


GOING ORGANIC:
FIELD PEA – TRIALS & MANAGEMENT

USDA-OREI: BREEDING BIOFORTIFIED PULSE AND CEREAL CROPS FOR U.S. ORGANIC CROPPING SYSTEMS

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FIELD PEA PLANTING MATERIALS

ELITE CULTIVARS & ADVANCED BREEDING LINES

Elite Cultivars – currently in production, obtained from Meridian Seeds and Pulse USA

- Year 1 (2019): 25
- Year 2 (2020): 29

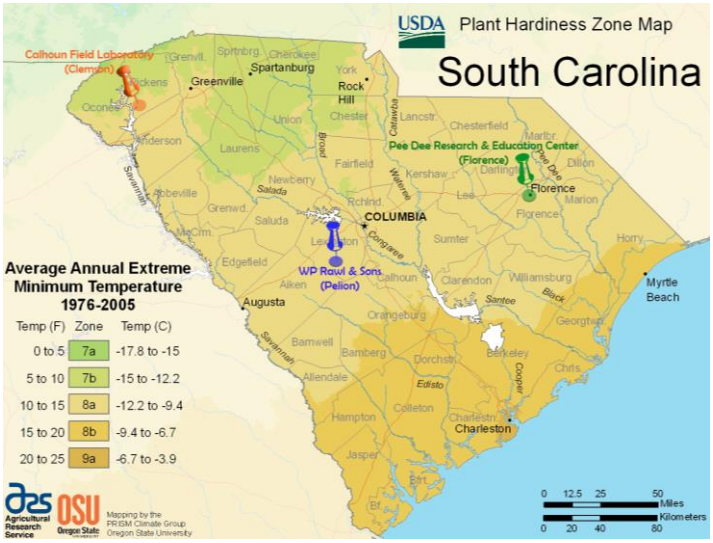
Advanced Breeding Lines – from the USDA-ARS pulse breeding program, Washington State Crop Improvement Association (Pullman, WA)

- Year 1 (2019): 19
- Year 2 (2020): 23

GERMPLASM COLLECTION

Pea Single Plant Plus Collection (PSPPC) – obtained from the USDA-ARS (Pullman, WA)

- Year 1 (2019): 299
- Year 2 (2020): 297



FIELD LOCATIONS

On-Farm Location

- W.P. Rawl and Sons (Pelion, SC)
  - Growing Zone: 8a
  - Soil Type: Sandy Loam

Research Station Locations

- Calhoun Field Laboratory (Clemson, SC)
  - Growing Zone: 8a
  - Soil Type: Clay Loam
- Pee Dee Research and Education Center (Florence, SC)
  - Growing Zone: 8a
  - Soil Type: Sandy Loam

FIELD DESIGN

FIELD DESIGN

- Randomized Complete Block Design (RCBD)
- Border plots around perimeter
- 2-3 replicates per entry

PLOTS

- Advanced/Elite Trial:
  - Dimensions (L x W): 20' x 5'
  - Rows: 7 – 7.5 inches apart
  - Seeding Rate: 90 seeds/m^2
  - Spacing: 5 ft alley
- Germplasm Trial:
  - Dimensions (L x W): 4' x 5'
  - Head rows: 4 – 15 inches apart
  - Spacing: 4 ft alley

RS20	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	RS20
11	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	11
10	B	336	337	338	339	340	341	342	343	344	345	346	347	348	349	350	351	352	B	B	10
9	B	335	334	333	332	331	330	329	328	327	CHK	326	325	324	323	322	321	320	319	B	9
8	B	301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	316	317	318	B	8
7	B	236	237	238	239	240	241	242	243	244	245	246	247	248	249	250	251	252	B	B	7
6	B	235	234	233	CHK	232	231	230	229	228	227	226	225	224	223	222	221	220	219	B	6
5	B	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	B	5
4	B	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	B	B	4
3	B	135	134	133	132	131	130	129	128	127	126	125	124	123	122	CHK	121	120	119	B	3
2	B	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	B	2
1	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	1
RS20	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	RS20

ROW (130 ft)

RANGE (275 ft)

PLANTING

Planting Dates

- Year 1
  - Rawl: January 29, 2019
  - Clemson: February 4, 2019
- Year 2
  - Rawl: January 29, 2020
  - Clemson : n/a

- Advanced/Elite Trial – ALMACO cone plot planter
- Germplasm Trial – 'Head-row' plot planter
- Commercial acre – Conventional grain drill

Inoculant – applied at a rate of 4 lb./ac, in-furrow application
  - AGTIV Pulses Granular Mycorrhizal Inoculant

EVALUATION

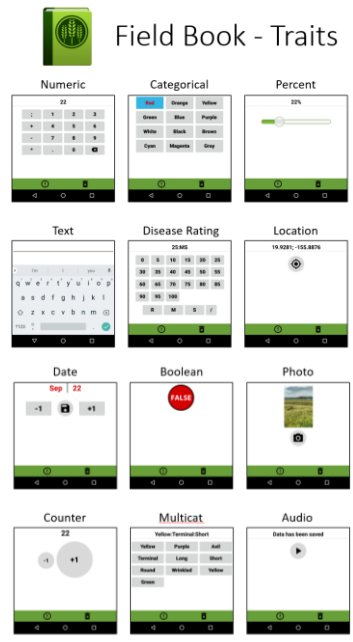
Agronomic Traits:

- Germination
- Vigor
- Days to Flower (DTF)
- Days to Maturity (DTM)
- Vine Length
- Canopy Height
- Canopy Closure
- Lodging
- Pod Height
- Pods per Peduncle
- Disease & Insect Resistance

DATA COLLECTION

'Field Book' App – PhenoApps

- Facilitate & Record – field data collection
  - Agronomic and performance data, photos, and notes
- Create and customize evaluation criteria for each trait
- Export data to a CSV file



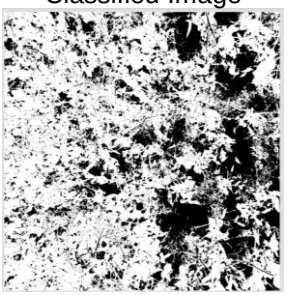
DATA COLLECTION

'Canopeo' App – Oklahoma State University

- Approximation of green canopy cover
- Canopy Closure – quantifies percentage (%) of green/live vegetation

Original Image

Classified Image



Canopy Cover | 66.21 %

Planting Date:	Jan, 29 2020
Upload Date:	May, 07 2020
Field:	ABL Rawl
Vegetation Type:	Pea
Vegetation Height:	in
Latitude:	33.82491683959961
Longitude:	-81.28825378417969
Adjustments:	0.95
Notes:	101

HARVEST

Harvest Dates

- **Year 1**
  - Rawl: May 22, 2019
    - 113 days
  - Clemson: May 30, 2019
    - 115 days
- **Year 2**
  - Rawl: June 3, 2020
    - 126 days
  - Clemson : n/a

Advanced/Elite Trials

- 1979 Almaco SPC20 plot combine with a platform header
- Seeds harvested into cloth or paper bags
- Stored in drying bin
- Cleaned using an air seed cleaner and sieves
- No desiccant used

Germplasm Trials

- Manually
- Plants harvested into mesh bags
- Stored in drying bin
- Almaco BT14 Belt Thresher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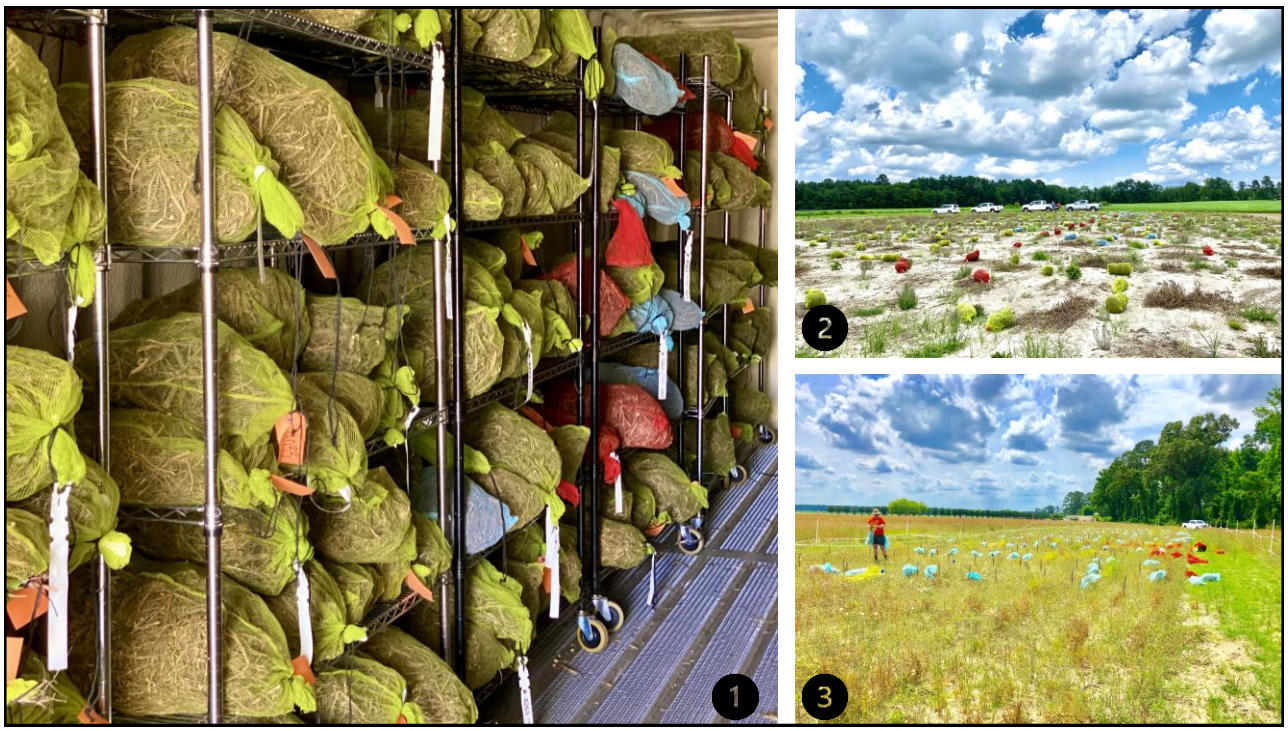
2
3
4
ALMACO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ORGANIC MANAGMENT

FIELD PREPARATIONS: Before Planting

1) Disk Harrow – 1 month
2) Chisel Plow – 3 weeks
3) Cultivate – 2 weeks
4) * Pre-planting Soil Amendments – 1-4 days
5) Cultivate – 1 day

- Cultivation is crucial
- Stale Bed Fallow
  - Allow weeds to germinate (rain or irrigation) before cultivation
- Apply fertilizer/soil amendments at the last cultivation

ORGANIC MANAGMENT

CROPPING SEASON: After Planting

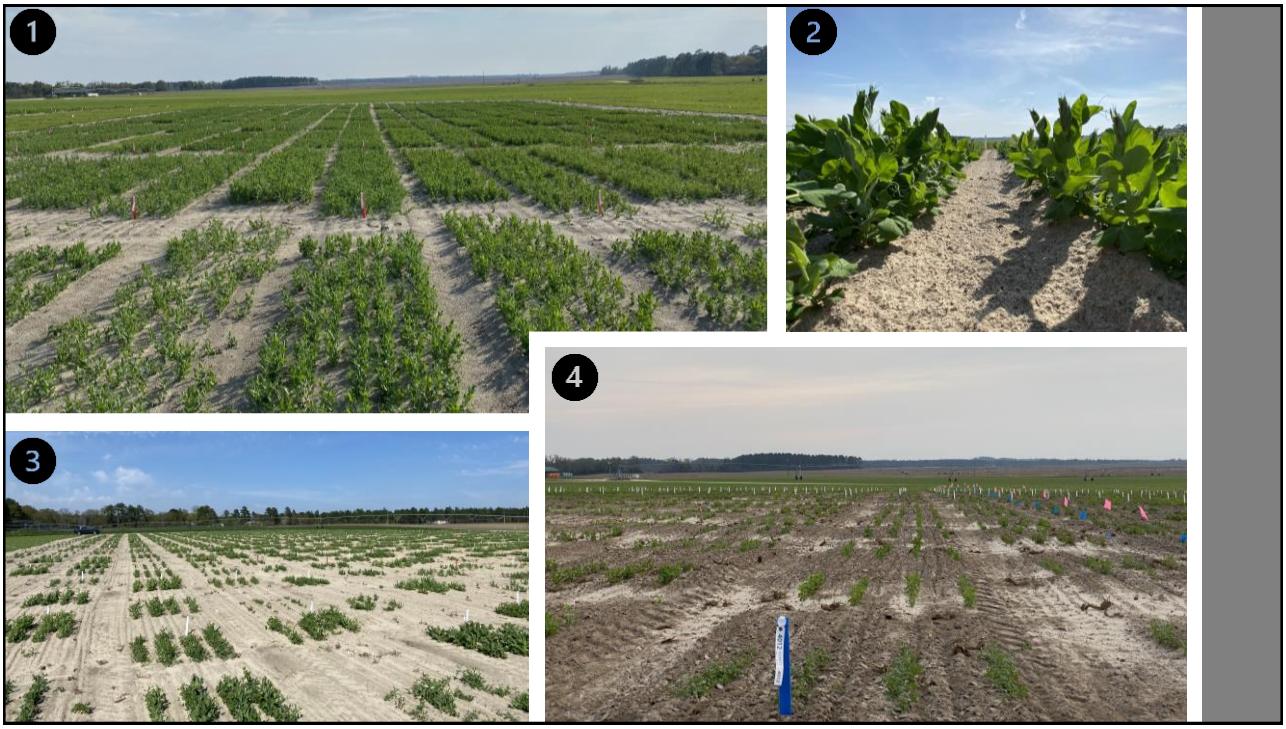
Interrow Cultivation (Tine Cultivator)

1) 3 days
2) 7 days
3) 10 days
4) 14 days
5) 30 days
6) 40 days

Hand Weed – after each cultivation

- Cultivate 1-4 times in the first 14 days
  - Controls ~80% of weed pressure
- Cultivate 5-6 times (ideally) before canopy closure
- Plant – straight and uniform
  - Allows for easy cultivation
  - Lowers risk of damaging plants


1
2
3
4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DISEASE & INSECTS

Powdery Mildew

(*Erysiphe pisi* & *E. trifolii*)

- Most prevalent late in season
  - Warm weather
  - Frequent precipitation and high humidity
- Severity of infection and damage varies, non-resistant cultivars heavily impacted

Bacterial Blight

(*Pseudomonas syringae pv. pisi and P. syringae pv. syringa*)

- Water-soaked lesions, vein-delimited, angular
- Most prevalent late in season
  - Warm weather
  - Frequent precipitation and high humidity
- Fairly common, but often not severe

Ascochyta Blight

(*Ascochyta pisi, A. pinodes*)

- Small, irregular, dark lesions on pod, leaves, and stem
- More frequent with cooler, wet weather
- Typically, not severe

Green Aphid

(*Myzus persicae*)

- Most significant, especially late in season
- Feeds on sap – buds, young foliage, and stems
  - Sticky residue
- Severity of infestation and damage vary
- Vector for viral pathogens
- Often found on underside of leaves

Southern Green Stink Bug

(*Nezara viridula*)

- Uncommon, low infestation
  - Immature (nymphs)
- Late in season
- Typically found on unhealthy or diseased plants
- Feeds upon pods
- Vector for pathogens

FIELD PEA TRIALS

WP RAWL - 2019

CLEMSON – 2019

WP RAWL - 2020

WP RAWL – 2020

CLEMSON – 2020

ACKNOWLEDGEMENTS

Field Team

- Brad Stancil & Team, South Carolina Crop Improvement
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- David Robb, Clemson Organic Farm
- Matt Myers, APT – Clemson University

Research Team & Collaborators

- Rebecca McGee, USDA-ARS
- Emerson Shipe, Clemson University
- Rick Boyles, Clemson University
- Dil Thavarajah, Clemson University

United States Department of Agriculture
National Institute of Food and Agriculture

Going Organic: Breeding biofortified field pea and sorghum

Developing and producing organic sorghum grain

Photo by Sirjan Sapkota

Photo by Ben Dubard

Richard Boyles

Plant & Env Sciences
Clemson University

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Going Organic: Breeding biofortified field pea and sorghum

Organic sorghum is doable!

Top entries yielded >100 bu ac^{-1} in both years of study

- Start off on the right foot — Cultivar/hybrid selection is critical
- Select a hybrid with disease and pest resistance
- Know history of the field, especially weeds
- Soil testing is important (as always)
- Marketing options: Where to sell?

Certified Organic Sorghum
Clemson, SC – Oct 2020

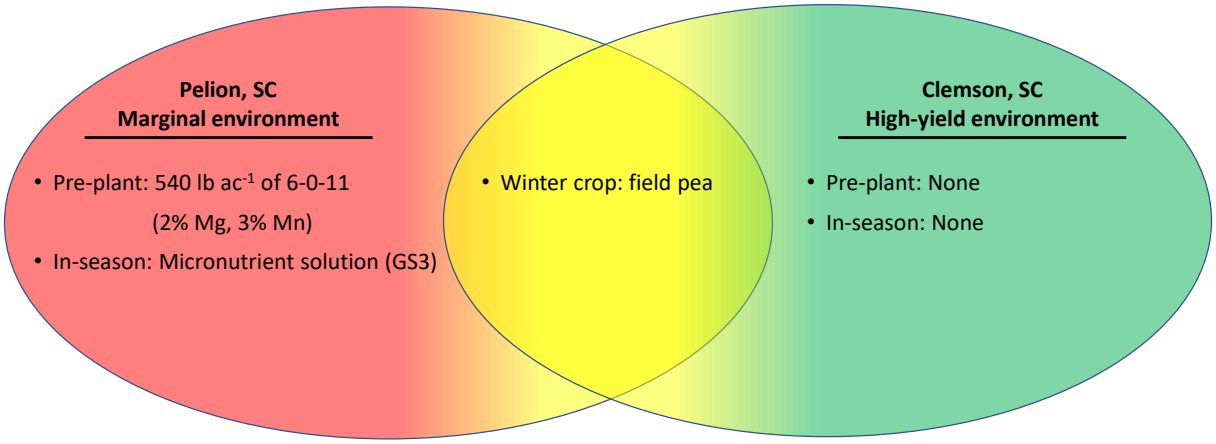
Going Organic: Breeding biofortified field pea and sorghum

Outline

1. Management practices used across locations
2. Traits of importance for organic production
3. Summary of cultivar/hybrid performance
4. Remaining steps to secure profitability

Going Organic: Breeding biofortified field pea and sorghum

Nutrient Requirements



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Weed Management

Pee Dee REC – Florence, SC

- In-row cultivation ONLY
- 30 inch row spacing

WP Rawl – Pelion, SC

- Stale bed fallow (3 weeks prior to planting)
- In-row cultivation, including blind cultivation
- Finger weeding (K.U.L.T Cress)
- Spot flame weeding (handheld)
- 38 inch row spacing

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Disease and Insect Management

NONE

Evaluate crop performance under stress

- Needed for proper disease ratings
- Assess plant tolerance to insect feeding

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Field Trial Overview

- Two years (2019 and 2020)
- Two environments (Pelion, SC and Clemson, SC)
- Two field replicates
- Two-row plots of 20ft length
- 5 ft alleys between plots
- RCBD

Class	Total	Sub – Pigmented	Sub – Food Grade	Sub – Commercial	Sub – Other
Hybrid	70	24	33	7	6
Advanced breeding line	72	41	25	0	6
SAP inbred	43	17	26	0	0
Sweet	10	n/a	n/a	0	10
Maize	4	n/a	n/a	4	0
Sum	**199**	**82**	**84**	**11**	**22**

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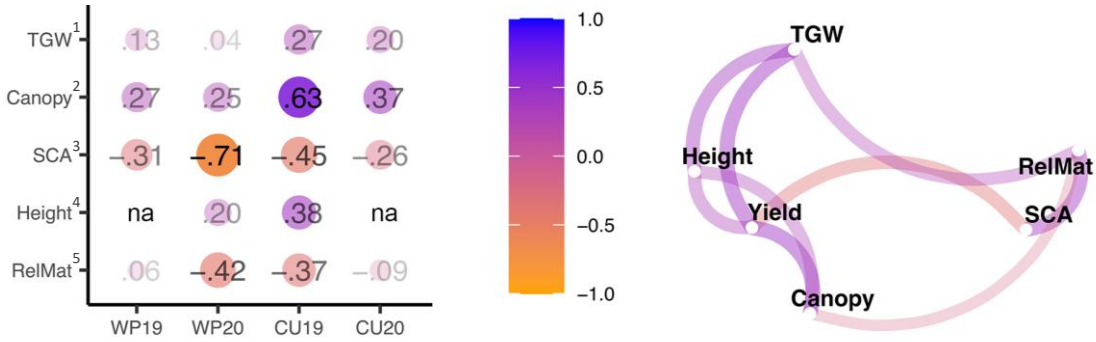
Trait Relationships with Grain Yield



[1]TGW, 1000-grain weight
[2]Canopy, canopy closure prior to heading (1-9 scale)
[3]SCA, sugarcane aphid tolerance (1-9 scale)
[4]Height, plant height (cm)
[5]RelMat, relative maturity (1-5 scale)

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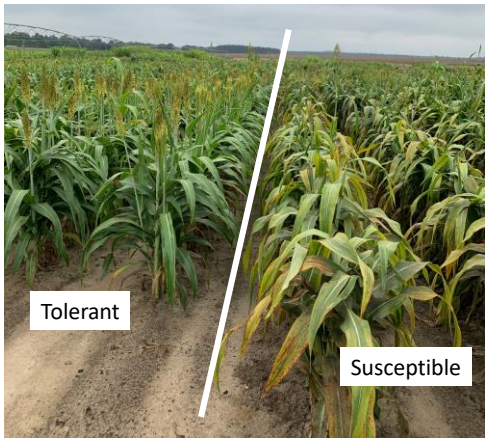
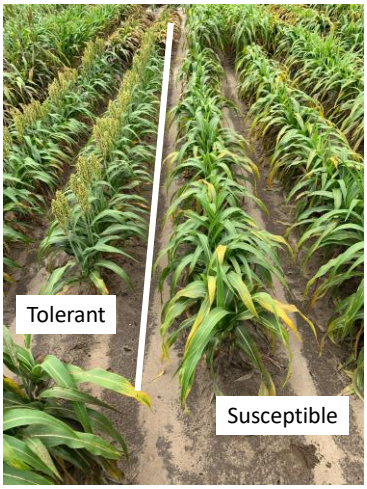
1. Sugarcane aphid Tolerance





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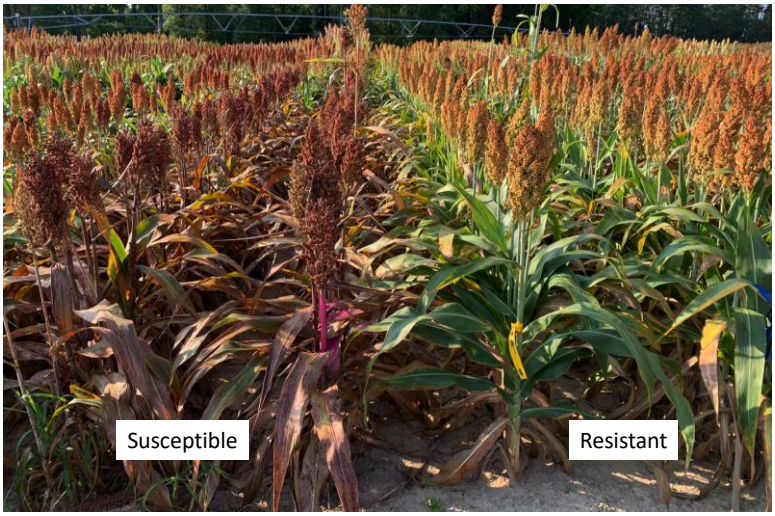
2. Anthracnose Resistance



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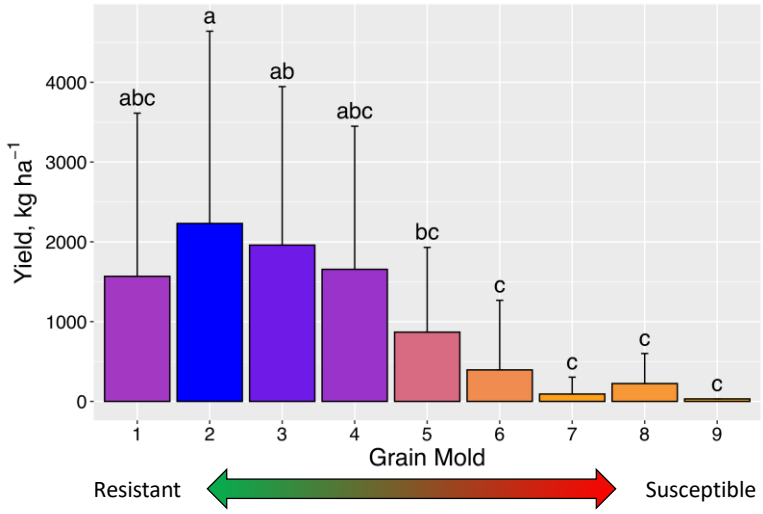
3. Grain Mold Resistance



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4. Standability, Exsertion, and Threshability

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5. Grain Quality and Composition

	Starch	Protein	Crude Fat	Resistant Starch	Phytate	Iron	Phosporus	Zinc
Min	53.6	6.3	1.03	15.4	244	1.43	260	1.44
Max	75.3	13.6	3.24	23.9	306	24.22	460	4.47
Mean	69.0	10.3	2.28	19.4	265	3.36	346	2.48

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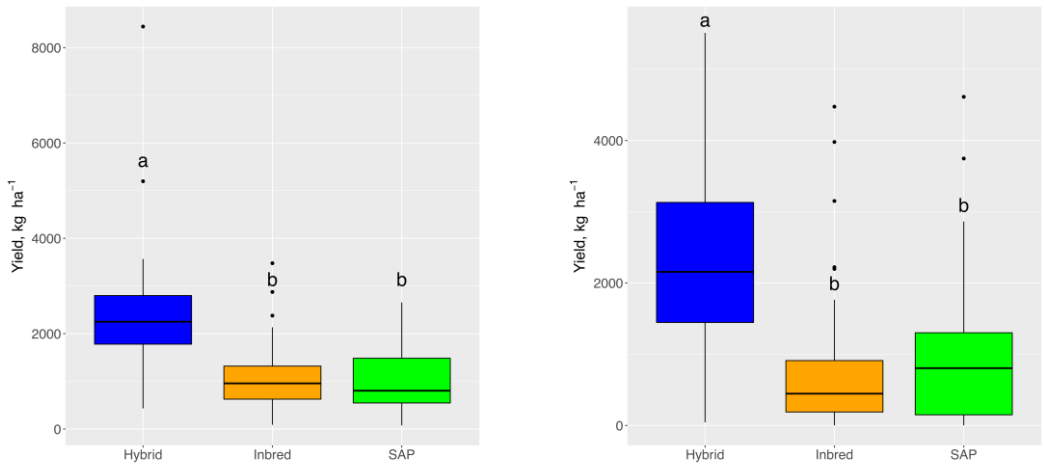
Yield Performance by Genotype Class



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Top Yielding Entries

Entry	Yield	Rel Mat	Canopy	SCA	Height	Mold	TGW
TAMU 5	95.1	2.6	7.3	2.1	149.8	1.8	23.7
PV20_0426	84.7	3.3	5.3	1.3	102.5	1.0	27.2
BRD_0508	78.8	3.5	7.1	3.0	139.8	2.0	25.6
BRD_0735	67.7	3.8	7.4	6.6	148.3	1.4	29.6
PV20_1323	62.5	2.0	6.5	6.3	120.5	2.1	22.5
BRD_0870	61.3	3.0	7.1	6.0	171.0	1.5	30.2
Launch	59.8	3.0	7.5	5.8	149.0	1.9	25.1
FL18_0625	55.4	2.5	2.5	2.5	114.0	n/a	31.9
PV20_1420	54.6	3.8	7.0	4.5	165.0	1.5	29.0
63C5	54.4	2.0	6.5	4.5	123.0	n/a	28.7
BRD_0690	54.2	3.6	7.6	6.3	161.8	1.5	32.6
BRD_0643	54.2	4.0	6.0	7.0	156.0	n/a	25.5
XG491	50.7	3.5	4.8	6.8	114.0	1.9	28.7
Trial Mean	23.2	3.7	4.6	6.4	121.6	2.9	26.0

Commercial hybrids

Launch, 63C5, XG491

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Top Yielding Entries

Advanced breeding lines

Entry	Yield	Rel Mat	Canopy	SCA	Height	Mold	TGW
TAMU 5	95.1	2.6	7.3	2.1	149.8	1.8	23.7
PV20_0426	84.7	3.3	5.3	1.3	102.5	1.0	27.2
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63C5	54.4	2.0	6.5	4.5	123.0	n/a	28.7
BRD_0690	54.2	3.6	7.6	6.3	161.8	1.5	32.6
BRD_0643	54.2	4.0	6.0	7.0	156.0	n/a	25.5
XG491	50.7	3.5	4.8	6.8	114.0	1.9	28.7
Trial Mean	23.2	3.7	4.6	6.4	121.6	2.9	26.0

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Potential Seed Providers

Blue River Organic Seed

PRAIRIE ROAD ORGANIC SEED

Seed Savers EXCHANGE

CarolinaSeed Systems

RICHARDSON SEEDS, LTD.

Sustainable SEED COMPANY EST. 2008

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Marketing Possibilities

General information

- Organic market is tied to regional demand
- Trading platforms: Mercaris and Combyne
- Contact United Sorghum Checkoff Program

Specific possible buyers

- Cornerstone Organic Feeds
- New Country Organics
- Tuscarora Grain Co.

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To get more information on:

- Organic breeding strategies
- Use of molecular breeding tools
- Crop biofortification
- Organic production & management

Virtual OPBI Workshop

7-10 June 2021

www.clemson.edu/cafls/organic-breeding/orei/index.html

FREE REGISTRATION

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Acknowledgments

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Dil Thavarajah, Clemson University
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Bill Rooney, Texas A&M University
Ben Dubard, Walter P. Rawl and Sons
David Robb, Clemson Organic Farm

Thank You!

Questions?

Project Team
Ryan Holmes, Research Associate
William Caughman, Research Associate
Matt Lennon, Research Associate
AJ Ackerman, PhD student

Questions

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