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

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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**

**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**
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**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
- Stage 1 [1.0–1.2] Leaf production
- 25 DAP

Vegetative
- Stage 2 [2.0–2.2] Stem elongation
- 70 DAP

Bolting
- 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

Seed yield (lb/acre)

- **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

Yield Building Factors
- Crop improvement
- Crop rotation
- Plant nutrition
- Tillage
- Plant density
- Planting Date

Seed Yield
- 1000 Seed Weight
- Reproductive branches
- Pod no., seeds per pod

Best Management Practices
Changing weather pattern

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- **October**: Rainfall = 0 cm, Temperature = 0 °C
- **November**: Rainfall = 5 cm, Temperature = 10 °C
- **December**: Rainfall = 10 cm, Temperature = 15 °C
- **January**: Rainfall = 15 cm, Temperature = 20 °C
- **February**: Rainfall = 20 cm, Temperature = 25 °C
- **March**: Rainfall = 25 cm, Temperature = 30 °C
- **April**: Rainfall = 30 cm, Temperature = 30 °C
- **May**: Rainfall = 0 cm, Temperature = 25 °C
- **June**: Rainfall = 5 cm, Temperature = 20 °C

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**Rainfall**
- Long-term avg
- 2013/2014

**Temperature**
- Long-term avg
- 2013/2014

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**Changing weather pattern**

- 2013/2014: 
  - Rainfall: 0-30 cm
  - Temperature: 0-30 °C
- 2014/2015: 
  - Rainfall: 0-30 cm
  - Temperature: 0-30 °C
- 2015/2016: 
  - Rainfall: 0-30 cm
  - Temperature: 0-30 °C

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**Month**
- October
- November
- December
- January
- February
- March
- April
- May
- June
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)

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<th>%</th>
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**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%
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</table>
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

Tillage Method
- Chisel
- Disk
- No Till

Seed yield (lb/acre)
- 0
- 500
- 1000
- 1500
- 2000
- 2500
- 3000
- 3500

2015
2016

Tillage Method

Seed yield (lb/acre)
Soil Compaction differs with Tillage Method

Penetration Resistance Cone Index (MPa)

Depth (cm)

Chisel  Disk  Notill
- 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

<table>
<thead>
<tr>
<th>Planting date</th>
<th>Yield</th>
<th>Oil content</th>
<th>Oil Yield</th>
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<tr>
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<td>lb/acre</td>
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<td>gal/acre</td>
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<td>Oct. 21</td>
<td>1167 b</td>
<td>38 b</td>
<td>66 b</td>
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<td>Nov. 13</td>
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<td>40 a</td>
<td>212 a</td>
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<td>Dec. 13</td>
<td>1550 b</td>
<td>39 ab</td>
<td>90 b</td>
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<tr>
<td>LSD</td>
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<td>1.71</td>
<td>462</td>
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† Within columns, means followed by the same letter are not different ($P > 0.05$)
Shifting the Planting Window with New Genetics

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

Depth

½ - ¾ 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)

Source: Chris Bliss
Row spacing effect on canopy architecture
Row spacing and seeding rate effects on carinata yield

Quincy, FL, 2014
# Row spacing and seeding rate effects on carinata yield

Quincy, FL, 2016

<table>
<thead>
<tr>
<th>Seeding rate (lb/acre)</th>
<th>Row spacing (inches)</th>
<th>Mean</th>
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<td>Mean</td>
<td><strong>3016 a</strong></td>
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Harvest Management

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

Carinata Harvest Management
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

May 13 2015
May 20 2015
May 27 2015
June 3 2015
June 10 2015

50%
35%
25%
14%
10.5%
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
Chemical desiccation effects on yield

Carinata Harvest Management

Seed yield (kg ha\(^{-1}\))

- 2015 treated carinata
- 2015 non-treated carinata
- 2016 treated carinata
- 2016 non-treated carinata

Days after physiological maturity

0 7 14 21 28
Carinata Harvest Management

Chemical desiccation effects on harvest moisture

Days after physiological maturity

- 0
- 7
- 14
- 21
- 28

Moisture at harvest (%)

- 0
- 10
- 20
- 30
- 40
- 50
- 60
- 70
- 80

Treated carinata
Non-treated carinata
7-day total rainfall

Rainfall during treatment period (cm/7 day)

- 0
- 2
- 4
- 6
- 8
- 10
- 12
- 14
- 16

1.3% per day
2.2% per day
Chemical desiccation effects on seed loss

Days after physiological maturity

Seed loss (kg ha$^{-1}$)

2015 treated carinata
2016 treated carinata
2015 non-treated carinata
2016 non-treated carinata
Carinata Harvest Management

Chemical desiccation effects on 1000 seed weight

Days after physiological maturity

TSW (g)

2015 treated carinata
2016 treated carinata
2015 non-treated carinata
2016 non-treated carinata

Days after physiological maturity
Carinata Harvest Management

Chemical desiccation effects on oil content

Days after physiological maturity

Oil content (%)

Days after physiological maturity

Erucic acid (%)

Days after physiological maturity
Chemical desiccation effects on oil yield

Carinata Harvest Management

2015 treated carinata
2016 treated carinata
2015 non-treated carinata
2016 non-treated carinata

Days after physiological maturity
0 7 14 21 28
Oil yield (liters ha\(^{-1}\))
0
200
400
600
800
1000
1200
1400
1600
1800
2000
Use machine settings and screens for rapeseed outlined in the operator’s manual and fine-tuned for conditions in the field.
Harvest Management

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

**AGR044 vegetative stage**

- **0** ppm
- **10 ppm**
- **30 ppm**

**AGR044 bolting**

- **1.22**
- **1.29**
- **2.4**
- **2.11**
- **2.19**
- **2.25**
- **3.3**
- **3.1**
- **3.17**
- **3.24**
- **4.3**
- **4.7**

**A120 vegetative stage**

**Plant height (cm)**

- **0**
- **20**
- **40**
- **60**
- **80**
- **100**
- **120**
- **140**
- **160**

**A120 bolting**

**Date**

- **1.22**
- **1.29**
- **2.4**
- **2.11**
- **2.19**
- **2.25**
- **3.3**
- **3.1**
- **3.17**
- **3.24**
- **4.3**
- **4.7**

**A120 bolting**

**AGR044 bolting**
Plant Growth Regulators

Vegetative stage

Paclobutrazol (ppm)

Seed yield per plant (g)

Bolting

A120

AGR044

Paclobutrazol (ppm)
Plant Growth Regulators

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

- 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 ½ to ¾” deep
- Use 14” row spacings (10-40 bu/ac increase over 7 or 21” rows)
- Insect and disease control- scout and apply pesticides as needed
- Direct combining at 8-10% moisture, desiccation can be used to hasten harvest maturity
### UF Carinata Team

<table>
<thead>
<tr>
<th>Location</th>
<th>People</th>
<th>Research Areas</th>
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<tr>
<td>NFREC, Marianna</td>
<td>N. DiLorenzo</td>
<td>Ruminant nutrition, Animal development</td>
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<tr>
<td>WFREC, Jay</td>
<td>R. Leon, M. Mulvaney</td>
<td>Herbicide chemistries, Crop protection, Agronomy Variety trial</td>
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<td>P. Troy</td>
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<td>PSREU, Citra</td>
<td>N. Dufault, B. Colvin</td>
<td>Pathology, Agronomy Variety trial</td>
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