

Impact of Reduced Lignin or Ferulate Crosslinking on Fitness of Temperate Grasses



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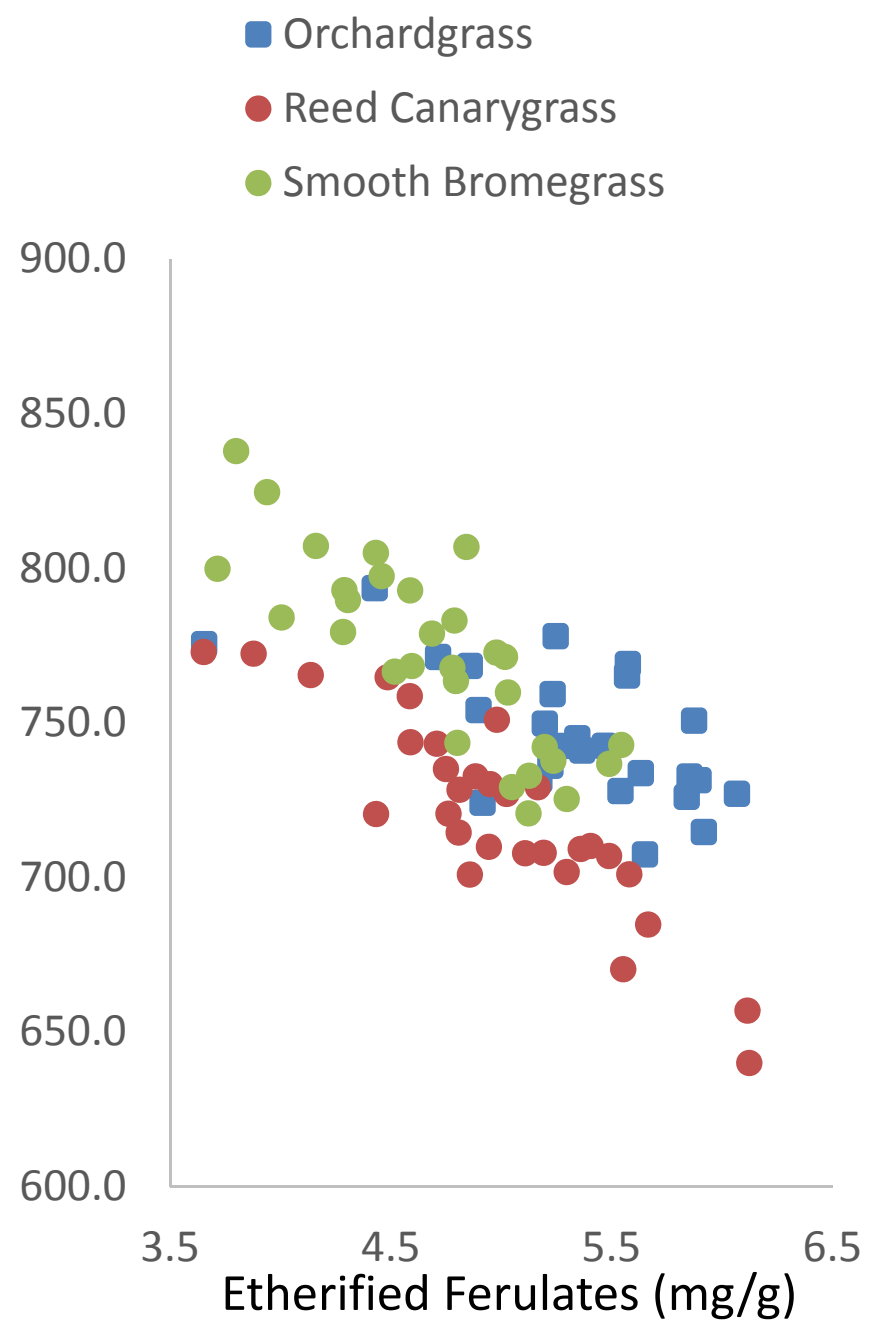
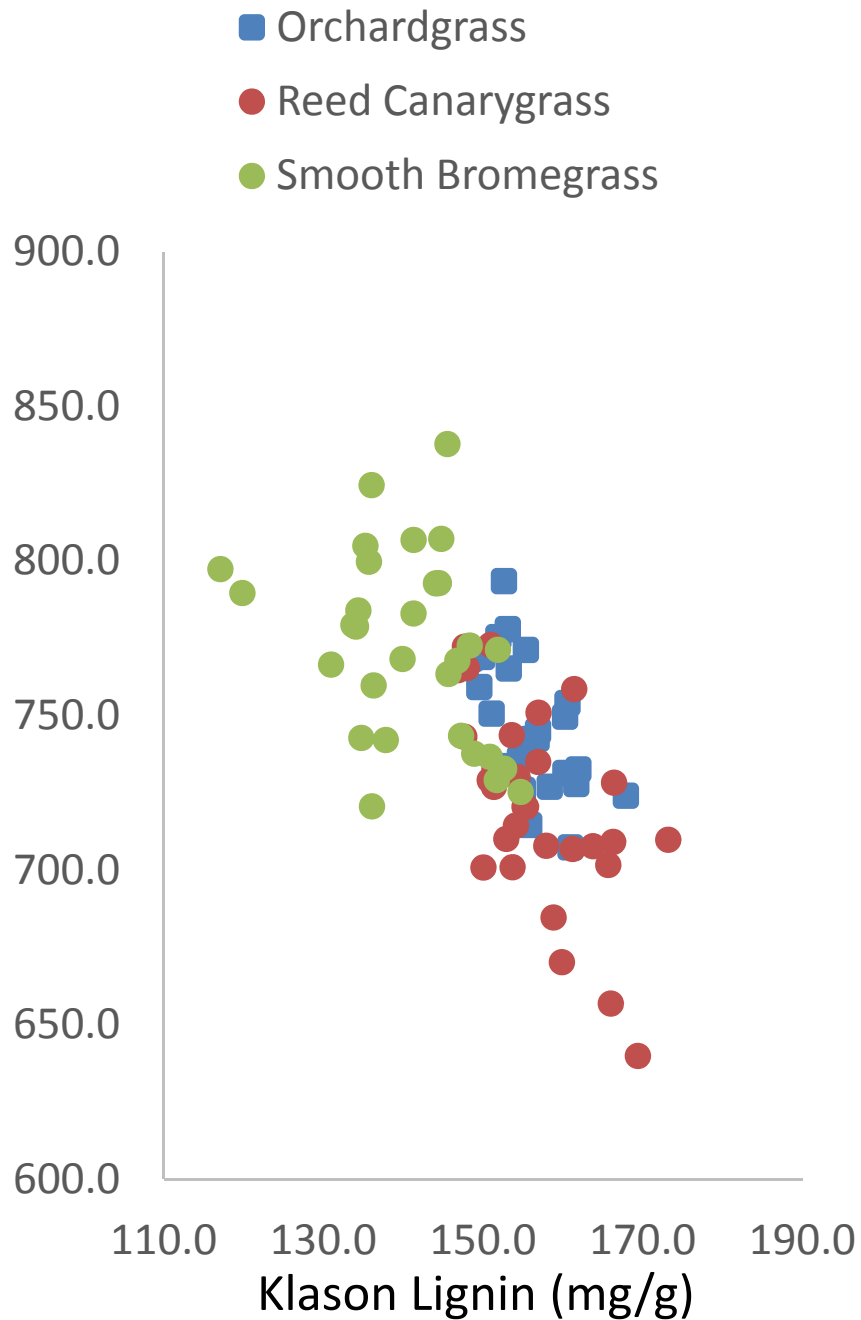
Orchardgrass
(*Dactylis
glomerata*)

Reed Canarygrass
(*Phalaris
arundinacea*)

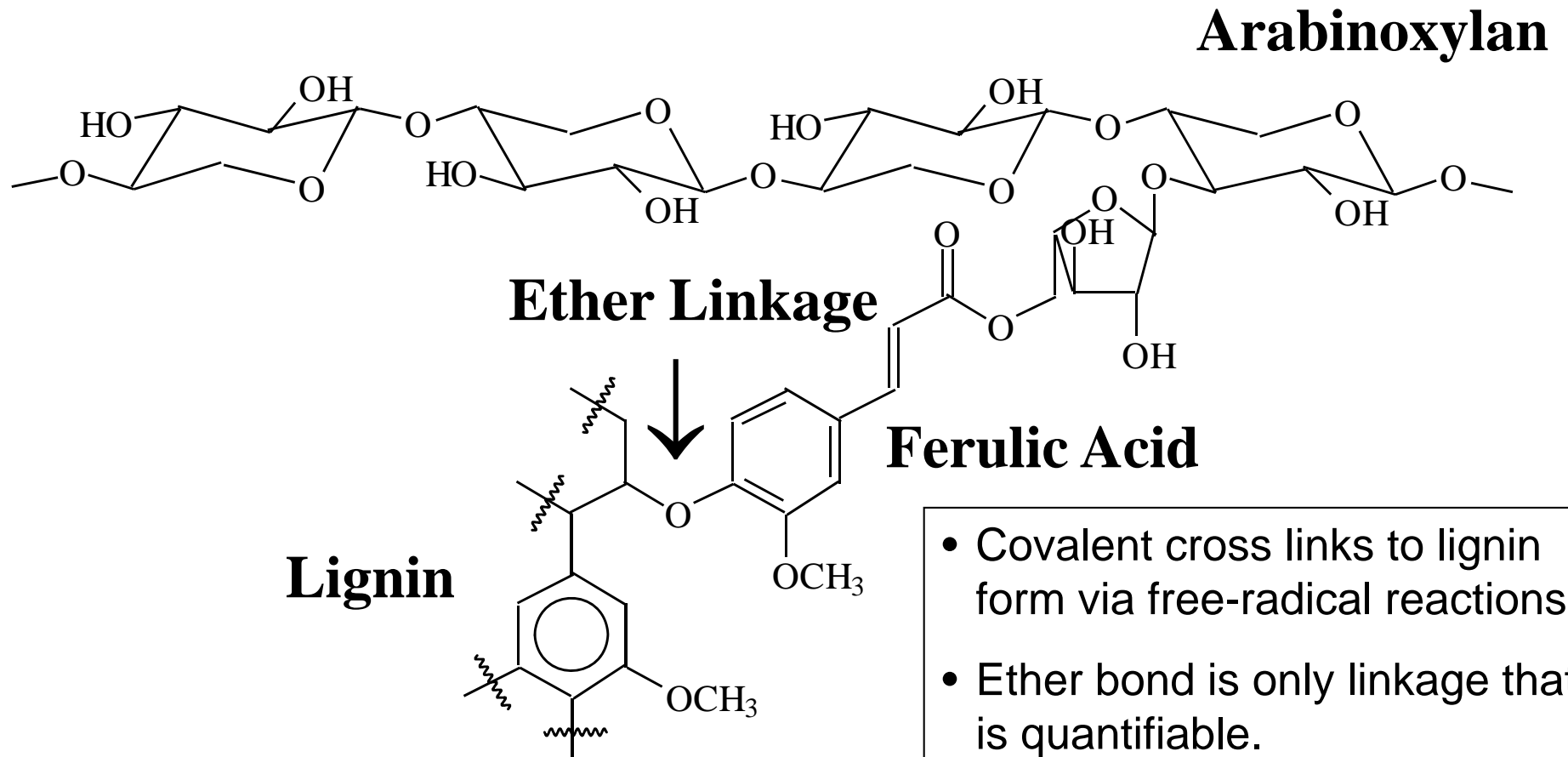
Smooth
Bromegrass
(*Bromus inermis*)



Impacts on In Vitro NDF Digestibility

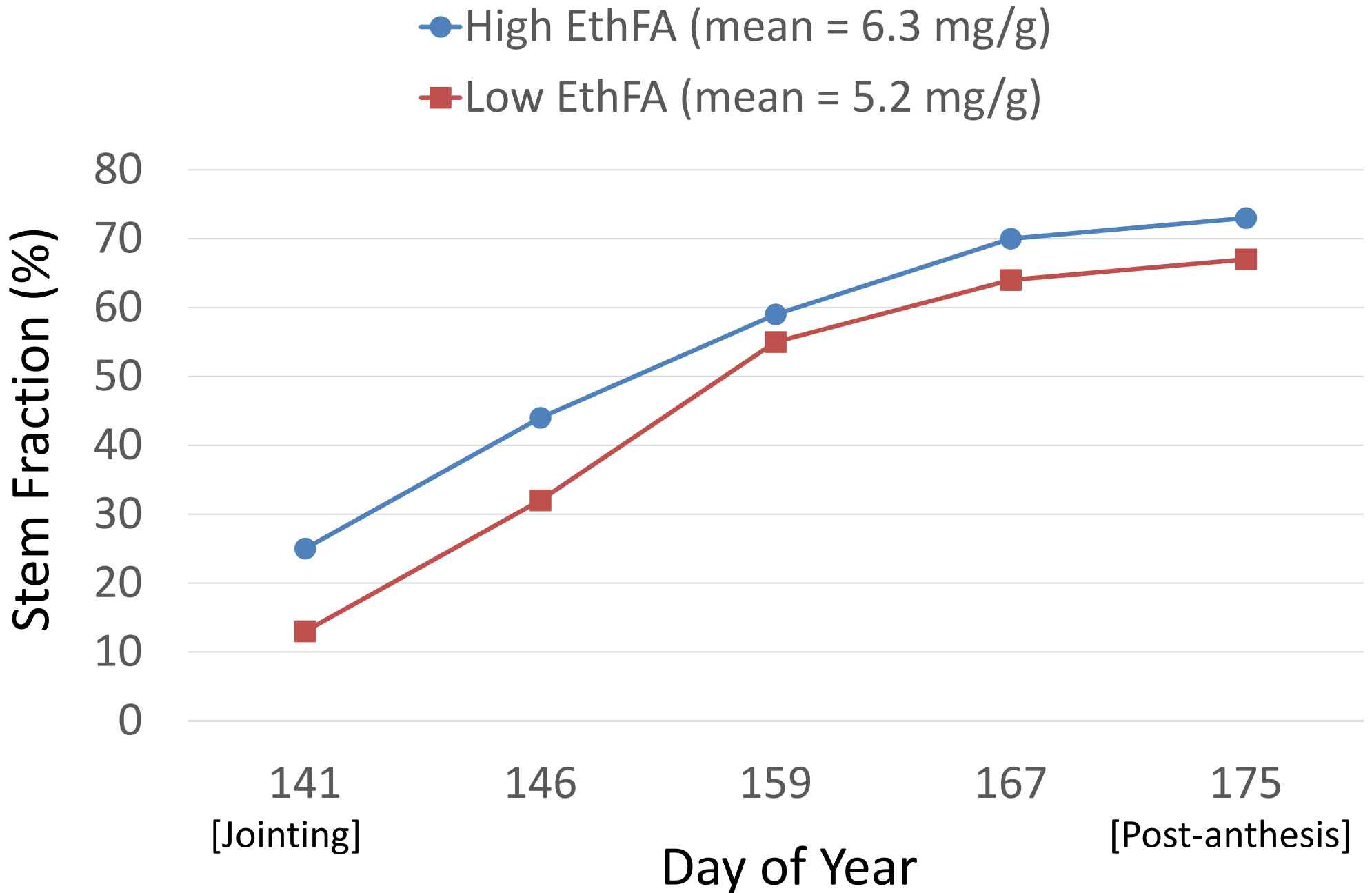


Lignin/Polysaccharide Cross-Linking in Grasses

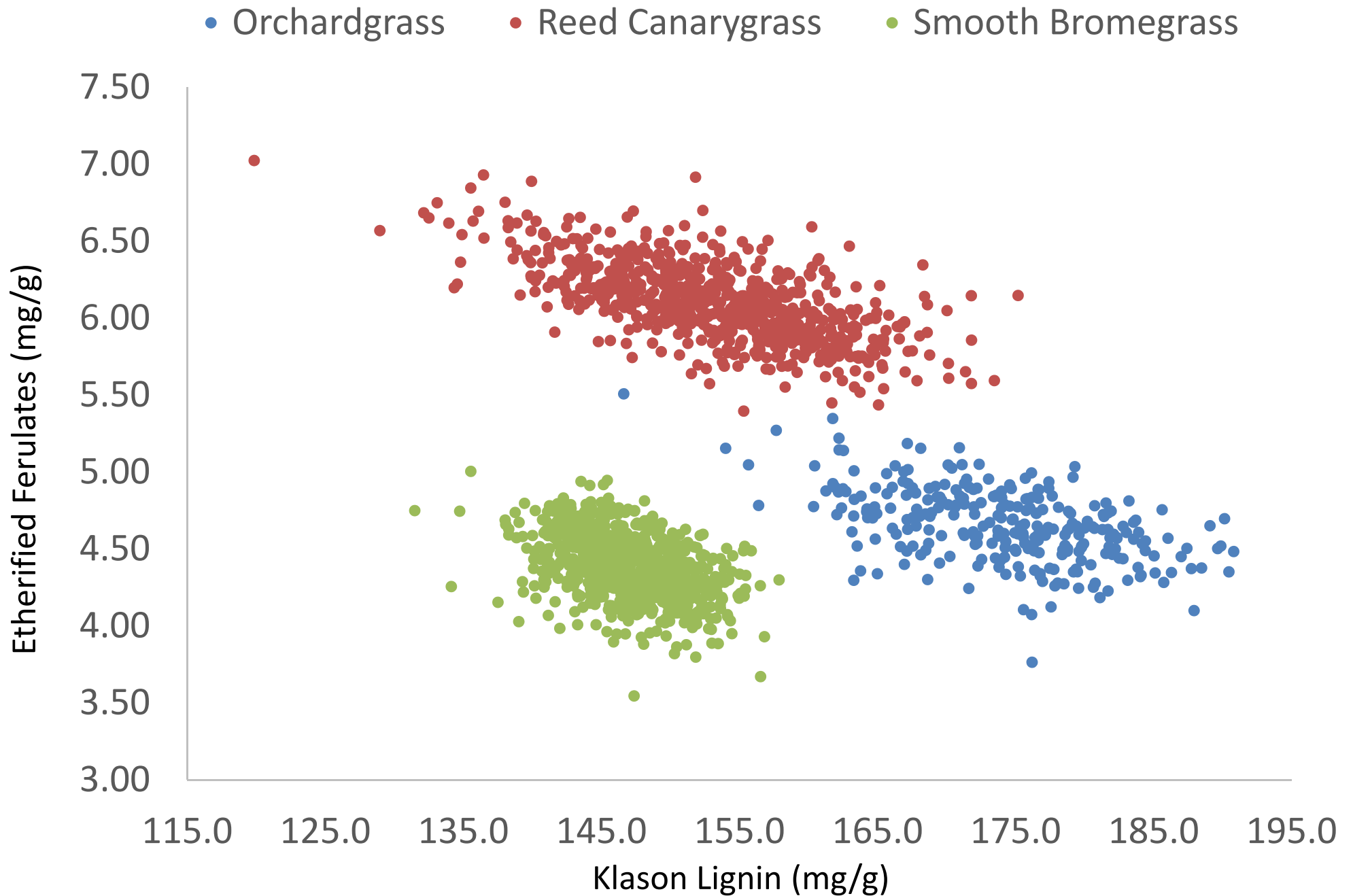


- Covalent cross links to lignin form via free-radical reactions.
- Ether bond is only linkage that is quantifiable.
- Ferulate molecules are the nucleation site for lignin deposition and growth.

Etherified Ferulates Impact Stem Fraction



Initial Screening & Selection: 1988



Divergent Selection for Etherified Ferulates: 8 Clones

Selection criterion	Orchardgrass	Reed canarygrass	Smooth bromegrass
	----- g EthFA kg ⁻¹ NDF -----		
High EthFA	5.72	6.28	5.77
Low EthFA	4.71	4.89	4.69
Percentage difference	<u>19%</u> **	<u>25%</u> **	<u>21%</u> **
	----- g Lignin kg ⁻¹ NDF -----		
High EthFA	164	178	168
Low EthFA	160	169	166
Percentage difference	2% ns	6% ns	1% ns

Divergent Selection for Klason Lignin: 8 Clones

Selection criterion	Orchardgrass	Reed canarygrass	Smooth bromegrass
	----- g Lignin kg ⁻¹ NDF -----		
High Lignin	173	185	172
Low Lignin	154	161	155
Percentage difference	<u>12%</u> **	<u>14%</u> **	<u>10%</u> **
	----- g EthFA kg ⁻¹ NDF -----		
High Lignin	5.69	5.73	5.55
Low Lignin	5.18	5.35	5.45
Percentage difference	9% *	7% *	2% ns

Field-based Diallel Crossing System

3 Species x 8 parents = 168 Crosses (3 yrs)



Field Plots: Seeded in Drilled Rows

Forage Yield: 3 cuts/yr for 2 yrs

Persistence: 2 yrs under frequent mowing

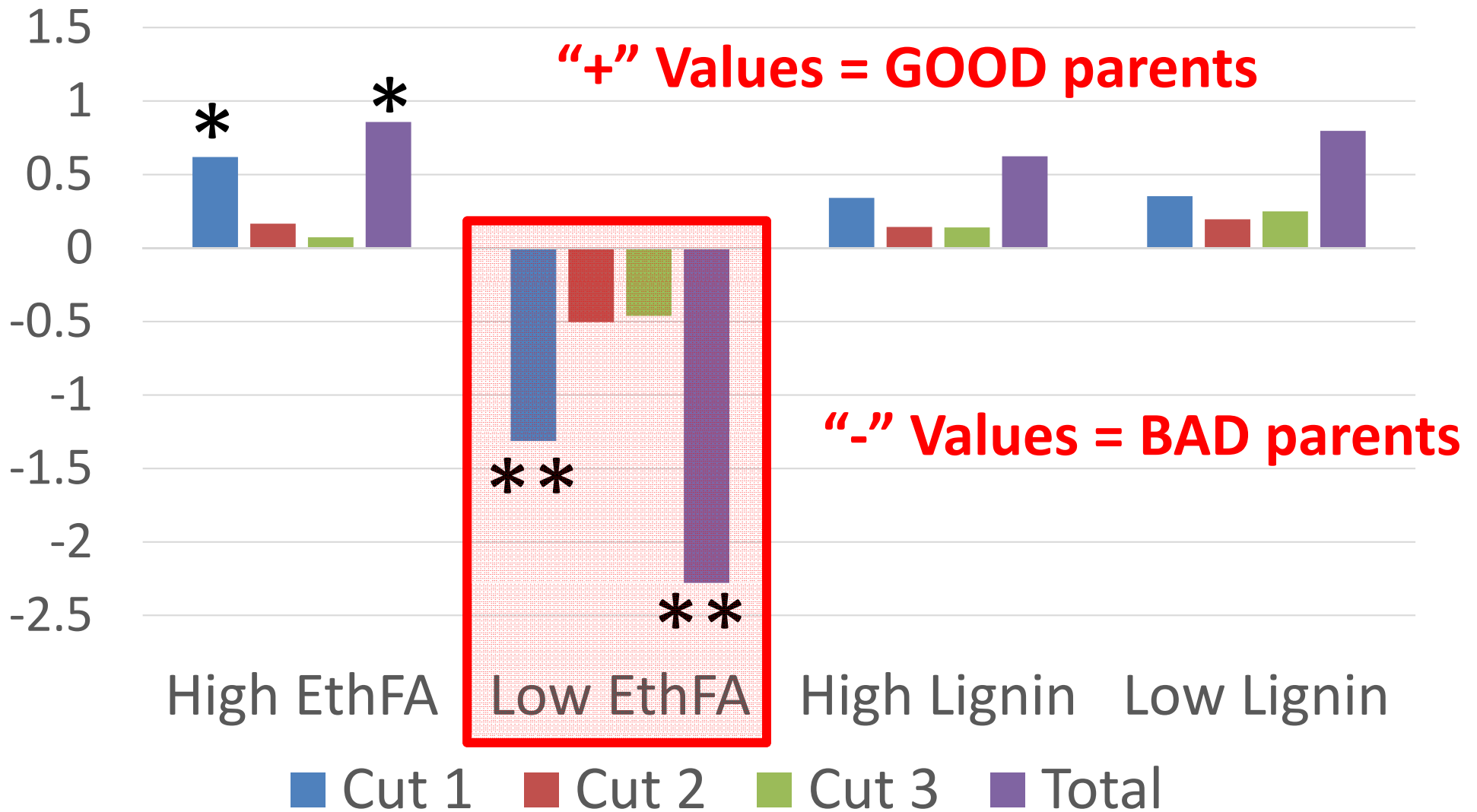


Diallel ANOVAs: Forage Yield

		Orchardgrass			Reed Canarygrass			Smooth Bromegrass		
Source	df	F	P	SS	F	P	SS	F	P	SS
				%			%			%
Geno.	63			100			100			100
GCA	7	3.54	0.01	54	11.98	0.01	73	6.12	0.01	70
SCA	28	0.25	1.00	15	0.61	0.94	15	0.40	1.00	18
Recip.	28	0.50	0.98	31	0.52	0.98	13	0.27	1.00	12

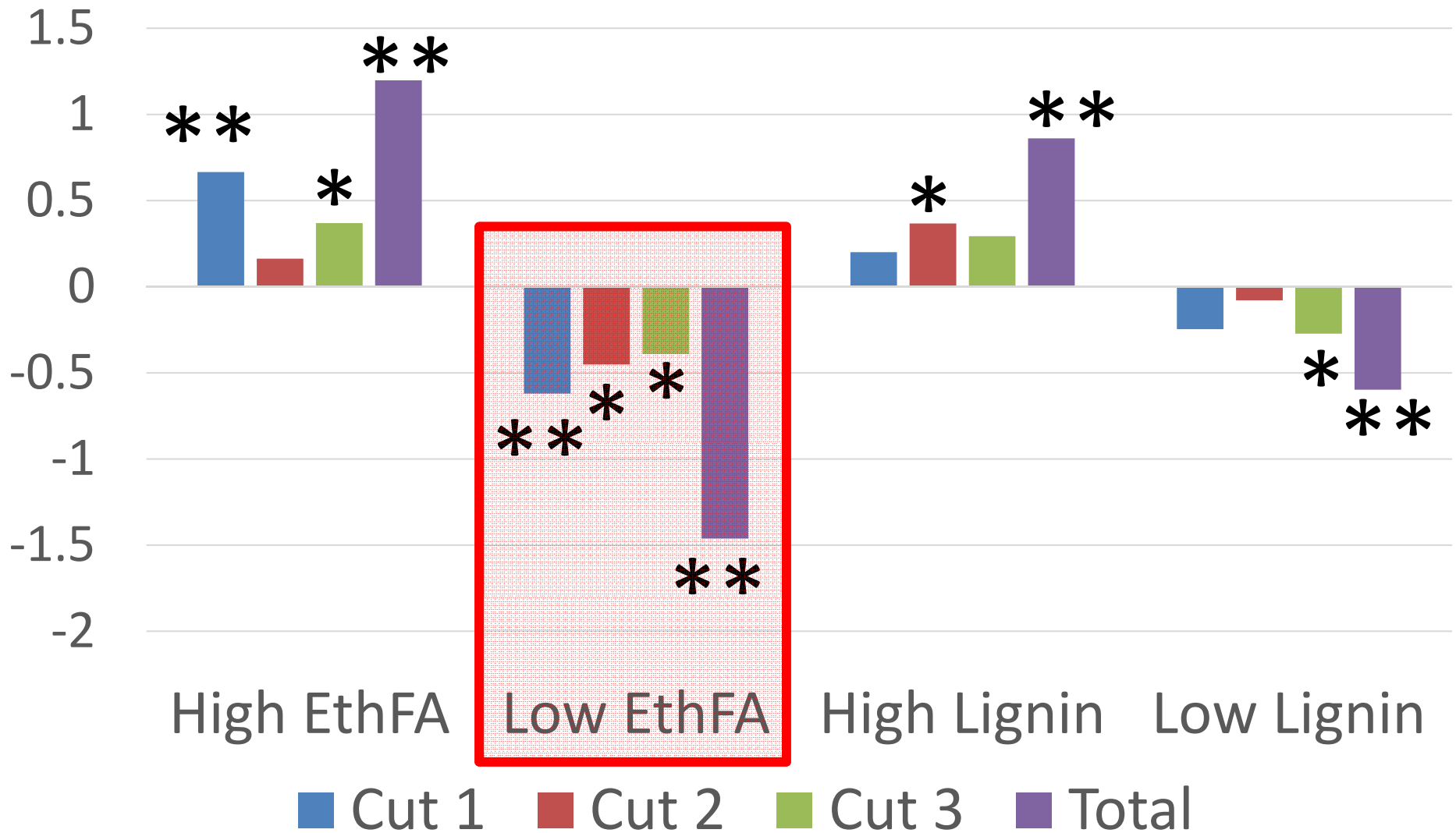
GCA Effects (Means of 2 Parents)

Orchardgrass Forage Yield (Mg/ha)



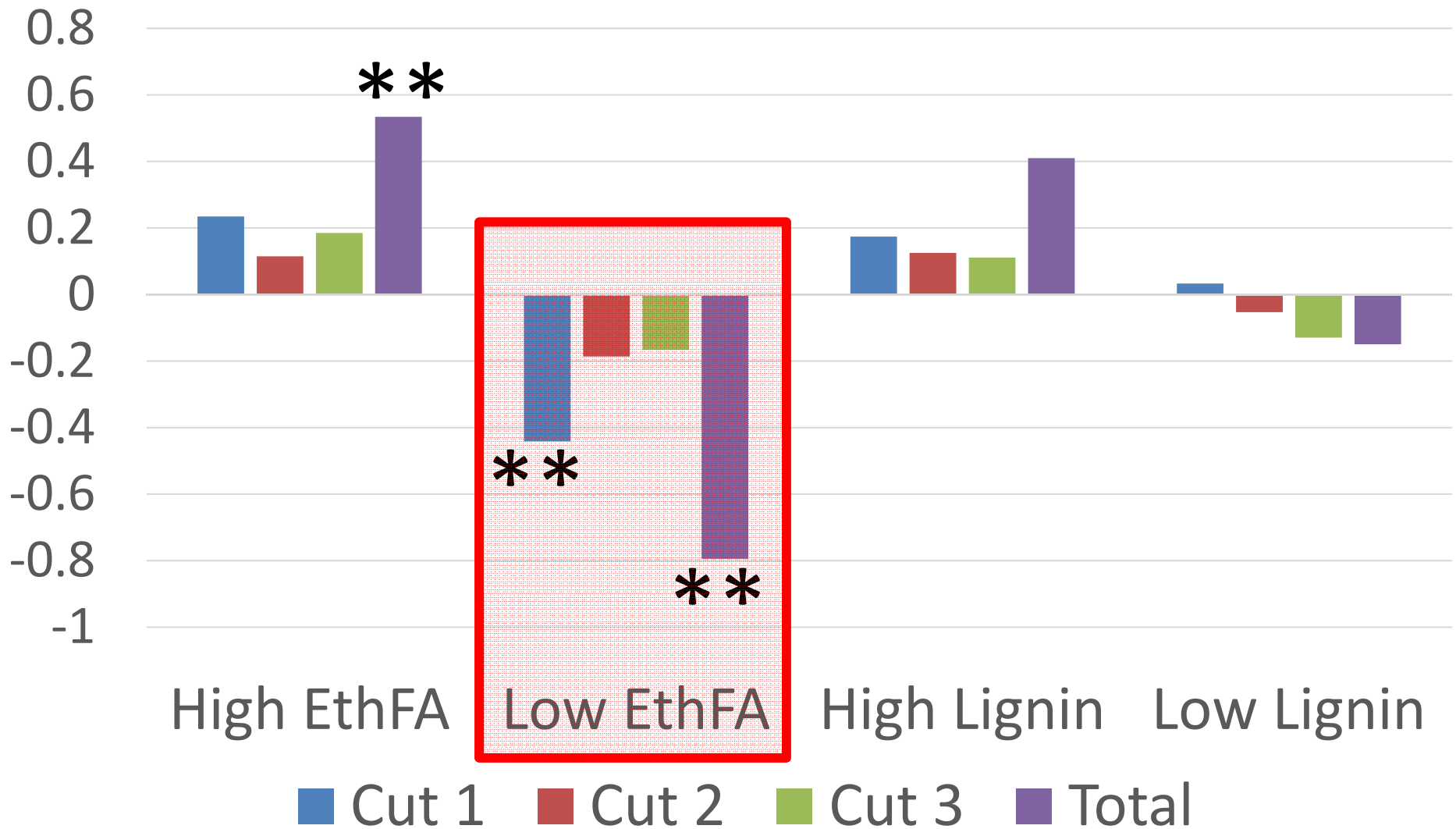
GCA Effects (Means of 2 Parents)

Reed Canary Forage Yield (Mg/ha)



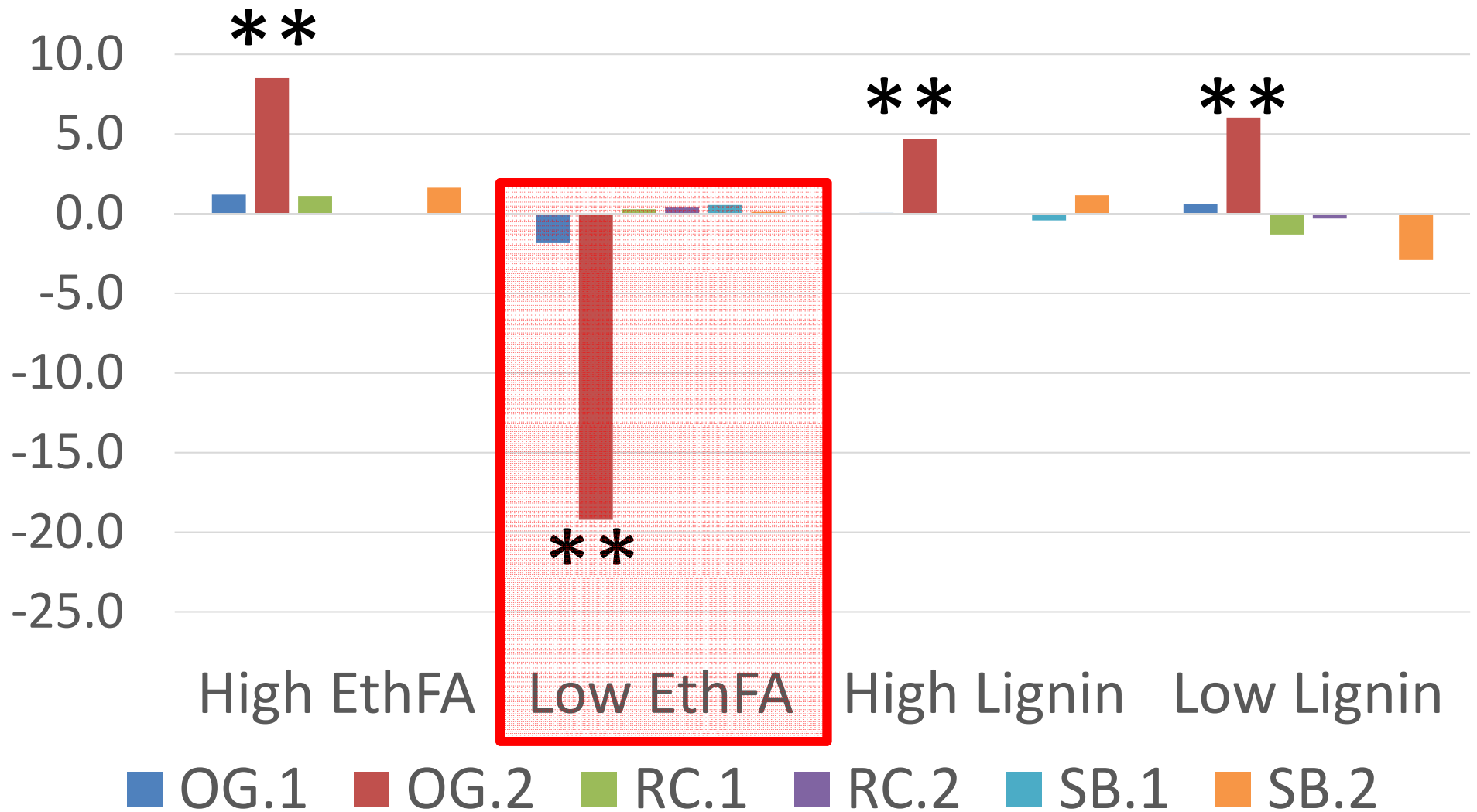
GCA Effects (Means of 2 Parents)

Smooth Brome Forage Yield (Mg/ha)



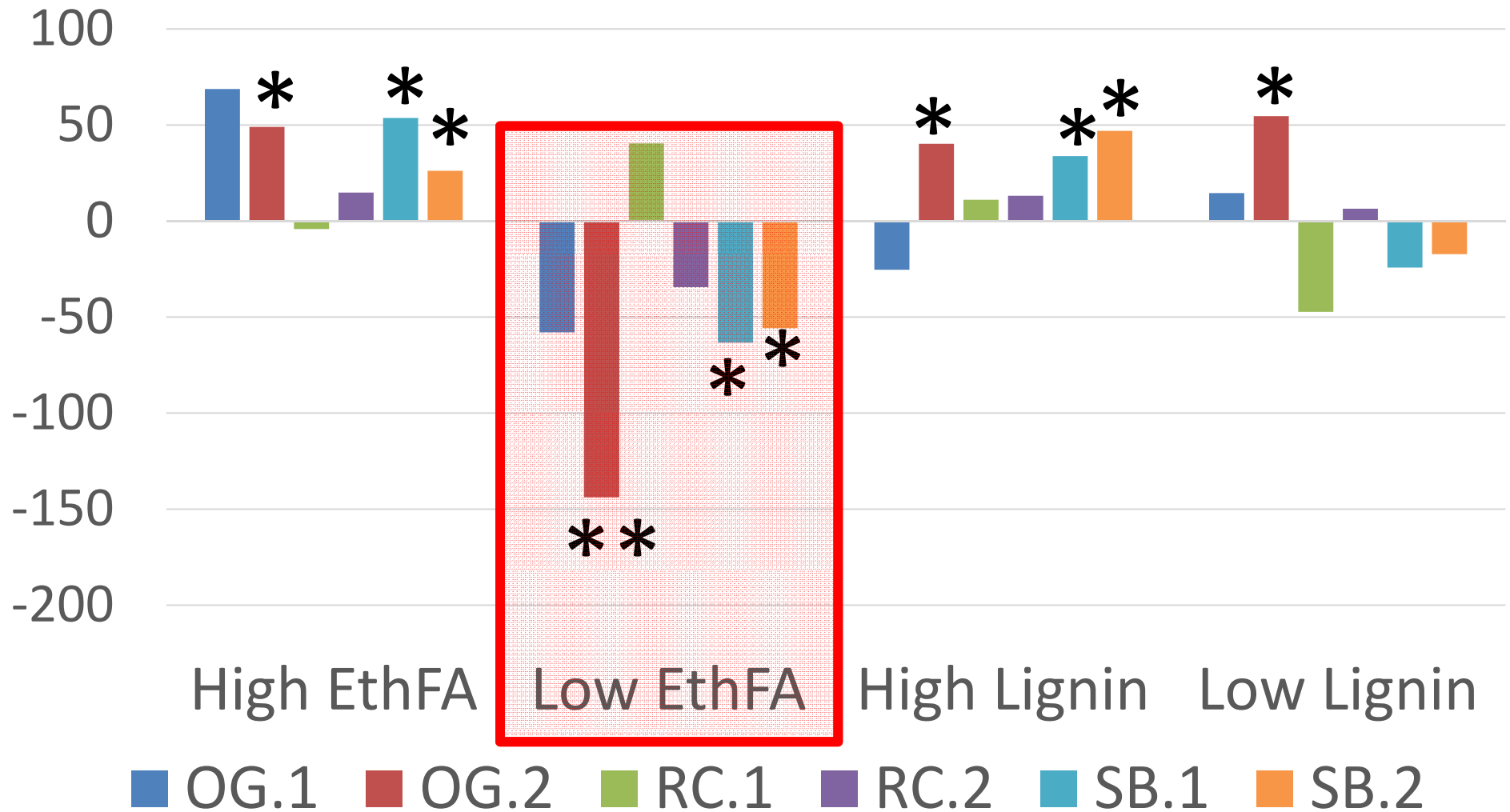
GCA Effects (Means of 2 Parents)

Ground Cover (%)



GCA Effects (Means of 2 Parents)

Tiller Density (Tillers/m²)



Conclusions

- Reduced lignin combined with slightly reduced ferulates had little impact on fitness.
- Selection for reduced etherified ferulates reduced forage yield by a mean of 36%.
- Reduced ferulates significantly impaired stem development, consistently reducing stem:leaf ratio, with the greatest impact when stem development was at its maximum.
- Crosslinking between hemicellulose molecules appears to be a critical component of normal growth and development for temperate grasses.

Collaborator Acknowledgement

Hans Jung, USDA-ARS, was my 30-year collaborator on this project, providing expertise and laboratory analysis for cell wall chemistry, as well as ideas and concepts for selection criteria and goals.

