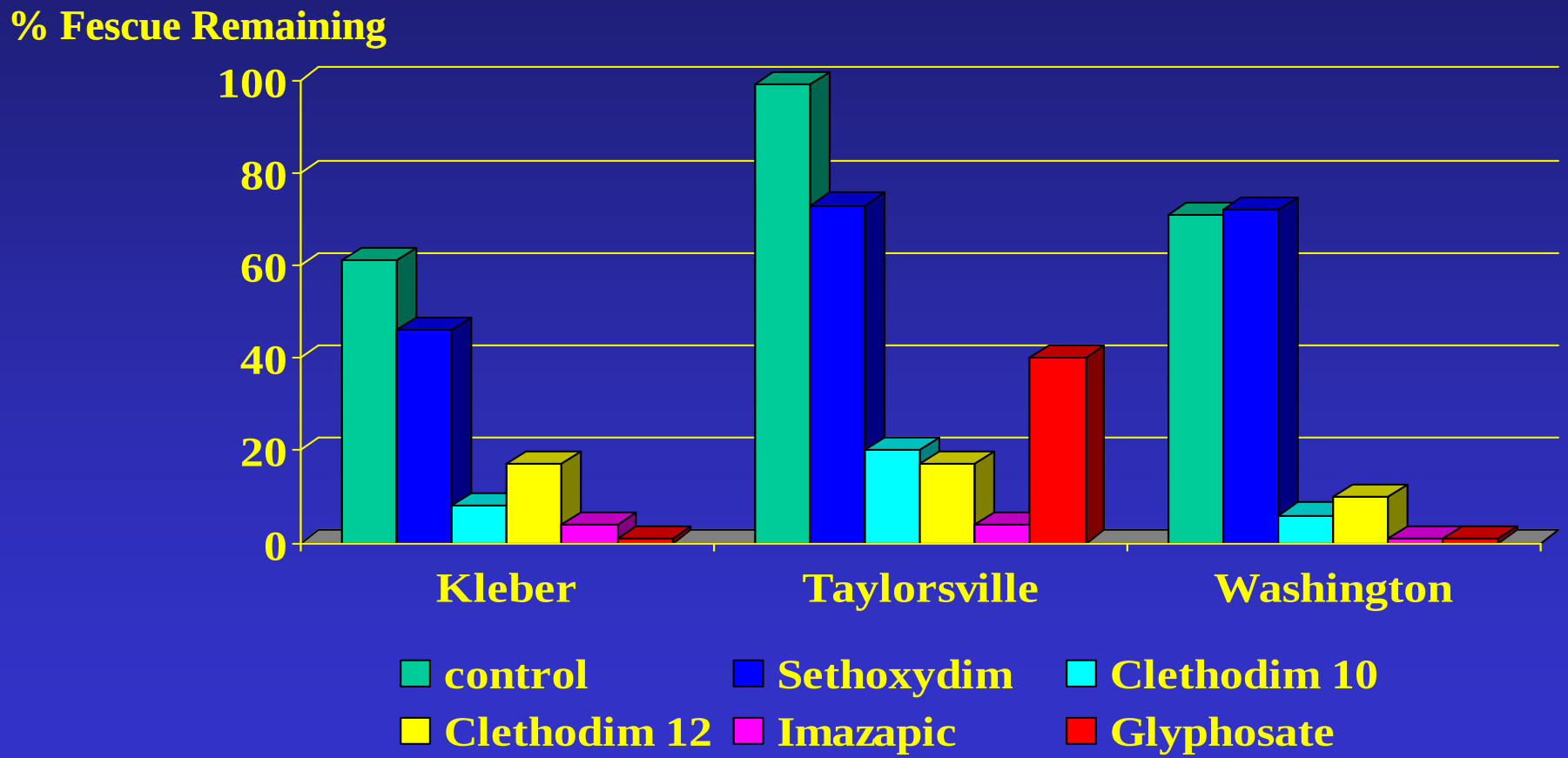
(more successful than using conventional tillage methods)

- Control All Existing Vegetation (this is critical)
- Provide Residual Weed Control
- Use Good Quality Seed & Match Species to Site Condition
- Do Not Seed To Deep

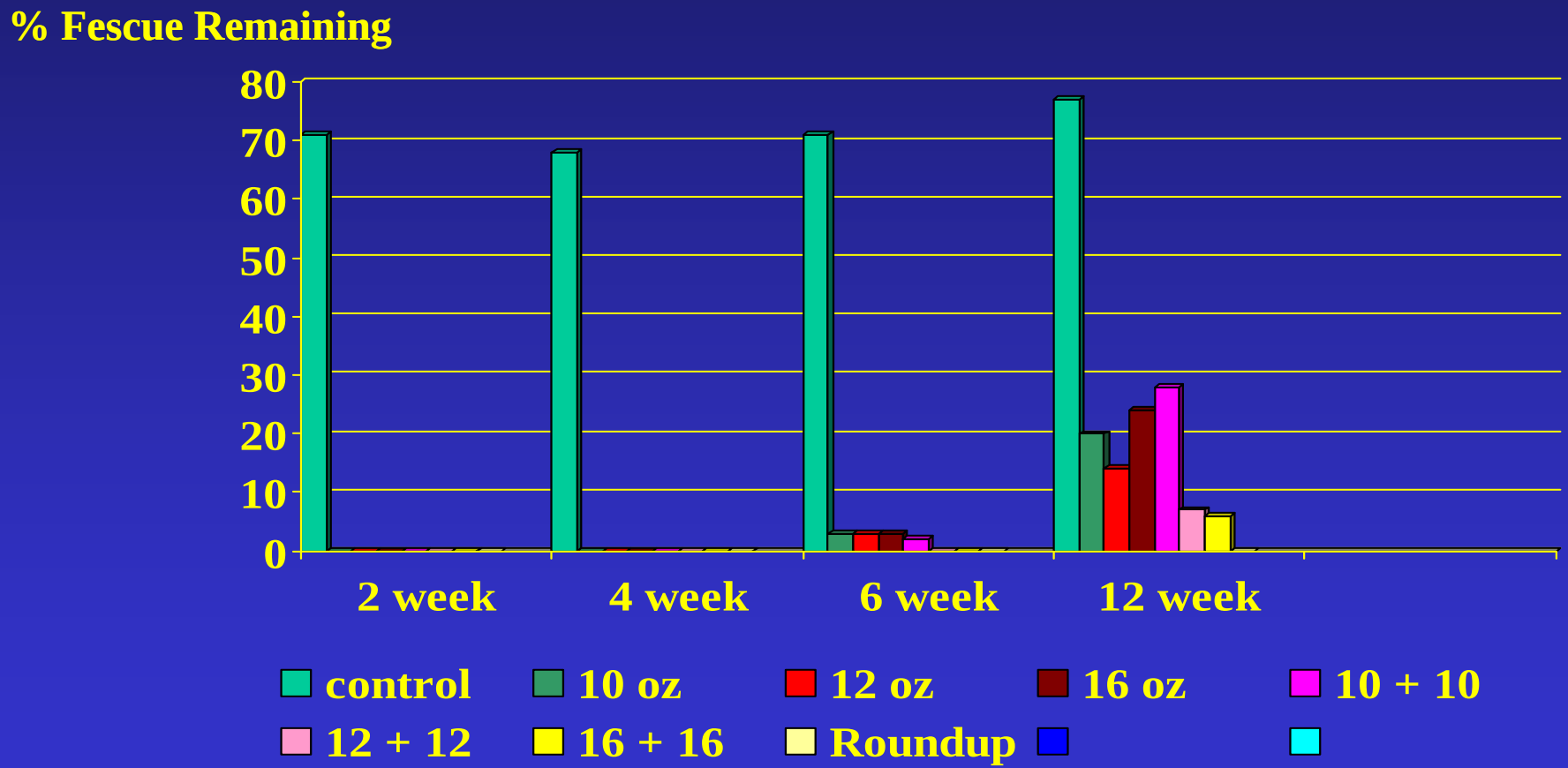
Fescue Control in Spring vs. Fall Using Glyphosate



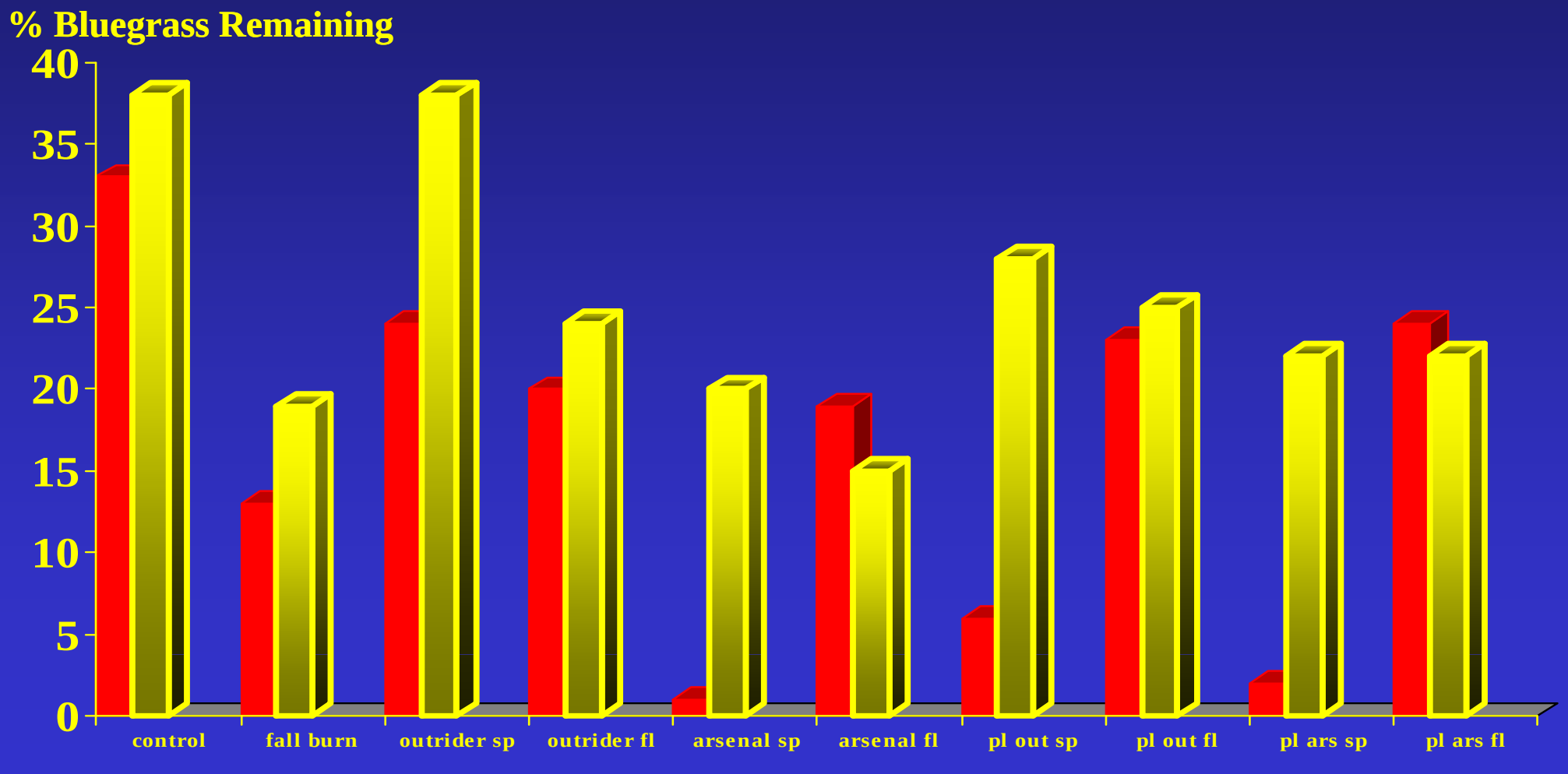
Herbicide Comparisons For Killing Tall Fescue (2000)



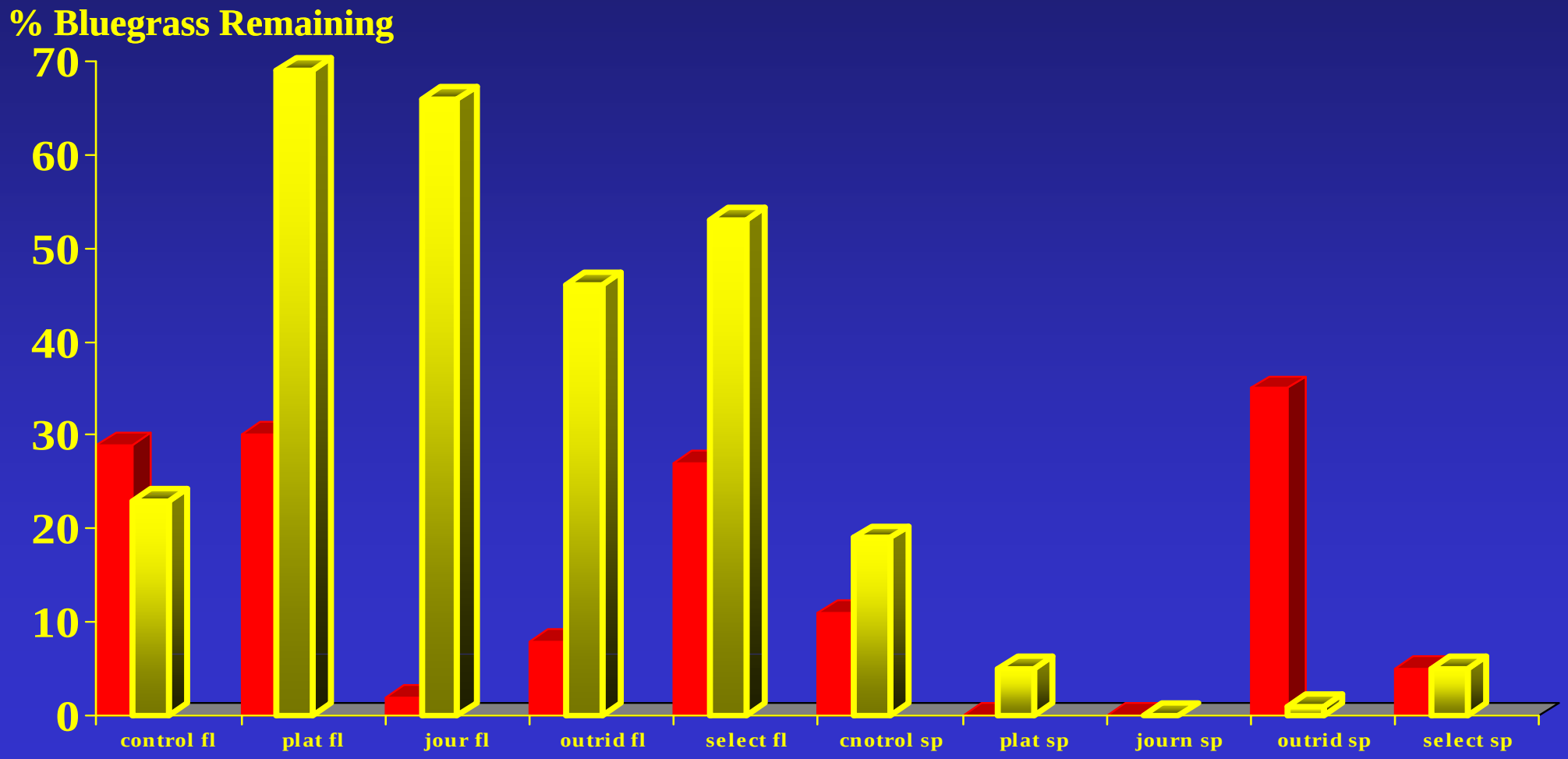
Killing Fescue With Clethodim & Glyphosate (2001)



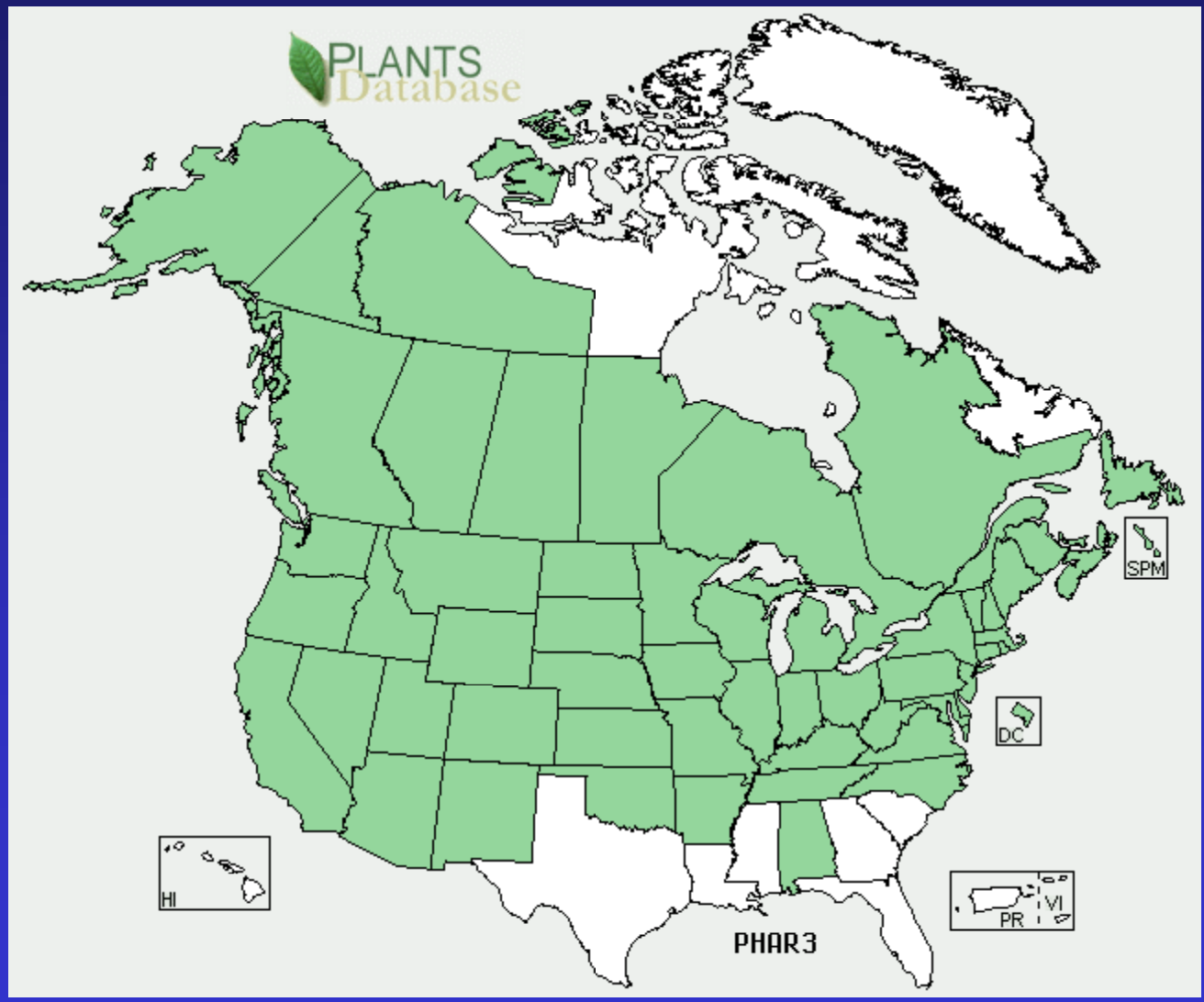
Controlling KY Bluegrass



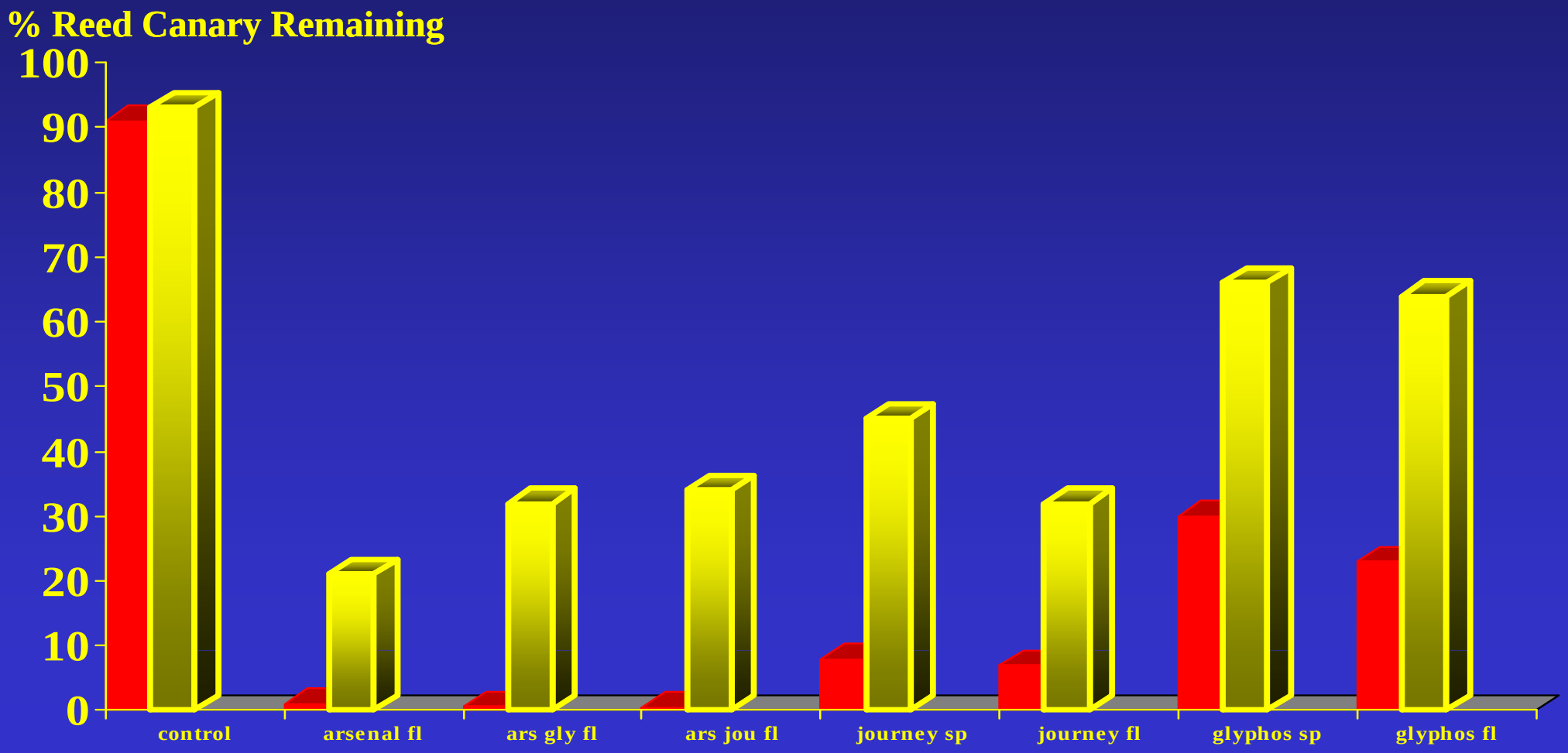
Controlling KY Bluegrass
Old Growth Bluegrass Savannah



Reed Canary Grass



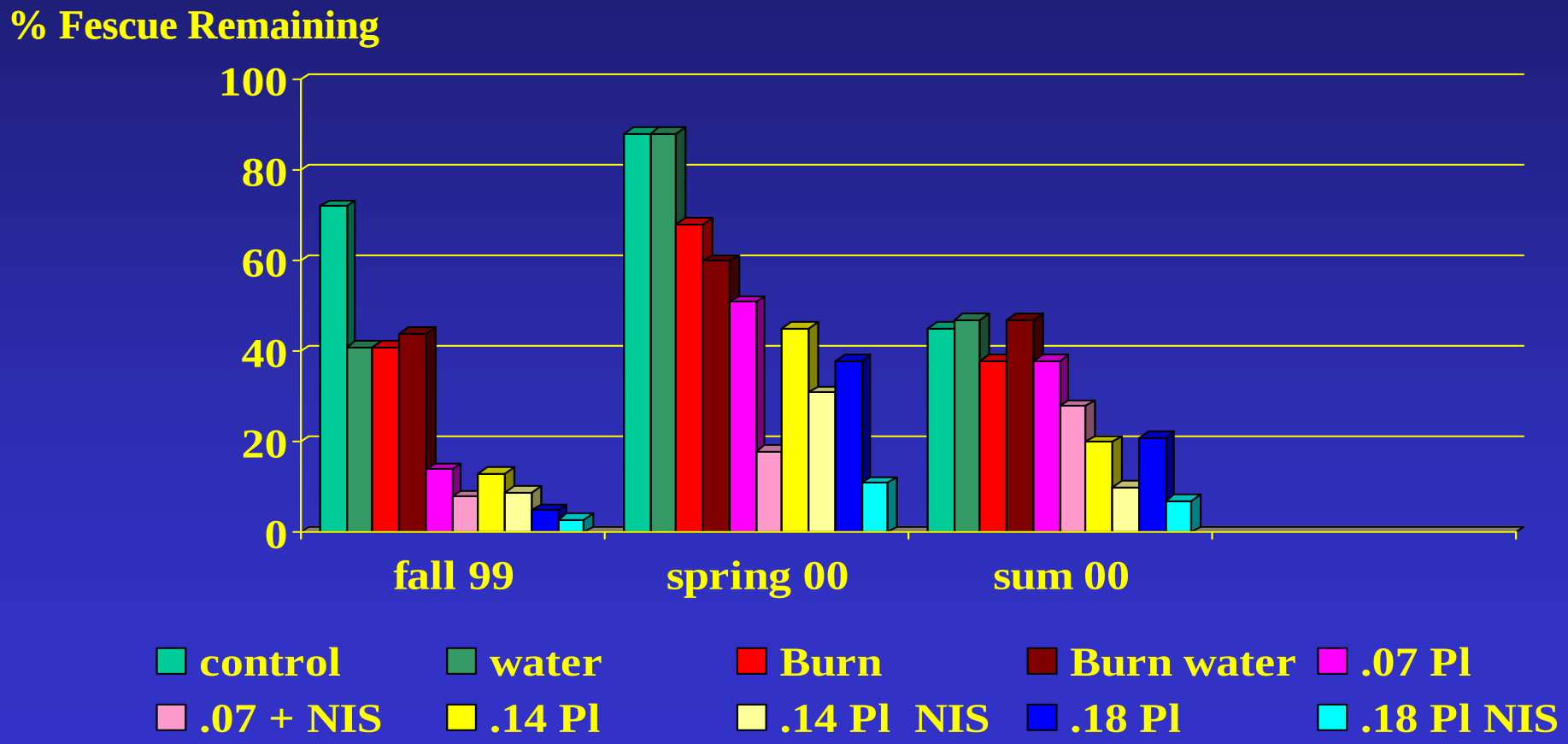
Controlling Reed Canary Grass



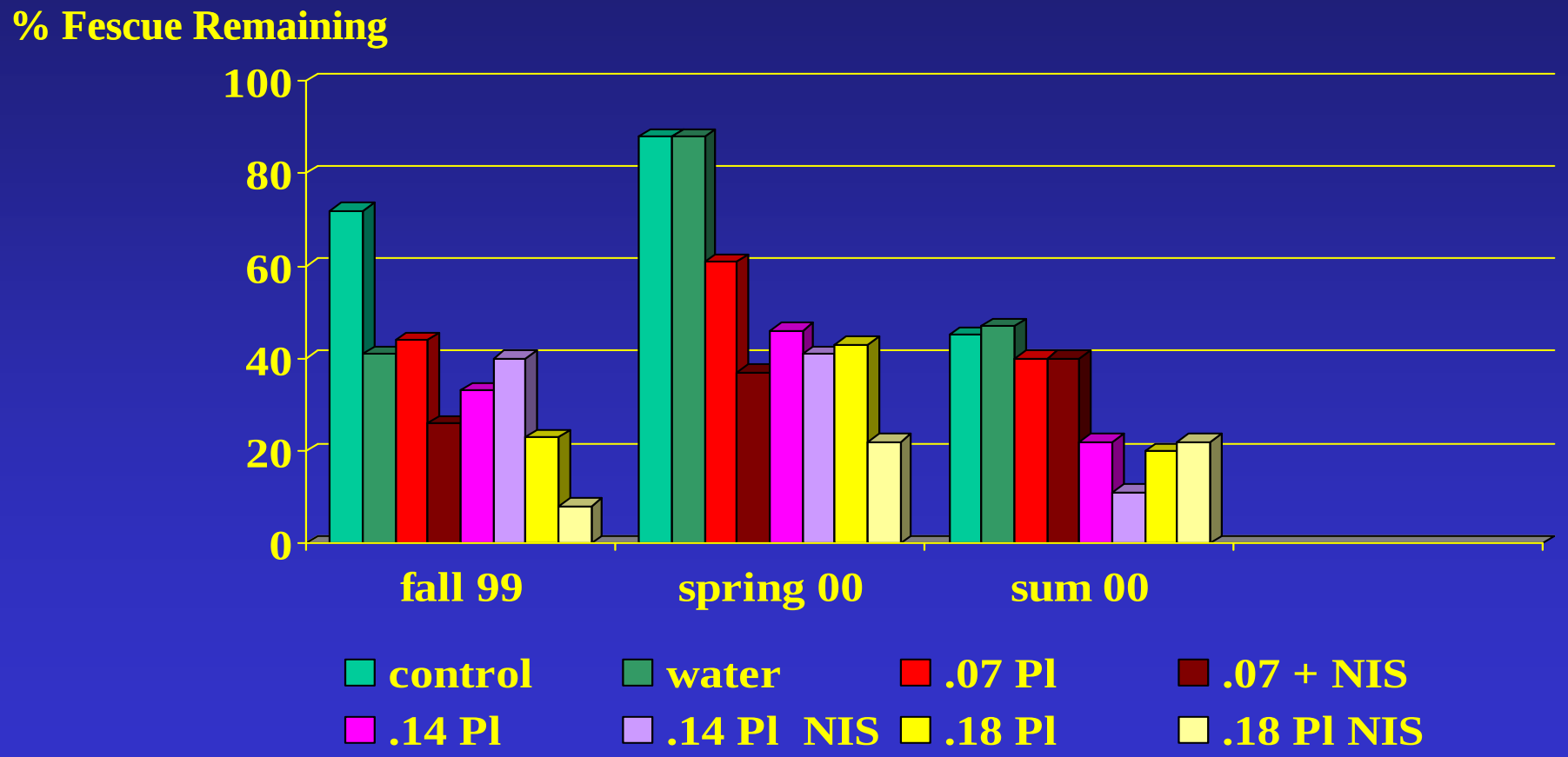
Killing Existing Vegetation

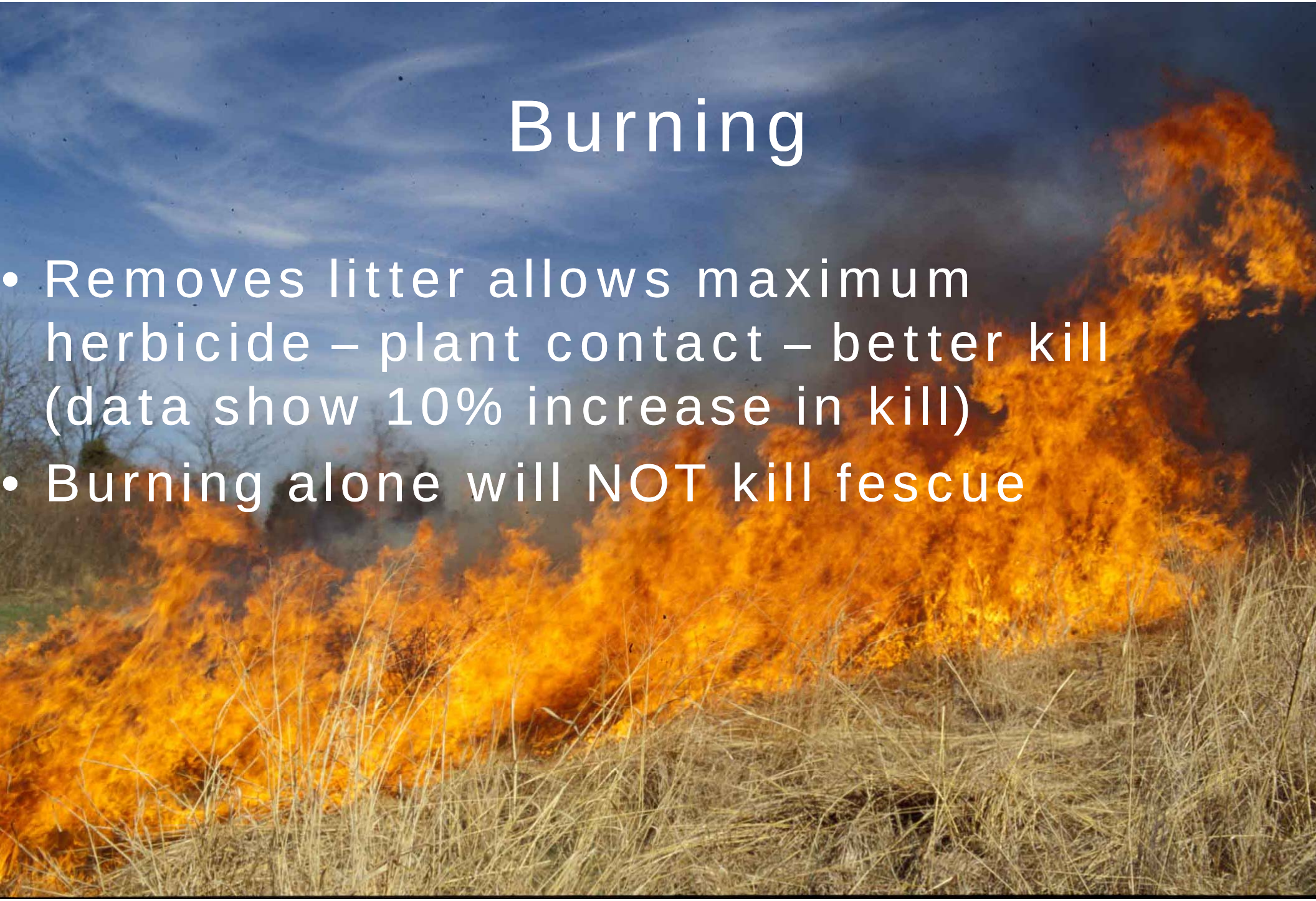
IMPORTANT: Burn (graze, hay) fescue

Effect of Imazapic on Fescue Reduction With Burning



Effect of Imazapic on Fescue Reduction Without Burning





Burning

- Removes litter allows maximum herbicide – plant contact – better kill (data show 10% increase in kill)
- Burning alone will NOT kill fescue

Seeding NWSG

Calibrate drill

Mix grass seeds & forbs together

Use no-till drill

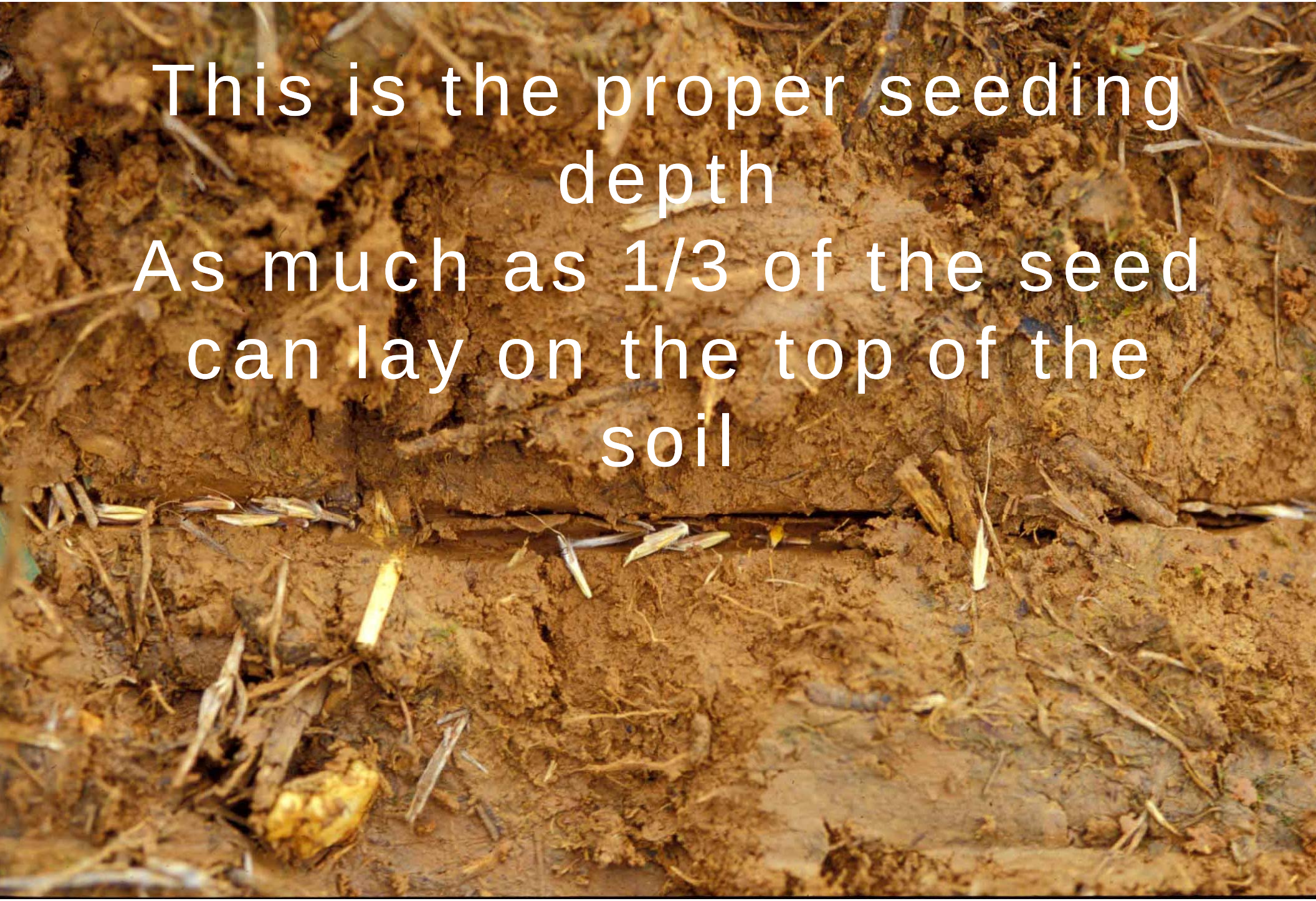
Seed from Mid-April through July

(if you get rain)

Make sure seed no deeper than ¼”

Get off tractor – check to seed if seed is dropping – tubes do & will plug


Fluffy Seed
Mix Grass & Forbs Together


This is the proper seeding depth
As much as 1/3 of the seed can lay on the top of the soil

Fescue Conversion Using No-till

- Several Studies – Summary
- Burn early Spring
- Apply 12 oz Imazapic about month later (mid-April) when 4- 6” tall (add 1 qt MSO & 2.5 lbs AMS / ac in tank) 20 gallon/acre spray rate
- Seed at 6 lbs PLS from May through June


6 Weeks Post-Planting
12 oz Plateau No-till


2 Months Post-Planting
12 oz Plateau No-till

Alternative No-Till Method

- Burn early Spring
- Apply 2 qts glyphosate/acre about month later (when fescue 4 – 6” tall)
- At seeding apply 4 – 6 oz Imazapic/acre (with surfactant & fertilizer)
- Seed 6 lbs PLS/acre from May - June



2 quarts glyphosate + 4 oz Plateau @ seeding Year One % cover = 70%

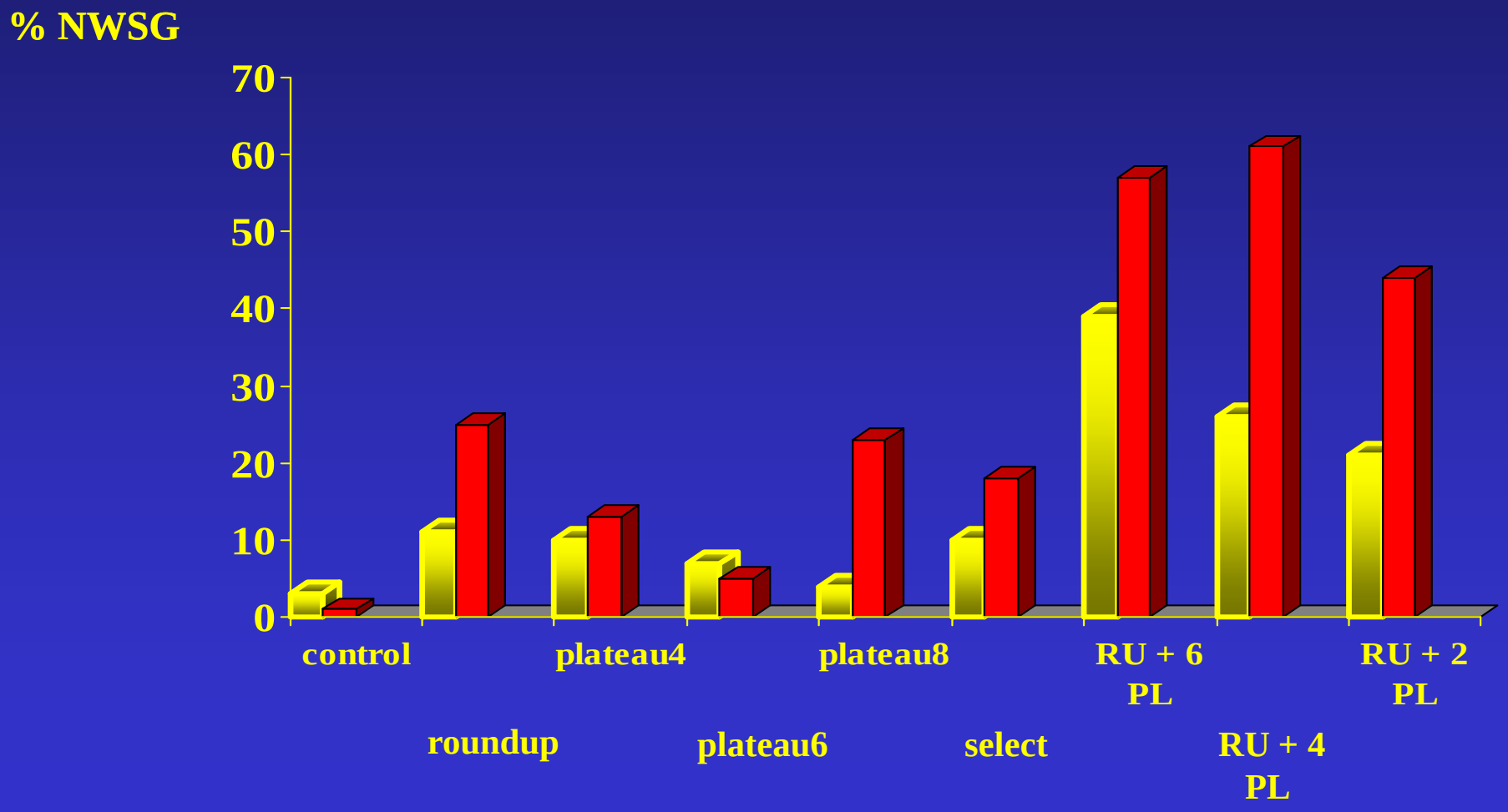
What About Diversity in Forbs?

- Research shows – almost impossible to put forbs in once grass is established in Eastern US (western US different)
- Recommended two – stage seeding:
  - Follow standard protocol with grasses and imazapic tolerant grasses/forbs
  - In fall – second seeding – perpendicular to first with non-tolerant forbs/grasses

Quack Grass Conversion

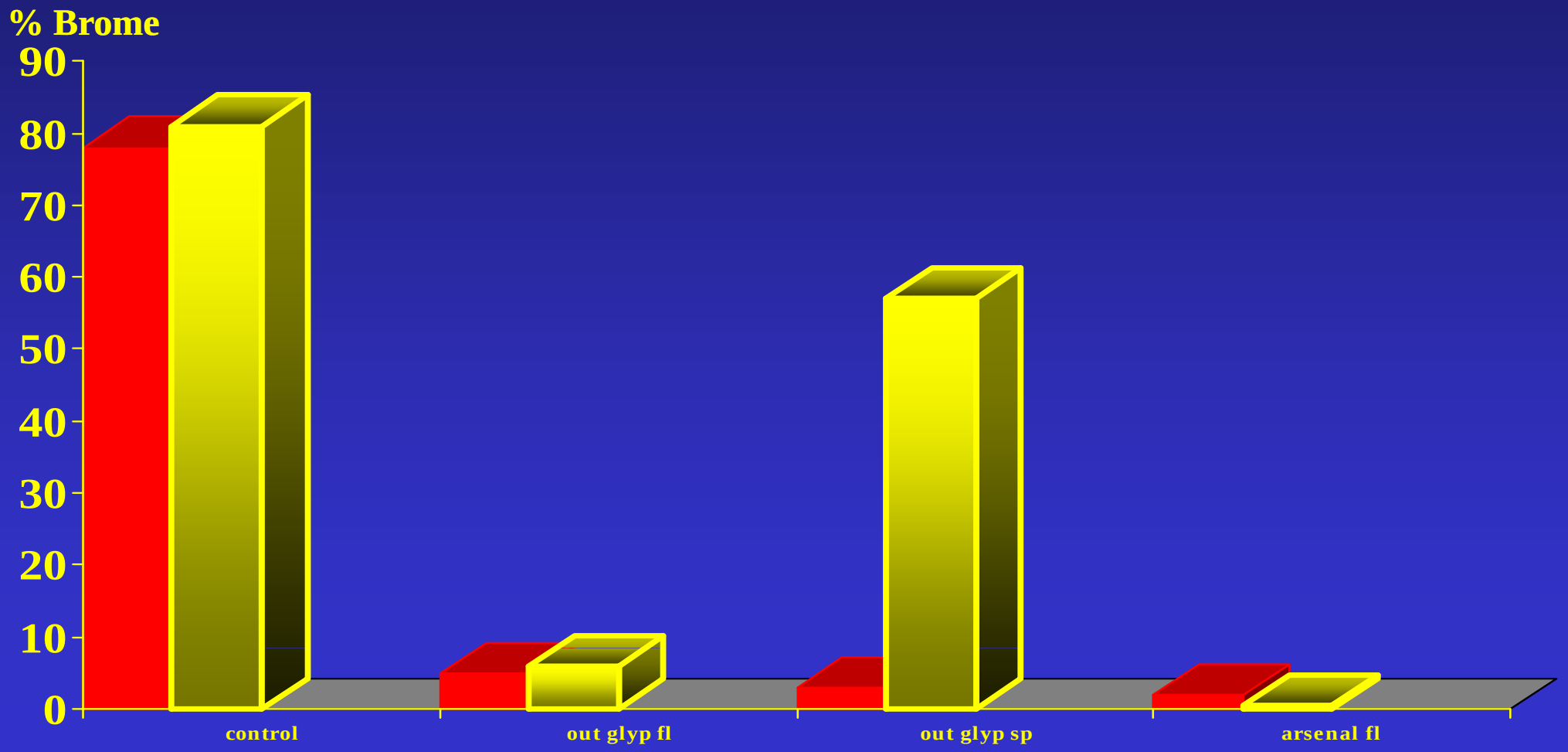
- As an agropyron (wheat grasses) completely tolerant to imazapic
- Find herbicide to control (some evidence that Outrider will work at 2 oz/ac)
- Use 4 – 6 oz imazapic for weed control

Quack Grass Conversion to NWSG

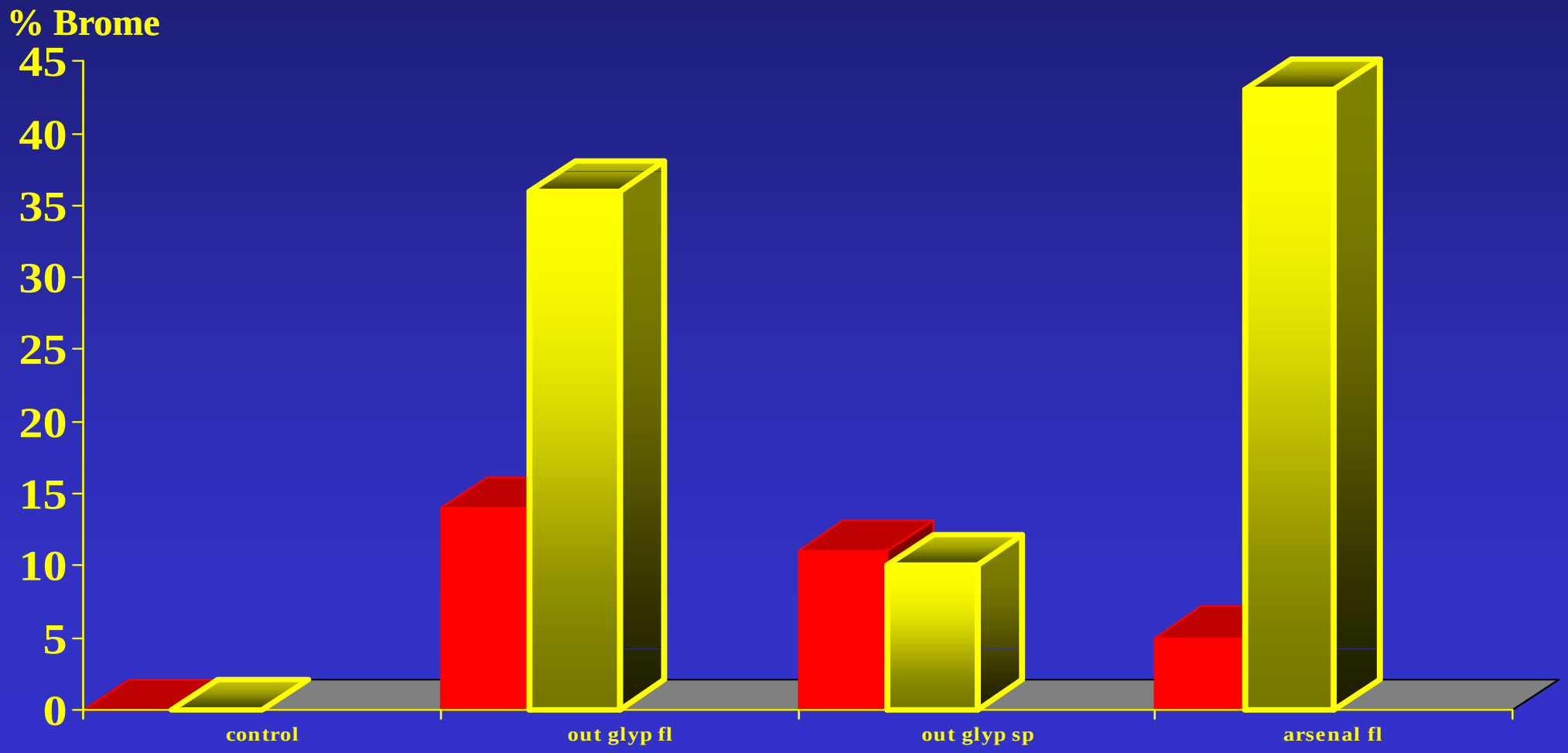


Quack-grass Site
Year Two

Smooth Brome Control
No-till Study



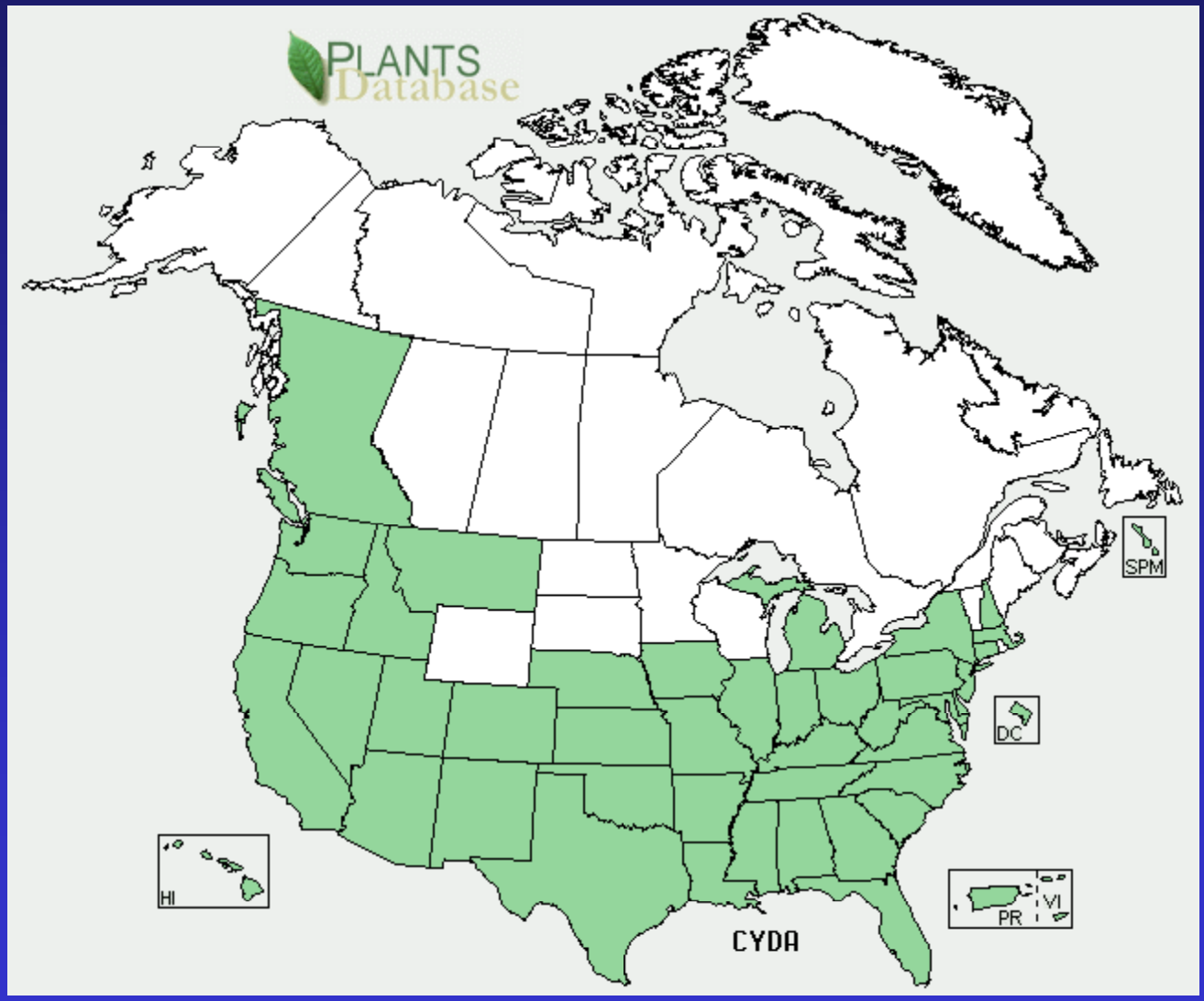
NWSG Response
No-till



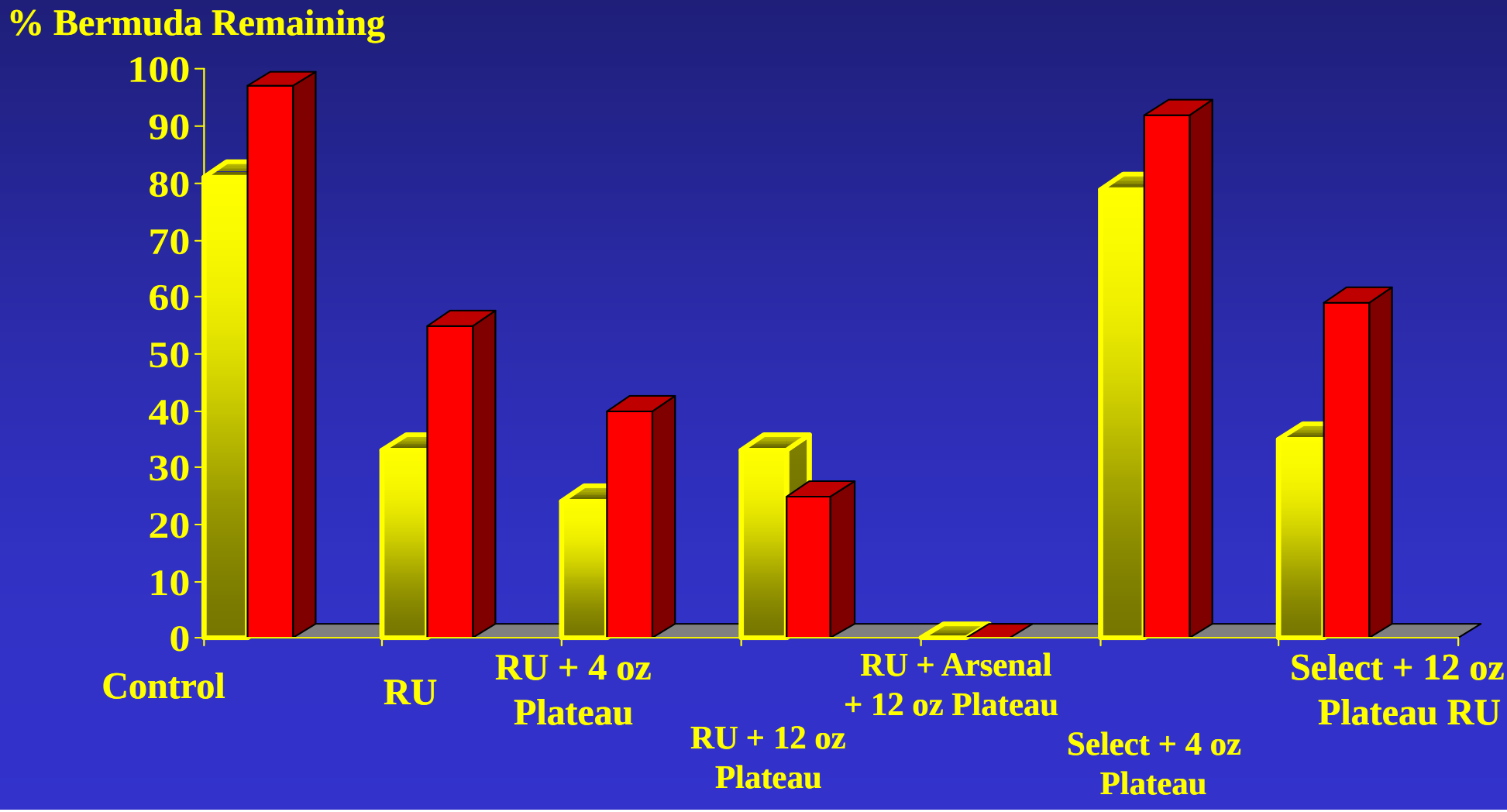
The Really Hard Situations
Exotic Warm Season

- Share a similar physiology to our NWSG & therefore tolerant to many of same herbicides
- Research from South Texas (Welder) showing that ultra-competitive – huge seed rain, seeds stay in seedbank, both above ground & below ground are more competitive than natives, germinate and grow more quickly than natives

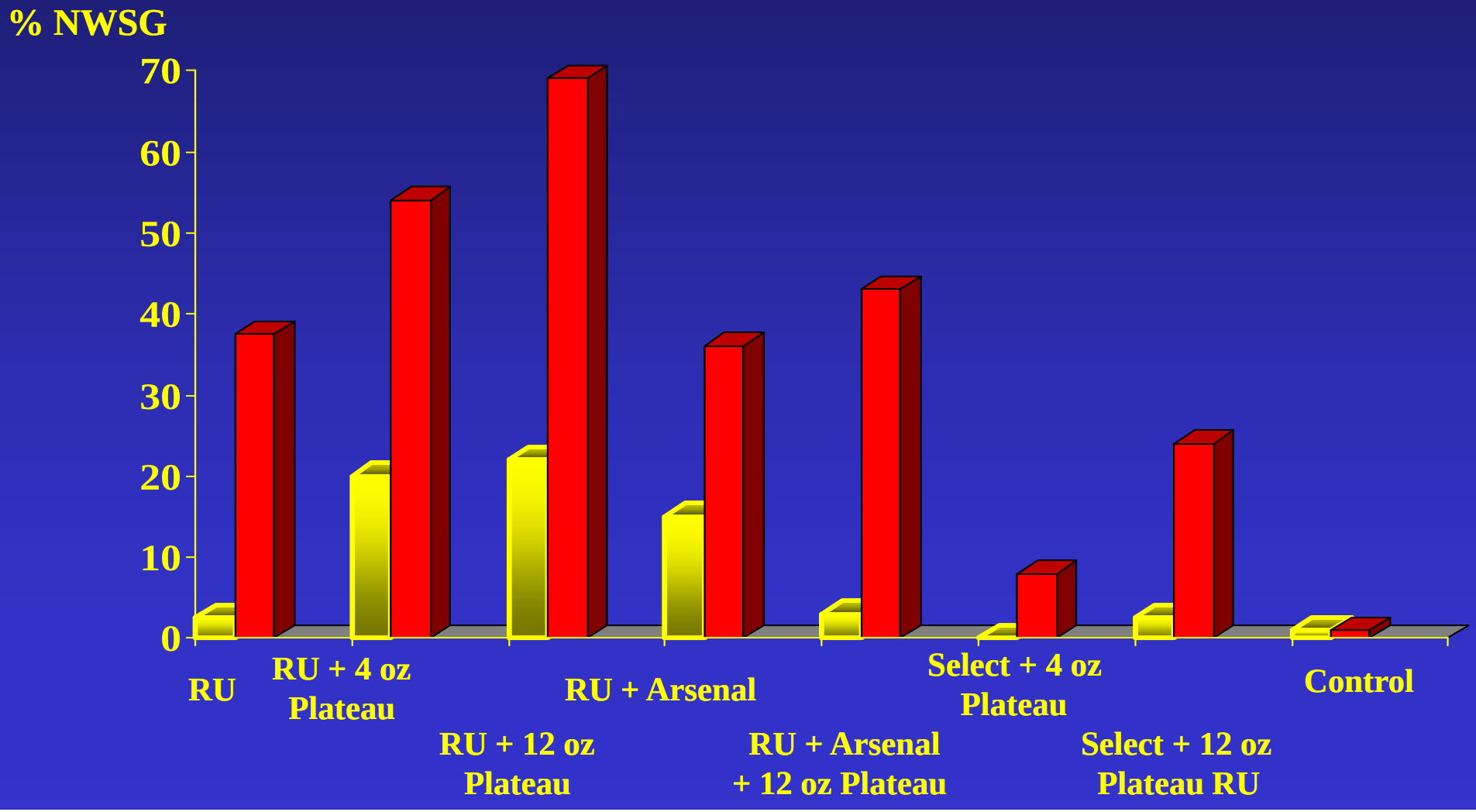
Bermuda Grass



Controlling Common Bermuda Grass



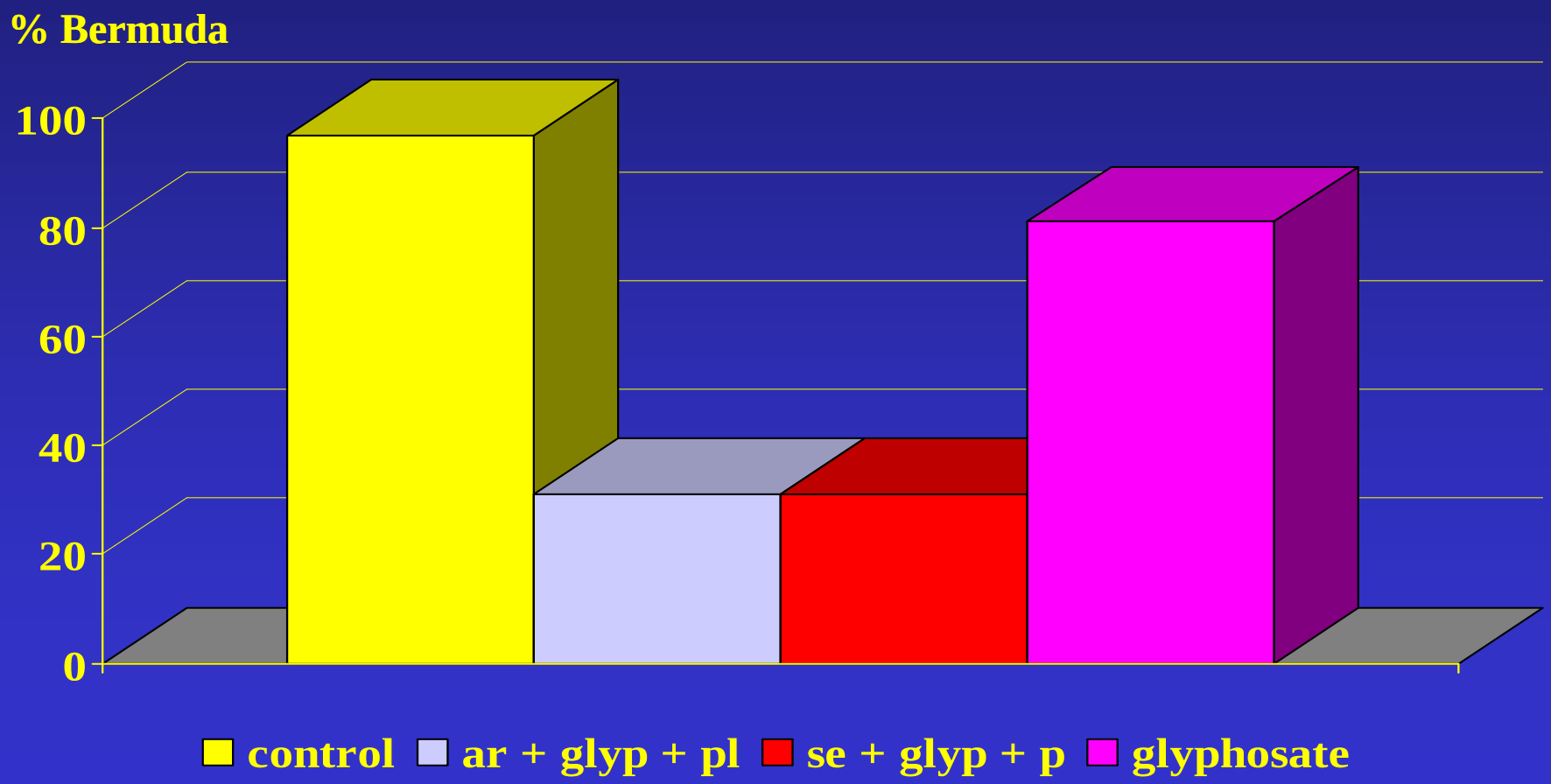
Bermuda Grass Conversion to NWSG



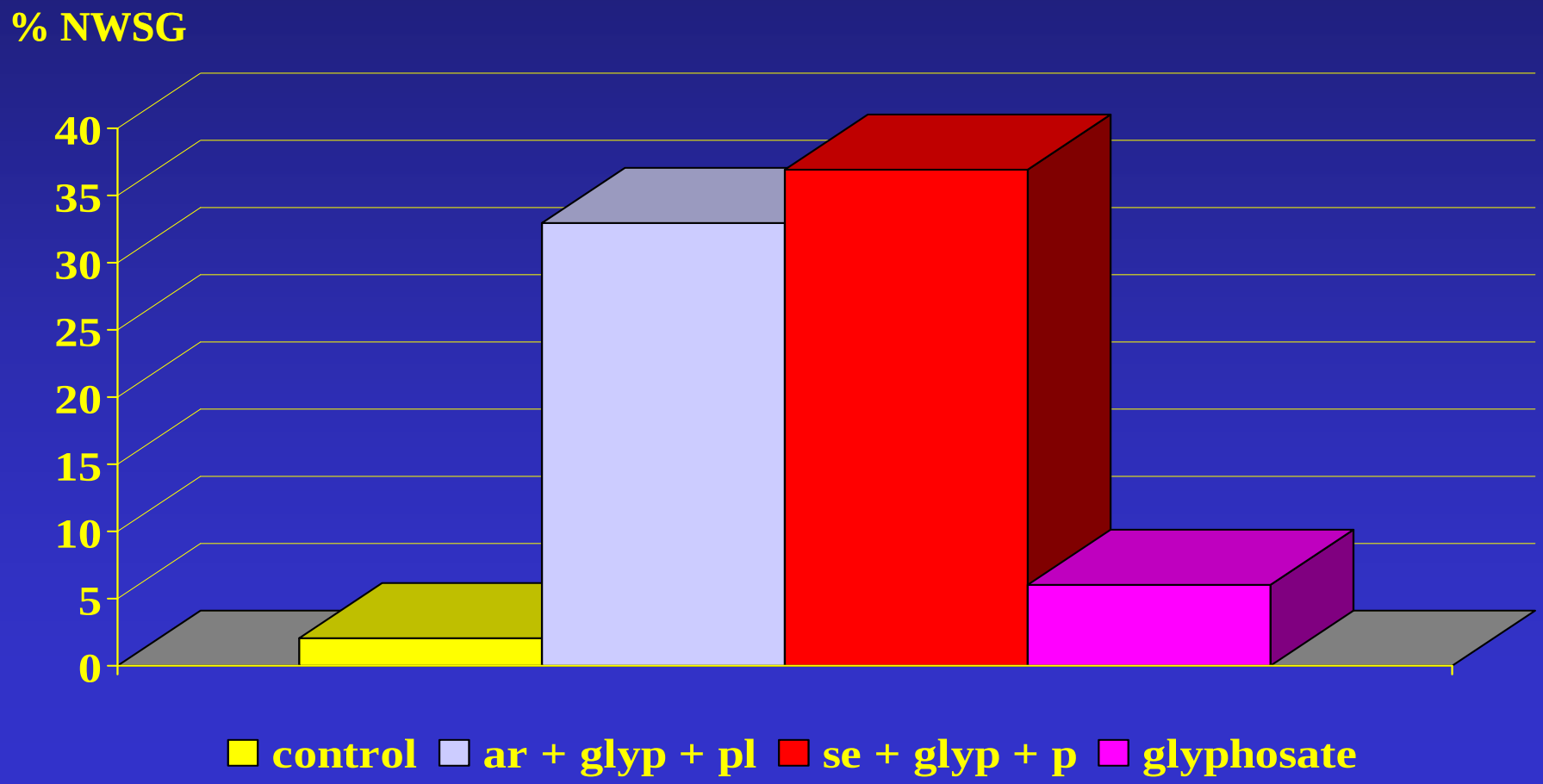
Mixed Planting Bermuda Grass Conversion

2 quarts glyphosate +
12 oz Plateau @ seeding
Year Two – 80% aerial cover

Bermuda Grass Conversion
Study Two: Bermuda

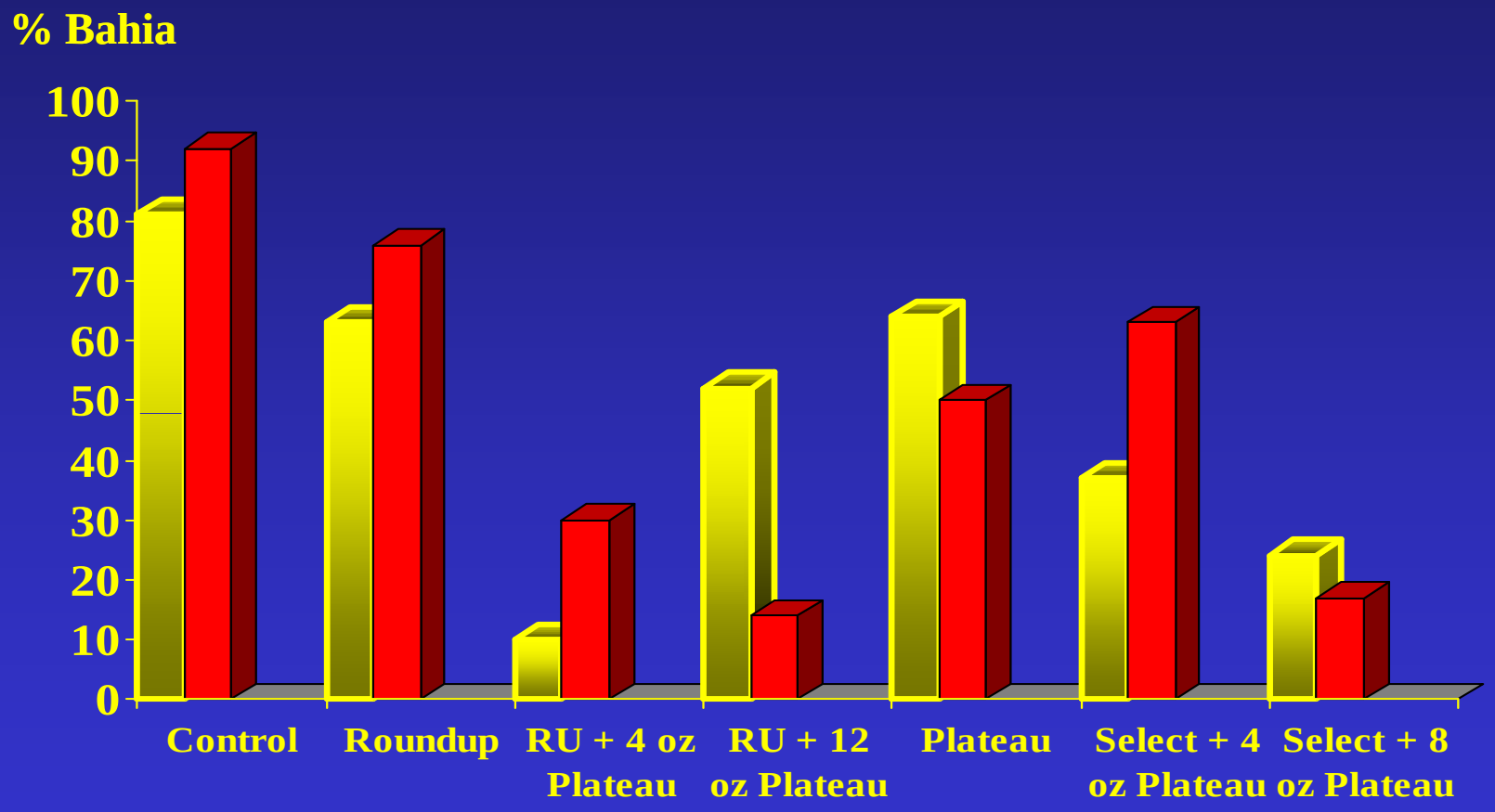


Bermuda Grass Conversion Study Two: NWSG

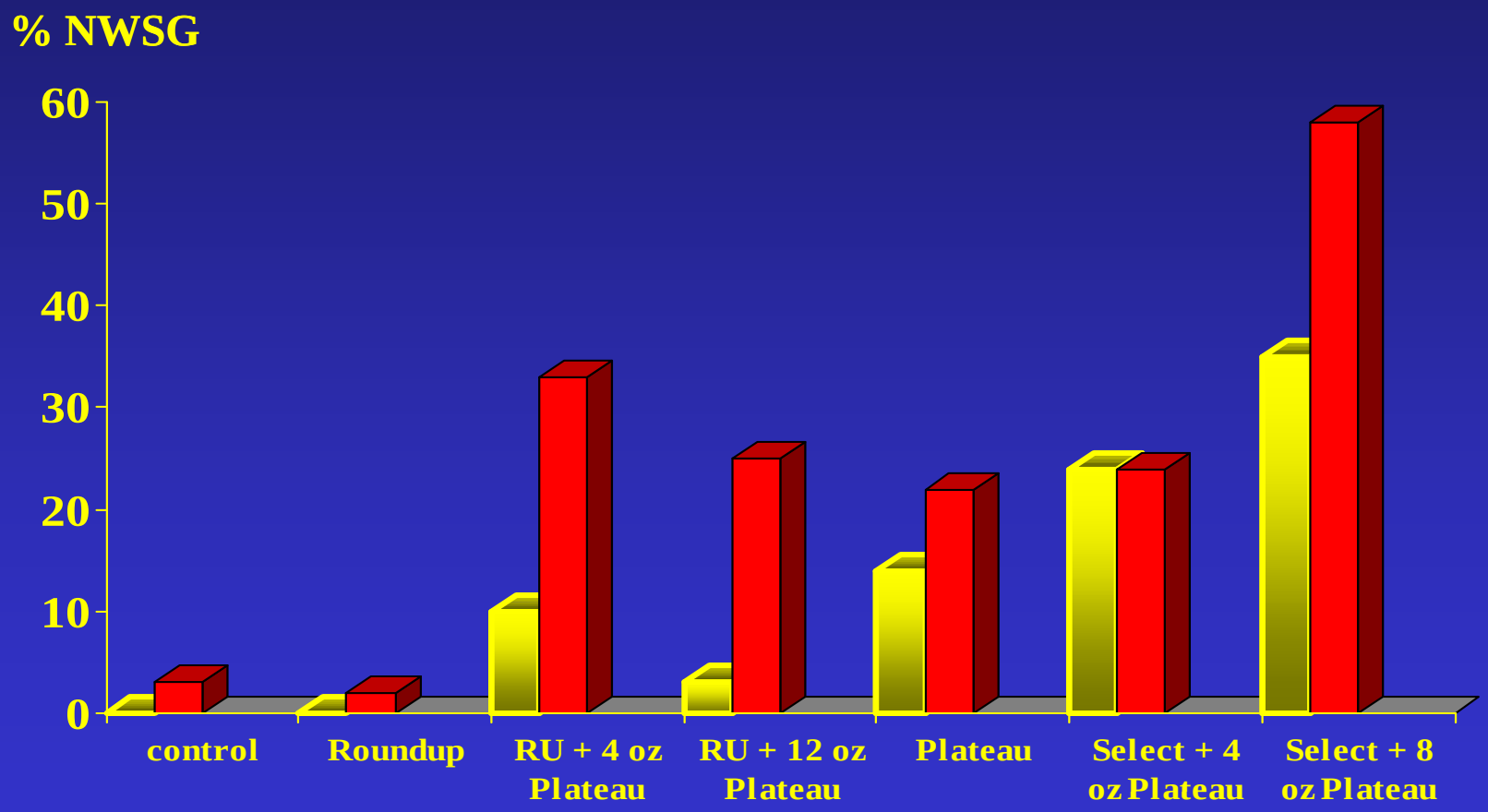


Bahia Grass

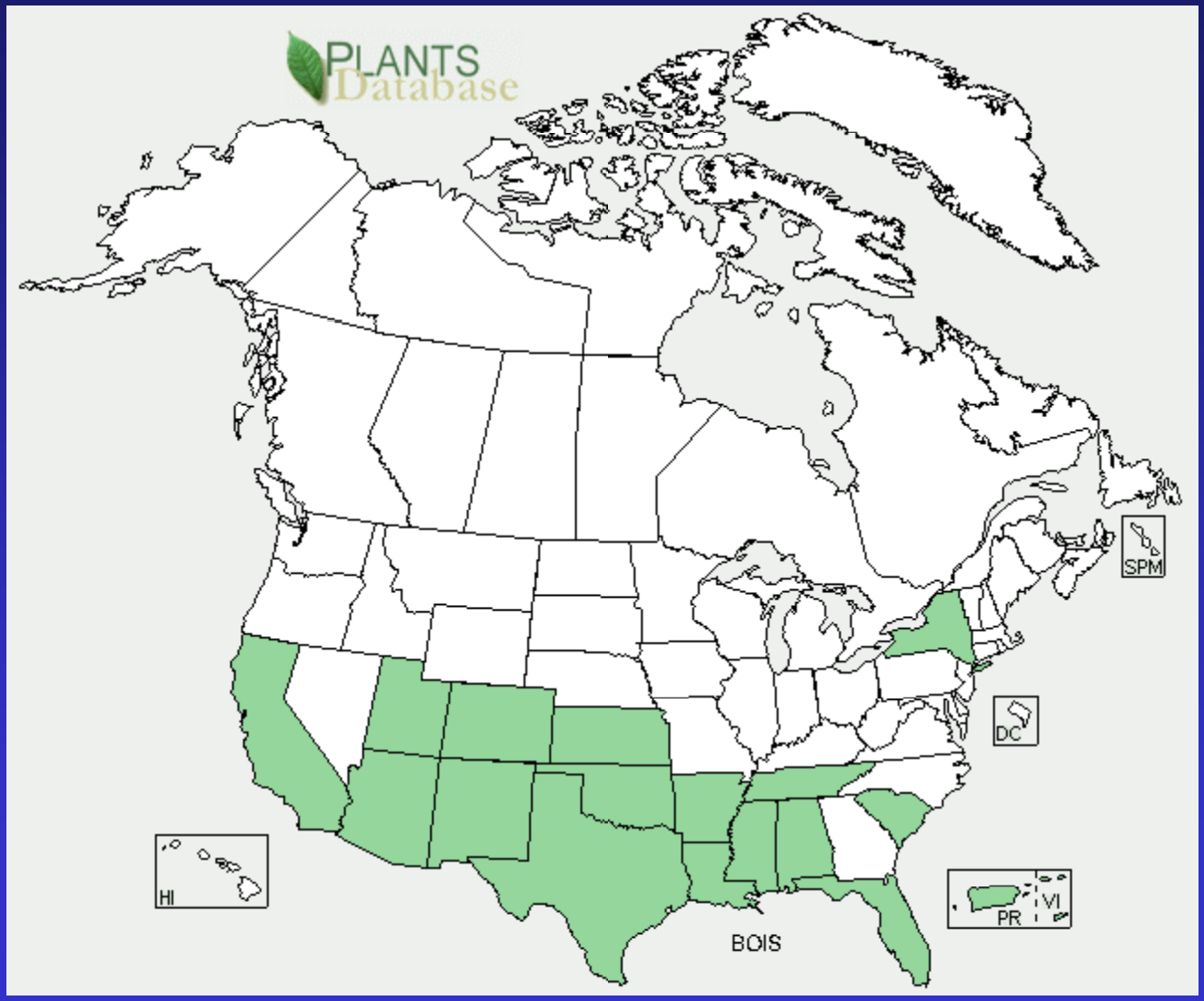
Controlling Bahia Grass



Converting Bahia Grass to NWSG



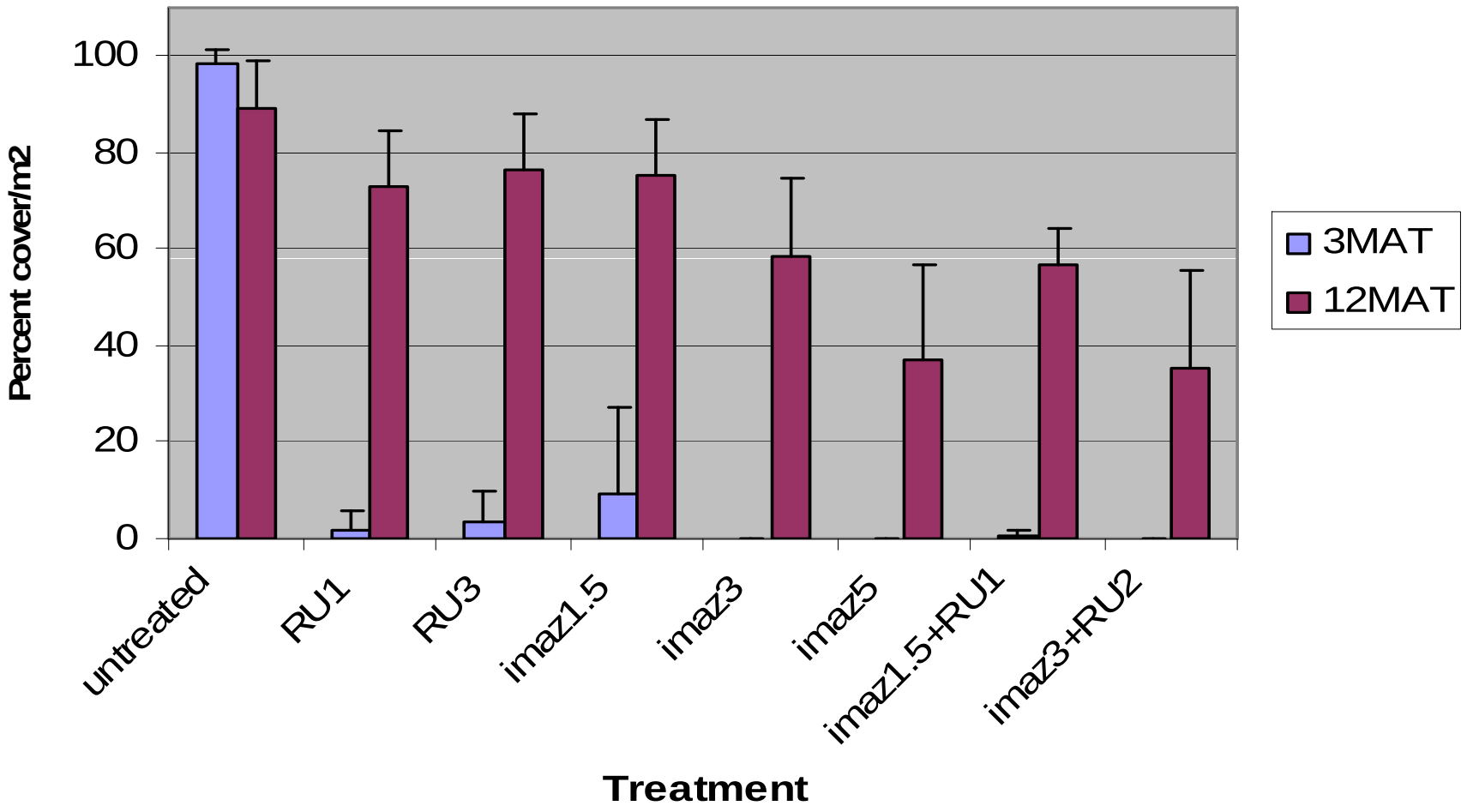
Yellow Bluestem

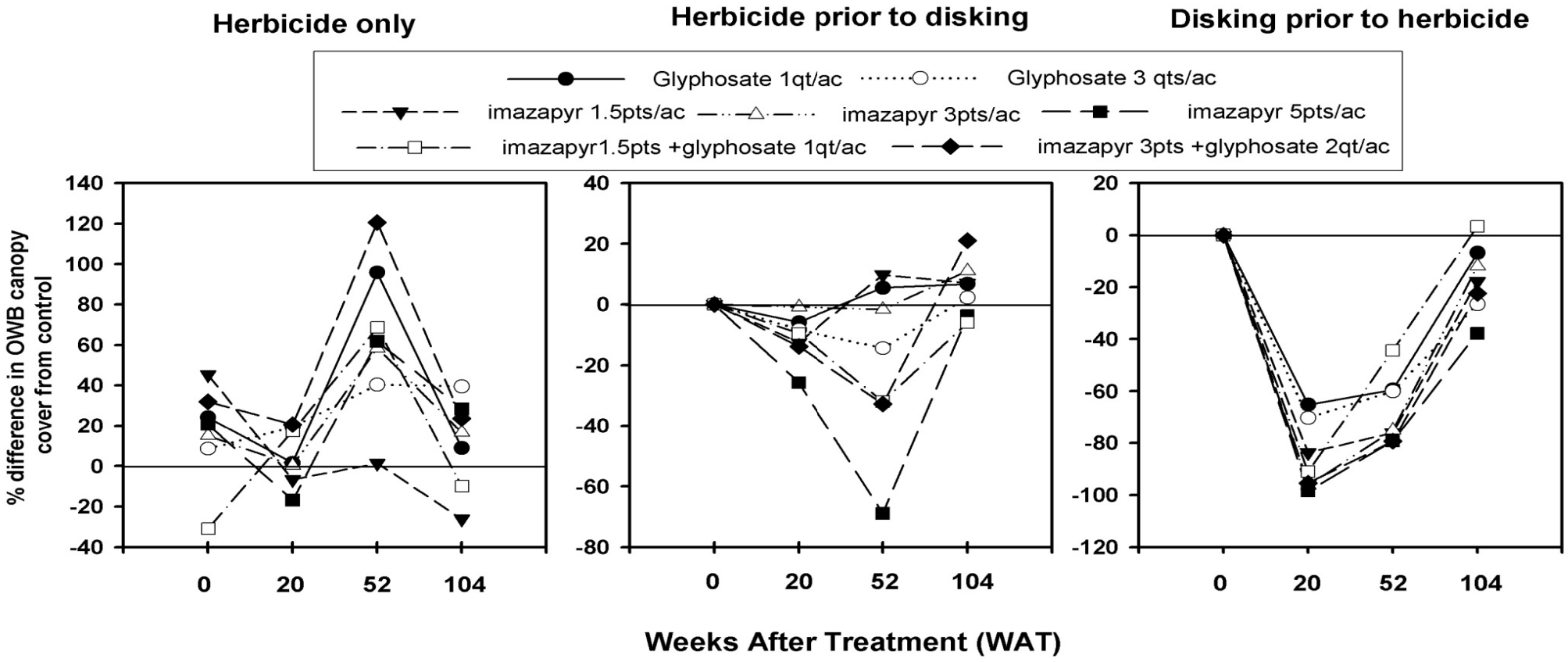


Old World Bluestems

- Untreated check
- Imazapic 0.21 ka ai/ha (12 oz)
- Imazapic + glyphosate 0.32 ai/ha & 0.64 ai/ha (1 pt & 1 qt)
- Imazapyr 0.57 ai/ha & 1.14 ai/ha (1 pt & 1 qt
- Sulfosufuron 0.11 ai/ha (2 oz)
- Chlorosulfuron 0.16 ai/ha (3 oz)

Old World bluestem control on sandy loam soils

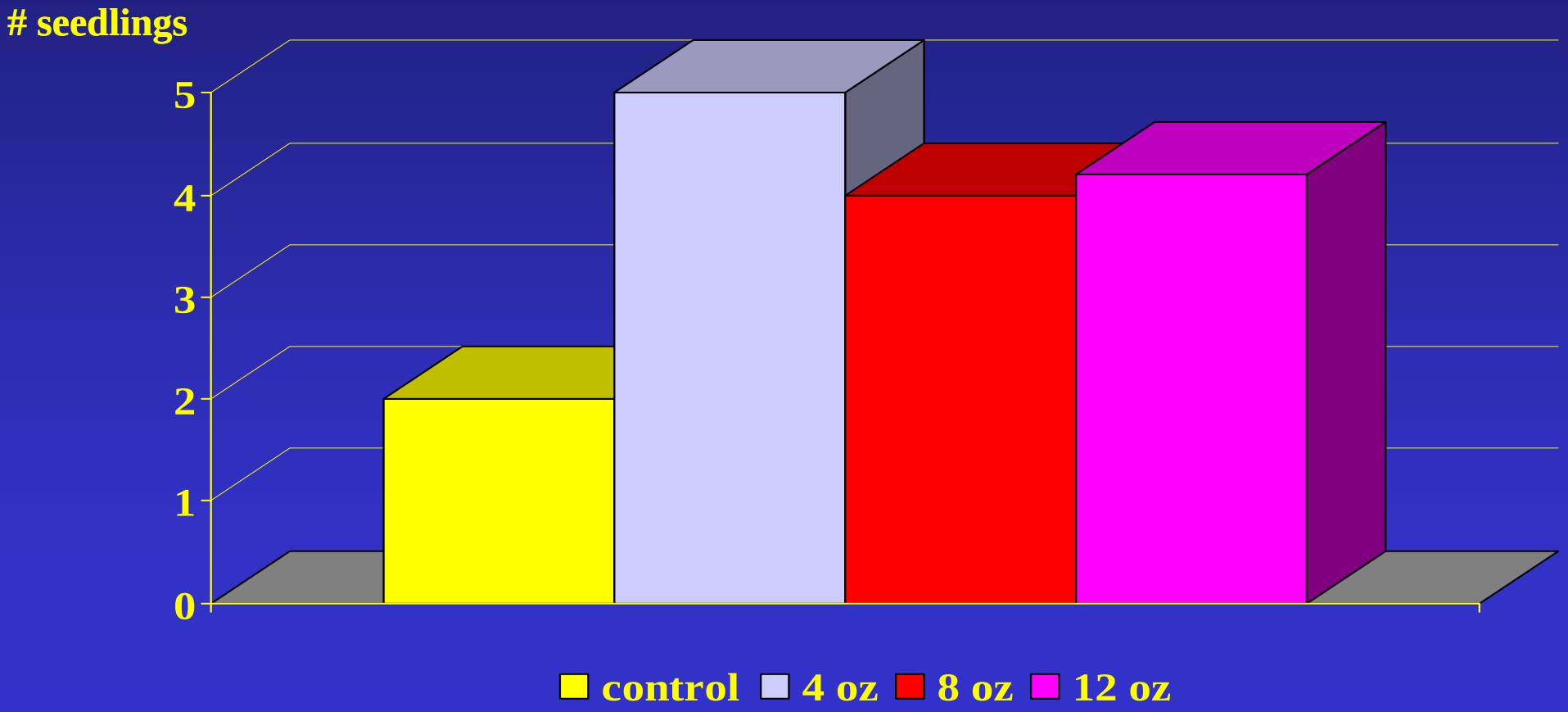



Herbicide only
Herbicide prior to disking
Disking prior to herbicide
Glyphosate 1qt/ac
Glyphosate 3 qts/ac
imazapyr 1.5pts/ac
imazapyr 3pts/ac
imazapyr 5pts/ac
imazapyr1.5pts +glyphosate 1qt/ac
imazapyr 3pts +glyphosate 2qt/ac
% difference in OWB canopy cover from control
Weeks After Treatment (WAT)

Old World Bluestem Study

- Randomized Block With 3 replications
- Disked Fall & Spring
- Spring Application of Glyphosate Prior to Seeding
- Seeded at 3 lbs PLS/acre
- Imazapic Applied @ Seeding at 4, 8, 12 oz/acre

Old World Bluestem Conversion Using Conventional Tillage and Imazapic For Weed Control



Results

- Only got seeded @ half recommended rate
- If at full rate may have been more successful
- At even higher rate may have been able to keep old world bluestems out
- Continuous growing season definitely an issue

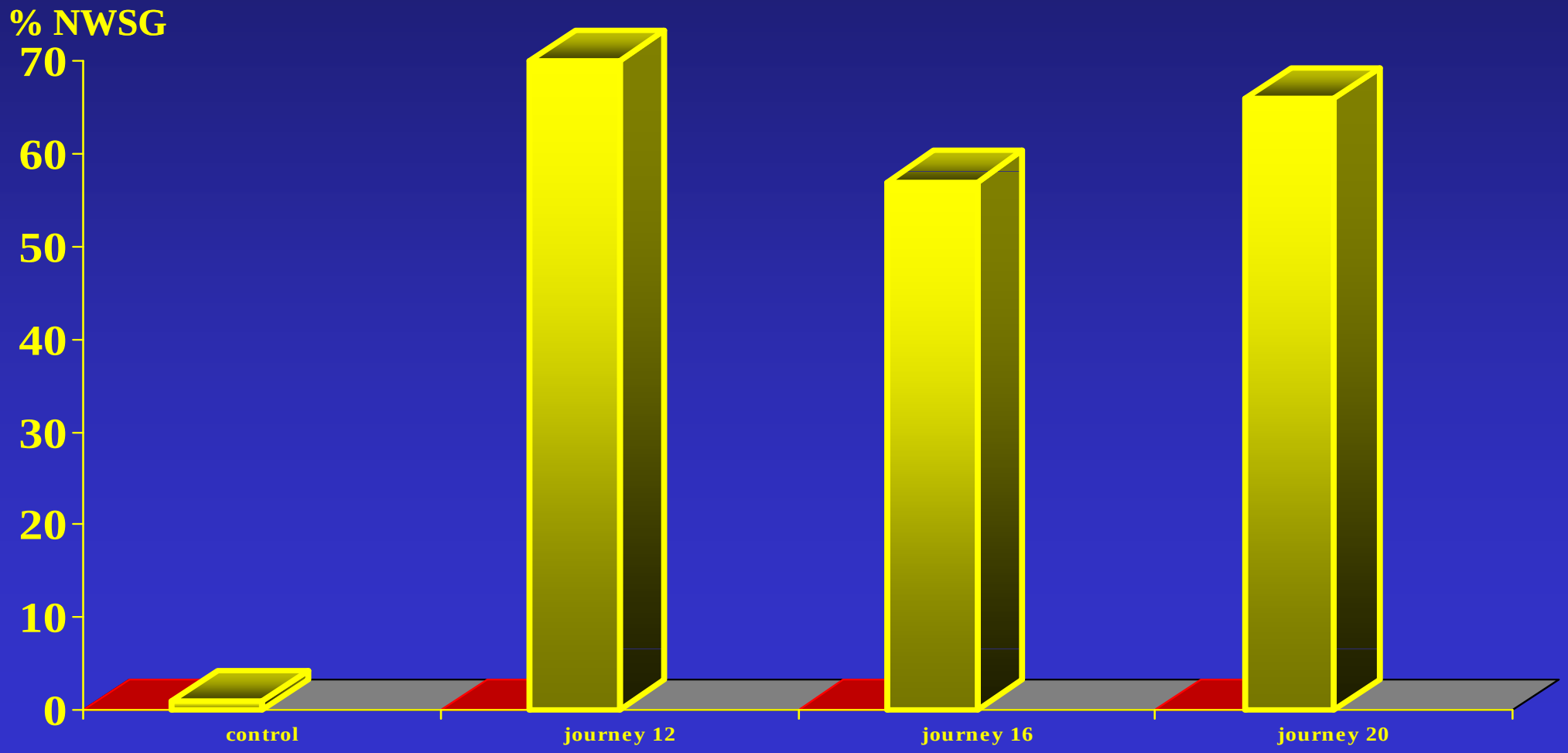
Establishment Using Conventional Tillage

- Prepare seedbed
- Cultipack or roll
- Seed
- Cultipack or roll
- Apply 4 – 6 oz Plateau

Data Supporting Recommendations

Trtmt	Little Bluestem	Big Bluestem	Indian grass
	(plants/sq meter)		
Control	4	7	7
4 oz	17	20	19
8 oz	14	15	21
12 oz	18	16	14

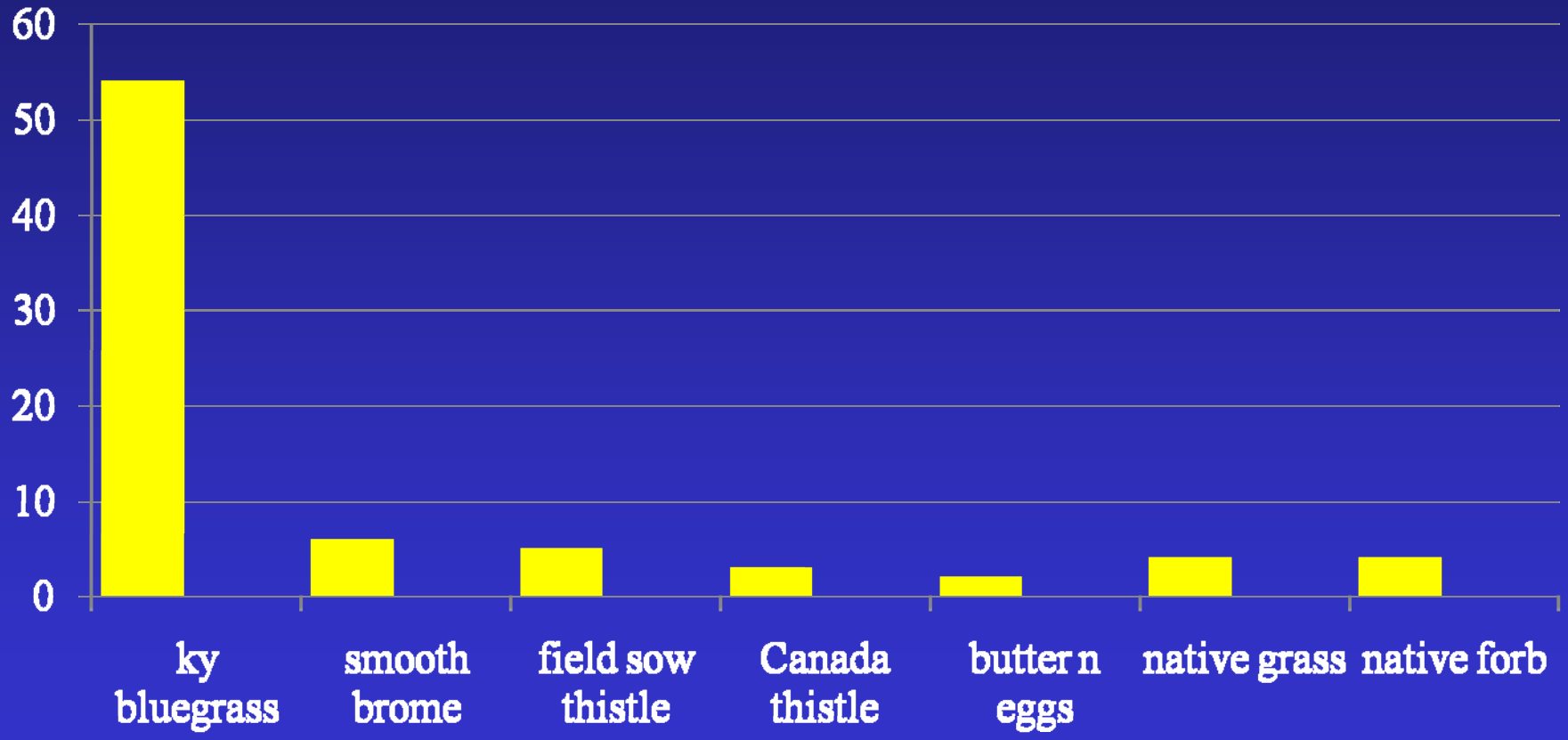
Seeding Into Soybean Stubble



What is a healthy grassland?

- **Integrity of soil and ecological processes are sustained**
- **Dominated by native species**
  - **Our research fits in**

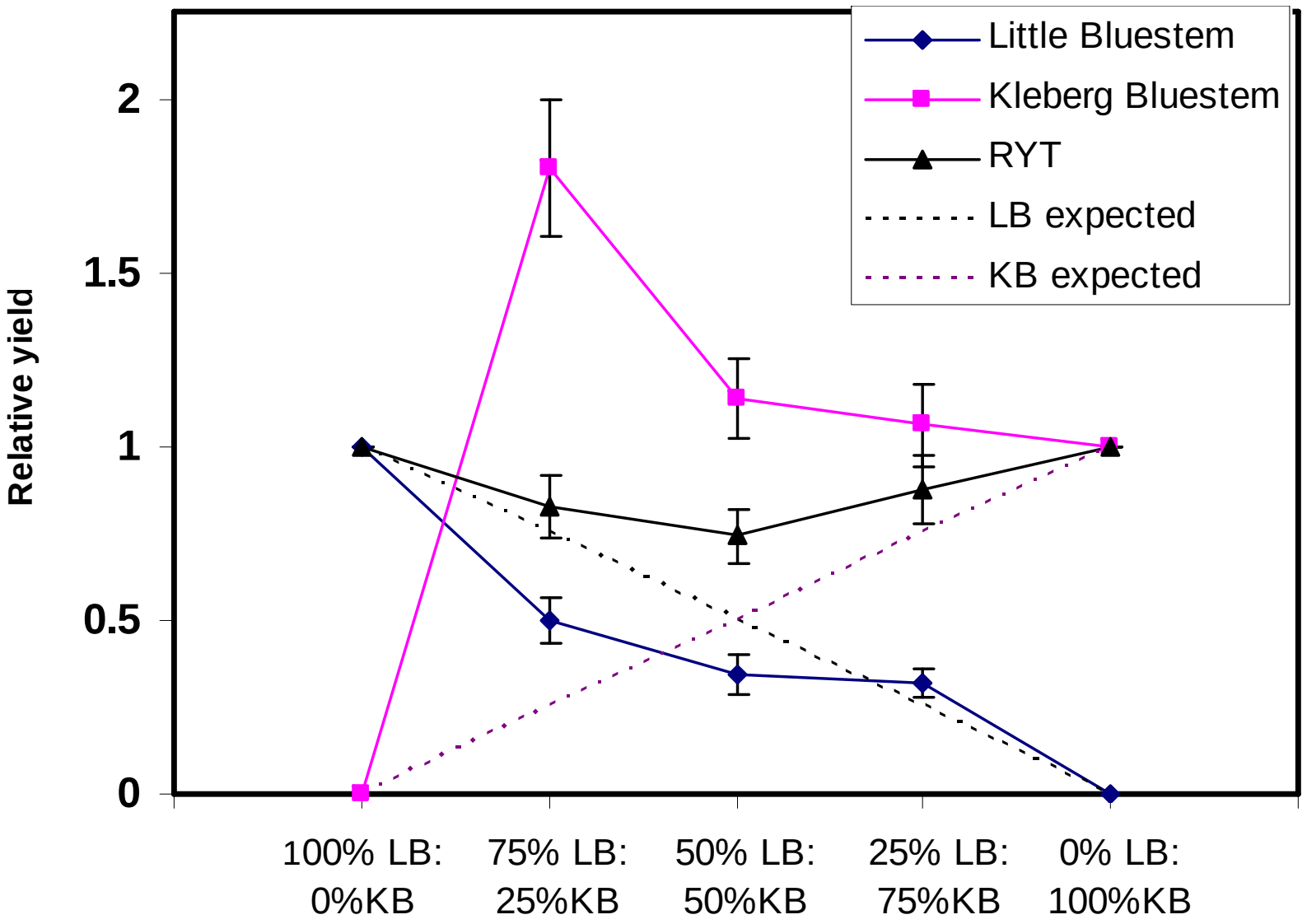
Seedbank Smooth Brome Release Study
216 soil cores, 1243 seedlings

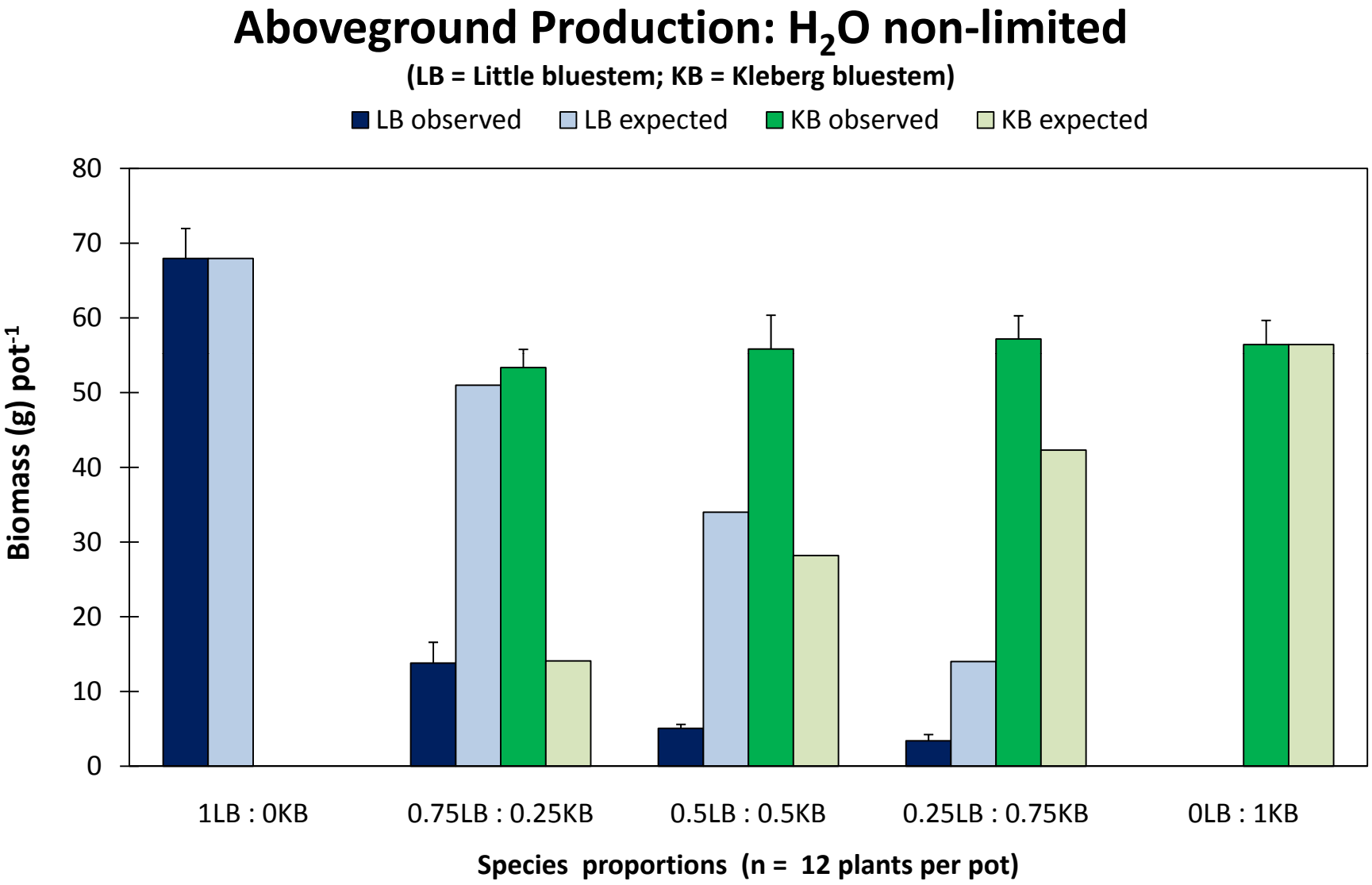


Old World Bluestem Seedbank Study

Grass species	No. germinable seeds in soil	
	Total	**Mean**
Dichanthium annulatum **(Kleberg bluestem)**	**32.7 ± 9.2**	**3.3 ± 0.9**
Dichanthium aristatum **(Angleton bluestem)**	**690 ± 102.9**	**69 ± 10.3**
Native grasses	**1.7 ± 1.2**	**0.17 ± 0.12**

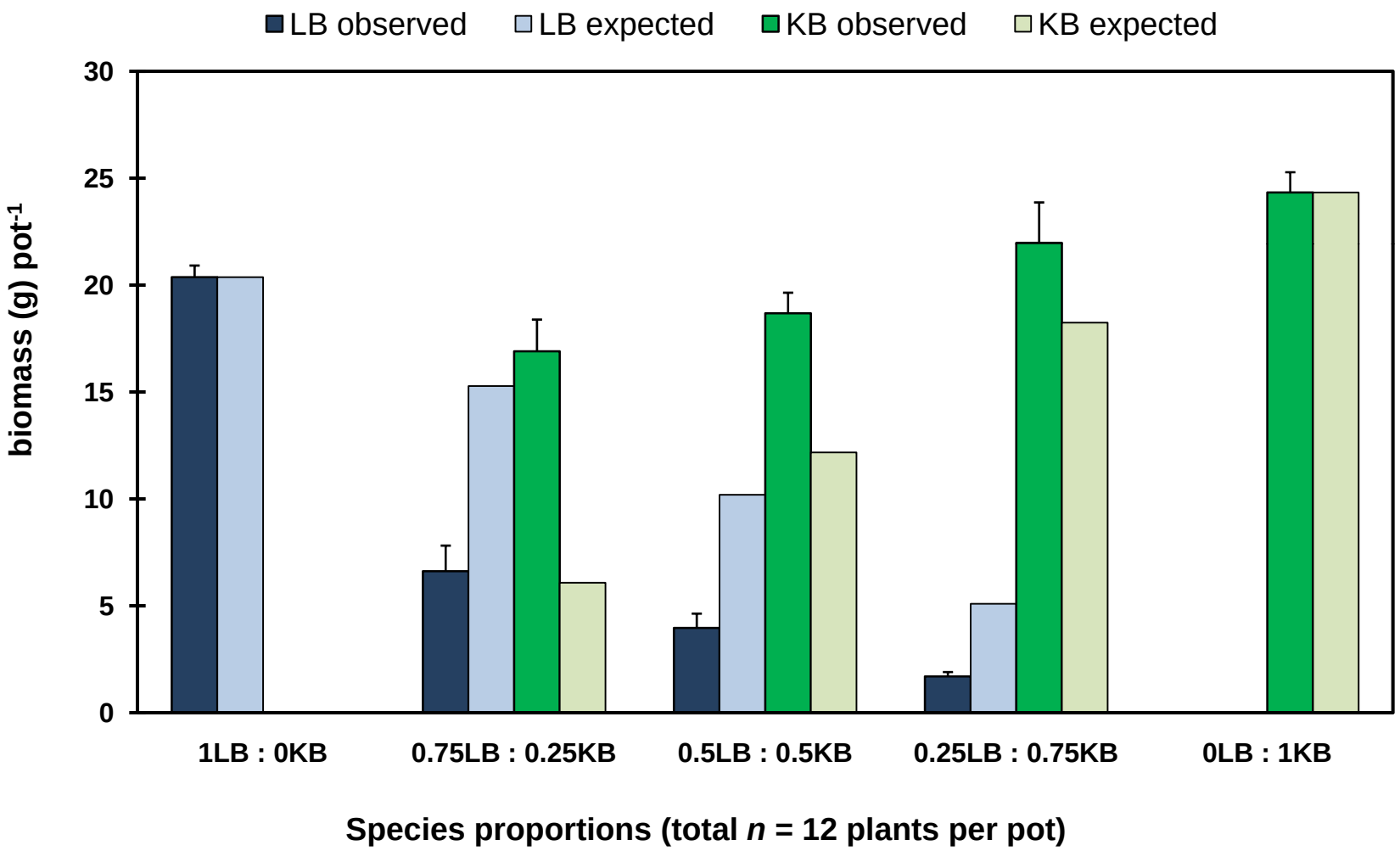
12 plants/pot

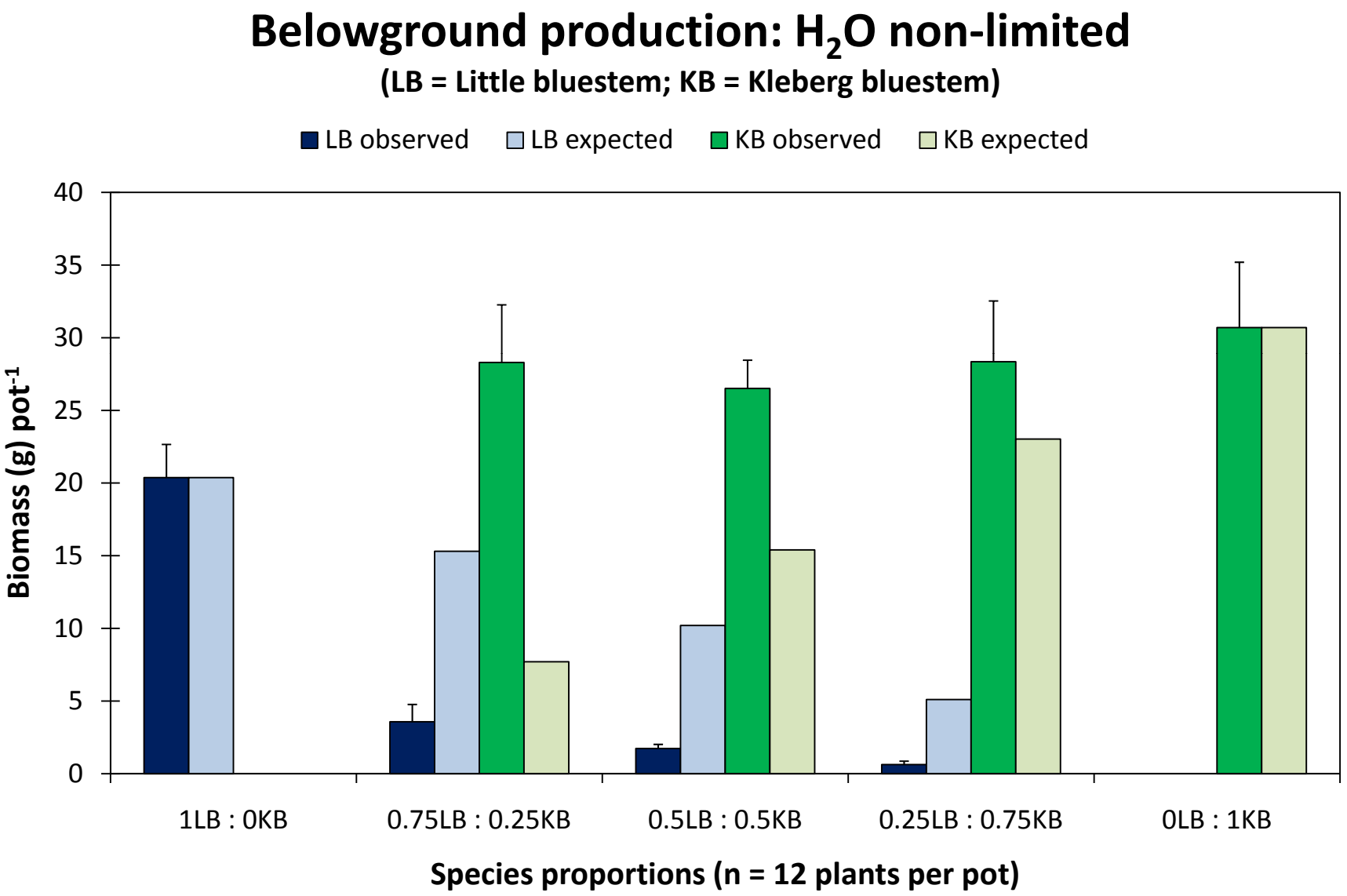



Aboveground Production: H2O non-limited
(LB = Little bluestem; KB = Kleberg bluestem)
LB observed
LB expected
KB observed
KB expected
Biomass (g) pot-1
80
70
60
50
40
30
20
10
0
1LB : 0KB
0.75LB : 0.25KB
0.5LB : 0.5KB
0.25LB : 0.75KB
0LB : 1KB
Species proportions (n = 12 plants per pot)

Aboveground Production: H_2O limited

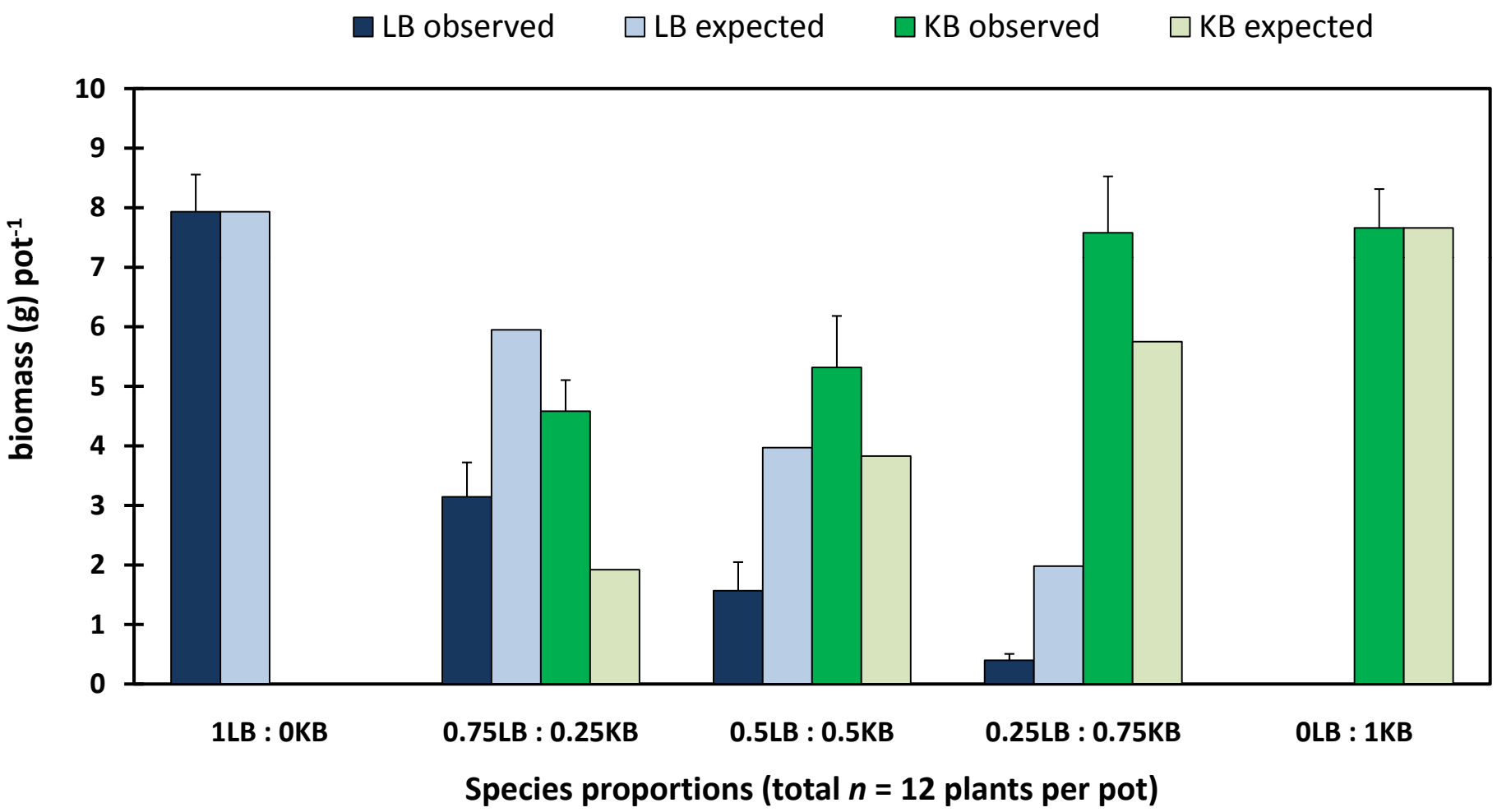
(LB = Little bluestem; KB = Kleberg bluestem)

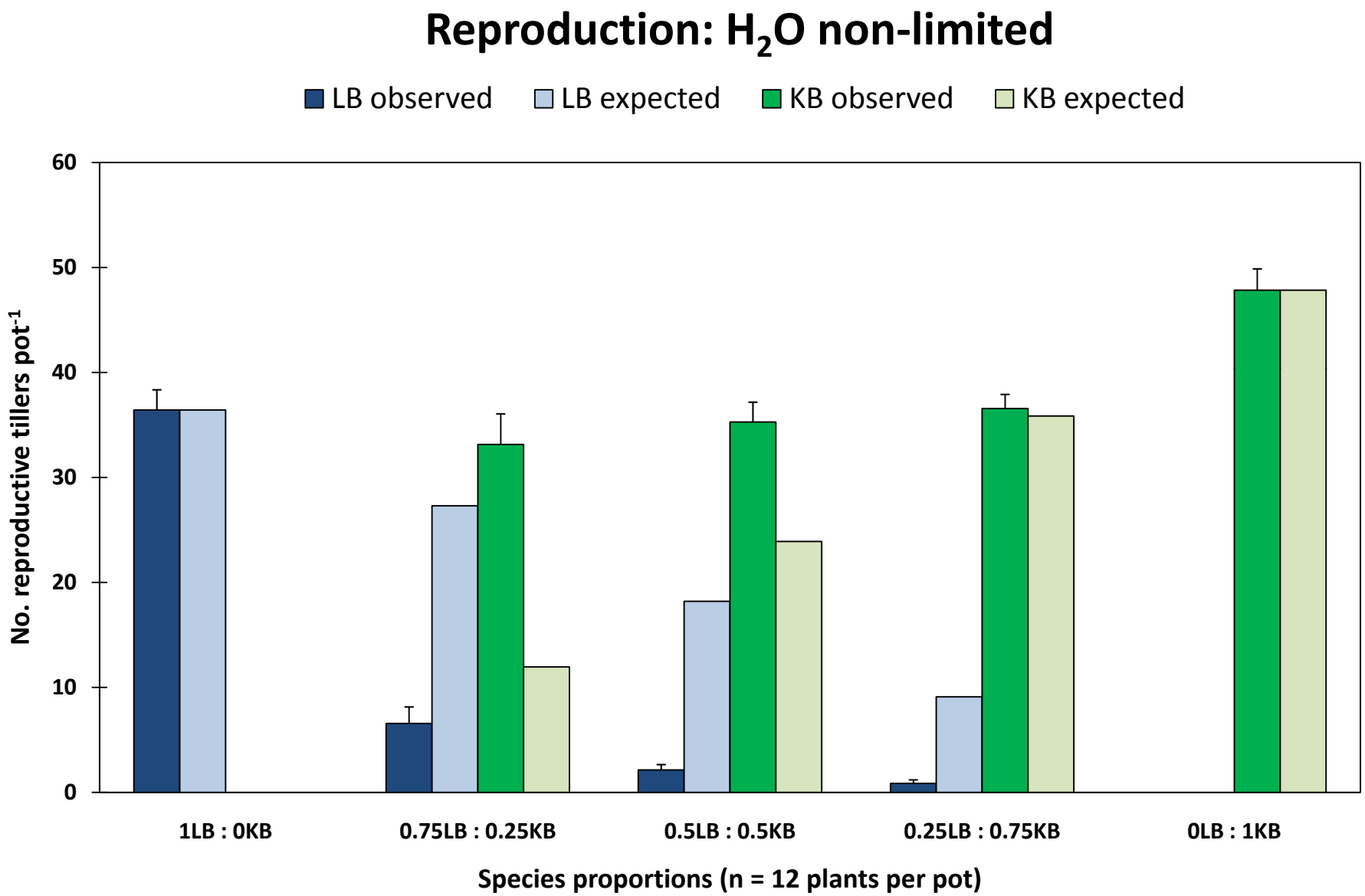


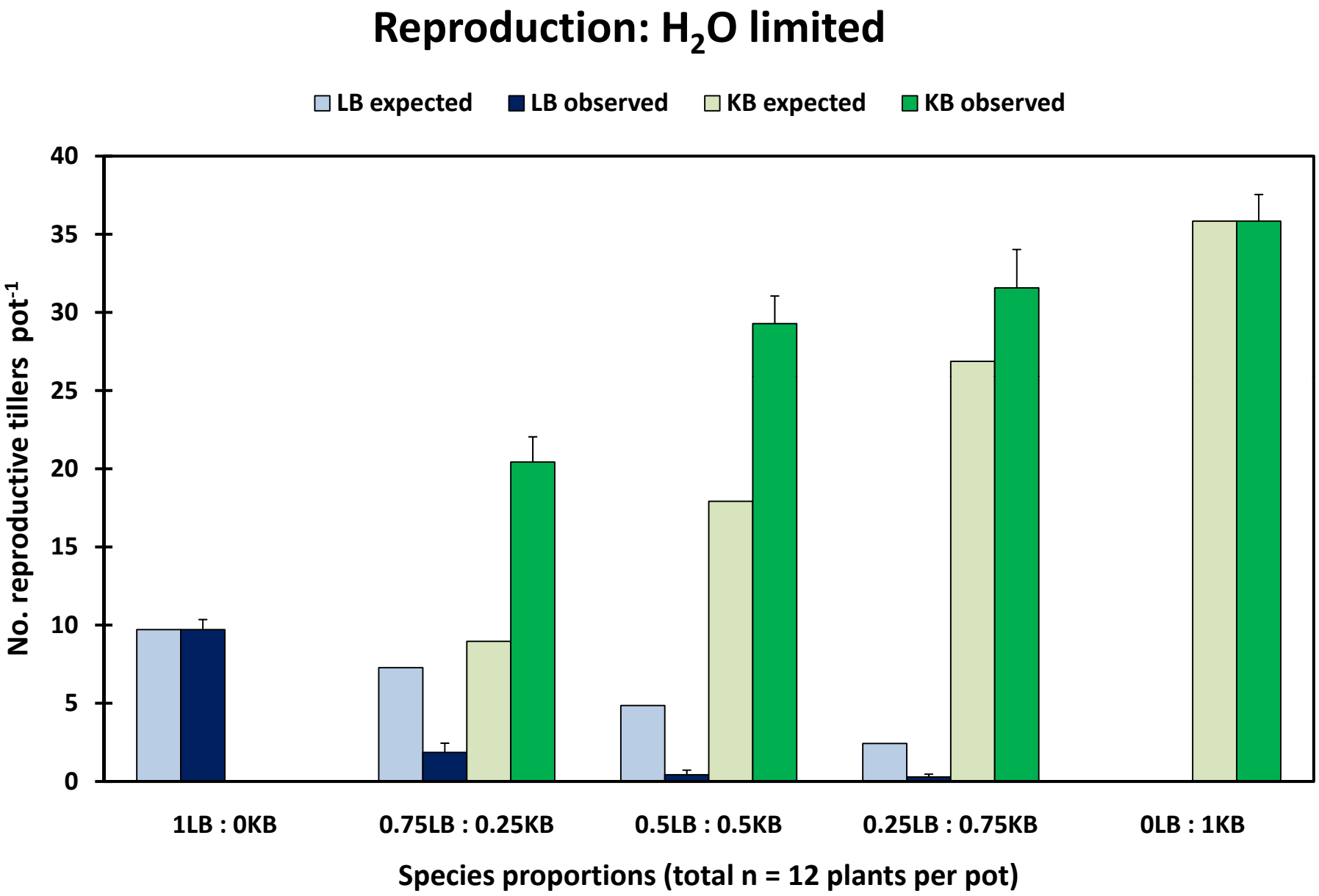

Belowground production: H2O non-limited
(LB = Little bluestem; KB = Kleberg bluestem)
LB observed
LB expected
KB observed
KB expected
Biomass (g) pot-1
40
35
30
25
20
15
10
5
0
1LB : 0KB
0.75LB : 0.25KB
0.5LB : 0.5KB
0.25LB : 0.75KB
0LB : 1KB
Species proportions (n = 12 plants per pot)

Belowground production: H_2O limited

(LB = Little bluestem; KB = Kleberg bluestem)




Reproduction: H2O non-limited
LB observed
LB expected
KB observed
KB expected
No. reproductive tillers pot-1
60
50
40
30
20
10
0
1LB : 0KB
0.75LB : 0.25KB
0.5LB : 0.5KB
0.25LB : 0.75KB
0LB : 1KB
Species proportions (n = 12 plants per pot)


Reproduction: H2O limited
LB expected
LB observed
KB expected
KB observed
No. reproductive tillers pot-1
40
35
30
25
20
15
10
5
0
1LB : 0KB
0.75LB : 0.25KB
0.5LB : 0.5KB
0.25LB : 0.75KB
0LB : 1KB
Species proportions (total n = 12 plants per pot)

Summary

- Burning alone will not kill most exotic grasses & herbicides may “speed up” restoration or conversion process
- Herbicides can be used to “restore, rehabilitate, or recreate” native grasslands
- Keys to success are to properly evaluate system and weed pressures
- Make a decision to release natives or start over with seeding
- Using the appropriate herbicide, rate, and timing to accomplish your goal
- If seeding, do-not put seed into ground until the exotic grasses have been eliminated
- Weed control is absolutely essential

Acknowledgements

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Questions?

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