

# Best Management Practices for Carinata Production in the Southeast



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Brassica carinata Summit | Quincy, FL | March 30, 2017





# History of *Brassica carinata* Research at UF, NFREC

- Evaluation of carinata germplasm in 2011-2013, Quincy, FL
- **FDACS grant 2013-2016**
  1. Genotype ecoedaphic adaptability screening – Jay, Quincy, Citra
  2. Production best management practices
  3. Providing ecosystem services
  4. Crop diversification
  5. Carinata oil to 'drop-in' fuels conversion
  6. Seed meal supplementation in ruminant nutrition
  7. Ruminal fermentation and animal performance



# History of *Brassica carinata* Research at UF, NFREC

- Partnership – UF, ARA, Agrisoma, Mustard 21
- Agrisoma, Mustard 21 grant 2013-2018
  1. Multi-location yield performance testing - at Jay, Quincy, Live Oak and Citra, FL
    - AGR044 sib lines (22 entries)
    - Advanced frost tolerant, early maturing lines (20 entries)
  2. Dicamba tolerant mustard screening
  3. NAM project seed increase – 3150 rows
  4. Seed increase of mutagenized *B. carinata* DH lines
  5. Early maturity carinata nursery– 1668 rows





# Agronomic Research Scope at UF, 2015-2017

## Best management practices for *B. carinata* production

Planting date (October, November, December)

### Row spacing and seeding rates

Four row spacing (7, 14, 21, 35")

Four seed rates (2.7, 5.4, 8, 10.7 lb/acre)

### Tillage method and N rates

Three tillage methods (no till, disk, and chisel)

Four N rates (0, 40, 80, and 120 lb N/acre)

### Timing and N rates

Application of 80 lb at planting, bolting, and flowering with differing application combinations

### N uptake and plant nutrient partitioning

Four N rates (0, 40, 80, and 120 lb N/acre)

### Harvest management

Timing of chemical desiccation or swathing

### Plant Growth Regulator

Two PGR (Paczol and Cycocel applied at bolting, flowering, 2 varieties)

### Sulphur and Nitrogen Rate

Four S (0, 15, 30 and 45 lb/acre) and 4 N rates (0, 40, 80, 120 lb/acre)

### Irrigation timing

Irrigated vs non-irrigated, canola vs carinata, bolting vs flowering vs pod set

### Cropping systems

Integration of carinata in sod-based rotation as a winter cover crop

### Fungicide screening

Screening 7 fungicides for Sclerotinia control

## Multi-location Yield Performance Testing – Jay, Quincy, Live Oak and Citra, FL

AGR044 sib lines (22 entries)

Advanced frost tolerant, early maturing lines (20 entries)

## Herbicide evaluations – Jay

Screening herbicide tolerance

Herbicide carry over effects on carinata establishment

## Greenhouse studies – Quincy

Determine N and S effects on early-season growth, physiology, and reproduction of carinata and canola

Determine the effect of irrigation on yield critical stages of carinata and canola

## Seed increase nurseries – Quincy

NAM Project Seed Increase

Seed Increase of Mutagenized *B. carinata* DH lines

## Selection nursery – Quincy

Early maturity carinata nursery

NFREC, Quincy	NFREC, Marianna	WFREC, Jay	SVAEC, Live Oak	PSREU, Citra
<b>D. Wright</b> <b>I. Small</b> <b>J. Marois</b> <b>C. Bliss</b> <b>S. George</b> <b>P. Anderson</b> <b>R. Seepaul</b> <b>T. Stansly</b> Agronomy Cropping systems Soil biogeochemistry Soil microbiology Physiology Crop improve.	<b>N. DiLorenzo</b>          Ruminant nutrition Animal development	<b>R. Leon</b> <b>M. Mulvaney</b>          Herbicide chemistries Crop protection Agronomy Variety trial	<b>P. Troy</b>          Agronomy Variety trial	<b>N. Dufault</b> <b>B. Colvin</b>          Pathology Agronomy Variety trial

# ***Brassica carinata***

## **Characteristics of a competitive dedicated energy crop**



### **Infrastructural fit**

- Fits current agricultural infrastructure of harvesting, handling, storage, transportation, processing etc.
- Crush facilities available

### **Opportunity for value enhancement**

- High value seed meal as well as chemical co-products

### **Crop timing conducive for production and consistent feedstock supply**

- Planted on fallowed underutilized lands
- Planted in fall and harvested in spring in the southeast
- Low water footprint
- Double cropped for increased farmer revenue-leaving May-October for summer crop

### **Desirable agronomics and oil chemistry**

- Superior agronomic traits (drought, heat tolerant, little seed shatter, non-dormant)
- Non edible industrial oil feedstock with proven conversion technology
- Highly desirable fuel chemistry for 'drop in' aviation fuels



# Growth stages: from seed to seed

## Emergence/seedling establishment

**Stage 0** [0.0–0.8]  
Germination and emergence



**25 DAP**

## Vegetative

**Stage 1** [1.0–1.2]  
Leaf production



**70 DAP**

## Bolting

**Stage 2** [2.0–2.2]  
Stem elongation



**95 DAP**

## Flowering

**Stage 3** [3.0–3.9]  
Flower bud development



**120 DAP**

## Seed development/maturation

**Stage 5** [5.1–5.9]  
Pod development



**145/175 DAP**

## Seed desiccation

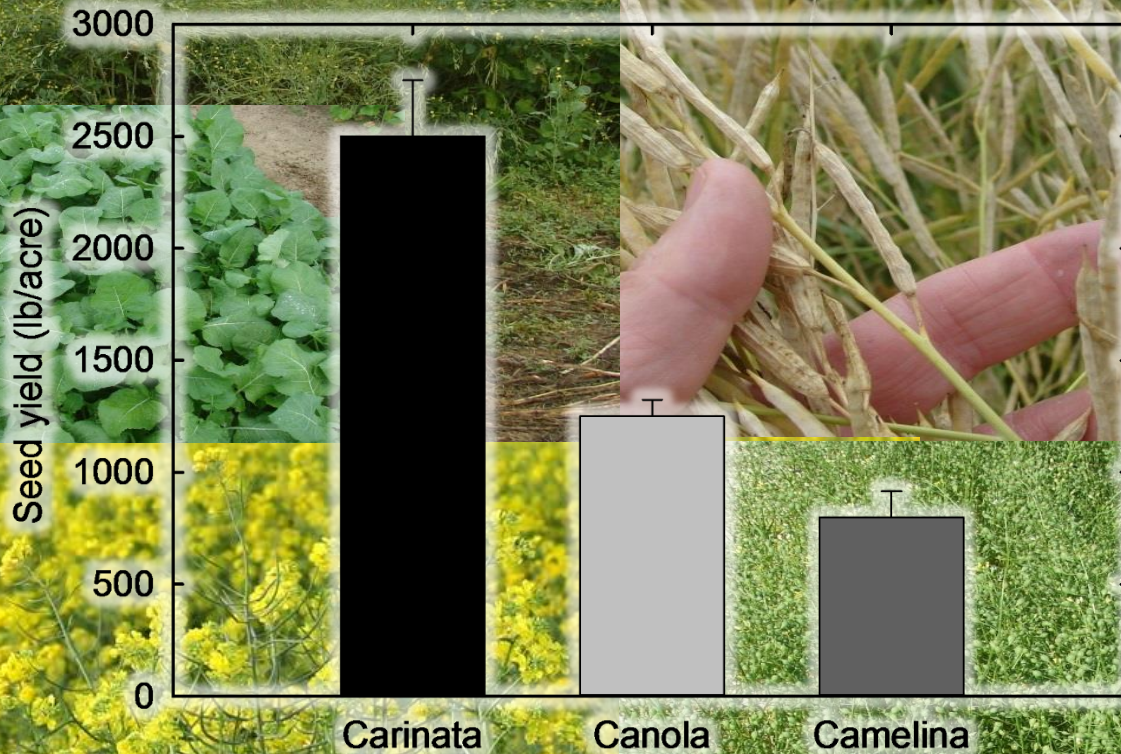


**190 DAP**



# Winter Oilseed Crops in the Southeast

Carinata



Canola

Camelina



# Maximizing Yield Potential

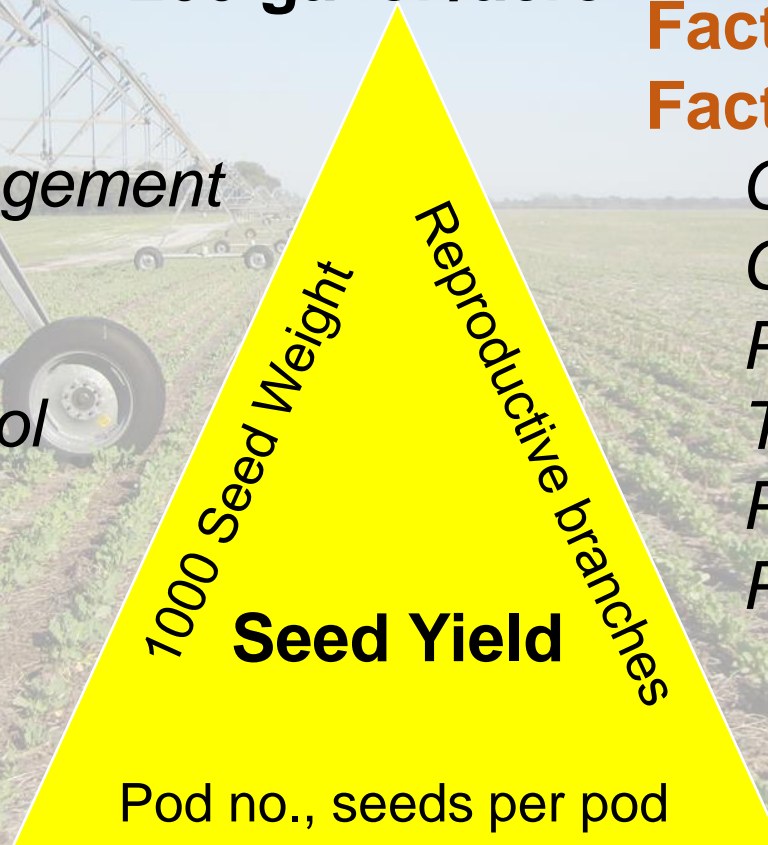
**3500 lb seed/acre  
200 gal oil/acre**

## **Yield Protecting Factors**

*Harvest management  
Weed control  
Insect control  
Disease control  
Irrigation*

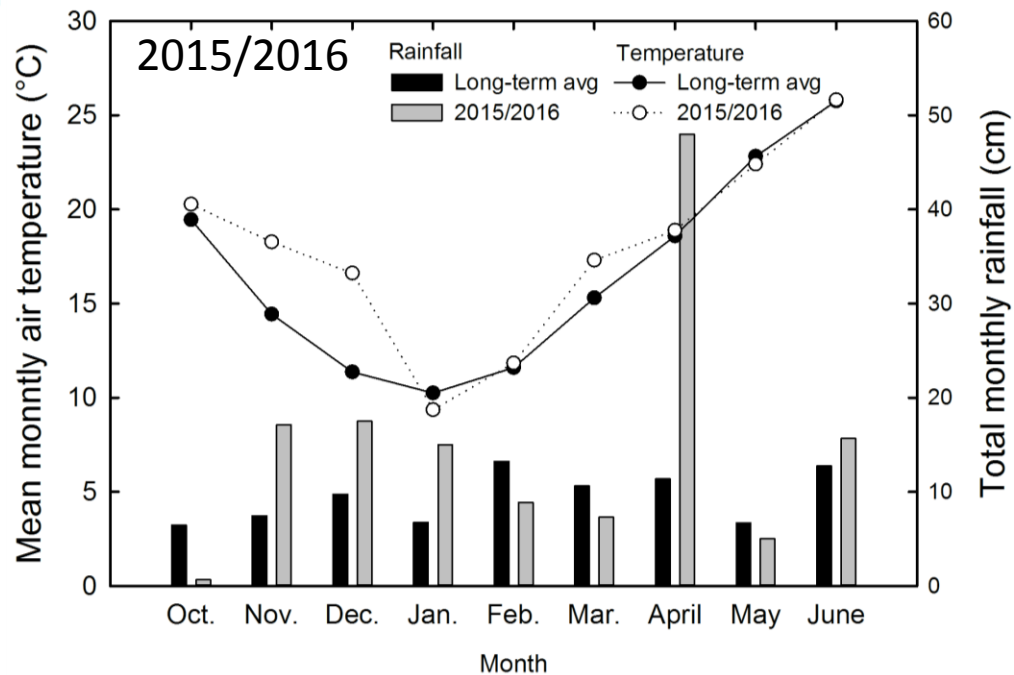
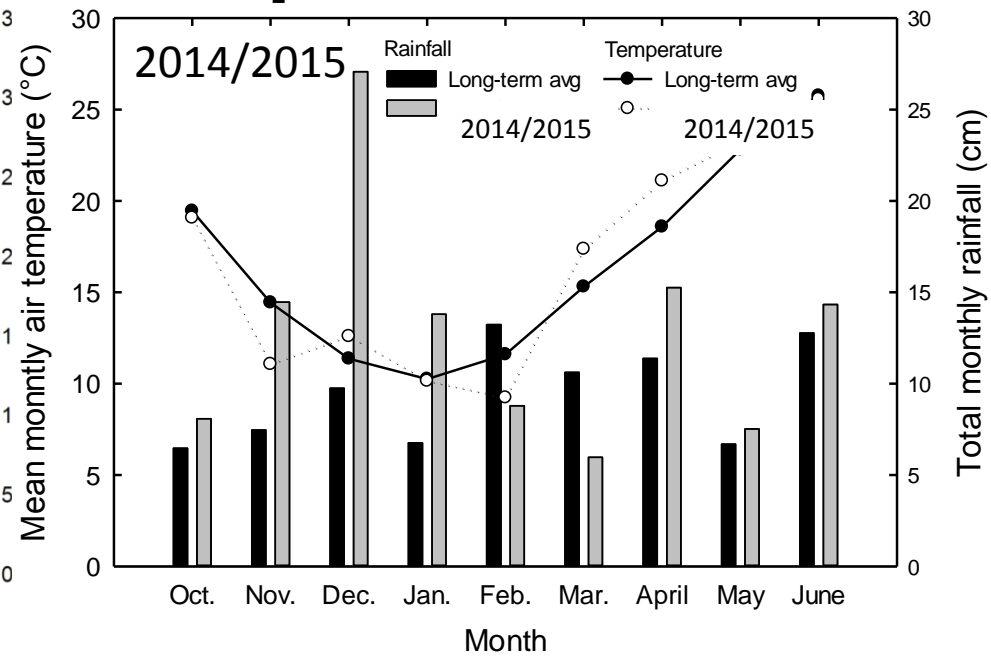
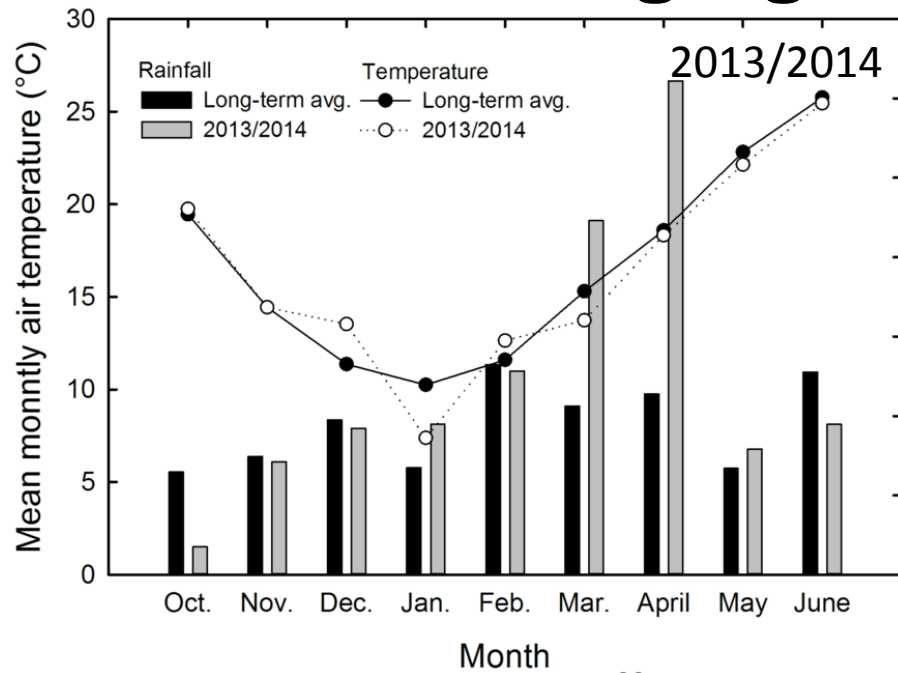
## **Factors Yield Building Factors**

*Crop improvement  
Crop rotation  
Plant nutrition  
Tillage  
Plant density  
Planting Date*



**Best Management Practices**

# Changing weather pattern





# Variety Selection

- AAC A110 has high yield potential, earlier maturing and has 0.5 % higher oil content than its predecessor AAC A100
- AAC A120 has greater yield potential than AAC A110
- AVANZA 641 was identified as a high yielding cold tolerant variety in Florida and currently in commercial production in the southeast
- Ongoing research in region-specific crop genetics



# Advanced yield trials





# Performance of *Brassica carinata* Genotypes (NFREC, Quincy, FL)

Seed Source	Genotype	50%	Freeze	Lodging	Lodging‡	Stand	Seed	Test	1000 SW\$	Seed Yield lb/ac re
		Flowering	Damage	Score†‡		Density	Moisture	Weight		
		DAP	%			plants/ft²	%	lb/bu		
Agrisoma	AGR400-A1	117	8	4.1	9.4	7.4	8.3	53.8	3.0	4996
Agrisoma	AGR044-3B1	119	25	4.9	25.6	6.7	9.3	52.3	3.1	4736
Agrisoma	AGR439-A	116	40	3.3	8.8	4.7	8.2	53.4	3.1	4402
Agrisoma	AGR207-A2	117	25	5	54.4	6.9	8.3	53.1	2.6	3831
Agrisoma	AGR207-11	115	18	4.8	27.5	6.4	7.9	53.6	2.6	3792
Agrisoma	AGR349-M2	95	22	1.5	5.0	6.8	9.7	53.1	2.9	3657
AAFC	AAFC-5465	111	22	4.5	25.6	5.6	8.8	54.1	3.7	3538
Agrisoma	AGR427-A	120	53	4.9	36.3	5.0	8.5	53.1	3.0	3465
Agrisoma	AGR159-1E	119	25	4.8	48.1	4.8	8.4	52.4	3.0	3462
Agrisoma	AGR136-CD	124	10	5	25.6	5.6	8.9	52.2	2.5	3331
Agrisoma	110999EM	118	70	5	33.1	5.3	8.1	52.8	3.1	3313
Agrisoma	AGR489-4	117	18	2.5	5.0	6.3	8.5	53.9	2.4	3288
Agrisoma	110994EM	118	53	5	71.9	4.9	7.9	53.7	3.1	3226
Agrisoma	AGR045-221	120	53	4.9	36.3	5.0	8.5	53.1	3.0	3155
Agrisoma	110998EM	119	48	5	40.6	4.4	8.0	52.4	2.8	3105
Agrisoma	AGR868-3	119	25	4.8	48.1	4.8	8.4	52.4	3.0	2988
Agrisoma	AGR840-A2	117	40	5	81.3	4.6	8.7	53.3	2.8	2973
Agrisoma	AGR859-1	111	18	3.9	10.6	6.0	8.4	53.8	2.5	2969
Agrisoma	AAC A110	119	48	5	67.5	6.0	8.3	52.3	2.9	2953
Agrisoma	AGR185-K2	118	40	5	71.9	4.0	8.5	53.3	2.7	2948
Agrisoma	7.AA60-3.4	119	15	4.9	58.8	6.7	9.2	52.1	3.0	2868
Agrisoma	3118	117	30	4.5	43.8	4.3	8.3	53.1	3.4	2847
Agrisoma	AGR002-C22	116	25	5	64.4	5.4	9.0	54.0	3.5	2830
Agrisoma	110910EM	118	43	5	69.4	4.2	8.2	52.9	2.9	2732
Agrisoma	110996EM	117	45	5	70.0	4.1	8.2	52.3	2.8	2710
AAFC	AAFC-5228	115	38	4.8	63.1	4.8	8.0	52.7	2.8	2629
AAFC	AAFC-5463	118	70	4.8	41.3	5.4	8.2	51.8	3.3	2602
AAFC	AAFC-5467	115	53	5	64.4	5.4	8.5	53.3	2.9	2584
Agrisoma	080814EM-J	111	40	5	71.9	4.5	8.1	52.9	2.6	2551
Agrisoma	AGR215-13	116	55	5	38.1	4.7	8.1	53.8	3.0	2534
Agrisoma	5228	116	25	5	71.3	7.6	8.0	52.1	2.9	2420
AAFC	AAFC-5464	115	53	5	35.0	3.9	8.3	54.0	2.9	2419
Agrisoma	111000EM	115	70	4.8	33.8	3.4	8.2	53.0	3.0	2400
Agrisoma	AGR409-2	117	55	5	53.8	2.9	8.8	50.2	2.5	2395
AAFC	AAFC-5478	114	70	4.3	20.0	4.7	8.6	53	2.9	2389
Agrisoma	AGR215Q-G2	117	50	5	52.5	4.6	8.3	54.3	2.9	2336
AAFC	AAFC-5458	118	55	5	64.4	3.8	8.1	51.5	2.9	2250
AAFC	AAFC-5475	118	50	5	78.1	3.4	8.4	51.9	3.0	2152
AAFC	AAFC-5457	118	53	5	73.8	3.4	8.5	52.4	3.0	1905
AAFC	AAFC-5422	115	68	5	28.1	5.2	8.5	53	3.2	1599
Mean		117	42	4.7	46.5	5.1	8.4	52.9	2.9	2982
Error df		120	120	120	120	120	120	120	80	120
LSD (0.05)		2.6	15.2	0.68	23.8	2	0.63	1.5	0.52	764
CV		1.6	25.9	10.5	36.6	28.7	5.4	2.1	10.9	18.3
R-sq		0.87	0.77	0.74	0.69	0.45	0.44	0.43	0.52	0.69

90 -100 bu/acre

## Variety Selection

- Earlier maturing frost tolerant varieties
- Advanced lines being tested in several locations
- Specific to the Southeast US
- Opportunities to increase yield by 40%

# Spatial Yield Stability: 2016 Carinata Yield Performance (lb per acre)

Genotype	Jay	Citra	Live Oak	Quincy	Mean
3A2B	2322	2822	4358	5384	3722
M-06	1042	3698	4828	5308	3719
M-04	1482	3624	4839	4858	3701
312E	2003	2802	4911	4908	3656
3B1	2114	2576	4515	5336	3635
3A21	2540	2456	4143	4848	3497
W-01	1286	2945	4879	4711	3455
HP-06	901	3322	4485	4866	3393
M-01	1085	2551	5132	4788	3389
3B2	1985	2436	3422	5553	3349
HP-10	989	2678	5426	4138	3308
3111	2157	2296	3472	5131	3264
HP-11	1420	2569	4639	4258	3222
LR-04	1399	2283	4867	4234	3196
HP-15	1181	2890	4218	4357	3162
AACA120 (Check)	886	2562	4862	4299	3152
E-05	1262	2034	4453	4593	3086
AACA110 (Check)	1050	3174	4237	3667	3032
E-04	1473	1933	3904	4680	2998
LR-03	1304	2668	4029	3794	2949
HP-09	1295	2111	3340	4274	2755
HP-08	1069	1908	3383	4065	2606
Grand Mean	1466	2652	4379	4639	



# Field Selection

- Medium to light well-drained soils with pH 5.5 – 6.8
- Deep sands require intense fertility program
- Avoid fields with excessive wild radish. Wild radish mixed with carinata seed will reduce oil quality and attract price dockage
- Avoid fields planted with carinata or other Brassicas in the past 12-24 months. Rotate with cereals.
- Carinata is susceptible to herbicides (Cadre, Strongarm) used in cotton-peanut rotations. Consider field herbicide history before planting and do not seed in fields where there is a herbicide carryover risk

# Crop Rotation

Cadre effect on carinata growth (Santa Rosa County, FL, 2016)



Source: Ramon Leon



# Field Preparation

## Tillage

- Conventional, minimum, or no-till
- Firm with roller if using deep tillage or chisel plow
- Minimum stubble height with no-till
- Level seed bed
- Localized compaction determines root and subsequent shoot growth





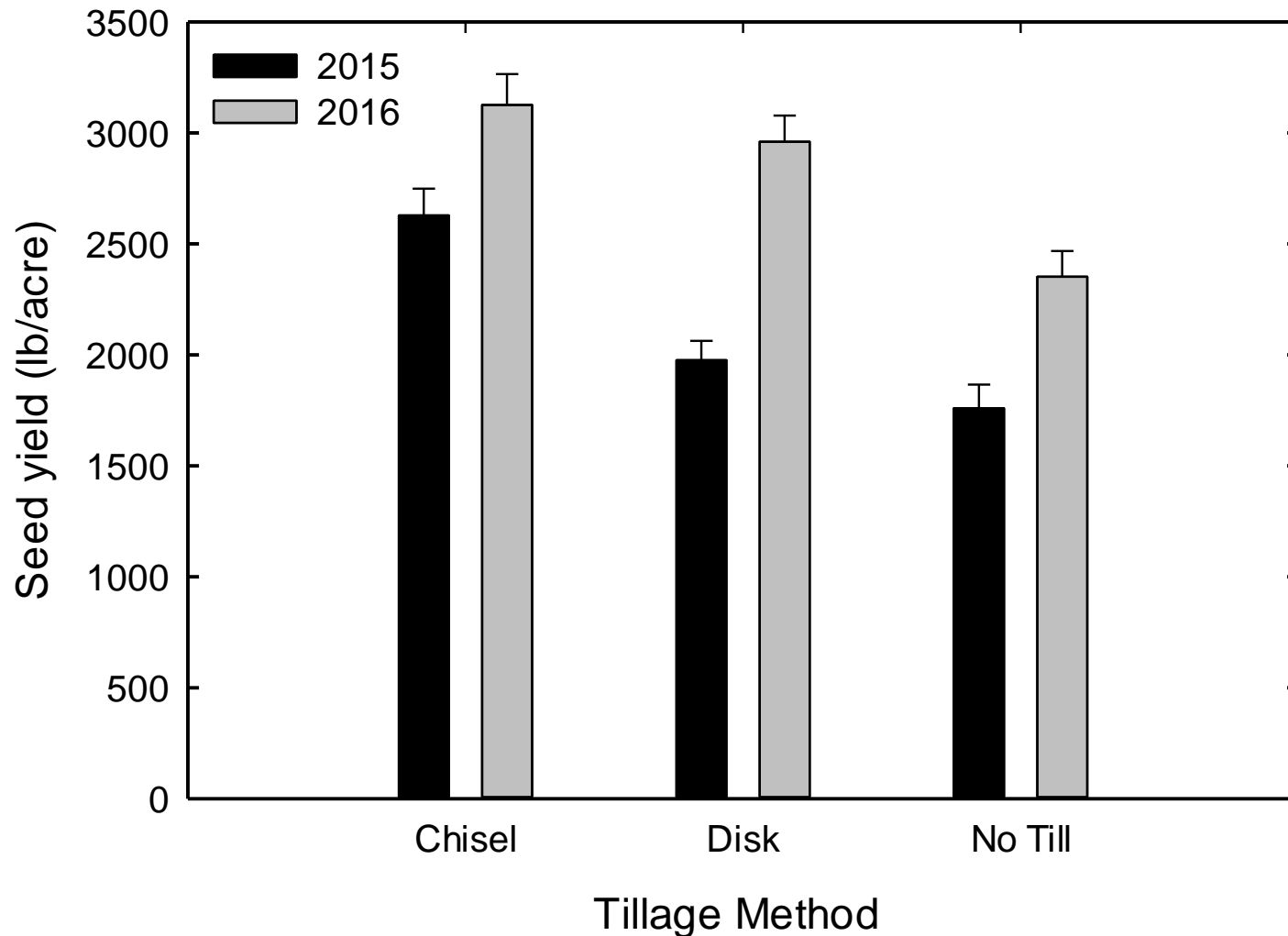
No till fields should have winter weeds killed before planting or immediately afterwards

No-till into killed bahiagrass  
Manage thatch to maximize seed-soil contact.

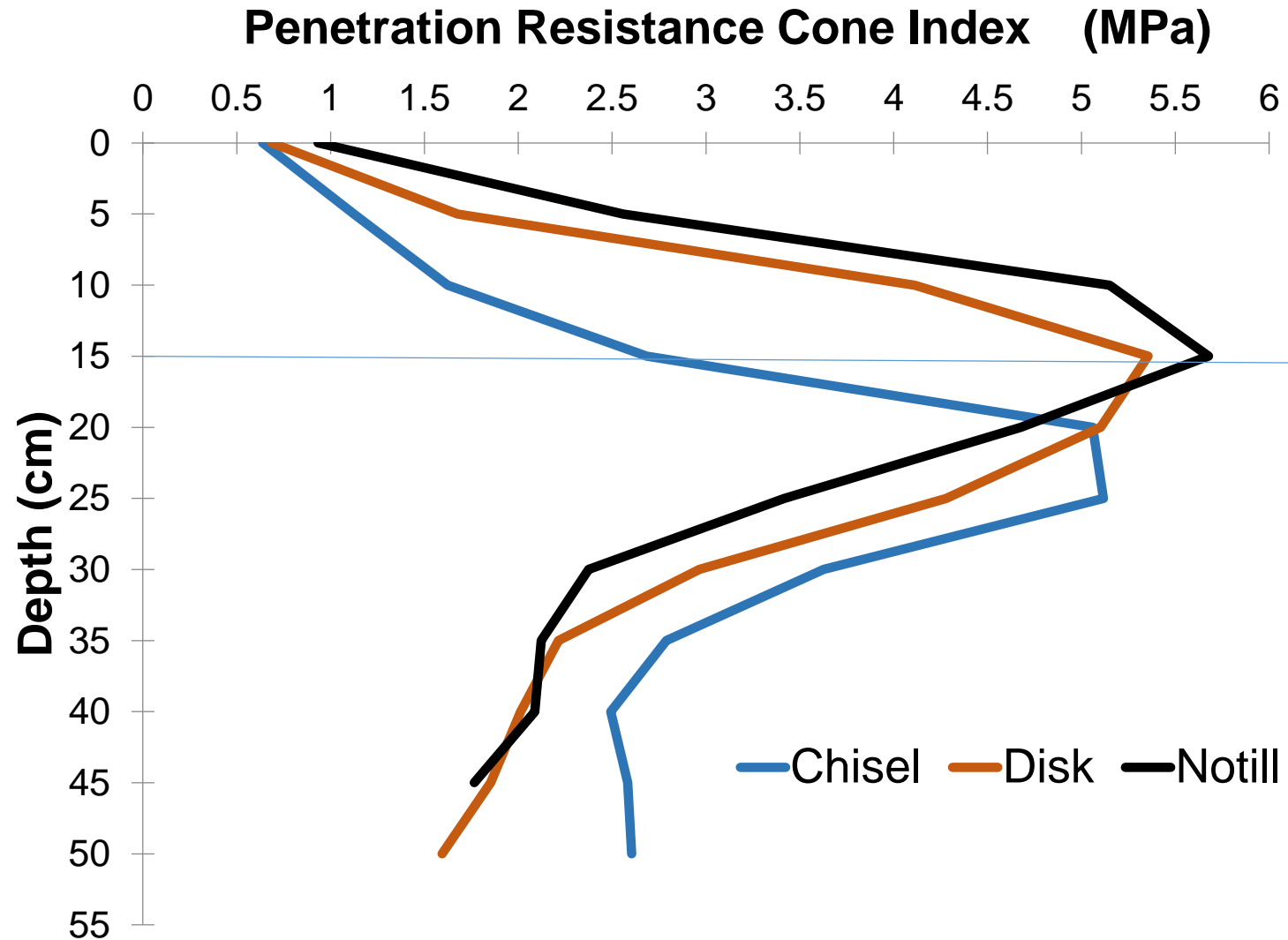


# Effect of tillage method on carinata yield

Quincy, FL, 2015 and 2016



# Soil Compaction differ with Tillage Method





# Planting date

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- **November 1-30**
- **November 1-15 is optimum**
  - Maximize yield potential
  - Reduce pest and disease incidence
  - Timely harvest allowing for on-time planting of next crop



# Planting date

Quincy, FL, March 2014

Nov. PD

Dec. PD

Oct. PD





# Planting date effect on carinata yield and oil yield

Quincy, FL, 2014

Planting date	Yield	Oil content	Oil Yield
	lb/acre	%	gal/acre
Oct. 21	1167 b	38 b	66 b
Nov. 13	3559 a	40 a	212 a
Dec. 13	1550 b	39 ab	90 b
LSD	858	1.71	462

† Within columns, means followed by the same letter are not different ( $P > 0.05$ )

# Shifting the Planting Window with New Genetics

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## 2016/2017 study

- Entries
  - 20.008 (cold tolerant)
  - 40.008 (cold tolerant)
  - Commercial check (Avanza 641)
- Three planting dates
  - 10/16/2016
  - 11/1/2016
  - 11/18/2016



# Crop establishment

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## **Depth**

$\frac{1}{2}$  -  $\frac{3}{4}$  inch - deeper with sandy soil

## **Seeding rate**

5-6 lbs/ac, depending on seeder

## **Row spacing**

7-14 inch





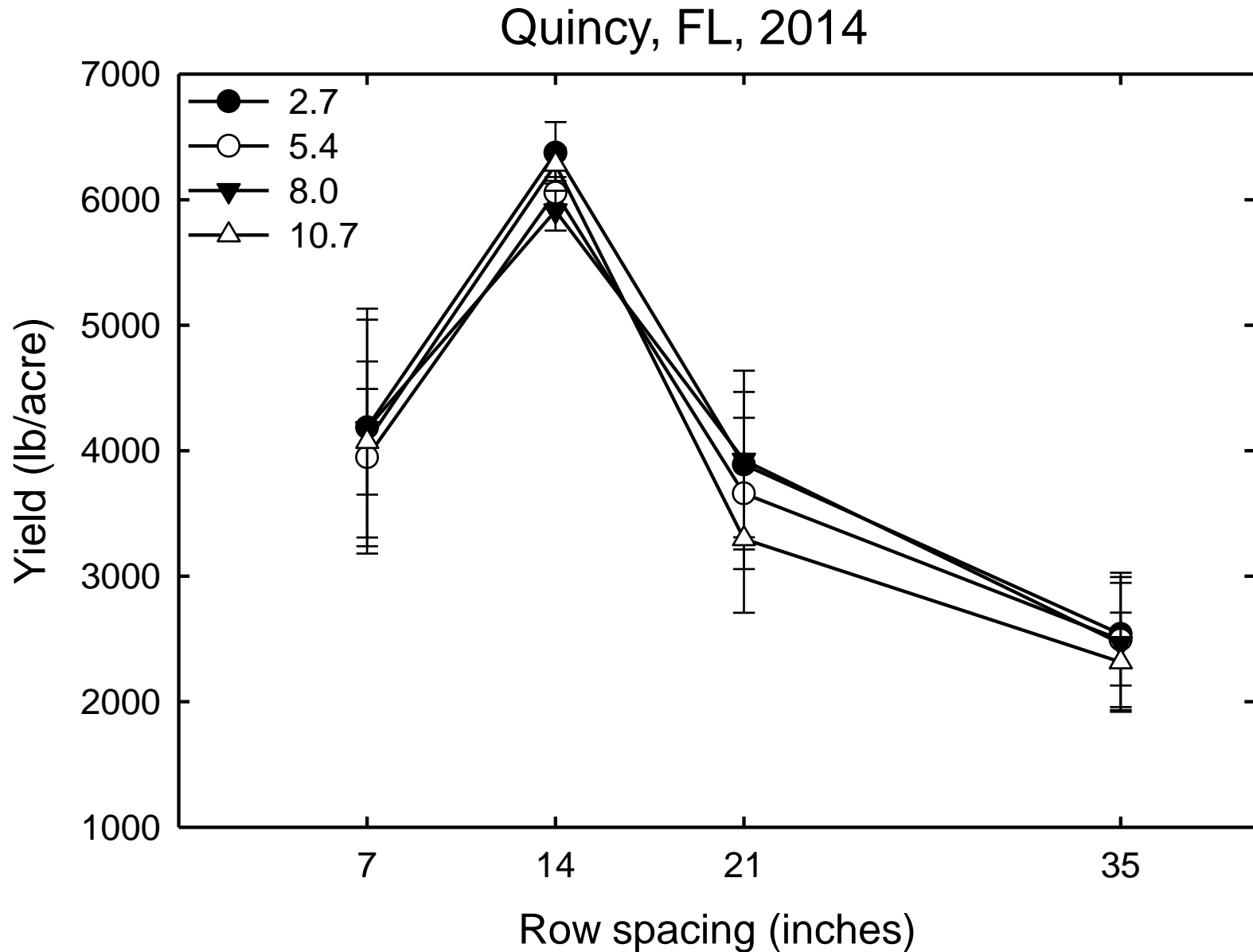
- Shallow seeding into a firm, moist seedbed
- Shallow seeding depth require adequate moisture in top 1"
- Post-rainfall soil crusting form a physical barrier to emergence (residue management)



# Row spacing effect on canopy architecture



# Row spacing and seeding rate effects on carinata yield





# Row spacing and seeding rate effects on carinata yield

Quincy, FL, 2016

Seeding rate (lb/acre)	Row spacing (inches)				Mean
	7	14	21	35	
2.7	2726	3056	2442	2591	2704 a
5.4	2891	2806	2554	2706	2739 a
8.0	3399	2921	2324	2464	2777 a
10.7	3046	2433	2410	2430	2580 a
Mean	<b>3016 a</b>	2804 b	2433 c	2548 c	

# Harvest Management

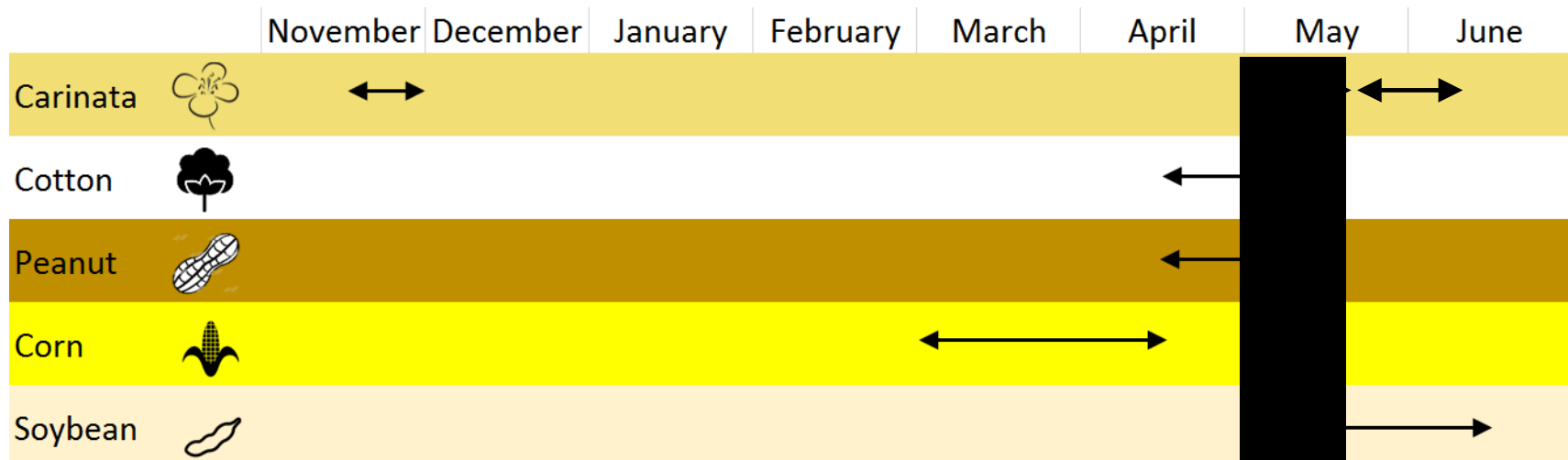
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- Seed moisture will decrease quickly after physiological maturity
- Pods and branches will continue to dry and appear brown
- Main stem will remain slightly green
- Harvest at 8-10% seed moisture
- Harvest aid for desiccation of late pods and stem
- Proper set-up of combines is a necessity – check manual for screen size and settings



# Carinata Harvest Management

## Favorable Planting Windows for Row Crops in Florida



- Harvest methods that accelerate seed dry-down and harvest would facilitate the timely planting of summer crops in the Southeast US

# Carinata Harvest Management

DAPM	2014/2015		2015/2016	
	Treatment	Harvest	Treatment	Harvest
0	13-May-15	13-May-15	27-Apr-16	27-Apr-16
7	13-May-15	20-May-15	27-Apr-16	04-May-16
14	20-May-15	27-May-15	04-May-16	11-May-16
21	27-May-15	3-Jun-15	11-May-16	18-May-16
28	03-Jun-15	10-Jun-15	18-May-16	25-May-16



# Harvest Management

## Staging carinata for chemical desiccation

Desiccated May 13 2015

Harvested May 20 2015



**50% seed MC**

**23% seed MC**



# Harvest Management

## Staging carinata for chemical desiccation

Desiccated May 27 2015



**19% seed MC**

Harvested June 3 2015



**16% seed MC**



# Harvest Management

## Staging carinata for chemical desiccation



50%



35%



25%



14%



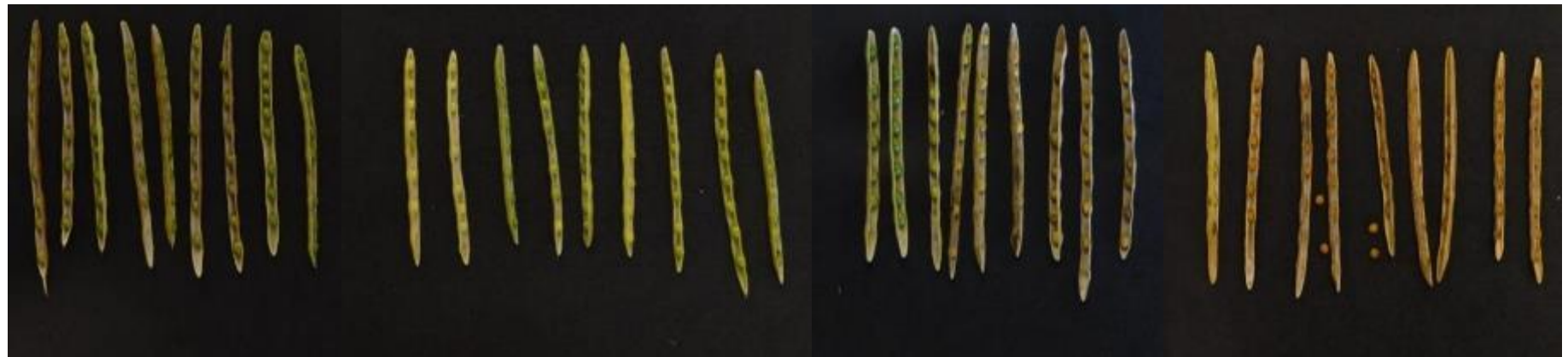
10.5%

May 13 2015

May 20 2015

May 27 2015

June 3 2015



# Carinata Harvest Management

**Staging carinata for chemical desiccation  
> 70% of seeds are physiologically mature**



Pods are tan to brown  
Seeds are yellow/brown



Pods are yellow to light brown  
Seeds are light yellow  
Stems are light green



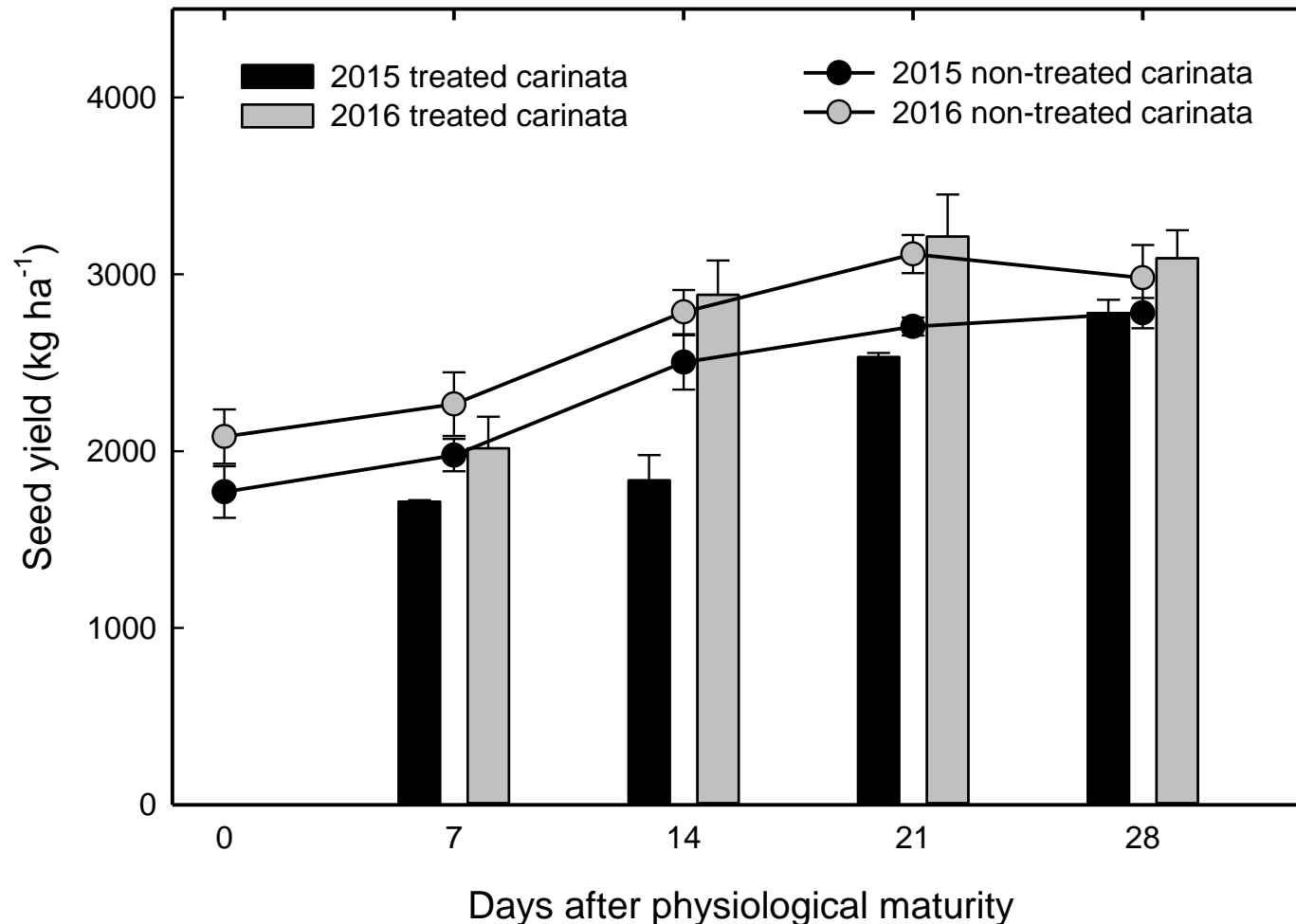
Pods are light green to yellow  
Seeds are green to light yellow





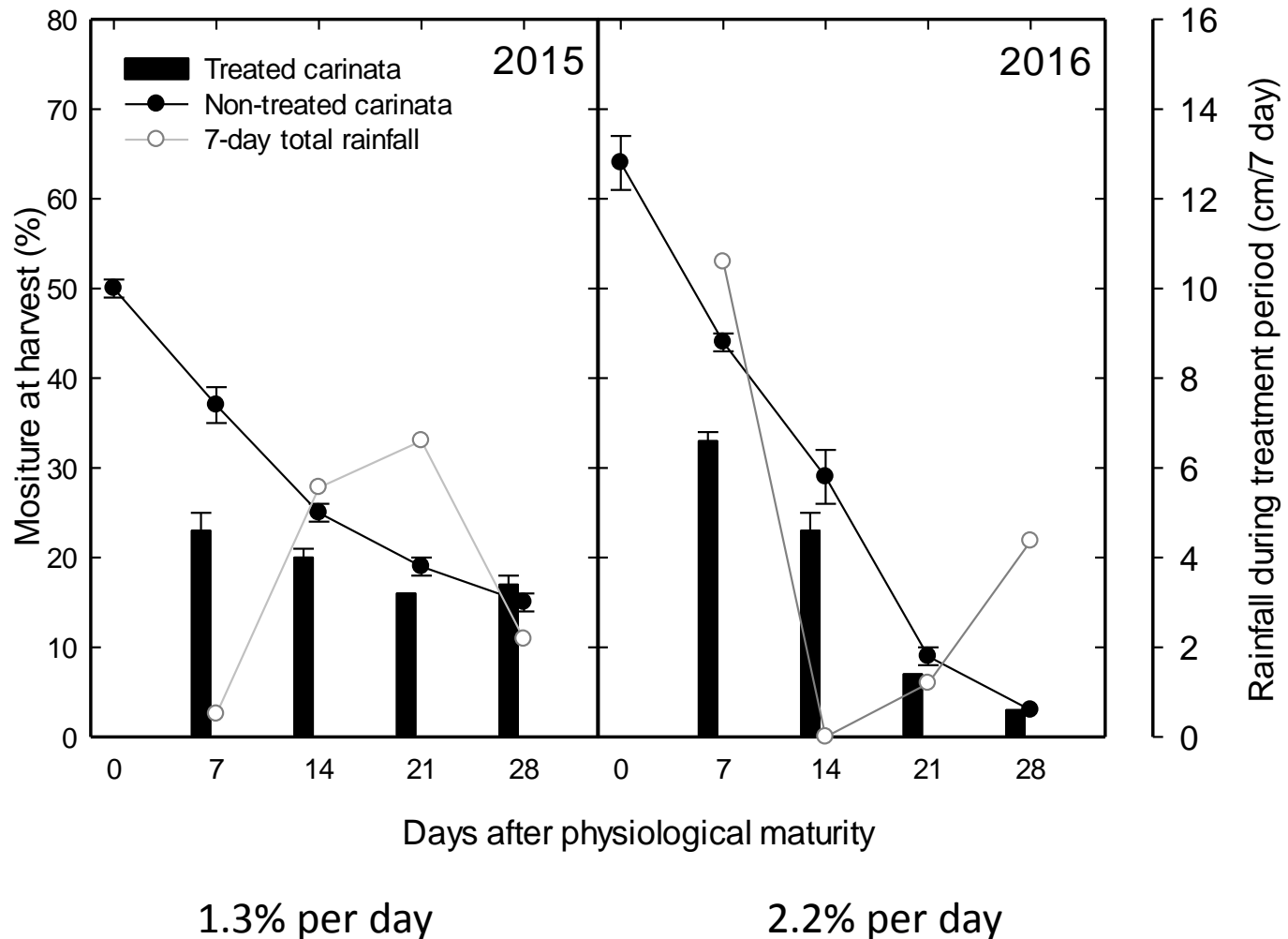
# Carinata Harvest Management

## Chemical desiccation effects on yield



# Carinata Harvest Management

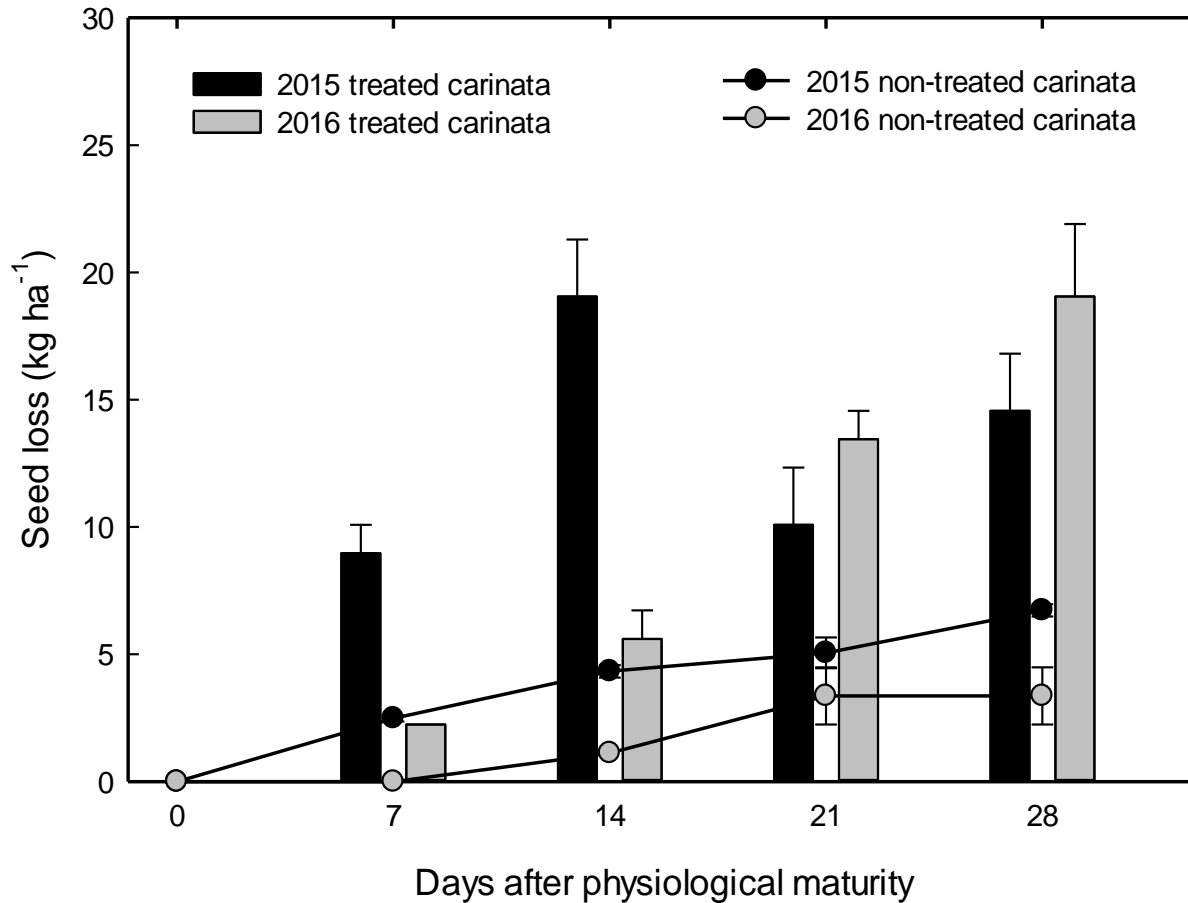
## Chemical desiccation effects on harvest moisture





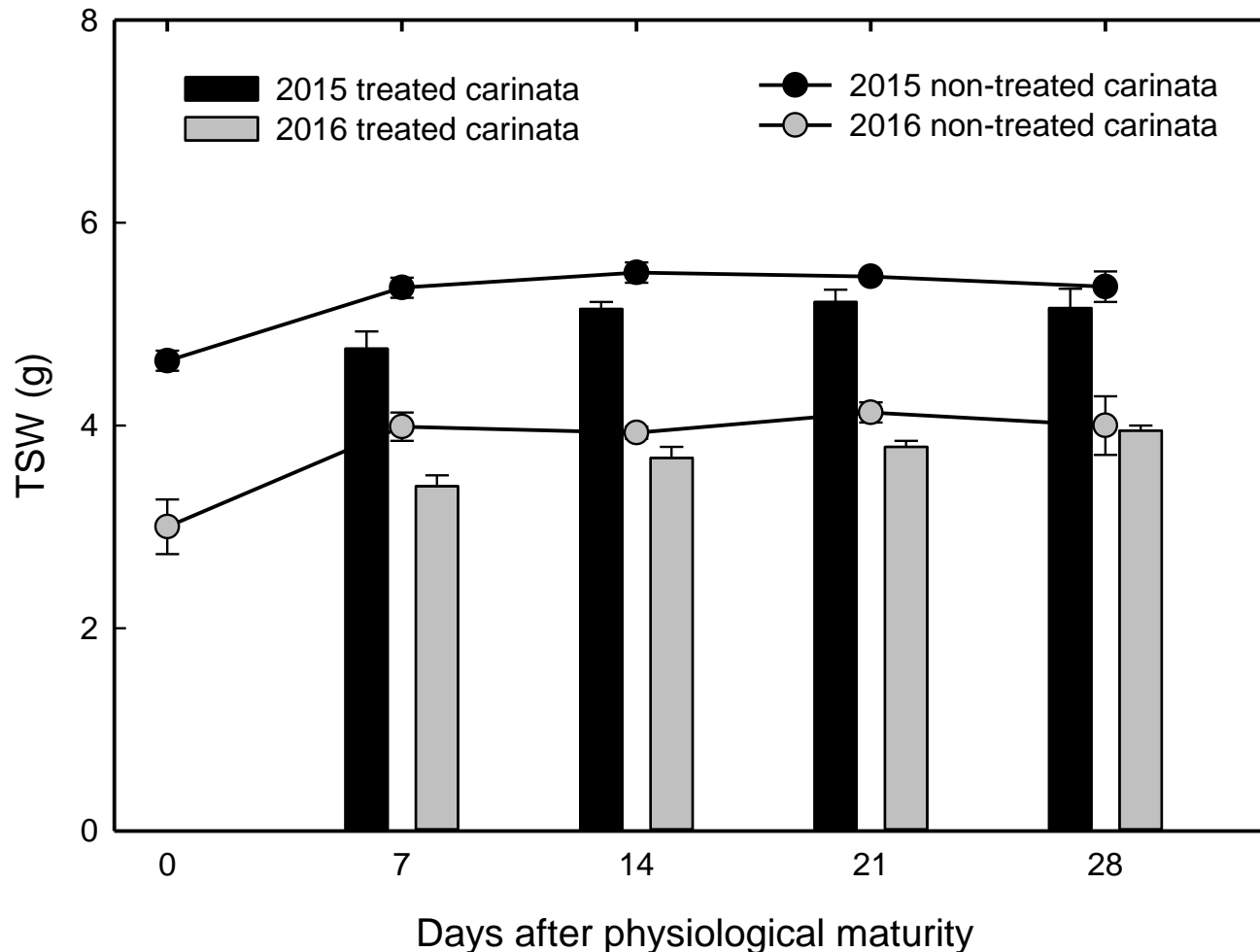
# Carinata Harvest Management

## Chemical desiccation effects on seed loss



# Carinata Harvest Management

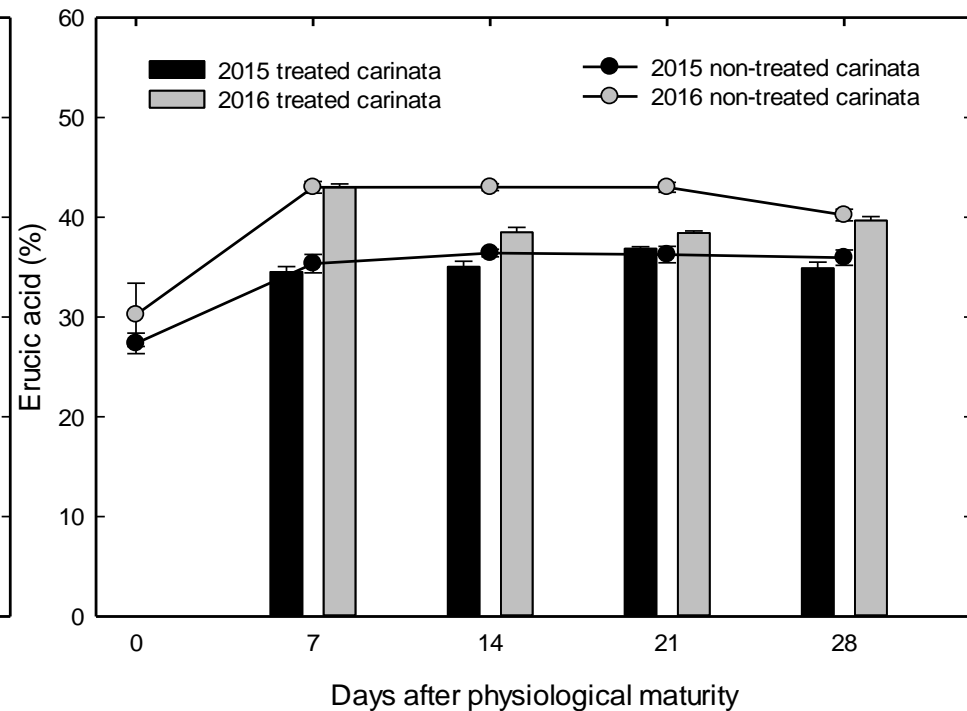
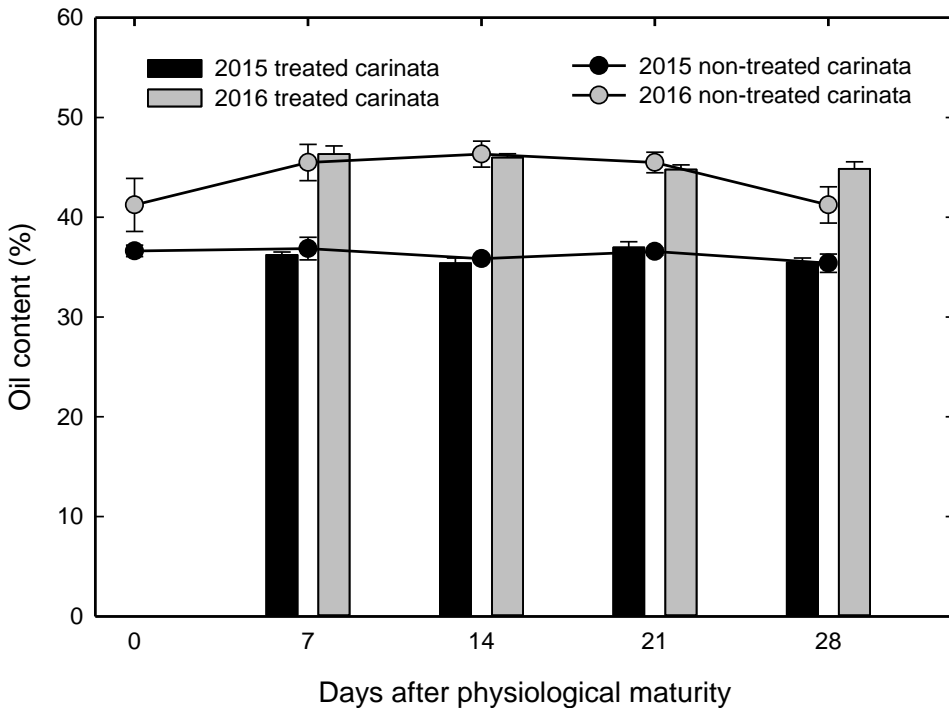
## Chemical desiccation effects on 1000 seed weight





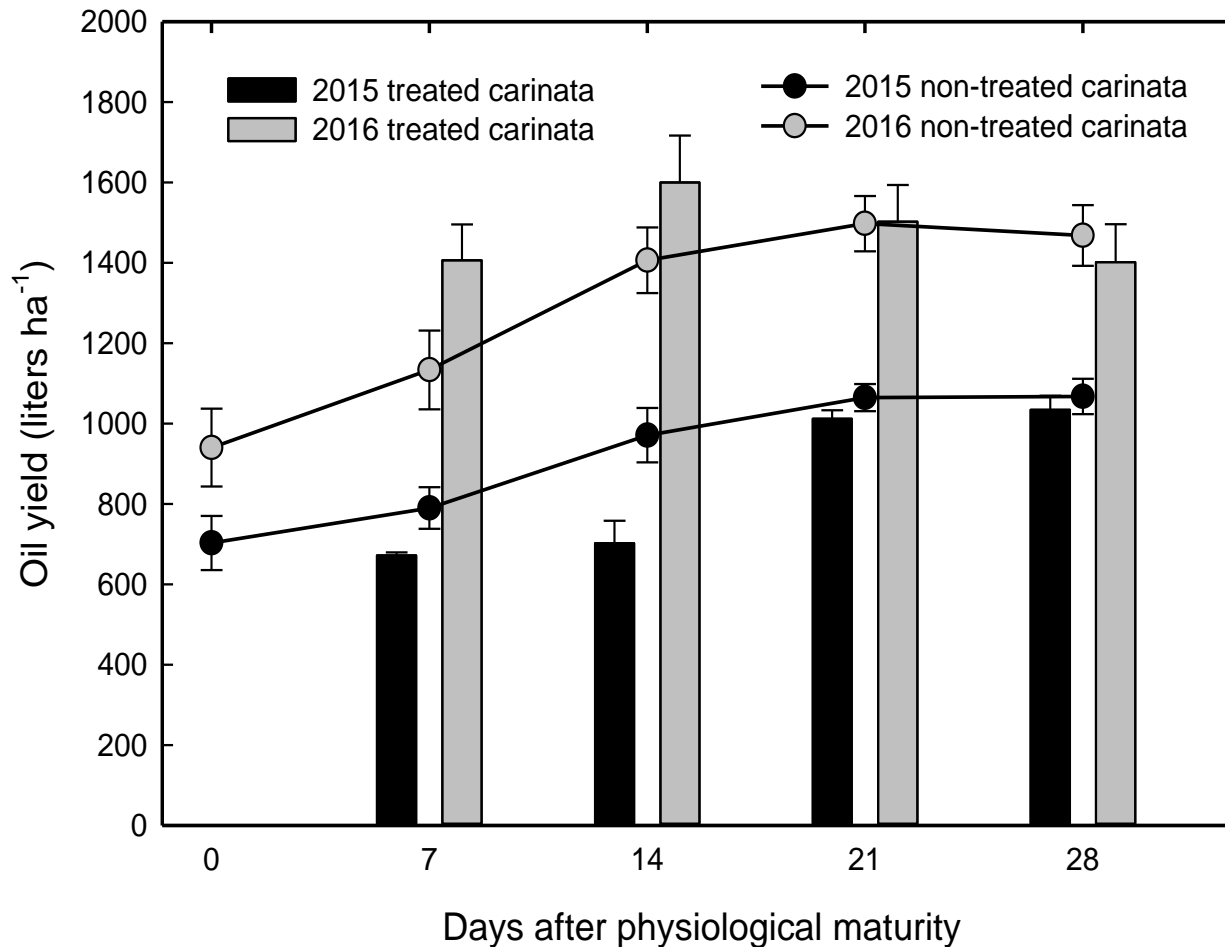
# Carinata Harvest Management

## Chemical desiccation effects on oil content



# Carinata Harvest Management

## Chemical desiccation effects on oil yield



# Production field at harvest in early June, Quincy, FL



Use machine settings and screens for rapeseed outlined in the operator's manual and fine-tuned for conditions in the field



# Harvest Management

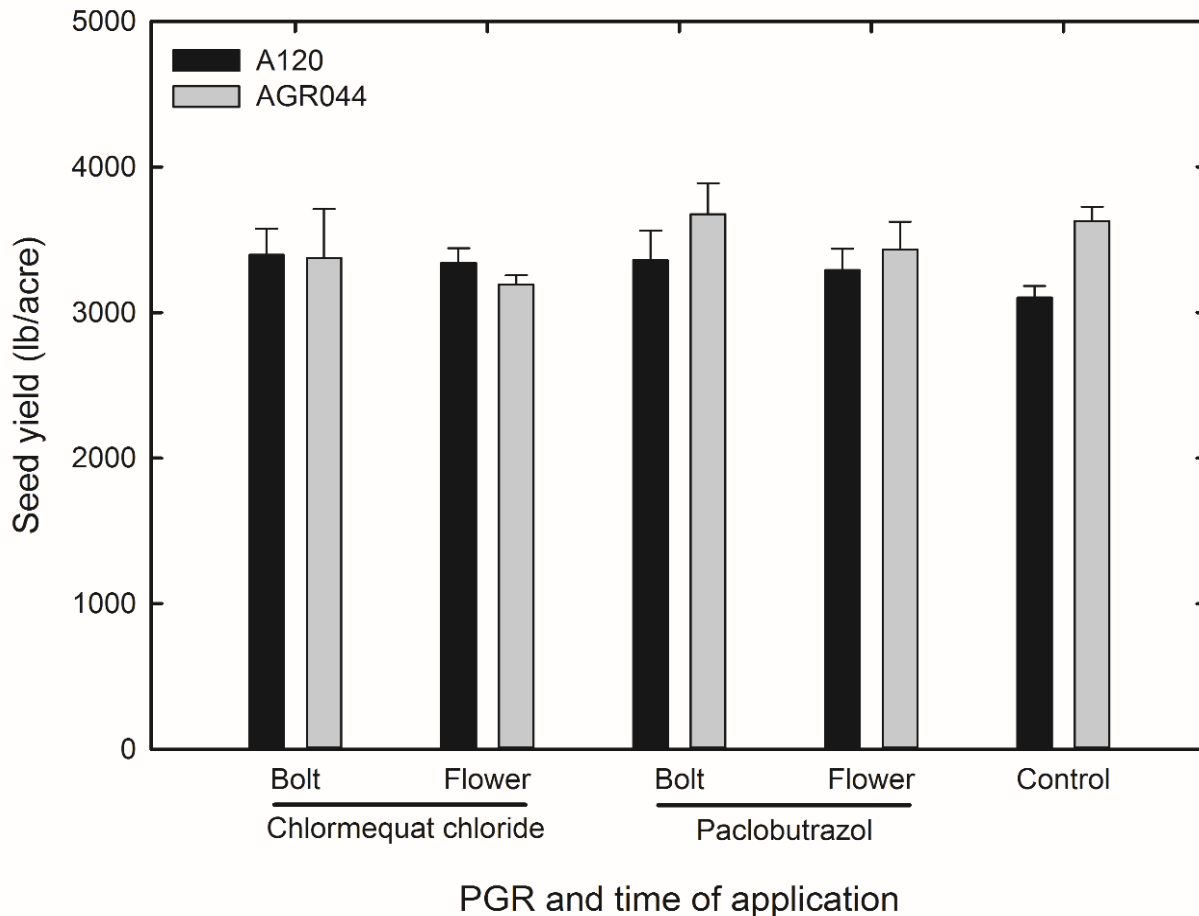
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## 2016/2017 study

- Two contact desiccants
  1. Reglone (diquat dibromide)
  2. Paraquat
- Two systemic desiccants
  1. Sharpen (saflufenacil)
  2. Roundup (glyphosate)
- applied at 1x and 2x label rates
- 7, 14, 21 and 28 days post physiological maturity

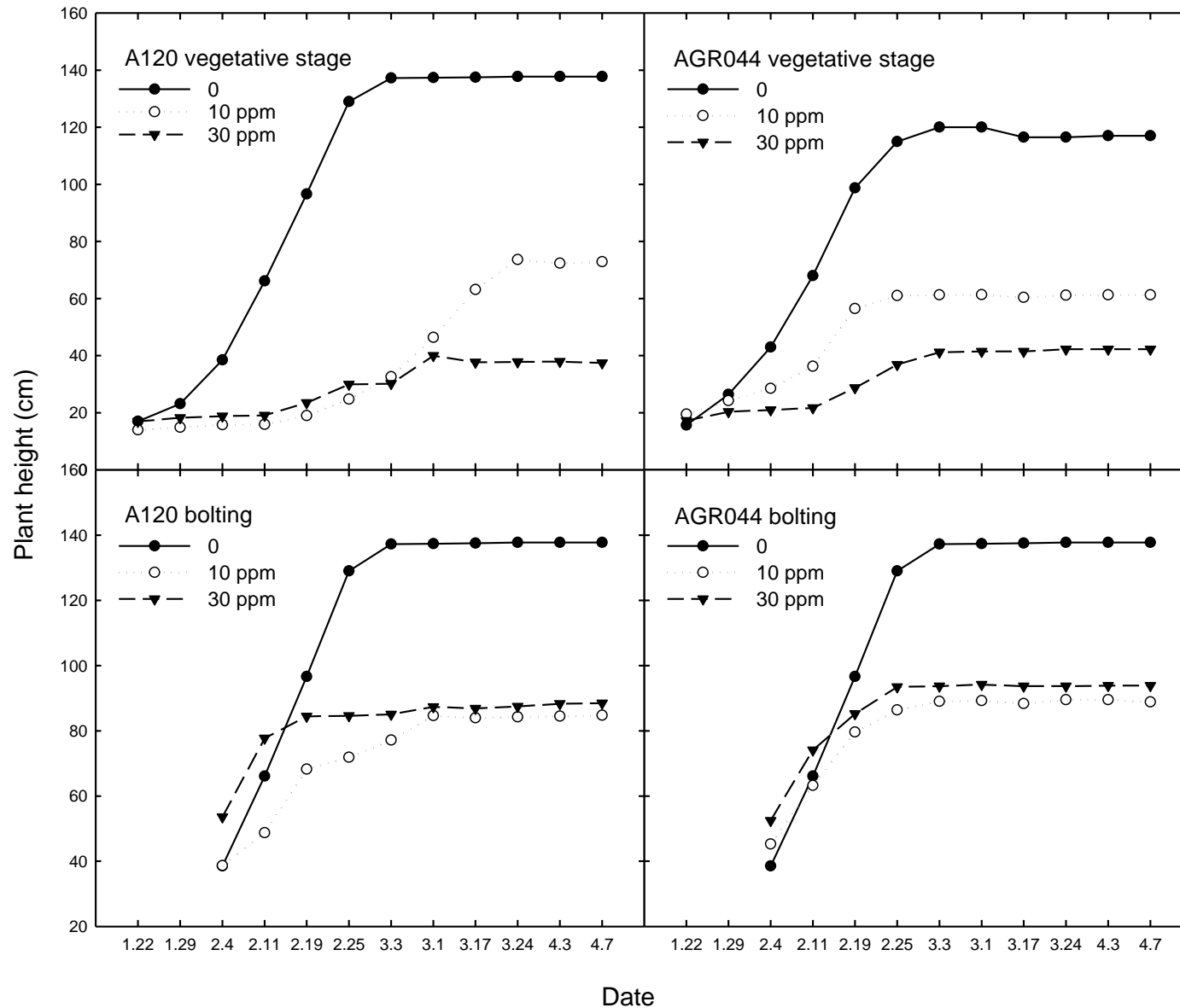
# Plant Growth Regulators

Response of carinata to plant growth regulators during the 2015/2016 growing season, Quincy, FL.

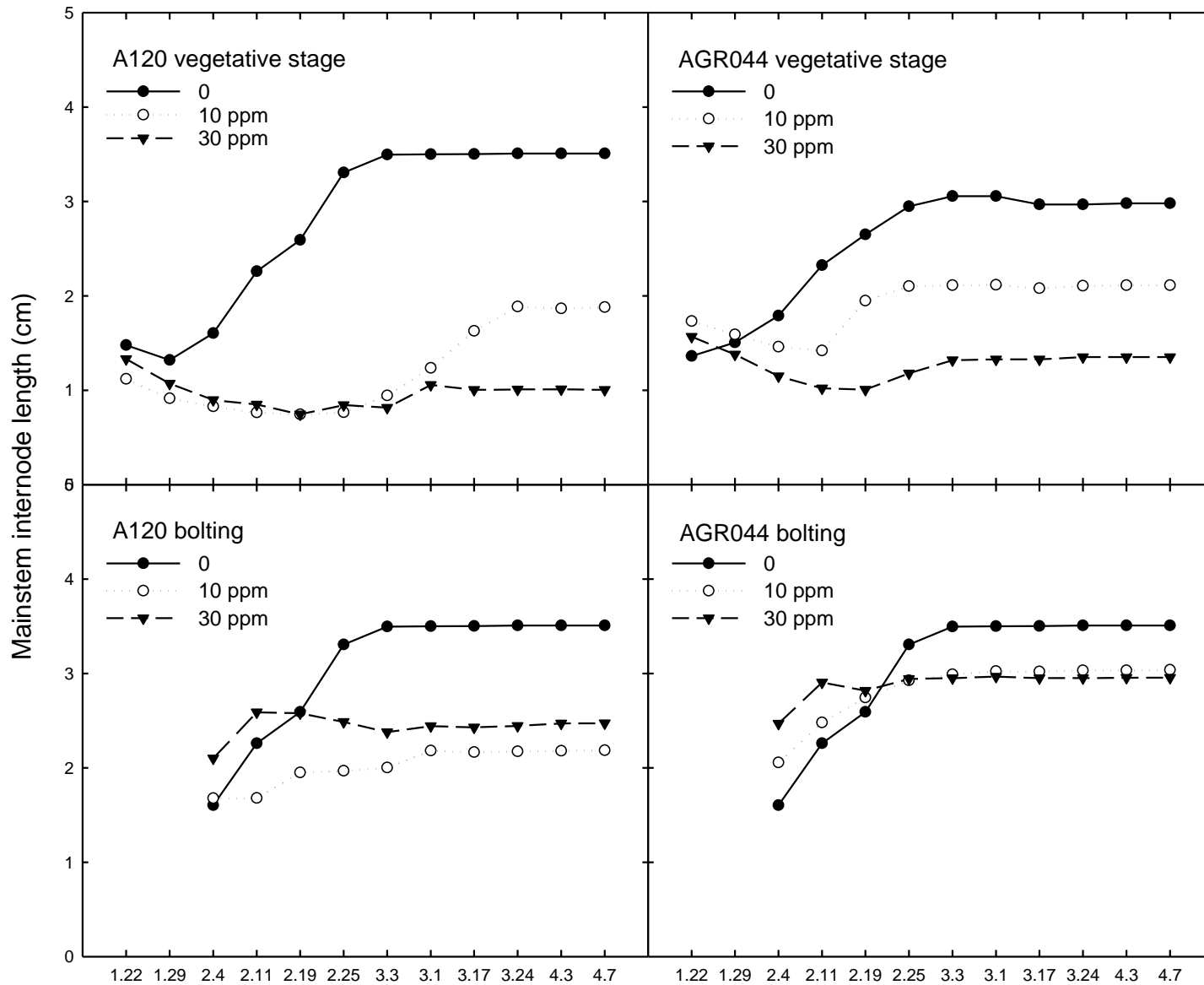




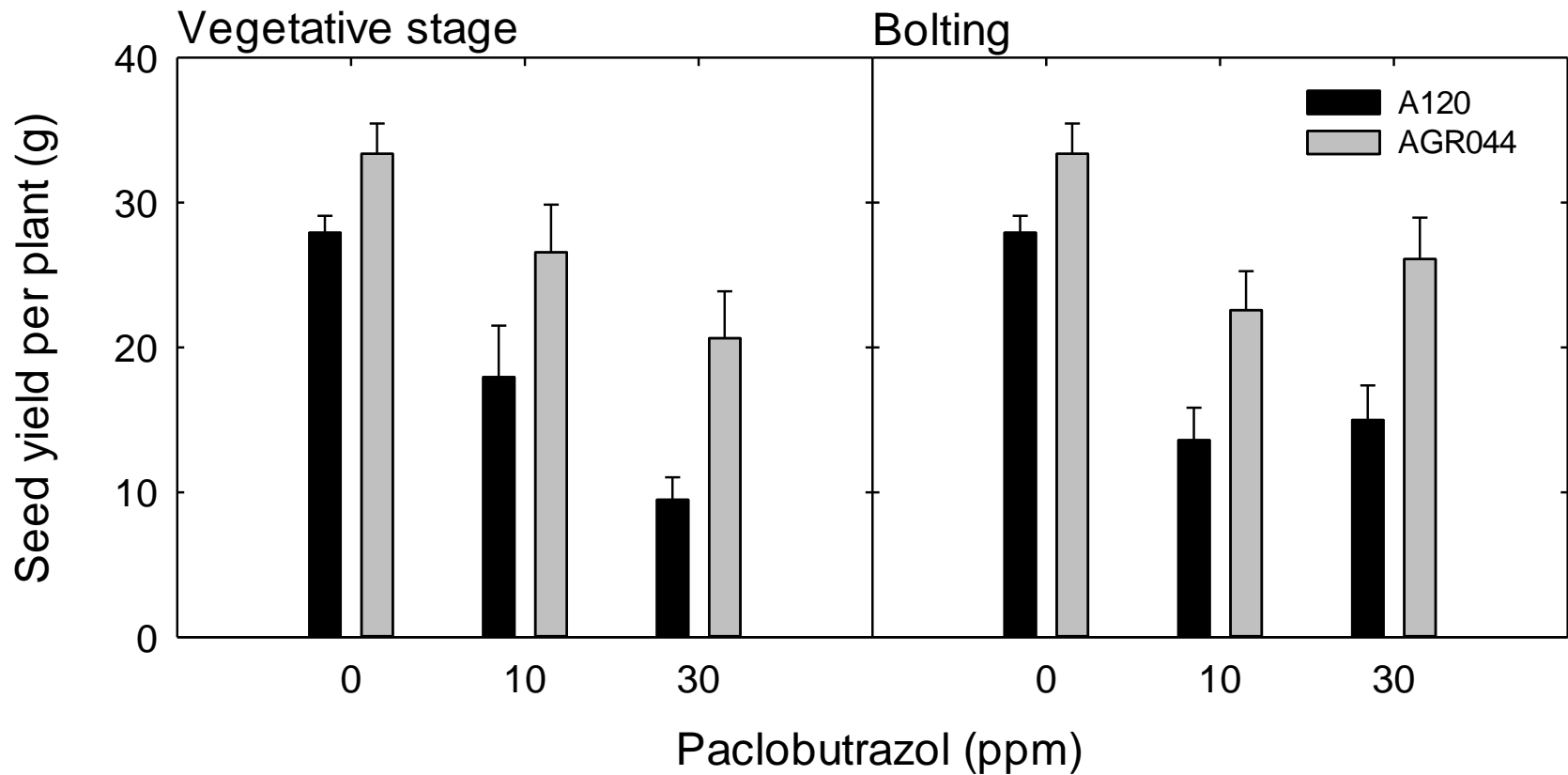
# Plant Growth Regulators



# Plant Growth Regulators



# Plant Growth Regulators





# Plant Growth Regulators

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## 2016/2017 study

- Three growth regulators:
  1. Cycocel (Chlormequat Chloride)
  2. Mep42 (Mepiquat Chloride)
  3. Paczol (Paclobutrazol)
- Application rate
  - 0.5, 1 and 2x label rates
- 5, 10 leaf stage and bolting

# Key Management Strategies for High Yields

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- Rotations (winter crop before soybean, sorghum, sesame, etc., ALS herbicides?)
- Variety selection - yield, maturity
- Fertility (soil test P, K, Ca, Mg, micros, pH)
- Planting date (Nov. 1-15)
- Chisel plough or deep tillage (10-20 bu/ac increase)
- Seed at 5-6 lb/A into a firm, moist seedbed  $\frac{1}{2}$  to  $\frac{3}{4}$ " deep
- Use 14" row spacings (10-40 bu/ac increase over 7 or 21" rows)
- N applied at 20-40 lb/acre at planting followed by 20-40 lb/acre late Jan. early Feb.
- Insect and disease control- scout and apply pesticides as needed
- Direct combining at 8-10% moisture, desiccation can be used to hasten harvest maturity







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 **ARA**

 **Mustard 21**

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