Nitrogen Rates for Biomass Sorghum Production across Tillage Systems.

Southern Conservation Agricultural Systems Conference

Norman, OK

February 19, 2013

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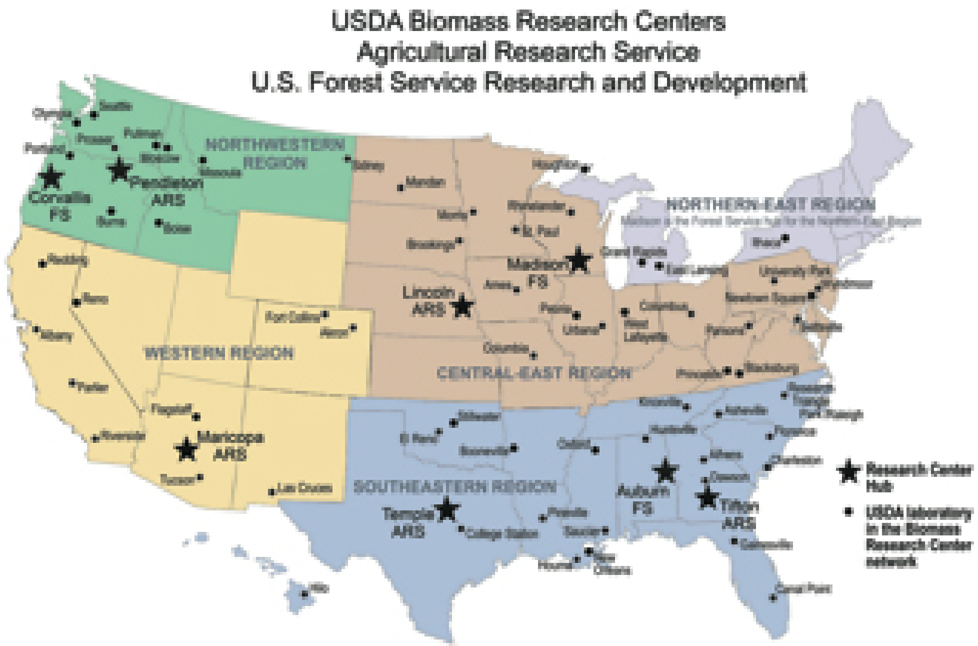
Background

Renewable Fuel Standards mandate the production of up to 36 Billion gallons of biofuel to help meet U.S. transportation needs by 2022.

It is expected that 15 Billion gallons will be supplied by grain ethanol and the remaining 21 Billion gallons will be supplied by other feedstocks.

Bioenergy Research



Five regions to coordinate research and resources.

Southeast region was deemed to have the most potential to supply biofuels.

Bioenergy Research

- **Minimize nutrient and water inputs**
- **Enhance environmental quality**
  - **Promote C sequestration**
  - **Reduce nutrient loss**
- **Systems must be compatible with current cropping systems**

Conservation Systems

High residue cover crops

Non-inversion tillage

Bioenergy Crops

Typical feedstocks include:

- **sugarcane**
- **perennial grasses, like switchgrass**
- **oilseed crops.**

Residue Removal for Biofuel

Cellulosic Ethanol

Sorghum

Two types:

- sweet sorghums, photo-period sensitive (PPS)
- sweet sorghums provide multiple paths for ethanol production
- PPS sorghums typically produce high biomass yields

Sorghum

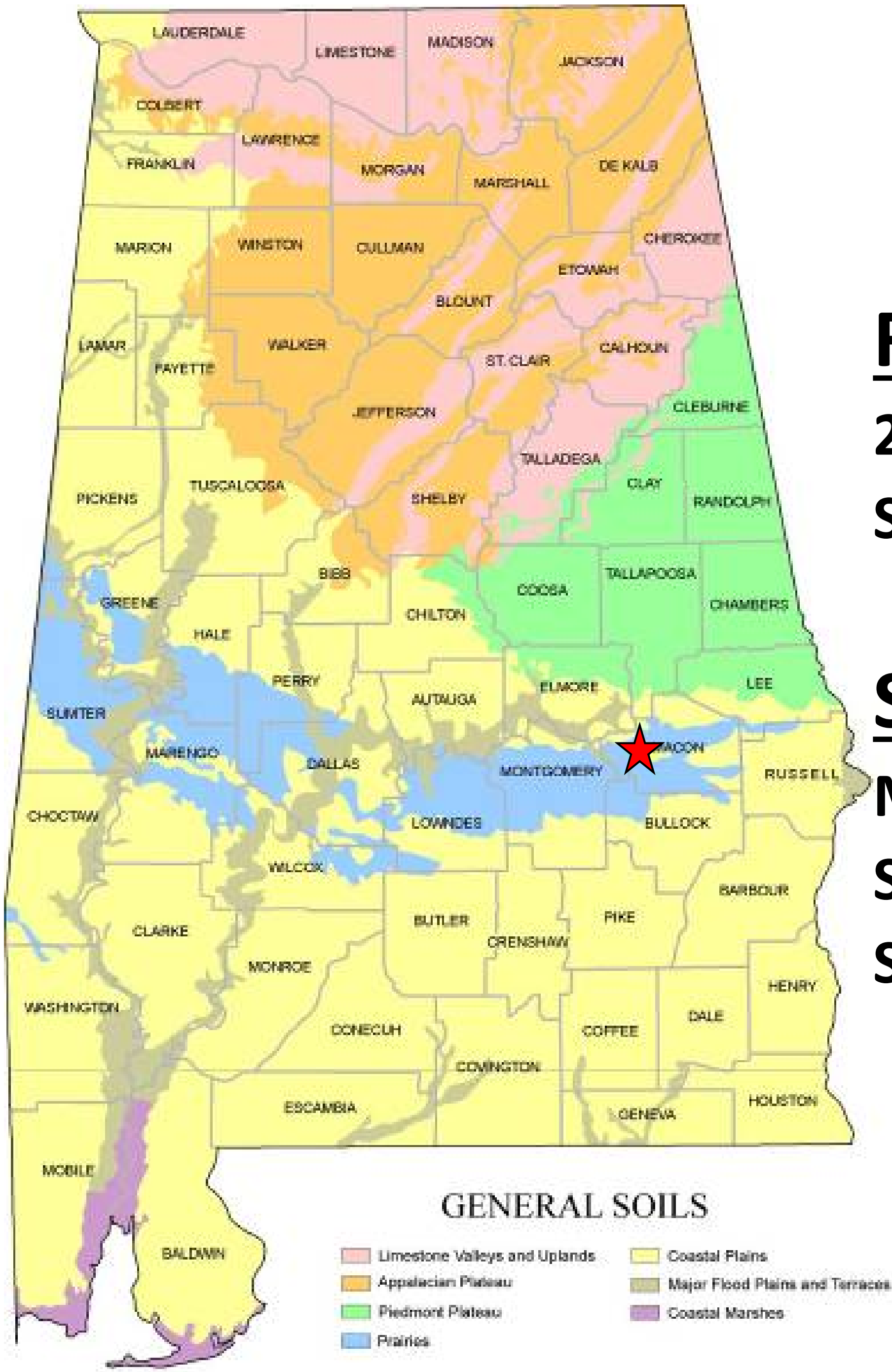
- Annual crops that could be grown in rotation with traditional row crops of the Southeast
- Drought tolerant, which might be enhanced with conservation systems
- N requirements and amount of nutrient levels removed is unknown in these systems and region.

Forage sorghum production across tillage and N rates

Objective

- **Determine sorghum biomass yield response and nutrient uptake across different nitrogen rates within a conventional and conservation tillage systems.**

E.V. Smith Research Center – Field Crops Unit
Shorter, AL



Forage Sorghum Study

2010, 2011, 2012

Soil type: Compass loamy sand

Split-split plot design:

Main plots – 6 N rates

Subplots – Tillage systems

Sub-subplots – 2 sorghum hybrids

$P \leq 0.10$

Forage Sorghum Study

N rates: 0, 34, 67, 101, 134, 168 kg ha^{-1}

Tillage systems:

- Conventional (CT)
- Strip tillage/cover crop (ST)

Sorghum hybrids:

- PPS - ES 5200
- Sweet sorghum – Sugar T

Sorghum Hybrids

ES 5200 – 4.5 kg/ha

Available through Blade Energy Crops

PPS, non-heading, thick stemmed

Flag-ship hybrid with Skyscraper® technology

Sugar T – 4.5 kg/ha

Available through Advanta U.S.

Exceptional yield potential with adequate moisture or irrigation

Good heat and stress tolerance

High tonnage and sugar content for biofuel production

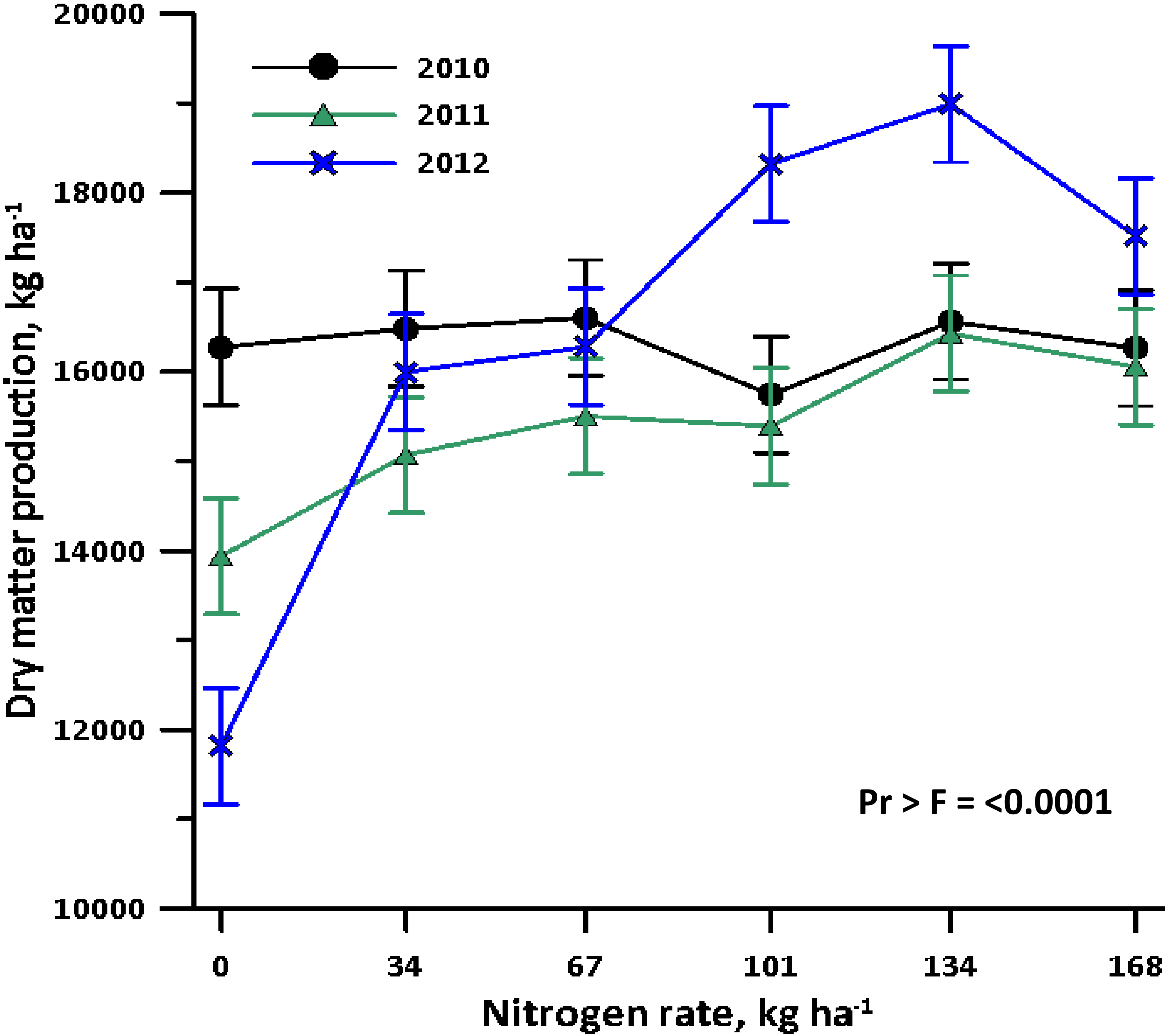
Forage Sorghum Harvest

Growing Season Rainfall

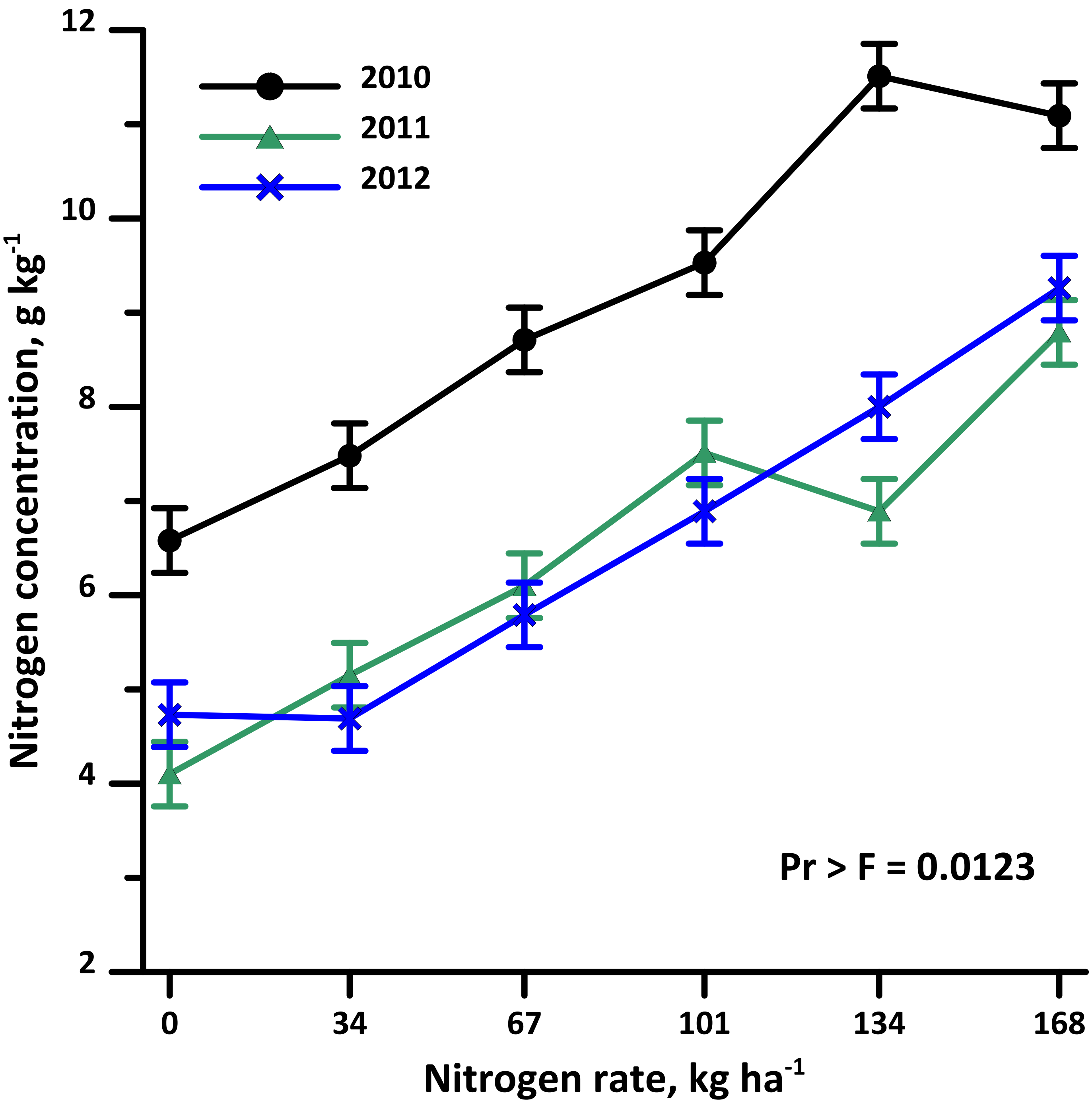
	2010	2011	2012
Planting date	5-14	5-19	5-18
Harvest date	9-21	9-21	9-10
	------------Precipitation, inches------------		
May	4.49	0.40	0.86
June	2.22	2.24	3.02
July	5.04	8.02	3.30
August	4.82	0.64	5.33
September	0.06	4.74	1.02
Total	16.63	16.04	13.53

2010, 2011, 2012 Growing Seasons

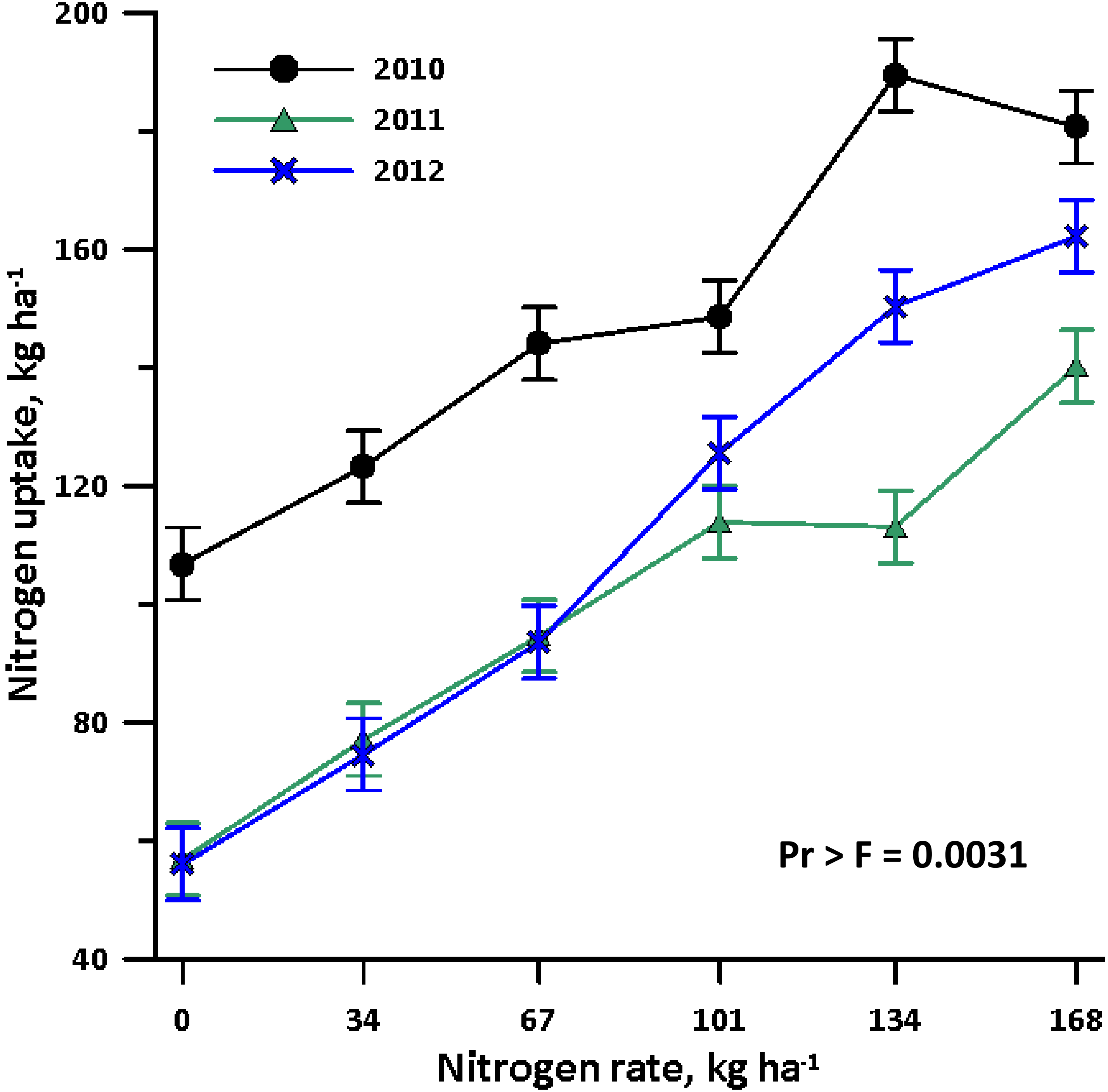
	df		Dry	N	N
Effect	Num	Den	Matter	Conc.	uptake
			------------------Prob > F	---------------	
Year (Y)	2	9	0.1530	<0.0001	<0.0001
Nrate (N)	5	45	<0.0001	<0.0001	<0.0001
Y * N	10	45	<0.0001	0.0123	0.0031
Tillage (T)	1	53	0.0515	0.0944	0.0075
Y * T	2	53	0.0241	<0.0001	<0.0001
N * T	5	53	0.4882	0.9125	0.8994
Cultivar (C)	1	107	0.6514	0.0112	0.0254
Y * C	2	107	0.0005	0.1552	0.1022
N * C	5	107	0.0668	0.9514	0.8353
T * C	1	107	0.1823	0.2282	0.9061



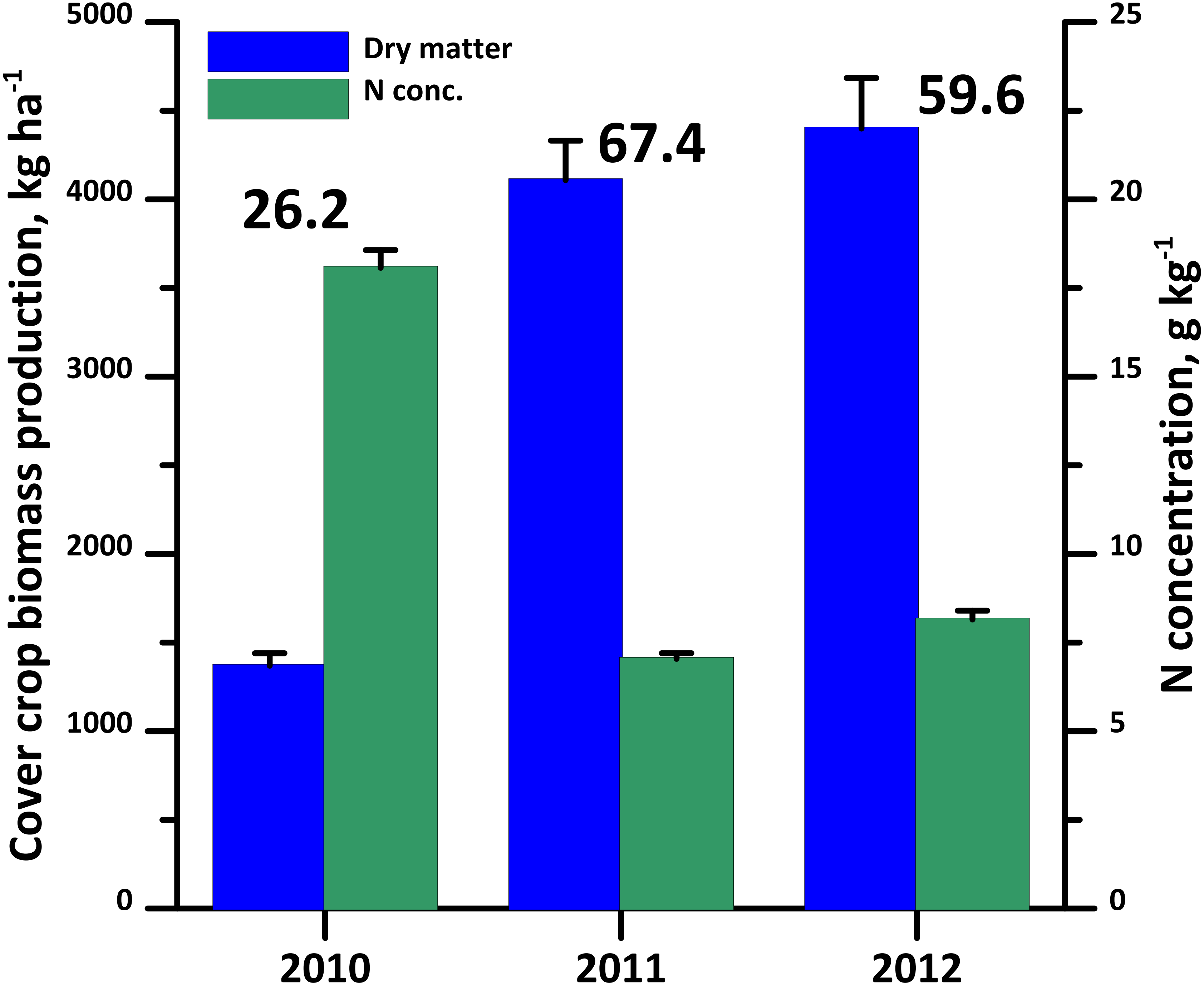
2010
2011
2012
Dry matter production, kg ha-1
20000
18000
16000
14000
12000
10000
0
34
67
101
134
168
Nitrogen rate, kg ha-1
Pr > F = <0.0001



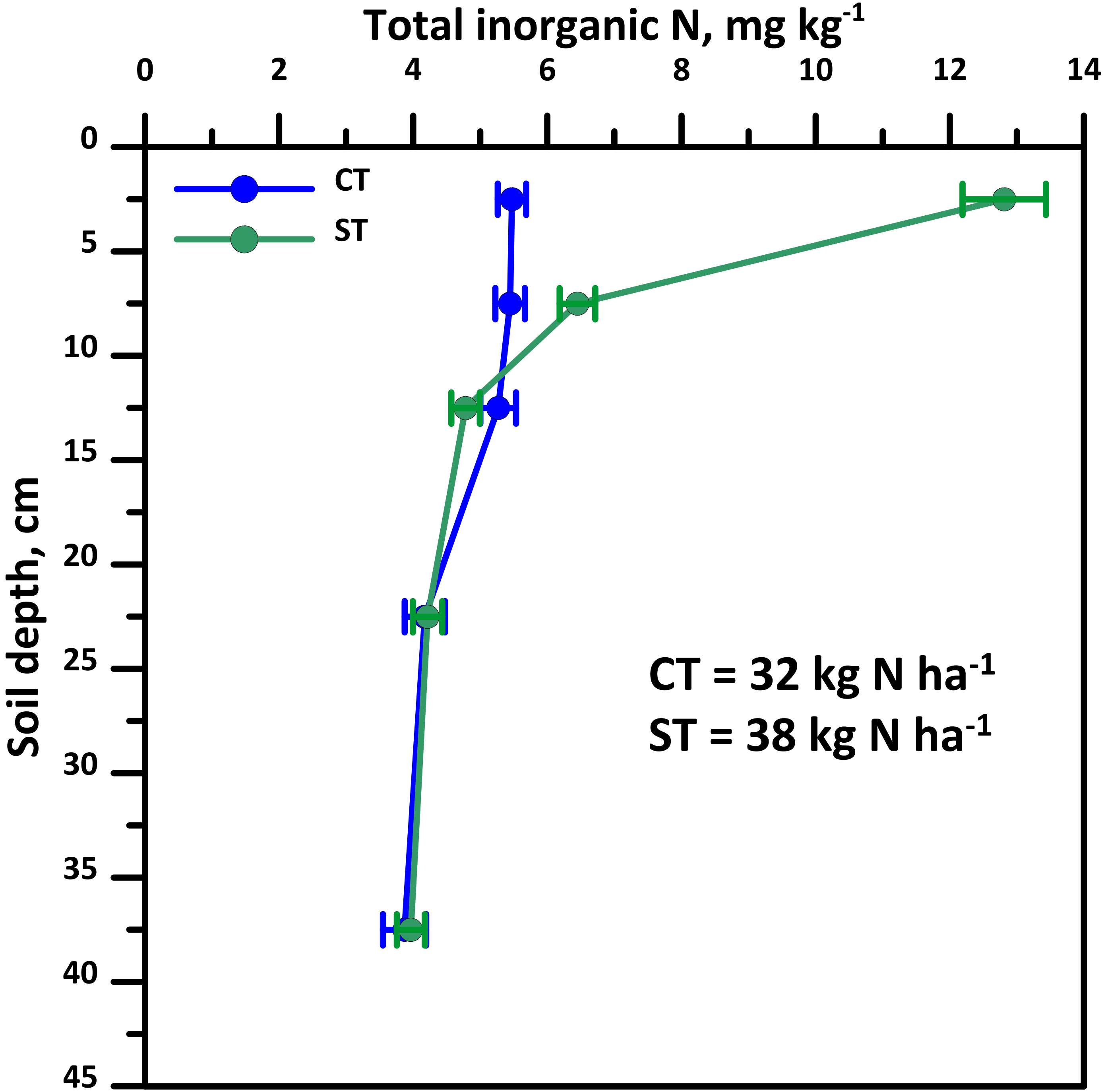
2010
2011
2012
Pr > F = 0.0123
Nitrogen concentration, g kg-1
Nitrogen rate, kg ha-1
12
10
8
6
4
2
0
34
67
101
134
168



200
160
120
80
40
Nitrogen uptake, kg ha-1
2010
2011
2012
Pr > F = 0.0031
0
34
67
101
134
168
Nitrogen rate, kg ha-1



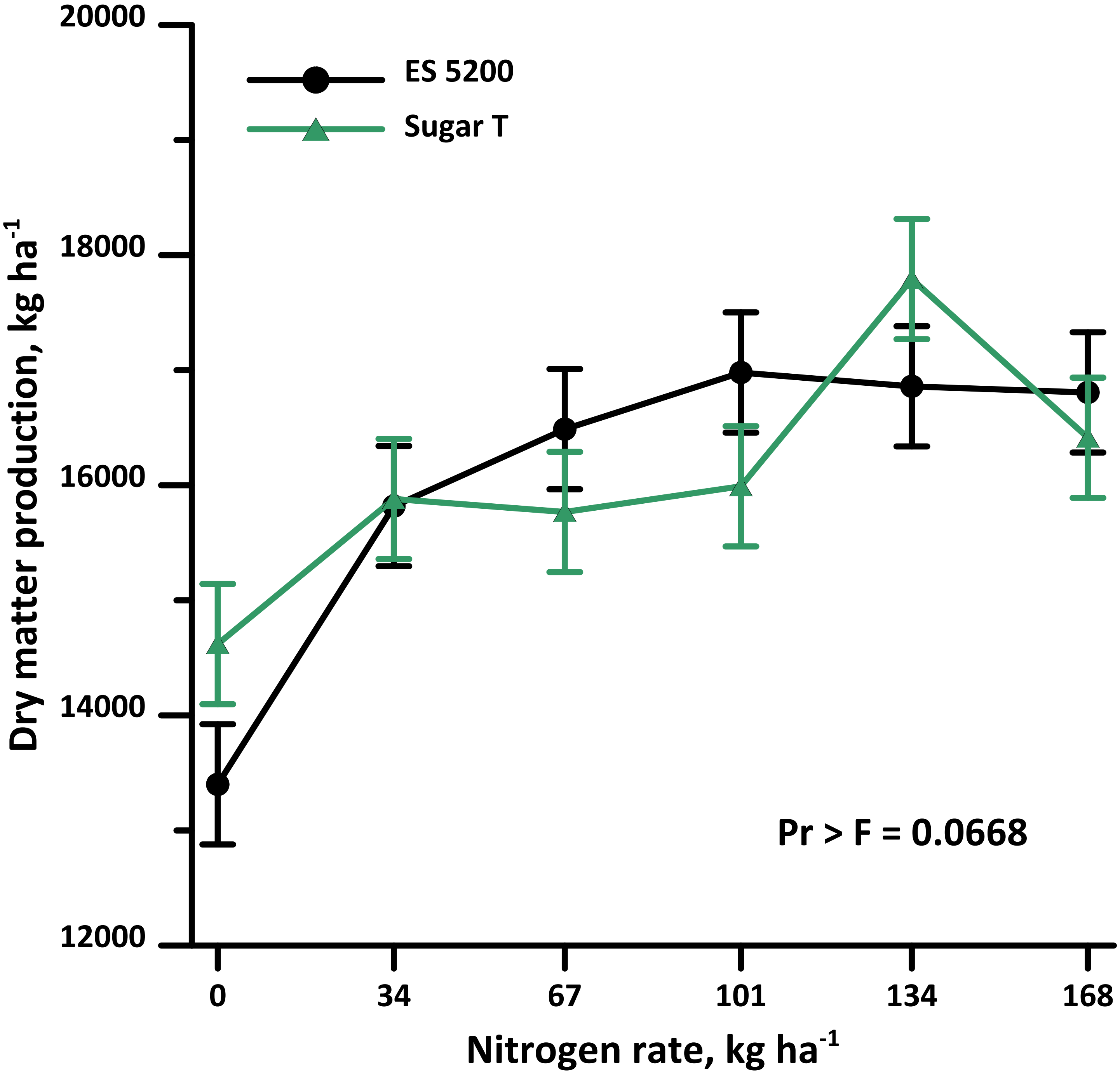
Dry matter
N conc.
26.2
67.4
59.6
Cover crop biomass production, kg ha^{-1}
N concentration, g kg^{-1}
5000
4000
3000
2000
1000
0
25
20
15
10
5
0
2010
2011
2012



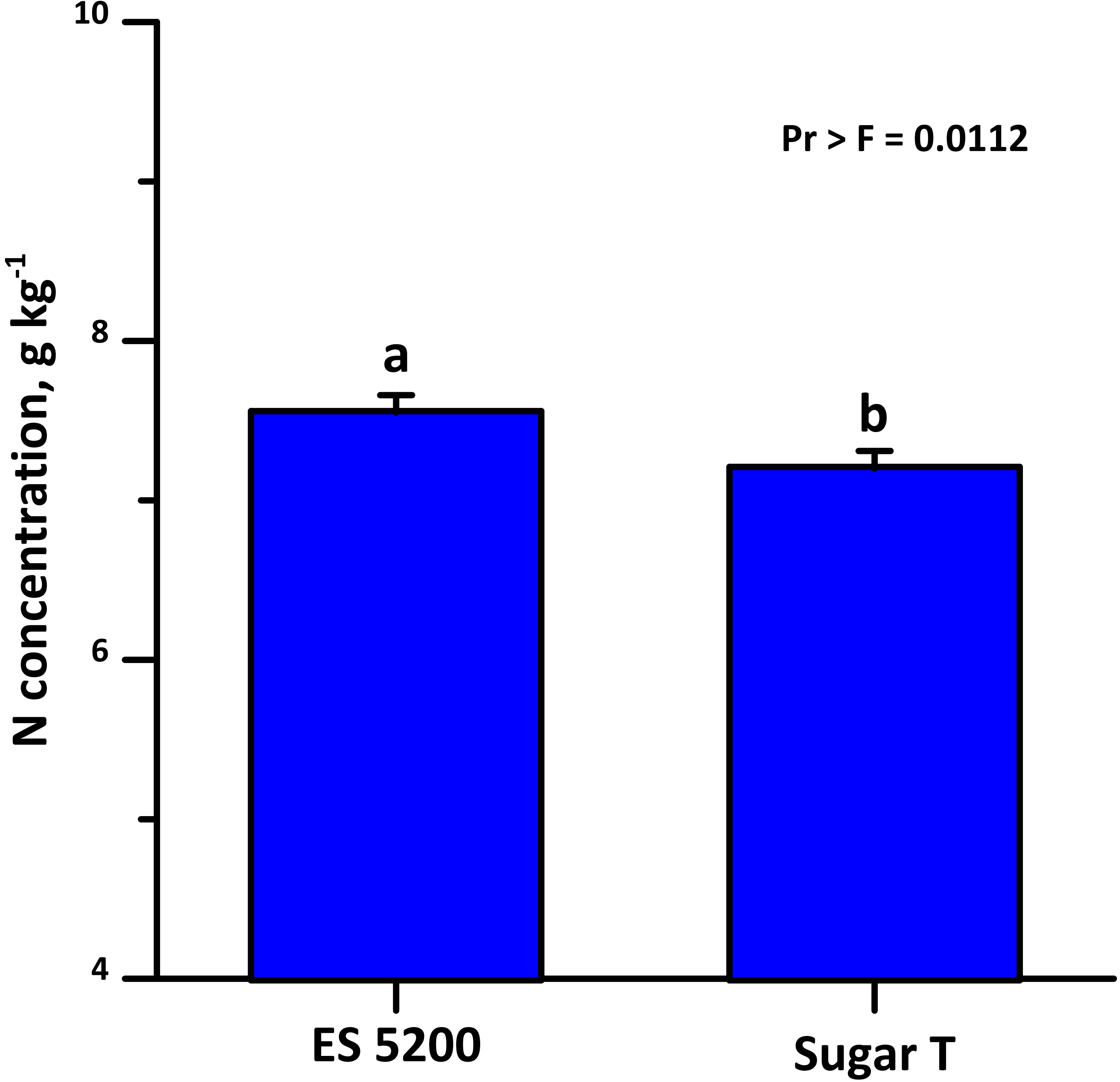
Total inorganic N, mg kg-1
0
2
4
6
8
10
12
14
0
5
10
15
20
25
30
35
40
45
Soil depth, cm
CT
ST
CT = 32 kg N ha-1
ST = 38 kg N ha-1

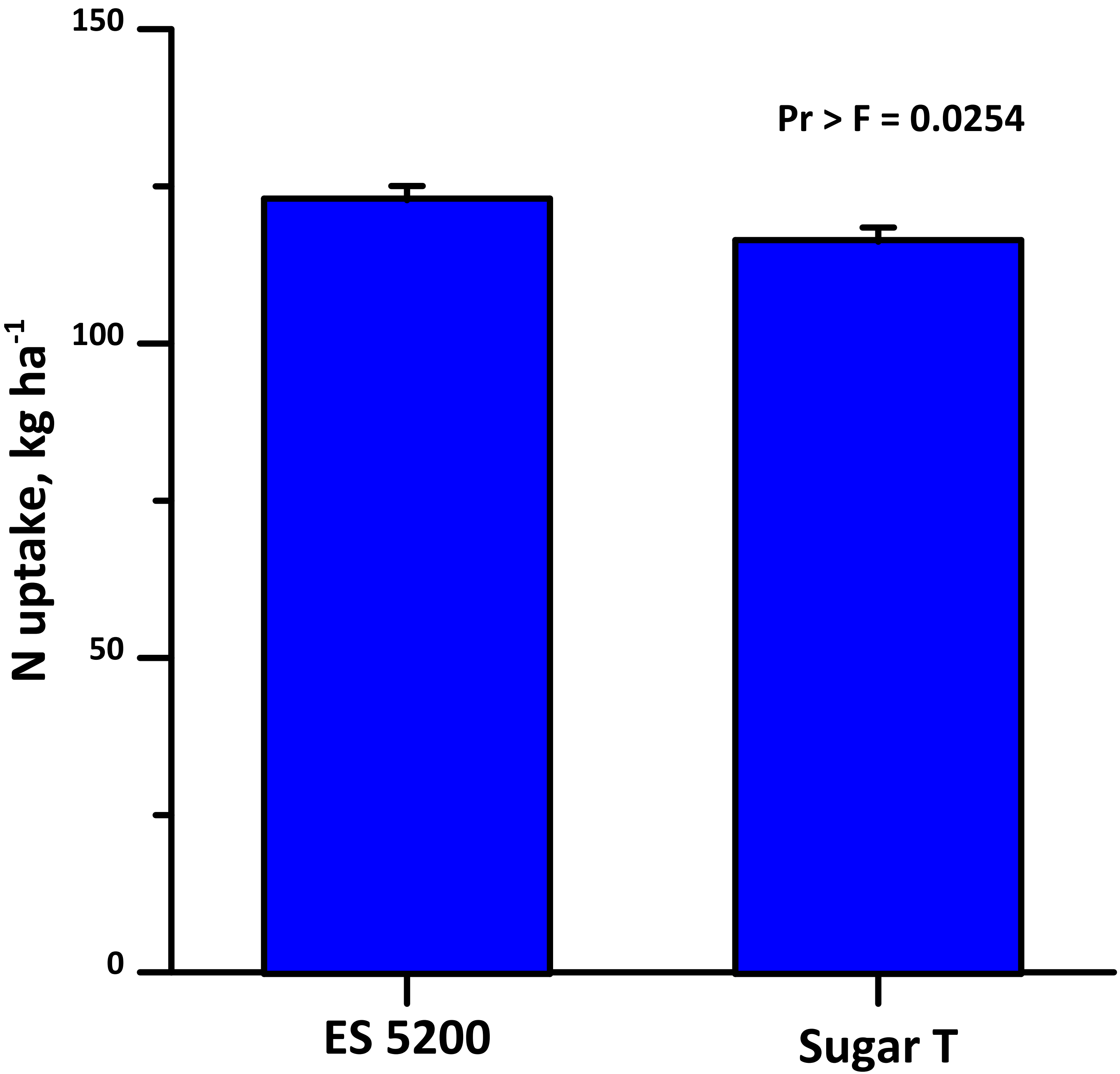
Year by Tillage

Crop Year	Dry Matter		N conc.		N uptake	
	CT	ST	CT	ST	CT	ST
	---Mg ha^{-1}---		-----g kg^{-1}-----		-----kg ha^{-1}-----	
2010	16.0	16.7	8.6b	9.7a	137.7b	160.0a
2011	15.6	15.2	6.8a	6.1b	106.6a	92.0b
2012	15.7b	17.3a	6.3b	6.8a	102.6b	118.1a
$LSD_{0.10}$	0.8		0.4		8.1	

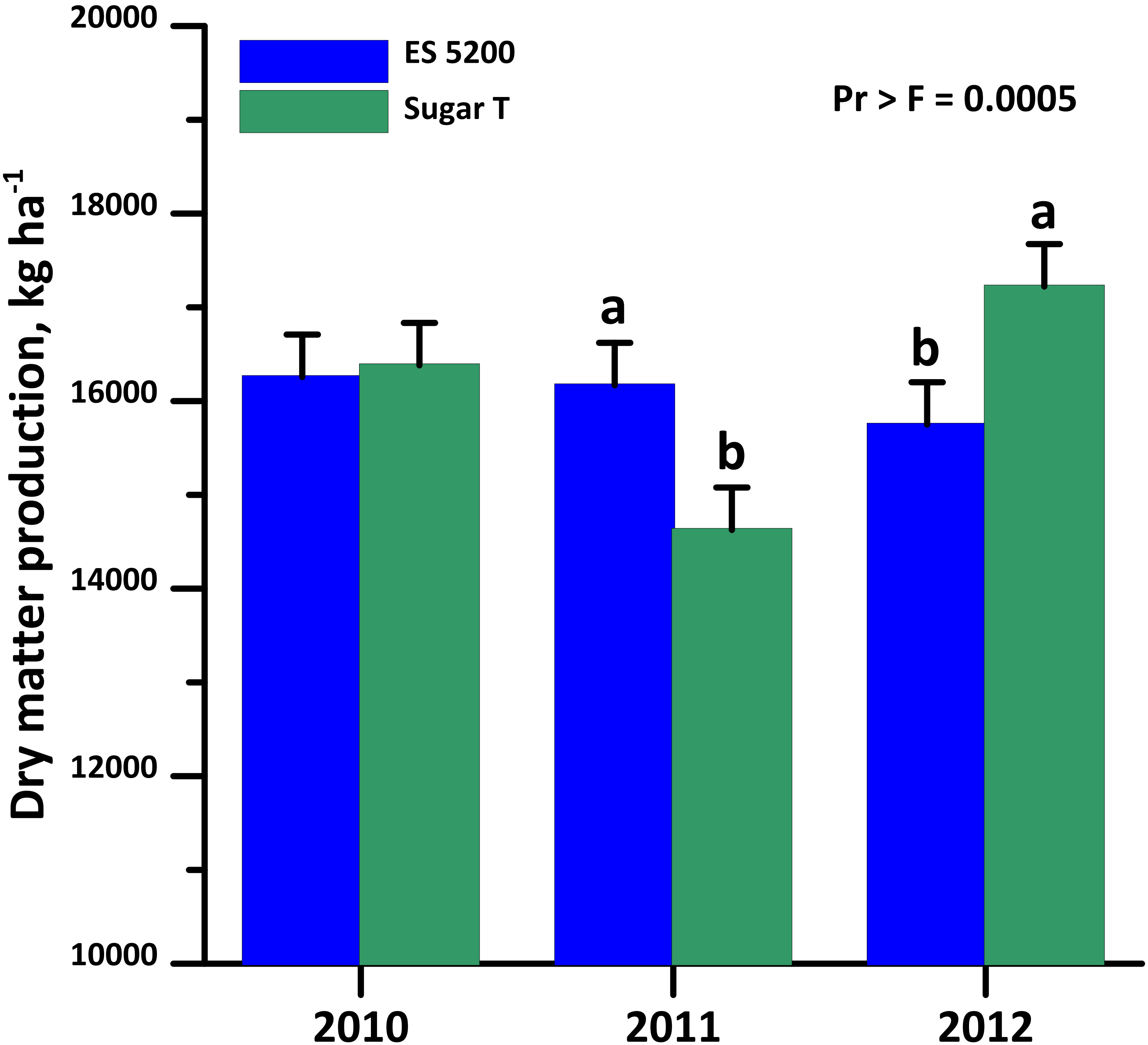


20000
18000
16000
14000
12000
Dry matter production, kg ha-1
ES 5200
Sugar T
Pr > F = 0.0668
0
34
67
101
134
168
Nitrogen rate, kg ha-1


Pr > F = 0.0112
N concentration, g kg-1
10
8
6
4
a
b
ES 5200
Sugar T



150
100
50
0
N uptake, kg ha-1
Pr > F = 0.0254
ES 5200
Sugar T



ES 5200
Sugar T
Pr > F = 0.0005
Dry matter production, kg ha-1
20000
18000
16000
14000
12000
10000
a
b
b
a
2010
2011
2012

2011-Root-knot Nematodes

	Tillage system	
Cultivar	CT	ST
	No. $(cm^3\ soil)^{-1}$	
ES 5200	427.5	369.5
SS 1515	56.5	15.0

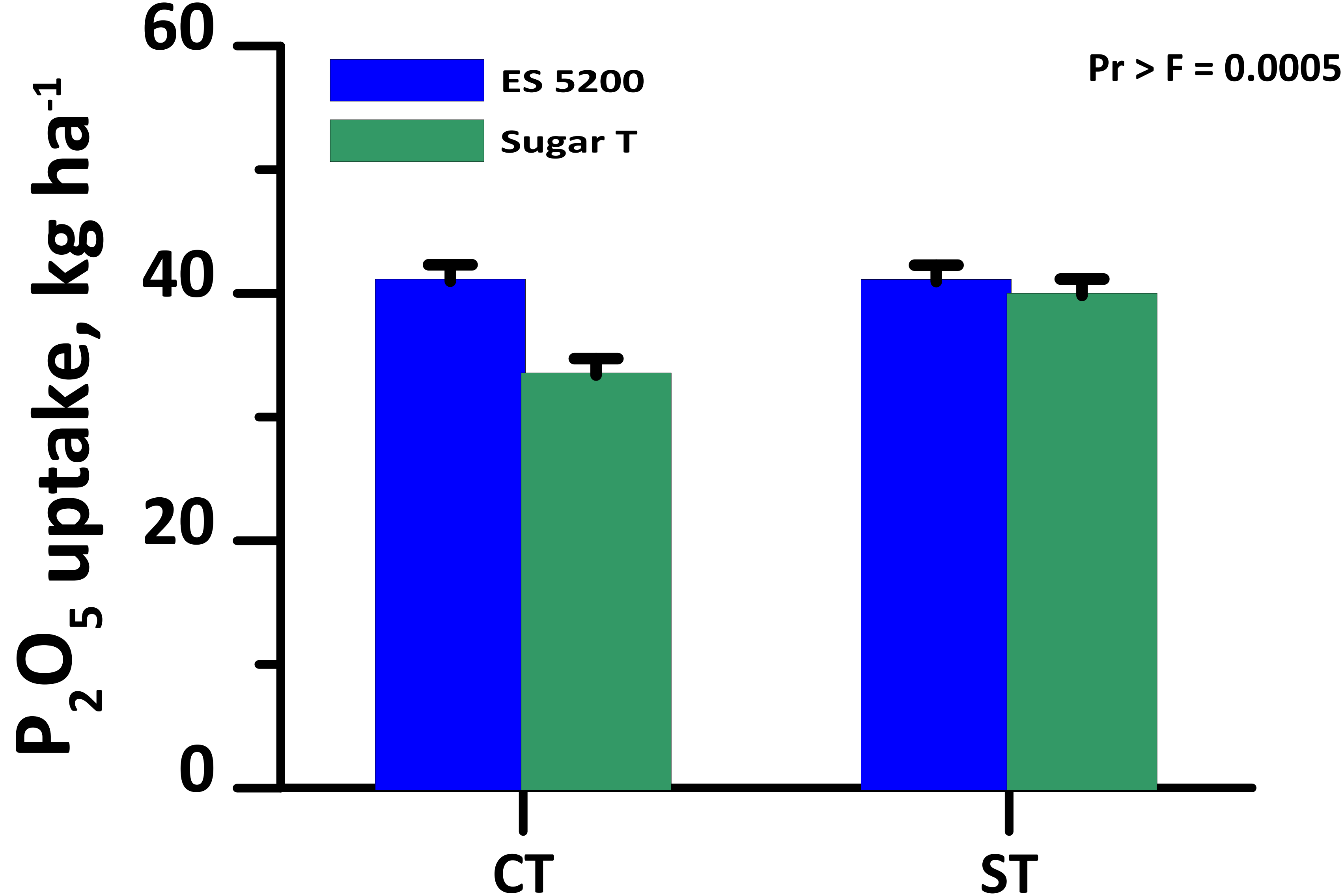
Counts performed by Richard Davis, ARS-Tifton

2012-Root-knot Nematodes

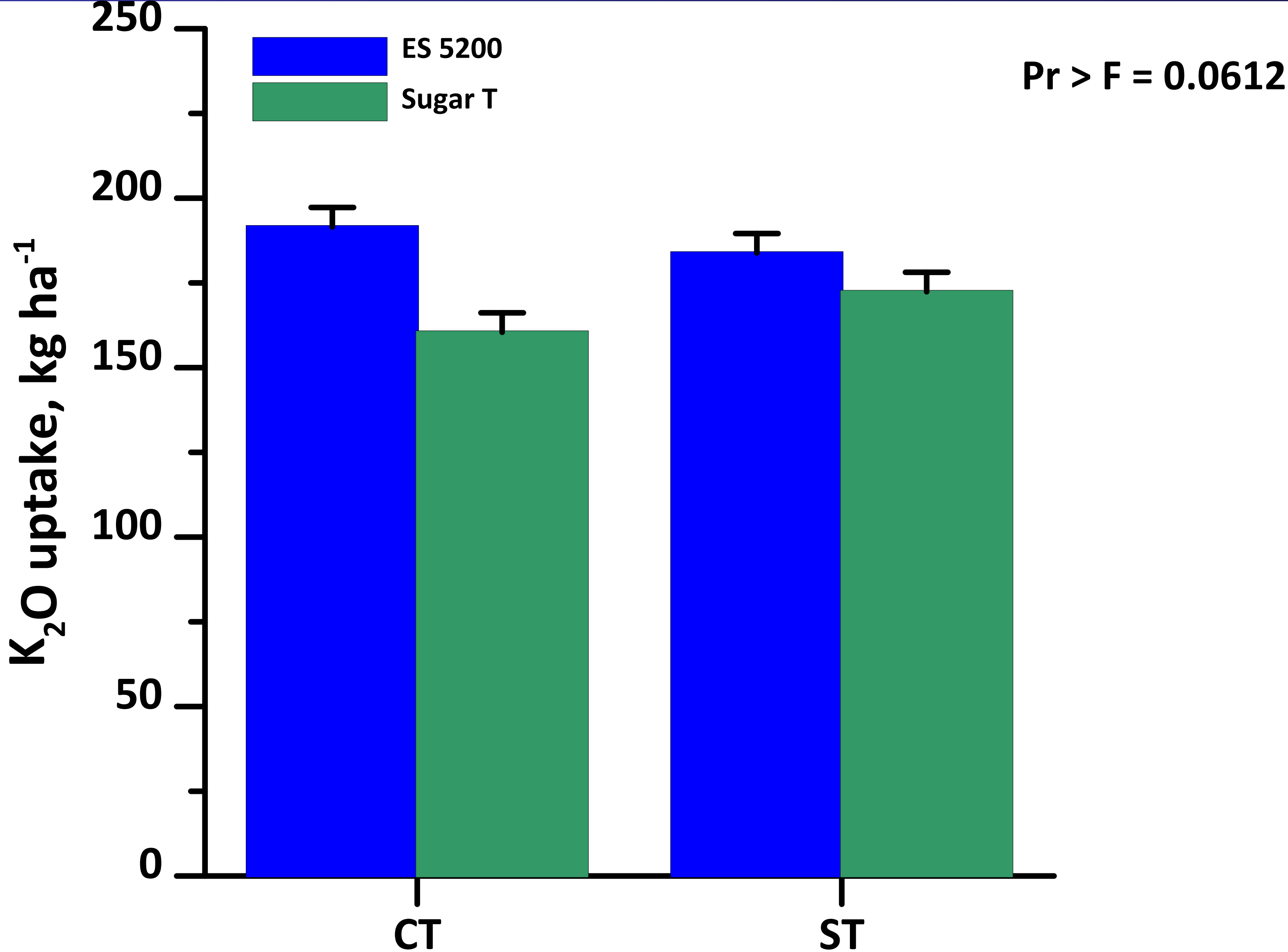
Cultivar	N	Mean	Standard Error	Min	Max
		--------------------No. (g root)$^{-1}$--------------------			
ES 5200	48	134.39	27.96	0	792.31
SS 1515	48	25.45	11.88	0	570.07

Counts performed by Kathy Lawrence, Auburn Univ.

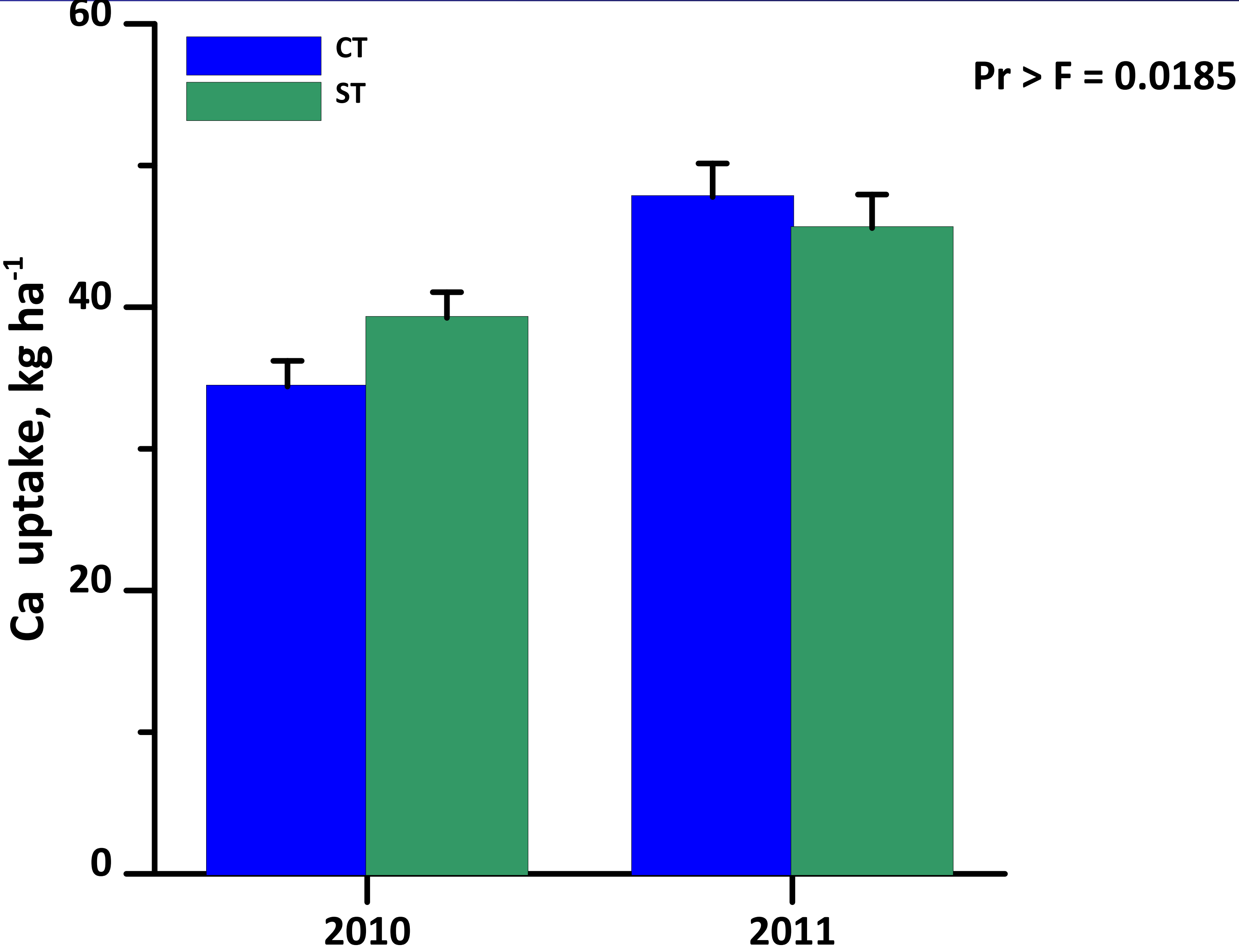
P_2O_5 Uptake – 2010, 2011



K_2O Uptake – 2010, 2011



Calcium Uptake – 2010, 2011



Nutrient Removal with Stover Harvest

	Shorter				Belle Mina		
	2009	2010	Mean		2009	2010	Mean
Biomass, ton/ac	2.28	1.57	1.93	7.2	2.45	2.13	2.29
P, lb/ton	1.7	1.5	1.6		1.4	2.6	2.0
P, lb P_2O_5/ac	9.0	5.5	7.3	35	7.8	12.5	10.2
K, lb/ton	14.5	14.6	14.5		12.5	23.0	17.8
K, lb K_2O/ac	39.9	27.6	33.8	158	36.8	59.0	47.9
Ca, lb/ton	3.2	3.2	3.2		2.90	4.4	3.6
Ca, lb/ac	7.3	5.0	6.2	38	7.1	9.3	8.2

- This experiment contributes to the ARS cross-location project **REAP** (**R**enewable **E**nergy **A**ssessment **P**roject)

Summary

- **On-going study with one more year of data collection planned.**
- **Inconsistencies across results: residual N during first year, nematode pressure for ES 5200.**
- **Preliminary optimum N fertilizer rates were between 101 and 134 kg N ha^{-1}.**
- **Nutrient removal averaged 120 kg N ha^{-1}, 39 kg P_2O_5 ha^{-1}, 177 kg K_2O ha^{-1}, 43 kg Ca ha^{-1}.**